MASTER

# Safety assessment for capacity design of bolted steel connections in tension

Knipping, J.B.N.

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Graduation research project | Master: Architecture, Building and Planning – Structural Design

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Eindhoven University of Technology

October 2018

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# PREFACE

This research report presents my graduation project "Safety assessment for capacity design of bolted steel connections in tension", which has been carried out as final component of the master Architecture, Building and Planning, track Structural Design at Eindhoven University of Technology.

The graduation project is supervised by Prof. ir. H.H. (Bert) Snijder, dr. ir. Paul Teeuwen, Prof. dr. ir. J. (Johan) Maljaars. I would like to express my deep gratitude to my supervisors for their constructive suggestions and their guidance. Besides my supervisors, I would like to thank ir. R.W.A. (Rianne) Dekker, TU/e doctoral candidate, for her extra supervision.

J.B.N. Knipping,
Eindhoven, October 2018

# SUMMARY


Capacity design is an earthquake proof design strategy. To this end, the structure is designed in such a way that ductile behavior occurs before a structural component fails in a brittle way. When considering a bolted steel connection in tension the gross cross-section must yield before the net cross-section fails in a brittle way, according to the Eurocode's capacity design rule. With this type of failure the structure is earthquake proof and a warning mechanism is created.

Due to the production of gas in the north of the Netherlands more earthquakes occur and therefore new and existing buildings in that area must be earthquake resistant. Unfortunately it is difficult to satisfy  the current capacity design rule of the Eurocode, because with a regular construction method the holes are already too large to satisfy the capacity design. The capacity design rule states that the plastic resistance (gross cross-section) must be determining instead of the ultimate resistance (net cross-section). In this capacity design rule both equations are considered independently, which is probably a conservative approach. The goal of the research is to determine if, the current capacity design rule is satisfying or needs improvement.

With the use of a Monte Carlo simulation a new capacity design rule with its own partial factor will be developed. A Monte Carlo simulation is an algorithm that simulates reality and with the use of the same start principles it can create numerous of data. The Monte Carlo simulation shows when a structural element, with a certain geometry and steel type, fails according to capacity design.  A normal distribution gives a description of reality with the use of the outcome of the Monte Carlo simulation. With these results the tipping point can be determined for a structure to satisfy capacity design. With the use of the reliability class, the probability of failure can be determined and because this research is only on the resistance side the reliability class can be lowered.

Several distributions for the geometry and steel properties are used as input for the Monte Carlo simulation. Furthermore, additional boundary conditions are used in the Monte Carlo simulation. These conditions state that the yield stress may not be lower than the design yield stress and that the ultimate stress should be at least equal or higher than the yield stress. Finally, there is a correlation between the yield stress and ultimate strength that is used in this Monte Carlo simulation.

In the Monte Carlo simulation a model factor is used. This factor describes the difference between the simulated and actual ultimate resistance. By using the model factor the Monte Carlo simulation achieves more realistic results. The model factor is determined by a finite element model. Here, the model factor is divided into two parts; 1. the actual factor that describes the difference between the actual ultimate resistance and the finite element ultimate resistance, 2. The simulated factor which describes the difference between the simulated ultimate resistance and the finite element ultimate resistance.

The current combined safety factor for the current capacity design rule is 1.39. Based on this research it can be concluded that this is very conservative and that a new capacity design rule with a corresponding partial factor can be used. The value of the partial factor in the new capacity design rule has a value of 1.03. The new capacity design rule with the determined partial factor is also visualized using a finite element model which shows the transition of failure mechanism from gross cross-section failure to net cross-section failure.  In this visualization were no particularities, therefore it can be concluded that the current capacity design rule is conservative and can be improved.

# SAMENVATTING

"Capacity design" is een ontwerpstrategie waardoor gebouwen aardbevingsbestendig ontworpen kunnen worden. De constructie wordt dan ontworpen op een manier dat er eerst vervorming plaats vinden voordat er een constructief element bros bezwijkt. Wanneer er specifiek naar een geboute staal verbinding wordt gekeken die belast wordt op trek, moet volgens de Eurocode "capacity design" ontwerpstrategie de stalen plaat bezwijken ter plaatse van de bruto doorsnede en niet op de netto doorsnede, want dan is er sprake van aardbevingsbestendigheid en ontstaat er een waarschuwingsmechanisme.

Door aardgas winning zijn er in het noorden van Nederland meer aardbevingen waardoor bestaande en nieuwe bebouwing aardbevingsbestendig moet zijn. Echter is het moeilijk om aan de huidige ontwerpstrategie van "capacity design" te voldoen. De formule voor de plastische weerstand (bruto doorsnede) moet maatgevend zijn ten op zichtte van de uiterste sterkte (netto doorsnede). Echter worden de formules voor de uiterste sterkte en de plastische weerstand los van elkaar beschouwt waardoor er naar verwachting een te conservatieve benadering is. Het doel van het onderzoek is dan ook om er achter te komen of de huidige regelgeving voor "capacity design" voldoet.

Er wordt een nieuwe "capacity design" ontwerpstrategie ontwikkelt met een bijbehorende partiële factor, dit wordt met behulp van een Monte Carlo simulatie gedaan. Een Monte Carlo simulatie is een algoritme dat de werkelijkheid beschrijft en voor dezelfde basiswaarde een groot scala aan simulaties kan doen. De Monte Carlo simulatie brengt in kaart hoe vaak er een constructie met een bepaalde geometrie en staal soort bezwijkt volgens "capacity design". De uitkomst van deze simulaties geven een verdeling die de werkelijkheid kan beschrijven. Hierdoor kan er gedefinieerd worden waar het kantel punt is wanneer een constructie nog voldoet aan "capacity design". De mate van betrouwbaarheid wordt bepaald door de betrouwbaarheidsklasse en de daarbij behorende kans op falen, omdat er in dit onderzoek alleen onderzoek wordt gedaan naar de ontwerpzijde en niet de belastingzijde mag de betrouwbaarheidsklasse verminderd worden.

De input van de Monte Carlo simulatie zijn de verschillende verdelingen van de geometrie en staal soort. Daarnaast zijn er randvoorwaarden in de Monte Carlo simulatie gezet. Hierin staat dat de vloeispanning niet lager mag zijn dan de ontwerp vloeispanning en de uiterste sterkte gelijk of groter moet zijn aan de vloeispanning. Ook is er een correlatie gevonden tussen de vloeispanning en de uiterste sterkte, deze wordt ook meegenomen in de randvoorwaarden.

Verder is in de Monte Carlo simulatie een modelfactor opgenomen. De modelfactor beschrijft het verschil tussen de theoretische uiterste sterkte en de experimentele uiterste sterkte. Door de modelfactor toe te passen komt de Monte Carlo simulatie dichterbij de realiteit. De modelfactor wordt beschreven door middel van een eindige elementen model en is opgedeeld in twee delen; 1. de experimentfactor die het verschil beschrijft tussen het eindige elementen model en de experimenten, 2. de theoriefactor die het verschil beschrijft tussen het eindige elementen model en de theorie.

Op dit moment zit op de "capacity design" ontwerpstrategie een partiële factor van 1.39. Uit dit onderzoek is gebleken dat dit vrij conservatief is en dat er voor de nieuwe "capacity design" regel een partiële factor gebruikt kan worden van 1.03. Dit betekent dat er een reductie is van ongeveer 34%. De nieuwe toetsingsregel is ook gevisualiseerd en gecontroleerd door middel van een eindige elementen model, waarin het faal mechanisme van de bruto doorsnede naar het faal mechanisme van de netto doorsnede in kaart wordt gebracht. Hier zijn geen merkwaardigheden in naar voren gekomen waardoor geconcludeerd kan worden dat de huidige regelgeving voor "capacity design" conservatief is.

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# SYMBOLS

| | | |
|---|---|---|
| $A$ | Area of a cross-section | $[\mathrm{mm}^2]$ |
| $A_{net}$ | Net-area of a cross-section | $[\mathrm{mm}^2]$ |
| $A_{net,nom}$ | Design value of the net-area of a cross-section | $[\mathrm{mm}^2]$ |
| $A_{net,sim}$ | Simulated (actual) net-area of a cross-section | $[\mathrm{mm}^2]$ |
| $A_{net,tran}$ | Net-area of a cross-section, transverse | $[\mathrm{mm}^2]$ |
| $A_{net,zig}$ | Net-area of a cross-section, zigzag | $[\mathrm{mm}^2]$ |
| $A_{sim}$ | Simulated (actual) area of a cross-section | $[\mathrm{mm}^2]$ |
| $b$ | Height off the plate | $[\mathrm{mm}]$ |
| $b_0$ | Estimated value and equal to $\widehat{\beta_0}$ | [-] |
| $b_1$ | Estimated value and equal to $\widehat{\beta_1}$ | [-] |
| $D$ | Overstrength factor | [-] |
| $d_0$ | Diameter of the hole | $[\mathrm{mm}]$ |
| $E$ | Modulus of elasticity | $[\mathrm{N/mm}^2]$ |
| $f_u$ | Ultimate strength | $[\mathrm{N/mm}^2]$ |
| $f_{um}$ | Mean value of the actual ultimate strength | $[\mathrm{N/mm}^2]$ |
| $f_{u,nom}$ | Design value of the ultimate strength | $[\mathrm{N/mm}^2]$ |
| $f_{u,sim}$ | Simulated (actual) ultimate strength | $[\mathrm{N/mm}^2]$ |
| $f_y$ | Yield stress | $[\mathrm{N/mm}^2]$ |
| $f_{ym}$ | Mean value of the actual yield stress | $[\mathrm{N/mm}^2]$ |
| $f_{y,nom}$ | Design value of the yield stress | $[\mathrm{N/mm}^2]$ |
| $f_{y,sim}$ | Simulated (actual) yield stress | $[\mathrm{N/mm}^2]$ |
| $k$ | Model factor | [-] |
| $\Delta L$ | Elongation of the initial gauge length | $[\mathrm{mm}]$ |
| $L_0$ | The initial gauge length | $[\mathrm{mm}]$ |
| $n$ | The number of holes extending in any diagonal or zigzag line progressively across the member or part of the member | [-] |
| $n$ | Number of experiments | [-] |
| $N_{Ed}$ | Tension force | $[\mathrm{N}]$ |
| $N_{pl,actual}$ | Actual plastic resistance of the gross cross-section | $[\mathrm{N}]$ |
| $N_{pl,Rd}$ | Design plastic resistance of the gross-section | $[\mathrm{N}]$ |
| $N_{pl,sim}$ | Simulated plastic resistance of the gross-section | $[\mathrm{N}]$ |
| $N_{t,Rd}$ | Design tension resistance | $[\mathrm{N}]$ |
| $N_{u,actual}$ | Actual ultimate resistance of the net cross-section | $[\mathrm{N}]$ |
| $N_{u,exp}$ | Experimental ultimate net cross-section resistance | $[\mathrm{N}]$ |
| $N_{u,fem}$ | Finite element model ultimate net cross-section resistance | $[\mathrm{N}]$ |
| $N_{u,nom}$ | Design value of the ultimate resistance of the net cross-section | $[\mathrm{N}]$ |
| $N_{u,Rd}$ | Normative value of the design ultimate resistance of the net cross-section | $[\mathrm{N}]$ |
| $N_{u,sim}$ | Simulated ultimate net cross-section resistance | $[\mathrm{N}]$ |
| $p_1$ | Pitch between holes in the direction of the load | $[\mathrm{mm}]$ |
| $p_2$ | Pitch between holes perpendicular in the direction of the load | $[\mathrm{mm}]$ |
| $P_f$ | Probability of failure | [-] |
| $r$ | Correlation coefficient | [-] |
| $R$ | Coefficient of determination | [-] |
| $S_0$ | Cross-sectional area | $[\mathrm{mm}^2]$ |
| $t$ | Thickness off the plate | $[\mathrm{mm}]$ |
| $x$ | Independent variable | [-] |
| $\bar{x}$ | Mean of the independent variable x | [-] |

| | | |
|---|---|---|
| $x_i$ | Independent variable x at the $\mathrm{i^{th}}$ trial | [-] |
| $y$ | Dependent variable | [-] |
| $\bar{y}$ | Mean of the dependent variable y | [-] |
| $y_i$ | Dependent variable y at the $\mathrm{i^{th}}$ trial | [-] |
| $\hat{y}$ | Predicted value of y | [-] |
| $\boldsymbol{\hat{y}}$ | Predicted vector of y | [-] |
| $\hat{y}_i$ | Predicted value at the $\mathrm{i^{th}}$ trial | [-] |
| | | |
| $\alpha$ | Sensitivity factor | [-] |
| $\beta$ | Reliability index | [-] |
| $\gamma_{M0}$ | Partial factor for resistance of cross-section for every class ($\gamma_{\mathrm{M0}} = 1.0$) | [-] |
| $\gamma_{M2}$ | Partial factor for resistance of cross-section in tension to fracture ($\gamma_{\mathrm{M2}} = 1.25$) | [-] |
| $\gamma_{m^*}$ | Partial factor for capacity design at the resistance side | [-] |
| $\delta$ | Standard deviation | [-] |
| $\delta_x$ | Standard deviation of the independent variable x | [-] |
| $\delta_y$ | Standard deviation of the dependent variable y | [-] |
| $\varepsilon$ | Engineering strain | [-] |
| $\varepsilon_{true}$ | True strain | [-] |
| $\varepsilon_u$ | Ultimate strain | [-] |
| $v$ | Poisson's ratio | [-] |
| $\sigma$ | Engineering stress | $[\mathrm{N/mm^2}]$ |
| $\sigma_{true}$ | True stress | $[\mathrm{N/mm^2}]$ |
| $\Phi$ | Cumulative distribution function of the standardized normal distribution | [-] |
| | | |
| $c.o.v.$ | Coefficient of variance | [%] |

# 1. INTRODUCTION

Clear codes provide that buildings will be strong and safe and it also creates clarity and transparency for both architects, builders and users. By building, studying existing codes and discussing them the codes will improve over time.

Due to the gas production from the Groningen gas field more and more earthquakes occur, affecting the buildings in that area and the daily lives of the people living there. It is very important (new) buildings will be designed and built earthquake proof for the safety and wellbeing of the people.

Capacity design is a design strategy that ensures earthquake proof buildings by providing a controlled ductile behavior of a building to prevent its immediate collapse during an earthquake. The structure is designed in such way to allow ductile failure at predetermined locations and to prevent multiple failures at other locations. To protect the remainder of the structure, ductile elements must fail before other parts of the structure. For a bolted steel connection that must satisfy capacity design, failure at the gross cross-section (Figure 1.1) must occur before failure at the net cross-section (Figure 1.2).

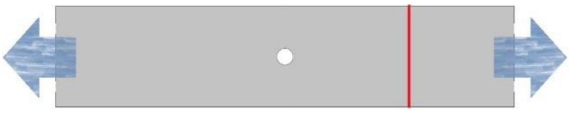


*Figure 1.1: Failure at the gross cross-section*

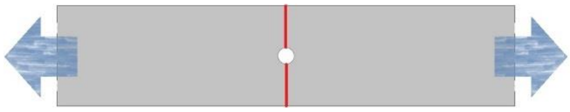


*Figure 1.2: Failure at the net cross-section*

It is difficult to meet up to the regulations of Eurocode 3 for capacity design since the demands are very high and therefore expensive. Given the increasing demand for earthquake proof buildings, not only in the Netherlands but worldwide, the question is raised whether the design rule needs to be that strict or adjustments are possible.

The goal of this graduation research project is to contribute to the manufacturability of earthquake proof bolted steel connections in tension. Based on this, the research question is:

***IS THE CURRENT RULE FOR CAPACITY DESIGN OF BOLTED STEEL CONNECTIONS IN TENSION SATISFYING?***

If the current capacity design rule of Eurocode 3 is conservative, a new capacity design rule can become less strict. This means that more or bigger holes are possible and the manufacturability of earthquake proof bolted steel connections in tension increases.

## 1.1. SCOPE

The scope of the research “Safety assessment for capacity design of bolted steel connections in tension” is limited to steel grades S235, S355 and S460. Furthermore, only steel plates are considered in this research. This research focusses on a steel plate with a hole. In other words the bolts presence will be neglected. Thicknesses of steel plates up to 63 mm will be investigated.

# 2. LITERATURE SURVEY

## 2.1. EUROCODE 3

Eurocode 3 (EN 1993-1-1, 2011) states that the design value of the tension force ($N_{Ed}$) should always be smaller than the design tension resistance ($\mathrm{N_{t,Rd}}$). Here, the design tension resistance is the normative value of the design ultimate resistance of the net cross-section at holes for fasteners ($\mathrm{N_{u,Rd}}$) and the design plastic resistance for the gross-section ($\mathrm{N_{pl,Rd}}$). The equations for the calculations of the ultimate resistance and the plastic resistance according to Eurocode 3 are:

$$N_{u,Rd} = \frac{0.9 A_{net} f_u}{\gamma_{M2}} \tag{2.1}$$

$$N_{pl,Rd} = \frac{A f_y}{\gamma_{M0}} \tag{2.2}$$

With:

| | |
|---|---|
| $A$ | Area of a cross-section [$mm^2$] |
| $A_{net}$ | Net-area of a cross-section [$mm^2$] |
| $f_u$ | Ultimate strength [$N/mm^2$] |
| $f_y$ | Yield stress [$N/mm^2$] |
| $\gamma_{M0}$ | Partial factor for resistance of cross-section for every class ($\gamma_{M0} = 1.0$) [-] |
| $\gamma_{M2}$ | Partial factor for resistance of cross-section in tension to fracture ($\gamma_{M2} = 1.25$) [-] |

When the bolts in the connection are staggered the net-area of a cross-section can fail in two ways:

1. Transverse over one bolt hole
2. Zigzag over multiple bolt holes

The different failure mechanisms are shown in Figure 2.1. To determine the net-area of a cross-section the following equations can be used :

$$A = b \cdot t \tag{2.3}$$

$$A_{net,tran} = A - (t \cdot nd_0) = t(b - nd_0) \tag{2.4}$$

$$A_{net,zig} = A - t\left(nd_0 - \sum \frac{{p_1}^2}{4 \cdot p_2}\right) = t\left(b - nd_0 + \sum \frac{{p_1}^2}{4 \cdot p_2}\right) \tag{2.5}$$

With:

| | |
|---|---|
| $A$ | Area of a cross-section [$mm^2$] |
| $A_{net,tran}$ | Net-area of a cross-section, transverse [$mm^2$] |
| $A_{net,zig}$ | Net-area of a cross-section, zigzag [$mm^2$] |
| $t$ | Thickness off the plate [$mm$] |
| $b$ | Height off the plate [$mm$] |
| $n$ | The number of holes extending in any diagonal or zigzag line progressively across the member or part of the member [-] |
| $d_0$ | Diameter of the hole [$mm$] |
| $p_1$ | Pitch between holes in the direction of the load, see Figure 2.2 [$mm$] |
| $p_2$ | Pitch between holes perpendicular in the direction of the load, see Figure 2.2 [$mm$] |

The mentioned equations are valid for all the bolted connection except for the pre-loaded bolted connections in category C, when the requirements on end and edge distances and pitch distances of Eurocode 3 are met (Rombouts et al., 2014).

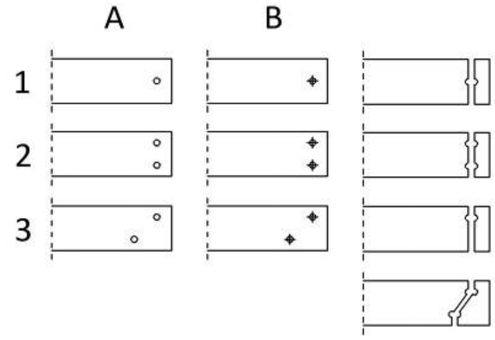



*Figure 2.1: Configurations and their failure modes (Rombouts et al., 2014)*

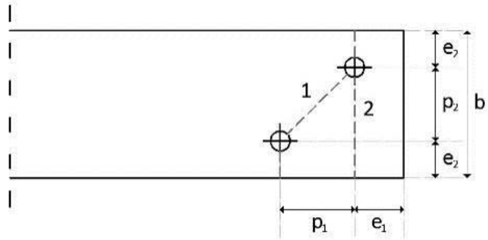



*Figure 2.2: Staggered bolted connection and the corresponding distances of the geometrical properties (Rombouts et al., 2014)*

Applying capacity design using equation 2.1 and equation 2.2, Eurocode 3 gives the following condition (EN 1993-1-1, 2011):

$$N_{u,Rd} > N_{pl,Rd} \tag{2.6}$$

This can be rewritten to:

$$\frac{N_{pl,Rd}}{N_{u,Rd}} < 1 \leftrightarrow \frac{Af_y\gamma_{M2}}{0{,}9A_{net}f_u\gamma_{M0}} < 1 \tag{2.7}$$

$$1.39\frac{Af_y}{A_{net}f_u} < 1 \tag{2.8}$$

Based on equation 2.8 it can be stated that, for a certain geometry and steel grade, a specific maximum allowable percentage from the steel height (b) can be used as hole diameter ($d_0$). The turning point is when equation 2.8 has a unity check of 1.0. That turning point gives a specific net cross-section in which the hole diameter is a percentage of the steel plate height. Figure 2.3 shows the indication of the hole diameter and the steel plate height.

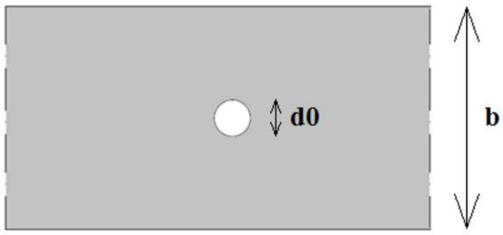



*Figure 2.3: Indication hole diameter ($d_0$ ) and plate height (b)*

For the ultimate strength and yield stress values from EN 10025-2 table 5 and table 7 (Appendix 1 and 2) are used. This is done since the thickness of the plate (t) is eliminated as shown in equation 2.9. Expecting that the steel plate thickness has an influence on capacity design, the ultimate strength and yield stress are chosen from EN 10025-2, by which the thickness of the steel plates are taken into account.

$$1.39\frac{f_y}{f_u}\frac{A}{A_{net}} = 1.39\frac{f_y}{f_u}\frac{t\cdot b}{t(b-nd_0)} = 1.39\frac{f_y}{f_u}\frac{b}{(b-nd_0)} \tag{2.9}$$

Visualizing the geometry of steel plates according equation 2.8 with a unity check of 1.0 for steel grades S235, S355 and S460 with steel thicknesses $t \leq 16mm$, $16mm < t \leq 40mm$ and $40mm < t \leq 63mm$ can help understanding what the limit is for the net cross-section. Table 2.1 shows a summary of the allowable percentage for the hole diameter per steel grade and per steel thickness. From this table can be conducted that there are higher percentages of hole diameters allowed in steel grade S235 and the allowable hole diameter percentage decreases when the steel grade increases.

Additionally from Table 2.1 can be conducted that the hole diameter ratio increases when the steel plate thickness increases.

*Table 2.1: Summary allowable hole diameter percentage according to Eurocode 3*

| | S235 | S355 | S460 |
|---|---|---|---|
| $t \leq 16\ mm$ | $d_0/b = 9.3\%$ | $d_0/b = 0.0\%$ | $d_0/b = 0.0\%$ |
| $16\ mm < t \leq 40\ mm$ | $d_0/b = 13.2\%$ | $d_0/b = 0.0\%$ | $d_0/b = 0.0\%$ |
| $40\ mm < t \leq 63\ mm$ | $d_0/b = 16.9\%$ | $d_0/b = 0.9\%$ | $d_0/b = 0.0\%$ |

In the new final draft of Eurocode 3 it is  stated that steel grades higher than S460 should not be used when capacity design is required (EN 1993-1-1 Final Draft, 2018).

## 2.2. NET CROSS-SECTION

### 2.2.1. Presence of bolts

Currently, in the Eurocode 3, in relation to the ultimate strength of the net cross-section, no distinction is made between connections in tension with or without bolts present in the holes. In the study published by Rombouts et al., 2014 the difference in ultimate resistance of the net cross-section of plates with holes with and without bolts present was investigated. They showed that the specimens with and without bolts have a similar ultimate resistance. This was done for cases where net cross-section failure was decisive. For these cases, the Eurocode design rule is correct not distinguishing between specimens with and without bolts, in regards to the ultimate resistance of the net cross-section (Rombouts et al., 2014).

### 2.2.2. 0.9 factor

Various studies about the reduction factor 0.9 stated in Eurocode 3's equation  of the net-cross section (see equation 2.1) to determine $N_{u,Rd}$ (Salih et al., 2010) (Može et al., 2014) (Snijder et al., 2017)have been conducted. The results of Može and Beg (Može et al., 2014) suggest that the factor 0.9 can be omitted but additional research is necessary. Similar results were obtained by Salih et al. and Snijder et al. (Salih et al., 2010), (Snijder et al., 2017). The latter study also stated that the design rule of Eurocode 3 is still sufficient when the partial factor for resistance of the cross-section in tension to failure becomes $\gamma_{M2} = 1.23$ instead of $\gamma_{M2} = 1.25$.

Furthermore the new final draft of Eurocode 3 states that the 0.9 factor can be equal to 1.0 when the steel plate has smooth holes. The holes are smooth when they are manufactured by drilling or water jet cutting. When the holes are manufactured by punching or flame cutting and when the structure is vulnerable for fatigue the 0.9 factor must be retained (EN 1993-1-1 Final Draft, 2018).

## 2.3. CONCLUSIONS ON LITERATURE

Taken together, the capacity design equation (2.6) can only be used for steel grades up to and including S460. With this capacity design equation it must be taken into account that the thickness of the steel plate is eliminated. Therefore EN 10025-2 is used for determining the yield stress and the ultimate strength. Furthermore the presence of bolts may be neglected in equation (2.6) which also will be maintained during this research. Additionally the 0.9 factor in equation 2.1 is equal to 1.0 when the holes are smooth, therefore only smooth holes are considered in this research.

Previous paragraphs shows as well that the steel grade and the thickness of the steel plate have an influence on the unity check of the capacity design rule. Subsequently, in this research, subgroups for the steel grades and steel plate thicknesses will be investigated independently.

Of importance is that in the capacity design rule, the yield stress and the ultimate strength are used independently. However there can be a relation between the yield stress and the ultimate strength since they are related to the same steel plate. Therefore it is interesting to do more research to the relationship betweenf the yield stress and ultimate strength.

The research question in this research *is: "Is the current regulation for capacity design of the cross section of a bolted steel connection in tension satisfying?"* Therefore, if not, the main objective in this research is to come with a new capacity design rule in which a single partial factor is introduced (equation 2.10). This new capacity design rule will be compared and evaluated with the existing capacity design rule of Eurocode 3. In this research the partial factor for capacity design at the resistance side ($\gamma_{m^*}$) will be determined. In the remaining part of this master thesis the partial factor for capacity design at the resistance side will be named partial factor.

$$\gamma_{m^*} \frac{A f_y}{A_{net} f_u} = \gamma_{m^*} \frac{f_y}{f_u} \frac{b}{(b - n d_0)} < 1 \qquad (2.10)$$

With:

| | |
|---|---|
| $A$ | Area of a cross-section [$mm^2$] |
| $A_{net}$ | Net-area of a cross-section [$mm^2$] |
| $f_u$ | Ultimate strength [$N/mm^2$] |
| $f_y$ | Yield stress [$N/mm^2$] |
| $\gamma_{m^*}$ | Partial factor for capacity design at the resistance side, in short 'partial factor' [-] |
| $t$ | Thickness off the plate [$mm$] |
| $b$ | Height off the plate [$mm$] |
| $n$ | The number of holes extending in any diagonal or zigzag line progressively across the member or part of the member [-] |
| $d_0$ | Diameter of the hole [$mm$] |

# 3. MONTE CARLO SIMULATION

The name Monte Carlo is derived from Monte Carlo, a city in Monaco famous for its casinos. One of the simplest mechanical devices to generate random numbers is the roulette wheel, which can be found in a casino (Sobol, 1994). A Monte Carlo simulation can be seen as a mathematical experiment in which random numbers are put in equations to execute a mathematical experiment. Monte Carlo simulations are executed by computer and generate mostly hundreds to billions numbers based on data (Madras, 2002).

The principal of Monte Carlo simulations is that the statistics in random specimens can be assessed by the empirical process of actually drawing lots of random specimens and observing the outcome. To this end, an artificial world is created, which resembles the actual world in all relevant aspects. The population consists of mathematical procedures for generating sets of numbers that resemble specimens of data drawn from the true population (Mooney, 1997).

Because it usually is impractical for scientists to measure actual data multiple times, artificially generated data is used to resemble actual experiments in relevant ways (Mooney, 1997).

The basic Monte Carlo procedure is as follows:

1. Specify the pseudo-population in symbolic terms in such a way that it can be used to generate specimens. This usually means developing a computer algorithm to generate data in a specified manner.
2. Draw specimens from the pseudo-population in ways reflective of the statistical situation of interest.
3. Calculate the estimator $\hat{y}$ in the pseudo-specimen and store it in a vector,$\hat{\boldsymbol{y}}$.
4. Repeat Steps 2 and 3 n times, where n is the number of trials.

The idea is to estimate a characteristic, $y$, with an estimator, $\hat{y}$, computed from observed data. A proper generation of random variables is critical to the success of a Monte Carlo simulation (Mooney, 1997).

## 3.1. MOTIVATION AND OBJECTIVE

The goal of the Monte Carlo simulation is in this case to determine the partial factor for the new capacity design rule (equation 2.10). To determine this partial factor, it is important to investigate the extreme values. In other words how many times does the capacity design rule not meet the requirements when design values are used for determining the unity check for the capacity design rule.

To investigate this, a lot of specimens are needed to study how many times the capacity design rule is not meet. The research focusses at the extreme cases, these extreme cases can only be properly mapped when enough data is generated. As mentioned later in this chapter at least 1,000,000 simulations are needed per test set-up to come to a proper conclusion. 1,000,000 experiments per test set-up are not doable with actual experiments and therefore a Monte Carlo simulation is carried out. A Monte Carlo simulation is a good method because it can generate large amounts of data that are similar to reality. The data that comes from the Monte Carlo simulation can be used to map the extreme cases without the use of actual experiments. Besides, already a lot of research has been done on the actual values and properties of steel, that can be used as input for the Monte Carlo Simulation.

## 3.2. Intention

In this paragraph it is explained what it means when a bolted steel connection in tension fails favorable and non-favorable according to capacity design. Additionally the necessary reliability of the capacity design rule is explained in terms of how many times it may not satisfy in a specified number of situations.

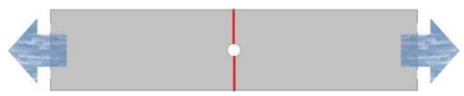
### 3.2.1. Failure mechanism

Failure of the cross-section of a steel plate can occur in four different mechanisms, also visualized in Table 3.1:

1. The gross cross-section failure is decisive for the geometry ($N_{pl,actual} < N_{u,actual}$). The design resistance of the gross cross-section ($N_{pl,nom}$) is smaller than the actual resistance of the gross cross-section ($N_{pl,actual}$).
2. The gross cross-section failure is decisive for the geometry ($N_{pl,actual} < N_{u,actual}$). The design resistance of the gross cross-section ($N_{pl,nom}$) is larger than the actual resistance of the gross cross-section ($N_{pl,actual}$).
3. The net cross-section failure is decisive for the geometry ($N_{pl,actual} > N_{u,actual}$). The design resistance of the net cross-section ($N_{u,nom}$) is smaller than the actual resistance of the net cross-section ($N_{u,actual}$).
4. The net cross-section failure is decisive for the geometry ($N_{pl,actual} > N_{u,actual}$). The design resistance of the net cross-section ($N_{u,nom}$) is larger than the actual resistance of the net cross-section ($N_{u,actual}$).

According to capacity design, the cross-section is allowed to fail in its gross cross-section. Therefore failure mechanism 1 and failure mechanism 2 can be defined as a favorable failure according to capacity design. Moreover, there will be no problem when the actual resistance of the cross-section is higher than the design resistance of the cross-section. So failure mechanism 3 is also allowed based on the capacity design. Lastly, mechanism 4 is the only mechanism described here not in agreement with the capacity design rule because it fails at the net cross-section and the actual resistance is lower than the design resistance.

*Table 3.1: Failure mechanisms of the cross-section summarized*

| Normative cross-section | | Normative failure | Failure according to capacity design |
|---|---|---|---|
|  | $N_{pl,actual} < N_{u,actual}$ | $N_{pl,actual} > N_{pl,nom}$ | ✓ |
| | | $N_{pl,actual} < N_{pl,nom}$ | ✓ |
|  | $N_{pl,actual} > N_{u,actual}$ | $N_{u,actual} > N_{u,nom}$ | ✓ |
| | | $N_{u,actual} < N_{u,nom}$ | ✗ |

An algorithm must be created for the Monte Carlo simulation that defines how many times, for a certain geometry and steel grade, the failure mechanism is not in line with capacity design. The failure mechanism not satisfying capacity design can be described as follows:

$$N_{pl,actual} > N_{u,actual} \wedge N_{u,actual} < N_{u,actual} \quad (3.1)$$

With:

| | |
|---|---|
| $N_{pl,actual}$ | Actual plastic resistance of the gross cross-section $[N]$ |
| $N_{u,actual}$ | Actual ultimate resistance of the net cross-section $[N]$ |
| $N_{u,nom}$ | Design value of the ultimate resistance of the net cross-section $[N]$ |

Equation 3.1 describes failure mechanism 4, where the net cross-section is decisive and the actual resistance of the net cross-section is lower than the design resistance of the net cross-section. To ensure safety and no brittle failure, the overstrength factor (D) is introduced. The ultimate design resistance of the net cross-section must be multiplied by the overstrength factor. The overstrength factor can have a value of 1.0 or 1.5 and is taken from the safety factor used for brittle failure of steel rods loaded in tension (EN 1993-1-11, 2006). The overstrength factor is implemented in equation 3.1 resulting in the following equation:

$$N_{pl,actual} > N_{u,actual} \wedge N_{u,actual} < D \cdot N_{u,nom} \tag{3.2}$$

With:

| | |
|---|---|
| $D$ | Overstrength factor [-] |

However, actual values will not be used for the plastic resistance and the ultimate resistance of the cross-section since then experimental research should be performed to obtain these values. As mentioned, a statistical survey will be carried out by using a Monte Carlo simulation. Here the actual values of the plastic resistance and ultimate resistance of the cross-section will be replaced by simulated values. By using a simulated value for the ultimate resistance a model factor (k) is introduced. This model factor describes the difference between the actual and simulated actual ultimate resistance of the cross-section. Introducing the model factor is done because simulations make use of the theoretical equations. The model factor must cover the difference between the actual ultimate resistance and the simulated (actual) ultimate resistance of the cross-section, this is shown in equation 3.3.

$$N_{pl,sim} > k \cdot N_{u,sim} \wedge k \cdot N_{u,sim} < D \cdot N_{u,nom} \tag{3.3}$$

With:

| | |
|---|---|
| $k$ | Model factor [-] |

Equation 3.4 shows the elaborated condition when a specimen does not satisfy capacity design as used in the Monte Carlo simulation. Equation 3.3 can be rewritten in equation 3.4. 1,000,000 simulations are carried out. The Monte Carlo simulation counts how many times the situation that is described in in equation 3.4 occurs per 1,000,000 simulations. The outcome of the simulations will give clarity about the probability of a geometry of a certain steel grade that will not satisfy the capacity design rule. The simulated values will be created by the Monte Carlo simulation.

$$A_{sim} \cdot f_{y,sim} > k \cdot A_{net,sim} \cdot f_{u,sim} \wedge k \cdot A_{net,sim} \cdot f_{u,sim} < D \cdot A_{net,nom} \cdot f_{u,nom} \tag{3.4}$$

With:

| | |
|---|---|
| $A_{sim}$ | Simulated (actual) area of a cross-section $[mm^2]$ |
| $f_{y,sim}$ | Simulated (actual) yield stress $[N/mm^2]$ |
| $A_{net,sim}$ | Simulated (actual) net-area of a cross-section $[mm^2]$ |
| $f_{u,sim}$ | Simulated (actual) ultimate strength $[N/mm^2]$ |
| $A_{net,nom}$ | Design value of the net-area of a cross-section $[mm^2]$ |
| $f_{u,nom}$ | Design value of the ultimate strength $[N/mm^2]$ |

### 3.2.2. Reliability index

The reliability index provides an indication of the probability of failure of a structure. As mentioned in paragraph 3.2.1 only failure mechanism 4 does not satisfy capacity design. Therefore the reliability index has to be determined for the failure of the cross-section, described by/according to failure mechanism 4, to retain a reliable structure in line with capacity design.

In Eurocode 0 annex B and annex C (NEN – EN 1990, 2011a)(NEN – EN 1990, 2011b) the level of reliability is selected as a function of a classification according to the consequence classes (CC), which are directly linked to reliability classes (RC). The RC are in turn associated with minimum values for the reliability index ($\beta$). In Table 3.2 the recommendations for the reliability index for the three reliability classes are shown.

*Table 3.2: Recommended minimum values of β highlighted in red (Taras et al., 2014)*

| Reliability Class | *(yearly)* $P_F$ | Minimum value of β for strength and stability (except fatigue) | |
|---|---|---|---|
| | | Reference period 1 year | Reference period 50 years |
| RC 3 | ≈$10^{-7}$ | 5,2 | 4,3 |
| RC 2 | ≈$10^{-6}$ | 4,7 | 3,8 |
| RC 1 | ≈$10^{-5}$ | 4,2 | 3,3 |

Most structures fall within RC 2 (highlighted in red in Table 3.2). Furthermore, this study focuses on the resistance side of a structural component.

The probability of failure of a structural component can be calculated by using the reliability index (equation 3.5 (NEN – EN 1990, 2011b):

$$P_f = \Phi(-\beta) \tag{3.5}$$

With:

| | |
|---|---|
| $P_f$ | Probability of failure [-] |
| $\Phi$ | Cumulative distribution function of the standardized normal distribution [-] |
| $\beta$ | Reliability index [-] |

The reliability index in Table 3.2 is described for a structural component that was tested for the resistance and effect of actions. Due to the fact that this research is on the resistance side of a structural element the reliability index can be multiplied with the sensitivity factor which gives the following equation (NEN – EN 1990, 2011b):

$$P_f = \Phi(-\beta \cdot \alpha) \tag{3.6}$$

With:

| | |
|---|---|
| $\alpha$ | Sensitivity factor [-] |

The relationship between the probability of failure and the reliability index is shown in Table 3.3

*Table 3.3: Relation between probability of failure ($P_f$) and the reliability index (β) (Taras et al., 2014)*

| $P_f$ | $10^{-1}$ | $10^{-2}$ | $10^{-3}$ | $10^{-4}$ | $10^{-5}$ | $10^{-6}$ | $10^{-7}$ |
|---|---|---|---|---|---|---|---|
| β | 1,28 | 2,32 | 3,09 | 3,72 | 4,27 | 4,75 | 5,20 |

As mentioned in paragraph 3.2.1 there is an overstrength factor in equation 3.4 with a value of 1.0 or 1.5. When an overstrength value of 1.5 is used in equation 3.4, the reliability index of RC 2 will be used ($\beta = 3.8$). When an overstrength value of 1.0 is used, a higher reliability index ($\beta = 4.3$) is maintained.

The reliability indices can be multiplied by the sensitivity factor, as mentioned before. To calculate the reliability indices on the resistance side, the indices have to be multiplied by the sensitivity factor. This leads to the following:

- For D=1.0 → $\beta \cdot \alpha = 4.3 \cdot 0.8 = 3.44$
- For D=1.5 → $\beta \cdot \alpha = 3.8 \cdot 0.8 = 3.04$

From the reliability index on the resistance side, the probability of failure can be obtained according to equation 3.6 and Table 3.3.

- For $\beta \cdot \alpha = 3.44$ → $P_f = 0.00029085$
- For $\beta \cdot \alpha = 3.04$ → $P_f = 0.00118289$

### 3.2.3. Number of simulations

As described in paragraph 3.2.1 and 3.2.2, there are two methods to test the capacity design rule when using a Monte Carlo simulation. Both with their own overstrength factor, reliability index on the resistance side and corresponding probability of failure. These two options are summarized in Table 3.4.

*Table 3.4: Options for testing the capacity design rule summarized*

| Option | failure according to capacity design with the overstrength factor | Corresponding reliability and probability of failure |
|---|---|---|
| **1** | $A_{sim} \cdot f_{y,sim} > k \cdot A_{net,sim} \cdot f_{u,sim} \wedge k \cdot A_{net,sim} \cdot f_{u,sim} < D(= 1.0) \cdot A_{net,nom} \cdot f_{u,nom}$ | $\beta \cdot \alpha = 3.44$ <br> $P_f = 0.00029085$ |
| **2** | $A_{sim} \cdot f_{y,sim} > k \cdot A_{net,sim} \cdot f_{u,sim} \wedge k \cdot A_{net,sim} \cdot f_{u,sim} < D(= 1.5) \cdot A_{net,nom} \cdot f_{u,nom}$ | $\beta \cdot \alpha = 3.04$ <br> $P_f = 0.00118289$ |

When running a Monte Carlo simulation at least 100 failures are needed to conclude in a proper way something about the outcome. When the population of failure is small, it is hard to say if the failures are sporadic or significant, an advice is to have at least 100 failures. With a probability of failure of $P_f = 0.00029085$ at least 1,000,000 simulation must be executed because with that probability of failure 290 failures may occur and that is more than the 100 failures that are needed at least. This means that for option 1 the turning point from when the specimens satisfy the capacity design is 290 failures and for option 2 that is 1182 failures. Both when 1,000,000 simulations are carried out. Thus, the specimens with a certain geometry and steel grade satisfy the capacity design rule when the amount of failure is lower than the allowed amount of failures. It is concluded that 1,000,000 simulations will be used in the Monte Carlo simulation for determining the partial factor in the new capacity design rule.

## 3.3. INPUT

For a Monte Carlo simulation, the input is of the utmost importance. The input has be as close to reality as possible to obtain the most realistic simulations. In this study, three different types of inputs were used: Geometry and steel grade of the specimens, boundary conditions for the steel grades and model factors. These inputs are described in detail in the following paragraphs.

### 3.3.1. Geometry and steel grade of the specimens

Each specimen has its own geometry and steel grade. These geometries and steel grades are chosen before conducting the actual experiments. There are always deviations between the chosen geometry and steel grade compared with the actual steel geometry and steel grade. Several studies have been performed aiming to characterize the differences between actual and chosen values and their frequency. This data is collected by Safebrictile in a database and is used in this research.

#### *3.3.1.1. Probability distributions*

A probability distribution is an equation that shows what the probability is for a certain outcome. From an actual data set, a probability distribution can be generated. A continuous probability distribution is a distribution that can provide any value of x that lies within its range. Most commonly used continuous probability distributions are shown in Figure 3.1 up to Figure 3.4. These figures are examples of uniform (Figure 3.1), exponential (Figure 3.2), normal (Figure 3.3) and lognormal (Figure 3.4) distribution.

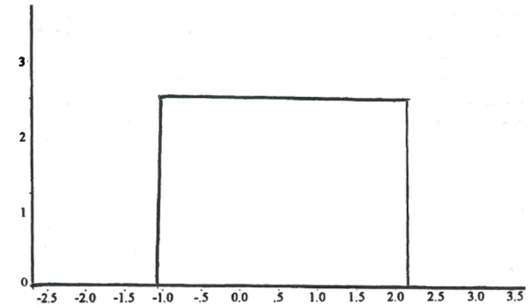


*Figure 3.1: uniform distribution (Mooney, 1997)*


*Figure 3.2: Exponential distribution (Mooney, 1997)*

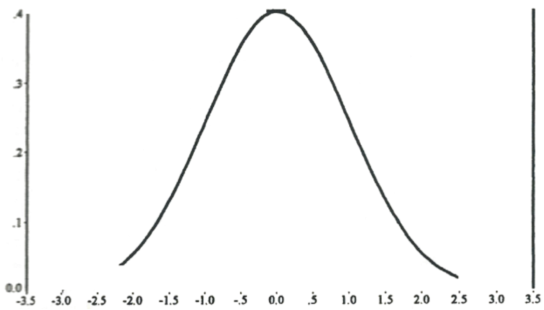


*Figure 3.3: Normal distribution (Mooney, 1997)*

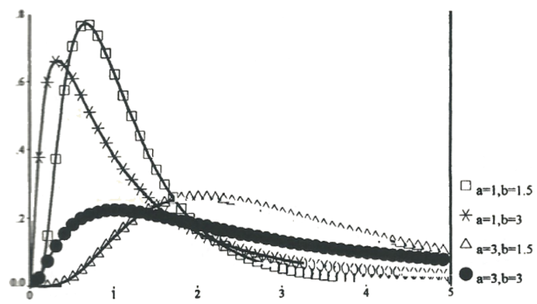



*Figure 3.4: Lognormal distribution (Mooney, 1997)*

These distributions have a mean, median and mode. The mean is the average value of a parameter observed in experiments. The median is the middle of a parameter observed in experiments value of the experiments. The mode is the most appearing value of the observed parameter in experiments (Moore et al., 1999).

#### 3.3.1.1.1. Standard normal distribution

If a distribution has the same values for the mean, median and mode the distribution is normally distributed and exactly symmetrical. The further the mean, median and mode value stray from each other the less symmetric the data distribution is. When the mean, median and mode are not related with each other, a normal distribution cannot be used to describe a data set.

In a normal distribution the mean is called $\mu$. The standard deviation $\delta$ provides information about the variation in the data with respect to the mean. A low standard deviation indicates that the observed data are relatively close to the mean and when no variation is observed the standard deviation will be zero. The standard deviation is sensitive for outliners and can become large due to extreme values (Moore et al., 1999). The standard deviation can be calculated with equation 3.7.

$$\delta = \sqrt{\frac{1}{n-1}\sum(x_i - \bar{x}\,)^2} \tag{3.7}$$

With:

| | |
|---|---|
| $\delta$ | Standard deviation [-] |
| $n$ | Number of experiments [-] |
| $x_i$ | Independent variable x at the $i^{th}$ trial [-] |
| $\bar{x}$ | Mean of the independent variable x [-] |

The normal distribution, shown in Figure 3.5, has some properties that are derived from the mean and the standard deviation. The vertical axis of the normal distribution represents the frequency and on the horizontal axis typically 7 values are shown. The middle value on the horizontal axis is the mean value of the observed experiments and the other values are the mean value summed with multiplications of the standard deviation, as shown in Figure 3.5(Moore et al., 1999).

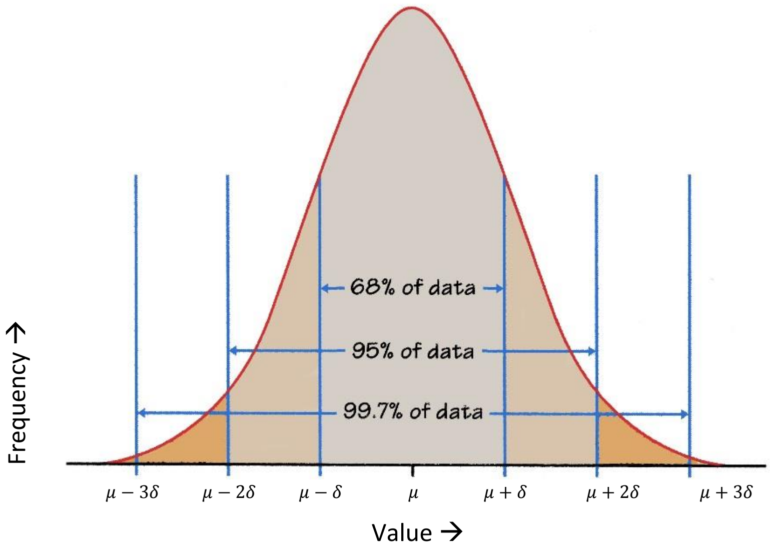



*Figure 3.5: Example of a normal distribution (Moore et al., 1999)*

#### *3.3.1.2. Database Safebrictile*

In the report of Safebrictile summaries are given about the different Work Packages that were a part of the Safebrictile project. The aim of Work Package 2 was to collect available experimental data of steel properties from the European research community and industry in a systematic way to statistically characterize the basic variables relevant to steel structures. The collected data covered steel grades S235, S355 and S460 and steel profiles with flange thickness up to 140 mm. The data is supplied as statistical parameters (Da Silva et al., 2015). In here, the recommended normal distributions for the yield stress, ultimate strength and geometrical dimensions were presented with the use of coefficient of variance (c.o.v.) and a mean. The standard deviation can be calculated with the coefficient of variance, as shown in equation 3.8.

$$\delta = \frac{\bar{x} \cdot c.o.v.}{100\%} \tag{3.8}$$

With:

| | |
|---|---|
| $\delta$ | Standard deviation [-] |
| $\bar{x}$ | Mean of the independent variable x [-] |
| $c.o.v.$ | Coefficient of variance [%] |

##### 3.3.1.2.1. Material

As mentioned in paragraph 3.3.1.2, Safebrictile has defined the normal distributions for the yield stress and the ultimate strength of the steel grades S235, S355 and S460. This is summarized in Table 3.5 and visualized in Figure 3.6, in where:

| | |
|---|---|
| $f_{y,nom}$ | Design value of the yield stress $[N/mm^2]$ |
| $f_{ym}$ | Mean value of the actual yield stress $[N/mm^2]$ |
| $f_{u,nom}$ | Design value of the ultimate strength $[N/mm^2]$ |
| $f_{um}$ | Mean value of the actual ultimate strength $[N/mm^2]$ |
| $c.o.v.$ | Coefficient of variance [%] |

*Table 3.5: Recommended distribution for yield and ultimate strength (Da Silva et al., 2015)*

| Steel | $f_{y,nom}$ | $f_{ym}/f_{y,nom}$ | c.o.v. | $f_{u,nom}$ | $f_{u,m}/f_{unom}$ | c.o.v. |
|---|---|---|---|---|---|---|
| **S235** | 235 | 1.25 | 5.5% | 360 | 1.2 | 4.5% |
| **S355** | 355 | 1.2 | 5% | 470 | 1.125 | 3.25% |
| **S460** | 460 | 1.15 | 4.5% | 540 | 1.1 | 3.25% |

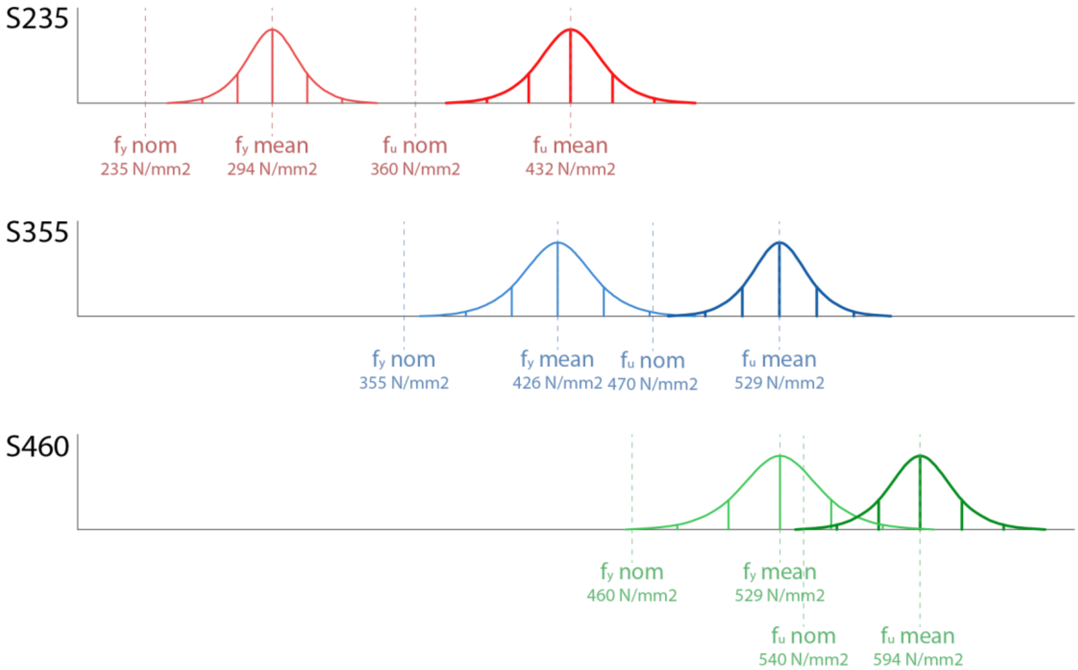



*Figure 3.6: Visualizations of the distributions of the steel grades*

Figure 3.6 defines on the vertical axis the probability and on the horizontal axis the stress in MPa. This figure shows also that the normal distributions of the yield stress and the ultimate strength come closer as the steel grade increases. Eventually the normal distributions will overlap, what can be seen clearly for steel grade S460. These overlapping parts of the distributions must have extra attention when creating a Monte Carlo Simulation. It can result in ultimate strengths which are lower than the yield stresses when generating random numbers. In practice this will not take place, since the ultimate strength should be at least equal or larger than its yield stress.

#### 3.3.1.2.2. Geometry

Work package 2 of the Safebrictile (Da Silva et al., 2015) defines the distributions of the height and thickness of the steel plate. The steel plate thickness comes from the distribution of the flange of an I-shaped section. In table 2 of the research of H.H. Snijder et al. (2017) is the normal distribution for the hole diameter of the steel plate defined. This is summarized in Table 3.6 and visualized in Figure 3.7.

*Table 3.6: Recommended distributions for geometrical dimensions of a steel plate*

| Dimension | b | t | $d_0$ |
|---|---|---|---|
| mean/nom | 1.000 | 0.975 | 1.000 |
| c.o.v. | 0.9% | 2.5% | 0.5% |

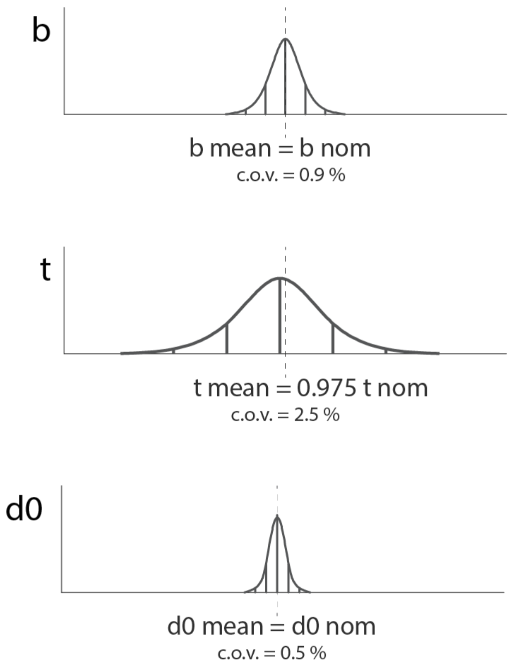



*Figure 3.7: Scaled visualizations of the distributions of the geometry*

In Figure 3.7 the vertical axis define the probability and on the horizontal axis the dimension in mm is shown. The distributions in Figure 3.7 are scaled 10 times, since the standard deviation is very small. It can be concluded that the difference between the design value and the actual value is really small. This is caused by the manufacturing process being highly developed and therefore differences between the chosen value and actual value are small. These distributions for the geometry of the steel plate will be used in the Monte Carlo simulations.

3.3.1.2.3. Generating randomly distributed numbers

From the database, distributions are given which are used as input for the Mont Carlo simulation. In this paragraph it is explained how random numbers are generated according to these distribution. Generating the random numbers for the Monte Carlo simulation will be executed in MATLab with equation 3.9.

```
d0=icdf('normal',rand(1,num_samp),d0m,d0st);
```
(3.9)

With:

| | |
|---|---|
| icdf | Inverse cumulative distribution function |
| 'normal' | Indicates that the generated numbers are from a normal distribution |
| rand | Function for generating a random number between 0 and 1. The numbers between the brackets determining the matrix of the generated numbers. |
| num_samp | Number of specimens that will be generated |
| d0 | Generated hole diameter |
| d0m | Mean value of the hole diameter |
| d0st | Standard deviation of the hole diameter |

The example is given for the hole diameter and similar equations are used for other variables. It must be taken into account that the correct distribution is used with its own parameters that define that certain distribution. In this example, the hole diameter has a normal distribution and this distribution can be defined by the mean and its standard deviation. When knowing the type of distribution and its parameters, an inverse cumulative distribution function can be used to generate numerous data in the Monte Carlo simulation.

### 3.3.2. Boundary conditions

#### *3.3.2.1. Relation yield stress and ultimate strength*

As mentioned in paragraph 2.3 the yield stress and ultimate strength are seen as independent variables in the capacity design rule. In this paragraph research is done on the relation between the yield stress and the ultimate strength.

From each test coupon in the Safebrictile database (ECCS., n.d.), the yield stress and ultimate strength were determined. Since two variables (ultimate strength and yield stress) were independently measured for each experiment, the data is bivariate. Subsequently, a scatter plot can be constructed from the two measured variables. From this scatter plot the relationship between these variables can be visualized. There is interest to find a relation between the yield stress and the ultimate strength of structural steel (Nelson et al., 2003). First, a fitting line will be used to determine a relation. Secondly, a correlation will be used to determine a relation.

3.3.2.1.1. Fitting line

A fitting line can express the relation between two variables in several ways. Ultimately, the fitting line will represent the relation between the variables $f_y$ and $f_u$. The variables are generically labeled as the independent variable ($f_y$) and the response variable ($f_u$). Here, $f_y$ should give information about $f_u$. There are different fitting lines to describe the relation between $f_y$ and $f_u$, for example: a linear fitting line, an exponential fitting curve and a polynomial fitting curve (Nelson et al., 2003). Defining a linear fitting line can be done with equation 3.10 (Nelson et al., 2003):

$$\hat{y}_i = b_0 + b_1 x_i \tag{3.10}$$

With:

| | |
|---|---|
| $\hat{y}_i$ | Predicted value at the $i^{th}$ trial [-] |
| $b_0$ | Estimated value and equal to $\widehat{\beta_0}$ [-] |
| $b_1$ | Estimated value and equal to $\widehat{\beta_1}$ [-] |
| $x_i$ | Independent variable at the $i^{th}$ trial [-] |

$b_0$ And $b_1$ can be described as:

$$b_0 = \widehat{\beta_0} = \bar{y} - \widehat{\beta_1}(\bar{x}) \tag{3.11}$$

$$b_1 = \widehat{\beta_1} = \frac{\sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y})}{\sum_{i=1}^{n}(x_i - \bar{x})^2} \tag{3.12}$$

With:

| | |
|---|---|
| $n$ | Number of experiments [-] |
| $x_i$ | Independent variable x at the $i^{th}$ trial [-] |
| $\bar{x}$ | Mean of the independent variable x [-] |
| $y_i$ | Dependent variable y at the $i^{th}$ trial [-] |
| $\bar{y}$ | Mean of the dependent variable y [-] |

The strength of different types of fitting lines can be compared with the use of the coefficient of determination. The coefficient of determination is expressed by $R^2$. The coefficient of determination calculates the difference between the observed value and the estimated value. The estimated value is calculated from the fitting line, the estimated value can come from a straight line or from a line with other dimensions. $R^2$ has no unit and has a value between 0 and 1. Here, 0 represents a weak relation and 1 represents a strong relation (Nelson et al., 2003).

$R^2$ Can computed with equation 3.13 (Nelson et al., 2003):

$$R^2 = \frac{SS_{total} - SS_e}{SS_{total}} \tag{3.13}$$

Where

$$SS_{total} = \sum_{i=1}^{n}(y_i - \bar{y})^2 \tag{3.14}$$

$$SS_e = \sum_{i=1}^{n}(y_i - \hat{y}_i)^2 \tag{3.15}$$

The fitting line can only be used for describing the relation when the coefficient of determination has a value of at least 0.9. The database of Safebrictile (ECCS., n.d.) is used to determine a linear fitting line. This paragraph shows the results of steel S235 with t ≤ 16 mm, S355 with t ≤ 16 mm and S355 16 mm < t ≤ 40 mm because these subcategories have the highest number of tested specimens. In Table 3.7 to Table 3.9 the linear fitting line is calculated for these subcategories and their corresponding coefficients of determination.

*Table 3.7: Hand calculated linear fitting line for S235 t ≤ 16 mm*

| | S235 t ≤ 16 mm | |
|---|---|---|
| | fym | 324.48 |
| | fum | 453.88 |
| | SStotal | 216188.44 |
| | number of samples | 201 |
| Linear | Sfyfu | 153254 |
| Linear | Sfyfy | 243969 |
| Linear | b1 | 0.628168184 |
| Linear | bo | 250.0536998 |
| Linear | formula | Fu= 0,6282Fy + 250,05 |
| Linear | SSe | 119919 |
| Linear | R2 | 0.4453 |

*Table 3.8: Hand calculated fitting line for S355 t ≤ 16 mm*

| | S355 t ≤ 16 mm | |
|---|---|---|
| | fym | 421.83 |
| | fum | 532.77 |
| | SStotal | 615484.86 |
| | number of samples | 492 |
| Linear | Sfyfu | 394758 |
| Linear | Sfyfy | 718686 |
| Linear | b1 | 0.549277143 |
| Linear | bo | 301.064575 |
| Linear | formula | Fu = 0,5493Fy + 301,06 |
| Linear | SSe | 398653 |
| Linear | R2 | 0.3523 |

*Table 3.9: Hand calculated linear fitting line for S355 16 mm < t ≤ 40 mm*

| | S355 t >16–40 mm | |
|---|---|---|
| | fym | 432.79 |
| | fum | 537.17 |
| | SStotal | 274401.87 |
| | number of samples | 247 |
| Linear | Sfyfu | 253561 |
| Linear | Sfyfy | 602432 |
| Linear | b1 | 0.420895412 |
| Linear | bo | 355.0092814 |
| Linear | formula | Fu = 0,4209Fy + 355,01 |
| Linear | SSe | 167679 |
| Linear | R2 | 0.3889 |

A linear fitting line is also made with Excel 2016 and the equation and coefficient of determination are compared with the calculated linear line and coefficient of determination. In Table 3.10 to Table 3.12 can be seen that the calculated equations and Excel equations are exactly the same. This also applies for the coefficient of determination.

*Table 3.10: Hand calculated VS Excel for S235 t ≤ 16 mm*

| | S235 t ≤ 16 mm | |
|---|---|---|
| Lin. | formula | Fu= 0,6282Fy + 250,05 |
| Lin. | R2 | 0.4453 |
| Ex. Lin | formula | y = 0,6282x + 250,05 |
| Ex. Lin | R2 | 0.4453 |

*Table 3.11: Hand calculated VS Excel for S355 t ≤ 16 mm*

| | S355 t ≤ 16 mm | |
|---|---|---|
| Lin. | formula | Fu = 0,5493Fy + 301,06 |
| Lin. | R2 | 0.3523 |
| Ex. Lin | formula | y = 0,5493x + 301,06 |
| Ex. Lin | R2 | 0.3523 |

*Table 3.12: Hand calculated VS Excel for S355 16 mm < t ≤ 40 mm*

| | S355 t >16–40 mm | |
|---|---|---|
| Lin. | formula | Fu = 0,4209Fy + 355,01 |
| Lin. | R2 | 0.3889 |
| Ex. Lin | formula | y = 0,4209x + 355,01 |
| Ex. Lin | R2 | 0.3889 |

*Table 3.13: Fitting lines for S235 t ≤ 16 mm*

| | S235 t ≤ 16 mm | |
|---|---|---|
| Lin | formula | $y = 0,6282x + 250,05$ |
| Lin | R2 | 0.4453 |
| Exp. | formula | $y = 293,61e^{0,0013x}$ |
| Exp. | $R^2$ | 0.4154 |
| P. | formula | $y = 35,174x^{0,4423}$ |
| P. | $R^2$ | 0.4064 |
| Log. | formula | $y = 207,03\ln(x) - 742,05$ |
| Log. | $R^2$ | 0.4307 |

*Table 3.14: Fitting lines for S355 t ≤ 16 mm*

| | S355 t ≤ 16 mm | |
|---|---|---|
| Lin | formula | $y = 0,5493x + 301,06$ |
| Lin | R2 | 0.3523 |
| Exp. | formula | $y = 343,53e^{0,001x}$ |
| Exp. | $R^2$ | 0.3590 |
| P. | formula | $y = 43,005x^{0,4163}$ |
| P. | $R^2$ | 0.3590 |
| Log. | formula | $y = 219,24\ln(x) - 791,48$ |
| Log. | $R^2$ | 0.3470 |

*Table 3.15: Fitting lines for S355 16 mm < t ≤ 40 mm*

| | S355 t >16–40 mm | |
|---|---|---|
| Lin | formula | $y = 0,4209x + 355,01$ |
| Lin | R2 | 0.3889 |
| Exp. | formula | $y = 380,91e^{0,0008x}$ |
| Exp. | $R^2$ | 0.4443 |
| P. | formula | $y = 63,525x^{0,3518}$ |
| P. | $R^2$ | 0.4517 |
| Log. | formula | $y = 187,41\ln(x) - 599,26$ |
| Log. | $R^2$ | 0.3955 |

Because the calculated results are the same as the Excel results, Excel 2016 will be used to define a linear fitting line, an exponential fitting curve, a polynomial fitting curve and a logarithmic fitting curve. The fitting curves with their corresponding coefficient of determination are shown in Table 3.13 to Table 3.15. It becomes clear that there is no fitting line of the subcategories that describes the specimens strong enough. The highest coefficient of determination here is 0.4517. To have a strong fitting line the coefficient of determination must be at least 0.9. Therefore a fitting line will not be used to define the relation between the yield stress and the ultimate strength.

#### 3.3.2.1.2. Correlation

The relation between bivariate data can be expressed with the correlation coefficient. The correlation coefficient (r) represents the relation between the two variables in the range of 1 to -1, where 1 represents a positive linear relationship (Figure 3.8 C and Figure 3.8 E), 0 represents no relationship between variables (Figure 3.8 A) and -1 represents a negative linear relationship (Figure 3.8 B, Figure 3.8 D and Figure 3.8 F) (Nelson et al., 2003).

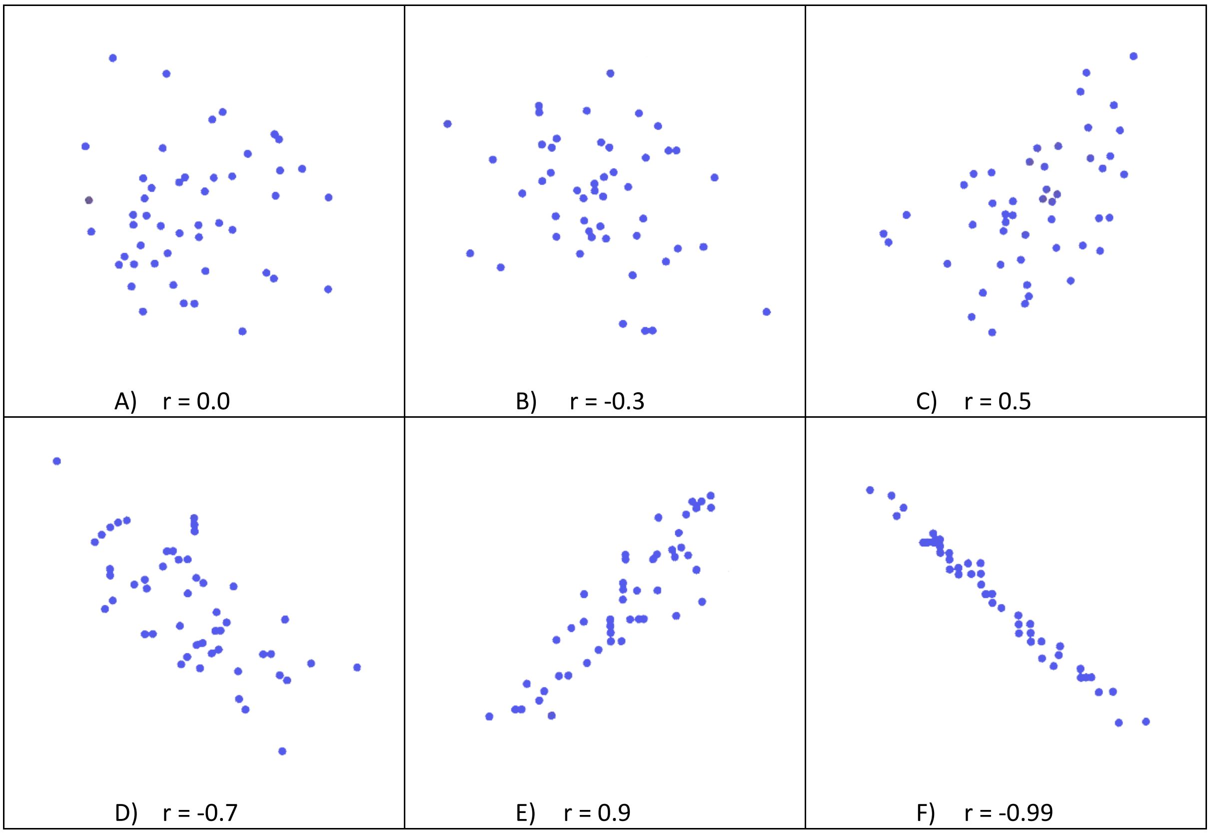



*Figure 3.8: Correlation coefficient r measures the strength of a linear association (Moore et al., 1999).*

The correlation coefficient can be calculated with equation 3.16 (Moore et al., 1999):

$$\mathrm{r} = \frac{1}{n-1} \cdot \sum \left( \frac{x_i - \bar{x}}{\delta_x} \right) \left( \frac{y_i - \bar{y}}{\delta_y} \right) \tag{3.16}$$

With:

| | |
|---|---|
| $r$ | Correlation coefficient [-] |
| $n$ | Number of experiments [-] |
| $x_i$ | Independent variable x at the $i^{th}$ trial [-] |
| $\bar{x}$ | Mean of the independent variable x [-] |
| $\delta_x$ | Standard deviation of the independent variable x [-] |
| $y_i$ | Dependent variable y at the $i^{th}$ trial [-] |
| $\bar{y}$ | Mean of the dependent variable y [-] |
| $\delta_y$ | Standard deviation of the dependent variable y [-] |

The correlation coefficient has no unit and  does not distinguish between explanatory and response variables. The correlation coefficient can only be employed in the case of linear relationships, other relationships such as curved relations cannot be represented by the correlation coefficient regardless of their respective relation strength. The correlation coefficient can be strongly affected by a few outlying observations. Thus if, outliers are observed in the scatter plot, the r value should be presented with caution (Moore et al., 1999).

The correlation is calculated for the same subcategories as in paragraph 3.3.2.1.1: steel grade S235 with t ≤ 16 mm, S355 with t ≤ 16 mm  and S355 16 mm < t ≤ 40 mm. First scatterplots are created for the subcategories, this is shown in Figure 3.9 to Figure 3.12.

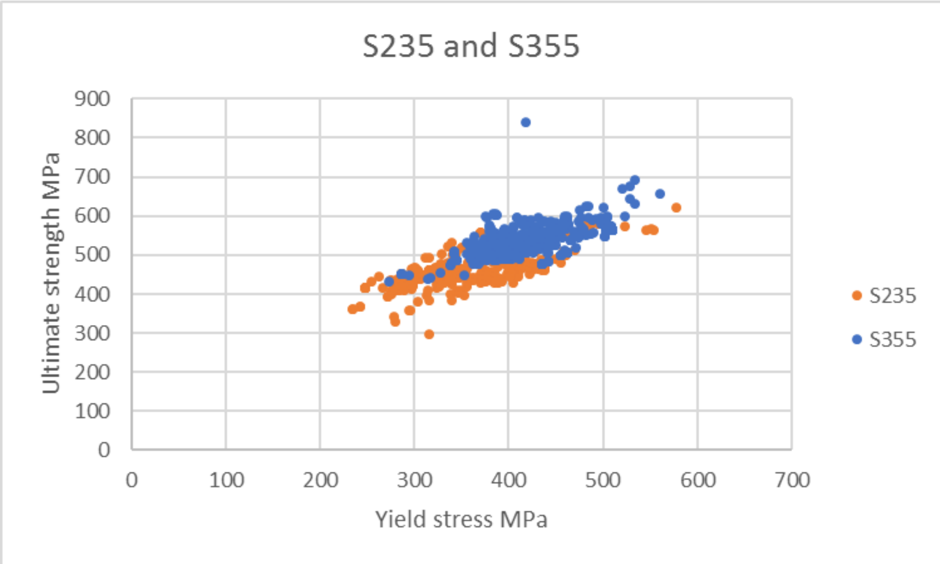



*Figure 3.9: Scatterplot of the yield stress and the ultimate strength for steel grade S235 and S355*

In Figure 3.9 can be seen that measurement points of S235 enclose the measurement points of S355. The measurement points of steel S235 and S355 form a compact cloud that has a few outliners. Next to that, Figure 3.9 shows that there is a positive correlation between the yield stress and the ultimate strength.

Figure 3.10 to Figure 3.12 show also all a positive correlation. The subcategories have a less compact cloud in comparison with the overall scatterplot in Figure 3.9. Due to this, it is possible that the subcategories have a lower correlation coefficient than the correlation coefficient for when all data are considered together.

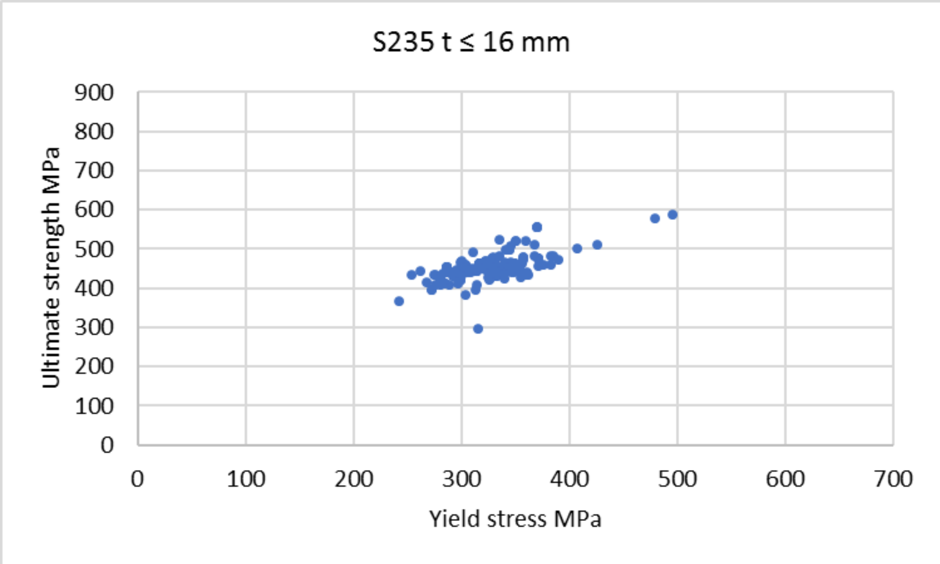



*Figure 3.10: Scatterplot of the yield stress and the ultimate strength for steel grade S235 for t ≤ 16 mm*

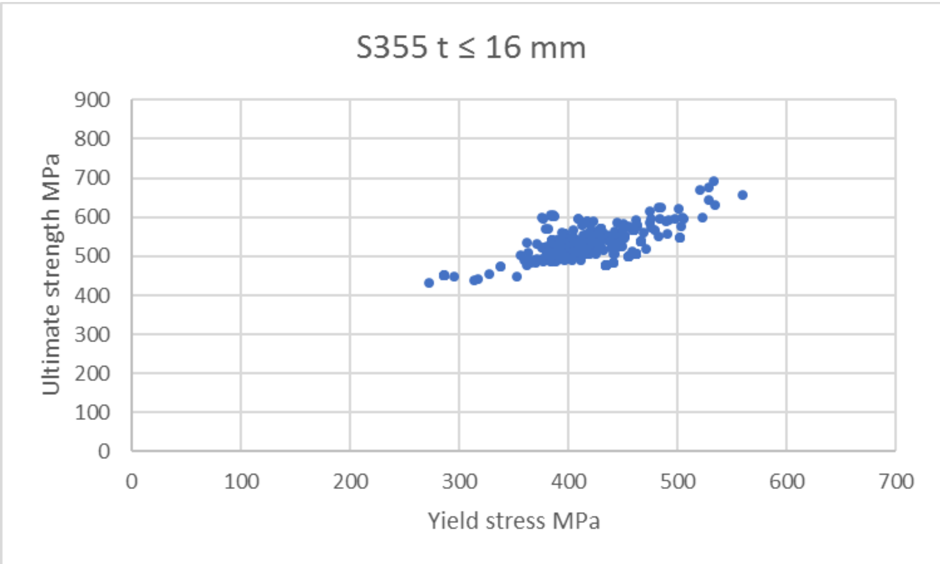



*Figure 3.11: Scatterplot of the yield stress and the ultimate strength for steel grade S355 for t ≤ 16 mm*

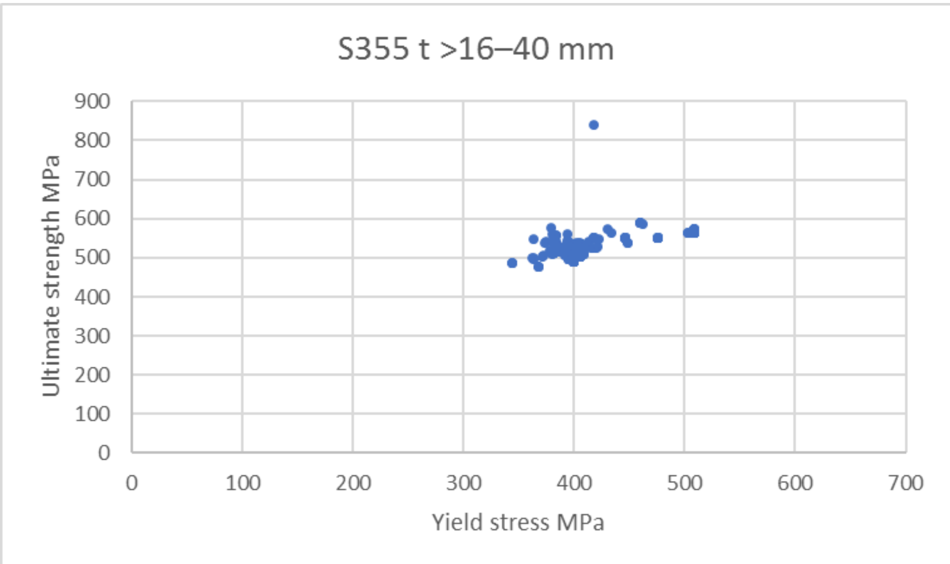



*Figure 3.12: Scatterplot of the yield stress and the ultimate strength for steel grade S355 for 16 mm < t ≤ 40 mm*

For the subcategories, the correlation coefficient is determined which is summarized in Table 3.16. Table 3.16 shows that the correlation coefficient of "S235 & S355" has a higher value than when considering only the subcategories. This may come by the fact that the subcategories complement each other making the overall correlation coefficient stronger.

*Table 3.16: Summarized correlation coefficients*

| Category | Number of specimens | Correlation coefficient |
|---|---|---|
| S235 & S355 | 1244 | 0.77 |
| S235 | 344 | 0.71 |
| S235 t ≤ 16 mm | 201 | 0.67 |
| S355 | 900 | 0.59 |
| S355 t ≤ 16 mm | 492 | 0.59 |
| S355 16 mm < t ≤ 40 mm | 247 | 0.62 |

The overall correlation coefficient that is determined of the data will be compared with the correlation coefficient from the literature.

*3.3.2.1.2.1. Correlation by literature*

The Joint Committee on Structural Safety (JCSS) is a committee in the field of structural related risk and reliability. The JCSS defines a correlation between different properties of steel. Properties that were considered by JCSS are (JCSS, 2015):

$f_y$ Yield stress $[N/mm^2]$
$f_u$ Ultimate strength $[N/mm^2]$
$E$ Modulus of elasticity $[N/mm^2]$
$v$ Poisson's ratio [-]
$\varepsilon_u$ Ultimate strain [-]

In Table 3.17 the correlation coefficient matrix is given for the mentioned structural steel properties. These values are only valid for static loading and should not be used for ultra-high strength. These values can be used up to a yield stress of 690 MPa. In Table 3.17 it is shown that the correlation coefficient between $f_y$ and $f_u$ is 0.75.

*Table 3.17: Correlation coefficient Matrix according JCSS (JCSS, 2015)*

| | $f_y$ | $f_u$ | $E$ | $v$ | $\varepsilon_u$ |
|---|---|---|---|---|---|
| $f_y$ | 1 | 0.75 | 0 | 0 | -0.45 |
| $f_u$ | | 1 | 0 | 0 | -0.60 |
| $E$ | | | 1 | 0 | 0 |
| $v$ | | | | 1 | 0 |
| $\varepsilon_u$ | | | | | 1 |

In the research of Melcher et al. (2004), a correlation matrix is defined for the yield stress, the ultimate strength and the strain, as shown in Table 3.18. Melcher's research determines a correlation coefficient of 0.57 between the yield stress and the ultimate strength.

*Table 3.18: Correlation coefficient Matrix according Melcher et al. (Melcher et al., 2004)*

| | $f_y$ | $f_u$ | $\varepsilon$ |
|---|---|---|---|
| $f_y$ | 1 | 0.57 | -0.32 |
| $f_u$ | | 1 | -0.18 |
| $\varepsilon$ | | | 1 |

#### 3.3.2.1.3. Correlation in Monte Carlo simulation

The correlation coefficient of Melcher et al. (2004) is significantly lower than the correlation coefficient of JCSS. Difference in the correlation coefficient can be explained by the fact that the manufacturing process was improved over time. The research of Melcher et al. (2004) was conducted for steel that was produced and manufactured in 1999, 2000 and 2001 (Melcher et al., 2004).

The correlation coefficient of JCSS will be used in the Monte Carlo simulation. This data is more recent than the data of the research of Melcher et al. (2004). Besides this, the 0.75 correlation coefficient of JCSS nearly corresponds to the overall correlation coefficient that is determined with use of the database of Safebrictile. Additionally, the JCSS correlation coefficient can be used for steel grades up to S690 and the correlation coefficient from the database of Safebrictile is only applicable for steel grades S235 and S355.

The boundary condition for the correlation between the yield stress and the ultimate strength will be used in the Monte Carlo simulation with equation 3.17. The Monte Carlo simulation is carried out in MATLab.

```
fu=cor*fy+sqrt(1-cor^2)*icdf('normal',rand(1,num_samp),fum,fust);        (3.17)
```

With:

| | |
|---|---|
| icdf | Inverse cumulative distribution function |
| 'normal' | Indicates that the generated numbers are from a normal distribution |
| rand | Function for generating a random number between 0 and 1. The numbers between the brackets determining the matrix of the generated numbers. |
| num_samp | Number of specimens that will be generated |
| fu | Generated ultimate strength |
| fum | Mean value of the ultimate strength |
| fust | Standard deviation of the ultimate strength |
| fy | Generated yield stress |
| cor | Correlation coefficient for the yield stress and the ultimate strength |

### *3.3.2.2. Minimum yield stress and ultimate strength*

Besides the generated boundary condition for the correlation of the yield stress and the ultimate strength, other boundary conditions need to be taken into account when generating random numbers. First, the minimum value of the yield stress is the design value of the yield stress, because steel can only be named S235 when the minimum yield stress is 235 $\mathrm{N}/mm^2$. Otherwise it will be removed and not used as S235 steel. This counts for all other steel grades as well. Secondly, the ultimate strength cannot be lower than the yield stress in one single simulation. When this occurs a new random ultimate strength must be chosen to ensure that the ultimate strength is at least equal to or higher than the yield stress.

These boundary conditions as a result of minimal values of the yield stress and the ultimate strength, have been incorporated into the Monte Carlo simulation by equation 3.18 and 3.19 and is executed in MATLab.

```
fy(fy<fyn)=icdf('normal',rand(1),fym,fyst);                                (3.18)
fu(fy>fu)=cor*fy+sqrt(1-cor^2)*icdf('normal',rand(1,test3),fum,fust);     (3.19)
```

### 3.3.3. Model factor

A model factor for the ultimate resistance will be used in the Monte Carlo simulation, which is also shown in equation 3.3. The model factor (k) is a factor that shows the difference between the actual and simulated ultimate resistance. If all the actual values are used in the theoretical equation, a difference between the actual ultimate resistance and the simulated actual ultimate resistance could still be present. This means that besides the geometrical parameters measured in the experiment, the actual ultimate strength of the specimen of the steel plate is used in the simulation instead of the design value of the ultimate steel strength. Eventually, the model factor is used to ensure that the outcome of the Mont Carlo simulation is as close to reality as possible. With the use of equation 3.20, the model factor can be determined.

$$N_{u,actual} / N_{u,sim} = k \tag{3.20}$$

With:

| | |
|---|---|
| $N_{u,actual}$ | Actual ultimate net cross-section resistance [kN] |
| $N_{u,sim}$ | Simulated ultimate net cross-section resistance [kN] |
| $k$ | Model factor [-] |

The simulated ultimate net cross-section resistance will be calculated without partial factor and the 0.9 safety factor, which will be done for every specimen. Unfortunately, not enough data was found in literature to determine a distribution for the model factor for the steel grades S235, S355 and S460. With the use of a finite element model, more data can be generated. Therefore the model factor is separated in two different factors that define the difference between the finite element model and the experiment (actual factor) and the difference between the finite element model and the theoretical model (simulated factor), which is explained in equation 3.21 and equation 3.22.

$$N_{u,actual} / N_{u,fem} = b \tag{3.21}$$

$$N_{u,fem} / N_{u,sim} = p \tag{3.22}$$

With:

| | |
|---|---|
| $N_{u,fem}$ | Finite element model ultimate net cross-section resistance [kN] |
| $b$ | Actual factor [-] |
| $p$ | Simulated factor [-] |

When the actual factor and simulated factor are defined, the factors can be multiplied to come to the model factor. In the following paragraphs the finite element model is defined and the model factor is explained in more detail. Also the application of the model factor in the Monte Carlo simulation is clarified.

#### 3.3.3.1. *Finite element model*

First a finite element model must be created and validated. In this research, the finite element model and analyses are executed in Abaqus FE Software 6.13. A material nonlinear analysis is executed using a static general analysis. A finite element model has already been created for a bolted steel connection in the graduation master thesis of A.H. Shahrajabian. The finite element model of Shahrajabian will be used, but an additional research for the mesh size will be done. The geometry and boundary condition is taken the same as the experimental research done by Snijder et al., 2017. In this experimental research, different geometries are tested, which offers the opportunity to define the actual factor. The element type that is used in the finite element model of Shahrajabian is C3D8I: linear hexahedral-dominated elements. These will be used in this research as well. Geometries A11, A21 and A25 (Figure 3.13 to Figure 3.15) are used to validate the finite element model and the experimental results are shown in Table 3.19.

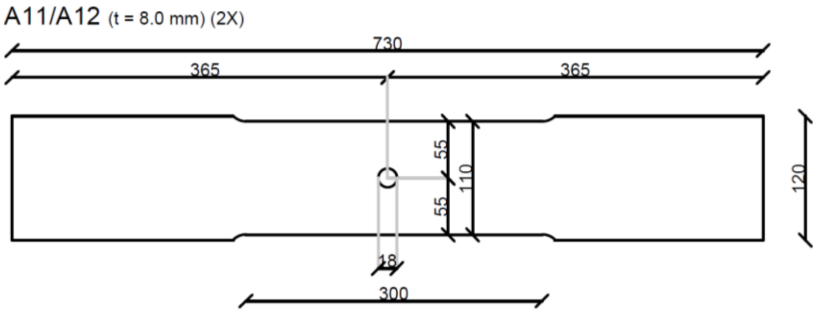



*Figure 3.13: Design values of geometry A11 and A12 (Shahrajabian, 2016)*

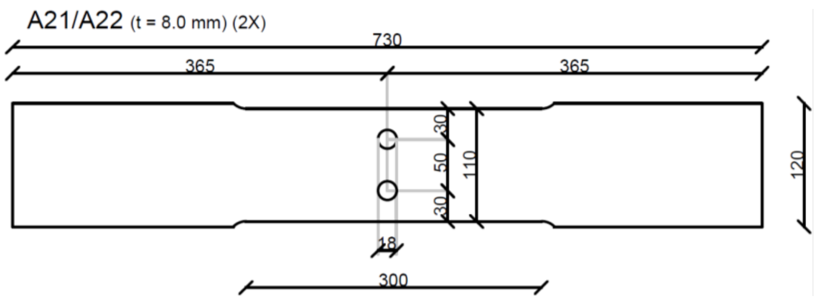



*Figure 3.14: Design values of geometry A21 and A22 (Shahrajabian, 2016)*

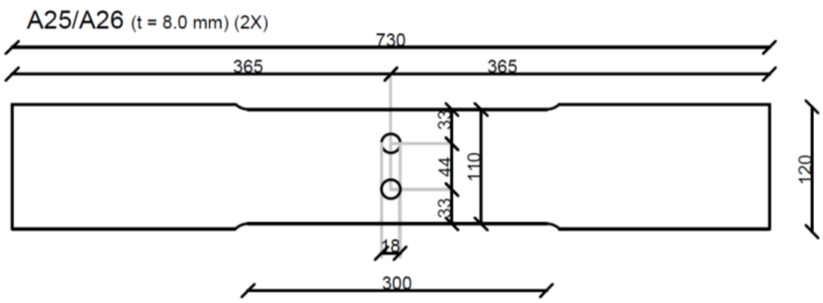



*Figure 3.15: Design values of geometry A25 and A26 (Shahrajabian, 2016)*

*Table 3.19: Experimental results for specimen A11 to A36 (Rombouts et al., 2014)*

| Test [-] | $b$ [mm] | $t$ [mm] | $d_0$ [mm] | $e_2$ [mm] | $e_1$ [mm] | $p_1$ [mm] | $p_2$ [mm] | $A_{net}$ [mm2] | $N_{u,actual}$ [kN] |
|---|---|---|---|---|---|---|---|---|---|
| **A11** | 110.03 | 7.99 | 17.98 | 55.02 | - | - | - | 735 | 327.0 |
| **A12** | 110.01 | 7.99 | 17.98 | 55.01 | - | - | - | 735 | 328.6 |
| **A21** | 110.00 | 9.00 | 18.00 | 30.00 | - | - | 50.00 | 592 | 275.5 |
| **A22** | 110.00 | 9.00 | 18.00 | 30.00 | - | - | 50.00 | 592 | 278.9 |
| **A23** | 110.05 | 7.98 | 17.98 | 25.03 | - | - | 60.00 | 591 | 278.9 |
| **A24** | 110.10 | 8.00 | 17.98 | 25.05 | - | - | 60.00 | 593 | 280.9 |
| **A25** | 110.00 | 8.00 | 18.00 | 33.00 | - | - | 44.00 | 592 | 274.8 |
| **A26** | 110.00 | 8.00 | 18.00 | 33.00 | - | - | 44.00 | 592 | 273.9 |
| **A31** | 110.04 | 8.01 | 17.99 | 25.02 | - | 40.00 | 60.00 | 647 | 282.1 |
| **A32** | 110.06 | 7.99 | 17.99 | 25.03 | - | 40.00 | 60.00 | 645 | 283.2 |
| **A33** | 110.00 | 8.00 | 18.00 | 25.00 | - | 50.00 | 60.00 | 675 | 284.7 |
| **A34** | 110.00 | 8.00 | 18.00 | 25.00 | - | 50.00 | 60.00 | 675 | 283.1 |
| **A35** | 110.00 | 8.00 | 18.00 | 25.00 | - | 80.00 | 60.00 | 736 | 291.1 |
| **A36** | 110.00 | 8.00 | 18.00 | 25.00 | - | 80.00 | 60.00 | 736 | 291.1 |

In the finite element model, boundary conditions were applied. The experiments were executed in a laboratory with two grips that were clamping the specimens. One of the clamps was fixed and the other clamp was moving to introduce a tensile force, which  is used in the finite element model. The dimensions of the grips are 65 mm x 80 mm, which are also used in the finite element model (Shahrajabian, 2016). Finally, this results in two boundary conditions which were implemented in the finite element model.

1. The fixed clamp did not move or rotate in any direction. Therefore on one side of the specimen in the finite element model, an area of 65 mm x 80 mm was totally fixed. (U1=U2=U3=R1=R2=R3=0)
2. The moving clamp does move in one direction, but does not rotate in any direction. Therefore on the other side of the specimen in the finite element model, an area of 65 mm x 80 mm was fixed except for one moving direction. The maximum displacement can differ for all the specimens, but generally the moving clamp was displaced 50 mm, to find the ultimate tensile resistance. (U1=50 and U2=U3=R1=R2=R3=0)

In Figure 3.16 the definitions of U1, U2, U3, R1, R2 and R3 are explained and is shown how the specimen is placed in the axial system.

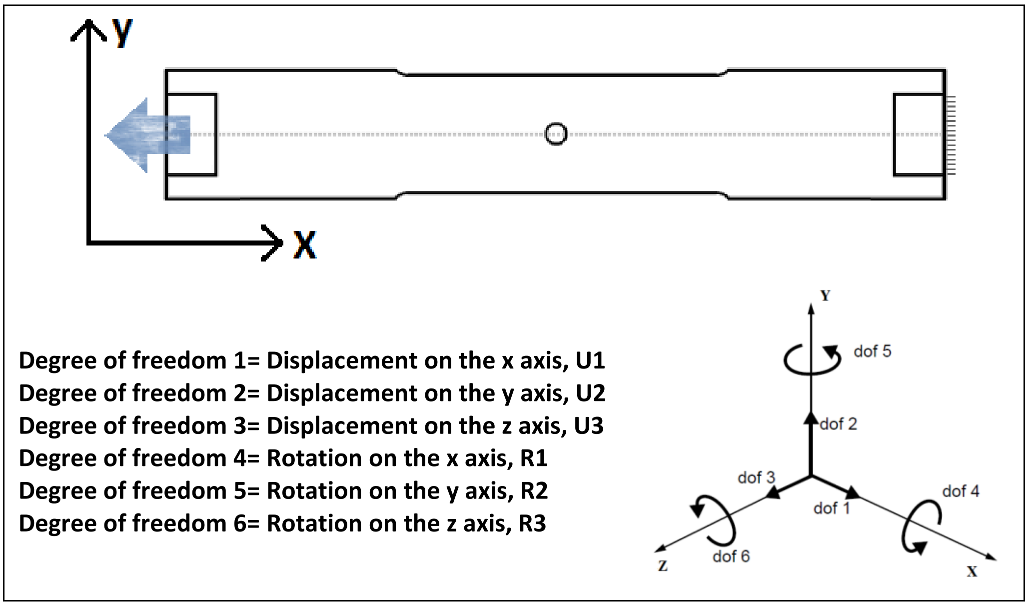



*Figure 3.16: Definition U1, U2, U3, R1, R2 and R3 (Shahrajabian, 2016)*

Material properties were defined from the experimental specimens, this is shown in Table 3.20.

*Table 3.20: Material properties test specimen (Shahrajabian, 2016)*

| Material properties test specimen | |
|---|---|
| **Modulus of Elasticity** | 210000 $N/mm^2$ |
| **Poisson's ratio** | v=0.3 |
| **Yield stress** | 283 $N/mm^2$ |
| **Ultimate strength** | 447 $N/mm^2$ |

In addition, the plastic behavior of the steel that is used for the experiments is captured. This means that the engineering stress and engineering strain were measured. The true stress and strain will be used in the finite element model. For using the engineering stress and strain in the finite element model, the engineering stress and strain must be translated to a true stress and strain (equation 3.23 and 3.24 )(EN 1993-1-5, 2011).

$$\sigma_{true} = \sigma \cdot (1 + \varepsilon) \quad (3.23)$$
$$\varepsilon_{true} = \ln(1 + \varepsilon) \quad (3.24)$$

With:

| | |
|---|---|
| $\sigma_{true}$ | True stress $[N/mm^2]$ |
| $\varepsilon_{true}$ | True strain [-] |
| $\sigma$ | Engineering stress $[N/mm^2]$ |
| $\varepsilon$ | Engineering strain [-] |

The translation from engineering stress and strain to true stress and strain is shown in Figure 3.17. The input that is used for the plastic behavior is shown in Table 3.21.

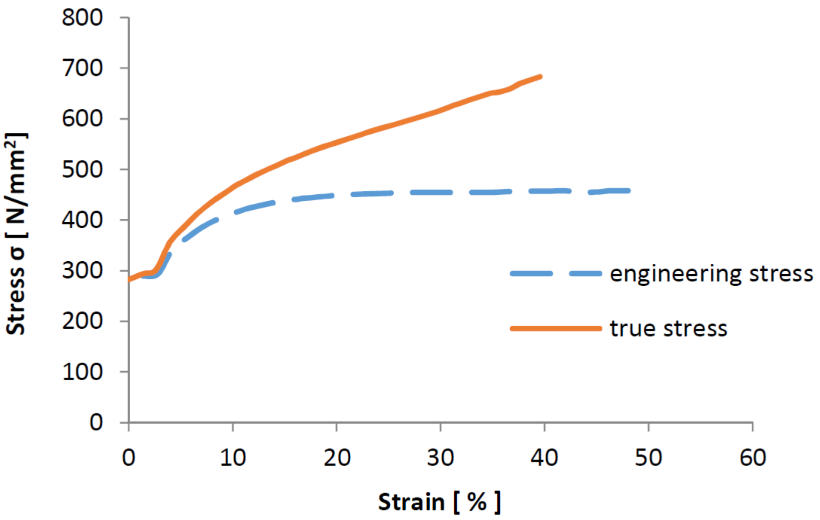



*Figure 3.17: Engineering- and true stress-strain graph of the steel of the experiment (Shahrajabian, 2016)*

*Table 3.21: Input plastic behavior finite element model (Shahrajabian, 2016)*

| True stress (N/mm2) | True plastic strain |
|---|---|
| **283** | 0.00 |
| **294** | 0.01 |
| **302** | 0.03 |
| **356** | 0.04 |
| **386** | 0.05 |
| **412** | 0.07 |
| **435** | 0.08 |
| **452** | 0.09 |
| **469** | 0.10 |
| **483** | 0.12 |
| **496** | 0.13 |
| **507** | 0.14 |
| **518** | 0.15 |
| **527** | 0.16 |
| **537** | 0.18 |
| **546** | 0.19 |
| **553** | 0.20 |
| **561** | 0.21 |
| **568** | 0.22 |
| **576** | 0.23 |
| **582** | 0.24 |
| **589** | 0.25 |
| **595** | 0.27 |
| **602** | 0.28 |
| **609** | 0.29 |
| **615** | 0.30 |
| **623** | 0.31 |
| **630** | 0.32 |
| **638** | 0.33 |
| **644** | 0.34 |
| **651** | 0.35 |
| **654** | 0.36 |
| **660** | 0.37 |
| **670** | 0.38 |
| **677** | 0.39 |
| **684** | 0.40 |

#### 3.3.3.1.1. Additional mesh study

In the research of Shahrajabian it is shown that the area around the holes is the important part of the geometry in the finite element simulation. Therefore the mesh nearby the hole is more fine than the outer part of the geometry. For both parts of the geometry, an additional mesh study is conducted. In Figure 3.18 it is shown what the hole area and the outer area is of the geometry. The hole area has a width of 90 mm, which is determined by Shahrajabian and is used in the finite element model for this research as well (Shahrajabian, 2016). The amount of elements in thickness direction will also be investigated in this research.

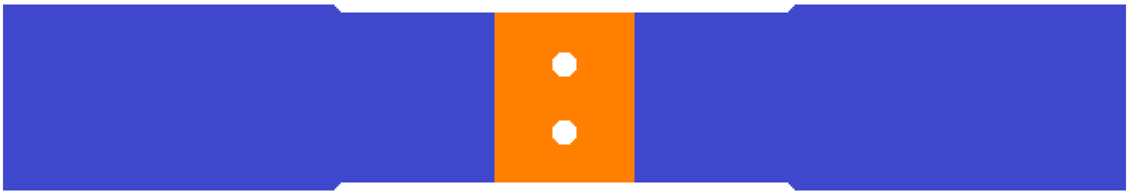


*Figure 3.18: Mesh area: blue indicates the outer area, orange indicates the hole area*

##### *3.3.3.1.1.1. Mesh study outer area*

In this paragraph the mesh ratio is determined for the outer area. The mesh ratio is determined by the size of one element. For example, the width is 5 times the height of one element. The different outer mesh ratio's that will be examined are:

- 1 to 5
- 1 to 10
- 1 to 20

This mesh study will only be executed on the geometry type A25. The exact sizes of the geometry of A25 are discussed in paragraph 3.3.3.1. Figure 3.19 to Figure 3.21 show the different mesh ratios in the geometry of A25. The hole area mesh in this mesh study is a mesh size of 2 mm.

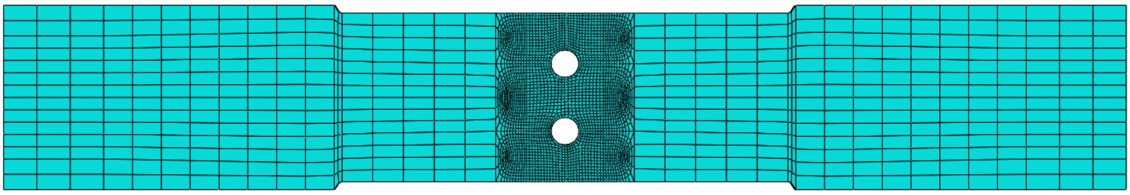


*Figure 3.19: A25 outer mesh ratio 1 to 5*

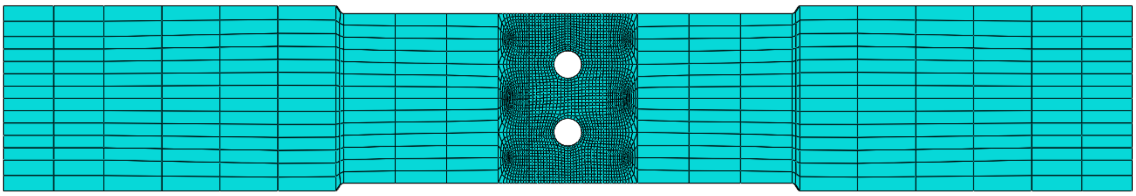


*Figure 3.20: A25 outer mesh ratio 1 to 10*

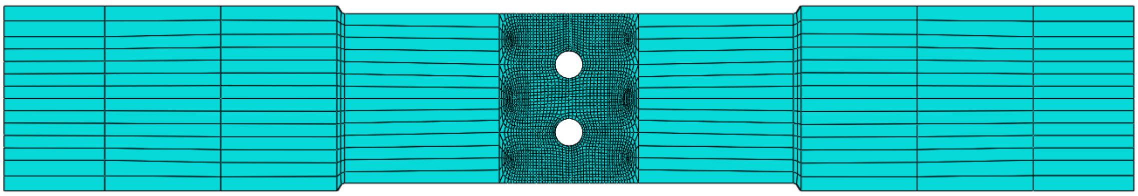


*Figure 3.21: A25 outer mesh ratio 1 to 20*

The results of the outer area mesh study are shown in the force-displacement graph in Figure 3.22. The graph shows that mesh 1 to 5 and mesh 1 to 20 follow the same path. Mesh 1 to 10 follows almost the same path as mesh 1 to 5 and mesh 1 to 20, but it reach its maximum load earlier. All the meshes have a difference in stiffness in the elastic area in comparison with the stiffness of the experiment. All the meshes have a similar stiffness in the plastic area like the experiment. The comparison to the stiffness can be neglected due to the fact that the measurement for the displacement was measured on the grips instead of directly on the specimen (Rombouts et al., 2014).

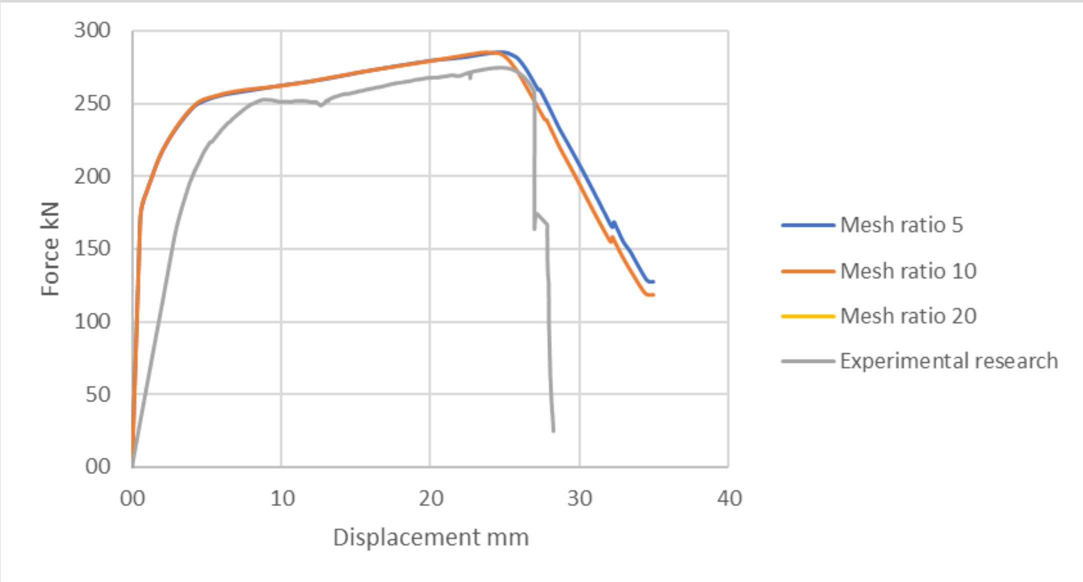



*Figure 3.22: Force-Displacement graph for mesh study outer area*

In Table 3.22 it is shown what the difference is between the ultimate load of the finite element model and the ultimate load of the experiment. The difference of the ultimate load depending on the mesh ratio is minimal. The mesh ratio of 10 will be used for the outer area in the finite element model, since the fact that difference in ultimate resistance with the other ratios is minimal and the computational effort is more favorable.

*Table 3.22: Mesh study outer area summarized*

| Mesh | FEM | Experiment | Ratio |
|---|---|---|---|
| **ratio** | $N_{u,fem}$ | $N_{u,actual}$ | $N_{u,fem}/N_{u,actual}$ |
| **#** | *kN* | *kN* | - |
| **5** | 285.1 | 274.8 | 1.037 |
| **10** | 284.7 | 274.8 | 1.036 |
| **20** | 284.9 | 274.8 | 1.037 |

*3.3.3.1.1.2. Mesh study hole area*

The mesh study for the hole area is executed for two different geometries, A11 and A25. The exact sizes of these geometries are discussed in paragraph 3.3.3.1. The outer mesh ratio that is used in this study is an outer mesh ratio of 10. In the hole area the mesh changes in size, the mesh sizes that will be considered are:

- 1 mm
- 2 mm
- 4 mm
- 8 mm

Figure 3.23 to Figure 3.26 show the different mesh sizes for geometry A11.

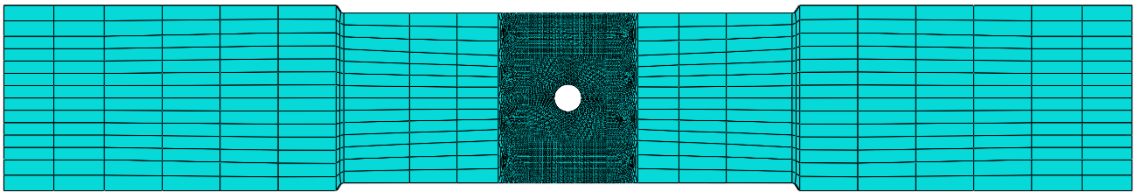


*Figure 3.23: A11 hole area mesh 1 mm*

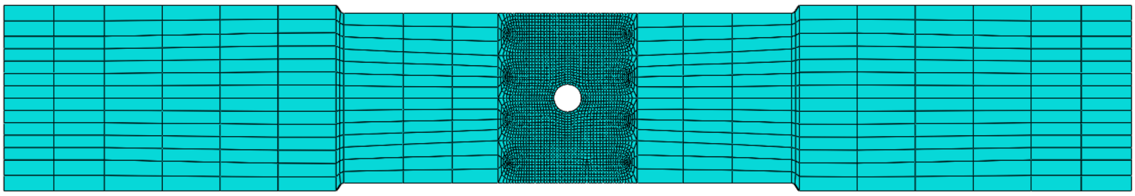


*Figure 3.24: A11 hole area mesh 2 mm*

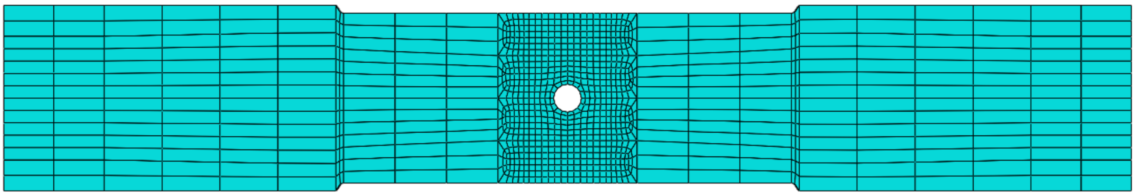


*Figure 3.25: A11 hole area mesh 4 mm*

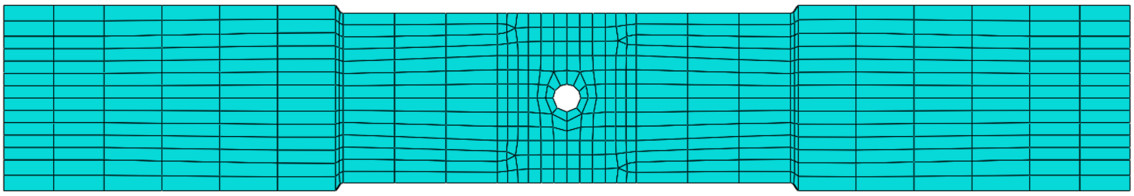


*Figure 3.26: A11 hole area mesh 8 mm*

The results of the hole area mesh study are shown in force-displacement graphs in Figure 3.27 and Figure 3.28. The graphs shows that for both geometries and all mesh sizes the force-displacement graph follows the same path. All the meshes have a difference in stiffness in the elastic area in comparison with the stiffness of the experiment. All the meshes have in the plastic area a similar stiffness as the experiment. In this case the comparison to the stiffness can also be neglected, due to the fact that the measurement for the displacement was measured on the grips instead of directly on the specimen (Rombouts et al., 2014).

The finite element model ultimate resistance of the mesh size of 1 mm and 2 mm come closest to the actual ultimate resistance, as shown in Table 3.23 and Table 3.24. The mesh size of 2 mm will be used for the hole area in the finite element model, since the difference between the finite element model ultimate resistance of mesh size 1 mm and 2 mm is minimal. Besides this, the difference between the finite element model ultimate resistance between mesh size 2 mm and the actual ultimate resistance is small. To conclude, mesh size 2 mm is chosen for its accuracy and its limited computational effort.

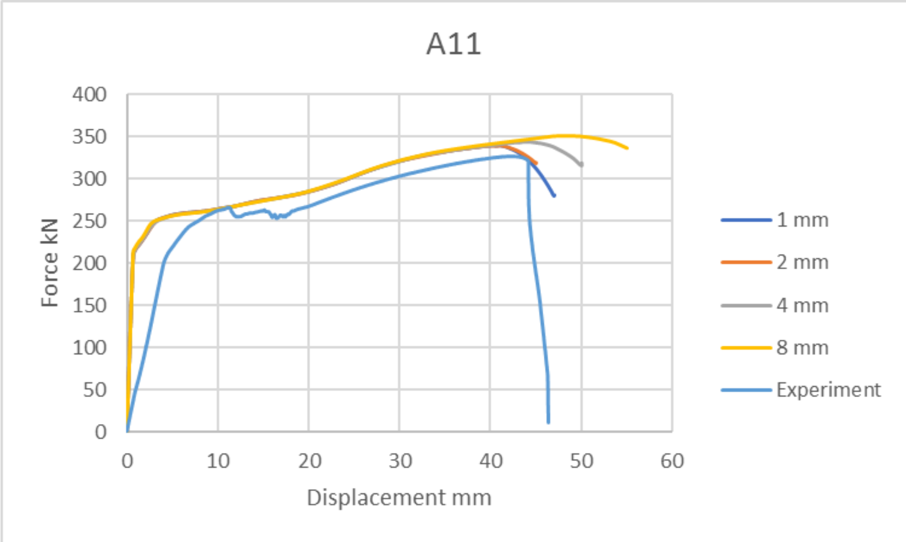



*Figure 3.27: Force-Displacement graph for mesh study hole area geometry A11*

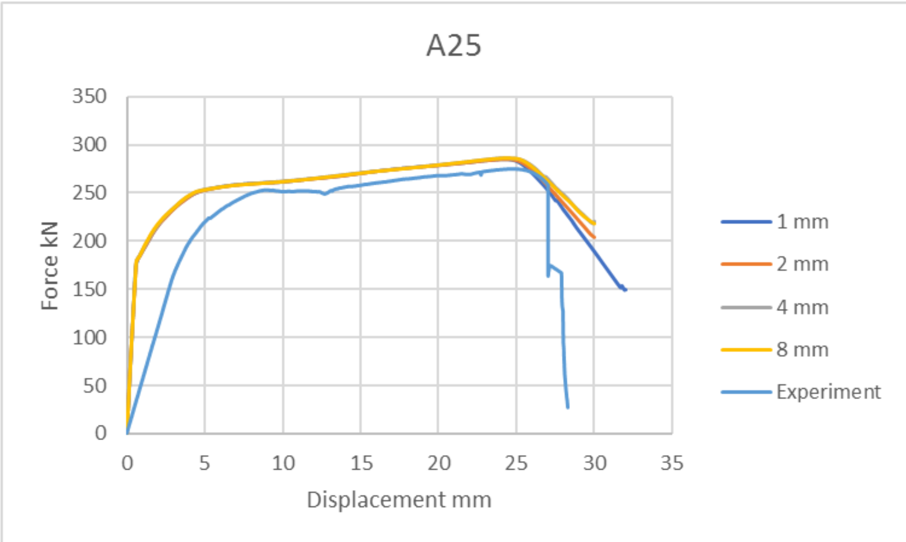



*Figure 3.28: Force-Displacement graph for mesh study hole area geometry A25*

*Table 3.23: Mesh study hole area summarized for geometry A11*

| Mesh size *mm* | FEM $N_{u,fem}$ *kN* | Experiment $N_{u,actual}$ *kN* | Ratio $N_{u,fem}/N_{u,actual}$ - | Computing time *min* |
|---|---|---|---|---|
| **1** | 339.2 | 327.0 | 1.037 | 370 |
| **2** | 339.3 | 327.0 | 1.038 | 25 |
| **4** | 343.9 | 327.0 | 1.052 | 4 |
| **8** | 351.1 | 327.0 | 1.074 | 1 |

*Table 3.24: Mesh study hole area summarized for geometry A25*

| Mesh size *mm* | FEM $N_{u,fem}$ *kN* | Experiment $N_{u,actual}$ *kN* | Ratio $N_{u,fem}/N_{u,actual}$ - | Computing time *min* |
|---|---|---|---|---|
| **1** | 285.3 | 274.8 | 1.038 | 420 |
| **2** | 285.4 | 274.8 | 1.039 | 21 |
| **4** | 286.0 | 274.8 | 1.041 | 3 |
| **8** | 286.7 | 274.8 | 1.043 | 3 |

*3.3.3.1.1.3. Elements in thickness direction*

The conclusions of paragraph 3.3.3.1.1.1 and 3.3.3.1.1.2 are used as starting point for the analysis of the amount of elements that are needed in the thickness direction of the finite element model. This analysis is conducted for geometry A11 and A25. Three different element thicknesses are tested:

- 4 elements
- 2 elements
- 1 element

How these elements are divided can be seen in Figure 3.29 to Figure 3.31.

*Figure 3.29: 4 Elements in thickness direction at the hole area*

*Figure 3.30: 2 Elements in thickness direction at the hole area*

*Figure 3.31: 1 Elements in thickness direction at the hole area*

The results for the number of elements in thickness direction in the hole area are shown in force-displacement graphs in Figure 3.32 and Figure 3.33. The graphs shows that for all numbers of elements in thickness direction, the force-displacement graphs follow the same path for both geometries. All the meshes differ in stiffness in the elastic area in compression with the stiffness of the experiment. However, all the meshes do have a similar stiffness in the plastic area as in the experiment. As well as in paragraph 3.3.3.1.1.1 and 3.3.3.1.1.2, the comparison to the stiffness can be neglected.

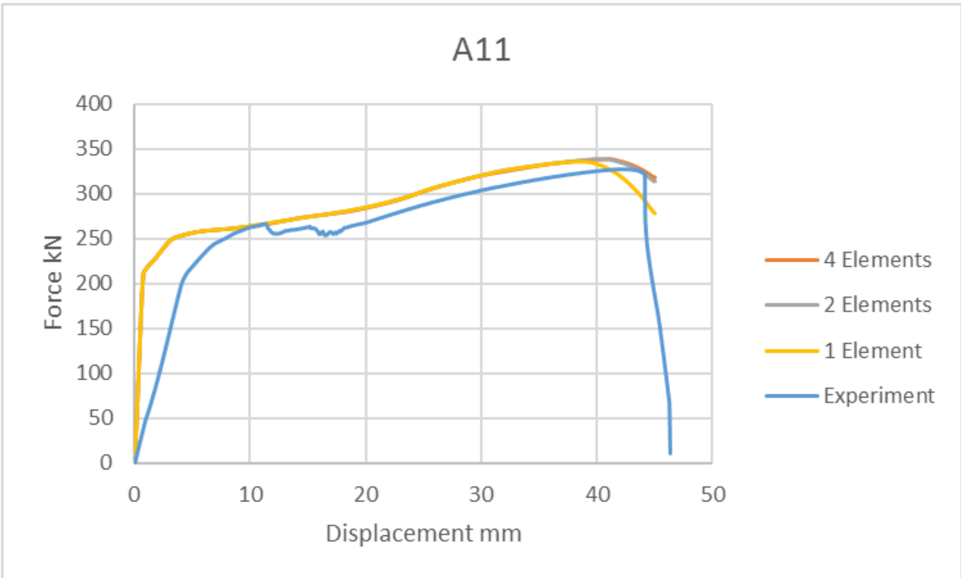



*Figure 3.32: Elements in thickness direction at the hole area for geometry A11*

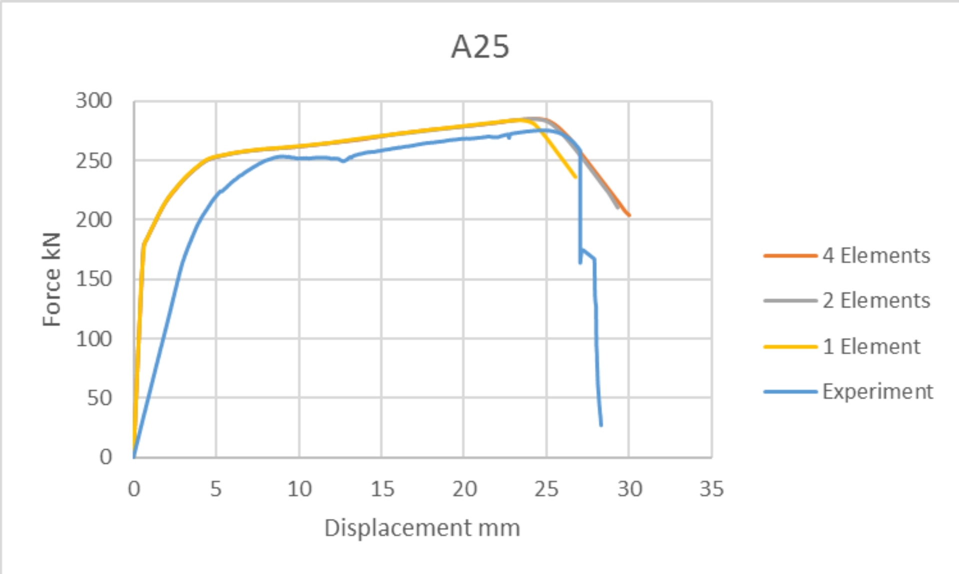


*Figure 3.33: Elements in thickness direction at the hole area for geometry A25*

The finite element model ultimate resistance for the number of elements in thickness direction of 4 and 2 are the closest to each other, as shown in Table 3.25 and Table 3.26. The difference in finite element model ultimate resistance stabilizes with number of elements 4 and 2, for both geometries. Because of its limited computational effort, the mesh with 2 elements in thickness direction at the hole area is chosen.

*Table 3.25: Mesh study element in thickness at the hole area summarized for geometry A11*

| Mesh | FEM | Experiment | Ratio | Computing |
|---|---|---|---|---|
| **Elements** | $N_{u,fem}$ | $N_{u,actual}$ | $N_{u,fem}/N_{u,actual}$ | time |
| **#** | *kN* | *kN* | - | *min* |
| **4** | 339.3 | 327.0 | 1.038 | 25 |
| **2** | 338.9 | 327.0 | 1.036 | 12 |
| **1** | 335.9 | 327.0 | 1.027 | 6 |

*Table 3.26: Mesh study element in thickness at the hole area summarized for geometry A11*

| Mesh | FEM | Experiment | Ratio | Computing |
|---|---|---|---|---|
| **Elements** | $N_{u,fem}$ | $N_{u,actual}$ | $N_{u,fem}/N_{u,actual}$ | time |
| **#** | *kN* | *kN* | - | *min* |
| **4** | 285.4 | 274.8 | 1.039 | 21 |
| **2** | 285.2 | 274.8 | 1.038 | 10 |
| **1** | 283.6 | 274.8 | 1.032 | 3 |

#### 3.3.3.1.2. Validation finite element model

The final mesh that will be used, has in the outer area an element ratio of 1 to 10, in the hole area a mesh size of 2 mm and in the thickness direction 2 elements. The finite element model ultimate resistance with this mesh for the geometries A11, A21 and A25 are summarized in Table 3.27. The over estimation is around 4%, which results in a finite element model that could be considered as validated.

Table 3.27: Validation finite element model

| Geometry | FEM | Experiment | Ratio |
|---|---|---|---|
| **Test** | $N_{u,fem}$ | $N_{u,actual}$ | $N_{u,fem}/N_{u,actual}$ |
| **-** | *kN* | *kN* | - |
| **A11** | 338.9 | 327.0 | 1.036 |
| **A21** | 289.5 | 275.2 | 1.052 |
| **A25** | 285.2 | 274.8 | 1.038 |

### *3.3.3.2. Difference finite element model and actual ultimate resistance*

With the use of the finite element model that is defined in paragraph 3.3.3.1 all the geometries in Table 3.19 are simulated. The principles of geometry A11 to A36 are shown in appendix 3 and the values are given in Table 3.19. Using the difference of the actual ultimate resistance and the finite element model ultimate resistance of the simulation with the finite element model, gives the actual factor of equation 3.21. The outcome of the simulations is summarized in Table 3.28 and the data of the finite element results are shown in appendix 4.

Table 3.28: Ratio for the actual ultimate resistance and the finite element model ultimate resistance

| Test [-] | $N_{u,actual}$ [kN] | $N_{u,fem}$ [kN] | $N_{u,actual}/N_{u,fem}$ [-] |
|---|---|---|---|
| A11 | 327.0 | 338.9 | 0.965 |
| A12 | 328.6 | 337.9 | 0.973 |
| A21 | 275.2 | 289.5 | 0.951 |
| A22 | 278.9 | 289.5 | 0.964 |
| A23 | 278.9 | 292.6 | 0.953 |
| A24 | 280.9 | 292.2 | 0.961 |
| A25 | 274.8 | 285.2 | 0.963 |
| A26 | 273.9 | 285.2 | 0.960 |
| A31 | 282.1 | 293.8 | 0.960 |
| A32 | 283.2 | 293.5 | 0.965 |
| A33 | 284.7 | 295.0 | 0.965 |
| A34 | 283.1 | 295.0 | 0.960 |
| A35 | 291.1 | 303.8 | 0.958 |
| A36 | 291.1 | 303.8 | 0.958 |

From the ratio of the actual ultimate resistance and the finite element model ultimate resistance, a mean, median, mode and standard deviation can be defined, which is shown in Table 3.29. Distributions are fitted on the data of the actual factor. The best fit is the normal distribution and is shown in Figure 3.34. The distribution fit is executed in MATLab.

Table 3.29: Mean, median, mode and standard deviation of the actual factor

| Parameters actual factor | |
|---|---|
| **Mean** | 0.9611 |
| **Median** | 0.9605 |
| **Mode** | 0.9600 |
| **Standard deviation** | 0.0055 |

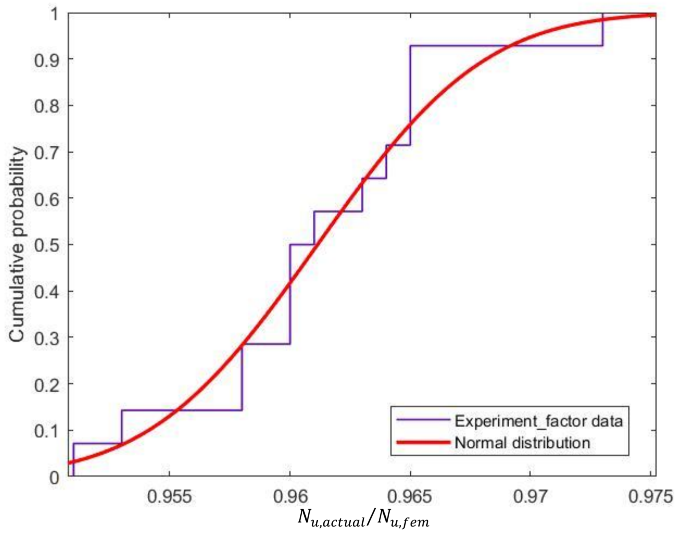



*Figure 3.34: Normal distribution fit on actual factor*

For the actual factor a normal distribution is used with a mean (μ) of 0.961143 and a standard deviation (δ) of 0.00547522. The normal distribution for the actual factor is applied without a standard error in the Monte Carlo simulation, because the mean, median and mode are close to each other.

#### *3.3.3.3. Difference finite element model and simulated ultimate resistance*

Generating finite element models for the steel grades S235, S355 and S460 will help defining the simulated factor per steel grade. The finite element model that is defined in paragraph 3.3.3.1 is used for generating finite element models. Per steel grade, 30 finite element models are simulated that differ in geometry. The baseline for the geometry is equal to the design value of geometry A11. In these models the hole diameter ($d_0$) will be increased from 18 mm to 47 mm with steps of 1 mm. Equation 3.22 will be used for determining the simulated factor in this paragraph.

Results from literature are used for the material model test. The research of Yun et al. (Yun et al., 2018) is used for steel grade S355 and the research of Wang et al. (Wang et al., 2016) for S460. Material models from these researches will be used in the finite element model. For each steel grade, the yield stress and ultimate strength are given and shown in Table 3.30.

*Table 3.30: Experimental material properties for S355 and S460 (Yun et al., 2018), (Wang et al., 2016)*

| Material properties | S355 | S460 |
|---|---|---|
| **Yield stress** | 408.4 $N/mm^2$ | 480.6 $N/mm^2$ |
| **Ultimate strength** | 518.4 $N/mm^2$ | 712.8 $N/mm^2$ |

Per steel grade a true stress-strain diagram is defined for the plastic behavior, using equations 3.23 and 3.24. The plastic behavior of steel grade S355 and S460 is shown in Figure 3.35 and Figure 3.36. Appendix 5 shows the input in Abaqus for the plastic behavior of steel grades S355 and S460.

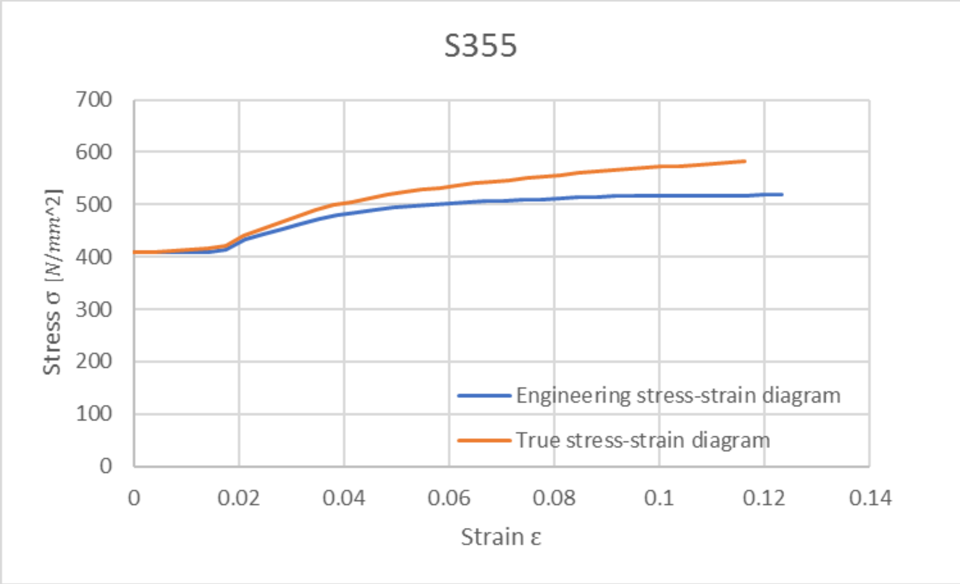



*Figure 3.35: Engineering- and true stress strain graph of the steel S355*

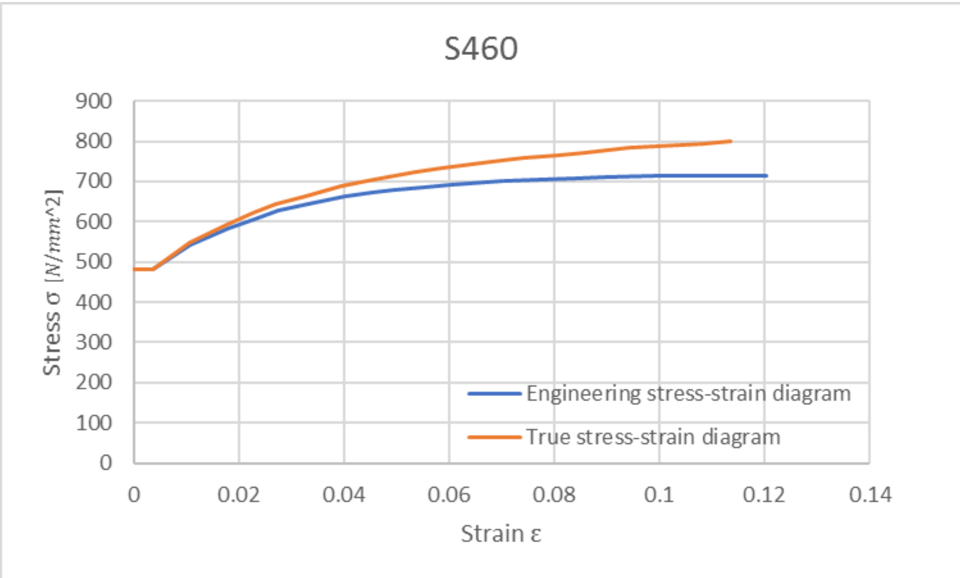



*Figure 3.36: Engineering- and true stress strain graph of the steel S460*

With the finite element model, per steel grade 30 simulations are conducted. The ultimate finite element model resistance is summarized in Table 3.31. These simulations are generated with a script, in which the material and hole diameter are variable. In appendix 6 the script of the finite element model is shown. In line 41 the hole diameter can be changed. Lines 281 to 297 represent the material that is used in the finite element model. This is changed for each steel grade. The total output of the finite element model simulations are shown in appendix 7 to 9. Table 3.1 shows also per simulation the corresponding ultimate theoretical resistance and the defined simulated factor per simulation. The simulated factor is determined with equation 3.22. Appendix 6 presents the output of the finite element models for steel grade S235. The same template is used for the other steel grades and their outcomes are summarized in Table 3.31.

Table 3.31: Simulated factor summarized per steel grade

| | S235 | | | S355 | | | S460 | | |
|---|---|---|---|---|---|---|---|---|---|
| Test [-] | $N_{u,fem}$ [kN] | $N_{u,sim}$ [kN] | $N_{u,fem}/N_{u,sim}$ [-] | $N_{u,fem}$ [kN] | $N_{u,sim}$ [kN] | $N_{u,fem}/N_{u,sim}$ [-] | $N_{u,fem}$ [kN] | $N_{u,sim}$ [kN] | $N_{u,fem}/N_{u,sim}$ [-] |
| 18 mm | 338.6 | 329.0 | 1.029 | 377.7 | 381.5 | 0.990 | 519.1 | 524.6 | 0.989 |
| 19 mm | 334.6 | 325.4 | 1.028 | 372.9 | 377.4 | 0.988 | 512.9 | 518.9 | 0.988 |
| 20 mm | 331.4 | 321.8 | 1.030 | 368.0 | 373.2 | 0.986 | 505.5 | 513.2 | 0.985 |
| 21 mm | 328.1 | 318.3 | 1.031 | 363.8 | 369.1 | 0.986 | 500.7 | 507.5 | 0.986 |
| 22 mm | 324.3 | 314.7 | 1.030 | 359.5 | 364.9 | 0.985 | 495.3 | 501.8 | 0.987 |
| 23 mm | 321.2 | 311.1 | 1.032 | 355.4 | 360.8 | 0.985 | 488.8 | 496.1 | 0.985 |
| 24 mm | 317.6 | 307.5 | 1.033 | 351.2 | 356.6 | 0.985 | 483.6 | 490.4 | 0.986 |
| 25 mm | 313.9 | 304.0 | 1.033 | 347.2 | 352.5 | 0.985 | 477.7 | 484.7 | 0.985 |
| 26 mm | 310.7 | 300.4 | 1.034 | 343.2 | 348.3 | 0.985 | 472.8 | 479.0 | 0.987 |
| 27 mm | 306.8 | 296.8 | 1.034 | 339.3 | 344.2 | 0.986 | 466.5 | 473.3 | 0.986 |
| 28 mm | 302.9 | 293.2 | 1.033 | 335.1 | 340.0 | 0.985 | 460.7 | 467.6 | 0.985 |
| 29 mm | 299.8 | 289.7 | 1.035 | 331.2 | 335.9 | 0.986 | 455.4 | 461.9 | 0.986 |
| 30 mm | 296.5 | 286.1 | 1.036 | 327.5 | 331.7 | 0.987 | 449.6 | 456.2 | 0.986 |
| 31 mm | 293.0 | 282.5 | 1.037 | 323.1 | 327.6 | 0.986 | 442.9 | 450.5 | 0.983 |
| 32 mm | 289.2 | 278.9 | 1.037 | 319.2 | 323.5 | 0.987 | 437.9 | 444.8 | 0.985 |
| 33 mm | 285.9 | 275.4 | 1.038 | 315.3 | 319.3 | 0.988 | 432.6 | 439.1 | 0.985 |
| 34 mm | 282.4 | 271.8 | 1.039 | 311.2 | 315.2 | 0.988 | 427.3 | 433.4 | 0.986 |
| 35 mm | 278.7 | 268.2 | 1.039 | 307.1 | 311.0 | 0.987 | 421.4 | 427.7 | 0.985 |
| 36 mm | 274.9 | 264.6 | 1.039 | 303.1 | 306.9 | 0.988 | 416.0 | 422.0 | 0.986 |
| 37 mm | 271.2 | 261.0 | 1.039 | 298.7 | 302.7 | 0.987 | 409.7 | 416.3 | 0.984 |
| 38 mm | 267.9 | 257.5 | 1.040 | 294.9 | 298.6 | 0.988 | 404.9 | 410.6 | 0.986 |
| 39 mm | 264.3 | 253.9 | 1.041 | 290.9 | 294.4 | 0.988 | 399.2 | 404.9 | 0.986 |
| 40 mm | 260.5 | 250.3 | 1.041 | 286.7 | 290.3 | 0.988 | 393.4 | 399.2 | 0.985 |
| 41 mm | 257.1 | 246.7 | 1.042 | 282.8 | 286.1 | 0.988 | 388.1 | 393.5 | 0.986 |
| 42 mm | 253.8 | 243.2 | 1.044 | 278.8 | 282.0 | 0.989 | 382.5 | 387.8 | 0.986 |
| 43 mm | 250.1 | 239.6 | 1.044 | 274.8 | 277.8 | 0.989 | 376.9 | 382.1 | 0.986 |
| 44 mm | 246.6 | 236.0 | 1.045 | 270.9 | 273.7 | 0.990 | 371.5 | 376.4 | 0.987 |
| 45 mm | 242.6 | 232.4 | 1.044 | 266.8 | 269.5 | 0.990 | 365.9 | 370.7 | 0.987 |
| 46 mm | 239.7 | 228.9 | 1.047 | 262.8 | 265.4 | 0.990 | 360.4 | 365.0 | 0.987 |
| 47 mm | 235.8 | 225.3 | 1.047 | 258.7 | 261.3 | 0.990 | 354.8 | 359.3 | 0.987 |

For each steel grade, a distribution is determined for the simulated factor. This distribution is used as input for the Monte Carlo simulation. Several shifted and non-shifted distributions are compared for the simulated factor to come to the best fitting distribution. For each steel grade an independent study is conducted for the best distribution fit. First, parameters are summarized in a table for the shifted and non-shifted data of the simulated factor. Secondly the shifted and non-shifted normal, lognormal and Weibull distribution will be fit. Thereafter the best distribution for simulated factor for the corresponding steel grade could be concluded. Finally, the parameters of the best fitting distribution are given. It is of importance that the distribution has a good fit in the lower tail, because this tail is determining in the Monte Carlo simulation. The tails have influence on how many times the structure will or will not fail according to capacity design.

#### 3.3.3.3.1. Simulated factor distribution fit for S235

For the simulated factor of steel S235, parameters are given in Table 3.32. As can be seen in Table 3.33, the non-shifted normal distribution and the non-shifted lognormal distribution are equal. The shifted distributions show a better fit. Looking more closely to the shifted distributions, it could be concluded that the shifted lognormal distribution provides the best fit, especially at the lower tail. Therefore the shifted lognormal distribution is chosen for the simulated factor of S235. The parameters of this distribution are shown in Table 3.34.

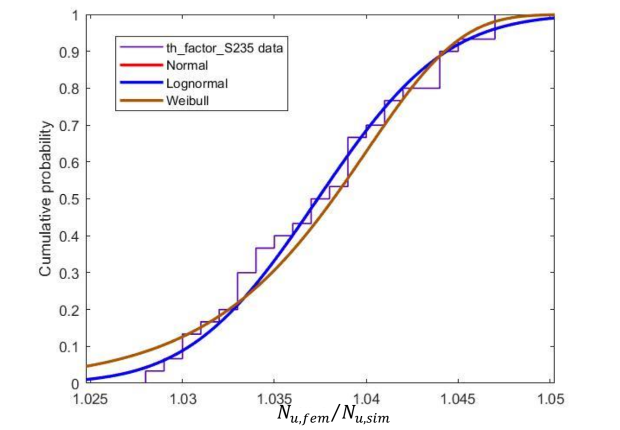
*Table 3.32: Parameters simulated factor S235*

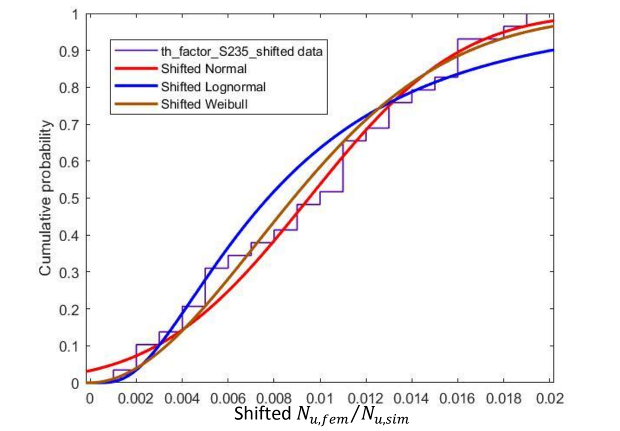
| Parameters simulated factor S235 | | |
|---|---|---|
| | Not shifted | Shifted |
| **Shifted value** | 0 | 1.02820 |
| **Mean** | 1.037 | 0.0095 |
| **Median** | 1.038 | 0.0100 |
| **Mode** | 1.040 | 0.0100 |
| **Standard deviation** | 0.00546 | 0.00517 |

*Table 3.33: Visualization of the fitted distribution for the simulated factor of S235*

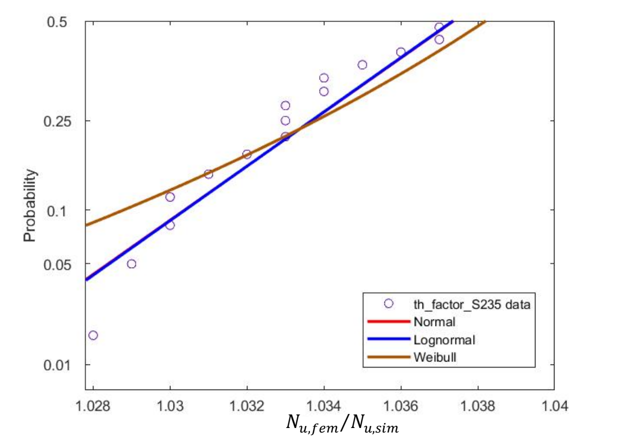
**Non-shifted distributions** | **Shifted distribution**

**Culmulative probability**




**Probability**



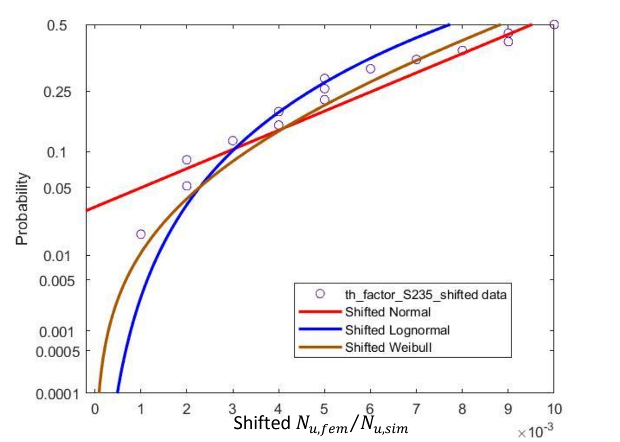




*Table 3.34: Parameters simulated factor distribution for S235*

| Parameter | Estimate | Std. Err. |
|---|---|---|
| **Mean** | -4.86272 | 0.138136 |
| **Standard deviation** | 0.743883 | 0.100305 |

### 3.3.3.3.2. Simulated factor distribution fit for S355

For the simulated factor of steel S355, parameters are given Table 3.35. As can be seen in Table 3.36, the non-shifted normal distribution and the non-shifted lognormal distribution are equal. The shifted distributions show a better fit. Looking closely to the shifted distributions, it can be said that the shifted lognormal distribution gives the best fit, especially when looking at the lower tail. Therefore the shifted lognormal distribution is chosen for the simulated factor of S355. The parameters of this distribution are shown in Table 3.37.

*Table 3.35: Parameters simulated factor S355*

| Parameters simulated factor S355 | | |
|---|---|---|
| | Not shifted | Shifted |
| **Shifted value** | 0 | 0.98488 |
| **Mean** | 0.987 | 0.0025 |
| **Median** | 0.988 | 0.0026 |
| **Mode** | 0.990 | 0.0029 |
| **Standard deviation** | 0.00173 | 0.0016 |

*Table 3.36: Visualization of the fitted distribution for the simulated factor of S355*

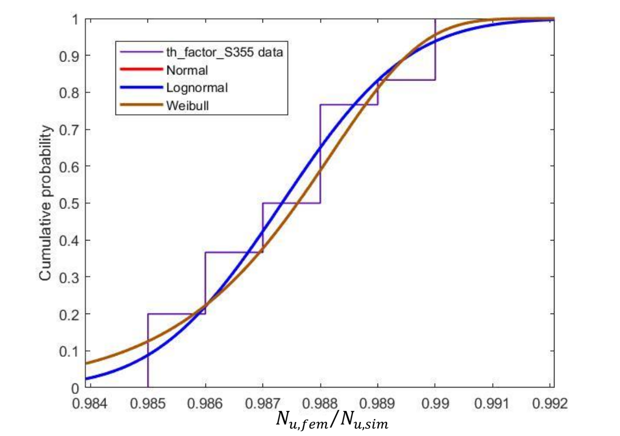
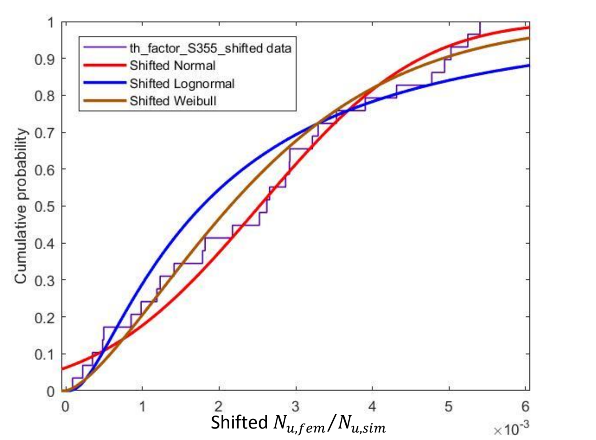
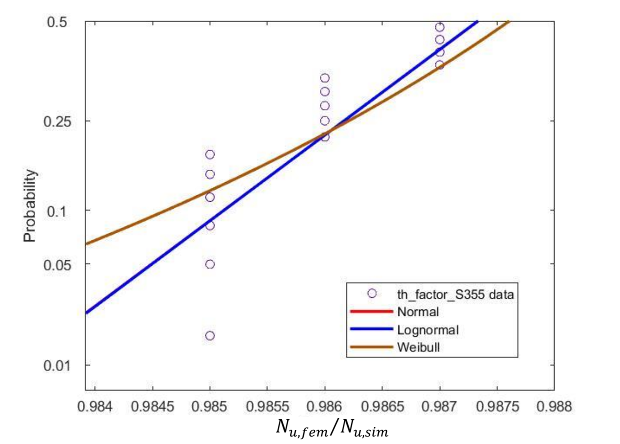
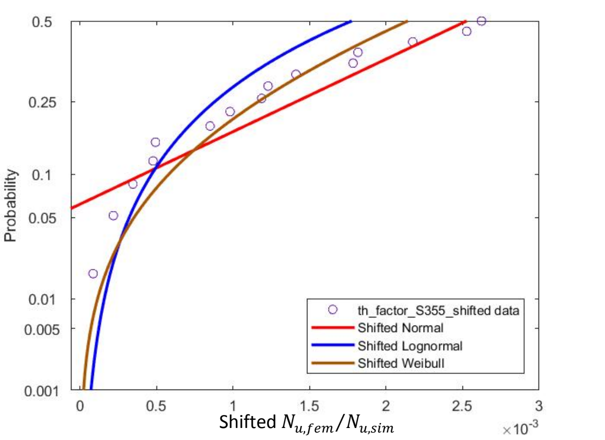
<table>
<tr><th></th><th>Non-shifted distributions</th><th>Shifted distribution</th></tr>
<tr><td>Culmulative probability</td><td>
</td><td>
</td></tr>
<tr><td>Probability</td><td>
</td><td>
</td></tr>
</table>

*Table 3.37: Parameters simulated factor distribution for S355*

| Parameter | Estimate | Std. Err. |
|---|---|---|
| **Mean** | -6.33422 | 0.192925 |
| **Standard deviation** | 1.03893 | 0.140089 |

### 3.3.3.3.3. Simulated factor distribution fit for S460

For the simulated factor of steel S460, the parameters are given in Table 3.38. As can be seen in Table 3.39, the non-shifted normal distribution and the non-shifted lognormal distribution are equal. The shifted distributions show a better fit. Looking into the shifted distributions, it can be said that the shifted lognormal distribution gives the best fit, especially when looking at the lower tail. Therefore the shifted lognormal distribution is chosen for the simulated factor of S460. The parameters of this distribution are shown in Table 3.40.

*Table 3.38: Parameters simulated factor S460*

| Parameters simulated factor S460 | | |
|---|---|---|
| | Not shifted | Shifted |
| **Shifted value** | 0 | 0.98306 |
| **Mean** | 0.986 | 0.0030 |
| **Median** | 0.986 | 0.0029 |
| **Mode** | 0.990 | 0.0034 |
| **Standard deviation** | 0.001173 | 0.0012 |

*Table 3.39: Visualization of the fitted distribution for the simulated factor of S460*

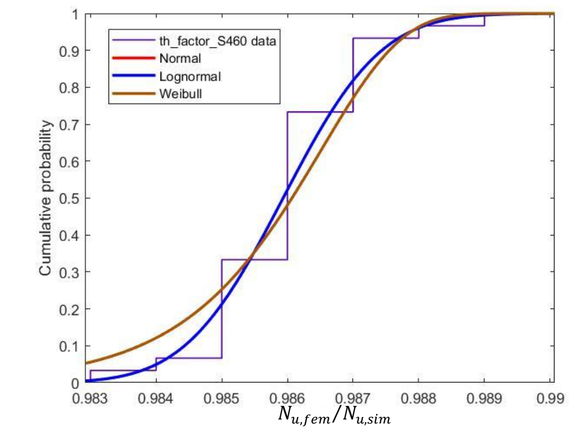
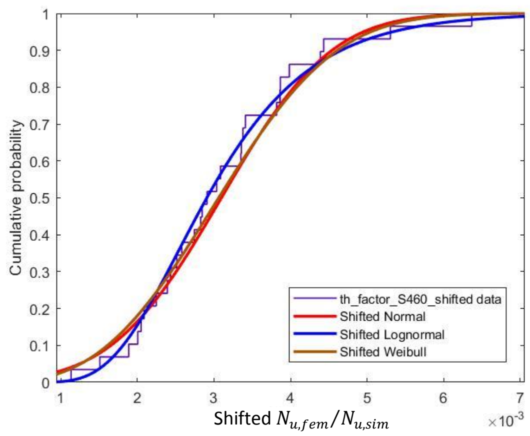
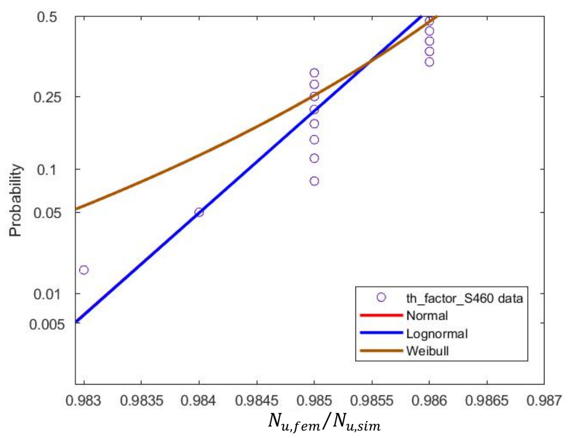
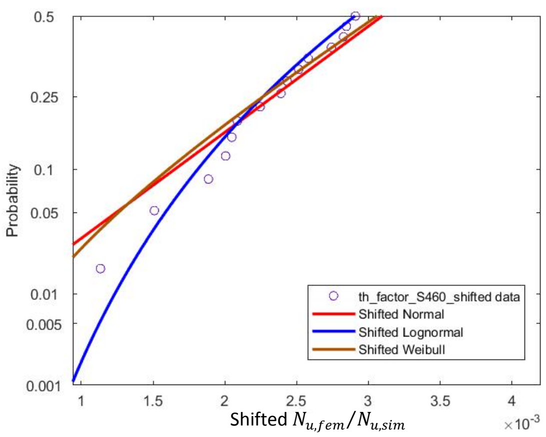
| | Non-shifted distributions | Shifted distribution |
|---|---|---|
| **Culmulative probability** |   |   |
| **Probability** |   |   |

*Table 3.40: Parameters simulated factor distribution for S460*

| Parameter | Estimate | Std. Err. |
|---|---|---|
| **Mean** | -5.84113 | 0.0684712 |
| **Standard deviation** | 0.368729 | 0.0497194 |

#### 3.3.3.4. Correlation $\boldsymbol{d_0/b}$ and $\boldsymbol{N_{u,fem}}/\boldsymbol{N_{u,sim}}$

The simulated factor relates to the ratio of the hole diameter and the height of the plate. The relationship between the ratio of the hole diameter and the height of the steel plate and the simulated factor is shown in Table 3.41.

*Table 3.41: Simulated factor per steel grade depending on $d_0/b$*

| | S235 | S355 | S460 |
|---|---|---|---|
| $d_0/b$ [-] | $N_{u,fem}/N_{u,sim}$ [-] | $N_{u,fem}/N_{u,sim}$ [-] | $N_{u,fem}/N_{u,sim}$ [-] |
| 0.16 | 1.029 | 0.990 | 0.989 |
| 0.17 | 1.028 | 0.988 | 0.988 |
| 0.18 | 1.030 | 0.986 | 0.985 |
| 0.19 | 1.031 | 0.986 | 0.986 |
| 0.2 | 1.030 | 0.985 | 0.987 |
| 0.21 | 1.032 | 0.985 | 0.985 |
| 0.22 | 1.033 | 0.985 | 0.986 |
| 0.23 | 1.033 | 0.985 | 0.985 |
| 0.24 | 1.034 | 0.985 | 0.987 |
| 0.25 | 1.034 | 0.986 | 0.986 |
| 0.25 | 1.033 | 0.985 | 0.985 |
| 0.26 | 1.035 | 0.986 | 0.986 |
| 0.27 | 1.036 | 0.987 | 0.986 |
| 0.28 | 1.037 | 0.986 | 0.983 |
| 0.29 | 1.037 | 0.987 | 0.985 |
| 0.3 | 1.038 | 0.988 | 0.985 |
| 0.31 | 1.039 | 0.988 | 0.986 |
| 0.32 | 1.039 | 0.987 | 0.985 |
| 0.33 | 1.039 | 0.988 | 0.986 |
| 0.34 | 1.039 | 0.987 | 0.984 |
| 0.35 | 1.040 | 0.988 | 0.986 |
| 0.35 | 1.041 | 0.988 | 0.986 |
| 0.36 | 1.041 | 0.988 | 0.985 |
| 0.37 | 1.042 | 0.988 | 0.986 |
| 0.38 | 1.044 | 0.989 | 0.986 |
| 0.39 | 1.044 | 0.989 | 0.986 |
| 0.4 | 1.045 | 0.990 | 0.987 |
| 0.41 | 1.044 | 0.990 | 0.987 |
| 0.42 | 1.047 | 0.990 | 0.987 |
| 0.43 | 1.047 | 0.990 | 0.987 |

The relationship is defined with a linear fitting line and corresponding standard error. The fitting lines are shown in Figure 3.37 to Figure 3.39. In Table 3.42 the standard errors are given for the fitting line that describes the relation.

*Table 3.42: Standard error per steel grade for relation $d_0/b$ and simulated factor*

| | Standard error |
|---|---|
| S235 | 0.00075 |
| S350 | 0.00122 |
| S460 | 0.00124 |

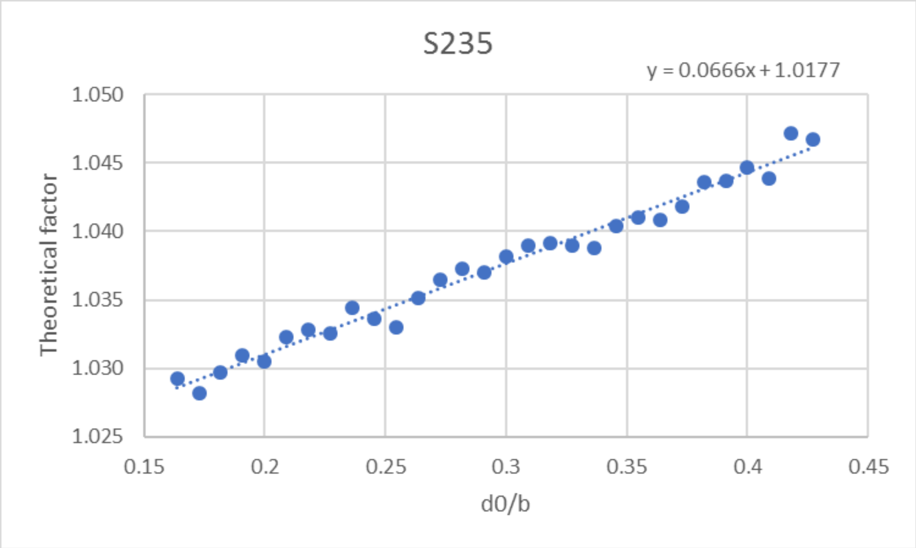



*Figure 3.37: Relationship of simulated factor with $d_0/b$ for S235*

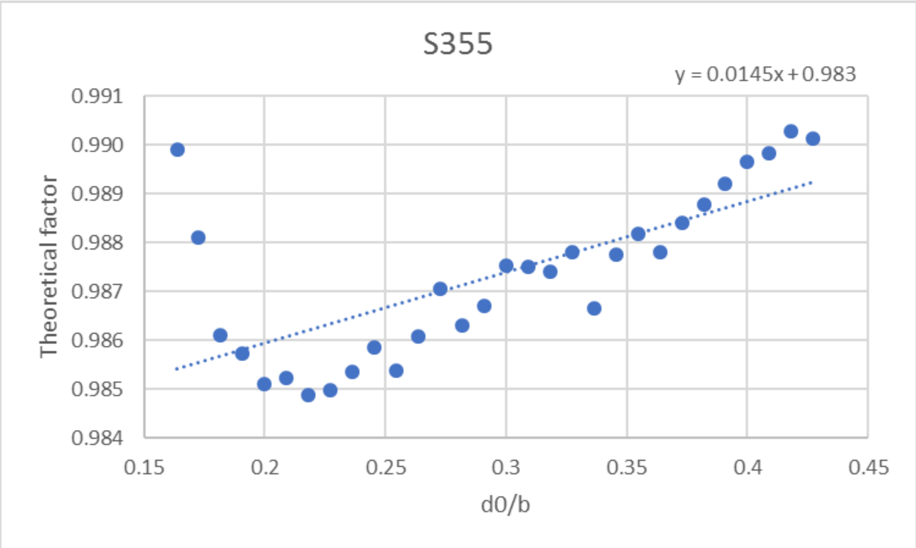



*Figure 3.38: Relationship of simulated factor with $d_0/b$ for S355*

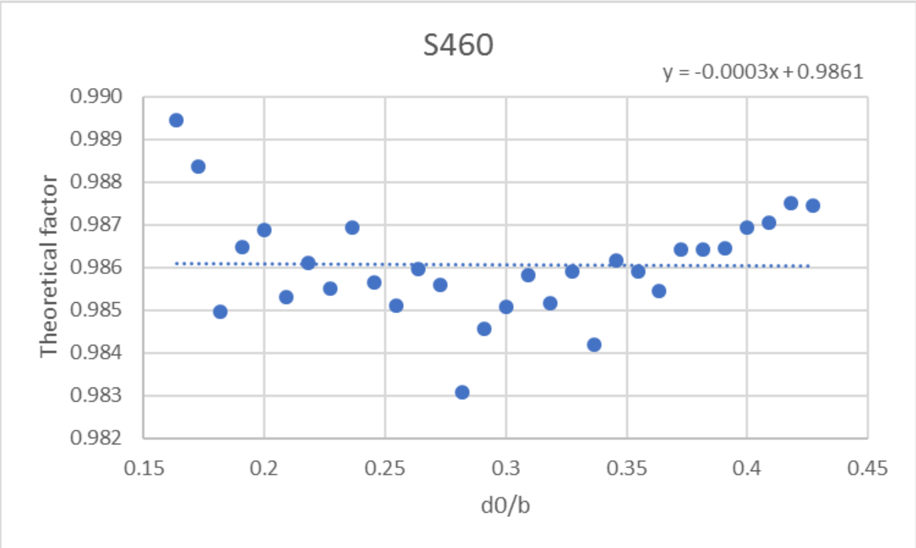



*Figure 3.39: : Relationship of simulated factor with $d_0/b$ for S460*

#### 3.3.3.5. *Model factor in Monte Carlo simulation*

The actual factor and simulated factor are both used in the Monte Carlo simulation to describe the model factor. The simulated factor can be expressed in two different ways:

1. The simulated factor can be described with the use of a distribution.
2. The simulated factor can be described by a linear relationship with $d_0/b$.

Therefore two different Monte Carlo simulations will be carried out. One in which the simulated factor is described with the use of a distribution and another in which the simulated factor is described by a linear relationship with $d_0/b$. The expression of the actual factor is in both situations the same. The actual factor and simulated factor are expressed by equations 3.25 to 3.29 and the model factor is described with the use of equation 3.30 in the Monte Carlo simulation. Equation 3.26 to equation 3.28 are used for describing the simulated factor with the use of a distribution and equation 3.27 describes the simulated factor with a linear relationship with $d_0/b$. This is carried out in MATLab.

```
ActFactor=(icdf('normal',rand(1,num_samp),ActFactorm,ActFactorst));                  (3.25)
SimFactormu=icdf('normal',rand(1,num_samp),SimFactormum,SimFactormust);              (3.26)
SimFactorsigma=icdf('normal',rand(1,num_samp),SimFactorsigmam,SimFactorsigmast);     (3.27)
SimFactor=(icdf('lognormal',rand(1,num_samp),SimFactormu,SimFactorsigma)+shifted));  (3.28)
SimFactor=(icdf('normal',rand(1,num_samp),SimFactormu,SimFactorst))+(p1*db+p2);      (3.29)
ModelFactor=(ActFactor.*SimFactor);                                                  (3.30)
```

With:

| | |
|---|---|
| icdf | Inverse cumulative distribution function |
| 'normal' | Indicates that the generated numbers are from a normal distribution |
| rand | Function for generating a random number between 0 and 1. The numbers between the brackets determining the matrix of the generated numbers. |
| num_samp | Number of specimens that will be generated |
| ActFactor | Actual factor |
| ActFactorm | Mean value of the actual factor |
| ActFactorst | Standard deviation of the actual factor |
| SimFactor | Simulated factor |
| SimFactormu | Mean value of the simulated factor |
| SimFactormum | Mean value of the mean of the simulated factor |
| SimFactormust | Standard error of the mean of the simulated factor |
| SimFactorsigma | Standard deviation of the simulated factor |
| SimFactorsigmam | Mean value of the standard deviation of the simulated factor |
| SimFactorsigmast | Standard error of the standard deviation of the simulated factor |
| p1 | Variable 1 that describes the relation |
| p2 | Variable 2 that describes the relation |
| db | Ratio hole diameter and steel plate height |

### 3.3.4. Overview input

In Table 3.43 an overview is given of the input for the different variables for in the Monte Carlo simulation per steel grade and per steel plate thickness.

*Table 3.43: Overview input variables Monte Carlo simulation*

| Input variables | S235 | | | S355 | | | S460 | | |
|---|---|---|---|---|---|---|---|---|---|
| | t≤ 16mm | 16mm <t ≤ 40mm | 40mm <t ≤ 63mm | t≤ 16mm | 16mm <t ≤ 40mm | 40mm <t ≤ 63mm | t≤ 16mm | 16mm <t ≤ 40mm | 40mm <t ≤ 63mm |
| $f_y$ nom | 235 | 225 | 215 | 355 | 345 | 335 | 460 | 440 | 430 |
| $f_u$ nom | 360 | 360 | 360 | 470 | 470 | 470 | 540 | 540 | 540 |
| $t$ nom | 8 | 28 | 51 | 8 | 28 | 51 | 8 | 28 | 51 |
| $b$ nom | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 | 110 |
| $d0$ nom | 0-55 | 0-55 | 0-55 | 0-55 | 0-55 | 0-55 | 0-55 | 0-55 | 0-55 |
| $\frac{f_y \text{ mean}}{f_y \text{ nom}}$ | 1.25 | 1.25 | 1.25 | 1.2 | 1.2 | 1.2 | 1.15 | 1.15 | 1.15 |
| $\frac{f_u \text{ mean}}{f_u \text{ nom}}$ | 1.2 | 1.2 | 1.2 | 1.125 | 1.125 | 1.125 | 1.1 | 1.1 | 1.1 |
| $\frac{t \text{ mean}}{t \text{ nom}}$ | 0.975 | 0.975 | 0.975 | 0.975 | 0.975 | 0.975 | 0.975 | 0.975 | 0.975 |
| $\frac{b \text{ mean}}{b \text{ nom}}$ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| $\frac{d0 \text{ mean}}{d0 \text{ nom}}$ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| $f_y$ c.o.v. | 5.5 | 5.5 | 5.5 | 5 | 5 | 5 | 4.5 | 4.5 | 4.5 |
| $f_u$ c.o.v. | 4.5 | 4.5 | 4.5 | 3.25 | 3.25 | 3.25 | 3.25 | 3.25 | 3.25 |
| $t$ c.o.v. | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 |
| $b$ c.o.v. | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 | 0.9 |
| $d0$ c.o.v. | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| correlation $f_y$ and $f_u$ | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| ActFactor μ | 0.96114 | 0.96114 | 0.96114 | 0.96114 | 0.96114 | 0.96114 | 0.96114 | 0.96114 | 0.96114 |
| ActFactor δ | 0.00548 | 0.00548 | 0.00548 | 0.00548 | 0.00548 | 0.00548 | 0.00548 | 0.00548 | 0.00548 |
| The simulated factor is described with the use of a shifted lognormal distribution. | | | | | | | | | |
| Shifted value | 1.02820 | 1.02820 | 1.02820 | 0.98488 | 0.98488 | 0.98488 | 0.98306 | 0.98306 | 0.98306 |
| SimFactor μ | -4.8627 | -4.8627 | -4.8627 | -6.3342 | -6.3342 | -6.3342 | -5.8411 | -5.8411 | -5.8411 |
| SimFactor δ | 0.74389 | 0.74389 | 0.74389 | 1.03893 | 1.03893 | 1.03893 | 0.36873 | 0.36873 | 0.36873 |
| SimFactor μ std. err. | 0.13814 | 0.13814 | 0.13814 | 0.19293 | 0.19293 | 0.19293 | 0.06847 | 0.06847 | 0.06847 |
| SimFactor δ std. err. | 0.10031 | 0.10031 | 0.10031 | 0.14009 | 0.14009 | 0.14009 | 0.04972 | 0.04972 | 0.04972 |
| The simulated factor is described with the use of a correlation with $d_0/b$ . | | | | | | | | | |
| p1 | 0.0666 | 0.0666 | 0.0666 | 0.0145 | 0.0145 | 0.0145 | -0.0003 | -0.0003 | -0.0003 |
| p2 | 1.0177 | 1.0177 | 1.0177 | 0.983 | 0.983 | 0.983 | 0.9861 | 0.9861 | 0.9861 |
| SimFactor std. err. | 0.00075 | 0.00075 | 0.00075 | 0.00122 | 0.00122 | 0.00122 | 0.00124 | 0.00124 | 0.00124 |

In appendix 10 and 11 the scripts are shown that are used for the Monte Carlo. The script is looped, whereby the hole diameter can differ. The loop script is shown in appendix 11 and the Monte Carlo script is shown in appendix 10.1 and 10.2.

## 3.4. OUTPUT

This chapter shows how the partial factor is determined for the new capacity design rule. Firstly, the corresponding partial factor is determined using the simulated factor with a shifted lognormal distribution. Secondly, the partial factor is determined for the simulated factor described by a relation with the ratio $d_0/b$ . This section concludes with which partial factor to use in the new capacity design rule that is described by equation 2.10.

As described in paragraph 3.2, the partial factor is determined according to the flipping point in which the geometry does not fulfill the requirements for the probability of failure and in which case it does fulfill the requirements according to failure in line with capacity design. In paragraph 3.2.1, 2 options are described and from this research it showed that option 2 was more conservative and therefore this method is chosen for determining the partial factor. Per 1.000.000 simulations a geometry shall not fail 1182 times or more on capacity design. If 1182 or more failures occur on capacity design, the unity check of the new capacity design rule may not be lower than 1. Because when the unity check for the capacity design is smaller than 1 the corresponding specimen is in line with capacity design.

### 3.4.1. Without correlation

As mentioned in the previous paragraph, only 1182 failures may occur on capacity design. This means that a geometry that contains less than 1182 failures satisfies the capacity design rule. In Table 3.44 it can be seen that the flipping point is between a $d_0/b$ ratio of 34.45% and 34.55%. A geometry with a $d_0/b$ ratio of 34.55% satisfies with a partial factor equal to 1.000, but as can be seen in Table 3.44 too many failures occur. All the geometries that have less than 1182 failures not in line with capacity design, satisfy the unity check with the use of a partial factor of 1.003. If a geometry has more than 1182 failures, it does not satisfy the unity check of the new capacity design rule with a partial factor of 1.003. Therefore the new capacity design rule with a partial factor of 1.003 satisfies for steel grade S235 and steel plate thickness t ≤ 16mm.

Table 3.44: Output simulations for S235 and t ≤ 16mm

| S235 $t \leq 16mm$ | | | | |
|---|---|---|---|---|
| $d_0/b$ % | Numbers of failures # | Unity check with $\gamma_{m^*}$ 1.000 [-] | Unity check with $\gamma_{m^*}$ 1.003 [-] | Formula check - |
| **22.73** | 0 | 0.845 | 0.847 | correct |
| **23.64** | 0 | 0.855 | 0.857 | correct |
| **24.55** | 0 | 0.865 | 0.868 | correct |
| **25.45** | 0 | 0.876 | 0.878 | correct |
| **26.36** | 0 | 0.886 | 0.889 | correct |
| **27.27** | 0 | 0.898 | 0.900 | correct |
| **28.18** | 0 | 0.909 | 0.912 | correct |
| **29.09** | 0 | 0.921 | 0.923 | correct |
| **30.00** | 0 | 0.933 | 0.935 | correct |
| **30.91** | 5 | 0.945 | 0.948 | correct |
| **31.82** | 20 | 0.957 | 0.960 | correct |
| **32.73** | 87 | 0.970 | 0.973 | correct |
| **33.64** | 334 | 0.984 | 0.987 | correct |
| **33.73** | 427 | 0.985 | 0.988 | correct |
| **33.82** | 471 | 0.986 | 0.989 | correct |
| **33.91** | 548 | 0.988 | 0.991 | correct |
| **34.00** | 567 | 0.989 | 0.992 | correct |
| **34.09** | 733 | 0.990 | 0.993 | correct |
| **34.18** | 793 | 0.992 | 0.995 | correct |
| **34.27** | 880 | 0.993 | 0.996 | correct |
| **34.36** | 1051 | 0.995 | 0.998 | correct |
| **34.45** | 1159 | 0.996 | 0.999 | correct |
| **34.55** | 1270 | 0.997 | 1.000 | correct |
| **35.45** | 4316 | 1.011 | 1.014 | correct |
| **36.36** | 11869 | 1.026 | 1.029 | correct |
| **37.27** | 30083 | 1.041 | 1.044 | correct |
| **38.18** | 65414 | 1.056 | 1.059 | correct |
| **39.09** | 127640 | 1.072 | 1.075 | correct |
| **40.00** | 221534 | 1.088 | 1.091 | correct |
| **40.91** | 346171 | 1.105 | 1.108 | correct |
| **41.82** | 488603 | 1.122 | 1.125 | correct |
| **42.73** | 629034 | 1.140 | 1.143 | correct |
| **43.64** | 752879 | 1.158 | 1.162 | correct |
| **44.55** | 845576 | 1.177 | 1.181 | correct |
| **45.45** | 907536 | 1.197 | 1.200 | correct |
| **46.36** | 943194 | 1.217 | 1.221 | correct |
| **47.27** | 961735 | 1.238 | 1.242 | correct |
| **48.18** | 970164 | 1.260 | 1.264 | correct |
| **49.09** | 973004 | 1.282 | 1.286 | correct |
| **50.00** | 974028 | 1.306 | 1.309 | correct |
| **50.91** | 974460 | 1.330 | 1.334 | correct |
| **51.82** | 973651 | 1.355 | 1.359 | correct |
| **52.73** | 973522 | 1.381 | 1.385 | correct |
| **53.64** | 973028 | 1.408 | 1.412 | correct |
| **54.55** | 972576 | 1.436 | 1.440 | correct |

The partial factor is determined in the same manner as for S235 for other steel plate thicknesses and steel grades. These partial factors are summarized in Table 3.45. Appendix 12.1 shows the output of the Monte Carlo simulation of this paragraph.

Table 3.45: Partial factors summarized, simulated factor determined by a shifted lognormal distribution

| | S235 | S355 | S460 |
|---|---|---|---|
| $t \leq 16\,mm$ | $\gamma_{m^*} = 1.003$ | $\gamma_{m^*} = 0.972$ | $\gamma_{m^*} = 0.900$ |
| $16\,mm < t \leq 40mm$ | $\gamma_{m^*} = 1.025$ | $\gamma_{m^*} = 0.986$ | $\gamma_{m^*} = 0.922$ |
| $40\,mm < t \leq 63\,mm$ | $\gamma_{m^*} = 1.000$ | $\gamma_{m^*} = 1.002$ | $\gamma_{m^*} = 0.933$ |

### 3.4.2. With correlation

In the previous paragraph is mentioned how the partial factor is determined in case the simulated factor is determined with a shifted lognormal distribution. In this paragraph the same method is applied, in case the simulated factor is determined with a relation of the ratio for the hole diameter and the plate height. In Table 3.46 summarize, what the corresponding partial factors are per steel grade and steel plate thickness. Appendix 12.2 shows the output of the Monte Carlo simulation of this paragraph.

*Table 3.46: Partial factors summarized, simulated factor determined by a relation with ratio $d_0/b$*

| | S235 | S355 | S460 |
|---|---|---|---|
| $\boldsymbol{t \leq 16\,mm}$ | $\gamma_{m^*} = 0.999$ | $\gamma_{m^*} = 0.973$ | $\gamma_{m^*} = 0.900$ |
| $\boldsymbol{16\,mm < t \leq 40mm}$ | $\gamma_{m^*} = 1.020$ | $\gamma_{m^*} = 0.988$ | $\gamma_{m^*} = 0.922$ |
| $\boldsymbol{40\,mm < t \leq 63\,mm}$ | $\gamma_{m^*} = 1.042$ | $\gamma_{m^*} = 1.002$ | $\gamma_{m^*} = 0.933$ |

### 3.4.3. Conclusion

Both methods are compared in Table 3.47. The difference between the outcomes in which the simulated factor is determined is minimal. Due to the fact that the underlying reason of the correlation is not further investigated, the outcomes in which the simulated factor is determined with the use of a shifted lognormal distribution are used.

*Table 3.47: Comparison partial factors*

| | | *Shifted Lognormal* | *Correlation* |
|---|---|---|---|
| **S235** | *t<16* | 1.003 | 0.999 |
| | *16<t<40* | 1.025 | 1.020 |
| | *40<t63* | 1.000 | 1.042 |
| **S355** | *t<16* | 0.972 | 0.973 |
| | *16<t<40* | 0.986 | 0.988 |
| | *40<t63* | 1.002 | 1.002 |
| **S460** | *t<16* | 0.900 | 0.900 |
| | *16<t<40* | 0.922 | 0.922 |
| | *40<t63* | 0.933 | 0.933 |

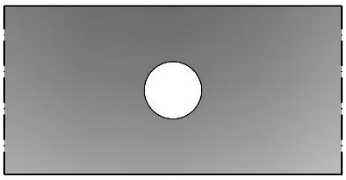
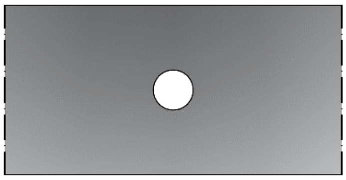
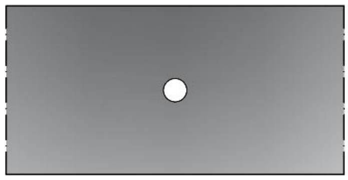
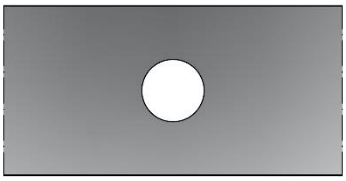
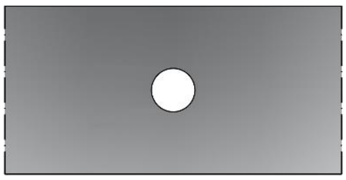
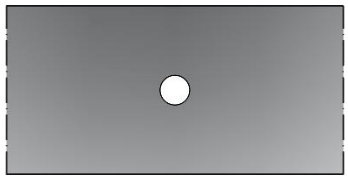
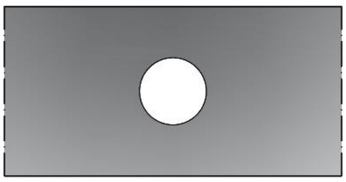
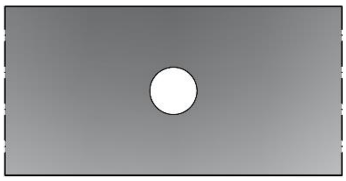
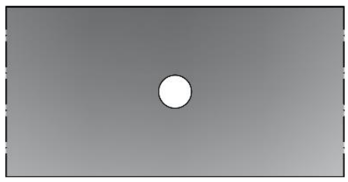
As can be seen in Table 3.45, the difference between the partial factors for the steel thicknesses per steel grade are minimal. Therefore the partial factor can be given per steel grade: for S235 the partial factor is 1.03, for S355 the partial factor is 1.00 and for S460 the partial factor is 0.93. The difference for the partial factors for steel grade S235 and S355 is minimal and for steel grade S460 even a less conservative partial factor is usable. Because of "ease of use", one uniform partial factor is chosen for the new capacity design rule, in which the partial factor has a rounded value of 1.03.

## 3.5. CONCLUSION

The Monte Carlo simulation is used to define the partial factor for the new capacity design rule. From the results of the Monte Carlo simulation it can be concluded that the partial factor for the new capacity design rule is 1.03, which is also shown in equation 3.31. Table 3.48 shows the allowable hole diameter per hole diameter–steel plate height ratio for the new capacity design rule.

$$1.03 \frac{A f_y}{A_{net} f_u} < 1 \tag{3.31}$$

*Table 3.48: Summary allowable hole diameter percentage according to the new capacity design rule*

| | S235 | S355 | S460 |
|---|---|---|---|
| $t \leq 16\ mm$ |  $d_0/b = 32.7\%$ |  $d_0/b = 22.2\%$ |  $d_0/b = 12.2\%$ |
| $16\ mm < t \leq 40\ mm$ |  $d_0/b = 35.6\%$ |  $d_0/b = 24.3\%$ |  $d_0/b = 16.0\%$ |
| $40\ mm < t \leq 63\ mm$ |  $d_0/b = 38.4\%$ |  $d_0/b = 26.5\%$ |  $d_0/b = 17.9\%$ |

# 4. VISUALIZATION FAILURE MECHANISM PROGRESS

## 4.1. MOTIVATION AND OBJECTIVE

The goal of this chapter is to visualize the failure mechanism progress of a bolted steel connection. In other words, the failure of a steel plate with holes from gross cross-section failure to net cross-section failure will be visualized. This visualization will give a better understanding of the behavior of the failure mechanisms of a steel plate. Next to that, it can contribute to check the safety of the new capacity design rule.

## 4.2. VISUALIZED GEOMETRIES

All the specimens that will be visualized are made of steel grade S235 and have a thickness of 8mm. The geometries are specimens that have an unity check of 0.9, 1.0 and 1.1 according to the new capacity design rule. Additionally, a geometry will be visualized that fails for 50% on capacity design. As can be seen in Table 3.44, 50% of the specimens fail according to capacity design between a 41.82% and 42.73% ratio of $d_0/b$. This results in a steel plate with a height of 110 mm and a corresponding hole diameter of 46 mm or 47 mm, this is further elaborated in Table 4.1. In Table 4.1 it can be seen that a steel plate with a hole diameter of 46.1 mm comes the closest to the situation where 50% of the specimens will fail according capacity design, because 1,000,000 simulations are carried out and the turning point is at 500,000 failures.

*Table 4.1: Number of failures of S235 and t ≤ 16mm*

| S235 t ≤ 16mm | | |
|---|---|---|
| $d_0$ | b | Numbers of failures |
| mm | mm | # |
| **46.0** | 110 | 487303 |
| **46.1** | 110 | 502734 |
| **46.2** | 110 | 517224 |
| **46.3** | 110 | 532513 |
| **46.4** | 110 | 545114 |
| **46.5** | 110 | 561295 |
| **46.6** | 110 | 574521 |
| **46.7** | 110 | 588572 |
| **46.8** | 110 | 602296 |
| **46.9** | 110 | 616569 |
| **47.0** | 110 | 630065 |

Table 4.2 shows which geometries will be visualized, in this table also the corresponding unity checks are given. All the geometries are made of S235 and have a thickness of t ≤ 16mm.

*Table 4.2: Visualized geometries*

| S235 | | | |
|---|---|---|---|
| $d_0$ | b | t | Unity check |
| **mm** | mm | mm | - |
| **27.8** | 110 | 8 | 0.90 |
| **36.0** | 110 | 8 | 1.00 |
| **42.7** | 110 | 8 | 1.10 |
| **46.1** | 110 | 8 | 1.15 |

## 4.3. Finite Element Model

For the visualization of the failure mechanism progress a finite element model is used. The finite element model that is used in paragraph 3.3.3 is also used in this paragraph. Only the stress-strain material model is different and will be explained in the upcoming paragraph.

### 4.3.1. Stress-Strain model

The stress strain (hardening) model of the Eurocode that is recommended for steel will be used. Figure 4.1 shows how the material model can be modeled according to the Eurocode (EN 1993-1-5, 2011). A yielding plateau with a slope is used and linear strain hardening is used for the material model that will be used in the finite element model, this is highlighted in Figure 4.1.

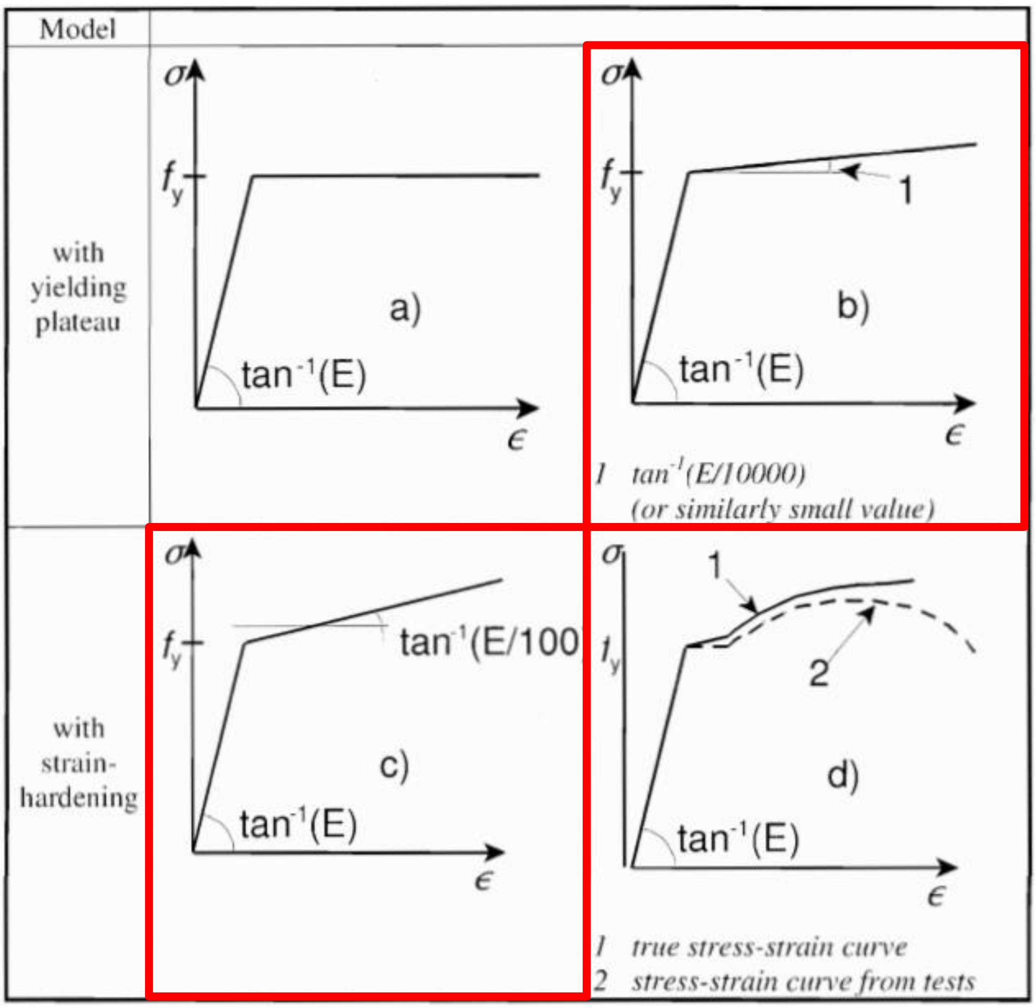



*Figure 4.1: Modelling of material behavior according to Eurocode (EN 1993-1-5, 2011)*

Table 4.3 shows which properties will be used for determining the stress-strain model. With the use of the material properties and Figure 4.1, an engineering stress-strain model can be determined. The engineering stress-strain model is translated into a true stress-strain model with the use of equation 3.23 and equation 3.24. The engineering and the true stress-strain behavior is shown in Figure 4.2. The true stresses will be used in the finite element model.

*Table 4.3: Material properties specimens*

| Material properties specimens | |
|---|---|
| **Modulus of Elasticity** | 210000 $N/mm^2$ |
| **Poisson's ratio** | v=0.3 |
| **Yield stress** | 235 $N/mm^2$ |
| **Ultimate strength** | 360 $N/mm^2$ |

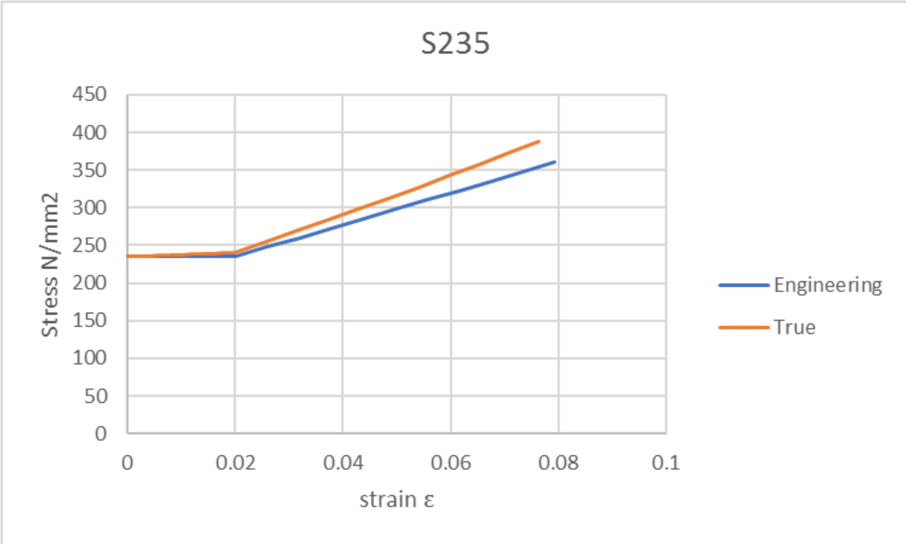



*Figure 4.2: Engineering and true stress-strain model for S235*

## 4.4. Visualizations

For each geometry the local strain, maximum principle stress and Von Mises stress are visualized. In Figure 4.3 to Figure 4.6 is the maximum local strain visualized. Figure 4.7 to Figure 4.10 show the maximum principle stress. And in Figure 4.11 to Figure 4.14 is the Von Mises stress visualized. Figure 4.3 to Figure 4.14 are made at the moment that the specimen reach its ultimate load. The results of finite element models are shown in appendix 13.

In Figure 4.3 to Figure 4.6 it can be seen that the highest strain is centered above and under the hole. The maximum strain decreases when the unity check increases, this is also shown in Table 4.4.


*Figure 4.3: Maximal local plastic strain for geometry with a unity check 0.90*

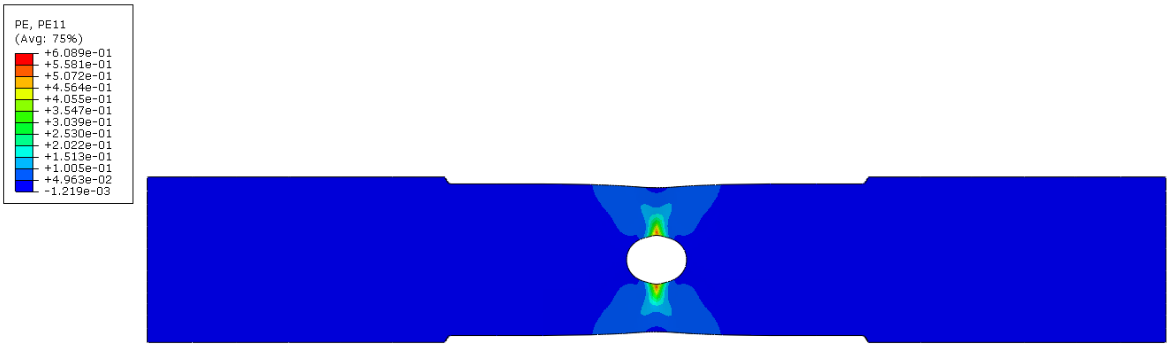



*Figure 4.4: Maximal local plastic strain for geometry with a unity check 1.00*

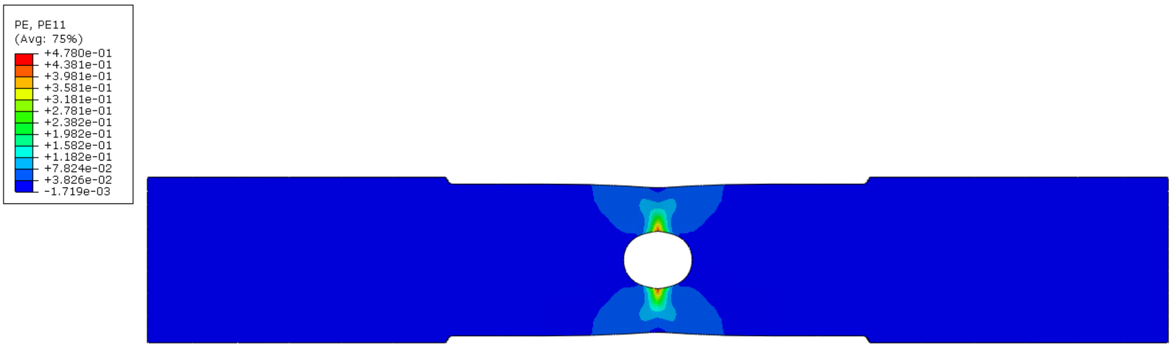



*Figure 4.5: Maximal local plastic strain for geometry with a unity check 1.10*

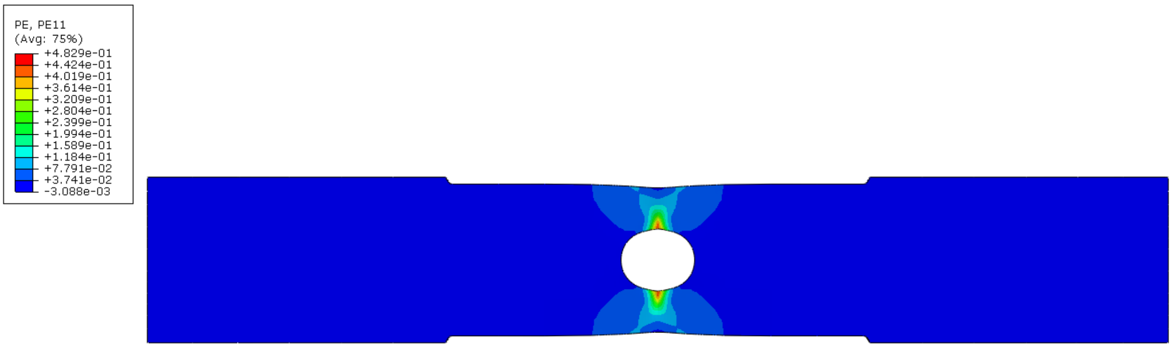



*Figure 4.6: Maximal local plastic strain for geometry with a unity check 1.15*

In Figure 4.7 to Figure 4.10 it can be seen that the maximum principle stress decreases when the unity check increases. The highest maximum principle stresses are on the vertical axis across the hole diameter, this is also shown in Table 4.4.

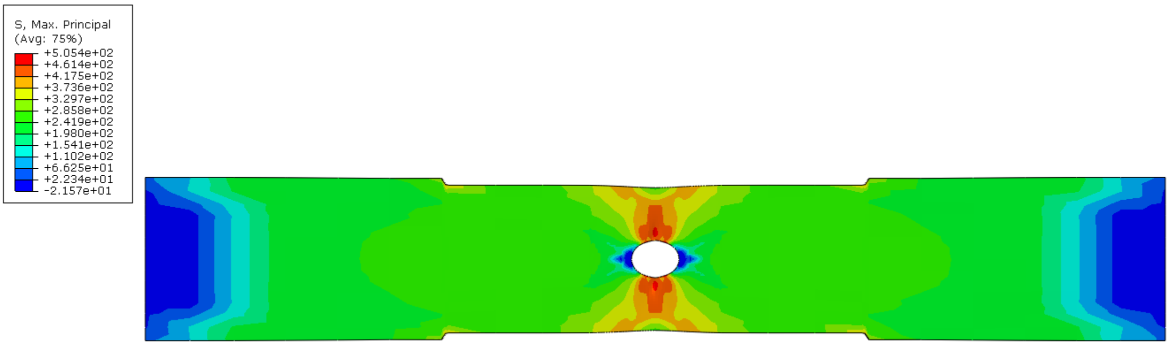



*Figure 4.7: Max. Principle stress for geometry with a unity check 0.90*

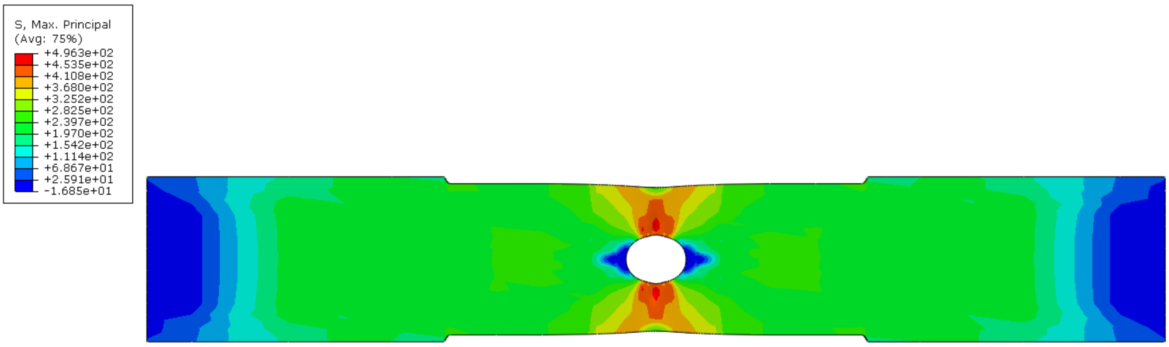



*Figure 4.8: Max. Principle stress for geometry with a unity check 1.00*

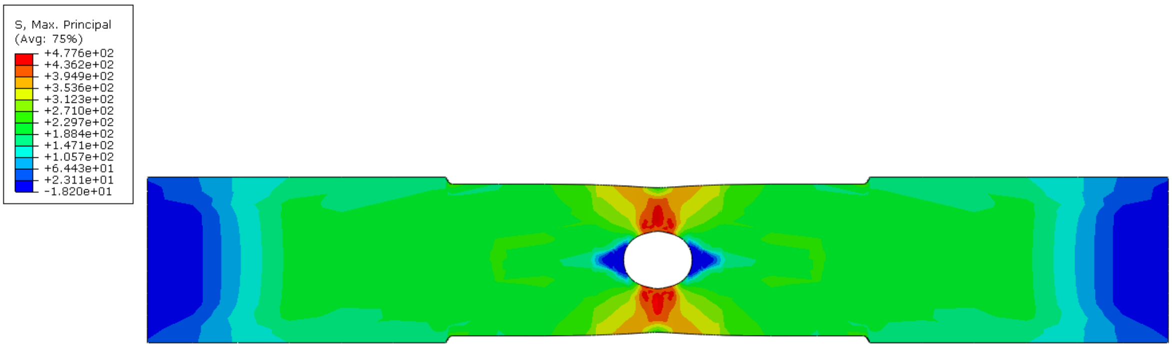



*Figure 4.9: Max. Principle stress for geometry with a unity check 1.10*

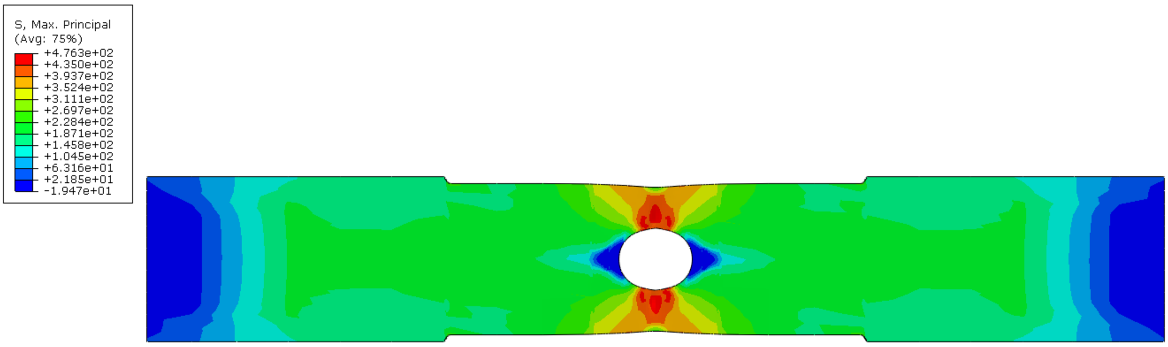



*Figure 4.10: Max. Principle stress for geometry with a unity check 1.15*

In Figure 4.11 to Figure 4.14 the Von Mises stress is shown. From the figures it can be said that the maximal Von Mises stress decreases when the unity check increases. At the moment where 50% fails according to capacity design rule, it can be seen that the maximum Von Mises stress is concentrated at the vertical axis across the hole diameter. This is much less when looking at the Von Mises stress of the geometry with unity check 1.00. The maximum Von Mises stresses are shown in Table 4.4.

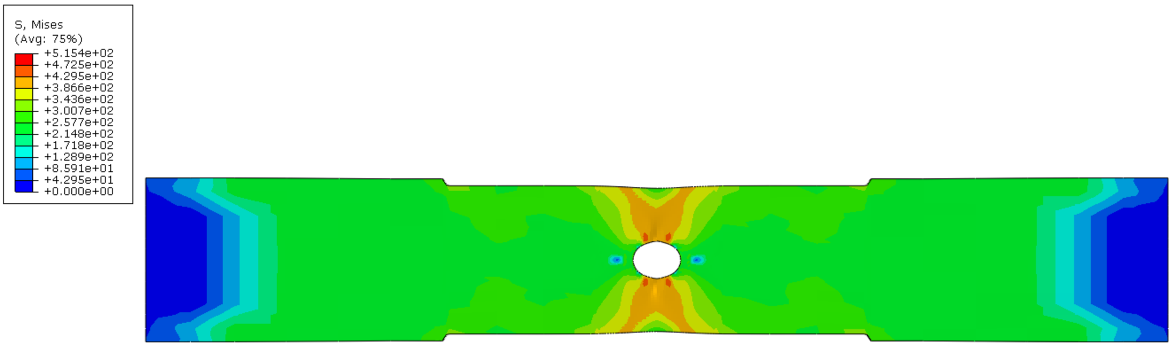



*Figure 4.11: Von Mises stress for geometry with a unity check 0.90*

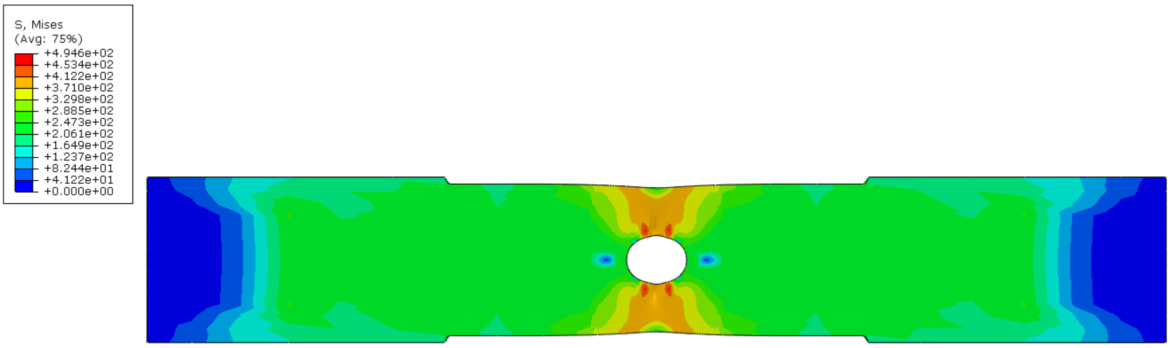



*Figure 4.12: Von Mises stress for geometry with a unity check 1.00*

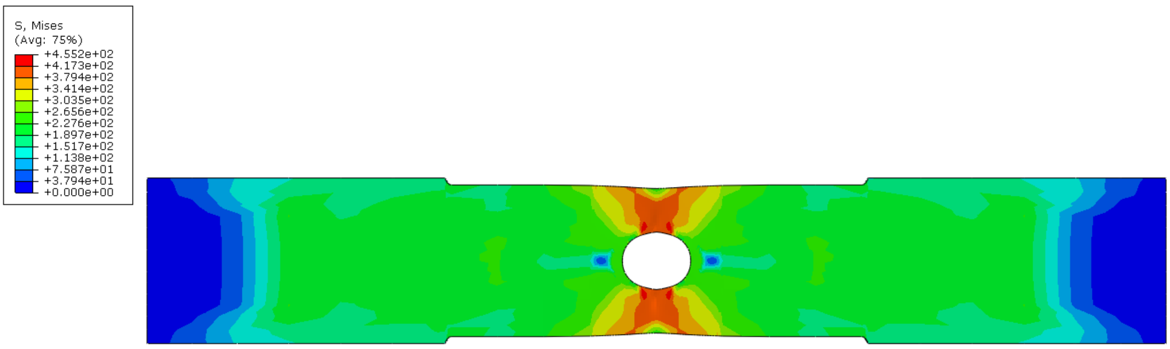



*Figure 4.13: Von Mises stress for geometry with a unity check 1.10*

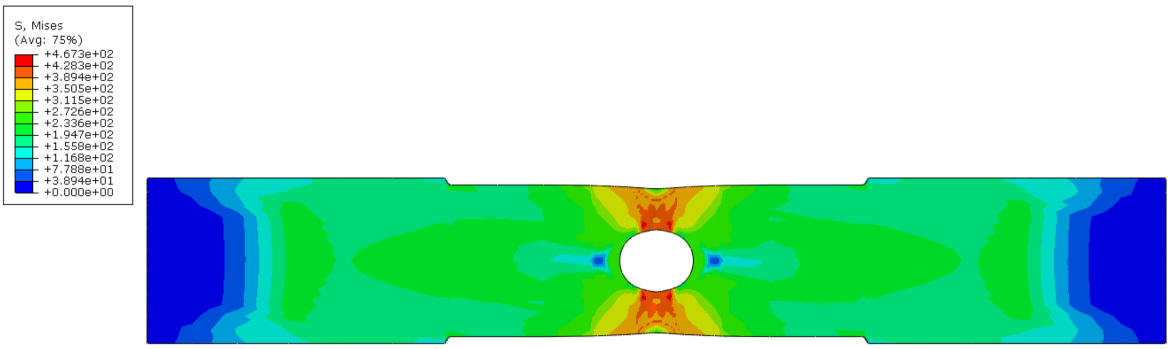



*Figure 4.14: Von Mises stress for geometry with a unity check 1.15*

Figure 4.15 shows the Force-Displacement graph of the geometries that are visualized. In this graph it can be seen that the displacement at maximum loading decreases when the hole diameter increases.

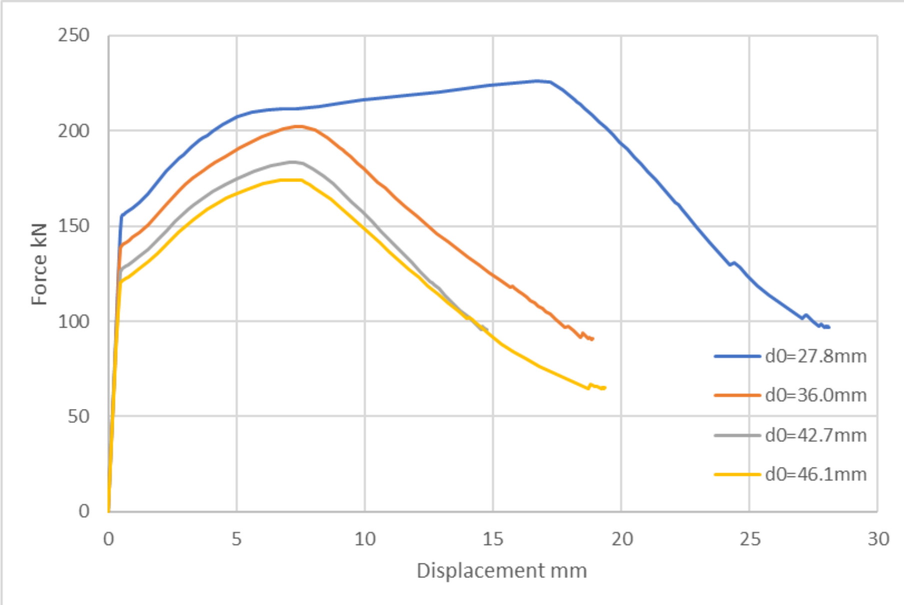



*Figure 4.15: Force-Displacement graph for geometries with a unity check of 0.90, 1.00, 1.10 and 1.15*

The maximum local and global strain are given in Table 4.4. Both the maximum local and global strain are used at the moment of maximum loading. The maximum local strain comes from Figure 4.3 to Figure 4.6. In appendix 2 the minimum strain at fracture is given per steel grade and steel thickness for a certain initial gauge length. The minimum strain at fracture for S235 with $3\ mm \leq t \leq 40\ mm$ is 26%. The global strain is obtained with the use of the initial gauge length. The dimension that the initial gauge length must have for calculating the strain is given in appendix 2 and equation 4.1. With the cross-sectional area, the initial gauge length is calculated. All the geometries of the visualizations have a cross-sectional area of $110\ mm\ x\ 8\ mm\ =\ 880\ mm^2$. This leads to an initial gauge length of $168\ mm$.

$$L_0 = 5.65\sqrt{S_0} \tag{4.1}$$

With:

| | |
|---|---|
| $L_0$ | The initial gauge length $[\text{mm}]$ |
| $S_0$ | Cross-sectional area $[\text{mm}^2]$ |

The global strain can be determined with equation 4.2. In Figure 4.16 it can be seen what the measurement points are for the initial gauge length. For the elongation of the initial gauge length the difference in displacement for measurement point 1 (mp 1) and measurement point 2 (mp 2) will be used. The measurement points are located at the heart line of the geometry. The distance between the measurement points is 168 mm. Both measurement points have an equal distance to the center of the hole in the plate. These measurement points are visualized in Figure 4.16.

$$\varepsilon = \frac{\Delta L}{L_0} \tag{4.2}$$

With:

| | |
|---|---|
| $\varepsilon$ | Strain [-] |
| $\Delta L$ | Elongation of the initial gauge length $[\text{mm}]$ |
| $L_0$ | The initial gauge length $[\text{mm}]$ |

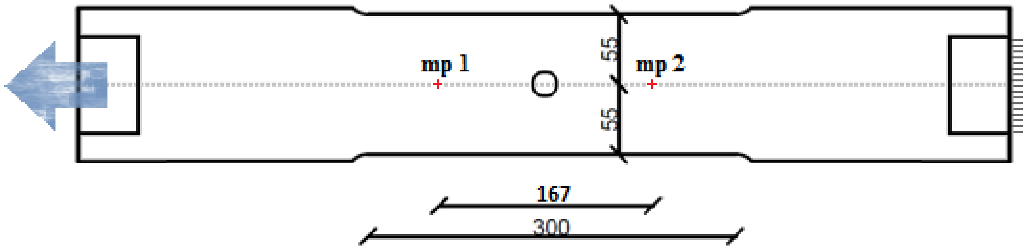



*Figure 4.16: Measurement points fort the global strain*

In Table 4.4 the maximum strains and stress are summarized per geometry and corresponding unity check.

*Table 4.4: Summarized maximum stress and strain per unity check*

| Hole diameter | Unity check | Max global strain | Max local strain | Max. Principle stress | Max Von Mises stress |
|---|---|---|---|---|---|
| mm | - | % | % | MPa | MPa |
| **27.8** | 0.90 | 5.29 | 63.68 | 505.4 | 515.4 |
| **36.0** | 1.00 | 4.51 | 60.89 | 496.3 | 496.6 |
| **42.7** | 1.10 | 4.31 | 47.80 | 477.6 | 455.2 |
| **46.1** | 1.15 | 4.44 | 48.29 | 476.3 | 467.3 |

In the research of Bewerse et al. are global and local strains mapped for a similar geometry as the geometry that are visualized in this chapter. The test specimen from the research of Bewerse et al. have a hole in the middle, like the specimens in this research. In the research of Bewerse et al. it is reflected that there are higher local strains located at the hole with a certain global strain. This is also the case in this research. The research of Bewerse et al. is done for the material Nickel Titanium, but the difference between local and global strain can also occur in steel (Bewerse et al., 2013).

## 4.5. CONCLUSIONS

The Von Mises stress figures show that with a low unity check, the whole plate yields. At the moment where 50% fails according to the capacity design rule, it is clearly visual that not the whole plate yields and the stress concentrates around the vertical axis across the hole diameter. This can be explained by the fact that the failure mechanism tends more to the net cross-section failure. The failure mechanism shows a more concentrated line of stress. Therefore the stresses in these figures can be logically explained.

Table 4.4 shows that the maximum strain decreases when the unity check increases. This means that the structure fails more brittle when the unity check increases. This is in line with the expectation that a brittle structure shows less deformation.

Overall in the visualizations, no irregularities occur at the point where the unity check is 1. With a unity check of 1, there is still a strain of at least 60%. This is more than the minimum required strain at fracture given by the Eurocode, which has a value of 26%. This means there is much deformation, which is in line with capacity design. More deformation means that more energy dissipates into the structure and a failure mechanism occurs which can be perceived.

# 5. CONCLUSION AND RECOMMENDATION

## 5.1. CONCLUSION

The research question of this graduation research project is: *Is the current regulation for capacity design of bolted steel connections in tension satisfying?* From this research it comes forward that the current regulation for capacity design is conservative and therefore not satisfying.

A Monte Carlo simulation is used to define a new capacity design rule. This new capacity design rule has its own partial factor that is determined using the Monte Carlo simulation. The Monte Carlo simulation is executed in two ways. One in which the simulated factor is determined by a shifted lognormal distribution and one in which the simulated factor is determined by a relation between the simulated factor and the ratio $d_0/b$. It came forward that the differences between these two methods are small. Therefore the cause of the correlation that occurs between the ratio $d_0/b$ and the simulated factor is not further investigated in this research. The output of the method in which the simulated factor is determined with the shifted lognormal distribution is used.

The output of the Monte Carlo simulation is used to determine the partial factor for the new capacity design rule. The differences between the partial factors for the steel plate thicknesses and steel grades were small. For clarity and uniformity just one partial factor is given for the new capacity design rule. This partial factor for the new capacity design rule has a value of 1.03 and it is the most conservative value rounded. The difference between allowable holes in the cross-section for the current capacity design rule and the new capacity design rule are shown in Table 5.1, in some cases the allowed hole diameter ratio is tripled  when comparing the current and new capacity design rule.

In this research it is chosen to use only one partial factor in the new capacity design rule. However a partial factor per steel grade can also be used for the new capacity design rule. This means that S235 should get a partial factor of 1.03, S355 a partial factor of 1.00 and S460 a partial factor 0.93.

Next to that a relation exists between the distribution of the yield stress and the distribution of the ultimate strength. This relation can be described by a correlation coefficient of 0.75.

*Table 5.1: Allowed $d_0/b$ ratio per steel grade and steel plate thickness for the current and new capacity design rule*

| | S235 | | S355 | | S460 | |
|---|---|---|---|---|---|---|
| | Current capacity design rule | New capacity design rule | Current capacity design rule | New capacity design rule | Current capacity design rule | New capacity design rule |
| $t \leq 16\ mm$ | $d_0/b$ = 9.3% | $d_0/b$ = 32.7% | $d_0/b$ = 0.0% | $d_0/b$ = 22.2% | $d_0/b$ = 0.0% | $d_0/b$ = 12.2% |
| $16\ mm < t \leq 40\ mm$ | $d_0/b$ = 13.2% | $d_0/b$ = 35.6% | $d_0/b$ = 0.0% | $d_0/b$ = 24.3% | $d_0/b$ = 0.0% | $d_0/b$ = 16.0% |
| $40\ mm < t \leq 63\ mm$ | $d_0/b$ = 16.9% | $d_0/b$ = 38.4% | $d_0/b$ = 0.9% | $d_0/b$ = 26.5% | $d_0/b$ = 0.0% | $d_0/b$ = 17.9% |

## 5.2. RECOMMENDATION

In this research, the presence of a bolt is neglected. Research was done to the presence of a bolt for cases where the net cross-section was decisive. Then, the bolts do not have any influence. The influence of the presence of bolts for when the net cross-section resistance and the gross cross-section resistance are close can be investigated in further research, because at the turning point the bolts can have influence.

Besides that, this research focuses only on a plate with one hole that differs in dimension. This research can be extended to steel plates with multiple holes in its cross-section.

The model factor in this research is only based on steel grade S235. To make the results even more close to reality, experiments to obtain the ultimate strength of the net cross-section can be conducted for steel grades S355 and S460. An model factor can be determined per steel grade from these experimental values. When enough experiments are carried out, the model factor can be determined without the use of an actual factor and simulated factor, whereby the Monte Carlo simulation becomes more close to reality.

With enough deformation, a failure mechanism occurs which can be timely observed. Therefore the plastic resistance of the gross cross-section must be determining instead of the ultimate resistance of the net cross-section. The desired deformation for such a failure mechanism is not covered in this research. Investigating the desired deformation for capacity design and implementing this in a capacity design rule will improve the capacity design rule.

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# LIST OF FIGURES

## LIST OF TABLES

# APPENDIX

## 1. EN 10025-2 TABLE 5

EN 10025-3:2004

**Tabel 5 — Mechanische eigenschappen bij omgevingstemperatuur voor normaalgegloeid staal**

| Aanduiding | | Minimumvloeigrens $R_{eH}$ [a] MPa[b] Nominale dikte mm | | | | | | | | Treksterkte $R_m$ [a] MPa[b] Nominale dikte mm | | | Minimumrek na breuk [a] % $L_0 = 5,65 \sqrt{S_0}$ Nominale dikte mm | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Volgens EN 10027-1 en CR 10260 | Volgens EN 10027-2 | ≤ 16 | > 16 ≤ 40 | > 40 ≤ 63 | > 63 ≤ 80 | > 80 ≤ 100 | > 100 ≤ 150 | > 150 ≤ 200 | > 200 ≤ 250 | ≤ 100 | > 100 ≤ 200 | > 200 ≤ 250 | ≤ 16 | > 16 ≤ 40 | > 40 ≤ 63 | > 63 ≤ 80 | > 80 ≤ 200 | > 200 ≤ 250 |
| S275N<br>S275NL | 1.0490<br>1.0491 | 275 | 265 | 255 | 245 | 235 | 225 | 215 | 205 | 370 t.m. 510 | 350 t.m. 480 | 350 t.m. 480 | 24 | 24 | 24 | 23 | 23 | 23 |
| S355N<br>S355NL | 1.0545<br>1.0546 | 355 | 345 | 335 | 325 | 315 | 295 | 285 | 275 | 470 t.m. 630 | 450 t.m. 600 | 450 t.m. 600 | 22 | 22 | 22 | 21 | 21 | 21 |
| S420N<br>S420NL | 1.8902<br>1.8912 | 420 | 400 | 390 | 370 | 360 | 340 | 330 | 320 | 520 t.m. 680 | 500 t.m. 650 | 500 t.m. 650 | 19 | 19 | 19 | 18 | 18 | 18 |
| S460N<br>S460NL | 1.8901<br>1.8903 | 460 | 440 | 430 | 410 | 400 | 380 | 370 | – | 540 t.m. 720 | 530 t.m. 710 | – | 17 | 17 | 17 | 17 | 17 | – |

[a] Voor plaat, band en universaalstaal met breedten ≥ 600 mm geldt de richting dwars (t) op de walsrichting. Voor alle andere producten gelden de waarden in de richting evenwijdig (l) aan de walsrichting.

[b] 1 MPa = 1 N/mm²

## 2. EN 10025-2 TABLE 7



**Tabel 7 — Mechanische eigenschappen bij omgevingstemperatuur voor platte en lange producten van staalsoorten en kwaliteiten met kerfslagwaarden**

| Aanduiding | | Minimumvloeigrens $R_{eH}$ [a] MPa [b] Nominale dikte mm | | | | | | | | | Treksterkte $R_m$ [a] MPa [b] Nominale dikte mm | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Volgens EN 10027-1 en CR 10260 | Volgens EN 10027-2 | ≤ 16 | > 16 ≤ 40 | > 40 ≤ 63 | > 63 ≤ 80 | > 80 ≤ 100 | > 100 ≤ 150 | > 150 ≤ 200 | > 200 ≤ 250 | > 250 ≤ 400 [c] | < 3 | ≥ 3 ≤ 100 | > 100 ≤ 150 | > 150 ≤ 250 | > 250 ≤ 400 [c] |
| S235JR | 1.0038 | 235 | 225 | 215 | 215 | 215 | 195 | 185 | 175 | – | 360 t.m. 510 | 360 t.m. 510 | 350 t.m. 500 | 340 t.m. 490 | – |
| S235J0 | 1.0114 | 235 | 225 | 215 | 215 | 215 | 195 | 185 | 175 | – | 360 t.m. 510 | 360 t.m. 510 | 350 t.m. 500 | 340 t.m. 490 | – |
| S235J2 | 1.0117 | 235 | 225 | 215 | 215 | 215 | 195 | 185 | 175 | 165 | 360 t.m. 510 | 360 t.m. 510 | 350 t.m. 500 | 340 t.m. 490 | 330 t.m. 480 |
| S275JR | 1.0044 | 275 | 265 | 255 | 245 | 235 | 225 | 215 | 205 | – | 430 t.m. 580 | 410 t.m. 560 | 400 t.m. 540 | 380 t.m. 540 | – |
| S275J0 | 1.0143 | 275 | 265 | 255 | 245 | 235 | 225 | 215 | 205 | – | 430 t.m. 580 | 410 t.m. 560 | 400 t.m. 540 | 380 t.m. 540 | – |
| S275J2 | 1.0145 | 275 | 265 | 255 | 245 | 235 | 225 | 215 | 205 | 195 | 430 t.m. 580 | 410 t.m. 560 | 400 t.m. 540 | 380 t.m. 540 | 380 t.m. 540 |
| S355JR | 1.0045 | 355 | 345 | 335 | 325 | 315 | 295 | 285 | 275 | – | 510 t.m. 680 | 470 t.m. 630 | 450 t.m. 600 | 450 t.m. 600 | – |
| S355J0 | 1.0553 | 355 | 345 | 335 | 325 | 315 | 295 | 285 | 275 | – | 510 t.m. 680 | 470 t.m. 630 | 450 t.m. 600 | 450 t.m. 600 | – |
| S355J2 | 1.0577 | 355 | 345 | 335 | 325 | 315 | 295 | 285 | 275 | 265 | 510 t.m. 680 | 470 t.m. 630 | 450 t.m. 600 | 450 t.m. 600 | 450 t.m. 600 |
| S355K2 | 1.0596 | 355 | 345 | 335 | 325 | 315 | 295 | 285 | 275 | 265 | 510 t.m. 680 | 470 t.m. 630 | 450 t.m. 600 | 450 t.m. 600 | 450 t.m. 600 |
| S450J0 [d] | 1.0590 | 450 | 430 | 410 | 390 | 380 | 380 | – | – | – | – | 550 t.m. 720 | 530 t.m. 700 | – | – |

[a] Voor plaat, band en universaalstaal met breedten ≥ 600 mm geldt de richting dwars (t) op de walsrichting. Voor alle andere producten gelden de waarden in de richting evenwijdig (l) aan de walsrichting.

[b] 1 MPa = 1 N/mm$^2$.

[c] De waarden gelden voor platte producten.

[d] Alleen toepasbaar voor lange producten.

Tabel 7 (einde)

| Aanduiding | | Ligging van proef-staven [a] | Minimumrek na breuk [a] % $L_0$ = 80 mm Nominale dikte mm | | | | | $L_0 = 5,65 \sqrt{S_0}$ Nominale dikte mm | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Volgens EN 10027-1 en CR 10260 | Volgens EN 10027-2 | | ≤ 1 | > 1 ≤ 1,5 | > 1,5 ≤ 2 | > 2 ≤ 2,5 | > 2,5 < 3 | ≥ 3 ≤ 40 | > 40 ≤ 63 | > 63 ≤ 100 | > 100 ≤ 150 | > 150 ≤ 250 | > 250 [c] ≤ 400 alleen voor J2 en K2 |
| S235JR<br>S235J0<br>S235J2 | 1.0038<br>1.0114<br>1.0117 | l | 17 | 18 | 19 | 20 | 21 | 26 | 25 | 24 | 22 | 21 | –<br>– |
| | | t | 15 | 16 | 17 | 18 | 19 | 24 | 23 | 22 | 22 | 21 | 21 (l en t) |
| S275JR<br>S275J0<br>S275J2 | 1.0044<br>1.0143<br>1.0145 | l | 15 | 16 | 17 | 18 | 19 | 23 | 22 | 21 | 19 | 18 | –<br>– |
| | | t | 13 | 14 | 15 | 16 | 17 | 21 | 20 | 19 | 19 | 18 | 18 (l en t) |
| S355JR<br>S355J0<br>S355J2<br>S355K2 | 1.0045<br>1.0553<br>1.0577<br>1.0596 | l | 14 | 15 | 16 | 17 | 18 | 22 | 21 | 20 | 18 | 17 | –<br>– |
| | | t | 12 | 13 | 14 | 15 | 16 | 20 | 19 | 18 | 18 | 17 | 17 (l en t)<br>17 (l en t) |
| S450J0 [d] | 1.0590 | l | – | – | – | – | – | 17 | 17 | 17 | 17 | – | – |

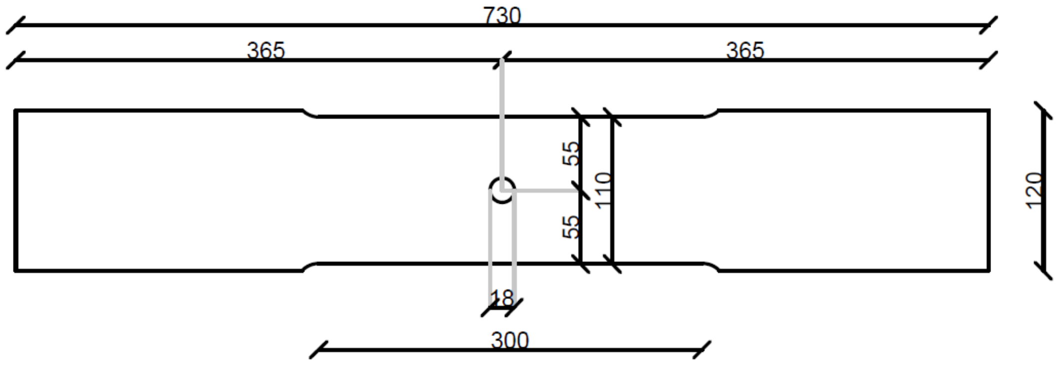
[a] Voor plaat, band en universaalstaal met breedten ≥ 600 mm geldt de richting dwars (t) op de walsrichting. Voor alle andere producten gelden de waarden in de richting evenwijdig (l) aan de walsrichting.

[c] De waarden gelden voor platte producten.

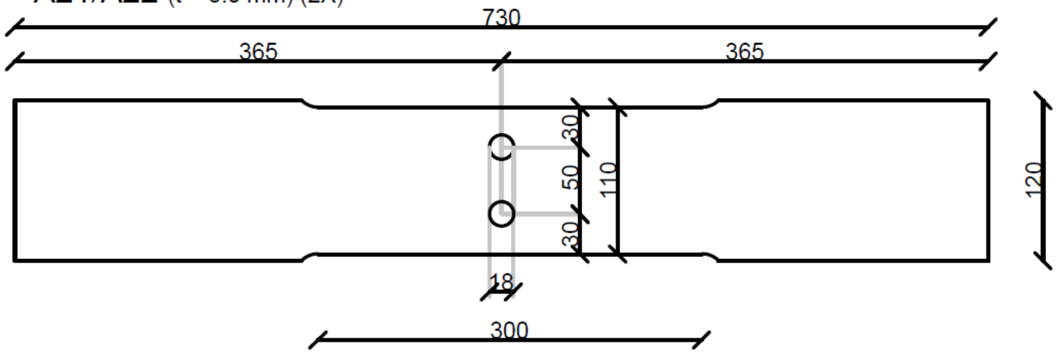
[d] Alleen toepasbaar voor lange producten.

# 3. Principles of geometry A11 to A36 by A.H. Shahrajabian

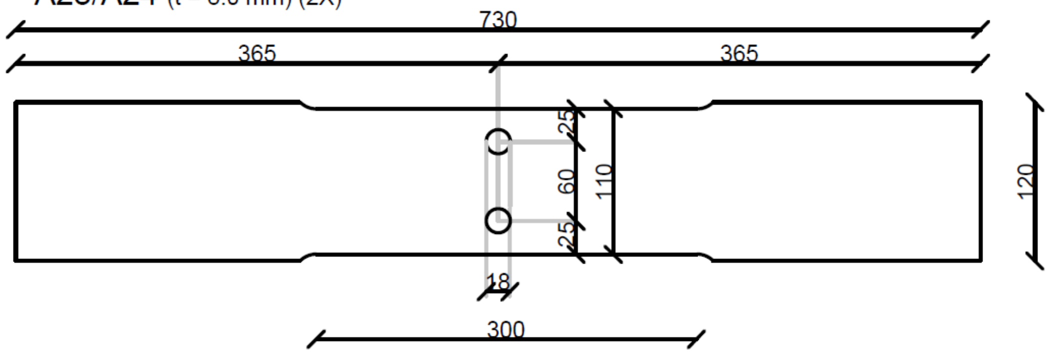
A11/A12 (t = 8.0 mm) (2X)



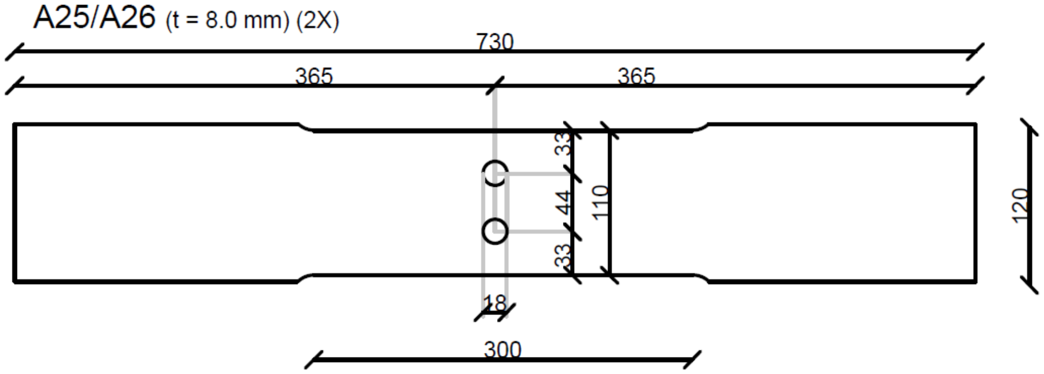

A21/A22 (t = 8.0 mm) (2X)



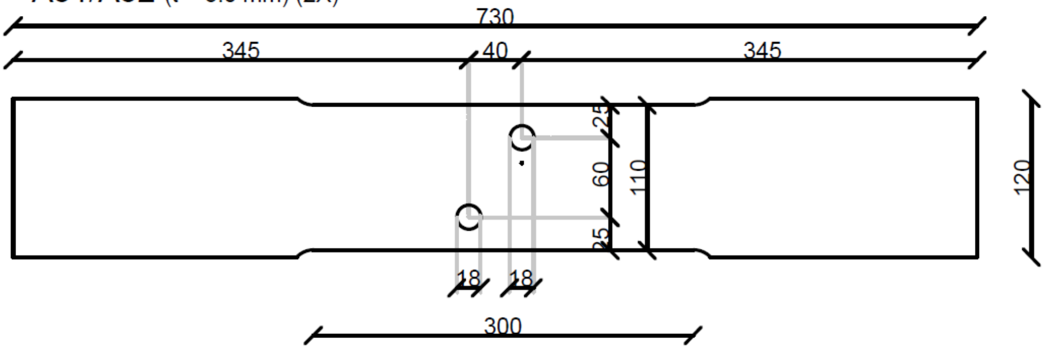

A23/A24 (t = 8.0 mm) (2X)



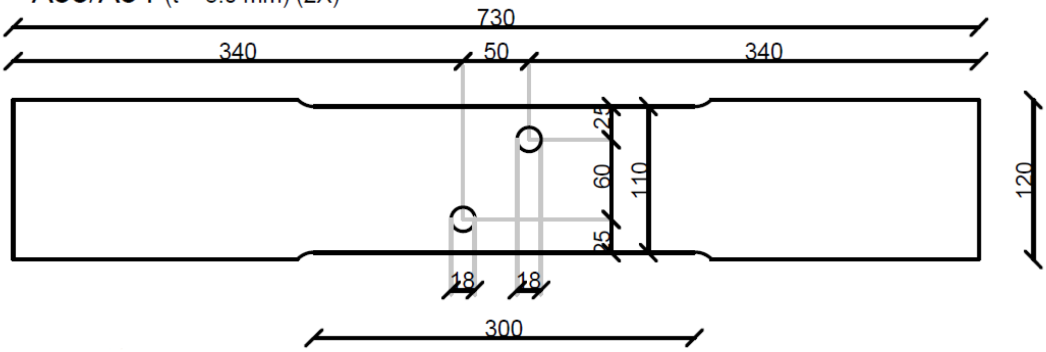

A25/A26 (t = 8.0 mm) (2X)



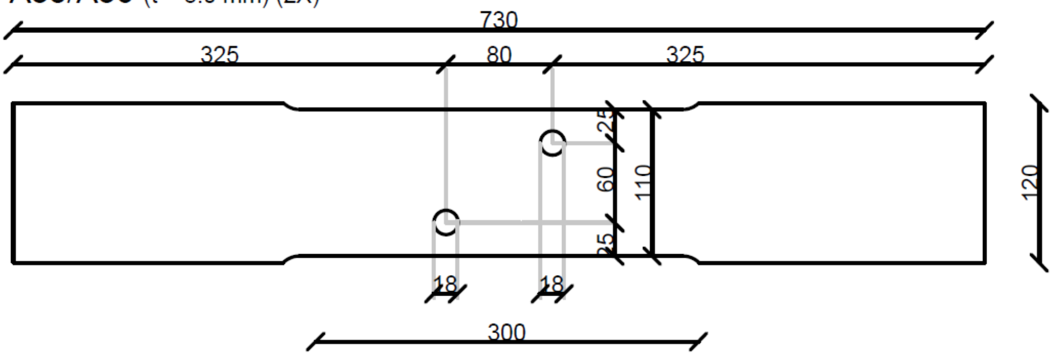
A31/A32 (t = 8.0 mm) (2X)




A33/A34 (t = 8.0 mm) (2X)




A35/A36 (t = 8.0 mm) (2X)



# 4. OUTPUT FINITE ELEMENT MODEL VS EXPERIMENT

**A11**

| | | | | |
|---|---|---|---|---|
| *Nu,exp* | *327.0* | *kN* | | |
| *Nu,fem* | *338.9* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.965* | | | |

| Time | Load | Displacement | Dis abs | Force kn |
|---|---|---|---|---|
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -141434.00 | -0.45 | 0.45 | 141.43 |
| 0.0125 | -176255.00 | -0.56 | 0.56 | 176.26 |
| 0.0163 | -211304.00 | -0.73 | 0.73 | 211.30 |
| 0.0200 | -215293.00 | -0.90 | 0.90 | 215.29 |
| 0.0238 | -218412.00 | -1.07 | 1.07 | 218.41 |
| 0.0275 | -220649.00 | -1.24 | 1.24 | 220.65 |
| 0.0313 | -222841.00 | -1.41 | 1.41 | 222.84 |
| 0.0369 | -226535.00 | -1.66 | 1.66 | 226.54 |
| 0.0453 | -232449.00 | -2.04 | 2.04 | 232.45 |
| 0.0580 | -242141.00 | -2.61 | 2.61 | 242.14 |
| 0.0627 | -245353.00 | -2.82 | 2.82 | 245.35 |
| 0.0698 | -248920.00 | -3.14 | 3.14 | 248.92 |
| 0.0770 | -250896.00 | -3.46 | 3.46 | 250.90 |
| 0.0841 | -252388.00 | -3.78 | 3.78 | 252.39 |
| 0.0948 | -254213.00 | -4.26 | 4.26 | 254.21 |
| 0.1108 | -256548.00 | -4.98 | 4.98 | 256.55 |
| 0.1168 | -257241.00 | -5.25 | 5.25 | 257.24 |
| 0.1258 | -258074.00 | -5.66 | 5.66 | 258.07 |
| 0.1348 | -258699.00 | -6.07 | 6.07 | 258.70 |
| 0.1438 | -259225.00 | -6.47 | 6.47 | 259.23 |
| 0.1573 | -259891.00 | -7.08 | 7.08 | 259.89 |
| 0.1776 | -260789.00 | -7.99 | 7.99 | 260.79 |
| 0.1979 | -262127.00 | -8.90 | 8.90 | 262.13 |
| 0.2181 | -263652.00 | -9.82 | 9.82 | 263.65 |
| 0.2384 | -265481.00 | -10.73 | 10.73 | 265.48 |
| 0.2688 | -268251.00 | -12.10 | 12.10 | 268.25 |
| 0.2992 | -271124.00 | -13.47 | 13.47 | 271.12 |
| 0.3296 | -273922.00 | -14.83 | 14.83 | 273.92 |
| 0.3753 | -277703.00 | -16.89 | 16.89 | 277.70 |
| 0.4437 | -284708.00 | -19.97 | 19.97 | 284.71 |
| 0.5121 | -294575.00 | -23.04 | 23.04 | 294.58 |
| 0.5805 | -307620.00 | -26.12 | 26.12 | 307.62 |
| 0.6831 | -322859.00 | -30.74 | 30.74 | 322.86 |
| 0.7216 | -327227.00 | -32.47 | 32.47 | 327.23 |
| 0.7794 | -332117.00 | -35.07 | 35.07 | 332.12 |
| 0.8010 | -333680.00 | -36.05 | 36.05 | 333.68 |
| 0.8335 | -335834.00 | -37.51 | 37.51 | 335.83 |
| 0.8457 | -336602.00 | -38.05 | 38.05 | 336.60 |
| 0.8639 | -337616.00 | -38.88 | 38.88 | 337.62 |
| 0.8708 | -337977.00 | -39.19 | 39.19 | 337.98 |
| 0.8811 | -338418.00 | -39.65 | 39.65 | 338.42 |
| 0.8965 | -338360.00 | -40.34 | 40.34 | 338.36 |
| 0.9003 | -338792.00 | -40.51 | 40.51 | 338.79 |
| 0.9013 | -338861.00 | -40.56 | 40.56 | 338.86 |
| 0.9022 | -338841.00 | -40.60 | 40.60 | 338.84 |
| 0.9032 | -338829.00 | -40.64 | 40.64 | 338.83 |
| 0.9042 | -338809.00 | -40.69 | 40.69 | 338.81 |
| 0.9051 | -338783.00 | -40.73 | 40.73 | 338.78 |
| 0.9066 | -338712.00 | -40.80 | 40.80 | 338.71 |
| 0.9088 | -338578.00 | -40.89 | 40.89 | 338.58 |
| 0.9120 | -338308.00 | -41.04 | 41.04 | 338.31 |
| 0.9169 | -337747.00 | -41.26 | 41.26 | 337.75 |
| 0.9242 | -336622.00 | -41.59 | 41.59 | 336.62 |
| 0.9315 | -335430.00 | -41.92 | 41.92 | 335.43 |
| 0.9388 | -334066.00 | -42.25 | 42.25 | 334.07 |
| 0.9461 | -332468.00 | -42.58 | 42.58 | 332.47 |
| 0.9535 | -330612.00 | -42.91 | 42.91 | 330.61 |
| 0.9608 | -328536.00 | -43.23 | 43.23 | 328.54 |
| 0.9681 | -326201.00 | -43.56 | 43.56 | 326.20 |
| 0.9754 | -323603.00 | -43.89 | 43.89 | 323.60 |
| 0.9827 | -320736.00 | -44.22 | 44.22 | 320.74 |
| 0.9900 | -317605.00 | -44.55 | 44.55 | 317.61 |

**A12**

| | | | | |
|---|---|---|---|---|
| *Nu,exp* | *328.6* | *kN* | | |
| *Nu,fem* | *337.9* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.973* | | | |

| Time | Load | Displacement | Dis abs | Force kn |
|---|---|---|---|---|
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -156957.00 | -0.50 | 0.50 | 156.96 |
| 0.0125 | -194955.00 | -0.63 | 0.63 | 194.96 |
| 0.0150 | -211676.00 | -0.75 | 0.75 | 211.68 |
| 0.0175 | -214608.00 | -0.88 | 0.88 | 214.61 |
| 0.0200 | -217134.00 | -1.00 | 1.00 | 217.13 |
| 0.0225 | -219086.00 | -1.13 | 1.13 | 219.09 |
| 0.0250 | -220711.00 | -1.25 | 1.25 | 220.71 |
| 0.0288 | -223191.00 | -1.44 | 1.44 | 223.19 |
| 0.0344 | -227421.00 | -1.72 | 1.72 | 227.42 |
| 0.0428 | -234180.00 | -2.14 | 2.14 | 234.18 |
| 0.0555 | -244387.00 | -2.77 | 2.77 | 244.39 |
| 0.0681 | -250320.00 | -3.41 | 3.41 | 250.32 |
| 0.0808 | -253209.00 | -4.04 | 4.04 | 253.21 |
| 0.0934 | -255516.00 | -4.67 | 4.67 | 255.52 |
| 0.1061 | -257285.00 | -5.30 | 5.30 | 257.29 |
| 0.1188 | -258450.00 | -5.94 | 5.94 | 258.45 |
| 0.1314 | -259277.00 | -6.57 | 6.57 | 259.28 |
| 0.1441 | -259963.00 | -7.20 | 7.20 | 259.96 |
| 0.1630 | -260932.00 | -8.15 | 8.15 | 260.93 |
| 0.1820 | -262443.00 | -9.10 | 9.10 | 262.44 |
| 0.2010 | -263998.00 | -10.05 | 10.05 | 264.00 |
| 0.2200 | -266066.00 | -11.00 | 11.00 | 266.07 |
| 0.2485 | -268859.00 | -12.42 | 12.42 | 268.86 |
| 0.2770 | -271882.00 | -13.85 | 13.85 | 271.88 |
| 0.3054 | -274725.00 | -15.27 | 15.27 | 274.73 |
| 0.3481 | -278667.00 | -17.41 | 17.41 | 278.67 |
| 0.3909 | -283583.00 | -19.54 | 19.54 | 283.58 |
| 0.4336 | -289882.00 | -21.68 | 21.68 | 289.88 |
| 0.4763 | -297913.00 | -23.81 | 23.81 | 297.91 |
| 0.5404 | -310871.00 | -27.02 | 27.02 | 310.87 |
| 0.6365 | -325615.00 | -31.82 | 31.82 | 325.62 |
| 0.6725 | -329462.00 | -33.63 | 33.63 | 329.46 |
| 0.7266 | -333965.00 | -36.33 | 36.33 | 333.97 |
| 0.7468 | -335453.00 | -37.34 | 37.34 | 335.45 |
| 0.7773 | -337296.00 | -38.86 | 38.86 | 337.30 |
| 0.7887 | -337759.00 | -39.43 | 39.43 | 337.76 |
| 0.7929 | -337884.00 | -39.65 | 39.65 | 337.88 |
| 0.7972 | -337874.00 | -39.86 | 39.86 | 337.87 |
| 0.8015 | -337719.00 | -40.07 | 40.07 | 337.72 |
| 0.8058 | -337417.00 | -40.29 | 40.29 | 337.42 |
| 0.8100 | -336953.00 | -40.50 | 40.50 | 336.95 |
| 0.8143 | -336315.00 | -40.72 | 40.72 | 336.32 |
| 0.8207 | -334936.00 | -41.04 | 41.04 | 334.94 |
| 0.8271 | -333431.00 | -41.36 | 41.36 | 333.43 |
| 0.8336 | -331774.00 | -41.68 | 41.68 | 331.77 |
| 0.8400 | -329870.00 | -42.00 | 42.00 | 329.87 |
| 0.8464 | -327745.00 | -42.32 | 42.32 | 327.75 |
| 0.8528 | -325382.00 | -42.64 | 42.64 | 325.38 |
| 0.8592 | -322796.00 | -42.96 | 42.96 | 322.80 |
| 0.8656 | -319954.00 | -43.28 | 43.28 | 319.95 |
| 0.8753 | -314413.00 | -43.76 | 43.76 | 314.41 |
| 0.8849 | -309014.00 | -44.24 | 44.24 | 309.01 |
| 0.8945 | -303003.00 | -44.72 | 44.72 | 303.00 |
| 0.9041 | -296409.00 | -45.21 | 45.21 | 296.41 |
| 0.9137 | -289344.00 | -45.69 | 45.69 | 289.34 |
| 0.9234 | -281850.00 | -46.17 | 46.17 | 281.85 |
| 0.9330 | -273903.00 | -46.65 | 46.65 | 273.90 |
| 0.9426 | -265529.00 | -47.13 | 47.13 | 265.53 |
| 0.9522 | -256732.00 | -47.61 | 47.61 | 256.73 |
| 0.9618 | -247524.00 | -48.09 | 48.09 | 247.52 |
| 0.9715 | -237944.00 | -48.57 | 48.57 | 237.94 |
| 0.9811 | -228046.00 | -49.05 | 49.05 | 228.05 |

**A21**

| | | | | |
|---|---|---|---|---|
| *Nu,exp* | *275.2* | *kN* | | |
| *Nu,fem* | *289.5* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.951* | | | |

| Time | Load | Displacement | Dis abs | Force kn |
|---|---|---|---|---|
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -93307.20 | -0.30 | 0.30 | 93.31 |
| 0.0200 | -178246.00 | -0.60 | 0.60 | 178.25 |
| 0.0225 | -182381.00 | -0.68 | 0.68 | 182.38 |
| 0.0250 | -184785.00 | -0.75 | 0.75 | 184.79 |
| 0.0288 | -187863.00 | -0.86 | 0.86 | 187.86 |
| 0.0344 | -192576.00 | -1.03 | 1.03 | 192.58 |
| 0.0365 | -194476.00 | -1.09 | 1.09 | 194.48 |
| 0.0396 | -197041.00 | -1.19 | 1.19 | 197.04 |
| 0.0444 | -200944.00 | -1.33 | 1.33 | 200.94 |
| 0.0515 | -206904.00 | -1.55 | 1.55 | 206.90 |
| 0.0586 | -212591.00 | -1.76 | 1.76 | 212.59 |
| 0.0658 | -217418.00 | -1.97 | 1.97 | 217.42 |
| 0.0764 | -223585.00 | -2.29 | 2.29 | 223.59 |
| 0.0871 | -229250.00 | -2.61 | 2.61 | 229.25 |
| 0.0978 | -234425.00 | -2.93 | 2.93 | 234.43 |
| 0.1138 | -240990.00 | -3.41 | 3.41 | 240.99 |
| 0.1378 | -248319.00 | -4.14 | 4.14 | 248.32 |
| 0.1619 | -252612.00 | -4.86 | 4.86 | 252.61 |
| 0.1859 | -254745.00 | -5.58 | 5.58 | 254.75 |
| 0.2099 | -256542.00 | -6.30 | 6.30 | 256.54 |
| 0.2460 | -258229.00 | -7.38 | 7.38 | 258.23 |
| 0.3000 | -260007.00 | -9.00 | 9.00 | 260.01 |
| 0.3541 | -262691.00 | -10.62 | 10.62 | 262.69 |
| 0.4081 | -265503.00 | -12.24 | 12.24 | 265.50 |
| 0.4622 | -268732.00 | -13.87 | 13.87 | 268.73 |
| 0.5433 | -273282.00 | -16.30 | 16.30 | 273.28 |
| 0.6649 | -279311.00 | -19.95 | 19.95 | 279.31 |
| 0.7866 | -286610.00 | -23.60 | 23.60 | 286.61 |
| 0.8170 | -288413.00 | -24.51 | 24.51 | 288.41 |
| 0.8474 | -289458.00 | -25.42 | 25.42 | 289.46 |
| 0.8588 | -289435.00 | -25.76 | 25.76 | 289.44 |
| 0.8702 | -288689.00 | -26.11 | 26.11 | 288.69 |
| 0.8816 | -287418.00 | -26.45 | 26.45 | 287.42 |
| 0.8930 | -285460.00 | -26.79 | 26.79 | 285.46 |
| 0.9044 | -282633.00 | -27.13 | 27.13 | 282.63 |
| 0.9073 | -282266.00 | -27.22 | 27.22 | 282.27 |
| 0.9101 | -281305.00 | -27.30 | 27.30 | 281.31 |
| 0.9144 | -279512.00 | -27.43 | 27.43 | 279.51 |
| 0.9187 | -277549.00 | -27.56 | 27.56 | 277.55 |
| 0.9229 | -275401.00 | -27.69 | 27.69 | 275.40 |
| 0.9272 | -273150.00 | -27.82 | 27.82 | 273.15 |
| 0.9336 | -269303.00 | -28.01 | 28.01 | 269.30 |
| 0.9432 | -262978.00 | -28.30 | 28.30 | 262.98 |
| 0.9577 | -252260.00 | -28.73 | 28.73 | 252.26 |
| 0.9613 | -252558.00 | -28.84 | 28.84 | 252.56 |
| 0.9649 | -250071.00 | -28.95 | 28.95 | 250.07 |
| 0.9703 | -245959.00 | -29.11 | 29.11 | 245.96 |
| 0.9784 | -239641.00 | -29.35 | 29.35 | 239.64 |
| 0.9865 | -234203.00 | -29.60 | 29.60 | 234.20 |
| 0.9947 | -228768.00 | -29.84 | 29.84 | 228.77 |
| 1.0000 | -226151.00 | -30.00 | 30.00 | 226.15 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |

| **A22** | | | | |
|---|---|---|---|---|
| *Nu,exp* | *278.9* | *kN* | | |
| *Nu,fem* | *289.5* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.964* | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -93307.20 | -0.30 | 0.30 | 93.31 |
| 0.0200 | -178246.00 | -0.60 | 0.60 | 178.25 |
| 0.0225 | -182381.00 | -0.68 | 0.68 | 182.38 |
| 0.0250 | -184785.00 | -0.75 | 0.75 | 184.79 |
| 0.0288 | -187863.00 | -0.86 | 0.86 | 187.86 |
| 0.0344 | -192576.00 | -1.03 | 1.03 | 192.58 |
| 0.0365 | -194476.00 | -1.09 | 1.09 | 194.48 |
| 0.0396 | -197041.00 | -1.19 | 1.19 | 197.04 |
| 0.0444 | -200944.00 | -1.33 | 1.33 | 200.94 |
| 0.0515 | -206904.00 | -1.55 | 1.55 | 206.90 |
| 0.0586 | -212591.00 | -1.76 | 1.76 | 212.59 |
| 0.0658 | -217418.00 | -1.97 | 1.97 | 217.42 |
| 0.0764 | -223585.00 | -2.29 | 2.29 | 223.59 |
| 0.0871 | -229250.00 | -2.61 | 2.61 | 229.25 |
| 0.0978 | -234425.00 | -2.93 | 2.93 | 234.43 |
| 0.1138 | -240990.00 | -3.41 | 3.41 | 240.99 |
| 0.1378 | -248319.00 | -4.14 | 4.14 | 248.32 |
| 0.1619 | -252612.00 | -4.86 | 4.86 | 252.61 |
| 0.1859 | -254745.00 | -5.58 | 5.58 | 254.75 |
| 0.2099 | -256542.00 | -6.30 | 6.30 | 256.54 |
| 0.2460 | -258229.00 | -7.38 | 7.38 | 258.23 |
| 0.3000 | -260007.00 | -9.00 | 9.00 | 260.01 |
| 0.3541 | -262691.00 | -10.62 | 10.62 | 262.69 |
| 0.4081 | -265503.00 | -12.24 | 12.24 | 265.50 |
| 0.4622 | -268732.00 | -13.87 | 13.87 | 268.73 |
| 0.5433 | -273282.00 | -16.30 | 16.30 | 273.28 |
| 0.6649 | -279311.00 | -19.95 | 19.95 | 279.31 |
| 0.7866 | -286610.00 | -23.60 | 23.60 | 286.61 |
| 0.8170 | -288413.00 | -24.51 | 24.51 | 288.41 |
| 0.8474 | -289458.00 | -25.42 | 25.42 | 289.46 |
| 0.8588 | -289435.00 | -25.76 | 25.76 | 289.44 |
| 0.8702 | -288689.00 | -26.11 | 26.11 | 288.69 |
| 0.8816 | -287418.00 | -26.45 | 26.45 | 287.42 |
| 0.8930 | -285460.00 | -26.79 | 26.79 | 285.46 |
| 0.9044 | -282633.00 | -27.13 | 27.13 | 282.63 |
| 0.9073 | -282266.00 | -27.22 | 27.22 | 282.27 |
| 0.9101 | -281305.00 | -27.30 | 27.30 | 281.31 |
| 0.9144 | -279512.00 | -27.43 | 27.43 | 279.51 |
| 0.9187 | -277549.00 | -27.56 | 27.56 | 277.55 |
| 0.9229 | -275401.00 | -27.69 | 27.69 | 275.40 |
| 0.9272 | -273150.00 | -27.82 | 27.82 | 273.15 |
| 0.9336 | -269303.00 | -28.01 | 28.01 | 269.30 |
| 0.9432 | -262978.00 | -28.30 | 28.30 | 262.98 |
| 0.9577 | -252260.00 | -28.73 | 28.73 | 252.26 |
| 0.9613 | -252558.00 | -28.84 | 28.84 | 252.56 |
| 0.9649 | -250071.00 | -28.95 | 28.95 | 250.07 |
| 0.9703 | -245959.00 | -29.11 | 29.11 | 245.96 |
| 0.9784 | -239641.00 | -29.35 | 29.35 | 239.64 |
| 0.9865 | -234203.00 | -29.60 | 29.60 | 234.20 |
| 0.9947 | -228768.00 | -29.84 | 29.84 | 228.77 |
| 1.0000 | -226151.00 | -30.00 | 30.00 | 226.15 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |

| **A23** | | | | |
|---|---|---|---|---|
| *Nu,exp* | *278.9* | *kN* | | |
| *Nu,fem* | *292.6* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.953* | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -123837.00 | -0.40 | 0.40 | 123.84 |
| 0.0125 | -154009.00 | -0.50 | 0.50 | 154.01 |
| 0.0150 | -178841.00 | -0.60 | 0.60 | 178.84 |
| 0.0175 | -185278.00 | -0.70 | 0.70 | 185.28 |
| 0.0200 | -188576.00 | -0.80 | 0.80 | 188.58 |
| 0.0225 | -191444.00 | -0.90 | 0.90 | 191.44 |
| 0.0263 | -195409.00 | -1.05 | 1.05 | 195.41 |
| 0.0319 | -201363.00 | -1.28 | 1.28 | 201.36 |
| 0.0375 | -207490.00 | -1.50 | 1.50 | 207.49 |
| 0.0431 | -212933.00 | -1.73 | 1.73 | 212.93 |
| 0.0488 | -217383.00 | -1.95 | 1.95 | 217.38 |
| 0.0544 | -221552.00 | -2.18 | 2.18 | 221.55 |
| 0.0628 | -227384.00 | -2.51 | 2.51 | 227.38 |
| 0.0755 | -235217.00 | -3.02 | 3.02 | 235.22 |
| 0.0945 | -244185.00 | -3.78 | 3.78 | 244.19 |
| 0.0992 | -246084.00 | -3.97 | 3.97 | 246.08 |
| 0.1039 | -247694.00 | -4.16 | 4.16 | 247.69 |
| 0.1111 | -249656.00 | -4.44 | 4.44 | 249.66 |
| 0.1217 | -251746.00 | -4.87 | 4.87 | 251.75 |
| 0.1324 | -253077.00 | -5.30 | 5.30 | 253.08 |
| 0.1431 | -254213.00 | -5.72 | 5.72 | 254.21 |
| 0.1591 | -255522.00 | -6.36 | 6.36 | 255.52 |
| 0.1831 | -256843.00 | -7.33 | 7.33 | 256.84 |
| 0.2192 | -258336.00 | -8.77 | 8.77 | 258.34 |
| 0.2327 | -259658.00 | -9.31 | 9.31 | 259.66 |
| 0.2462 | -260831.00 | -9.85 | 9.85 | 260.83 |
| 0.2597 | -261826.00 | -10.39 | 10.39 | 261.83 |
| 0.2732 | -262811.00 | -10.93 | 10.93 | 262.81 |
| 0.2935 | -264071.00 | -11.74 | 11.74 | 264.07 |
| 0.3239 | -266486.00 | -12.96 | 12.96 | 266.49 |
| 0.3695 | -270184.00 | -14.78 | 14.78 | 270.18 |
| 0.4380 | -274857.00 | -17.52 | 17.52 | 274.86 |
| 0.5064 | -279727.00 | -20.26 | 20.26 | 279.73 |
| 0.5748 | -285789.00 | -22.99 | 22.99 | 285.79 |
| 0.6005 | -288224.00 | -24.02 | 24.02 | 288.22 |
| 0.6390 | -291163.00 | -25.56 | 25.56 | 291.16 |
| 0.6486 | -291928.00 | -25.94 | 25.94 | 291.93 |
| 0.6582 | -292465.00 | -26.33 | 26.33 | 292.47 |
| 0.6678 | -292607.00 | -26.71 | 26.71 | 292.61 |
| 0.6774 | -292074.00 | -27.10 | 27.10 | 292.07 |
| 0.6871 | -291015.00 | -27.48 | 27.48 | 291.02 |
| 0.6967 | -289167.00 | -27.87 | 27.87 | 289.17 |
| 0.7063 | -286296.00 | -28.25 | 28.25 | 286.30 |
| 0.7159 | -282773.00 | -28.64 | 28.64 | 282.77 |
| 0.7255 | -278380.00 | -29.02 | 29.02 | 278.38 |
| 0.7352 | -272661.00 | -29.41 | 29.41 | 272.66 |
| 0.7376 | -272256.00 | -29.50 | 29.50 | 272.26 |
| 0.7400 | -270435.00 | -29.60 | 29.60 | 270.44 |
| 0.7424 | -268392.00 | -29.70 | 29.70 | 268.39 |
| 0.7448 | -266136.00 | -29.79 | 29.79 | 266.14 |
| 0.7472 | -263743.00 | -29.89 | 29.89 | 263.74 |
| 0.7508 | -259745.00 | -30.03 | 30.03 | 259.75 |
| 0.7562 | -253350.00 | -30.25 | 30.25 | 253.35 |
| 0.7643 | -242953.00 | -30.57 | 30.57 | 242.95 |
| 0.7674 | -241622.00 | -30.70 | 30.70 | 241.62 |
| 0.7719 | -235599.00 | -30.88 | 30.88 | 235.60 |
| 0.7765 | -230386.00 | -31.06 | 31.06 | 230.39 |
| 0.7811 | -225180.00 | -31.24 | 31.24 | 225.18 |
| 0.7879 | -216178.00 | -31.52 | 31.52 | 216.18 |
| 0.7948 | -209147.00 | -31.79 | 31.79 | 209.15 |
| 0.8016 | -202524.00 | -32.07 | 32.07 | 202.52 |
| 0.8085 | -196369.00 | -32.34 | 32.34 | 196.37 |

| **A24** | | | | |
|---|---|---|---|---|
| *Nu,exp* | *280.9* | *kN* | | |
| *Nu,fem* | *292.2* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.961* | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0010 | -12447.90 | -0.04 | 0.04 | 12.45 |
| 0.0020 | -24894.10 | -0.08 | 0.08 | 24.89 |
| 0.0035 | -43560.30 | -0.14 | 0.14 | 43.56 |
| 0.0058 | -71552.20 | -0.23 | 0.23 | 71.55 |
| 0.0091 | -113383.00 | -0.37 | 0.37 | 113.38 |
| 0.0142 | -173662.00 | -0.57 | 0.57 | 173.66 |
| 0.0193 | -187836.00 | -0.77 | 0.77 | 187.84 |
| 0.0243 | -193658.00 | -0.97 | 0.97 | 193.66 |
| 0.0294 | -199152.00 | -1.18 | 1.18 | 199.15 |
| 0.0313 | -201354.00 | -1.25 | 1.25 | 201.35 |
| 0.0341 | -204620.00 | -1.36 | 1.36 | 204.62 |
| 0.0384 | -209275.00 | -1.54 | 1.54 | 209.28 |
| 0.0448 | -214963.00 | -1.79 | 1.79 | 214.96 |
| 0.0512 | -219875.00 | -2.05 | 2.05 | 219.88 |
| 0.0576 | -224605.00 | -2.30 | 2.30 | 224.61 |
| 0.0672 | -231008.00 | -2.69 | 2.69 | 231.01 |
| 0.0816 | -239208.00 | -3.27 | 3.27 | 239.21 |
| 0.0870 | -241939.00 | -3.48 | 3.48 | 241.94 |
| 0.0952 | -245418.00 | -3.81 | 3.81 | 245.42 |
| 0.1073 | -249353.00 | -4.29 | 4.29 | 249.35 |
| 0.1256 | -252932.00 | -5.02 | 5.02 | 252.93 |
| 0.1438 | -254980.00 | -5.75 | 5.75 | 254.98 |
| 0.1621 | -256436.00 | -6.48 | 6.48 | 256.44 |
| 0.1803 | -257464.00 | -7.21 | 7.21 | 257.46 |
| 0.2077 | -258597.00 | -8.31 | 8.31 | 258.60 |
| 0.2487 | -261678.00 | -9.95 | 9.95 | 261.68 |
| 0.2898 | -264481.00 | -11.59 | 11.59 | 264.48 |
| 0.3308 | -267762.00 | -13.23 | 13.23 | 267.76 |
| 0.3719 | -271174.00 | -14.88 | 14.88 | 271.17 |
| 0.4335 | -275376.00 | -17.34 | 17.34 | 275.38 |
| 0.4566 | -276861.00 | -18.26 | 18.26 | 276.86 |
| 0.4912 | -279353.00 | -19.65 | 19.65 | 279.35 |
| 0.5431 | -283700.00 | -21.73 | 21.73 | 283.70 |
| 0.5951 | -288581.00 | -23.80 | 23.80 | 288.58 |
| 0.6471 | -291983.00 | -25.88 | 25.88 | 291.98 |
| 0.6601 | -292203.00 | -26.40 | 26.40 | 292.20 |
| 0.6633 | -292202.00 | -26.53 | 26.53 | 292.20 |
| 0.6665 | -291947.00 | -26.66 | 26.66 | 291.95 |
| 0.6698 | -291657.00 | -26.79 | 26.79 | 291.66 |
| 0.6730 | -291289.00 | -26.92 | 26.92 | 291.29 |
| 0.6779 | -290499.00 | -27.12 | 27.12 | 290.50 |
| 0.6852 | -288834.00 | -27.41 | 27.41 | 288.83 |
| 0.6925 | -286620.00 | -27.70 | 27.70 | 286.62 |
| 0.6998 | -283911.00 | -27.99 | 27.99 | 283.91 |
| 0.7071 | -280764.00 | -28.29 | 28.29 | 280.76 |
| 0.7181 | -274291.00 | -28.72 | 28.72 | 274.29 |
| 0.7208 | -273712.00 | -28.83 | 28.83 | 273.71 |
| 0.7236 | -271803.00 | -28.94 | 28.94 | 271.80 |
| 0.7277 | -268288.00 | -29.11 | 29.11 | 268.29 |
| 0.7318 | -264100.00 | -29.27 | 29.27 | 264.10 |
| 0.7359 | -259437.00 | -29.44 | 29.44 | 259.44 |
| 0.7400 | -254411.00 | -29.60 | 29.60 | 254.41 |
| 0.7462 | -245927.00 | -29.85 | 29.85 | 245.93 |
| 0.7554 | -232070.00 | -30.22 | 30.22 | 232.07 |
| 0.7647 | -219341.00 | -30.59 | 30.59 | 219.34 |
| 0.7670 | -220448.00 | -30.68 | 30.68 | 220.45 |
| 0.7693 | -217281.00 | -30.77 | 30.77 | 217.28 |
| 0.7728 | -212192.00 | -30.91 | 30.91 | 212.19 |
| 0.7780 | -204504.00 | -31.12 | 31.12 | 204.50 |
| 0.7832 | -198467.00 | -31.33 | 31.33 | 198.47 |
| 0.7884 | -192769.00 | -31.53 | 31.53 | 192.77 |
| 0.7962 | -183100.00 | -31.85 | 31.85 | 183.10 |

| | | *A25* | | |
|---|---|---|---|---|
| *Nu,exp* | *274.8* | *kN* | | |
| *Nu,fem* | *285.2* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.963* | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -93300.70 | -0.30 | 0.30 | 93.30 |
| 0.0200 | -177063.00 | -0.60 | 0.60 | 177.06 |
| 0.0225 | -180521.00 | -0.68 | 0.68 | 180.52 |
| 0.0250 | -182588.00 | -0.75 | 0.75 | 182.59 |
| 0.0288 | -185751.00 | -0.86 | 0.86 | 185.75 |
| 0.0344 | -190749.00 | -1.03 | 1.03 | 190.75 |
| 0.0365 | -192630.00 | -1.09 | 1.09 | 192.63 |
| 0.0396 | -195177.00 | -1.19 | 1.19 | 195.18 |
| 0.0444 | -199130.00 | -1.33 | 1.33 | 199.13 |
| 0.0515 | -205203.00 | -1.55 | 1.55 | 205.20 |
| 0.0622 | -213444.00 | -1.87 | 1.87 | 213.44 |
| 0.0729 | -220239.00 | -2.19 | 2.19 | 220.24 |
| 0.0835 | -225904.00 | -2.51 | 2.51 | 225.90 |
| 0.0996 | -233376.00 | -2.99 | 2.99 | 233.38 |
| 0.1236 | -242834.00 | -3.71 | 3.71 | 242.83 |
| 0.1476 | -250284.00 | -4.43 | 4.43 | 250.28 |
| 0.1716 | -253519.00 | -5.15 | 5.15 | 253.52 |
| 0.1957 | -255578.00 | -5.87 | 5.87 | 255.58 |
| 0.2197 | -257352.00 | -6.59 | 6.59 | 257.35 |
| 0.2557 | -259163.00 | -7.67 | 7.67 | 259.16 |
| 0.2918 | -260380.00 | -8.75 | 8.75 | 260.38 |
| 0.3278 | -261612.00 | -9.83 | 9.83 | 261.61 |
| 0.3639 | -263184.00 | -10.92 | 10.92 | 263.18 |
| 0.3999 | -264889.00 | -12.00 | 12.00 | 264.89 |
| 0.4359 | -267016.00 | -13.08 | 13.08 | 267.02 |
| 0.4720 | -269025.00 | -14.16 | 14.16 | 269.03 |
| 0.5260 | -271970.00 | -15.78 | 15.78 | 271.97 |
| 0.6071 | -275902.00 | -18.21 | 18.21 | 275.90 |
| 0.7288 | -281854.00 | -21.86 | 21.86 | 281.85 |
| 0.7592 | -283648.00 | -22.78 | 22.78 | 283.65 |
| 0.7896 | -284939.00 | -23.69 | 23.69 | 284.94 |
| 0.8010 | -285237.00 | -24.03 | 24.03 | 285.24 |
| 0.8124 | -285169.00 | -24.37 | 24.37 | 285.17 |
| 0.8238 | -284523.00 | -24.71 | 24.71 | 284.52 |
| 0.8352 | -283041.00 | -25.06 | 25.06 | 283.04 |
| 0.8466 | -279987.00 | -25.40 | 25.40 | 279.99 |
| 0.8580 | -275684.00 | -25.74 | 25.74 | 275.68 |
| 0.8694 | -270707.00 | -26.08 | 26.08 | 270.71 |
| 0.8808 | -265248.00 | -26.42 | 26.42 | 265.25 |
| 0.8922 | -259425.00 | -26.77 | 26.77 | 259.43 |
| 0.9036 | -253311.00 | -27.11 | 27.11 | 253.31 |
| 0.9150 | -247153.00 | -27.45 | 27.45 | 247.15 |
| 0.9264 | -240940.00 | -27.79 | 27.79 | 240.94 |
| 0.9378 | -234625.00 | -28.14 | 28.14 | 234.63 |
| 0.9492 | -228283.00 | -28.48 | 28.48 | 228.28 |
| 0.9606 | -221867.00 | -28.82 | 28.82 | 221.87 |
| 0.9778 | -210335.00 | -29.33 | 29.33 | 210.34 |
| 0.9949 | -200297.00 | -29.85 | 29.85 | 200.30 |
| 1.0000 | -201284.00 | -30.00 | 30.00 | 201.28 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |
| | | | 0.00 | 0.00 |

| | | *A26* | | |
|---|---|---|---|---|
| *Nu,exp* | *273.9* | *kN* | | |
| *Nu,fem* | *285.2* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.960* | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -155267.00 | -0.50 | 0.50 | 155.27 |
| 0.0125 | -178672.00 | -0.63 | 0.63 | 178.67 |
| 0.0150 | -182634.00 | -0.75 | 0.75 | 182.63 |
| 0.0175 | -186249.00 | -0.88 | 0.88 | 186.25 |
| 0.0213 | -191711.00 | -1.06 | 1.06 | 191.71 |
| 0.0250 | -196922.00 | -1.25 | 1.25 | 196.92 |
| 0.0288 | -202309.00 | -1.44 | 1.44 | 202.31 |
| 0.0344 | -210049.00 | -1.72 | 1.72 | 210.05 |
| 0.0400 | -216566.00 | -2.00 | 2.00 | 216.57 |
| 0.0456 | -222131.00 | -2.28 | 2.28 | 222.13 |
| 0.0541 | -229219.00 | -2.70 | 2.70 | 229.22 |
| 0.0572 | -231782.00 | -2.86 | 2.86 | 231.78 |
| 0.0620 | -235313.00 | -3.10 | 3.10 | 235.31 |
| 0.0691 | -240071.00 | -3.45 | 3.45 | 240.07 |
| 0.0798 | -246229.00 | -3.99 | 3.99 | 246.23 |
| 0.0904 | -251072.00 | -4.52 | 4.52 | 251.07 |
| 0.1011 | -253206.00 | -5.06 | 5.06 | 253.21 |
| 0.1118 | -254798.00 | -5.59 | 5.59 | 254.80 |
| 0.1225 | -256276.00 | -6.12 | 6.12 | 256.28 |
| 0.1385 | -258013.00 | -6.93 | 6.93 | 258.01 |
| 0.1625 | -259716.00 | -8.13 | 8.13 | 259.72 |
| 0.1866 | -261149.00 | -9.33 | 9.33 | 261.15 |
| 0.2106 | -263225.00 | -10.53 | 10.53 | 263.23 |
| 0.2346 | -265001.00 | -11.73 | 11.73 | 265.00 |
| 0.2586 | -267474.00 | -12.93 | 12.93 | 267.47 |
| 0.2827 | -269656.00 | -14.13 | 14.13 | 269.66 |
| 0.3067 | -271716.00 | -15.33 | 15.33 | 271.72 |
| 0.3307 | -273644.00 | -16.54 | 16.54 | 273.64 |
| 0.3668 | -276367.00 | -18.34 | 18.34 | 276.37 |
| 0.4208 | -280496.00 | -21.04 | 21.04 | 280.50 |
| 0.4411 | -282142.00 | -22.05 | 22.05 | 282.14 |
| 0.4715 | -284549.00 | -23.58 | 23.58 | 284.55 |
| 0.4829 | -285090.00 | -24.15 | 24.15 | 285.09 |
| 0.4840 | -285170.00 | -24.20 | 24.20 | 285.17 |
| 0.4850 | -285181.00 | -24.25 | 24.25 | 285.18 |
| 0.4853 | -285187.00 | -24.27 | 24.27 | 285.19 |
| 0.4857 | -285192.00 | -24.29 | 24.29 | 285.19 |
| 0.4863 | -285193.00 | -24.32 | 24.32 | 285.19 |
| 0.4872 | -285188.00 | -24.36 | 24.36 | 285.19 |
| 0.4886 | -285158.00 | -24.43 | 24.43 | 285.16 |
| 0.4899 | -285111.00 | -24.50 | 24.50 | 285.11 |
| 0.4913 | -285037.00 | -24.56 | 24.56 | 285.04 |
| 0.4933 | -284849.00 | -24.67 | 24.67 | 284.85 |
| 0.4964 | -284454.00 | -24.82 | 24.82 | 284.45 |
| 0.5009 | -283510.00 | -25.05 | 25.05 | 283.51 |
| 0.5055 | -281939.00 | -25.27 | 25.27 | 281.94 |
| 0.5101 | -279495.00 | -25.50 | 25.50 | 279.50 |
| 0.5146 | -276584.00 | -25.73 | 25.73 | 276.58 |
| 0.5192 | -273323.00 | -25.96 | 25.96 | 273.32 |
| 0.5238 | -269837.00 | -26.19 | 26.19 | 269.84 |
| 0.5306 | -263636.00 | -26.53 | 26.53 | 263.64 |
| 0.5374 | -257401.00 | -26.87 | 26.87 | 257.40 |
| 0.5443 | -250876.00 | -27.22 | 27.22 | 250.88 |
| 0.5511 | -244516.00 | -27.56 | 27.56 | 244.52 |
| 0.5580 | -238176.00 | -27.90 | 27.90 | 238.18 |
| 0.5648 | -231801.00 | -28.24 | 28.24 | 231.80 |
| 0.5674 | -231386.00 | -28.37 | 28.37 | 231.39 |
| 0.5713 | -227171.00 | -28.56 | 28.56 | 227.17 |
| 0.5751 | -223643.00 | -28.76 | 28.76 | 223.64 |
| 0.5790 | -220079.00 | -28.95 | 28.95 | 220.08 |
| 0.5848 | -213717.00 | -29.24 | 29.24 | 213.72 |
| 0.5934 | -204034.00 | -29.67 | 29.67 | 204.03 |

| | | *A31* | | |
|---|---|---|---|---|
| *Nu,exp* | *282.1* | *kN* | | |
| *Nu,fem* | *293.8* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.960* | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -118044.00 | -0.38 | 0.38 | 118.04 |
| 0.0125 | -146873.00 | -0.48 | 0.48 | 146.87 |
| 0.0163 | -174884.00 | -0.62 | 0.62 | 174.88 |
| 0.0200 | -179758.00 | -0.76 | 0.76 | 179.76 |
| 0.0238 | -183368.00 | -0.90 | 0.90 | 183.37 |
| 0.0275 | -188354.00 | -1.05 | 1.05 | 188.35 |
| 0.0313 | -193474.00 | -1.19 | 1.19 | 193.47 |
| 0.0350 | -198364.00 | -1.33 | 1.33 | 198.36 |
| 0.0406 | -205554.00 | -1.54 | 1.54 | 205.55 |
| 0.0427 | -208340.00 | -1.62 | 1.62 | 208.34 |
| 0.0459 | -212202.00 | -1.74 | 1.74 | 212.20 |
| 0.0506 | -217425.00 | -1.92 | 1.92 | 217.43 |
| 0.0578 | -222744.00 | -2.20 | 2.20 | 222.74 |
| 0.0649 | -226683.00 | -2.47 | 2.47 | 226.68 |
| 0.0720 | -230196.00 | -2.74 | 2.74 | 230.20 |
| 0.0827 | -234827.00 | -3.14 | 3.14 | 234.83 |
| 0.0987 | -240582.00 | -3.75 | 3.75 | 240.58 |
| 0.1147 | -245435.00 | -4.36 | 4.36 | 245.44 |
| 0.1307 | -249507.00 | -4.97 | 4.97 | 249.51 |
| 0.1468 | -252487.00 | -5.58 | 5.58 | 252.49 |
| 0.1628 | -254824.00 | -6.19 | 6.19 | 254.82 |
| 0.1788 | -256774.00 | -6.79 | 6.79 | 256.77 |
| 0.2028 | -259157.00 | -7.71 | 7.71 | 259.16 |
| 0.2389 | -261608.00 | -9.08 | 9.08 | 261.61 |
| 0.2749 | -263538.00 | -10.45 | 10.45 | 263.54 |
| 0.3109 | -265882.00 | -11.82 | 11.82 | 265.88 |
| 0.3470 | -268473.00 | -13.19 | 13.19 | 268.47 |
| 0.3830 | -271197.00 | -14.55 | 14.55 | 271.20 |
| 0.4191 | -273587.00 | -15.92 | 15.92 | 273.59 |
| 0.4551 | -275888.00 | -17.29 | 17.29 | 275.89 |
| 0.4911 | -278051.00 | -18.66 | 18.66 | 278.05 |
| 0.5272 | -280490.00 | -20.03 | 20.03 | 280.49 |
| 0.5632 | -283000.00 | -21.40 | 21.40 | 283.00 |
| 0.5993 | -286303.00 | -22.77 | 22.77 | 286.30 |
| 0.6353 | -289413.00 | -24.14 | 24.14 | 289.41 |
| 0.6713 | -292005.00 | -25.51 | 25.51 | 292.01 |
| 0.6804 | -292649.00 | -25.85 | 25.85 | 292.65 |
| 0.6894 | -293152.00 | -26.20 | 26.20 | 293.15 |
| 0.6984 | -293567.00 | -26.54 | 26.54 | 293.57 |
| 0.7074 | -293779.00 | -26.88 | 26.88 | 293.78 |
| 0.7164 | -293727.00 | -27.22 | 27.22 | 293.73 |
| 0.7254 | -293424.00 | -27.57 | 27.57 | 293.42 |
| 0.7344 | -292884.00 | -27.91 | 27.91 | 292.88 |
| 0.7434 | -291954.00 | -28.25 | 28.25 | 291.95 |
| 0.7524 | -290616.00 | -28.59 | 28.59 | 290.62 |
| 0.7614 | -288815.00 | -28.94 | 28.94 | 288.82 |
| 0.7705 | -286491.00 | -29.28 | 29.28 | 286.49 |
| 0.7795 | -283581.00 | -29.62 | 29.62 | 283.58 |
| 0.7885 | -280342.00 | -29.96 | 29.96 | 280.34 |
| 0.7975 | -276915.00 | -30.30 | 30.30 | 276.92 |
| 0.8065 | -273535.00 | -30.65 | 30.65 | 273.54 |
| 0.8155 | -270305.00 | -30.99 | 30.99 | 270.31 |
| 0.8245 | -267235.00 | -31.33 | 31.33 | 267.24 |
| 0.8335 | -264324.00 | -31.67 | 31.67 | 264.32 |
| 0.8425 | -261537.00 | -32.02 | 32.02 | 261.54 |
| 0.8561 | -256785.00 | -32.53 | 32.53 | 256.79 |
| 0.8696 | -252965.00 | -33.04 | 33.04 | 252.97 |
| 0.8831 | -249296.00 | -33.56 | 33.56 | 249.30 |
| 0.8966 | -245836.00 | -34.07 | 34.07 | 245.84 |
| 0.9101 | -242402.00 | -34.58 | 34.58 | 242.40 |
| 0.9236 | -238730.00 | -35.10 | 35.10 | 238.73 |
| 0.9371 | -234615.00 | -35.61 | 35.61 | 234.62 |

| | A32 | | | |
|---|---|---|---|---|
| Nu,exp | 283.2 | kN | | |
| Nu,fem | 293.5 | kN | | |
| Nu,exp/Nu,fem | 0.965 | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -117772.00 | -0.38 | 0.38 | 117.77 |
| 0.0125 | -146538.00 | -0.48 | 0.48 | 146.54 |
| 0.0150 | -171280.00 | -0.57 | 0.57 | 171.28 |
| 0.0175 | -176728.00 | -0.67 | 0.67 | 176.73 |
| 0.0200 | -179596.00 | -0.76 | 0.76 | 179.60 |
| 0.0225 | -182009.00 | -0.86 | 0.86 | 182.01 |
| 0.0263 | -186297.00 | -1.00 | 1.00 | 186.30 |
| 0.0319 | -193840.00 | -1.21 | 1.21 | 193.84 |
| 0.0375 | -201219.00 | -1.43 | 1.43 | 201.22 |
| 0.0389 | -203162.00 | -1.48 | 1.48 | 203.16 |
| 0.0410 | -205954.00 | -1.56 | 1.56 | 205.95 |
| 0.0442 | -209892.00 | -1.68 | 1.68 | 209.89 |
| 0.0454 | -211326.00 | -1.72 | 1.72 | 211.33 |
| 0.0471 | -213384.00 | -1.79 | 1.79 | 213.38 |
| 0.0498 | -216283.00 | -1.89 | 1.89 | 216.28 |
| 0.0538 | -219864.00 | -2.05 | 2.05 | 219.86 |
| 0.0598 | -223595.00 | -2.27 | 2.27 | 223.60 |
| 0.0658 | -226803.00 | -2.50 | 2.50 | 226.80 |
| 0.0718 | -229719.00 | -2.73 | 2.73 | 229.72 |
| 0.0809 | -233689.00 | -3.07 | 3.07 | 233.69 |
| 0.0944 | -238743.00 | -3.59 | 3.59 | 238.74 |
| 0.1079 | -243042.00 | -4.10 | 4.10 | 243.04 |
| 0.1214 | -246806.00 | -4.61 | 4.61 | 246.81 |
| 0.1349 | -249897.00 | -5.13 | 5.13 | 249.90 |
| 0.1484 | -252258.00 | -5.64 | 5.64 | 252.26 |
| 0.1619 | -254193.00 | -6.15 | 6.15 | 254.19 |
| 0.1755 | -255855.00 | -6.67 | 6.67 | 255.86 |
| 0.1957 | -257979.00 | -7.44 | 7.44 | 257.98 |
| 0.2261 | -260248.00 | -8.59 | 8.59 | 260.25 |
| 0.2565 | -261962.00 | -9.75 | 9.75 | 261.96 |
| 0.2870 | -263649.00 | -10.90 | 10.90 | 263.65 |
| 0.3174 | -265756.00 | -12.06 | 12.06 | 265.76 |
| 0.3478 | -267934.00 | -13.22 | 13.22 | 267.93 |
| 0.3782 | -270235.00 | -14.37 | 14.37 | 270.24 |
| 0.4086 | -272282.00 | -15.53 | 15.53 | 272.28 |
| 0.4390 | -274274.00 | -16.68 | 16.68 | 274.27 |
| 0.4694 | -276086.00 | -17.84 | 17.84 | 276.09 |
| 0.4998 | -278000.00 | -18.99 | 18.99 | 278.00 |
| 0.5302 | -280091.00 | -20.15 | 20.15 | 280.09 |
| 0.5606 | -282194.00 | -21.30 | 21.30 | 282.19 |
| 0.5911 | -284968.00 | -22.46 | 22.46 | 284.97 |
| 0.6215 | -287676.00 | -23.62 | 23.62 | 287.68 |
| 0.6519 | -290112.00 | -24.77 | 24.77 | 290.11 |
| 0.6823 | -292139.00 | -25.93 | 25.93 | 292.14 |
| 0.6899 | -292721.00 | -26.22 | 26.22 | 292.72 |
| 0.6975 | -293098.00 | -26.50 | 26.50 | 293.10 |
| 0.7051 | -293374.00 | -26.79 | 26.79 | 293.37 |
| 0.7127 | -293503.00 | -27.08 | 27.08 | 293.50 |
| 0.7241 | -293196.00 | -27.52 | 27.52 | 293.20 |
| 0.7355 | -292596.00 | -27.95 | 27.95 | 292.60 |
| 0.7469 | -291453.00 | -28.38 | 28.38 | 291.45 |
| 0.7583 | -289658.00 | -28.82 | 28.82 | 289.66 |
| 0.7697 | -287152.00 | -29.25 | 29.25 | 287.15 |
| 0.7811 | -283795.00 | -29.68 | 29.68 | 283.80 |
| 0.7925 | -279939.00 | -30.12 | 30.12 | 279.94 |
| 0.8039 | -275958.00 | -30.55 | 30.55 | 275.96 |
| 0.8153 | -272202.00 | -30.98 | 30.98 | 272.20 |
| 0.8267 | -268592.00 | -31.42 | 31.42 | 268.59 |
| 0.8381 | -265113.00 | -31.85 | 31.85 | 265.11 |
| 0.8424 | -265266.00 | -32.01 | 32.01 | 265.27 |
| 0.8488 | -262955.00 | -32.26 | 32.26 | 262.96 |
| 0.8552 | -261190.00 | -32.50 | 32.50 | 261.19 |

| | A33 | | | |
|---|---|---|---|---|
| Nu,exp | 284.7 | kN | | |
| Nu,fem | 295.0 | kN | | |
| Nu,exp/Nu,fem | 0.965 | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -124286.00 | -0.40 | 0.40 | 124.29 |
| 0.0125 | -154424.00 | -0.50 | 0.50 | 154.42 |
| 0.0150 | -176158.00 | -0.60 | 0.60 | 176.16 |
| 0.0175 | -180948.00 | -0.70 | 0.70 | 180.95 |
| 0.0200 | -183790.00 | -0.80 | 0.80 | 183.79 |
| 0.0225 | -186191.00 | -0.90 | 0.90 | 186.19 |
| 0.0263 | -190603.00 | -1.05 | 1.05 | 190.60 |
| 0.0300 | -195707.00 | -1.20 | 1.20 | 195.71 |
| 0.0338 | -200671.00 | -1.35 | 1.35 | 200.67 |
| 0.0394 | -207740.00 | -1.58 | 1.58 | 207.74 |
| 0.0415 | -210425.00 | -1.66 | 1.66 | 210.43 |
| 0.0446 | -214153.00 | -1.79 | 1.79 | 214.15 |
| 0.0494 | -218896.00 | -1.98 | 1.98 | 218.90 |
| 0.0541 | -222086.00 | -2.17 | 2.17 | 222.09 |
| 0.0589 | -224889.00 | -2.36 | 2.36 | 224.89 |
| 0.0660 | -228547.00 | -2.64 | 2.64 | 228.55 |
| 0.0767 | -233402.00 | -3.07 | 3.07 | 233.40 |
| 0.0807 | -235139.00 | -3.23 | 3.23 | 235.14 |
| 0.0867 | -237568.00 | -3.47 | 3.47 | 237.57 |
| 0.0957 | -240847.00 | -3.83 | 3.83 | 240.85 |
| 0.1092 | -245083.00 | -4.37 | 4.37 | 245.08 |
| 0.1295 | -250165.00 | -5.18 | 5.18 | 250.17 |
| 0.1346 | -251256.00 | -5.38 | 5.38 | 251.26 |
| 0.1396 | -252252.00 | -5.59 | 5.59 | 252.25 |
| 0.1472 | -253594.00 | -5.89 | 5.89 | 253.59 |
| 0.1586 | -255335.00 | -6.35 | 6.35 | 255.34 |
| 0.1757 | -257476.00 | -7.03 | 7.03 | 257.48 |
| 0.1928 | -259229.00 | -7.71 | 7.71 | 259.23 |
| 0.2100 | -260623.00 | -8.40 | 8.40 | 260.62 |
| 0.2356 | -262292.00 | -9.42 | 9.42 | 262.29 |
| 0.2613 | -263684.00 | -10.45 | 10.45 | 263.68 |
| 0.2869 | -265215.00 | -11.48 | 11.48 | 265.22 |
| 0.3126 | -267086.00 | -12.50 | 12.50 | 267.09 |
| 0.3382 | -269034.00 | -13.53 | 13.53 | 269.03 |
| 0.3639 | -271033.00 | -14.56 | 14.56 | 271.03 |
| 0.3896 | -272891.00 | -15.58 | 15.58 | 272.89 |
| 0.4280 | -275307.00 | -17.12 | 17.12 | 275.31 |
| 0.4665 | -277562.00 | -18.66 | 18.66 | 277.56 |
| 0.5050 | -280730.00 | -20.20 | 20.20 | 280.73 |
| 0.5435 | -284833.00 | -21.74 | 21.74 | 284.83 |
| 0.5820 | -288345.00 | -23.28 | 23.28 | 288.35 |
| 0.5964 | -289537.00 | -23.86 | 23.86 | 289.54 |
| 0.6181 | -291209.00 | -24.72 | 24.72 | 291.21 |
| 0.6397 | -292974.00 | -25.59 | 25.59 | 292.97 |
| 0.6614 | -294340.00 | -26.45 | 26.45 | 294.34 |
| 0.6668 | -294749.00 | -26.67 | 26.67 | 294.75 |
| 0.6722 | -294932.00 | -26.89 | 26.89 | 294.93 |
| 0.6776 | -295023.00 | -27.10 | 27.10 | 295.02 |
| 0.6830 | -295022.00 | -27.32 | 27.32 | 295.02 |
| 0.6884 | -294899.00 | -27.54 | 27.54 | 294.90 |
| 0.6938 | -294674.00 | -27.75 | 27.75 | 294.67 |
| 0.6993 | -294317.00 | -27.97 | 27.97 | 294.32 |
| 0.7047 | -293821.00 | -28.19 | 28.19 | 293.82 |
| 0.7101 | -293163.00 | -28.40 | 28.40 | 293.16 |
| 0.7155 | -292356.00 | -28.62 | 28.62 | 292.36 |
| 0.7209 | -291373.00 | -28.84 | 28.84 | 291.37 |
| 0.7290 | -289334.00 | -29.16 | 29.16 | 289.33 |
| 0.7371 | -287149.00 | -29.49 | 29.49 | 287.15 |
| 0.7453 | -284585.00 | -29.81 | 29.81 | 284.59 |
| 0.7534 | -281848.00 | -30.14 | 30.14 | 281.85 |
| 0.7615 | -279105.00 | -30.46 | 30.46 | 279.11 |
| 0.7696 | -276422.00 | -30.78 | 30.78 | 276.42 |

| | A34 | | | |
|---|---|---|---|---|
| Nu,exp | 283.1 | kN | | |
| Nu,fem | 295.0 | kN | | |
| Nu,exp/Nu,fem | 0.960 | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -124286.00 | -0.38 | 0.38 | 124.29 |
| 0.0125 | -154424.00 | -0.48 | 0.48 | 154.42 |
| 0.0150 | -176158.00 | -0.57 | 0.57 | 176.16 |
| 0.0175 | -180948.00 | -0.67 | 0.67 | 180.95 |
| 0.0200 | -183790.00 | -0.76 | 0.76 | 183.79 |
| 0.0225 | -186191.00 | -0.86 | 0.86 | 186.19 |
| 0.0263 | -190603.00 | -1.00 | 1.00 | 190.60 |
| 0.0300 | -195707.00 | -1.14 | 1.14 | 195.71 |
| 0.0338 | -200671.00 | -1.28 | 1.28 | 200.67 |
| 0.0394 | -207740.00 | -1.50 | 1.50 | 207.74 |
| 0.0415 | -210425.00 | -1.58 | 1.58 | 210.43 |
| 0.0446 | -214153.00 | -1.70 | 1.70 | 214.15 |
| 0.0494 | -218896.00 | -1.88 | 1.88 | 218.90 |
| 0.0541 | -222086.00 | -2.15 | 2.15 | 222.09 |
| 0.0589 | -224889.00 | -2.42 | 2.42 | 224.89 |
| 0.0660 | -228547.00 | -2.69 | 2.69 | 228.55 |
| 0.0767 | -233402.00 | -3.09 | 3.09 | 233.40 |
| 0.0807 | -235139.00 | -3.70 | 3.70 | 235.14 |
| 0.0867 | -237568.00 | -4.31 | 4.31 | 237.57 |
| 0.0957 | -240847.00 | -4.46 | 4.46 | 240.85 |
| 0.1092 | -245083.00 | -4.62 | 4.62 | 245.08 |
| 0.1295 | -250165.00 | -4.84 | 4.84 | 250.17 |
| 0.1346 | -251256.00 | -5.19 | 5.19 | 251.26 |
| 0.1396 | -252252.00 | -5.53 | 5.53 | 252.25 |
| 0.1472 | -253594.00 | -5.87 | 5.87 | 253.59 |
| 0.1586 | -255335.00 | -6.39 | 6.39 | 255.34 |
| 0.1757 | -257476.00 | -7.16 | 7.16 | 257.48 |
| 0.1928 | -259229.00 | -7.93 | 7.93 | 259.23 |
| 0.2100 | -260623.00 | -8.70 | 8.70 | 260.62 |
| 0.2356 | -262292.00 | -9.47 | 9.47 | 262.29 |
| 0.2613 | -263684.00 | -10.24 | 10.24 | 263.68 |
| 0.2869 | -265215.00 | -11.39 | 11.39 | 265.22 |
| 0.3126 | -267086.00 | -12.55 | 12.55 | 267.09 |
| 0.3382 | -269034.00 | -13.70 | 13.70 | 269.03 |
| 0.3639 | -271033.00 | -14.86 | 14.86 | 271.03 |
| 0.3896 | -272891.00 | -16.59 | 16.59 | 272.89 |
| 0.4280 | -275307.00 | -18.33 | 18.33 | 275.31 |
| 0.4665 | -277562.00 | -20.06 | 20.06 | 277.56 |
| 0.5050 | -280730.00 | -21.79 | 21.79 | 280.73 |
| 0.5435 | -284833.00 | -23.53 | 23.53 | 284.83 |
| 0.5820 | -288345.00 | -25.26 | 25.26 | 288.35 |
| 0.5964 | -289537.00 | -25.69 | 25.69 | 289.54 |
| 0.6181 | -291209.00 | -26.13 | 26.13 | 291.21 |
| 0.6397 | -292974.00 | -26.56 | 26.56 | 292.97 |
| 0.6614 | -294340.00 | -26.99 | 26.99 | 294.34 |
| 0.6668 | -294749.00 | -27.43 | 27.43 | 294.75 |
| 0.6722 | -294932.00 | -27.86 | 27.86 | 294.93 |
| 0.6776 | -295023.00 | -28.29 | 28.29 | 295.02 |
| 0.6830 | -295022.00 | -28.73 | 28.73 | 295.02 |
| 0.6884 | -294899.00 | -29.16 | 29.16 | 294.90 |
| 0.6938 | -294674.00 | -29.59 | 29.59 | 294.67 |
| 0.6993 | -294317.00 | -30.03 | 30.03 | 294.32 |
| 0.7047 | -293821.00 | -30.46 | 30.46 | 293.82 |
| 0.7101 | -293163.00 | -30.89 | 30.89 | 293.16 |
| 0.7155 | -292356.00 | -31.33 | 31.33 | 292.36 |
| 0.7209 | -291373.00 | -31.76 | 31.76 | 291.37 |
| 0.7290 | -289334.00 | -32.19 | 32.19 | 289.33 |
| 0.7371 | -287149.00 | -32.63 | 32.63 | 287.15 |
| 0.7453 | -284585.00 | -33.06 | 33.06 | 284.59 |
| 0.7534 | -281848.00 | -33.49 | 33.49 | 281.85 |
| 0.7615 | -279105.00 | -33.93 | 33.93 | 279.11 |
| 0.7696 | -276422.00 | -34.36 | 34.36 | 276.42 |

| *A35* | | | | |
|---|---|---|---|---|
| *Nu,exp* | *291.1* | *kN* | | |
| *Nu,fem* | *303.8* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.958* | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -124046.00 | -0.40 | 0.40 | 124.05 |
| 0.0125 | -154193.00 | -0.50 | 0.50 | 154.19 |
| 0.0150 | -178859.00 | -0.60 | 0.60 | 178.86 |
| 0.0175 | -191703.00 | -0.70 | 0.70 | 191.70 |
| 0.0200 | -197737.00 | -0.80 | 0.80 | 197.74 |
| 0.0225 | -200870.00 | -0.90 | 0.90 | 200.87 |
| 0.0250 | -203127.00 | -1.00 | 1.00 | 203.13 |
| 0.0275 | -205043.00 | -1.10 | 1.10 | 205.04 |
| 0.0313 | -207778.00 | -1.25 | 1.25 | 207.78 |
| 0.0369 | -211993.00 | -1.48 | 1.48 | 211.99 |
| 0.0453 | -217663.00 | -1.81 | 1.81 | 217.66 |
| 0.0485 | -219678.00 | -1.94 | 1.94 | 219.68 |
| 0.0532 | -222407.00 | -2.13 | 2.13 | 222.41 |
| 0.0603 | -226010.00 | -2.41 | 2.41 | 226.01 |
| 0.0630 | -227296.00 | -2.52 | 2.52 | 227.30 |
| 0.0670 | -229092.00 | -2.68 | 2.68 | 229.09 |
| 0.0730 | -231546.00 | -2.92 | 2.92 | 231.55 |
| 0.0820 | -234899.00 | -3.28 | 3.28 | 234.90 |
| 0.0955 | -239318.00 | -3.82 | 3.82 | 239.32 |
| 0.1158 | -245067.00 | -4.63 | 4.63 | 245.07 |
| 0.1361 | -250037.00 | -5.44 | 5.44 | 250.04 |
| 0.1564 | -253425.00 | -6.25 | 6.25 | 253.43 |
| 0.1614 | -254191.00 | -6.46 | 6.46 | 254.19 |
| 0.1690 | -255301.00 | -6.76 | 6.76 | 255.30 |
| 0.1804 | -256889.00 | -7.22 | 7.22 | 256.89 |
| 0.1975 | -258989.00 | -7.90 | 7.90 | 258.99 |
| 0.2232 | -261449.00 | -8.93 | 8.93 | 261.45 |
| 0.2489 | -263169.00 | -9.95 | 9.95 | 263.17 |
| 0.2745 | -264752.00 | -10.98 | 10.98 | 264.75 |
| 0.3002 | -266422.00 | -12.01 | 12.01 | 266.42 |
| 0.3258 | -268484.00 | -13.03 | 13.03 | 268.48 |
| 0.3515 | -270699.00 | -14.06 | 14.06 | 270.70 |
| 0.3772 | -272631.00 | -15.09 | 15.09 | 272.63 |
| 0.4028 | -274364.00 | -16.11 | 16.11 | 274.36 |
| 0.4413 | -276748.00 | -17.65 | 17.65 | 276.75 |
| 0.4990 | -281093.00 | -19.96 | 19.96 | 281.09 |
| 0.5568 | -286481.00 | -22.27 | 22.27 | 286.48 |
| 0.6145 | -292471.00 | -24.58 | 24.58 | 292.47 |
| 0.6722 | -298990.00 | -26.89 | 26.89 | 298.99 |
| 0.6866 | -300540.00 | -27.47 | 27.47 | 300.54 |
| 0.7011 | -301788.00 | -28.04 | 28.04 | 301.79 |
| 0.7155 | -302812.00 | -28.62 | 28.62 | 302.81 |
| 0.7299 | -303519.00 | -29.20 | 29.20 | 303.52 |
| 0.7444 | -303777.00 | -29.78 | 29.78 | 303.78 |
| 0.7588 | -303460.00 | -30.35 | 30.35 | 303.46 |
| 0.7732 | -302534.00 | -30.93 | 30.93 | 302.53 |
| 0.7877 | -300868.00 | -31.51 | 31.51 | 300.87 |
| 0.8021 | -298238.00 | -32.08 | 32.08 | 298.24 |
| 0.8057 | -298825.00 | -32.23 | 32.23 | 298.83 |
| 0.8093 | -297975.00 | -32.37 | 32.37 | 297.98 |
| 0.8129 | -297190.00 | -32.52 | 32.52 | 297.19 |
| 0.8165 | -296355.00 | -32.66 | 32.66 | 296.36 |
| 0.8220 | -294787.00 | -32.88 | 32.88 | 294.79 |
| 0.8274 | -293499.00 | -33.09 | 33.09 | 293.50 |
| 0.8328 | -292187.00 | -33.31 | 33.31 | 292.19 |
| 0.8409 | -289622.00 | -33.64 | 33.64 | 289.62 |
| 0.8490 | -287737.00 | -33.96 | 33.96 | 287.74 |
| 0.8571 | -285945.00 | -34.29 | 34.29 | 285.95 |
| 0.8653 | -284322.00 | -34.61 | 34.61 | 284.32 |
| 0.8734 | -282840.00 | -34.93 | 34.93 | 282.84 |
| 0.8855 | -279884.00 | -35.42 | 35.42 | 279.88 |
| 0.8977 | -278150.00 | -35.91 | 35.91 | 278.15 |

| *A36* | | | | |
|---|---|---|---|---|
| *Nu,exp* | *291.1* | *kN* | | |
| *Nu,fem* | *303.8* | *kN* | | |
| *Nu,exp/Nu,fem* | *0.958* | | | |
| **Time** | **Load** | **Displacement** | **Dis abs** | **Force kn** |
| 0.0000 | 0.00 | 0.00 | 0.00 | 0.00 |
| 0.0100 | -124046.00 | -0.40 | 0.40 | 124.05 |
| 0.0125 | -154193.00 | -0.50 | 0.50 | 154.19 |
| 0.0150 | -178859.00 | -0.60 | 0.60 | 178.86 |
| 0.0175 | -191703.00 | -0.70 | 0.70 | 191.70 |
| 0.0200 | -197737.00 | -0.80 | 0.80 | 197.74 |
| 0.0225 | -200870.00 | -0.90 | 0.90 | 200.87 |
| 0.0250 | -203127.00 | -1.00 | 1.00 | 203.13 |
| 0.0275 | -205043.00 | -1.10 | 1.10 | 205.04 |
| 0.0313 | -207778.00 | -1.25 | 1.25 | 207.78 |
| 0.0369 | -211993.00 | -1.48 | 1.48 | 211.99 |
| 0.0453 | -217663.00 | -1.81 | 1.81 | 217.66 |
| 0.0485 | -219678.00 | -1.94 | 1.94 | 219.68 |
| 0.0532 | -222407.00 | -2.13 | 2.13 | 222.41 |
| 0.0603 | -226010.00 | -2.41 | 2.41 | 226.01 |
| 0.0630 | -227296.00 | -2.52 | 2.52 | 227.30 |
| 0.0670 | -229092.00 | -2.68 | 2.68 | 229.09 |
| 0.0730 | -231546.00 | -2.92 | 2.92 | 231.55 |
| 0.0820 | -234899.00 | -3.28 | 3.28 | 234.90 |
| 0.0955 | -239318.00 | -3.82 | 3.82 | 239.32 |
| 0.1158 | -245067.00 | -4.63 | 4.63 | 245.07 |
| 0.1361 | -250037.00 | -5.44 | 5.44 | 250.04 |
| 0.1564 | -253425.00 | -6.25 | 6.25 | 253.43 |
| 0.1614 | -254191.00 | -6.46 | 6.46 | 254.19 |
| 0.1690 | -255301.00 | -6.76 | 6.76 | 255.30 |
| 0.1804 | -256889.00 | -7.22 | 7.22 | 256.89 |
| 0.1975 | -258989.00 | -7.90 | 7.90 | 258.99 |
| 0.2232 | -261449.00 | -8.93 | 8.93 | 261.45 |
| 0.2489 | -263169.00 | -9.95 | 9.95 | 263.17 |
| 0.2745 | -264752.00 | -10.98 | 10.98 | 264.75 |
| 0.3002 | -266422.00 | -12.01 | 12.01 | 266.42 |
| 0.3258 | -268484.00 | -13.03 | 13.03 | 268.48 |
| 0.3515 | -270699.00 | -14.06 | 14.06 | 270.70 |
| 0.3772 | -272631.00 | -15.09 | 15.09 | 272.63 |
| 0.4028 | -274364.00 | -16.11 | 16.11 | 274.36 |
| 0.4413 | -276748.00 | -17.65 | 17.65 | 276.75 |
| 0.4990 | -281093.00 | -19.96 | 19.96 | 281.09 |
| 0.5568 | -286481.00 | -22.27 | 22.27 | 286.48 |
| 0.6145 | -292471.00 | -24.58 | 24.58 | 292.47 |
| 0.6722 | -298990.00 | -26.89 | 26.89 | 298.99 |
| 0.6866 | -300540.00 | -27.47 | 27.47 | 300.54 |
| 0.7011 | -301788.00 | -28.04 | 28.04 | 301.79 |
| 0.7155 | -302812.00 | -28.62 | 28.62 | 302.81 |
| 0.7299 | -303519.00 | -29.20 | 29.20 | 303.52 |
| 0.7444 | -303777.00 | -29.78 | 29.78 | 303.78 |
| 0.7588 | -303460.00 | -30.35 | 30.35 | 303.46 |
| 0.7732 | -302534.00 | -30.93 | 30.93 | 302.53 |
| 0.7877 | -300868.00 | -31.51 | 31.51 | 300.87 |
| 0.8021 | -298238.00 | -32.08 | 32.08 | 298.24 |
| 0.8057 | -298825.00 | -32.23 | 32.23 | 298.83 |
| 0.8093 | -297975.00 | -32.37 | 32.37 | 297.98 |
| 0.8129 | -297190.00 | -32.52 | 32.52 | 297.19 |
| 0.8165 | -296355.00 | -32.66 | 32.66 | 296.36 |
| 0.8220 | -294787.00 | -32.88 | 32.88 | 294.79 |
| 0.8274 | -293499.00 | -33.09 | 33.09 | 293.50 |
| 0.8328 | -292187.00 | -33.31 | 33.31 | 292.19 |
| 0.8409 | -289622.00 | -33.64 | 33.64 | 289.62 |
| 0.8490 | -287737.00 | -33.96 | 33.96 | 287.74 |
| 0.8571 | -285945.00 | -34.29 | 34.29 | 285.95 |
| 0.8653 | -284322.00 | -34.61 | 34.61 | 284.32 |
| 0.8734 | -282840.00 | -34.93 | 34.93 | 282.84 |
| 0.8855 | -279884.00 | -35.42 | 35.42 | 279.88 |
| 0.8977 | -278150.00 | -35.91 | 35.91 | 278.15 |

## 5. INPUT PLASTIC BEHAVIOR FOR THE FINITE ELEMENT MODEL

| S355 | | S460 | |
|---|---|---|---|
| *Stress* | *Stress* | *Strain* | *Strain* |
| 408.4342 | 0 | 480.5776 | 0 |
| 409.8735 | 0.003518 | 482.3666 | 0.003716 |
| 411.3127 | 0.007023 | 548.6731 | 0.010583 |
| 412.752 | 0.010516 | 594.0182 | 0.017745 |
| 415.4054 | 0.013997 | 620.7106 | 0.022545 |
| 420.7102 | 0.017466 | 643.9874 | 0.027085 |
| 441.4135 | 0.020923 | 664.5206 | 0.032552 |
| 453.7611 | 0.024368 | 690.0388 | 0.039461 |
| 465.4159 | 0.027801 | 702.7293 | 0.04433 |
| 477.7575 | 0.031223 | 712.1875 | 0.048284 |
| 488.7901 | 0.034632 | 723.3277 | 0.053506 |
| 498.4632 | 0.03803 | 733.7953 | 0.058524 |
| 505.3232 | 0.041417 | 750.0836 | 0.06786 |
| 512.7413 | 0.044792 | 758.3915 | 0.074109 |
| 518.037 | 0.048156 | 765.9688 | 0.080731 |
| 523.2232 | 0.051509 | 773.0579 | 0.085809 |
| 527.8075 | 0.05485 | 783.2871 | 0.094244 |
| 531.8523 | 0.05818 | 794.5576 | 0.10853 |
| 536.0651 | 0.0615 | 798.6171 | 0.113626 |
| 539.8854 | 0.064808 | | |
| 543.171 | 0.068105 | | |
| 546.7078 | 0.071392 | | |
| 549.9981 | 0.074667 | | |
| 552.9939 | 0.077932 | | |
| 556.6663 | 0.081187 | | |
| 559.5693 | 0.084431 | | |
| 562.7329 | 0.087664 | | |
| 565.2304 | 0.090887 | | |
| 567.6588 | 0.0941 | | |
| 569.4796 | 0.097302 | | |
| 572.1231 | 0.100494 | | |
| 573.9465 | 0.103676 | | |
| 575.7698 | 0.106848 | | |
| 577.5932 | 0.110009 | | |
| 580.4595 | 0.113161 | | |
| 582.2862 | 0.116303 | | |

## 6. Finite element model script

```
##################################################################################
####################################start#########################################
##################################################################################
###########################steelplate with 1 hole#################################
##################################################################################
#
# -*- coding: mbcs -*-
from part import *
from material import *
from section import *
from assembly import *
from step import *
from interaction import *
from load import *
from mesh import *
from optimization import *
from job import *
from sketch import *
from visualization import *
from connectorBehavior import *
mdb.models['Model-1'].ConstrainedSketch(name='__profile__', sheetSize=1000.0)
#GEOMETRY
#Basic geometry
mdb.models['Model-1'].sketches['__profile__'].rectangle(point1=(0.0, 0.0),
point2=(220.0, 120.0))
mdb.models['Model-1'].sketches['__profile__'].rectangle(point1=(220.0, 5.0),
point2=(510.0, 115.0))
mdb.models['Model-1'].sketches['__profile__'].rectangle(point1=(510.0, 0.0),
point2=(730.0, 120.0))
#Rounded edges
mdb.models['Model-1'].sketches['__profile__'].CircleByCenterPerimeter(center=(
220.0, 0.0), point1=(220.0, 5.0))
mdb.models['Model-1'].sketches['__profile__'].CircleByCenterPerimeter(center=(
220.0, 120.0), point1=(220.0, 115.0))
mdb.models['Model-1'].sketches['__profile__'].CircleByCenterPerimeter(center=(
510.0, 0.0), point1=(510.0, 5.0))
mdb.models['Model-1'].sketches['__profile__'].CircleByCenterPerimeter(center=(
510.0, 120.0), point1=(510.0, 115.0))
#Hole for bolt
mdb.models['Model-1'].sketches['__profile__'].CircleByCenterPerimeter(center=(
365.0, 60.0), point1=(365.0, 69.0))
#Trimming geometry
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0, 6.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0, 6.0),
), point1=(220.402954101563, 87.5898284912109))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0, 60.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0,
60.0), ), point1=(219.763122558594, 87.5898284912109))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((110.0, 120.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((110.0,
120.0), ), point1=(216.902389526367, 119.587341308594))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0, 117.5))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0,
117.5), ), point1=(219.701675415039, 117.98397064209))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0, 125.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0,
125.0), ), point1=(224.800384521484, 118.384811401367))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0, -5.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0,
-5.0), ), point1=(221.183624267578, -4.67462539672852))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((110.0, 0.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((110.0, 0.0),
), point1=(218.652191162109, -0.276409149169922))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0, 2.5))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((220.0, 2.5),
), point1=(219.833526611328, 1.24604797363281))
```

```
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0, 10.5))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0,
10.5), ), point1=(510.232604980469, 103.535079956055))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0, 60.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0,
60.0), ), point1=(510.232604980469, 103.282760620117))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((620.0, 120.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((620.0,
120.0), ), point1=(511.4912109375, 119.683395385742))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0, 117.5))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0,
117.5), ), point1=(509.980895996094, 119.431076049805))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0, 125.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0,
125.0), ), point1=(506.456756591797, 118.674125671387))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0, -5.0))
mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0,
-5.0), ), point1=(506.700469970703, -4.72927474975586))
mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((620.0, 0.0))
    mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
    mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((620.0, 0.0),
    ), point1=(510.721527099609, 0.740779876708984))
    mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0, 2.5))
    mdb.models['Model-1'].sketches['__profile__'].autoTrimCurve(curve1=
    mdb.models['Model-1'].sketches['__profile__'].geometry.findAt((510.0, 2.5),
    ), point1=(509.572631835938, 1.60447311401367))
    #Body thickness
    mdb.models['Model-1'].Part(dimensionality=THREE_D, name='Jitske 1 018', type=
    DEFORMABLE_BODY)
    mdb.models['Model-1'].parts['Jitske 1 018'].BaseSolidExtrude(depth=8.0, sketch=
    mdb.models['Model-1'].sketches['__profile__'])
    del mdb.models['Model-1'].sketches['__profile__']

    #DATUMS
    #Datum clamps left
    mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
    mdb.models['Model-1'].parts['Jitske 1 018'].vertices.findAt((0.0, 120.0,
    8.0), ), vector=(65.0, 0.0, 0.0))
    mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
    mdb.models['Model-1'].parts['Jitske 1 018'].vertices.findAt((0.0, 120.0,
    8.0), ), vector=(0.0, -20.0, 0.0))
    mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
    mdb.models['Model-1'].parts['Jitske 1 018'].datums[3], vector=(0.0, -80.0,
    0.0))
    #
    #Datum clamps right
    mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
    mdb.models['Model-1'].parts['Jitske 1 018'].vertices.findAt((730.0, 120.0,
    8.0), ), vector=(-65.0, 0.0, 0.0))
    mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
    mdb.models['Model-1'].parts['Jitske 1 018'].vertices.findAt((730.0, 120.0,
    8.0), ), vector=(0.0, -20.0, 0.0))
    mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
    mdb.models['Model-1'].parts['Jitske 1 018'].datums[6], vector=(0.0, -80.0,
    0.0))
    #
    #Datum reference point
    mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
    mdb.models['Model-1'].parts['Jitske 1 018'].InterestingPoint(
    mdb.models['Model-1'].parts['Jitske 1 018'].edges.findAt((0.0, 30.0, 8.0),
    ), MIDDLE), vector=(-100.0, 0.0, -4.0))
    mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
    mdb.models['Model-1'].parts['Jitske 1 018'].InterestingPoint(
    mdb.models['Model-1'].parts['Jitske 1 018'].edges.findAt((730.0, 90.0,
    8.0), ), MIDDLE), vector=(100.0, 0.0, -4.0))
    #
    #Datums stress field
    mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
    mdb.models['Model-1'].parts['Jitske 1 018'].InterestingPoint(
    mdb.models['Model-1'].parts['Jitske 1 018'].edges[10], MIDDLE), vector=(
```

```
0.0, 0.0, 0.0))
mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
mdb.models['Model-1'].parts['Jitske 1 018'].datums[10], vector=(-25.0, 0.0,
0.0))
mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
mdb.models['Model-1'].parts['Jitske 1 018'].datums[11], vector=(-20.0, 0.0,
0.0))
mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
mdb.models['Model-1'].parts['Jitske 1 018'].datums[10], vector=(25.0, 0.0,
0.0))
mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
mdb.models['Model-1'].parts['Jitske 1 018'].datums[13], vector=(20.0, 0.0,
0.0))
mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
mdb.models['Model-1'].parts['Jitske 1 018'].datums[14], vector=(0.0, -27.5,
0.0))
mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
mdb.models['Model-1'].parts['Jitske 1 018'].datums[15], vector=(0.0, -27.5,
0.0))
mdb.models['Model-1'].parts['Jitske 1 018'].DatumPointByOffset(point=
mdb.models['Model-1'].parts['Jitske 1 018'].datums[16], vector=(0.0, -27.5,
0.0))
#
#
#
#PARTITION
#Clamp left
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#1 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[4],
point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[2])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#2 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[23]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[3])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#1 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[33]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[4])
#
#Clamp right
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#4 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[36]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[5])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#1 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[24]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[6])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#1 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[9],
point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[7])
#
#From 120 to 110 right and left
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#20 ]', ), ), normal=
mdb.models['Model-1'].parts['Jitske 1 018'].edges[69], point=
mdb.models['Model-1'].parts['Jitske 1 018'].vertices[43])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#1 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[6],
point=mdb.models['Model-1'].parts['Jitske 1 018'].vertices[5])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#1 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[6],
```

```
point=mdb.models['Model-1'].parts['Jitske 1 018'].vertices[5])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#2 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[20]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].vertices[16])
#
#Stress field
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#1 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[10]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[12])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#2 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[21]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[11])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#4 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[10]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[10])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#8 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[27]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[13])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#1 ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[4],
point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[14])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#2d ]', ), ), normal=mdb.models['Model-1'].parts['Jitske 1 018'].edges[3]
, point=mdb.models['Model-1'].parts['Jitske 1 018'].datums[15])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#24a ]', ), ), normal=
mdb.models['Model-1'].parts['Jitske 1 018'].edges[44], point=
mdb.models['Model-1'].parts['Jitske 1 018'].datums[16])
mdb.models['Model-1'].parts['Jitske 1 018'].PartitionCellByPlanePointNormal(
cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#24a0 ]', ), ), normal=
mdb.models['Model-1'].parts['Jitske 1 018'].edges[34], point=
mdb.models['Model-1'].parts['Jitske 1 018'].datums[17])
#
#
#
#MATERIAL
#Material definition
mdb.models['Model-1'].Material(name='Steel S235')
mdb.models['Model-1'].materials['Steel S235'].Density(table=((7.85e-09, ), ))
mdb.models['Model-1'].materials['Steel S235'].Elastic(table=((209303.0, 0.3),
))
mdb.models['Model-1'].materials['Steel S235'].Plastic(table=((278.3126294,
0.0), (284.735737, 0.019288963), (286.5623625, 0.019568717), (298.2478878,
0.02282471), (310.2291111, 0.027181126), (321.1651666, 0.031793793), (
333.3540942, 0.036661494), (345.5872806, 0.042143519), (358.0555486,
0.048048067), (376.7065272, 0.058410377), (385.0125284, 0.063417109), (
399.9363663, 0.073710123), (416.1946147, 0.086168084), (424.0068627,
0.092685681), (432.8995636, 0.100623034), (442.6324443, 0.110201775), (
451.4823026, 0.119604538), (456.4497942, 0.123392555), (459.7680014,
0.128168303), (462.3325727, 0.131173833), (465.1746345, 0.134751822), (
467.8698147, 0.137985083), (470.8675543, 0.140052146), (473.9629526,
0.146229972), (477.3455601, 0.151469964), (481.6180706, 0.153672811), (
487.7678802, 0.165340419), (487.9700333, 0.165662379), (493.7944238,
0.17511856), (504.8141641, 0.194786329), (516.9368898, 0.212076702)))
#
#Steel section
mdb.models['Model-1'].HomogeneousSolidSection(material='Steel S235', name=
'SteelSection', thickness=None)
```

```
#
#Assign section
mdb.models['Model-1'].parts['Jitske 1 018'].Set(cells=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#fffffff ]', ), ), name='SteelPlate')
mdb.models['Model-1'].parts['Jitske 1 018'].SectionAssignment(offset=0.0,
offsetField='', offsetType=MIDDLE_SURFACE, region=
mdb.models['Model-1'].parts['Jitske 1 018'].sets['SteelPlate'],
sectionName='SteelSection', thicknessAssignment=FROM_SECTION)
#
#
#
#ASSEMBLY
#INSTANCE
mdb.models['Model-1'].rootAssembly.DatumCsysByDefault(CARTESIAN)
mdb.models['Model-1'].rootAssembly.Instance(dependent=ON, name='Jitske 1 018-1'
, part=mdb.models['Model-1'].parts['Jitske 1 018'])
#
#
#
#REFERENCE POINT
mdb.models['Model-1'].rootAssembly.ReferencePoint(point=
mdb.models['Model-1'].rootAssembly.instances['Jitske 1 018-1'].datums[8])
mdb.models['Model-1'].rootAssembly.ReferencePoint(point=
mdb.models['Model-1'].rootAssembly.instances['Jitske 1 018-1'].datums[9])
mdb.models['Model-1'].rootAssembly.features.changeKey(fromName='RP-1', toName=
'RP Moving')
mdb.models['Model-1'].rootAssembly.features.changeKey(fromName='RP-2', toName=
'RP Fixed')
#
#Create sets
mdb.models['Model-1'].rootAssembly.Set(cells=
mdb.models['Model-1'].rootAssembly.instances['Jitske 1 018-
1'].cells.getSequenceFromMask(
('[#2000000 ]', ), ), name='Moving Clamp')
mdb.models['Model-1'].rootAssembly.Set(cells=
mdb.models['Model-1'].rootAssembly.instances['Jitske 1 018-
1'].cells.getSequenceFromMask(
('[#400000 ]', ), ), name='Fixed Clamp')
mdb.models['Model-1'].rootAssembly.Set(cells=
mdb.models['Model-1'].rootAssembly.instances['Jitske 1 018-
1'].cells.getSequenceFromMask(
('[#24533 ]', ), ), name='Stress field')
mdb.models['Model-1'].rootAssembly.Set(name='Moving RP', referencePoints=(
mdb.models['Model-1'].rootAssembly.referencePoints[4], ))
mdb.models['Model-1'].rootAssembly.Set(name='Fixed RP', referencePoints=(
mdb.models['Model-1'].rootAssembly.referencePoints[5], ))
#
#Constraint
mdb.models['Model-1'].RigidBody(name='Fixed Constraint', refPointRegion=
mdb.models['Model-1'].rootAssembly.sets['Fixed RP'], tieRegion=
mdb.models['Model-1'].rootAssembly.sets['Fixed Clamp'])
mdb.models['Model-1'].RigidBody(name='Moving Constraint', refPointRegion=
mdb.models['Model-1'].rootAssembly.sets['Moving RP'], tieRegion=
mdb.models['Model-1'].rootAssembly.sets['Moving Clamp'])
#
#
#
#STEPS
mdb.models['Model-1'].StaticStep(initialInc=0.01, maxNumInc=10000, name='Load',
nlgeom=ON, previous='Initial')
#
#
#
#BC
#Load
mdb.models['Model-1'].DisplacementBC(amplitude=UNSET, createStepName='Load',
distributionType=UNIFORM, fieldName='', fixed=OFF, localCsys=None, name=
'Load BC', region=mdb.models['Model-1'].rootAssembly.sets['Moving RP'], u1=
-50.0, u2=UNSET, u3=UNSET, ur1=UNSET, ur2=UNSET, ur3=UNSET)
#
#Fixed
mdb.models['Model-1'].DisplacementBC(amplitude=UNSET, createStepName='Initial',
distributionType=UNIFORM, fieldName='', localCsys=None, name='Fixed BC',
region=mdb.models['Model-1'].rootAssembly.sets['Fixed RP'], u1=SET, u2=SET,
u3=SET, ur1=SET, ur2=SET, ur3=SET)
```

```
#
#
#
#MESH
#Element type
mdb.models['Model-1'].parts['Jitske 1 018'].setElementType(elemTypes=(ElemType(
elemCode=C3D8I, elemLibrary=STANDARD, secondOrderAccuracy=OFF,
distortionControl=DEFAULT), ElemType(elemCode=C3D6, elemLibrary=STANDARD),
ElemType(elemCode=C3D4, elemLibrary=STANDARD)), regions=(
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#fffffff ]', ), ), ))
#
#Mesh controls
mdb.models['Model-1'].parts['Jitske 1 018'].setMeshControls(algorithm=
MEDIAL_AXIS, elemShape=HEX_DOMINATED, regions=
mdb.models['Model-1'].parts['Jitske 1 018'].cells.getSequenceFromMask((
'[#fffffff ]', ), ), technique=SWEEP)
#
#Global seed
mdb.models['Model-1'].parts['Jitske 1 018'].seedPart(deviationFactor=0.1,
minSizeFactor=0.1, size=2.0)
#
#Clamp left
mdb.models['Model-1'].rootAssembly.regenerate()
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#0:4 #800 #800000 #1002 ]', ), ), number=10)
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#0:4 #1400 #51400000 #52ad5 ]', ), ), number=2)
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#0:5 #20000000 #c520 ]', ), ), number=2)
#
#Clamp right
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#0:4 #8000000 #10088 ]', ), ), number=10)
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#0:4 #d4000000 #41eff77 #80000 ]', ), ), number=2)
#
#From 120 to 110
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#0:3 #20040200 #240092 ]', ), ), number=14)
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#0:3 #4040 #1db816d ]', ), ), number=2)
#
#Outside mesh 120
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#0:4 #22002200 #a200000 #20000 ]', ), ), number=4)
#
#Outside mesh 110
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#0:3 #d00021a0 #4000 ]', ), ), number=3)
#
#Boundaries stressfield
mdb.models['Model-1'].rootAssembly.regenerate()
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#a000 #200 #30000 #8000009 ]', ), ), number=3)
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
```

```
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#40000 #6a000088 #1 ]', ), ), number=4)
mdb.models['Model-1'].parts['Jitske 1 018'].seedEdgeByNumber(constraint=FINER,
edges=
mdb.models['Model-1'].parts['Jitske 1 018'].edges.getSequenceFromMask((
'[#a004155 #91015104 #10240508 #42a0810 ]', ), ), number=2)
#
#Mesh part
mdb.models['Model-1'].parts['Jitske 1 018'].generateMesh()
mdb.models['Model-1'].rootAssembly.regenerate()
#
#
#
#CREATE JOB
mdb.Job(atTime=None, contactPrint=OFF, description='', echoPrint=OFF,
explicitPrecision=SINGLE, getMemoryFromAnalysis=True, historyPrint=OFF,
memory=90, memoryUnits=PERCENTAGE, model='Model-1', modelPrint=OFF,
multiprocessingMode=DEFAULT, name='Job-1', nodalOutputPrecision=SINGLE,
numCpus=1, numGPUs=0, queue=None, scratch='', type=ANALYSIS,
userSubroutine='', waitHours=0, waitMinutes=0)
################################################################################
#######################################END######################################
################################################################################
```

# 7. OUTPUT FINITE ELEMENT MODEL VS THEORY FOR STEEL GRADE S235

**S235 — 1 hole — *18 mm***

| | | | | | |
|---|---|---|---|---|---|
| $F_{u,fem}$ | 338.618 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -157150 | -0.5 | | 157.15 | 0.5 |
| 0.0125 | -195198 | -0.625 | | 195.198 | 0.625 |
| 0.01625 | -213474 | -0.8125 | | 213.474 | 0.8125 |
| 0.02 | -217449 | -1 | | 217.449 | 1 |
| 0.02375 | -220171 | -1.1875 | | 220.171 | 1.1875 |
| 0.0275 | -222593 | -1.375 | | 222.593 | 1.375 |
| 0.03125 | -225313 | -1.5625 | | 225.313 | 1.5625 |
| 0.035 | -228171 | -1.75 | | 228.171 | 1.75 |
| 0.040625 | -232743 | -2.03125 | | 232.743 | 2.03125 |
| 0.049063 | -239813 | -2.45313 | | 239.813 | 2.45313 |
| 0.055391 | -244796 | -2.76953 | | 244.796 | 2.76953 |
| 0.064883 | -249773 | -3.24414 | | 249.773 | 3.24414 |
| 0.074375 | -252290 | -3.71875 | | 252.29 | 3.71875 |
| 0.083867 | -254165 | -4.19336 | | 254.165 | 4.19336 |
| 0.093359 | -255837 | -4.66797 | | 255.837 | 4.66797 |
| 0.102852 | -257229 | -5.14258 | | 257.229 | 5.14258 |
| 0.11709 | -258637 | -5.85449 | | 258.637 | 5.85449 |
| 0.131328 | -259576 | -6.56641 | | 259.576 | 6.56641 |
| 0.145566 | -260340 | -7.27832 | | 260.34 | 7.27832 |
| 0.166924 | -261482 | -8.34619 | | 261.482 | 8.34619 |
| 0.19896 | -264071 | -9.948 | | 264.071 | 9.948 |
| 0.230996 | -267373 | -11.5498 | | 267.373 | 11.5498 |
| 0.263032 | -270744 | -13.1516 | | 270.744 | 13.1516 |
| 0.295068 | -274058 | -14.7534 | | 274.058 | 14.7534 |
| 0.327104 | -277001 | -16.3552 | | 277.001 | 16.3552 |
| 0.375159 | -281763 | -18.7579 | | 281.763 | 18.7579 |
| 0.44724 | -292135 | -22.362 | | 292.135 | 22.362 |
| 0.519321 | -307279 | -25.9661 | | 307.279 | 25.9661 |
| 0.591403 | -319759 | -29.5701 | | 319.759 | 29.5701 |
| 0.699525 | -332218 | -34.9762 | | 332.218 | 34.9762 |
| 0.726555 | -334386 | -36.3278 | | 334.386 | 36.3278 |
| 0.753586 | -336352 | -37.6793 | | 336.352 | 37.6793 |
| 0.763722 | -337045 | -38.1861 | | 337.045 | 38.1861 |
| 0.778927 | -337929 | -38.9463 | | 337.929 | 38.9463 |
| 0.784628 | -338262 | -39.2314 | | 338.262 | 39.2314 |
| 0.793181 | -338618 | -39.659 | | 338.618 | 39.659 |
| 0.80601 | -338341 | -40.3005 | | 338.341 | 40.3005 |
| 0.818839 | -337083 | -40.9419 | | 337.083 | 40.9419 |
| 0.831668 | -334768 | -41.5834 | | 334.768 | 41.5834 |
| 0.844497 | -331680 | -42.2248 | | 331.68 | 42.2248 |
| 0.857326 | -327605 | -42.8663 | | 327.605 | 42.8663 |
| 0.870155 | -322520 | -43.5077 | | 322.52 | 43.5077 |
| 0.882983 | -316339 | -44.1492 | | 316.339 | 44.1492 |
| 0.895812 | -309001 | -44.7906 | | 309.001 | 44.7906 |
| 0.908641 | -300546 | -45.4321 | | 300.546 | 45.4321 |
| 0.911848 | -301723 | -45.5924 | | 301.723 | 45.5924 |
| 0.915056 | -299365 | -45.7528 | | 299.365 | 45.7528 |
| 0.919867 | -295403 | -45.9933 | | 295.403 | 45.9933 |
| 0.927083 | -289100 | -46.3541 | | 289.1 | 46.3541 |
| 0.934299 | -283465 | -46.715 | | 283.465 | 46.715 |
| 0.941515 | -277548 | -47.0758 | | 277.548 | 47.0758 |
| 0.948732 | -271368 | -47.4366 | | 271.368 | 47.4366 |
| 0.955948 | -264954 | -47.7974 | | 264.954 | 47.7974 |
| 0.963164 | -258309 | -48.1582 | | 258.309 | 48.1582 |
| 0.97038 | -251459 | -48.519 | | 251.459 | 48.519 |
| 0.977597 | -244426 | -48.8798 | | 244.426 | 48.8798 |
| 0.988421 | -230856 | -49.4211 | | 230.856 | 49.4211 |
| 0.999246 | -219747 | -49.9623 | | 219.747 | 49.9623 |
| 0.999434 | -221333 | -49.9717 | | 221.333 | 49.9717 |
| 0.999623 | -223248 | -49.9811 | | 223.248 | 49.9811 |
| 0.999906 | -225697 | -49.9953 | | 225.697 | 49.9953 |
| 1 | -226277 | -50 | | 226.277 | 50 |

**S235 — 1 hole — *19 mm***

| | | | | | |
|---|---|---|---|---|---|
| $F_{u,fem}$ | 334.593 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -156871 | -0.5 | | 156.871 | 0.5 |
| 0.0125 | -194658 | -0.625 | | 194.658 | 0.625 |
| 0.01625 | -211251 | -0.8125 | | 211.251 | 0.8125 |
| 0.02 | -215176 | -1 | | 215.176 | 1 |
| 0.02375 | -217828 | -1.1875 | | 217.828 | 1.1875 |
| 0.0275 | -220205 | -1.375 | | 220.205 | 1.375 |
| 0.033125 | -224232 | -1.65625 | | 224.232 | 1.65625 |
| 0.041563 | -230848 | -2.07813 | | 230.848 | 2.07813 |
| 0.054219 | -241410 | -2.71094 | | 241.41 | 2.71094 |
| 0.057383 | -244021 | -2.86914 | | 244.021 | 2.86914 |
| 0.060547 | -246125 | -3.02734 | | 246.125 | 3.02734 |
| 0.065293 | -248894 | -3.26465 | | 248.894 | 3.26465 |
| 0.072412 | -251251 | -3.62061 | | 251.251 | 3.62061 |
| 0.083091 | -253674 | -4.15454 | | 253.674 | 4.15454 |
| 0.099109 | -256505 | -4.95544 | | 256.505 | 4.95544 |
| 0.115127 | -258483 | -5.75635 | | 258.483 | 5.75635 |
| 0.131145 | -259627 | -6.55725 | | 259.627 | 6.55725 |
| 0.147163 | -260524 | -7.35815 | | 260.524 | 7.35815 |
| 0.163181 | -261291 | -8.15906 | | 261.291 | 8.15906 |
| 0.187208 | -263107 | -9.36041 | | 263.107 | 9.36041 |
| 0.211235 | -265244 | -10.5618 | | 265.244 | 10.5618 |
| 0.235262 | -267741 | -11.7631 | | 267.741 | 11.7631 |
| 0.25929 | -270178 | -12.9645 | | 270.178 | 12.9645 |
| 0.283317 | -272644 | -14.1658 | | 272.644 | 14.1658 |
| 0.319357 | -276029 | -15.9679 | | 276.029 | 15.9679 |
| 0.373418 | -281235 | -18.6709 | | 281.235 | 18.6709 |
| 0.427479 | -288678 | -21.374 | | 288.678 | 21.374 |
| 0.48154 | -298312 | -24.077 | | 298.312 | 24.077 |
| 0.562632 | -314080 | -28.1316 | | 314.08 | 28.1316 |
| 0.684269 | -329593 | -34.2134 | | 329.593 | 34.2134 |
| 0.714678 | -332047 | -35.7339 | | 332.047 | 35.7339 |
| 0.745087 | -333801 | -37.2544 | | 333.801 | 37.2544 |
| 0.75269 | -334433 | -37.6345 | | 334.433 | 37.6345 |
| 0.760292 | -334593 | -38.0146 | | 334.593 | 38.0146 |
| 0.767894 | -334551 | -38.3947 | | 334.551 | 38.3947 |
| 0.775497 | -334164 | -38.7748 | | 334.164 | 38.7748 |
| 0.783099 | -333357 | -39.155 | | 333.357 | 39.155 |
| 0.790701 | -332163 | -39.5351 | | 332.163 | 39.5351 |
| 0.798304 | -330685 | -39.9152 | | 330.685 | 39.9152 |
| 0.805906 | -328975 | -40.2953 | | 328.975 | 40.2953 |
| 0.813508 | -326932 | -40.6754 | | 326.932 | 40.6754 |
| 0.821111 | -324566 | -41.0555 | | 324.566 | 41.0555 |
| 0.828713 | -321855 | -41.4357 | | 321.855 | 41.4357 |
| 0.836315 | -318796 | -41.8158 | | 318.796 | 41.8158 |
| 0.843918 | -315383 | -42.1959 | | 315.383 | 42.1959 |
| 0.85152 | -311579 | -42.576 | | 311.579 | 42.576 |
| 0.859122 | -307386 | -42.9561 | | 307.386 | 42.9561 |
| 0.866725 | -302810 | -43.3362 | | 302.81 | 43.3362 |
| 0.874327 | -297885 | -43.7164 | | 297.885 | 43.7164 |
| 0.881929 | -292634 | -44.0965 | | 292.634 | 44.0965 |
| 0.889532 | -287095 | -44.4766 | | 287.095 | 44.4766 |
| 0.897134 | -281227 | -44.8567 | | 281.227 | 44.8567 |
| 0.904736 | -275064 | -45.2368 | | 275.064 | 45.2368 |
| 0.912339 | -268613 | -45.6169 | | 268.613 | 45.6169 |
| 0.919941 | -261907 | -45.997 | | 261.907 | 45.997 |
| 0.927543 | -254899 | -46.3772 | | 254.899 | 46.3772 |
| 0.935146 | -247706 | -46.7573 | | 247.706 | 46.7573 |
| 0.942748 | -240292 | -47.1374 | | 240.292 | 47.1374 |
| 0.95035 | -232690 | -47.5175 | | 232.69 | 47.5175 |
| 0.957953 | -225017 | -47.8976 | | 225.017 | 47.8976 |
| 0.965555 | -217210 | -48.2777 | | 217.21 | 48.2777 |
| 0.973157 | -209256 | -48.6579 | | 209.256 | 48.6579 |

**S235 — 1 hole — *20 mm***

| | | | | | |
|---|---|---|---|---|---|
| $F_{u,fem}$ | 331.399 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -156570 | -0.5 | | 156.57 | 0.5 |
| 0.0125 | -194055 | -0.625 | | 194.055 | 0.625 |
| 0.015 | -207553 | -0.75 | | 207.553 | 0.75 |
| 0.0175 | -210404 | -0.875 | | 210.404 | 0.875 |
| 0.02 | -212858 | -1 | | 212.858 | 1 |
| 0.0225 | -214688 | -1.125 | | 214.688 | 1.125 |
| 0.02625 | -217019 | -1.3125 | | 217.019 | 1.3125 |
| 0.031875 | -220815 | -1.59375 | | 220.815 | 1.59375 |
| 0.040313 | -227313 | -2.01563 | | 227.313 | 2.01563 |
| 0.052969 | -237905 | -2.64844 | | 237.905 | 2.64844 |
| 0.065625 | -246889 | -3.28125 | | 246.889 | 3.28125 |
| 0.068789 | -248821 | -3.43945 | | 248.821 | 3.43945 |
| 0.071953 | -250174 | -3.59766 | | 250.174 | 3.59766 |
| 0.076699 | -251614 | -3.83496 | | 251.614 | 3.83496 |
| 0.083818 | -253367 | -4.19092 | | 253.367 | 4.19092 |
| 0.094497 | -255422 | -4.72485 | | 255.422 | 4.72485 |
| 0.105176 | -257201 | -5.25879 | | 257.201 | 5.25879 |
| 0.115854 | -258513 | -5.79272 | | 258.513 | 5.79272 |
| 0.131873 | -259716 | -6.59363 | | 259.716 | 6.59363 |
| 0.147891 | -260660 | -7.39453 | | 260.66 | 7.39453 |
| 0.163909 | -261409 | -8.19543 | | 261.409 | 8.19543 |
| 0.179927 | -262426 | -8.99634 | | 262.426 | 8.99634 |
| 0.203954 | -264394 | -10.1977 | | 264.394 | 10.1977 |
| 0.227981 | -266906 | -11.399 | | 266.906 | 11.399 |
| 0.252008 | -269233 | -12.6004 | | 269.233 | 12.6004 |
| 0.276035 | -271664 | -13.8018 | | 271.664 | 13.8018 |
| 0.300062 | -274051 | -15.0031 | | 274.051 | 15.0031 |
| 0.336103 | -277353 | -16.8051 | | 277.353 | 16.8051 |
| 0.390164 | -282724 | -19.5082 | | 282.724 | 19.5082 |
| 0.444225 | -290381 | -22.2112 | | 290.381 | 22.2112 |
| 0.498286 | -300655 | -24.9143 | | 300.655 | 24.9143 |
| 0.552347 | -311201 | -27.6173 | | 311.201 | 27.6173 |
| 0.633438 | -323135 | -31.6719 | | 323.135 | 31.6719 |
| 0.663848 | -326487 | -33.1924 | | 326.487 | 33.1924 |
| 0.709462 | -329959 | -35.4731 | | 329.959 | 35.4731 |
| 0.720865 | -330762 | -36.0433 | | 330.762 | 36.0433 |
| 0.732268 | -331165 | -36.6134 | | 331.165 | 36.6134 |
| 0.736545 | -331399 | -36.8272 | | 331.399 | 36.8272 |
| 0.742959 | -331249 | -37.148 | | 331.249 | 37.148 |
| 0.749374 | -330903 | -37.4687 | | 330.903 | 37.4687 |
| 0.755788 | -330246 | -37.7894 | | 330.246 | 37.7894 |
| 0.762203 | -329264 | -38.1101 | | 329.264 | 38.1101 |
| 0.768617 | -328060 | -38.4309 | | 328.06 | 38.4309 |
| 0.775032 | -326653 | -38.7516 | | 326.653 | 38.7516 |
| 0.781446 | -325092 | -39.0723 | | 325.092 | 39.0723 |
| 0.78786 | -323294 | -39.393 | | 323.294 | 39.393 |
| 0.794275 | -321257 | -39.7137 | | 321.257 | 39.7137 |
| 0.800689 | -318988 | -40.0345 | | 318.988 | 40.0345 |
| 0.810311 | -314465 | -40.5156 | | 314.465 | 40.5156 |
| 0.819933 | -309939 | -40.9966 | | 309.939 | 40.9966 |
| 0.829554 | -304765 | -41.4777 | | 304.765 | 41.4777 |
| 0.839176 | -298977 | -41.9588 | | 298.977 | 41.9588 |
| 0.848798 | -292568 | -42.4399 | | 292.568 | 42.4399 |
| 0.85842 | -285654 | -42.921 | | 285.654 | 42.921 |
| 0.868041 | -278253 | -43.4021 | | 278.253 | 43.4021 |
| 0.877663 | -270349 | -43.8831 | | 270.349 | 43.8831 |
| 0.887285 | -261985 | -44.3642 | | 261.985 | 44.3642 |
| 0.896906 | -253192 | -44.8453 | | 253.192 | 44.8453 |
| 0.906528 | -244020 | -45.3264 | | 244.02 | 45.3264 |
| 0.91615 | -234494 | -45.8075 | | 234.494 | 45.8075 |
| 0.925771 | -224721 | -46.2886 | | 224.721 | 46.2886 |
| 0.935393 | -214787 | -46.7697 | | 214.787 | 46.7697 |

| **S235** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *21 mm* | | | | | |
| $F_{u,fem}$ | 328.1 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -156255 | -0.5 | | 156.255 | 0.5 |
| 0.0125 | -193406 | -0.625 | | 193.406 | 0.625 |
| 0.015 | -205349 | -0.75 | | 205.349 | 0.75 |
| 0.0175 | -208156 | -0.875 | | 208.156 | 0.875 |
| 0.02 | -210584 | -1 | | 210.584 | 1 |
| 0.0225 | -212364 | -1.125 | | 212.364 | 1.125 |
| 0.02625 | -214639 | -1.3125 | | 214.639 | 1.3125 |
| 0.031875 | -218340 | -1.59375 | | 218.34 | 1.59375 |
| 0.040313 | -224697 | -2.01563 | | 224.697 | 2.01563 |
| 0.052969 | -235545 | -2.64844 | | 235.545 | 2.64844 |
| 0.065625 | -244964 | -3.28125 | | 244.964 | 3.28125 |
| 0.068789 | -247019 | -3.43945 | | 247.019 | 3.43945 |
| 0.071953 | -248914 | -3.59766 | | 248.914 | 3.59766 |
| 0.076699 | -250814 | -3.83496 | | 250.814 | 3.83496 |
| 0.083818 | -252741 | -4.19092 | | 252.741 | 4.19092 |
| 0.094497 | -255065 | -4.72485 | | 255.065 | 4.72485 |
| 0.110515 | -257703 | -5.52576 | | 257.703 | 5.52576 |
| 0.126533 | -259346 | -6.32666 | | 259.346 | 6.32666 |
| 0.142551 | -260416 | -7.12756 | | 260.416 | 7.12756 |
| 0.158569 | -261241 | -7.92847 | | 261.241 | 7.92847 |
| 0.174587 | -261986 | -8.72937 | | 261.986 | 8.72937 |
| 0.198615 | -263815 | -9.93073 | | 263.815 | 9.93073 |
| 0.222642 | -266263 | -11.1321 | | 266.263 | 11.1321 |
| 0.246669 | -268571 | -12.3334 | | 268.571 | 12.3334 |
| 0.270696 | -270902 | -13.5348 | | 270.902 | 13.5348 |
| 0.294723 | -273237 | -14.7361 | | 273.237 | 14.7361 |
| 0.31875 | -275474 | -15.9375 | | 275.474 | 15.9375 |
| 0.342777 | -277718 | -17.1389 | | 277.718 | 17.1389 |
| 0.378818 | -281215 | -18.9409 | | 281.215 | 18.9409 |
| 0.414858 | -285773 | -20.7429 | | 285.773 | 20.7429 |
| 0.450899 | -290797 | -22.545 | | 290.797 | 22.545 |
| 0.50496 | -300833 | -25.248 | | 300.833 | 25.248 |
| 0.586051 | -315268 | -29.3026 | | 315.268 | 29.3026 |
| 0.616461 | -319537 | -30.823 | | 319.537 | 30.823 |
| 0.662075 | -324551 | -33.1037 | | 324.551 | 33.1037 |
| 0.67918 | -326097 | -33.959 | | 326.097 | 33.959 |
| 0.704838 | -327396 | -35.2419 | | 327.396 | 35.2419 |
| 0.711252 | -327962 | -35.5626 | | 327.962 | 35.5626 |
| 0.712856 | -328019 | -35.6428 | | 328.019 | 35.6428 |
| 0.713457 | -328047 | -35.6729 | | 328.047 | 35.6729 |
| 0.714359 | -328058 | -35.718 | | 328.058 | 35.718 |
| 0.715712 | -328065 | -35.7856 | | 328.065 | 35.7856 |
| 0.71622 | -328092 | -35.811 | | 328.092 | 35.811 |
| 0.71641 | -328097 | -35.8205 | | 328.097 | 35.8205 |
| 0.716695 | -328097 | -35.8348 | | 328.097 | 35.8348 |
| 0.717124 | -328097 | -35.8562 | | 328.097 | 35.8562 |
| 0.717552 | -328100 | -35.8776 | | 328.1 | 35.8776 |
| 0.71798 | -328100 | -35.899 | | 328.1 | 35.899 |
| 0.718622 | -328094 | -35.9311 | | 328.094 | 35.9311 |
| 0.719264 | -328090 | -35.9632 | | 328.09 | 35.9632 |
| 0.719906 | -328086 | -35.9953 | | 328.086 | 35.9953 |
| 0.720869 | -328066 | -36.0435 | | 328.066 | 36.0435 |
| 0.722314 | -328009 | -36.1157 | | 328.009 | 36.1157 |
| 0.724482 | -327887 | -36.2241 | | 327.887 | 36.2241 |
| 0.727733 | -327635 | -36.3866 | | 327.635 | 36.3866 |
| 0.730984 | -327353 | -36.5492 | | 327.353 | 36.5492 |
| 0.734235 | -326987 | -36.7117 | | 326.987 | 36.7117 |
| 0.739111 | -326140 | -36.9556 | | 326.14 | 36.9556 |
| 0.743988 | -325266 | -37.1994 | | 325.266 | 37.1994 |
| 0.748864 | -324274 | -37.4432 | | 324.274 | 37.4432 |
| 0.756179 | -322309 | -37.8089 | | 322.309 | 37.8089 |
| 0.763494 | -320339 | -38.1747 | | 320.339 | 38.1747 |

| **S235** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *22 mm* | | | | | |
| $F_{u,fem}$ | 324.285 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -155916 | -0.5 | | 155.916 | 0.5 |
| 0.0125 | -192690 | -0.625 | | 192.69 | 0.625 |
| 0.015 | -203101 | -0.75 | | 203.101 | 0.75 |
| 0.0175 | -205882 | -0.875 | | 205.882 | 0.875 |
| 0.02 | -208237 | -1 | | 208.237 | 1 |
| 0.0225 | -210027 | -1.125 | | 210.027 | 1.125 |
| 0.02625 | -212252 | -1.3125 | | 212.252 | 1.3125 |
| 0.031875 | -215912 | -1.59375 | | 215.912 | 1.59375 |
| 0.040313 | -222207 | -2.01563 | | 222.207 | 2.01563 |
| 0.052969 | -232951 | -2.64844 | | 232.951 | 2.64844 |
| 0.056133 | -235792 | -2.80664 | | 235.792 | 2.80664 |
| 0.059297 | -238510 | -2.96484 | | 238.51 | 2.96484 |
| 0.064043 | -242235 | -3.20215 | | 242.235 | 3.20215 |
| 0.065823 | -243470 | -3.29114 | | 243.47 | 3.29114 |
| 0.068492 | -245201 | -3.42462 | | 245.201 | 3.42462 |
| 0.072497 | -247571 | -3.62485 | | 247.571 | 3.62485 |
| 0.078504 | -250391 | -3.92519 | | 250.391 | 3.92519 |
| 0.087514 | -252916 | -4.37569 | | 252.916 | 4.37569 |
| 0.096524 | -255021 | -4.8262 | | 255.021 | 4.8262 |
| 0.105534 | -256618 | -5.27671 | | 256.618 | 5.27671 |
| 0.119049 | -258533 | -5.95247 | | 258.533 | 5.95247 |
| 0.139322 | -260227 | -6.96612 | | 260.227 | 6.96612 |
| 0.159595 | -261318 | -7.97976 | | 261.318 | 7.97976 |
| 0.179868 | -262278 | -8.9934 | | 262.278 | 8.9934 |
| 0.200141 | -263823 | -10.007 | | 263.823 | 10.007 |
| 0.220414 | -265820 | -11.0207 | | 265.82 | 11.0207 |
| 0.240687 | -267748 | -12.0343 | | 267.748 | 12.0343 |
| 0.271096 | -270655 | -13.5548 | | 270.655 | 13.5548 |
| 0.31671 | -274893 | -15.8355 | | 274.893 | 15.8355 |
| 0.333815 | -276393 | -16.6908 | | 276.393 | 16.6908 |
| 0.359473 | -278906 | -17.9736 | | 278.906 | 17.9736 |
| 0.39796 | -282728 | -19.898 | | 282.728 | 19.898 |
| 0.436446 | -288112 | -21.8223 | | 288.112 | 21.8223 |
| 0.474933 | -293734 | -23.7467 | | 293.734 | 23.7467 |
| 0.532663 | -305001 | -26.6332 | | 305.001 | 26.6332 |
| 0.619259 | -318186 | -30.9629 | | 318.186 | 30.9629 |
| 0.651732 | -321609 | -32.5866 | | 321.609 | 32.5866 |
| 0.663909 | -322719 | -33.1955 | | 322.719 | 33.1955 |
| 0.682176 | -323928 | -34.1088 | | 323.928 | 34.1088 |
| 0.689025 | -324285 | -34.4513 | | 324.285 | 34.4513 |
| 0.6993 | -324099 | -34.965 | | 324.099 | 34.965 |
| 0.709575 | -323186 | -35.4787 | | 323.186 | 35.4787 |
| 0.719849 | -321428 | -35.9925 | | 321.428 | 35.9925 |
| 0.730124 | -319056 | -36.5062 | | 319.056 | 36.5062 |
| 0.740399 | -316177 | -37.0199 | | 316.177 | 37.0199 |
| 0.750674 | -312679 | -37.5337 | | 312.679 | 37.5337 |
| 0.760948 | -308550 | -38.0474 | | 308.55 | 38.0474 |
| 0.771223 | -303765 | -38.5612 | | 303.765 | 38.5612 |
| 0.781498 | -298304 | -39.0749 | | 298.304 | 39.0749 |
| 0.791773 | -292150 | -39.5886 | | 292.15 | 39.5886 |
| 0.802047 | -285293 | -40.1024 | | 285.293 | 40.1024 |
| 0.812322 | -277856 | -40.6161 | | 277.856 | 40.6161 |
| 0.822597 | -269868 | -41.1298 | | 269.868 | 41.1298 |
| 0.832871 | -261320 | -41.6436 | | 261.32 | 41.6436 |
| 0.843146 | -252255 | -42.1573 | | 252.255 | 42.1573 |
| 0.853421 | -242713 | -42.671 | | 242.713 | 42.671 |
| 0.863696 | -232750 | -43.1848 | | 232.75 | 43.1848 |
| 0.87397 | -222441 | -43.6985 | | 222.441 | 43.6985 |
| 0.884245 | -211922 | -44.2123 | | 211.922 | 44.2123 |
| 0.89452 | -201140 | -44.726 | | 201.14 | 44.726 |
| 0.904795 | -190294 | -45.2397 | | 190.294 | 45.2397 |
| 0.915069 | -179822 | -45.7535 | | 179.822 | 45.7535 |

| **S235** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *23 mm* | | | | | |
| $F_{u,fem}$ | 321.15 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -155561 | -0.5 | | 155.561 | 0.5 |
| 0.0125 | -191913 | -0.625 | | 191.913 | 0.625 |
| 0.015 | -200890 | -0.75 | | 200.89 | 0.75 |
| 0.0175 | -203635 | -0.875 | | 203.635 | 0.875 |
| 0.02 | -205955 | -1 | | 205.955 | 1 |
| 0.0225 | -207704 | -1.125 | | 207.704 | 1.125 |
| 0.02625 | -209900 | -1.3125 | | 209.9 | 1.3125 |
| 0.031875 | -213482 | -1.59375 | | 213.482 | 1.59375 |
| 0.040313 | -219737 | -2.01563 | | 219.737 | 2.01563 |
| 0.052969 | -230484 | -2.64844 | | 230.484 | 2.64844 |
| 0.056133 | -233349 | -2.80664 | | 233.349 | 2.80664 |
| 0.059297 | -236042 | -2.96484 | | 236.042 | 2.96484 |
| 0.064043 | -239843 | -3.20215 | | 239.843 | 3.20215 |
| 0.071162 | -244637 | -3.55811 | | 244.637 | 3.55811 |
| 0.073832 | -246293 | -3.69159 | | 246.293 | 3.69159 |
| 0.077836 | -248614 | -3.89182 | | 248.614 | 3.89182 |
| 0.083843 | -251070 | -4.19215 | | 251.07 | 4.19215 |
| 0.092853 | -253528 | -4.64266 | | 253.528 | 4.64266 |
| 0.106368 | -256295 | -5.31842 | | 256.295 | 5.31842 |
| 0.119884 | -258354 | -5.99419 | | 258.354 | 5.99419 |
| 0.133399 | -259730 | -6.66995 | | 259.73 | 6.66995 |
| 0.153672 | -261050 | -7.68359 | | 261.05 | 7.68359 |
| 0.173945 | -262020 | -8.69724 | | 262.02 | 8.69724 |
| 0.194218 | -263230 | -9.71088 | | 263.23 | 9.71088 |
| 0.224627 | -265995 | -11.2313 | | 265.995 | 11.2313 |
| 0.255036 | -268825 | -12.7518 | | 268.825 | 12.7518 |
| 0.285445 | -271705 | -14.2723 | | 271.705 | 14.2723 |
| 0.331059 | -275778 | -16.553 | | 275.778 | 16.553 |
| 0.39948 | -282103 | -19.974 | | 282.103 | 19.974 |
| 0.467901 | -291402 | -23.3951 | | 291.402 | 23.3951 |
| 0.536322 | -304214 | -26.8161 | | 304.214 | 26.8161 |
| 0.56198 | -308701 | -28.099 | | 308.701 | 28.099 |
| 0.600467 | -314242 | -30.0233 | | 314.242 | 30.0233 |
| 0.614899 | -315965 | -30.745 | | 315.965 | 30.745 |
| 0.636548 | -318216 | -31.8274 | | 318.216 | 31.8274 |
| 0.652785 | -319692 | -32.6392 | | 319.692 | 32.6392 |
| 0.658873 | -320189 | -32.9437 | | 320.189 | 32.9437 |
| 0.668007 | -320770 | -33.4003 | | 320.77 | 33.4003 |
| 0.681706 | -320899 | -34.0853 | | 320.899 | 34.0853 |
| 0.685131 | -321150 | -34.2566 | | 321.15 | 34.2566 |
| 0.688556 | -321006 | -34.4278 | | 321.006 | 34.4278 |
| 0.691981 | -320795 | -34.599 | | 320.795 | 34.599 |
| 0.695406 | -320498 | -34.7703 | | 320.498 | 34.7703 |
| 0.698831 | -320110 | -34.9415 | | 320.11 | 34.9415 |
| 0.702256 | -319618 | -35.1128 | | 319.618 | 35.1128 |
| 0.707393 | -318583 | -35.3697 | | 318.583 | 35.3697 |
| 0.715099 | -316650 | -35.755 | | 316.65 | 35.755 |
| 0.722805 | -314682 | -36.1403 | | 314.682 | 36.1403 |
| 0.730511 | -312372 | -36.5256 | | 312.372 | 36.5256 |
| 0.738217 | -309719 | -36.9109 | | 309.719 | 36.9109 |
| 0.745923 | -306723 | -37.2962 | | 306.723 | 37.2962 |
| 0.753629 | -303350 | -37.6815 | | 303.35 | 37.6815 |
| 0.761335 | -299641 | -38.0668 | | 299.641 | 38.0668 |
| 0.769041 | -295521 | -38.4521 | | 295.521 | 38.4521 |
| 0.776747 | -291038 | -38.8374 | | 291.038 | 38.8374 |
| 0.784453 | -286150 | -39.2227 | | 286.15 | 39.2227 |
| 0.792159 | -280924 | -39.608 | | 280.924 | 39.608 |
| 0.799866 | -275418 | -39.9933 | | 275.418 | 39.9933 |
| 0.807572 | -269563 | -40.3786 | | 269.563 | 40.3786 |
| 0.815278 | -263426 | -40.7639 | | 263.426 | 40.7639 |
| 0.822984 | -256961 | -41.1492 | | 256.961 | 41.1492 |
| 0.83069 | -250242 | -41.5345 | | 250.242 | 41.5345 |

| **S235** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *24 mm* | | | | | |
| $F_{u,fem}$ | 317.623 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -155188 | -0.5 | | 155.188 | 0.5 |
| 0.0125 | -191062 | -0.625 | | 191.062 | 0.625 |
| 0.015 | -198674 | -0.75 | | 198.674 | 0.75 |
| 0.0175 | -201383 | -0.875 | | 201.383 | 0.875 |
| 0.02 | -203674 | -1 | | 203.674 | 1 |
| 0.02375 | -206100 | -1.1875 | | 206.1 | 1.1875 |
| 0.029375 | -209390 | -1.46875 | | 209.39 | 1.46875 |
| 0.037813 | -215321 | -1.89063 | | 215.321 | 1.89063 |
| 0.050469 | -225804 | -2.52344 | | 225.804 | 2.52344 |
| 0.053633 | -228842 | -2.68164 | | 228.842 | 2.68164 |
| 0.056797 | -231620 | -2.83984 | | 231.62 | 2.83984 |
| 0.061543 | -235425 | -3.07715 | | 235.425 | 3.07715 |
| 0.068662 | -240765 | -3.43311 | | 240.765 | 3.43311 |
| 0.071332 | -242618 | -3.56659 | | 242.618 | 3.56659 |
| 0.075336 | -245167 | -3.76682 | | 245.167 | 3.76682 |
| 0.081343 | -248600 | -4.06715 | | 248.6 | 4.06715 |
| 0.090353 | -251979 | -4.51766 | | 251.979 | 4.51766 |
| 0.099363 | -254348 | -4.96817 | | 254.348 | 4.96817 |
| 0.108374 | -256130 | -5.41868 | | 256.13 | 5.41868 |
| 0.121889 | -258282 | -6.09444 | | 258.282 | 6.09444 |
| 0.142162 | -260292 | -7.10808 | | 260.292 | 7.10808 |
| 0.162435 | -261470 | -8.12173 | | 261.47 | 8.12173 |
| 0.182707 | -262421 | -9.13537 | | 262.421 | 9.13537 |
| 0.20298 | -263745 | -10.149 | | 263.745 | 10.149 |
| 0.223253 | -265661 | -11.1627 | | 265.661 | 11.1627 |
| 0.243526 | -267456 | -12.1763 | | 267.456 | 12.1763 |
| 0.263799 | -269336 | -13.1899 | | 269.336 | 13.1899 |
| 0.294208 | -272154 | -14.7104 | | 272.154 | 14.7104 |
| 0.339822 | -276139 | -16.9911 | | 276.139 | 16.9911 |
| 0.408243 | -282545 | -20.4122 | | 282.545 | 20.4122 |
| 0.476664 | -291843 | -23.8332 | | 291.843 | 23.8332 |
| 0.545085 | -304201 | -27.2542 | | 304.201 | 27.2542 |
| 0.570743 | -308432 | -28.5371 | | 308.432 | 28.5371 |
| 0.60923 | -313375 | -30.4615 | | 313.375 | 30.4615 |
| 0.623662 | -314879 | -31.1831 | | 314.879 | 31.1831 |
| 0.645311 | -316720 | -32.2655 | | 316.72 | 32.2655 |
| 0.653429 | -317258 | -32.6715 | | 317.258 | 32.6715 |
| 0.665607 | -317402 | -33.2803 | | 317.402 | 33.2803 |
| 0.668651 | -317623 | -33.4325 | | 317.623 | 33.4325 |
| 0.671695 | -317514 | -33.5848 | | 317.514 | 33.5848 |
| 0.67474 | -317376 | -33.737 | | 317.376 | 33.737 |
| 0.677784 | -317156 | -33.8892 | | 317.156 | 33.8892 |
| 0.680828 | -316878 | -34.0414 | | 316.878 | 34.0414 |
| 0.683873 | -316510 | -34.1936 | | 316.51 | 34.1936 |
| 0.688439 | -315723 | -34.422 | | 315.723 | 34.422 |
| 0.695289 | -314191 | -34.7645 | | 314.191 | 34.7645 |
| 0.702139 | -312597 | -35.1069 | | 312.597 | 35.1069 |
| 0.708989 | -310779 | -35.4494 | | 310.779 | 35.4494 |
| 0.715839 | -308696 | -35.7919 | | 308.696 | 35.7919 |
| 0.722688 | -306345 | -36.1344 | | 306.345 | 36.1344 |
| 0.729538 | -303726 | -36.4769 | | 303.726 | 36.4769 |
| 0.736388 | -300805 | -36.8194 | | 300.805 | 36.8194 |
| 0.743238 | -297636 | -37.1619 | | 297.636 | 37.1619 |
| 0.750088 | -294143 | -37.5044 | | 294.143 | 37.5044 |
| 0.756938 | -290349 | -37.8469 | | 290.349 | 37.8469 |
| 0.763787 | -286270 | -38.1894 | | 286.27 | 38.1894 |
| 0.774062 | -278482 | -38.7031 | | 278.482 | 38.7031 |
| 0.784337 | -271104 | -39.2168 | | 271.104 | 39.2168 |
| 0.794612 | -263111 | -39.7306 | | 263.111 | 39.7306 |
| 0.804886 | -254552 | -40.2443 | | 254.552 | 40.2443 |
| 0.815161 | -245469 | -40.758 | | 245.469 | 40.758 |
| 0.825436 | -235917 | -41.2718 | | 235.917 | 41.2718 |

| **S235** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *25 mm* | | | | | |
| $F_{u,fem}$ | 313.853 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -154787 | -0.5 | | 154.787 | 0.5 |
| 0.0125 | -190115 | -0.625 | | 190.115 | 0.625 |
| 0.015 | -196420 | -0.75 | | 196.42 | 0.75 |
| 0.0175 | -199079 | -0.875 | | 199.079 | 0.875 |
| 0.02 | -201331 | -1 | | 201.331 | 1 |
| 0.0225 | -203030 | -1.125 | | 203.03 | 1.125 |
| 0.02625 | -205137 | -1.3125 | | 205.137 | 1.3125 |
| 0.031875 | -208648 | -1.59375 | | 208.648 | 1.59375 |
| 0.040313 | -214674 | -2.01563 | | 214.674 | 2.01563 |
| 0.052969 | -225350 | -2.64844 | | 225.35 | 2.64844 |
| 0.065625 | -235801 | -3.28125 | | 235.801 | 3.28125 |
| 0.068789 | -238308 | -3.43945 | | 238.308 | 3.43945 |
| 0.071953 | -240679 | -3.59766 | | 240.679 | 3.59766 |
| 0.076699 | -243768 | -3.83496 | | 243.768 | 3.83496 |
| 0.083818 | -247874 | -4.19092 | | 247.874 | 4.19092 |
| 0.094497 | -252109 | -4.72485 | | 252.109 | 4.72485 |
| 0.110515 | -255836 | -5.52576 | | 255.836 | 5.52576 |
| 0.126533 | -258478 | -6.32666 | | 258.478 | 6.32666 |
| 0.142551 | -260178 | -7.12756 | | 260.178 | 7.12756 |
| 0.166578 | -261608 | -8.32892 | | 261.608 | 8.32892 |
| 0.202619 | -263475 | -10.131 | | 263.475 | 10.131 |
| 0.211629 | -264283 | -10.5815 | | 264.283 | 10.5815 |
| 0.220639 | -265167 | -11.032 | | 265.167 | 11.032 |
| 0.229649 | -266062 | -11.4825 | | 266.062 | 11.4825 |
| 0.243165 | -267148 | -12.1582 | | 267.148 | 12.1582 |
| 0.263438 | -268944 | -13.1719 | | 268.944 | 13.1719 |
| 0.293847 | -271704 | -14.6923 | | 271.704 | 14.6923 |
| 0.324256 | -274509 | -16.2128 | | 274.509 | 16.2128 |
| 0.354666 | -277102 | -17.7333 | | 277.102 | 17.7333 |
| 0.400279 | -281320 | -20.014 | | 281.32 | 20.014 |
| 0.4687 | -289710 | -23.435 | | 289.71 | 23.435 |
| 0.571332 | -306543 | -28.5666 | | 306.543 | 28.5666 |
| 0.59699 | -309886 | -29.8495 | | 309.886 | 29.8495 |
| 0.622647 | -312442 | -31.1324 | | 312.442 | 31.1324 |
| 0.632269 | -313218 | -31.6135 | | 313.218 | 31.6135 |
| 0.646702 | -313688 | -32.3351 | | 313.688 | 32.3351 |
| 0.65031 | -313853 | -32.5155 | | 313.853 | 32.5155 |
| 0.653918 | -313772 | -32.6959 | | 313.772 | 32.6959 |
| 0.657526 | -313615 | -32.8763 | | 313.615 | 32.8763 |
| 0.661134 | -313354 | -33.0567 | | 313.354 | 33.0567 |
| 0.664742 | -312993 | -33.2371 | | 312.993 | 33.2371 |
| 0.66835 | -312530 | -33.4175 | | 312.53 | 33.4175 |
| 0.673763 | -311503 | -33.6881 | | 311.503 | 33.6881 |
| 0.679175 | -310362 | -33.9587 | | 310.362 | 33.9587 |
| 0.684587 | -309065 | -34.2294 | | 309.065 | 34.2294 |
| 0.692705 | -306502 | -34.6353 | | 306.502 | 34.6353 |
| 0.700824 | -303861 | -35.0412 | | 303.861 | 35.0412 |
| 0.708942 | -300817 | -35.4471 | | 300.817 | 35.4471 |
| 0.71706 | -297383 | -35.853 | | 297.383 | 35.853 |
| 0.725179 | -293571 | -36.2589 | | 293.571 | 36.2589 |
| 0.733297 | -289343 | -36.6648 | | 289.343 | 36.6648 |
| 0.741415 | -284694 | -37.0708 | | 284.694 | 37.0708 |
| 0.749534 | -279639 | -37.4767 | | 279.639 | 37.4767 |
| 0.757652 | -274167 | -37.8826 | | 274.167 | 37.8826 |
| 0.76577 | -268366 | -38.2885 | | 268.366 | 38.2885 |
| 0.773888 | -262252 | -38.6944 | | 262.252 | 38.6944 |
| 0.782007 | -255775 | -39.1003 | | 255.775 | 39.1003 |
| 0.790125 | -248989 | -39.5063 | | 248.989 | 39.5063 |
| 0.798243 | -241863 | -39.9122 | | 241.863 | 39.9122 |
| 0.806362 | -234480 | -40.3181 | | 234.48 | 40.3181 |
| 0.81448 | -226844 | -40.724 | | 226.844 | 40.724 |
| 0.822598 | -219010 | -41.1299 | | 219.01 | 41.1299 |

| **S235** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *26 mm* | | | | | |
| $F_{u,fem}$ | 310.716 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -154376 | -0.5 | | 154.376 | 0.5 |
| 0.0125 | -189090 | -0.625 | | 189.09 | 0.625 |
| 0.015 | -194233 | -0.75 | | 194.233 | 0.75 |
| 0.0175 | -196860 | -0.875 | | 196.86 | 0.875 |
| 0.02 | -199078 | -1 | | 199.078 | 1 |
| 0.02375 | -201447 | -1.1875 | | 201.447 | 1.1875 |
| 0.0275 | -203554 | -1.375 | | 203.554 | 1.375 |
| 0.03125 | -205889 | -1.5625 | | 205.889 | 1.5625 |
| 0.036875 | -209815 | -1.84375 | | 209.815 | 1.84375 |
| 0.045313 | -216273 | -2.26563 | | 216.273 | 2.26563 |
| 0.057969 | -227067 | -2.89844 | | 227.067 | 2.89844 |
| 0.070625 | -236991 | -3.53125 | | 236.991 | 3.53125 |
| 0.073789 | -239389 | -3.68945 | | 239.389 | 3.68945 |
| 0.076953 | -241596 | -3.84766 | | 241.596 | 3.84766 |
| 0.081699 | -244575 | -4.08496 | | 244.575 | 4.08496 |
| 0.088818 | -248512 | -4.44092 | | 248.512 | 4.44092 |
| 0.099497 | -252441 | -4.97485 | | 252.441 | 4.97485 |
| 0.110176 | -255102 | -5.50879 | | 255.102 | 5.50879 |
| 0.120854 | -257028 | -6.04272 | | 257.028 | 6.04272 |
| 0.136873 | -259380 | -6.84363 | | 259.38 | 6.84363 |
| 0.1609 | -261209 | -8.04498 | | 261.209 | 8.04498 |
| 0.184927 | -262410 | -9.24634 | | 262.41 | 9.24634 |
| 0.208954 | -263763 | -10.4477 | | 263.763 | 10.4477 |
| 0.232981 | -265976 | -11.649 | | 265.976 | 11.649 |
| 0.257008 | -267907 | -12.8504 | | 267.907 | 12.8504 |
| 0.281035 | -270066 | -14.0518 | | 270.066 | 14.0518 |
| 0.317076 | -273362 | -15.8538 | | 273.362 | 15.8538 |
| 0.353116 | -276430 | -17.6558 | | 276.43 | 17.6558 |
| 0.389157 | -279793 | -19.4579 | | 279.793 | 19.4579 |
| 0.425198 | -283422 | -21.2599 | | 283.422 | 21.2599 |
| 0.461238 | -288218 | -23.0619 | | 288.218 | 23.0619 |
| 0.497279 | -292961 | -24.864 | | 292.961 | 24.864 |
| 0.55134 | -301758 | -27.567 | | 301.758 | 27.567 |
| 0.571613 | -304685 | -28.5806 | | 304.685 | 28.5806 |
| 0.602022 | -308231 | -30.1011 | | 308.231 | 30.1011 |
| 0.613426 | -309360 | -30.6713 | | 309.36 | 30.6713 |
| 0.630531 | -310414 | -31.5265 | | 310.414 | 31.5265 |
| 0.634807 | -310652 | -31.7404 | | 310.652 | 31.7404 |
| 0.639084 | -310716 | -31.9542 | | 310.716 | 31.9542 |
| 0.64336 | -310666 | -32.168 | | 310.666 | 32.168 |
| 0.647636 | -310503 | -32.3818 | | 310.503 | 32.3818 |
| 0.648705 | -310528 | -32.4353 | | 310.528 | 32.4353 |
| 0.649774 | -310465 | -32.4887 | | 310.465 | 32.4887 |
| 0.650843 | -310396 | -32.5422 | | 310.396 | 32.5422 |
| 0.651912 | -310324 | -32.5956 | | 310.324 | 32.5956 |
| 0.653516 | -310177 | -32.6758 | | 310.177 | 32.6758 |
| 0.655921 | -309912 | -32.7961 | | 309.912 | 32.7961 |
| 0.65953 | -309409 | -32.9765 | | 309.409 | 32.9765 |
| 0.664942 | -308410 | -33.2471 | | 308.41 | 33.2471 |
| 0.67306 | -306423 | -33.653 | | 306.423 | 33.653 |
| 0.681178 | -304384 | -34.0589 | | 304.384 | 34.0589 |
| 0.689297 | -301991 | -34.4648 | | 301.991 | 34.4648 |
| 0.697415 | -299238 | -34.8708 | | 299.238 | 34.8708 |
| 0.705533 | -296114 | -35.2767 | | 296.114 | 35.2767 |
| 0.713652 | -292635 | -35.6826 | | 292.635 | 35.6826 |
| 0.72177 | -288783 | -36.0885 | | 288.783 | 36.0885 |
| 0.729888 | -284537 | -36.4944 | | 284.537 | 36.4944 |
| 0.738007 | -279894 | -36.9003 | | 279.894 | 36.9003 |
| 0.746125 | -274846 | -37.3062 | | 274.846 | 37.3062 |
| 0.754243 | -269437 | -37.7122 | | 269.437 | 37.7122 |
| 0.762361 | -263698 | -38.1181 | | 263.698 | 38.1181 |
| 0.77048 | -257609 | -38.524 | | 257.609 | 38.524 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *27 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 306.773 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -153930 | -0.5 | | 153.93 | 0.5 |
| 0.0125 | -187751 | -0.625 | | 187.751 | 0.625 |
| 0.015 | -191960 | -0.75 | | 191.96 | 0.75 |
| 0.0175 | -194541 | -0.875 | | 194.541 | 0.875 |
| 0.02 | -196732 | -1 | | 196.732 | 1 |
| 0.02375 | -199076 | -1.1875 | | 199.076 | 1.1875 |
| 0.029375 | -202199 | -1.46875 | | 202.199 | 1.46875 |
| 0.037813 | -207870 | -1.89063 | | 207.87 | 1.89063 |
| 0.050469 | -218050 | -2.52344 | | 218.05 | 2.52344 |
| 0.063125 | -228857 | -3.15625 | | 228.857 | 3.15625 |
| 0.066289 | -231440 | -3.31445 | | 231.44 | 3.31445 |
| 0.069453 | -233910 | -3.47266 | | 233.91 | 3.47266 |
| 0.074199 | -237388 | -3.70996 | | 237.388 | 3.70996 |
| 0.075979 | -238676 | -3.79895 | | 238.676 | 3.79895 |
| 0.078649 | -240474 | -3.93243 | | 240.474 | 3.93243 |
| 0.082653 | -242902 | -4.13266 | | 242.902 | 4.13266 |
| 0.08866 | -246280 | -4.433 | | 246.28 | 4.433 |
| 0.09767 | -250438 | -4.88351 | | 250.438 | 4.88351 |
| 0.111185 | -254338 | -5.55927 | | 254.338 | 5.55927 |
| 0.124701 | -256962 | -6.23503 | | 256.962 | 6.23503 |
| 0.138216 | -259071 | -6.91079 | | 259.071 | 6.91079 |
| 0.158489 | -260892 | -7.92444 | | 260.892 | 7.92444 |
| 0.188898 | -262451 | -9.4449 | | 262.451 | 9.4449 |
| 0.219307 | -264310 | -10.9654 | | 264.31 | 10.9654 |
| 0.249717 | -266944 | -12.4858 | | 266.944 | 12.4858 |
| 0.280126 | -269486 | -14.0063 | | 269.486 | 14.0063 |
| 0.310535 | -272246 | -15.5268 | | 272.246 | 15.5268 |
| 0.340945 | -275006 | -17.0472 | | 275.006 | 17.0472 |
| 0.371354 | -277591 | -18.5677 | | 277.591 | 18.5677 |
| 0.416968 | -281763 | -20.8484 | | 281.763 | 20.8484 |
| 0.462582 | -287318 | -23.1291 | | 287.318 | 23.1291 |
| 0.508196 | -293207 | -25.4098 | | 293.207 | 25.4098 |
| 0.576617 | -302985 | -28.8308 | | 302.985 | 28.8308 |
| 0.593722 | -304876 | -29.6861 | | 304.876 | 29.6861 |
| 0.610827 | -306294 | -30.5414 | | 306.294 | 30.5414 |
| 0.617242 | -306646 | -30.8621 | | 306.646 | 30.8621 |
| 0.623656 | -306773 | -31.1828 | | 306.773 | 31.1828 |
| 0.63007 | -306616 | -31.5035 | | 306.616 | 31.5035 |
| 0.636485 | -306143 | -31.8242 | | 306.143 | 31.8242 |
| 0.642899 | -305333 | -32.145 | | 305.333 | 32.145 |
| 0.649314 | -304167 | -32.4657 | | 304.167 | 32.4657 |
| 0.655728 | -302704 | -32.7864 | | 302.704 | 32.7864 |
| 0.662143 | -301020 | -33.1071 | | 301.02 | 33.1071 |
| 0.668557 | -299131 | -33.4279 | | 299.131 | 33.4279 |
| 0.678179 | -295304 | -33.9089 | | 295.304 | 33.9089 |
| 0.687801 | -291370 | -34.39 | | 291.37 | 34.39 |
| 0.697422 | -286848 | -34.8711 | | 286.848 | 34.8711 |
| 0.707044 | -281765 | -35.3522 | | 281.765 | 35.3522 |
| 0.716666 | -276098 | -35.8333 | | 276.098 | 35.8333 |
| 0.726287 | -269838 | -36.3144 | | 269.838 | 36.3144 |
| 0.735909 | -263044 | -36.7955 | | 263.044 | 36.7955 |
| 0.745531 | -255790 | -37.2765 | | 255.79 | 37.2765 |
| 0.755152 | -248061 | -37.7576 | | 248.061 | 37.7576 |
| 0.764774 | -239887 | -38.2387 | | 239.887 | 38.2387 |
| 0.774396 | -231298 | -38.7198 | | 231.298 | 38.7198 |
| 0.784018 | -222311 | -39.2009 | | 222.311 | 39.2009 |
| 0.793639 | -213035 | -39.682 | | 213.035 | 39.682 |
| 0.803261 | -203555 | -40.163 | | 203.555 | 40.163 |
| 0.812883 | -193837 | -40.6441 | | 193.837 | 40.6441 |
| 0.822504 | -184051 | -41.1252 | | 184.051 | 41.1252 |
| 0.832126 | -174554 | -41.6063 | | 174.554 | 41.6063 |
| 0.841748 | -165583 | -42.0874 | | 165.583 | 42.0874 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *28 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 302.914 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -153467 | -0.5 | | 153.467 | 0.5 |
| 0.0125 | -185891 | -0.625 | | 185.891 | 0.625 |
| 0.015 | -189738 | -0.75 | | 189.738 | 0.75 |
| 0.0175 | -192289 | -0.875 | | 192.289 | 0.875 |
| 0.02 | -194434 | -1 | | 194.434 | 1 |
| 0.02375 | -196750 | -1.1875 | | 196.75 | 1.1875 |
| 0.0275 | -198749 | -1.375 | | 198.749 | 1.375 |
| 0.03125 | -201068 | -1.5625 | | 201.068 | 1.5625 |
| 0.036875 | -204888 | -1.84375 | | 204.888 | 1.84375 |
| 0.045313 | -211160 | -2.26563 | | 211.16 | 2.26563 |
| 0.05375 | -218739 | -2.6875 | | 218.739 | 2.6875 |
| 0.062188 | -225846 | -3.10938 | | 225.846 | 3.10938 |
| 0.064297 | -227550 | -3.21484 | | 227.55 | 3.21484 |
| 0.066406 | -229194 | -3.32031 | | 229.194 | 3.32031 |
| 0.06957 | -231561 | -3.47852 | | 231.561 | 3.47852 |
| 0.074316 | -234970 | -3.71582 | | 234.97 | 3.71582 |
| 0.081436 | -239701 | -4.07178 | | 239.701 | 4.07178 |
| 0.084105 | -241339 | -4.20526 | | 241.339 | 4.20526 |
| 0.08811 | -243657 | -4.40549 | | 243.657 | 4.40549 |
| 0.094117 | -246831 | -4.70583 | | 246.831 | 4.70583 |
| 0.103127 | -250701 | -5.15633 | | 250.701 | 5.15633 |
| 0.112137 | -253456 | -5.60684 | | 253.456 | 5.60684 |
| 0.121147 | -255570 | -6.05735 | | 255.57 | 6.05735 |
| 0.134662 | -257854 | -6.73311 | | 257.854 | 6.73311 |
| 0.154935 | -260354 | -7.74676 | | 260.354 | 7.74676 |
| 0.175208 | -261638 | -8.7604 | | 261.638 | 8.7604 |
| 0.195481 | -262639 | -9.77404 | | 262.639 | 9.77404 |
| 0.22589 | -264524 | -11.2945 | | 264.524 | 11.2945 |
| 0.256299 | -267077 | -12.815 | | 267.077 | 12.815 |
| 0.286709 | -269557 | -14.3354 | | 269.557 | 14.3354 |
| 0.317118 | -272296 | -15.8559 | | 272.296 | 15.8559 |
| 0.347527 | -275055 | -17.3764 | | 275.055 | 17.3764 |
| 0.377937 | -277624 | -18.8968 | | 277.624 | 18.8968 |
| 0.423551 | -281764 | -21.1775 | | 281.764 | 21.1775 |
| 0.469165 | -287137 | -23.4582 | | 287.137 | 23.4582 |
| 0.514778 | -292657 | -25.7389 | | 292.657 | 25.7389 |
| 0.583199 | -301151 | -29.16 | | 301.151 | 29.16 |
| 0.600305 | -302556 | -30.0152 | | 302.556 | 30.0152 |
| 0.604581 | -302818 | -30.229 | | 302.818 | 30.229 |
| 0.610995 | -302914 | -30.5498 | | 302.914 | 30.5498 |
| 0.61741 | -302752 | -30.8705 | | 302.752 | 30.8705 |
| 0.623824 | -302254 | -31.1912 | | 302.254 | 31.1912 |
| 0.630239 | -301410 | -31.5119 | | 301.41 | 31.5119 |
| 0.636653 | -300229 | -31.8327 | | 300.229 | 31.8327 |
| 0.643068 | -298745 | -32.1534 | | 298.745 | 32.1534 |
| 0.649482 | -297070 | -32.4741 | | 297.07 | 32.4741 |
| 0.655897 | -295171 | -32.7948 | | 295.171 | 32.7948 |
| 0.662311 | -293038 | -33.1156 | | 293.038 | 33.1156 |
| 0.671933 | -288822 | -33.5966 | | 288.822 | 33.5966 |
| 0.681554 | -284534 | -34.0777 | | 284.534 | 34.0777 |
| 0.691176 | -279666 | -34.5588 | | 279.666 | 34.5588 |
| 0.700798 | -274211 | -35.0399 | | 274.211 | 35.0399 |
| 0.71042 | -268165 | -35.521 | | 268.165 | 35.521 |
| 0.720041 | -261543 | -36.0021 | | 261.543 | 36.0021 |
| 0.729663 | -254449 | -36.4831 | | 254.449 | 36.4831 |
| 0.739285 | -246878 | -36.9642 | | 246.878 | 36.9642 |
| 0.748906 | -238858 | -37.4453 | | 238.858 | 37.4453 |
| 0.758528 | -230415 | -37.9264 | | 230.415 | 37.9264 |
| 0.76815 | -221569 | -38.4075 | | 221.569 | 38.4075 |
| 0.777771 | -212409 | -38.8886 | | 212.409 | 38.8886 |
| 0.787393 | -203020 | -39.3697 | | 203.02 | 39.3697 |
| 0.797015 | -193408 | -39.8507 | | 193.408 | 39.8507 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *29 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 299.827 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | 0 | 0 | 0 |
| 0.01 | -152985 | 0.01 | -0.5 | 152.985 | 0.01 |
| 0.0125 | -183926 | 0.0125 | -0.625 | 183.926 | 0.0125 |
| 0.015 | -187540 | 0.015 | -0.75 | 187.54 | 0.015 |
| 0.0175 | -190065 | 0.0175 | -0.875 | 190.065 | 0.0175 |
| 0.02 | -192162 | 0.02 | -1 | 192.162 | 0.02 |
| 0.0225 | -193747 | 0.0225 | -1.125 | 193.747 | 0.0225 |
| 0.025 | -195147 | 0.025 | -1.25 | 195.147 | 0.025 |
| 0.02875 | -197128 | 0.02875 | -1.4375 | 197.128 | 0.02875 |
| 0.034375 | -200723 | 0.034375 | -1.71875 | 200.723 | 0.034375 |
| 0.042813 | -206659 | 0.042813 | -2.14063 | 206.659 | 0.042813 |
| 0.05125 | -213851 | 0.05125 | -2.5625 | 213.851 | 0.05125 |
| 0.059688 | -221271 | 0.059688 | -2.98438 | 221.271 | 0.059688 |
| 0.068125 | -227794 | 0.068125 | -3.40625 | 227.794 | 0.068125 |
| 0.076563 | -233927 | 0.076563 | -3.82813 | 233.927 | 0.076563 |
| 0.078672 | -235415 | 0.078672 | -3.93359 | 235.415 | 0.078672 |
| 0.080781 | -236847 | 0.080781 | -4.03906 | 236.847 | 0.080781 |
| 0.083945 | -238881 | 0.083945 | -4.19727 | 238.881 | 0.083945 |
| 0.088691 | -241593 | 0.088691 | -4.43457 | 241.593 | 0.088691 |
| 0.095811 | -245331 | 0.095811 | -4.79053 | 245.331 | 0.095811 |
| 0.106489 | -250036 | 0.106489 | -5.32446 | 250.036 | 0.106489 |
| 0.110494 | -251482 | 0.110494 | -5.52469 | 251.482 | 0.110494 |
| 0.114498 | -252729 | 0.114498 | -5.72491 | 252.729 | 0.114498 |
| 0.118503 | -253968 | 0.118503 | -5.92514 | 253.968 | 0.118503 |
| 0.12451 | -255303 | 0.12451 | -6.22548 | 255.303 | 0.12451 |
| 0.13352 | -256883 | 0.13352 | -6.67599 | 256.883 | 0.13352 |
| 0.147035 | -258907 | 0.147035 | -7.35175 | 258.907 | 0.147035 |
| 0.167308 | -260900 | 0.167308 | -8.36539 | 260.9 | 0.167308 |
| 0.197717 | -262533 | 0.197717 | -9.88586 | 262.533 | 0.197717 |
| 0.228126 | -264309 | 0.228126 | -11.4063 | 264.309 | 0.228126 |
| 0.258536 | -266845 | 0.258536 | -12.9268 | 266.845 | 0.258536 |
| 0.288945 | -269227 | 0.288945 | -14.4473 | 269.227 | 0.288945 |
| 0.319354 | -271942 | 0.319354 | -15.9677 | 271.942 | 0.319354 |
| 0.349764 | -274742 | 0.349764 | -17.4882 | 274.742 | 0.349764 |
| 0.380173 | -277234 | 0.380173 | -19.0086 | 277.234 | 0.380173 |
| 0.425787 | -281315 | 0.425787 | -21.2893 | 281.315 | 0.425787 |
| 0.471401 | -286334 | 0.471401 | -23.57 | 286.334 | 0.471401 |
| 0.517015 | -291499 | 0.517015 | -25.8507 | 291.499 | 0.517015 |
| 0.53412 | -293566 | 0.53412 | -26.706 | 293.566 | 0.53412 |
| 0.559778 | -296523 | 0.559778 | -27.9889 | 296.523 | 0.559778 |
| 0.5694 | -297585 | 0.5694 | -28.47 | 297.585 | 0.5694 |
| 0.583832 | -298991 | 0.583832 | -29.1916 | 298.991 | 0.583832 |
| 0.605481 | -299617 | 0.605481 | -30.274 | 299.617 | 0.605481 |
| 0.610893 | -299827 | 0.610893 | -30.5447 | 299.827 | 0.610893 |
| 0.616305 | -299454 | 0.616305 | -30.8153 | 299.454 | 0.616305 |
| 0.621718 | -298885 | 0.621718 | -31.0859 | 298.885 | 0.621718 |
| 0.62713 | -298062 | 0.62713 | -31.3565 | 298.062 | 0.62713 |
| 0.632542 | -297022 | 0.632542 | -31.6271 | 297.022 | 0.632542 |
| 0.637954 | -295806 | 0.637954 | -31.8977 | 295.806 | 0.637954 |
| 0.646072 | -293363 | 0.646072 | -32.3036 | 293.363 | 0.646072 |
| 0.654191 | -290856 | 0.654191 | -32.7095 | 290.856 | 0.654191 |
| 0.662309 | -287976 | 0.662309 | -33.1155 | 287.976 | 0.662309 |
| 0.670427 | -284748 | 0.670427 | -33.5214 | 284.748 | 0.670427 |
| 0.678546 | -281159 | 0.678546 | -33.9273 | 281.159 | 0.678546 |
| 0.686664 | -277200 | 0.686664 | -34.3332 | 277.2 | 0.686664 |
| 0.694782 | -272849 | 0.694782 | -34.7391 | 272.849 | 0.694782 |
| 0.702901 | -268095 | 0.702901 | -35.145 | 268.095 | 0.702901 |
| 0.711019 | -262932 | 0.711019 | -35.5509 | 262.932 | 0.711019 |
| 0.719137 | -257440 | 0.719137 | -35.9569 | 257.44 | 0.719137 |
| 0.727255 | -251613 | 0.727255 | -36.3628 | 251.613 | 0.727255 |
| 0.735374 | -245433 | 0.735374 | -36.7687 | 245.433 | 0.735374 |
| 0.743492 | -238912 | 0.743492 | -37.1746 | 238.912 | 0.743492 |
| 0.75161 | -232090 | 0.75161 | -37.5805 | 232.09 | 0.75161 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *30 mm* | | | | | |
| $F_{u,fem}$ | 296.502 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -152470 | -0.5 | | 152.47 | 0.5 |
| 0.0125 | -181861 | -0.625 | | 181.861 | 0.625 |
| 0.015 | -185293 | -0.75 | | 185.293 | 0.75 |
| 0.0175 | -187769 | -0.875 | | 187.769 | 0.875 |
| 0.02 | -189841 | -1 | | 189.841 | 1 |
| 0.0225 | -191424 | -1.125 | | 191.424 | 1.125 |
| 0.02625 | -193384 | -1.3125 | | 193.384 | 1.3125 |
| 0.031875 | -196641 | -1.59375 | | 196.641 | 1.59375 |
| 0.040313 | -202331 | -2.01563 | | 202.331 | 2.01563 |
| 0.052969 | -212628 | -2.64844 | | 212.628 | 2.64844 |
| 0.056133 | -215735 | -2.80664 | | 215.735 | 2.80664 |
| 0.059297 | -218544 | -2.96484 | | 218.544 | 2.96484 |
| 0.064043 | -222432 | -3.20215 | | 222.432 | 3.20215 |
| 0.071162 | -227661 | -3.55811 | | 227.661 | 3.55811 |
| 0.073832 | -229579 | -3.69159 | | 229.579 | 3.69159 |
| 0.077836 | -232338 | -3.89182 | | 232.338 | 3.89182 |
| 0.083843 | -236227 | -4.19215 | | 236.227 | 4.19215 |
| 0.092853 | -241296 | -4.64266 | | 241.296 | 4.64266 |
| 0.101863 | -245792 | -5.09317 | | 245.792 | 5.09317 |
| 0.110874 | -249654 | -5.54368 | | 249.654 | 5.54368 |
| 0.119884 | -252716 | -5.99419 | | 252.716 | 5.99419 |
| 0.128894 | -255010 | -6.44469 | | 255.01 | 6.44469 |
| 0.137904 | -256641 | -6.8952 | | 256.641 | 6.8952 |
| 0.151419 | -258675 | -7.57096 | | 258.675 | 7.57096 |
| 0.171692 | -260797 | -8.58461 | | 260.797 | 8.58461 |
| 0.202101 | -262534 | -10.1051 | | 262.534 | 10.1051 |
| 0.247715 | -265464 | -12.3858 | | 265.464 | 12.3858 |
| 0.259119 | -266451 | -12.9559 | | 266.451 | 12.9559 |
| 0.270522 | -267333 | -13.5261 | | 267.333 | 13.5261 |
| 0.287628 | -268620 | -14.3814 | | 268.62 | 14.3814 |
| 0.313285 | -270761 | -15.6643 | | 270.761 | 15.6643 |
| 0.338943 | -273171 | -16.9472 | | 273.171 | 16.9472 |
| 0.364601 | -275367 | -18.2301 | | 275.367 | 18.2301 |
| 0.403088 | -278546 | -20.1544 | | 278.546 | 20.1544 |
| 0.41752 | -279918 | -20.876 | | 279.918 | 20.876 |
| 0.439169 | -281849 | -21.9585 | | 281.849 | 21.9585 |
| 0.471642 | -285307 | -23.5821 | | 285.307 | 23.5821 |
| 0.520352 | -290406 | -26.0176 | | 290.406 | 26.0176 |
| 0.538618 | -292206 | -26.9309 | | 292.206 | 26.9309 |
| 0.566018 | -294802 | -28.3009 | | 294.802 | 28.3009 |
| 0.576292 | -295683 | -28.8146 | | 295.683 | 28.8146 |
| 0.591705 | -296387 | -29.5852 | | 296.387 | 29.5852 |
| 0.595558 | -296502 | -29.7779 | | 296.502 | 29.7779 |
| 0.599411 | -296446 | -29.9705 | | 296.446 | 29.9705 |
| 0.603264 | -296287 | -30.1632 | | 296.287 | 30.1632 |
| 0.604227 | -296281 | -30.2113 | | 296.281 | 30.2113 |
| 0.60519 | -296219 | -30.2595 | | 296.219 | 30.2595 |
| 0.606635 | -296108 | -30.3318 | | 296.108 | 30.3318 |
| 0.608802 | -295907 | -30.4401 | | 295.907 | 30.4401 |
| 0.612053 | -295531 | -30.6027 | | 295.531 | 30.6027 |
| 0.61693 | -294767 | -30.8465 | | 294.767 | 30.8465 |
| 0.624245 | -293202 | -31.2122 | | 293.202 | 31.2122 |
| 0.631559 | -291380 | -31.578 | | 291.38 | 31.578 |
| 0.633388 | -291393 | -31.6694 | | 291.393 | 31.6694 |
| 0.635217 | -290913 | -31.7608 | | 290.913 | 31.7608 |
| 0.63796 | -290083 | -31.898 | | 290.083 | 31.898 |
| 0.642074 | -288696 | -32.1037 | | 288.696 | 32.1037 |
| 0.648246 | -286356 | -32.4123 | | 286.356 | 32.4123 |
| 0.657504 | -282325 | -32.8752 | | 282.325 | 32.8752 |
| 0.666761 | -278270 | -33.3381 | | 278.27 | 33.3381 |
| 0.676019 | -273733 | -33.801 | | 273.733 | 33.801 |
| 0.685277 | -268677 | -34.2638 | | 268.677 | 34.2638 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *31 mm* | | | | | |
| $F_{u,fem}$ | 293.038 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -151933 | -0.5 | | 151.933 | 0.5 |
| 0.0125 | -179788 | -0.625 | | 179.788 | 0.625 |
| 0.015 | -183065 | -0.75 | | 183.065 | 0.75 |
| 0.0175 | -185511 | -0.875 | | 185.511 | 0.875 |
| 0.02 | -187543 | -1 | | 187.543 | 1 |
| 0.02375 | -189782 | -1.1875 | | 189.782 | 1.1875 |
| 0.029375 | -192713 | -1.46875 | | 192.713 | 1.46875 |
| 0.035 | -196320 | -1.75 | | 196.32 | 1.75 |
| 0.040625 | -200218 | -2.03125 | | 200.218 | 2.03125 |
| 0.049063 | -206772 | -2.45313 | | 206.772 | 2.45313 |
| 0.0575 | -214371 | -2.875 | | 214.371 | 2.875 |
| 0.065938 | -221186 | -3.29688 | | 221.186 | 3.29688 |
| 0.074375 | -227303 | -3.71875 | | 227.303 | 3.71875 |
| 0.077539 | -229540 | -3.87695 | | 229.54 | 3.87695 |
| 0.082285 | -232656 | -4.11426 | | 232.656 | 4.11426 |
| 0.089404 | -236913 | -4.47021 | | 236.913 | 4.47021 |
| 0.092074 | -238432 | -4.6037 | | 238.432 | 4.6037 |
| 0.096079 | -240558 | -4.80392 | | 240.558 | 4.80392 |
| 0.102085 | -243497 | -5.10426 | | 243.497 | 5.10426 |
| 0.111095 | -247494 | -5.55477 | | 247.494 | 5.55477 |
| 0.124611 | -252331 | -6.23053 | | 252.331 | 6.23053 |
| 0.138126 | -255547 | -6.9063 | | 255.547 | 6.9063 |
| 0.151641 | -257733 | -7.58206 | | 257.733 | 7.58206 |
| 0.165156 | -259630 | -8.25782 | | 259.63 | 8.25782 |
| 0.178672 | -260841 | -8.93358 | | 260.841 | 8.93358 |
| 0.192187 | -261726 | -9.60934 | | 261.726 | 9.60934 |
| 0.21246 | -262869 | -10.623 | | 262.869 | 10.623 |
| 0.242869 | -264609 | -12.1435 | | 264.609 | 12.1435 |
| 0.254273 | -265633 | -12.7136 | | 265.633 | 12.7136 |
| 0.265676 | -266534 | -13.2838 | | 266.534 | 13.2838 |
| 0.27708 | -267382 | -13.854 | | 267.382 | 13.854 |
| 0.294185 | -268653 | -14.7092 | | 268.653 | 14.7092 |
| 0.319843 | -270722 | -15.9921 | | 270.722 | 15.9921 |
| 0.358329 | -274213 | -17.9165 | | 274.213 | 17.9165 |
| 0.396816 | -277284 | -19.8408 | | 277.284 | 19.8408 |
| 0.435303 | -280612 | -21.7651 | | 280.612 | 21.7651 |
| 0.47379 | -284211 | -23.6895 | | 284.211 | 23.6895 |
| 0.512276 | -288106 | -25.6138 | | 288.106 | 25.6138 |
| 0.526709 | -289470 | -26.3354 | | 289.47 | 26.3354 |
| 0.548358 | -291194 | -27.4179 | | 291.194 | 27.4179 |
| 0.556476 | -291824 | -27.8238 | | 291.824 | 27.8238 |
| 0.568654 | -292617 | -28.4327 | | 292.617 | 28.4327 |
| 0.57322 | -292864 | -28.661 | | 292.864 | 28.661 |
| 0.58007 | -293038 | -29.0035 | | 293.038 | 29.0035 |
| 0.58692 | -292944 | -29.346 | | 292.944 | 29.346 |
| 0.59377 | -292502 | -29.6885 | | 292.502 | 29.6885 |
| 0.600619 | -291678 | -30.031 | | 291.678 | 30.031 |
| 0.607469 | -290477 | -30.3735 | | 290.477 | 30.3735 |
| 0.614319 | -288933 | -30.7159 | | 288.933 | 30.7159 |
| 0.621169 | -287119 | -31.0584 | | 287.119 | 31.0584 |
| 0.623737 | -286816 | -31.1869 | | 286.816 | 31.1869 |
| 0.62759 | -285531 | -31.3795 | | 285.531 | 31.3795 |
| 0.63337 | -283384 | -31.6685 | | 283.384 | 31.6685 |
| 0.642039 | -279681 | -32.102 | | 279.681 | 32.102 |
| 0.650709 | -275978 | -32.5354 | | 275.978 | 32.5354 |
| 0.659378 | -271849 | -32.9689 | | 271.849 | 32.9689 |
| 0.668047 | -267270 | -33.4024 | | 267.27 | 33.4024 |
| 0.676717 | -262243 | -33.8358 | | 262.243 | 33.8358 |
| 0.685386 | -256749 | -34.2693 | | 256.749 | 34.2693 |
| 0.694055 | -250854 | -34.7028 | | 250.854 | 34.7028 |
| 0.702724 | -244586 | -35.1362 | | 244.586 | 35.1362 |
| 0.711394 | -237937 | -35.5697 | | 237.937 | 35.5697 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *32 mm* | | | | | |
| $F_{u,fem}$ | 289.24 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -151363 | -0.5 | | 151.363 | 0.5 |
| 0.0125 | -177660 | -0.625 | | 177.66 | 0.625 |
| 0.015 | -180801 | -0.75 | | 180.801 | 0.75 |
| 0.0175 | -183212 | -0.875 | | 183.212 | 0.875 |
| 0.02 | -185214 | -1 | | 185.214 | 1 |
| 0.02375 | -187407 | -1.1875 | | 187.407 | 1.1875 |
| 0.029375 | -190313 | -1.46875 | | 190.313 | 1.46875 |
| 0.037813 | -195642 | -1.89063 | | 195.642 | 1.89063 |
| 0.050469 | -205237 | -2.52344 | | 205.237 | 2.52344 |
| 0.053633 | -208371 | -2.68164 | | 208.371 | 2.68164 |
| 0.056797 | -211376 | -2.83984 | | 211.376 | 2.83984 |
| 0.061543 | -215367 | -3.07715 | | 215.367 | 3.07715 |
| 0.068662 | -220808 | -3.43311 | | 220.808 | 3.43311 |
| 0.079341 | -228078 | -3.96704 | | 228.078 | 3.96704 |
| 0.083345 | -230693 | -4.16727 | | 230.693 | 4.16727 |
| 0.089352 | -234227 | -4.46761 | | 234.227 | 4.46761 |
| 0.098362 | -239020 | -4.91811 | | 239.02 | 4.91811 |
| 0.111878 | -245183 | -5.59388 | | 245.183 | 5.59388 |
| 0.116946 | -247250 | -5.84729 | | 247.25 | 5.84729 |
| 0.124548 | -250159 | -6.2274 | | 250.159 | 6.2274 |
| 0.135952 | -253756 | -6.79758 | | 253.756 | 6.79758 |
| 0.147355 | -255961 | -7.36775 | | 255.961 | 7.36775 |
| 0.158759 | -257761 | -7.93793 | | 257.761 | 7.93793 |
| 0.175864 | -259973 | -8.79319 | | 259.973 | 8.79319 |
| 0.192969 | -261311 | -9.64845 | | 261.311 | 9.64845 |
| 0.210074 | -262407 | -10.5037 | | 262.407 | 10.5037 |
| 0.235732 | -263847 | -11.7866 | | 263.847 | 11.7866 |
| 0.26139 | -265635 | -13.0695 | | 265.635 | 13.0695 |
| 0.287048 | -267590 | -14.3524 | | 267.59 | 14.3524 |
| 0.312706 | -269488 | -15.6353 | | 269.488 | 15.6353 |
| 0.338363 | -271658 | -16.9182 | | 271.658 | 16.9182 |
| 0.37685 | -274992 | -18.8425 | | 274.992 | 18.8425 |
| 0.415337 | -277986 | -20.7668 | | 277.986 | 20.7668 |
| 0.453824 | -281176 | -22.6912 | | 281.176 | 22.6912 |
| 0.49231 | -284557 | -24.6155 | | 284.557 | 24.6155 |
| 0.530797 | -287781 | -26.5399 | | 287.781 | 26.5399 |
| 0.54523 | -288786 | -27.2615 | | 288.786 | 27.2615 |
| 0.550642 | -289070 | -27.5321 | | 289.07 | 27.5321 |
| 0.55876 | -289240 | -27.938 | | 289.24 | 27.938 |
| 0.566879 | -288961 | -28.3439 | | 288.961 | 28.3439 |
| 0.574997 | -288137 | -28.7498 | | 288.137 | 28.7498 |
| 0.583115 | -286743 | -29.1558 | | 286.743 | 29.1558 |
| 0.591234 | -284792 | -29.5617 | | 284.792 | 29.5617 |
| 0.599352 | -282393 | -29.9676 | | 282.393 | 29.9676 |
| 0.60747 | -279594 | -30.3735 | | 279.594 | 30.3735 |
| 0.615588 | -276381 | -30.7794 | | 276.381 | 30.7794 |
| 0.623707 | -272796 | -31.1853 | | 272.796 | 31.1853 |
| 0.631825 | -268800 | -31.5913 | | 268.8 | 31.5913 |
| 0.639943 | -264428 | -31.9972 | | 264.428 | 31.9972 |
| 0.648062 | -259621 | -32.4031 | | 259.621 | 32.4031 |
| 0.65618 | -254431 | -32.809 | | 254.431 | 32.809 |
| 0.664298 | -248864 | -33.2149 | | 248.864 | 33.2149 |
| 0.672417 | -242971 | -33.6208 | | 242.971 | 33.6208 |
| 0.680535 | -236765 | -34.0267 | | 236.765 | 34.0267 |
| 0.688653 | -230210 | -34.4327 | | 230.21 | 34.4327 |
| 0.696771 | -223394 | -34.8386 | | 223.394 | 34.8386 |
| 0.70489 | -216289 | -35.2445 | | 216.289 | 35.2445 |
| 0.713008 | -208923 | -35.6504 | | 208.923 | 35.6504 |
| 0.721126 | -201353 | -36.0563 | | 201.353 | 36.0563 |
| 0.729245 | -193678 | -36.4622 | | 193.678 | 36.4622 |
| 0.737363 | -185826 | -36.8681 | | 185.826 | 36.8681 |
| 0.745481 | -177930 | -37.2741 | | 177.93 | 37.2741 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *33 mm* | | | | | |
| $F_{u,fem}$ | 285.861 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -150773 | -0.5 | | 150.773 | 0.5 |
| 0.0125 | -175553 | -0.625 | | 175.553 | 0.625 |
| 0.015 | -178578 | -0.75 | | 178.578 | 0.75 |
| 0.0175 | -180954 | -0.875 | | 180.954 | 0.875 |
| 0.02 | -182922 | -1 | | 182.922 | 1 |
| 0.02375 | -185100 | -1.1875 | | 185.1 | 1.1875 |
| 0.029375 | -187969 | -1.46875 | | 187.969 | 1.46875 |
| 0.037813 | -193229 | -1.89063 | | 193.229 | 1.89063 |
| 0.050469 | -202689 | -2.52344 | | 202.689 | 2.52344 |
| 0.063125 | -213729 | -3.15625 | | 213.729 | 3.15625 |
| 0.075781 | -223057 | -3.78906 | | 223.057 | 3.78906 |
| 0.088438 | -230958 | -4.42188 | | 230.958 | 4.42188 |
| 0.091602 | -232806 | -4.58008 | | 232.806 | 4.58008 |
| 0.094766 | -234559 | -4.73828 | | 234.559 | 4.73828 |
| 0.099512 | -237039 | -4.97559 | | 237.039 | 4.97559 |
| 0.106631 | -240384 | -5.33154 | | 240.384 | 5.33154 |
| 0.11731 | -244841 | -5.86548 | | 244.841 | 5.86548 |
| 0.133328 | -250803 | -6.66638 | | 250.803 | 6.66638 |
| 0.149346 | -254963 | -7.46729 | | 254.963 | 7.46729 |
| 0.165364 | -257556 | -8.26819 | | 257.556 | 8.26819 |
| 0.181382 | -259694 | -9.06909 | | 259.694 | 9.06909 |
| 0.205409 | -261570 | -10.2704 | | 261.57 | 10.2704 |
| 0.229436 | -263176 | -11.4718 | | 263.176 | 11.4718 |
| 0.253463 | -264550 | -12.6732 | | 264.55 | 12.6732 |
| 0.27749 | -266368 | -13.8745 | | 266.368 | 13.8745 |
| 0.301517 | -268134 | -15.0759 | | 268.134 | 15.0759 |
| 0.325544 | -269849 | -16.2772 | | 269.849 | 16.2772 |
| 0.349572 | -271843 | -17.4786 | | 271.843 | 17.4786 |
| 0.373599 | -273988 | -18.6799 | | 273.988 | 18.6799 |
| 0.397626 | -275778 | -19.8813 | | 275.778 | 19.8813 |
| 0.433666 | -278507 | -21.6833 | | 278.507 | 21.6833 |
| 0.469707 | -281226 | -23.4854 | | 281.226 | 23.4854 |
| 0.505748 | -283885 | -25.2874 | | 283.885 | 25.2874 |
| 0.514758 | -284596 | -25.7379 | | 284.596 | 25.7379 |
| 0.528273 | -285451 | -26.4137 | | 285.451 | 26.4137 |
| 0.533341 | -285704 | -26.6671 | | 285.704 | 26.6671 |
| 0.540944 | -285861 | -27.0472 | | 285.861 | 27.0472 |
| 0.548546 | -285650 | -27.4273 | | 285.65 | 27.4273 |
| 0.556148 | -284982 | -27.8074 | | 284.982 | 27.8074 |
| 0.563751 | -283839 | -28.1875 | | 283.839 | 28.1875 |
| 0.571353 | -282238 | -28.5676 | | 282.238 | 28.5676 |
| 0.578955 | -280244 | -28.9478 | | 280.244 | 28.9478 |
| 0.586558 | -277920 | -29.3279 | | 277.92 | 29.3279 |
| 0.59416 | -275256 | -29.708 | | 275.256 | 29.708 |
| 0.601762 | -272288 | -30.0881 | | 272.288 | 30.0881 |
| 0.609365 | -269022 | -30.4682 | | 269.022 | 30.4682 |
| 0.616967 | -265460 | -30.8483 | | 265.46 | 30.8483 |
| 0.624569 | -261558 | -31.2285 | | 261.558 | 31.2285 |
| 0.632172 | -257299 | -31.6086 | | 257.299 | 31.6086 |
| 0.639774 | -252686 | -31.9887 | | 252.686 | 31.9887 |
| 0.647376 | -247757 | -32.3688 | | 247.757 | 32.3688 |
| 0.654979 | -242537 | -32.7489 | | 242.537 | 32.7489 |
| 0.662581 | -237019 | -33.129 | | 237.019 | 33.129 |
| 0.670183 | -231191 | -33.5092 | | 231.191 | 33.5092 |
| 0.677785 | -225095 | -33.8893 | | 225.095 | 33.8893 |
| 0.685388 | -218724 | -34.2694 | | 218.724 | 34.2694 |
| 0.69299 | -212070 | -34.6495 | | 212.07 | 34.6495 |
| 0.700592 | -205244 | -35.0296 | | 205.244 | 35.0296 |
| 0.708195 | -198267 | -35.4097 | | 198.267 | 35.4097 |
| 0.715797 | -191138 | -35.7899 | | 191.138 | 35.7899 |
| 0.723399 | -183897 | -36.17 | | 183.897 | 36.17 |
| 0.731002 | -176668 | -36.5501 | | 176.668 | 36.5501 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *34 mm* | | | | | |
| $F_{u,fem}$ | 282.362 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -150144 | -0.5 | | 150.144 | 0.5 |
| 0.0125 | -173425 | -0.625 | | 173.425 | 0.625 |
| 0.015 | -176340 | -0.75 | | 176.34 | 0.75 |
| 0.0175 | -178678 | -0.875 | | 178.678 | 0.875 |
| 0.02 | -180617 | -1 | | 180.617 | 1 |
| 0.02375 | -182762 | -1.1875 | | 182.762 | 1.1875 |
| 0.0275 | -184633 | -1.375 | | 184.633 | 1.375 |
| 0.03125 | -186771 | -1.5625 | | 186.771 | 1.5625 |
| 0.036875 | -190299 | -1.84375 | | 190.299 | 1.84375 |
| 0.045313 | -196120 | -2.26563 | | 196.12 | 2.26563 |
| 0.057969 | -206849 | -2.89844 | | 206.849 | 2.89844 |
| 0.070625 | -216854 | -3.53125 | | 216.854 | 3.53125 |
| 0.073789 | -219239 | -3.68945 | | 219.239 | 3.68945 |
| 0.076953 | -221485 | -3.84766 | | 221.485 | 3.84766 |
| 0.081699 | -224585 | -4.08496 | | 224.585 | 4.08496 |
| 0.088818 | -228689 | -4.44092 | | 228.689 | 4.44092 |
| 0.091488 | -230194 | -4.5744 | | 230.194 | 4.5744 |
| 0.095493 | -232365 | -4.77463 | | 232.365 | 4.77463 |
| 0.101499 | -235394 | -5.07497 | | 235.394 | 5.07497 |
| 0.110509 | -239417 | -5.52547 | | 239.417 | 5.52547 |
| 0.124025 | -244699 | -6.20124 | | 244.699 | 6.20124 |
| 0.13754 | -249737 | -6.877 | | 249.737 | 6.877 |
| 0.151055 | -253673 | -7.55276 | | 253.673 | 7.55276 |
| 0.16457 | -256164 | -8.22852 | | 256.164 | 8.22852 |
| 0.178086 | -258185 | -8.90429 | | 258.185 | 8.90429 |
| 0.191601 | -259855 | -9.58005 | | 259.855 | 9.58005 |
| 0.211874 | -261470 | -10.5937 | | 261.47 | 10.5937 |
| 0.232147 | -262914 | -11.6073 | | 262.914 | 11.6073 |
| 0.25242 | -264149 | -12.621 | | 264.149 | 12.621 |
| 0.282829 | -266094 | -14.1414 | | 266.094 | 14.1414 |
| 0.328443 | -269238 | -16.4221 | | 269.238 | 16.4221 |
| 0.374057 | -273002 | -18.7028 | | 273.002 | 18.7028 |
| 0.419671 | -276307 | -20.9835 | | 276.307 | 20.9835 |
| 0.465285 | -279471 | -23.2642 | | 279.471 | 23.2642 |
| 0.476688 | -280282 | -23.8344 | | 280.282 | 23.8344 |
| 0.488092 | -281002 | -24.4046 | | 281.002 | 24.4046 |
| 0.505197 | -281909 | -25.2598 | | 281.909 | 25.2598 |
| 0.511611 | -282185 | -25.5806 | | 282.185 | 25.5806 |
| 0.521233 | -282299 | -26.0616 | | 282.299 | 26.0616 |
| 0.521834 | -282361 | -26.0917 | | 282.361 | 26.0917 |
| 0.522436 | -282362 | -26.1218 | | 282.362 | 26.1218 |
| 0.523037 | -282358 | -26.1519 | | 282.358 | 26.1519 |
| 0.523638 | -282348 | -26.1819 | | 282.348 | 26.1819 |
| 0.52454 | -282325 | -26.227 | | 282.325 | 26.227 |
| 0.525894 | -282275 | -26.2947 | | 282.275 | 26.2947 |
| 0.527923 | -282179 | -26.3962 | | 282.179 | 26.3962 |
| 0.530967 | -281966 | -26.5484 | | 281.966 | 26.5484 |
| 0.535534 | -281507 | -26.7767 | | 281.507 | 26.7767 |
| 0.542384 | -280463 | -27.1192 | | 280.463 | 27.1192 |
| 0.549234 | -279069 | -27.4617 | | 279.069 | 27.4617 |
| 0.556083 | -277392 | -27.8042 | | 277.392 | 27.8042 |
| 0.566358 | -273923 | -28.3179 | | 273.923 | 28.3179 |
| 0.568927 | -274049 | -28.4463 | | 274.049 | 28.4463 |
| 0.571496 | -273186 | -28.5748 | | 273.186 | 28.5748 |
| 0.575349 | -271695 | -28.7674 | | 271.695 | 28.7674 |
| 0.581128 | -269218 | -29.0564 | | 269.218 | 29.0564 |
| 0.586908 | -266892 | -29.3454 | | 266.892 | 29.3454 |
| 0.592687 | -264386 | -29.6344 | | 264.386 | 29.6344 |
| 0.601356 | -259751 | -30.0678 | | 259.751 | 30.0678 |
| 0.610026 | -255169 | -30.5013 | | 255.169 | 30.5013 |
| 0.618695 | -250072 | -30.9348 | | 250.072 | 30.9348 |
| 0.627364 | -244491 | -31.3682 | | 244.491 | 31.3682 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *35 mm* | | | | | |
| $F_{u,fem}$ | 278.708 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -149489 | -0.5 | | 149.489 | 0.5 |
| 0.0125 | -171272 | -0.625 | | 171.272 | 0.625 |
| 0.015 | -174093 | -0.75 | | 174.093 | 0.75 |
| 0.0175 | -176402 | -0.875 | | 176.402 | 0.875 |
| 0.02 | -178298 | -1 | | 178.298 | 1 |
| 0.02375 | -180419 | -1.1875 | | 180.419 | 1.1875 |
| 0.029375 | -183242 | -1.46875 | | 183.242 | 1.46875 |
| 0.037813 | -188376 | -1.89063 | | 188.376 | 1.89063 |
| 0.050469 | -197592 | -2.52344 | | 197.592 | 2.52344 |
| 0.053633 | -200681 | -2.68164 | | 200.681 | 2.68164 |
| 0.056797 | -203646 | -2.83984 | | 203.646 | 2.83984 |
| 0.061543 | -207793 | -3.07715 | | 207.793 | 3.07715 |
| 0.068662 | -213220 | -3.43311 | | 213.22 | 3.43311 |
| 0.079341 | -220352 | -3.96704 | | 220.352 | 3.96704 |
| 0.09002 | -226614 | -4.50098 | | 226.614 | 4.50098 |
| 0.100698 | -232107 | -5.03491 | | 232.107 | 5.03491 |
| 0.111377 | -236952 | -5.56885 | | 236.952 | 5.56885 |
| 0.122056 | -241198 | -6.10278 | | 241.198 | 6.10278 |
| 0.132734 | -245304 | -6.63672 | | 245.304 | 6.63672 |
| 0.143413 | -249152 | -7.17065 | | 249.152 | 7.17065 |
| 0.154092 | -252378 | -7.70459 | | 252.378 | 7.70459 |
| 0.164771 | -254701 | -8.23853 | | 254.701 | 8.23853 |
| 0.175449 | -256534 | -8.77246 | | 256.534 | 8.77246 |
| 0.191467 | -258759 | -9.57336 | | 258.759 | 9.57336 |
| 0.207485 | -260410 | -10.3743 | | 260.41 | 10.3743 |
| 0.223503 | -261723 | -11.1752 | | 261.723 | 11.1752 |
| 0.247531 | -263378 | -12.3765 | | 263.378 | 12.3765 |
| 0.283571 | -265389 | -14.1786 | | 265.389 | 14.1786 |
| 0.319612 | -268005 | -15.9806 | | 268.005 | 15.9806 |
| 0.355652 | -270392 | -17.7826 | | 270.392 | 17.7826 |
| 0.391693 | -273332 | -19.5847 | | 273.332 | 19.5847 |
| 0.445754 | -276690 | -22.2877 | | 276.69 | 22.2877 |
| 0.466027 | -277890 | -23.3013 | | 277.89 | 23.3013 |
| 0.473629 | -278281 | -23.6815 | | 278.281 | 23.6815 |
| 0.485033 | -278647 | -24.2516 | | 278.647 | 24.2516 |
| 0.489309 | -278708 | -24.4655 | | 278.708 | 24.4655 |
| 0.495724 | -278477 | -24.7862 | | 278.477 | 24.7862 |
| 0.502138 | -277948 | -25.1069 | | 277.948 | 25.1069 |
| 0.508552 | -277070 | -25.4276 | | 277.07 | 25.4276 |
| 0.514967 | -275842 | -25.7483 | | 275.842 | 25.7483 |
| 0.521381 | -274345 | -26.0691 | | 274.345 | 26.0691 |
| 0.531003 | -271266 | -26.5502 | | 271.266 | 26.5502 |
| 0.540625 | -267829 | -27.0312 | | 267.829 | 27.0312 |
| 0.550246 | -263896 | -27.5123 | | 263.896 | 27.5123 |
| 0.559868 | -259471 | -27.9934 | | 259.471 | 27.9934 |
| 0.56949 | -254514 | -28.4745 | | 254.514 | 28.4745 |
| 0.579112 | -248979 | -28.9556 | | 248.979 | 28.9556 |
| 0.588733 | -242874 | -29.4367 | | 242.874 | 29.4367 |
| 0.598355 | -236268 | -29.9177 | | 236.268 | 29.9177 |
| 0.607977 | -229178 | -30.3988 | | 229.178 | 30.3988 |
| 0.617598 | -221601 | -30.8799 | | 221.601 | 30.8799 |
| 0.62722 | -213579 | -31.361 | | 213.579 | 31.361 |
| 0.636842 | -205135 | -31.8421 | | 205.135 | 31.8421 |
| 0.646463 | -196366 | -32.3232 | | 196.366 | 32.3232 |
| 0.656085 | -187382 | -32.8043 | | 187.382 | 32.8043 |
| 0.665707 | -178170 | -33.2853 | | 178.17 | 33.2853 |
| 0.675328 | -169092 | -33.7664 | | 169.092 | 33.7664 |
| 0.68495 | -160541 | -34.2475 | | 160.541 | 34.2475 |
| 0.694572 | -152373 | -34.7286 | | 152.373 | 34.7286 |
| 0.696977 | -156034 | -34.8489 | | 156.034 | 34.8489 |
| 0.699383 | -153728 | -34.9691 | | 153.728 | 34.9691 |
| 0.701788 | -151945 | -35.0894 | | 151.945 | 35.0894 |

| **S235** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *36 mm* | | | | | |
| $F_{u,fem}$ | 274.93 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -148800 | -0.5 | | 148.8 | 0.5 |
| 0.0125 | -169124 | -0.625 | | 169.124 | 0.625 |
| 0.015 | -171856 | -0.75 | | 171.856 | 0.75 |
| 0.0175 | -174132 | -0.875 | | 174.132 | 0.875 |
| 0.02 | -175994 | -1 | | 175.994 | 1 |
| 0.02375 | -178095 | -1.1875 | | 178.095 | 1.1875 |
| 0.029375 | -180874 | -1.46875 | | 180.874 | 1.46875 |
| 0.037813 | -185952 | -1.89063 | | 185.952 | 1.89063 |
| 0.050469 | -195044 | -2.52344 | | 195.044 | 2.52344 |
| 0.053633 | -198119 | -2.68164 | | 198.119 | 2.68164 |
| 0.056797 | -201087 | -2.83984 | | 201.087 | 2.83984 |
| 0.061543 | -205202 | -3.07715 | | 205.202 | 3.07715 |
| 0.068662 | -210671 | -3.43311 | | 210.671 | 3.43311 |
| 0.079341 | -217760 | -3.96704 | | 217.76 | 3.96704 |
| 0.083345 | -220301 | -4.16727 | | 220.301 | 4.16727 |
| 0.089352 | -223731 | -4.46761 | | 223.731 | 4.46761 |
| 0.098362 | -228332 | -4.91811 | | 228.332 | 4.91811 |
| 0.111878 | -234366 | -5.59388 | | 234.366 | 5.59388 |
| 0.116946 | -236432 | -5.84729 | | 236.432 | 5.84729 |
| 0.124548 | -239345 | -6.2274 | | 239.345 | 6.2274 |
| 0.135952 | -243622 | -6.79758 | | 243.622 | 6.79758 |
| 0.153057 | -249505 | -7.65284 | | 249.505 | 7.65284 |
| 0.170162 | -253902 | -8.5081 | | 253.902 | 8.5081 |
| 0.187267 | -256796 | -9.36336 | | 256.796 | 9.36336 |
| 0.204372 | -259042 | -10.2186 | | 259.042 | 10.2186 |
| 0.23003 | -261362 | -11.5015 | | 261.362 | 11.5015 |
| 0.255688 | -263251 | -12.7844 | | 263.251 | 12.7844 |
| 0.281346 | -264794 | -14.0673 | | 264.794 | 14.0673 |
| 0.319833 | -267171 | -15.9916 | | 267.171 | 15.9916 |
| 0.35832 | -269539 | -17.916 | | 269.539 | 17.916 |
| 0.396806 | -272215 | -19.8403 | | 272.215 | 19.8403 |
| 0.435293 | -274527 | -21.7647 | | 274.527 | 21.7647 |
| 0.444915 | -274930 | -22.2457 | | 274.93 | 22.2457 |
| 0.459347 | -274556 | -22.9674 | | 274.556 | 22.9674 |
| 0.462955 | -274456 | -23.1478 | | 274.456 | 23.1478 |
| 0.466564 | -274066 | -23.3282 | | 274.066 | 23.3282 |
| 0.470172 | -273573 | -23.5086 | | 273.573 | 23.5086 |
| 0.47378 | -272957 | -23.689 | | 272.957 | 23.689 |
| 0.479192 | -271788 | -23.9596 | | 271.788 | 23.9596 |
| 0.48731 | -269544 | -24.3655 | | 269.544 | 24.3655 |
| 0.495429 | -267043 | -24.7714 | | 267.043 | 24.7714 |
| 0.503547 | -264126 | -25.1773 | | 264.126 | 25.1773 |
| 0.511665 | -260871 | -25.5833 | | 260.871 | 25.5833 |
| 0.519784 | -257240 | -25.9892 | | 257.24 | 25.9892 |
| 0.527902 | -253249 | -26.3951 | | 253.249 | 26.3951 |
| 0.53602 | -248839 | -26.801 | | 248.839 | 26.801 |
| 0.544138 | -244038 | -27.2069 | | 244.038 | 27.2069 |
| 0.552257 | -238834 | -27.6128 | | 238.834 | 27.6128 |
| 0.560375 | -233316 | -28.0188 | | 233.316 | 28.0188 |
| 0.568493 | -227464 | -28.4247 | | 227.464 | 28.4247 |
| 0.576612 | -221268 | -28.8306 | | 221.268 | 28.8306 |
| 0.58473 | -214715 | -29.2365 | | 214.715 | 29.2365 |
| 0.592848 | -207892 | -29.6424 | | 207.892 | 29.6424 |
| 0.600967 | -200808 | -30.0483 | | 200.808 | 30.0483 |
| 0.609085 | -193511 | -30.4542 | | 193.511 | 30.4542 |
| 0.611114 | -194682 | -30.5557 | | 194.682 | 30.5557 |
| 0.613144 | -192696 | -30.6572 | | 192.696 | 30.6572 |
| 0.616188 | -189462 | -30.8094 | | 189.462 | 30.8094 |
| 0.620755 | -184480 | -31.0377 | | 184.48 | 31.0377 |
| 0.627605 | -176925 | -31.3802 | | 176.925 | 31.3802 |
| 0.634455 | -170687 | -31.7227 | | 170.687 | 31.7227 |
| 0.641304 | -164611 | -32.0652 | | 164.611 | 32.0652 |

| **S235** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *37 mm* | | | | | |
| $F_{u,fem}$ | 271.183 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -148068 | -0.5 | | 148.068 | 0.5 |
| 0.010625 | -156230 | -0.53125 | | 156.23 | 0.53125 |
| 0.01125 | -163320 | -0.5625 | | 163.32 | 0.5625 |
| 0.012188 | -166525 | -0.60938 | | 166.525 | 0.609375 |
| 0.013594 | -168322 | -0.67969 | | 168.322 | 0.679688 |
| 0.015703 | -170242 | -0.78516 | | 170.242 | 0.785156 |
| 0.018867 | -172888 | -0.94336 | | 172.888 | 0.943359 |
| 0.023613 | -175628 | -1.18066 | | 175.628 | 1.18066 |
| 0.028359 | -177996 | -1.41797 | | 177.996 | 1.41797 |
| 0.033106 | -180662 | -1.65527 | | 180.662 | 1.65527 |
| 0.040225 | -185179 | -2.01123 | | 185.179 | 2.01123 |
| 0.050903 | -192947 | -2.54517 | | 192.947 | 2.54517 |
| 0.054908 | -196709 | -2.74539 | | 196.709 | 2.74539 |
| 0.060915 | -202038 | -3.04573 | | 202.038 | 3.04573 |
| 0.069925 | -208891 | -3.49624 | | 208.891 | 3.49624 |
| 0.08344 | -217619 | -4.172 | | 217.619 | 4.172 |
| 0.096955 | -224793 | -4.84776 | | 224.793 | 4.84776 |
| 0.100334 | -226495 | -5.0167 | | 226.495 | 5.0167 |
| 0.103713 | -228117 | -5.18564 | | 228.117 | 5.18564 |
| 0.108781 | -230354 | -5.43905 | | 230.354 | 5.43905 |
| 0.116383 | -233416 | -5.81917 | | 233.416 | 5.81917 |
| 0.127787 | -237631 | -6.38935 | | 237.631 | 6.38935 |
| 0.144892 | -243814 | -7.24461 | | 243.814 | 7.24461 |
| 0.161997 | -249471 | -8.09987 | | 249.471 | 8.09987 |
| 0.179103 | -253707 | -8.95513 | | 253.707 | 8.95513 |
| 0.196208 | -256514 | -9.81039 | | 256.514 | 9.81039 |
| 0.221866 | -259511 | -11.0933 | | 259.511 | 11.0933 |
| 0.247524 | -261794 | -12.3762 | | 261.794 | 12.3762 |
| 0.273181 | -263630 | -13.6591 | | 263.63 | 13.6591 |
| 0.298839 | -265047 | -14.942 | | 265.047 | 14.942 |
| 0.337326 | -267279 | -16.8663 | | 267.279 | 16.8663 |
| 0.375813 | -269343 | -18.7906 | | 269.343 | 18.7906 |
| 0.4143 | -271180 | -20.715 | | 271.18 | 20.715 |
| 0.423921 | -271183 | -21.1961 | | 271.183 | 21.1961 |
| 0.426327 | -271140 | -21.3163 | | 271.14 | 21.3163 |
| 0.428732 | -270983 | -21.4366 | | 270.983 | 21.4366 |
| 0.431137 | -270783 | -21.5569 | | 270.783 | 21.5569 |
| 0.434746 | -270373 | -21.7373 | | 270.373 | 21.7373 |
| 0.440158 | -269516 | -22.0079 | | 269.516 | 22.0079 |
| 0.448276 | -267682 | -22.4138 | | 267.682 | 22.4138 |
| 0.456394 | -265396 | -22.8197 | | 265.396 | 22.8197 |
| 0.464513 | -262668 | -23.2256 | | 262.668 | 23.2256 |
| 0.472631 | -259439 | -23.6316 | | 259.439 | 23.6316 |
| 0.480749 | -255805 | -24.0375 | | 255.805 | 24.0375 |
| 0.488868 | -251770 | -24.4434 | | 251.77 | 24.4434 |
| 0.496986 | -247346 | -24.8493 | | 247.346 | 24.8493 |
| 0.505104 | -242505 | -25.2552 | | 242.505 | 25.2552 |
| 0.513223 | -237287 | -25.6611 | | 237.287 | 25.6611 |
| 0.521341 | -231705 | -26.067 | | 231.705 | 26.067 |
| 0.529459 | -225825 | -26.473 | | 225.825 | 26.473 |
| 0.537577 | -219604 | -26.8789 | | 219.604 | 26.8789 |
| 0.545696 | -213112 | -27.2848 | | 213.112 | 27.2848 |
| 0.553814 | -206333 | -27.6907 | | 206.333 | 27.6907 |
| 0.561932 | -199296 | -28.0966 | | 199.296 | 28.0966 |
| 0.570051 | -192019 | -28.5025 | | 192.019 | 28.5025 |
| 0.578169 | -184626 | -28.9084 | | 184.626 | 28.9084 |
| 0.586287 | -177043 | -29.3144 | | 177.043 | 29.3144 |
| 0.594406 | -169404 | -29.7203 | | 169.404 | 29.7203 |
| 0.602524 | -161993 | -30.1262 | | 161.993 | 30.1262 |
| 0.610642 | -154966 | -30.5321 | | 154.966 | 30.5321 |
| 0.61876 | -148227 | -30.938 | | 148.227 | 30.938 |
| 0.621805 | -149784 | -31.0902 | | 149.784 | 31.0902 |

| **S235** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *38 mm* | | | | | |
| $F_{u,fem}$ | 267.884 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -147314 | -0.5 | | 147.314 | 0.5 |
| 0.010625 | -155292 | -0.53125 | | 155.292 | 0.53125 |
| 0.01125 | -161917 | -0.5625 | | 161.917 | 0.5625 |
| 0.012188 | -164403 | -0.60938 | | 164.403 | 0.609375 |
| 0.013125 | -165639 | -0.65625 | | 165.639 | 0.65625 |
| 0.014063 | -166582 | -0.70313 | | 166.582 | 0.703125 |
| 0.015469 | -167816 | -0.77344 | | 167.816 | 0.773438 |
| 0.017578 | -169651 | -0.87891 | | 169.651 | 0.878906 |
| 0.020742 | -171815 | -1.03711 | | 171.815 | 1.03711 |
| 0.025488 | -174252 | -1.27441 | | 174.252 | 1.27441 |
| 0.032607 | -177940 | -1.63037 | | 177.94 | 1.63037 |
| 0.043286 | -184649 | -2.16431 | | 184.649 | 2.16431 |
| 0.059304 | -197646 | -2.96521 | | 197.646 | 2.96521 |
| 0.075322 | -209963 | -3.76611 | | 209.963 | 3.76611 |
| 0.079327 | -212666 | -3.96634 | | 212.666 | 3.96634 |
| 0.083331 | -215125 | -4.16656 | | 215.125 | 4.16656 |
| 0.089338 | -218460 | -4.4669 | | 218.46 | 4.4669 |
| 0.098348 | -222945 | -4.91741 | | 222.945 | 4.91741 |
| 0.111863 | -228782 | -5.59317 | | 228.782 | 5.59317 |
| 0.132136 | -236236 | -6.60682 | | 236.236 | 6.60682 |
| 0.137205 | -238139 | -6.86023 | | 238.139 | 6.86023 |
| 0.142273 | -239942 | -7.11364 | | 239.942 | 7.11364 |
| 0.149875 | -242617 | -7.49375 | | 242.617 | 7.49375 |
| 0.161279 | -246483 | -8.06393 | | 246.483 | 8.06393 |
| 0.178384 | -251241 | -8.91919 | | 251.241 | 8.91919 |
| 0.195489 | -254588 | -9.77445 | | 254.588 | 9.77445 |
| 0.212594 | -257029 | -10.6297 | | 257.029 | 10.6297 |
| 0.238252 | -259710 | -11.9126 | | 259.71 | 11.9126 |
| 0.276739 | -262797 | -13.8369 | | 262.797 | 13.8369 |
| 0.334469 | -265879 | -16.7235 | | 265.879 | 16.7235 |
| 0.348902 | -266666 | -17.4451 | | 266.666 | 17.4451 |
| 0.363334 | -267344 | -18.1667 | | 267.344 | 18.1667 |
| 0.368746 | -267592 | -18.4373 | | 267.592 | 18.4373 |
| 0.376865 | -267884 | -18.8432 | | 267.884 | 18.8432 |
| 0.389042 | -267762 | -19.4521 | | 267.762 | 19.4521 |
| 0.40122 | -266330 | -20.061 | | 266.33 | 20.061 |
| 0.413397 | -263609 | -20.6698 | | 263.609 | 20.6698 |
| 0.425574 | -259859 | -21.2787 | | 259.859 | 21.2787 |
| 0.428619 | -259900 | -21.4309 | | 259.9 | 21.4309 |
| 0.431663 | -258888 | -21.5832 | | 258.888 | 21.5832 |
| 0.43623 | -257110 | -21.8115 | | 257.11 | 21.8115 |
| 0.44308 | -254119 | -22.154 | | 254.119 | 22.154 |
| 0.449929 | -251192 | -22.4965 | | 251.192 | 22.4965 |
| 0.456779 | -248004 | -22.839 | | 248.004 | 22.839 |
| 0.467054 | -241964 | -23.3527 | | 241.964 | 23.3527 |
| 0.477329 | -235799 | -23.8664 | | 235.799 | 23.8664 |
| 0.487603 | -228929 | -24.3802 | | 228.929 | 24.3802 |
| 0.497878 | -221439 | -24.8939 | | 221.439 | 24.8939 |
| 0.508153 | -213335 | -25.4076 | | 213.335 | 25.4076 |
| 0.518428 | -204694 | -25.9214 | | 204.694 | 25.9214 |
| 0.528702 | -195629 | -26.4351 | | 195.629 | 26.4351 |
| 0.538977 | -186249 | -26.9488 | | 186.249 | 26.9488 |
| 0.549252 | -176595 | -27.4626 | | 176.595 | 27.4626 |
| 0.559526 | -166895 | -27.9763 | | 166.895 | 27.9763 |
| 0.569801 | -157755 | -28.4901 | | 157.755 | 28.4901 |
| 0.580076 | -149030 | -29.0038 | | 149.03 | 29.0038 |
| 0.582645 | -152565 | -29.1322 | | 152.565 | 29.1322 |
| 0.585213 | -150188 | -29.2607 | | 150.188 | 29.2607 |
| 0.589066 | -146377 | -29.4533 | | 146.377 | 29.4533 |
| 0.592919 | -143686 | -29.646 | | 143.686 | 29.646 |
| 0.596772 | -141042 | -29.8386 | | 141.042 | 29.8386 |
| 0.602552 | -135841 | -30.1276 | | 135.841 | 30.1276 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *39 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 264.318 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -146510 | -0.5 | | 146.51 | 0.5 |
| 0.010625 | -154287 | -0.53125 | | 154.287 | 0.53125 |
| 0.01125 | -160190 | -0.5625 | | 160.19 | 0.5625 |
| 0.012188 | -162253 | -0.60938 | | 162.253 | 0.609375 |
| 0.013125 | -163432 | -0.65625 | | 163.432 | 0.65625 |
| 0.014063 | -164346 | -0.70313 | | 164.346 | 0.703125 |
| 0.015469 | -165567 | -0.77344 | | 165.567 | 0.773438 |
| 0.017578 | -167377 | -0.87891 | | 167.377 | 0.878906 |
| 0.020742 | -169488 | -1.03711 | | 169.488 | 1.03711 |
| 0.025488 | -171892 | -1.27441 | | 171.892 | 1.27441 |
| 0.032607 | -175552 | -1.63037 | | 175.552 | 1.63037 |
| 0.043286 | -182224 | -2.16431 | | 182.224 | 2.16431 |
| 0.053965 | -190519 | -2.69824 | | 190.519 | 2.69824 |
| 0.064644 | -199716 | -3.23218 | | 199.716 | 3.23218 |
| 0.075322 | -207428 | -3.76611 | | 207.428 | 3.76611 |
| 0.086001 | -213922 | -4.30005 | | 213.922 | 4.30005 |
| 0.09668 | -219422 | -4.83398 | | 219.422 | 4.83398 |
| 0.107358 | -224183 | -5.36792 | | 224.183 | 5.36792 |
| 0.111363 | -225788 | -5.56815 | | 225.788 | 5.56815 |
| 0.11737 | -228091 | -5.86848 | | 228.091 | 5.86848 |
| 0.12638 | -231395 | -6.31899 | | 231.395 | 6.31899 |
| 0.139895 | -236084 | -6.99475 | | 236.084 | 6.99475 |
| 0.160168 | -243043 | -8.0084 | | 243.043 | 8.0084 |
| 0.180441 | -248964 | -9.02204 | | 248.964 | 9.02204 |
| 0.200714 | -253249 | -10.0357 | | 253.249 | 10.0357 |
| 0.220987 | -256211 | -11.0493 | | 256.211 | 11.0493 |
| 0.241259 | -258453 | -12.063 | | 258.453 | 12.063 |
| 0.271669 | -260972 | -13.5834 | | 260.972 | 13.5834 |
| 0.317283 | -263687 | -15.8641 | | 263.687 | 15.8641 |
| 0.328686 | -264160 | -16.4343 | | 264.16 | 16.4343 |
| 0.334388 | -264318 | -16.7194 | | 264.318 | 16.7194 |
| 0.342941 | -264150 | -17.147 | | 264.15 | 17.147 |
| 0.351493 | -263348 | -17.5747 | | 263.348 | 17.5747 |
| 0.360046 | -261920 | -18.0023 | | 261.92 | 18.0023 |
| 0.368598 | -259932 | -18.4299 | | 259.932 | 18.4299 |
| 0.377151 | -257484 | -18.8575 | | 257.484 | 18.8575 |
| 0.385704 | -254535 | -19.2852 | | 254.535 | 19.2852 |
| 0.394256 | -251119 | -19.7128 | | 251.119 | 19.7128 |
| 0.402809 | -247278 | -20.1404 | | 247.278 | 20.1404 |
| 0.411361 | -243007 | -20.5681 | | 243.007 | 20.5681 |
| 0.419914 | -238279 | -20.9957 | | 238.279 | 20.9957 |
| 0.428467 | -233129 | -21.4233 | | 233.129 | 21.4233 |
| 0.437019 | -227576 | -21.851 | | 227.576 | 21.851 |
| 0.445572 | -221649 | -22.2786 | | 221.649 | 22.2786 |
| 0.454125 | -215355 | -22.7062 | | 215.355 | 22.7062 |
| 0.462677 | -208662 | -23.1339 | | 208.662 | 23.1339 |
| 0.47123 | -201667 | -23.5615 | | 201.667 | 23.5615 |
| 0.479782 | -194380 | -23.9891 | | 194.38 | 23.9891 |
| 0.488335 | -186841 | -24.4167 | | 186.841 | 24.4167 |
| 0.496888 | -179086 | -24.8444 | | 179.086 | 24.8444 |
| 0.50544 | -171263 | -25.272 | | 171.263 | 25.272 |
| 0.513993 | -163523 | -25.6996 | | 163.523 | 25.6996 |
| 0.522545 | -156174 | -26.1273 | | 156.174 | 26.1273 |
| 0.531098 | -149195 | -26.5549 | | 149.195 | 26.5549 |
| 0.539651 | -142528 | -26.9825 | | 142.528 | 26.9825 |
| 0.548203 | -136465 | -27.4102 | | 136.465 | 27.4102 |
| 0.556756 | -130974 | -27.8378 | | 130.974 | 27.8378 |
| 0.565309 | -125935 | -28.2654 | | 125.935 | 28.2654 |
| 0.573861 | -121280 | -28.6931 | | 121.28 | 28.6931 |
| 0.58669 | -111841 | -29.3345 | | 111.841 | 29.3345 |
| 0.605933 | -99109.4 | -30.2967 | | 99.1094 | 30.2967 |
| 0.610744 | -109240 | -30.5372 | | 109.24 | 30.5372 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *40 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 260.548 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -145657 | -0.5 | | 145.657 | 0.5 |
| 0.010625 | -153212 | -0.53125 | | 153.212 | 0.53125 |
| 0.01125 | -158239 | -0.5625 | | 158.239 | 0.5625 |
| 0.011875 | -159614 | -0.59375 | | 159.614 | 0.59375 |
| 0.0125 | -160510 | -0.625 | | 160.51 | 0.625 |
| 0.013438 | -161530 | -0.67188 | | 161.53 | 0.671875 |
| 0.014844 | -162748 | -0.74219 | | 162.748 | 0.742188 |
| 0.016953 | -164556 | -0.84766 | | 164.556 | 0.847656 |
| 0.020117 | -166776 | -1.00586 | | 166.776 | 1.00586 |
| 0.024863 | -169253 | -1.24316 | | 169.253 | 1.24316 |
| 0.031982 | -172795 | -1.59912 | | 172.795 | 1.59912 |
| 0.042661 | -179336 | -2.13306 | | 179.336 | 2.13306 |
| 0.05334 | -187380 | -2.66699 | | 187.38 | 2.66699 |
| 0.064019 | -196657 | -3.20093 | | 196.657 | 3.20093 |
| 0.074697 | -204473 | -3.73486 | | 204.473 | 3.73486 |
| 0.077367 | -206282 | -3.86835 | | 206.282 | 3.86835 |
| 0.080037 | -207978 | -4.00183 | | 207.978 | 4.00183 |
| 0.084041 | -210296 | -4.20206 | | 210.296 | 4.20206 |
| 0.090048 | -213467 | -4.5024 | | 213.467 | 4.5024 |
| 0.099058 | -217795 | -4.9529 | | 217.795 | 4.9529 |
| 0.112573 | -223329 | -5.62867 | | 223.329 | 5.62867 |
| 0.126089 | -228288 | -6.30443 | | 228.288 | 6.30443 |
| 0.139604 | -232914 | -6.98019 | | 232.914 | 6.98019 |
| 0.153119 | -237500 | -7.65595 | | 237.5 | 7.65595 |
| 0.166634 | -242021 | -8.33171 | | 242.021 | 8.33171 |
| 0.186907 | -247622 | -9.34536 | | 247.622 | 9.34536 |
| 0.217316 | -253473 | -10.8658 | | 253.473 | 10.8658 |
| 0.247726 | -256988 | -12.3863 | | 256.988 | 12.3863 |
| 0.278135 | -259411 | -13.9068 | | 259.411 | 13.9068 |
| 0.285737 | -259947 | -14.2869 | | 259.947 | 14.2869 |
| 0.297141 | -260548 | -14.857 | | 260.548 | 14.857 |
| 0.314246 | -259973 | -15.7123 | | 259.973 | 15.7123 |
| 0.318522 | -259631 | -15.9261 | | 259.631 | 15.9261 |
| 0.322799 | -258972 | -16.1399 | | 258.972 | 16.1399 |
| 0.327075 | -258149 | -16.3538 | | 258.149 | 16.3538 |
| 0.331351 | -257188 | -16.5676 | | 257.188 | 16.5676 |
| 0.337766 | -255423 | -16.8883 | | 255.423 | 16.8883 |
| 0.347387 | -252032 | -17.3694 | | 252.032 | 17.3694 |
| 0.357009 | -247987 | -17.8505 | | 247.987 | 17.8505 |
| 0.359415 | -247933 | -17.9707 | | 247.933 | 17.9707 |
| 0.36182 | -246844 | -18.091 | | 246.844 | 18.091 |
| 0.365428 | -244991 | -18.2714 | | 244.991 | 18.2714 |
| 0.37084 | -241982 | -18.542 | | 241.982 | 18.542 |
| 0.376253 | -239090 | -18.8126 | | 239.09 | 18.8126 |
| 0.381665 | -236018 | -19.0832 | | 236.018 | 19.0832 |
| 0.389783 | -230434 | -19.4892 | | 230.434 | 19.4892 |
| 0.397901 | -225088 | -19.8951 | | 225.088 | 19.8951 |
| 0.40602 | -219423 | -20.301 | | 219.423 | 20.301 |
| 0.414138 | -213433 | -20.7069 | | 213.433 | 20.7069 |
| 0.422256 | -207175 | -21.1128 | | 207.175 | 21.1128 |
| 0.430375 | -200624 | -21.5187 | | 200.624 | 21.5187 |
| 0.438493 | -193803 | -21.9246 | | 193.803 | 21.9246 |
| 0.446611 | -186730 | -22.3306 | | 186.73 | 22.3306 |
| 0.454729 | -179527 | -22.7365 | | 179.527 | 22.7365 |
| 0.462848 | -172132 | -23.1424 | | 172.132 | 23.1424 |
| 0.470966 | -164656 | -23.5483 | | 164.656 | 23.5483 |
| 0.479084 | -157372 | -23.9542 | | 157.372 | 23.9542 |
| 0.487203 | -150466 | -24.3601 | | 150.466 | 24.3601 |
| 0.495321 | -143846 | -24.7661 | | 143.846 | 24.7661 |
| 0.498365 | -145168 | -24.9183 | | 145.168 | 24.9183 |
| 0.502932 | -140329 | -25.1466 | | 140.329 | 25.1466 |
| 0.507498 | -137153 | -25.3749 | | 137.153 | 25.3749 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *41 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 257.069 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -144778 | -0.5 | | 144.778 | 0.5 |
| 0.010625 | -152084 | -0.53125 | | 152.084 | 0.53125 |
| 0.01125 | -156259 | -0.5625 | | 156.259 | 0.5625 |
| 0.011875 | -157504 | -0.59375 | | 157.504 | 0.59375 |
| 0.012813 | -158705 | -0.64063 | | 158.705 | 0.640625 |
| 0.014219 | -160006 | -0.71094 | | 160.006 | 0.710938 |
| 0.016328 | -161786 | -0.81641 | | 161.786 | 0.816406 |
| 0.019492 | -164107 | -0.97461 | | 164.107 | 0.974609 |
| 0.024238 | -166628 | -1.21191 | | 166.628 | 1.21191 |
| 0.031357 | -170105 | -1.56787 | | 170.105 | 1.56787 |
| 0.042036 | -176507 | -2.10181 | | 176.507 | 2.10181 |
| 0.052715 | -184309 | -2.63574 | | 184.309 | 2.63574 |
| 0.055385 | -186768 | -2.76923 | | 186.768 | 2.76923 |
| 0.058054 | -189226 | -2.90271 | | 189.226 | 2.90271 |
| 0.062059 | -192667 | -3.10294 | | 192.667 | 3.10294 |
| 0.068066 | -197423 | -3.40327 | | 197.423 | 3.40327 |
| 0.077076 | -203488 | -3.85378 | | 203.488 | 3.85378 |
| 0.086086 | -208706 | -4.30429 | | 208.706 | 4.30429 |
| 0.095096 | -213239 | -4.7548 | | 213.239 | 4.7548 |
| 0.104106 | -217269 | -5.20531 | | 217.269 | 5.20531 |
| 0.107485 | -218644 | -5.37425 | | 218.644 | 5.37425 |
| 0.112553 | -220579 | -5.62766 | | 220.579 | 5.62766 |
| 0.120155 | -223339 | -6.00777 | | 223.339 | 6.00777 |
| 0.131559 | -227269 | -6.57795 | | 227.269 | 6.57795 |
| 0.148664 | -232931 | -7.43321 | | 232.931 | 7.43321 |
| 0.165769 | -238613 | -8.28847 | | 238.613 | 8.28847 |
| 0.182875 | -243549 | -9.14373 | | 243.549 | 9.14373 |
| 0.208533 | -249302 | -10.4266 | | 249.302 | 10.4266 |
| 0.23419 | -253153 | -11.7095 | | 253.153 | 11.7095 |
| 0.259848 | -255692 | -12.9924 | | 255.692 | 12.9924 |
| 0.285506 | -257069 | -14.2753 | | 257.069 | 14.2753 |
| 0.291921 | -257049 | -14.596 | | 257.049 | 14.596 |
| 0.298335 | -256569 | -14.9167 | | 256.569 | 14.9167 |
| 0.304749 | -255738 | -15.2375 | | 255.738 | 15.2375 |
| 0.311164 | -254554 | -15.5582 | | 254.554 | 15.5582 |
| 0.317578 | -253091 | -15.8789 | | 253.091 | 15.8789 |
| 0.3272 | -250147 | -16.36 | | 250.147 | 16.36 |
| 0.336822 | -246728 | -16.8411 | | 246.728 | 16.8411 |
| 0.346443 | -242696 | -17.3222 | | 242.696 | 17.3222 |
| 0.356065 | -238091 | -17.8033 | | 238.091 | 17.8033 |
| 0.365687 | -232907 | -18.2843 | | 232.907 | 18.2843 |
| 0.375309 | -227132 | -18.7654 | | 227.132 | 18.7654 |
| 0.38493 | -220826 | -19.2465 | | 220.826 | 19.2465 |
| 0.394552 | -214049 | -19.7276 | | 214.049 | 19.7276 |
| 0.404174 | -206790 | -20.2087 | | 206.79 | 20.2087 |
| 0.413795 | -199073 | -20.6898 | | 199.073 | 20.6898 |
| 0.423417 | -190968 | -21.1708 | | 190.968 | 21.1708 |
| 0.433039 | -182525 | -21.6519 | | 182.525 | 21.6519 |
| 0.44266 | -173809 | -22.133 | | 173.809 | 22.133 |
| 0.452282 | -165021 | -22.6141 | | 165.021 | 22.6141 |
| 0.461904 | -156504 | -23.0952 | | 156.504 | 23.0952 |
| 0.471525 | -148478 | -23.5763 | | 148.478 | 23.5763 |
| 0.481147 | -140824 | -24.0574 | | 140.824 | 24.0574 |
| 0.483553 | -143932 | -24.1776 | | 143.932 | 24.1776 |
| 0.485958 | -141848 | -24.2979 | | 141.848 | 24.2979 |
| 0.489566 | -138516 | -24.4783 | | 138.516 | 24.4783 |
| 0.493174 | -136139 | -24.6587 | | 136.139 | 24.6587 |
| 0.496782 | -133793 | -24.8391 | | 133.793 | 24.8391 |
| 0.502195 | -129178 | -25.1097 | | 129.178 | 25.1097 |
| 0.510313 | -122735 | -25.5156 | | 122.735 | 25.5156 |
| 0.52249 | -113802 | -26.1245 | | 113.802 | 26.1245 |
| 0.534668 | -108278 | -26.7334 | | 108.278 | 26.7334 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *42 mm* | | | | | |
| $F_{u,fem}$ | 253.771 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -143844 | -0.5 | | 143.844 | 0.5 |
| 0.010625 | -150867 | -0.53125 | | 150.867 | 0.53125 |
| 0.01125 | -154253 | -0.5625 | | 154.253 | 0.5625 |
| 0.011875 | -155394 | -0.59375 | | 155.394 | 0.59375 |
| 0.012813 | -156537 | -0.64063 | | 156.537 | 0.640625 |
| 0.014219 | -157795 | -0.71094 | | 157.795 | 0.710938 |
| 0.016328 | -159522 | -0.81641 | | 159.522 | 0.816406 |
| 0.019492 | -161795 | -0.97461 | | 161.795 | 0.974609 |
| 0.024238 | -164336 | -1.21191 | | 164.336 | 1.21191 |
| 0.031357 | -167757 | -1.56787 | | 167.757 | 1.56787 |
| 0.042036 | -174086 | -2.10181 | | 174.086 | 2.10181 |
| 0.052715 | -181768 | -2.63574 | | 181.768 | 2.63574 |
| 0.063394 | -190902 | -3.16968 | | 190.902 | 3.16968 |
| 0.074072 | -198921 | -3.70361 | | 198.921 | 3.70361 |
| 0.084751 | -205375 | -4.23755 | | 205.375 | 4.23755 |
| 0.09543 | -210720 | -4.77148 | | 210.72 | 4.77148 |
| 0.099434 | -212568 | -4.97171 | | 212.568 | 4.97171 |
| 0.105441 | -215059 | -5.27205 | | 215.059 | 5.27205 |
| 0.114451 | -218422 | -5.72256 | | 218.422 | 5.72256 |
| 0.127966 | -223089 | -6.39832 | | 223.089 | 6.39832 |
| 0.141482 | -227481 | -7.07408 | | 227.481 | 7.07408 |
| 0.154997 | -231932 | -7.74984 | | 231.932 | 7.74984 |
| 0.17527 | -238292 | -8.76349 | | 238.292 | 8.76349 |
| 0.205679 | -245627 | -10.284 | | 245.627 | 10.284 |
| 0.251293 | -252056 | -12.5646 | | 252.056 | 12.5646 |
| 0.254144 | -252352 | -12.7072 | | 252.352 | 12.7072 |
| 0.256995 | -252622 | -12.8497 | | 252.622 | 12.8497 |
| 0.259846 | -252875 | -12.9923 | | 252.875 | 12.9923 |
| 0.264122 | -253213 | -13.2061 | | 253.213 | 13.2061 |
| 0.270536 | -253588 | -13.5268 | | 253.588 | 13.5268 |
| 0.280158 | -253771 | -14.0079 | | 253.771 | 14.0079 |
| 0.28978 | -253121 | -14.489 | | 253.121 | 14.489 |
| 0.299401 | -251545 | -14.9701 | | 251.545 | 14.9701 |
| 0.309023 | -249176 | -15.4512 | | 249.176 | 15.4512 |
| 0.318645 | -246174 | -15.9322 | | 246.174 | 15.9322 |
| 0.328267 | -242461 | -16.4133 | | 242.461 | 16.4133 |
| 0.337888 | -238057 | -16.8944 | | 238.057 | 16.8944 |
| 0.34751 | -232973 | -17.3755 | | 232.973 | 17.3755 |
| 0.357132 | -227224 | -17.8566 | | 227.224 | 17.8566 |
| 0.366753 | -220873 | -18.3377 | | 220.873 | 18.3377 |
| 0.376375 | -214029 | -18.8187 | | 214.029 | 18.8187 |
| 0.385997 | -206745 | -19.2998 | | 206.745 | 19.2998 |
| 0.395618 | -198994 | -19.7809 | | 198.994 | 19.7809 |
| 0.40524 | -190827 | -20.262 | | 190.827 | 20.262 |
| 0.414862 | -182318 | -20.7431 | | 182.318 | 20.7431 |
| 0.424483 | -173568 | -21.2242 | | 173.568 | 21.2242 |
| 0.434105 | -164620 | -21.7053 | | 164.62 | 21.7053 |
| 0.443727 | -155838 | -22.1863 | | 155.838 | 22.1863 |
| 0.453349 | -147558 | -22.6674 | | 147.558 | 22.6674 |
| 0.455754 | -150179 | -22.7877 | | 150.179 | 22.7877 |
| 0.458159 | -147979 | -22.908 | | 147.979 | 22.908 |
| 0.461767 | -144404 | -23.0884 | | 144.404 | 23.0884 |
| 0.46718 | -139102 | -23.359 | | 139.102 | 23.359 |
| 0.472592 | -135325 | -23.6296 | | 135.325 | 23.6296 |
| 0.478004 | -131703 | -23.9002 | | 131.703 | 23.9002 |
| 0.486122 | -124787 | -24.3061 | | 124.787 | 24.3061 |
| 0.4983 | -115442 | -24.915 | | 115.442 | 24.915 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *43 mm* | | | | | |
| $F_{u,fem}$ | 250.072 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -142855 | -0.5 | | 142.855 | 0.5 |
| 0.010625 | -149513 | -0.53125 | | 149.513 | 0.53125 |
| 0.01125 | -152174 | -0.5625 | | 152.174 | 0.5625 |
| 0.011875 | -153227 | -0.59375 | | 153.227 | 0.59375 |
| 0.012813 | -154321 | -0.64063 | | 154.321 | 0.640625 |
| 0.014219 | -155539 | -0.71094 | | 155.539 | 0.710938 |
| 0.016328 | -157253 | -0.81641 | | 157.253 | 0.816406 |
| 0.019492 | -159473 | -0.97461 | | 159.473 | 0.974609 |
| 0.024238 | -161984 | -1.21191 | | 161.984 | 1.21191 |
| 0.031357 | -165381 | -1.56787 | | 165.381 | 1.56787 |
| 0.042036 | -171651 | -2.10181 | | 171.651 | 2.10181 |
| 0.052715 | -179216 | -2.63574 | | 179.216 | 2.63574 |
| 0.063394 | -188282 | -3.16968 | | 188.282 | 3.16968 |
| 0.074072 | -196314 | -3.70361 | | 196.314 | 3.70361 |
| 0.084751 | -202711 | -4.23755 | | 202.711 | 4.23755 |
| 0.09543 | -207943 | -4.77148 | | 207.943 | 4.77148 |
| 0.106108 | -212451 | -5.30542 | | 212.451 | 5.30542 |
| 0.116787 | -216352 | -5.83936 | | 216.352 | 5.83936 |
| 0.132805 | -221699 | -6.64026 | | 221.699 | 6.64026 |
| 0.148823 | -226805 | -7.44116 | | 226.805 | 7.44116 |
| 0.164841 | -231939 | -8.24207 | | 231.939 | 8.24207 |
| 0.180859 | -236597 | -9.04297 | | 236.597 | 9.04297 |
| 0.196877 | -240538 | -9.84387 | | 240.538 | 9.84387 |
| 0.220905 | -245112 | -11.0452 | | 245.112 | 11.0452 |
| 0.256945 | -249400 | -12.8473 | | 249.4 | 12.8473 |
| 0.265955 | -249988 | -13.2978 | | 249.988 | 13.2978 |
| 0.274966 | -250072 | -13.7483 | | 250.072 | 13.7483 |
| 0.283976 | -249383 | -14.1988 | | 249.383 | 14.1988 |
| 0.292986 | -247847 | -14.6493 | | 247.847 | 14.6493 |
| 0.301996 | -245630 | -15.0998 | | 245.63 | 15.0998 |
| 0.311006 | -242847 | -15.5503 | | 242.847 | 15.5503 |
| 0.320016 | -239443 | -16.0008 | | 239.443 | 16.0008 |
| 0.329026 | -235431 | -16.4513 | | 235.431 | 16.4513 |
| 0.338037 | -230767 | -16.9018 | | 230.767 | 16.9018 |
| 0.347047 | -225503 | -17.3523 | | 225.503 | 17.3523 |
| 0.356057 | -219678 | -17.8028 | | 219.678 | 17.8028 |
| 0.365067 | -213372 | -18.2534 | | 213.372 | 18.2534 |
| 0.374077 | -206659 | -18.7039 | | 206.659 | 18.7039 |
| 0.383087 | -199540 | -19.1544 | | 199.54 | 19.1544 |
| 0.392098 | -192071 | -19.6049 | | 192.071 | 19.6049 |
| 0.401108 | -184283 | -20.0554 | | 184.283 | 20.0554 |
| 0.410118 | -176267 | -20.5059 | | 176.267 | 20.5059 |
| 0.419128 | -168016 | -20.9564 | | 168.016 | 20.9564 |
| 0.428138 | -159672 | -21.4069 | | 159.672 | 21.4069 |
| 0.437148 | -151618 | -21.8574 | | 151.618 | 21.8574 |
| 0.446159 | -143970 | -22.3079 | | 143.97 | 22.3079 |
| 0.455169 | -136651 | -22.7584 | | 136.651 | 22.7584 |
| 0.457421 | -139536 | -22.8711 | | 139.536 | 22.8711 |
| 0.459674 | -137547 | -22.9837 | | 137.547 | 22.9837 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *44 mm* | | | | | |
| $F_{u,fem}$ | 246.565 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -141799 | -0.5 | | 141.799 | 0.5 |
| 0.010625 | -148001 | -0.53125 | | 148.001 | 0.53125 |
| 0.01125 | -150059 | -0.5625 | | 150.059 | 0.5625 |
| 0.011875 | -151041 | -0.59375 | | 151.041 | 0.59375 |
| 0.012813 | -152086 | -0.64063 | | 152.086 | 0.640625 |
| 0.014219 | -153267 | -0.71094 | | 153.267 | 0.710938 |
| 0.016328 | -154941 | -0.81641 | | 154.941 | 0.816406 |
| 0.019492 | -157149 | -0.97461 | | 157.149 | 0.974609 |
| 0.024238 | -159616 | -1.21191 | | 159.616 | 1.21191 |
| 0.031357 | -162961 | -1.56787 | | 162.961 | 1.56787 |
| 0.042036 | -169189 | -2.10181 | | 169.189 | 2.10181 |
| 0.044706 | -171146 | -2.23529 | | 171.146 | 2.23529 |
| 0.047376 | -173077 | -2.36877 | | 173.077 | 2.36877 |
| 0.05138 | -176003 | -2.569 | | 176.003 | 2.569 |
| 0.057387 | -180733 | -2.86934 | | 180.733 | 2.86934 |
| 0.059639 | -182711 | -2.98197 | | 182.711 | 2.98197 |
| 0.063018 | -185582 | -3.15091 | | 185.582 | 3.15091 |
| 0.068086 | -189556 | -3.40432 | | 189.556 | 3.40432 |
| 0.075689 | -194744 | -3.78443 | | 194.744 | 3.78443 |
| 0.087092 | -201169 | -4.35461 | | 201.169 | 4.35461 |
| 0.104197 | -208829 | -5.20987 | | 208.829 | 5.20987 |
| 0.121303 | -214902 | -6.06513 | | 214.902 | 6.06513 |
| 0.138408 | -220417 | -6.92039 | | 220.417 | 6.92039 |
| 0.155513 | -225800 | -7.77565 | | 225.8 | 7.77565 |
| 0.172618 | -231023 | -8.63092 | | 231.023 | 8.63092 |
| 0.189724 | -235522 | -9.48618 | | 235.522 | 9.48618 |
| 0.215381 | -240855 | -10.7691 | | 240.855 | 10.7691 |
| 0.253868 | -245774 | -12.6934 | | 245.774 | 12.6934 |
| 0.268301 | -246538 | -13.415 | | 246.538 | 13.415 |
| 0.271909 | -246565 | -13.5954 | | 246.565 | 13.5954 |
| 0.275517 | -246451 | -13.7758 | | 246.451 | 13.7758 |
| 0.279125 | -246202 | -13.9563 | | 246.202 | 13.9563 |
| 0.282733 | -245821 | -14.1367 | | 245.821 | 14.1367 |
| 0.288145 | -245007 | -14.4073 | | 245.007 | 14.4073 |
| 0.296264 | -243319 | -14.8132 | | 243.319 | 14.8132 |
| 0.304382 | -241255 | -15.2191 | | 241.255 | 15.2191 |
| 0.3125 | -238754 | -15.625 | | 238.754 | 15.625 |
| 0.320619 | -235808 | -16.0309 | | 235.808 | 16.0309 |
| 0.328737 | -232412 | -16.4368 | | 232.412 | 16.4368 |
| 0.336855 | -228553 | -16.8428 | | 228.553 | 16.8428 |
| 0.344974 | -224203 | -17.2487 | | 224.203 | 17.2487 |
| 0.353092 | -219423 | -17.6546 | | 219.423 | 17.6546 |
| 0.36121 | -214275 | -18.0605 | | 214.275 | 18.0605 |
| 0.369328 | -208793 | -18.4664 | | 208.793 | 18.4664 |
| 0.377447 | -202990 | -18.8723 | | 202.99 | 18.8723 |
| 0.385565 | -196895 | -19.2783 | | 196.895 | 19.2783 |
| 0.393683 | -190523 | -19.6842 | | 190.523 | 19.6842 |
| 0.401802 | -183860 | -20.0901 | | 183.86 | 20.0901 |
| 0.40992 | -177038 | -20.496 | | 177.038 | 20.496 |
| 0.418038 | -169993 | -20.9019 | | 169.993 | 20.9019 |
| 0.426157 | -162843 | -21.3078 | | 162.843 | 21.3078 |
| 0.434275 | -155896 | -21.7137 | | 155.896 | 21.7137 |
| 0.442393 | -149293 | -22.1197 | | 149.293 | 22.1197 |
| 0.450511 | -142955 | -22.5256 | | 142.955 | 22.5256 |
| 0.45863 | -136997 | -22.9315 | | 136.997 | 22.9315 |
| 0.466748 | -131636 | -23.3374 | | 131.636 | 23.3374 |
| 0.474866 | -126726 | -23.7433 | | 126.726 | 23.7433 |
| 0.487044 | -117880 | -24.3522 | | 117.88 | 24.3522 |
| 0.50531 | -106255 | -25.2655 | | 106.255 | 25.2655 |
| 0.523576 | -98959.8 | -26.1788 | | 98.9598 | 26.1788 |
| 0.541842 | -92124.8 | -27.0921 | | 92.1248 | 27.0921 |
| 0.546409 | -99768.7 | -27.3204 | | 99.7687 | 27.3204 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *45 mm* | | | | | |
| $F_{u,fem}$ | 242.646 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.0025 | -36550.7 | -0.125 | | 36.5507 | 0.125 |
| 0.005 | -73078.4 | -0.25 | | 73.0784 | 0.25 |
| 0.00875 | -125460 | -0.4375 | | 125.46 | 0.4375 |
| 0.010156 | -142383 | -0.50781 | | 142.383 | 0.507813 |
| 0.012266 | -149298 | -0.61328 | | 149.298 | 0.613281 |
| 0.014375 | -151154 | -0.71875 | | 151.154 | 0.71875 |
| 0.016484 | -152850 | -0.82422 | | 152.85 | 0.824219 |
| 0.019648 | -154953 | -0.98242 | | 154.953 | 0.982422 |
| 0.024395 | -157403 | -1.21973 | | 157.403 | 1.21973 |
| 0.031514 | -160729 | -1.57568 | | 160.729 | 1.57568 |
| 0.042192 | -166903 | -2.10962 | | 166.903 | 2.10962 |
| 0.052871 | -174324 | -2.64355 | | 174.324 | 2.64355 |
| 0.06355 | -183204 | -3.17749 | | 183.204 | 3.17749 |
| 0.074229 | -191133 | -3.71143 | | 191.133 | 3.71143 |
| 0.084907 | -197426 | -4.24536 | | 197.426 | 4.24536 |
| 0.100925 | -204830 | -5.04626 | | 204.83 | 5.04626 |
| 0.116943 | -210652 | -5.84717 | | 210.652 | 5.84717 |
| 0.120948 | -212016 | -6.04739 | | 212.016 | 6.04739 |
| 0.124952 | -213330 | -6.24762 | | 213.33 | 6.24762 |
| 0.130959 | -215248 | -6.54796 | | 215.248 | 6.54796 |
| 0.139969 | -218029 | -6.99847 | | 218.029 | 6.99847 |
| 0.153485 | -222132 | -7.67423 | | 222.132 | 7.67423 |
| 0.158553 | -223697 | -7.92764 | | 223.697 | 7.92764 |
| 0.166155 | -225969 | -8.30776 | | 225.969 | 8.30776 |
| 0.177559 | -229218 | -8.87793 | | 229.218 | 8.87793 |
| 0.194664 | -233424 | -9.73319 | | 233.424 | 9.73319 |
| 0.220322 | -238320 | -11.0161 | | 238.32 | 11.0161 |
| 0.258808 | -242622 | -12.9404 | | 242.622 | 12.9404 |
| 0.273241 | -242646 | -13.662 | | 242.646 | 13.662 |
| 0.276849 | -242416 | -13.8425 | | 242.416 | 13.8425 |
| 0.280457 | -242019 | -14.0229 | | 242.019 | 14.0229 |
| 0.284065 | -241486 | -14.2033 | | 241.486 | 14.2033 |
| 0.289478 | -240425 | -14.4739 | | 240.425 | 14.4739 |
| 0.297596 | -238388 | -14.8798 | | 238.388 | 14.8798 |
| 0.305714 | -235940 | -15.2857 | | 235.94 | 15.2857 |
| 0.313832 | -232994 | -15.6916 | | 232.994 | 15.6916 |
| 0.321951 | -229565 | -16.0975 | | 229.565 | 16.0975 |
| 0.330069 | -225661 | -16.5035 | | 225.661 | 16.5035 |
| 0.338187 | -221263 | -16.9094 | | 221.263 | 16.9094 |
| 0.346306 | -216419 | -17.3153 | | 216.419 | 17.3153 |
| 0.354424 | -211176 | -17.7212 | | 211.176 | 17.7212 |
| 0.362542 | -205568 | -18.1271 | | 205.568 | 18.1271 |
| 0.370661 | -199622 | -18.533 | | 199.622 | 18.533 |
| 0.378779 | -193332 | -18.9389 | | 193.332 | 18.9389 |
| 0.386897 | -186750 | -19.3449 | | 186.75 | 19.3449 |
| 0.395016 | -179844 | -19.7508 | | 179.844 | 19.7508 |
| 0.397045 | -180443 | -19.8523 | | 180.443 | 19.8523 |
| 0.399075 | -178627 | -19.9537 | | 178.627 | 19.9537 |
| 0.402119 | -175641 | -20.106 | | 175.641 | 20.106 |
| 0.406686 | -171060 | -20.3343 | | 171.06 | 20.3343 |
| 0.413535 | -163991 | -20.6768 | | 163.991 | 20.6768 |
| 0.42381 | -153131 | -21.1905 | | 153.131 | 21.1905 |
| 0.434085 | -144465 | -21.7042 | | 144.465 | 21.7042 |
| 0.44436 | -136087 | -22.218 | | 136.087 | 22.218 |
| 0.446928 | -139078 | -22.3464 | | 139.078 | 22.3464 |
| 0.449497 | -136878 | -22.4748 | | 136.878 | 22.4748 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *46 mm* | | | | | |
| $F_{u,fem}$ | 239.654 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -139550 | -0.5 | | 139.55 | 0.5 |
| 0.010625 | -144485 | -0.53125 | | 144.485 | 0.53125 |
| 0.01125 | -145882 | -0.5625 | | 145.882 | 0.5625 |
| 0.011875 | -146750 | -0.59375 | | 146.75 | 0.59375 |
| 0.012813 | -147710 | -0.64063 | | 147.71 | 0.640625 |
| 0.014219 | -148819 | -0.71094 | | 148.819 | 0.710938 |
| 0.016328 | -150457 | -0.81641 | | 150.457 | 0.816406 |
| 0.019492 | -152563 | -0.97461 | | 152.563 | 0.974609 |
| 0.024238 | -155001 | -1.21191 | | 155.001 | 1.21191 |
| 0.031357 | -158282 | -1.56787 | | 158.282 | 1.56787 |
| 0.042036 | -164391 | -2.10181 | | 164.391 | 2.10181 |
| 0.052715 | -171670 | -2.63574 | | 171.67 | 2.63574 |
| 0.055385 | -173921 | -2.76923 | | 173.921 | 2.76923 |
| 0.058054 | -176191 | -2.90271 | | 176.191 | 2.90271 |
| 0.062059 | -179606 | -3.10294 | | 179.606 | 3.10294 |
| 0.068066 | -184293 | -3.40327 | | 184.293 | 3.40327 |
| 0.077076 | -190365 | -3.85378 | | 190.365 | 3.85378 |
| 0.090591 | -197523 | -4.52954 | | 197.523 | 4.52954 |
| 0.104106 | -203242 | -5.20531 | | 203.242 | 5.20531 |
| 0.117621 | -207969 | -5.88107 | | 207.969 | 5.88107 |
| 0.131137 | -212273 | -6.55683 | | 212.273 | 6.55683 |
| 0.144652 | -216361 | -7.23259 | | 216.361 | 7.23259 |
| 0.164925 | -222347 | -8.24624 | | 222.347 | 8.24624 |
| 0.185198 | -227860 | -9.25988 | | 227.86 | 9.25988 |
| 0.20547 | -232357 | -10.2735 | | 232.357 | 10.2735 |
| 0.23588 | -237006 | -11.794 | | 237.006 | 11.794 |
| 0.247283 | -238342 | -12.3642 | | 238.342 | 12.3642 |
| 0.264388 | -239551 | -13.2194 | | 239.551 | 13.2194 |
| 0.270803 | -239654 | -13.5401 | | 239.654 | 13.5401 |
| 0.277217 | -239367 | -13.8609 | | 239.367 | 13.8609 |
| 0.283632 | -238697 | -14.1816 | | 238.697 | 14.1816 |
| 0.290046 | -237644 | -14.5023 | | 237.644 | 14.5023 |
| 0.296461 | -236302 | -14.823 | | 236.302 | 14.823 |
| 0.302875 | -234729 | -15.1438 | | 234.729 | 15.1438 |
| 0.312497 | -231674 | -15.6248 | | 231.674 | 15.6248 |
| 0.322119 | -228049 | -16.1059 | | 228.049 | 16.1059 |
| 0.33174 | -223756 | -16.587 | | 223.756 | 16.587 |
| 0.341362 | -218771 | -17.0681 | | 218.771 | 17.0681 |
| 0.350984 | -213143 | -17.5492 | | 213.143 | 17.5492 |
| 0.360605 | -206984 | -18.0303 | | 206.984 | 18.0303 |
| 0.370227 | -200380 | -18.5114 | | 200.38 | 18.5114 |
| 0.379849 | -193339 | -18.9924 | | 193.339 | 18.9924 |
| 0.38947 | -185886 | -19.4735 | | 185.886 | 19.4735 |
| 0.399092 | -178073 | -19.9546 | | 178.073 | 19.9546 |
| 0.408714 | -169955 | -20.4357 | | 169.955 | 20.4357 |
| 0.418336 | -161626 | -20.9168 | | 161.626 | 20.9168 |
| 0.427957 | -153567 | -21.3979 | | 153.567 | 21.3979 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S235 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *47 mm* | | | | | |
| $F_{u,fem}$ | 235.808 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.0025 | -36206.9 | -0.125 | | 36.2069 | 0.125 |
| 0.005 | -72387.9 | -0.25 | | 72.3879 | 0.25 |
| 0.00875 | -123827 | -0.4375 | | 123.827 | 0.4375 |
| 0.009688 | -135003 | -0.48438 | | 135.003 | 0.484375 |
| 0.010625 | -142454 | -0.53125 | | 142.454 | 0.53125 |
| 0.012031 | -144664 | -0.60156 | | 144.664 | 0.601563 |
| 0.013438 | -145943 | -0.67188 | | 145.943 | 0.671875 |
| 0.014844 | -146987 | -0.74219 | | 146.987 | 0.742188 |
| 0.016953 | -148607 | -0.84766 | | 148.607 | 0.847656 |
| 0.020117 | -150590 | -1.00586 | | 150.59 | 1.00586 |
| 0.024863 | -152899 | -1.24316 | | 152.899 | 1.24316 |
| 0.031982 | -156211 | -1.59912 | | 156.211 | 1.59912 |
| 0.034652 | -157817 | -1.7326 | | 157.817 | 1.7326 |
| 0.038657 | -160186 | -1.93283 | | 160.186 | 1.93283 |
| 0.044663 | -163794 | -2.23317 | | 163.794 | 2.23317 |
| 0.053674 | -169907 | -2.68368 | | 169.907 | 2.68368 |
| 0.057052 | -172706 | -2.85262 | | 172.706 | 2.85262 |
| 0.062121 | -176904 | -3.10603 | | 176.904 | 3.10603 |
| 0.069723 | -182790 | -3.48615 | | 182.79 | 3.48615 |
| 0.081126 | -189968 | -4.05632 | | 189.968 | 4.05632 |
| 0.098232 | -198111 | -4.91158 | | 198.111 | 4.91158 |
| 0.115337 | -204230 | -5.76684 | | 204.23 | 5.76684 |
| 0.119613 | -205667 | -5.98066 | | 205.667 | 5.98066 |
| 0.123889 | -207068 | -6.19447 | | 207.068 | 6.19447 |
| 0.130304 | -209068 | -6.5152 | | 209.068 | 6.5152 |
| 0.139926 | -211958 | -6.99628 | | 211.958 | 6.99628 |
| 0.154358 | -216118 | -7.71791 | | 216.118 | 7.71791 |
| 0.176007 | -222149 | -8.80035 | | 222.149 | 8.80035 |
| 0.197656 | -227361 | -9.88279 | | 227.361 | 9.88279 |
| 0.219305 | -231236 | -10.9652 | | 231.236 | 10.9652 |
| 0.251778 | -235137 | -12.5889 | | 235.137 | 12.5889 |
| 0.263955 | -235808 | -13.1978 | | 235.808 | 13.1978 |
| 0.276133 | -235315 | -13.8066 | | 235.315 | 13.8066 |
| 0.28831 | -233331 | -14.4155 | | 233.331 | 14.4155 |
| 0.300488 | -230249 | -15.0244 | | 230.249 | 15.0244 |
| 0.312665 | -226080 | -15.6333 | | 226.08 | 15.6333 |
| 0.324843 | -220786 | -16.2421 | | 220.786 | 16.2421 |
| 0.33702 | -214324 | -16.851 | | 214.324 | 16.851 |
| 0.349197 | -206791 | -17.4599 | | 206.791 | 17.4599 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

# 8. OUTPUT FINITE ELEMENT MODEL VS THEORY FOR STEEL GRADE S355

**S355**
**1 hole**
*18 mm*

$F_{u,fem}$ 377.659 kN

| Time | Load | Displace ment | | abs Load | abs Displace ment |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -157489 | -0.5 | | 157.489 | 0.5 |
| 0.0125 | -196637 | -0.625 | | 196.637 | 0.625 |
| 0.01625 | -254731 | -0.8125 | | 254.731 | 0.8125 |
| 0.021875 | -304574 | -1.09375 | | 304.574 | 1.09375 |
| 0.0275 | -310117 | -1.375 | | 310.117 | 1.375 |
| 0.033125 | -317195 | -1.65625 | | 317.195 | 1.65625 |
| 0.03875 | -324801 | -1.9375 | | 324.801 | 1.9375 |
| 0.047188 | -335909 | -2.35938 | | 335.909 | 2.35938 |
| 0.055625 | -344897 | -2.78125 | | 344.897 | 2.78125 |
| 0.064063 | -352310 | -3.20313 | | 352.31 | 3.20313 |
| 0.076719 | -359685 | -3.83594 | | 359.685 | 3.83594 |
| 0.081465 | -361129 | -4.07324 | | 361.129 | 4.07324 |
| 0.086211 | -362148 | -4.31055 | | 362.148 | 4.31055 |
| 0.090957 | -363065 | -4.54785 | | 363.065 | 4.54785 |
| 0.098076 | -363801 | -4.90381 | | 363.801 | 4.90381 |
| 0.108755 | -364479 | -5.43774 | | 364.479 | 5.43774 |
| 0.119434 | -365480 | -5.97168 | | 365.48 | 5.97168 |
| 0.130112 | -367074 | -6.50562 | | 367.074 | 6.50562 |
| 0.14613 | -370222 | -7.30652 | | 370.222 | 7.30652 |
| 0.162148 | -372985 | -8.10742 | | 372.985 | 8.10742 |
| 0.178167 | -375201 | -8.90833 | | 375.201 | 8.90833 |
| 0.194185 | -376956 | -9.70923 | | 376.956 | 9.70923 |
| 0.198189 | -377307 | -9.90945 | | 377.307 | 9.90945 |
| 0.204196 | -377596 | -10.2098 | | 377.596 | 10.2098 |
| 0.206448 | -377659 | -10.3224 | | 377.659 | 10.3224 |
| 0.208701 | -377619 | -10.435 | | 377.619 | 10.435 |
| 0.210953 | -377495 | -10.5477 | | 377.495 | 10.5477 |
| 0.213206 | -377281 | -10.6603 | | 377.281 | 10.6603 |
| 0.216585 | -376774 | -10.8292 | | 376.774 | 10.8292 |
| 0.221653 | -375645 | -11.0827 | | 375.645 | 11.0827 |
| 0.229255 | -373046 | -11.4628 | | 373.046 | 11.4628 |
| 0.236858 | -369656 | -11.8429 | | 369.656 | 11.8429 |
| 0.24446 | -365446 | -12.223 | | 365.446 | 12.223 |
| 0.252062 | -360342 | -12.6031 | | 360.342 | 12.6031 |
| 0.259665 | -354406 | -12.9832 | | 354.406 | 12.9832 |
| 0.261565 | -353849 | -13.0783 | | 353.849 | 13.0783 |
| 0.263466 | -352268 | -13.1733 | | 352.268 | 13.1733 |
| 0.266317 | -349708 | -13.3158 | | 349.708 | 13.3158 |
| 0.270593 | -345686 | -13.5297 | | 345.686 | 13.5297 |
| 0.274869 | -341711 | -13.7435 | | 341.711 | 13.7435 |
| 0.279146 | -337485 | -13.9573 | | 337.485 | 13.9573 |
| 0.283422 | -333017 | -14.1711 | | 333.017 | 14.1711 |
| 0.287698 | -328354 | -14.3849 | | 328.354 | 14.3849 |
| 0.291975 | -323548 | -14.5987 | | 323.548 | 14.5987 |
| 0.296251 | -318630 | -14.8125 | | 318.63 | 14.8125 |
| 0.300527 | -313622 | -15.0264 | | 313.622 | 15.0264 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

**S355**
**1 hole**
*19 mm*

$F_{u,fem}$ 372.872 kN

| Time | Load | Displace ment | | abs Load | abs Displace ment |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -157257 | -0.5 | | 157.257 | 0.5 |
| 0.02 | -299076 | -1 | | 299.076 | 1 |
| 0.0225 | -302092 | -1.125 | | 302.092 | 1.125 |
| 0.025 | -304344 | -1.25 | | 304.344 | 1.25 |
| 0.0275 | -307035 | -1.375 | | 307.035 | 1.375 |
| 0.03125 | -311709 | -1.5625 | | 311.709 | 1.5625 |
| 0.036875 | -318811 | -1.84375 | | 318.811 | 1.84375 |
| 0.045313 | -330217 | -2.26563 | | 330.217 | 2.26563 |
| 0.05375 | -339688 | -2.6875 | | 339.688 | 2.6875 |
| 0.062188 | -347453 | -3.10938 | | 347.453 | 3.10938 |
| 0.070625 | -353758 | -3.53125 | | 353.758 | 3.53125 |
| 0.083281 | -360090 | -4.16406 | | 360.09 | 4.16406 |
| 0.086445 | -361045 | -4.32227 | | 361.045 | 4.32227 |
| 0.089609 | -361806 | -4.48047 | | 361.806 | 4.48047 |
| 0.092773 | -362493 | -4.63867 | | 362.493 | 4.63867 |
| 0.09752 | -363397 | -4.87598 | | 363.397 | 4.87598 |
| 0.104639 | -364185 | -5.23193 | | 364.185 | 5.23193 |
| 0.115317 | -364856 | -5.76587 | | 364.856 | 5.76587 |
| 0.125996 | -365819 | -6.2998 | | 365.819 | 6.2998 |
| 0.136675 | -367275 | -6.83374 | | 367.275 | 6.83374 |
| 0.152693 | -369948 | -7.63464 | | 369.948 | 7.63464 |
| 0.17672 | -372608 | -8.836 | | 372.608 | 8.836 |
| 0.182727 | -372872 | -9.13634 | | 372.872 | 9.13634 |
| 0.188734 | -372328 | -9.43668 | | 372.328 | 9.43668 |
| 0.19474 | -371218 | -9.73701 | | 371.218 | 9.73701 |
| 0.200747 | -369529 | -10.0374 | | 369.529 | 10.0374 |
| 0.206754 | -367261 | -10.3377 | | 367.261 | 10.3377 |
| 0.215764 | -362441 | -10.7882 | | 362.441 | 10.7882 |
| 0.224774 | -356834 | -11.2387 | | 356.834 | 11.2387 |
| 0.227027 | -356293 | -11.3513 | | 356.293 | 11.3513 |
| 0.229279 | -354635 | -11.464 | | 354.635 | 11.464 |
| 0.232658 | -351896 | -11.6329 | | 351.896 | 11.6329 |
| 0.237726 | -347547 | -11.8863 | | 347.547 | 11.8863 |
| 0.242794 | -343303 | -12.1397 | | 343.303 | 12.1397 |
| 0.247863 | -338863 | -12.3931 | | 338.863 | 12.3931 |
| 0.252931 | -334194 | -12.6465 | | 334.194 | 12.6465 |
| 0.257999 | -329242 | -12.9 | | 329.242 | 12.9 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

**S355**
**1 hole**
*20 mm*

$F_{u,fem}$ 368.032 kN

| Time | Load | Displace ment | | abs Load | abs Displace ment |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -157008 | -0.5 | | 157.008 | 0.5 |
| 0.02 | -295851 | -1 | | 295.851 | 1 |
| 0.0225 | -298816 | -1.125 | | 298.816 | 1.125 |
| 0.025 | -301126 | -1.25 | | 301.126 | 1.25 |
| 0.0275 | -303818 | -1.375 | | 303.818 | 1.375 |
| 0.03125 | -308409 | -1.5625 | | 308.409 | 1.5625 |
| 0.036875 | -315547 | -1.84375 | | 315.547 | 1.84375 |
| 0.045313 | -326710 | -2.26563 | | 326.71 | 2.26563 |
| 0.05375 | -336218 | -2.6875 | | 336.218 | 2.6875 |
| 0.062188 | -344051 | -3.10938 | | 344.051 | 3.10938 |
| 0.070625 | -350549 | -3.53125 | | 350.549 | 3.53125 |
| 0.079063 | -355525 | -3.95313 | | 355.525 | 3.95313 |
| 0.091719 | -360499 | -4.58594 | | 360.499 | 4.58594 |
| 0.104375 | -363254 | -5.21875 | | 363.254 | 5.21875 |
| 0.117031 | -364655 | -5.85156 | | 364.655 | 5.85156 |
| 0.129688 | -365551 | -6.48438 | | 365.551 | 6.48438 |
| 0.148672 | -367336 | -7.43359 | | 367.336 | 7.43359 |
| 0.155791 | -368032 | -7.78955 | | 368.032 | 7.78955 |
| 0.16647 | -367902 | -8.32349 | | 367.902 | 8.32349 |
| 0.177148 | -365736 | -8.85742 | | 365.736 | 8.85742 |
| 0.187827 | -361634 | -9.39136 | | 361.634 | 9.39136 |
| 0.190497 | -361198 | -9.52484 | | 361.198 | 9.52484 |
| 0.193167 | -359878 | -9.65833 | | 359.878 | 9.65833 |
| 0.197171 | -357574 | -9.85855 | | 357.574 | 9.85855 |
| 0.203178 | -353662 | -10.1589 | | 353.662 | 10.1589 |
| 0.212188 | -346559 | -10.6094 | | 346.559 | 10.6094 |
| 0.21444 | -346016 | -10.722 | | 346.016 | 10.722 |
| 0.216693 | -344185 | -10.8347 | | 344.185 | 10.8347 |
| 0.220072 | -341206 | -11.0036 | | 341.206 | 11.0036 |
| 0.22514 | -336561 | -11.257 | | 336.561 | 11.257 |
| 0.230208 | -332116 | -11.5104 | | 332.116 | 11.5104 |
| 0.235277 | -327506 | -11.7638 | | 327.506 | 11.7638 |
| 0.240345 | -322691 | -12.0172 | | 322.691 | 12.0172 |
| 0.245413 | -317617 | -12.2706 | | 317.617 | 12.2706 |
| 0.250481 | -312262 | -12.5241 | | 312.262 | 12.5241 |
| 0.255549 | -306680 | -12.7775 | | 306.68 | 12.7775 |
| 0.260618 | -300945 | -13.0309 | | 300.945 | 13.0309 |
| 0.265686 | -295099 | -13.2843 | | 295.099 | 13.2843 |
| 0.270754 | -289168 | -13.5377 | | 289.168 | 13.5377 |
| 0.275822 | -283174 | -13.7911 | | 283.174 | 13.7911 |
| 0.283425 | -273202 | -14.1712 | | 273.202 | 14.1712 |
| 0.291027 | -264035 | -14.5513 | | 264.035 | 14.5513 |
| 0.292927 | -263942 | -14.6464 | | 263.942 | 14.6464 |
| 0.294828 | -261590 | -14.7414 | | 261.59 | 14.7414 |
| 0.297679 | -257853 | -14.8839 | | 257.853 | 14.8839 |
| 0.301955 | -252259 | -15.0978 | | 252.259 | 15.0978 |
| 0.30837 | -243857 | -15.4185 | | 243.857 | 15.4185 |
| 0.317991 | -231148 | -15.8996 | | 231.148 | 15.8996 |
| 0.327613 | -220291 | -16.3807 | | 220.291 | 16.3807 |
| 0.330018 | -221984 | -16.5009 | | 221.984 | 16.5009 |
| 0.332424 | -219174 | -16.6212 | | 219.174 | 16.6212 |
| 0.336032 | -214680 | -16.8016 | | 214.68 | 16.8016 |
| 0.341444 | -208006 | -17.0722 | | 208.006 | 17.0722 |
| 0.349563 | -198300 | -17.4781 | | 198.3 | 17.4781 |
| 0.357681 | -191005 | -17.884 | | 191.005 | 17.884 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *21 mm* | | | | | |
| $F_{u,fem}$ | 363.803 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -156746 | -0.5 | | 156.746 | 0.5 |
| 0.02 | -292710 | -1 | | 292.71 | 1 |
| 0.0225 | -295621 | -1.125 | | 295.621 | 1.125 |
| 0.025 | -297918 | -1.25 | | 297.918 | 1.25 |
| 0.0275 | -300594 | -1.375 | | 300.594 | 1.375 |
| 0.03125 | -305142 | -1.5625 | | 305.142 | 1.5625 |
| 0.036875 | -312125 | -1.84375 | | 312.125 | 1.84375 |
| 0.045313 | -323319 | -2.26563 | | 323.319 | 2.26563 |
| 0.05375 | -332884 | -2.6875 | | 332.884 | 2.6875 |
| 0.062188 | -340655 | -3.10938 | | 340.655 | 3.10938 |
| 0.074844 | -349840 | -3.74219 | | 349.84 | 3.74219 |
| 0.093828 | -358482 | -4.69141 | | 358.482 | 4.69141 |
| 0.098574 | -359905 | -4.92871 | | 359.905 | 4.92871 |
| 0.10332 | -361004 | -5.16602 | | 361.004 | 5.16602 |
| 0.108066 | -361916 | -5.40332 | | 361.916 | 5.40332 |
| 0.115186 | -362986 | -5.75928 | | 362.986 | 5.75928 |
| 0.125864 | -363757 | -6.29321 | | 363.757 | 6.29321 |
| 0.129869 | -363803 | -6.49344 | | 363.803 | 6.49344 |
| 0.133873 | -363481 | -6.69366 | | 363.481 | 6.69366 |
| 0.137878 | -362885 | -6.89389 | | 362.885 | 6.89389 |
| 0.141882 | -362012 | -7.09412 | | 362.012 | 7.09412 |
| 0.145887 | -360902 | -7.29434 | | 360.902 | 7.29434 |
| 0.151894 | -358576 | -7.59468 | | 358.576 | 7.59468 |
| 0.160904 | -353805 | -8.04519 | | 353.805 | 8.04519 |
| 0.169914 | -348223 | -8.4957 | | 348.223 | 8.4957 |
| 0.172166 | -347732 | -8.60832 | | 347.732 | 8.60832 |
| 0.174419 | -346118 | -8.72095 | | 346.118 | 8.72095 |
| 0.177798 | -343408 | -8.88989 | | 343.408 | 8.88989 |
| 0.182866 | -339060 | -9.1433 | | 339.06 | 9.1433 |
| 0.187934 | -334806 | -9.39671 | | 334.806 | 9.39671 |
| 0.193002 | -330372 | -9.65012 | | 330.372 | 9.65012 |
| 0.198071 | -325757 | -9.90353 | | 325.757 | 9.90353 |
| 0.203139 | -320929 | -10.1569 | | 320.929 | 10.1569 |
| 0.208207 | -315849 | -10.4104 | | 315.849 | 10.4104 |
| 0.213275 | -310510 | -10.6638 | | 310.51 | 10.6638 |
| 0.218344 | -304957 | -10.9172 | | 304.957 | 10.9172 |
| 0.223412 | -299250 | -11.1706 | | 299.25 | 11.1706 |
| 0.22848 | -293431 | -11.424 | | 293.431 | 11.424 |
| 0.233548 | -287526 | -11.6774 | | 287.526 | 11.6774 |
| 0.238616 | -281557 | -11.9308 | | 281.557 | 11.9308 |
| 0.243685 | -275544 | -12.1842 | | 275.544 | 12.1842 |
| 0.251287 | -265571 | -12.5643 | | 265.571 | 12.5643 |
| 0.253188 | -265335 | -12.6594 | | 265.335 | 12.6594 |
| 0.255088 | -263003 | -12.7544 | | 263.003 | 12.7544 |
| 0.257939 | -259305 | -12.8969 | | 259.305 | 12.8969 |
| 0.262215 | -253754 | -13.1108 | | 253.754 | 13.1108 |
| 0.26863 | -245368 | -13.4315 | | 245.368 | 13.4315 |
| 0.278251 | -232503 | -13.9126 | | 232.503 | 13.9126 |
| 0.280657 | -233455 | -14.0328 | | 233.455 | 14.0328 |
| 0.283062 | -230555 | -14.1531 | | 230.555 | 14.1531 |
| 0.28667 | -225901 | -14.3335 | | 225.901 | 14.3335 |
| 0.292083 | -218926 | -14.6041 | | 218.926 | 14.6041 |
| 0.294112 | -218729 | -14.7056 | | 218.729 | 14.7056 |
| 0.297157 | -214796 | -14.8578 | | 214.796 | 14.8578 |
| 0.301723 | -209202 | -15.0862 | | 209.202 | 15.0862 |
| 0.308573 | -201058 | -15.4286 | | 201.058 | 15.4286 |
| 0.318848 | -189546 | -15.9424 | | 189.546 | 15.9424 |
| 0.322701 | -190628 | -16.135 | | 190.628 | 16.135 |
| 0.32848 | -184202 | -16.424 | | 184.202 | 16.424 |
| 0.33715 | -175546 | -16.8575 | | 175.546 | 16.8575 |
| 0.339317 | -178638 | -16.9658 | | 178.638 | 16.9658 |
| 0.341484 | -176538 | -17.0742 | | 176.538 | 17.0742 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *22 mm* | | | | | |
| $F_{u,fem}$ | 359.485 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -156469 | -0.5 | | 156.469 | 0.5 |
| 0.0125 | -195248 | -0.625 | | 195.248 | 0.625 |
| 0.01625 | -252398 | -0.8125 | | 252.398 | 0.8125 |
| 0.017656 | -272719 | -0.88281 | | 272.719 | 0.882813 |
| 0.019766 | -289237 | -0.98828 | | 289.237 | 0.988281 |
| 0.021875 | -291792 | -1.09375 | | 291.792 | 1.09375 |
| 0.023984 | -293760 | -1.19922 | | 293.76 | 1.19922 |
| 0.026094 | -295773 | -1.30469 | | 295.773 | 1.30469 |
| 0.029258 | -299464 | -1.46289 | | 299.464 | 1.46289 |
| 0.034004 | -305191 | -1.7002 | | 305.191 | 1.7002 |
| 0.041123 | -314418 | -2.05615 | | 314.418 | 2.05615 |
| 0.051802 | -327377 | -2.59009 | | 327.377 | 2.59009 |
| 0.062481 | -337290 | -3.12402 | | 337.29 | 3.12402 |
| 0.073159 | -345206 | -3.65796 | | 345.206 | 3.65796 |
| 0.089177 | -353414 | -4.45886 | | 353.414 | 4.45886 |
| 0.093182 | -354905 | -4.65909 | | 354.905 | 4.65909 |
| 0.097186 | -356164 | -4.85931 | | 356.164 | 4.85931 |
| 0.103193 | -357698 | -5.15965 | | 357.698 | 5.15965 |
| 0.112203 | -359151 | -5.61016 | | 359.151 | 5.61016 |
| 0.121213 | -359485 | -6.06067 | | 359.485 | 6.06067 |
| 0.130224 | -358347 | -6.51118 | | 358.347 | 6.51118 |
| 0.139234 | -355757 | -6.96169 | | 355.757 | 6.96169 |
| 0.148244 | -351794 | -7.41219 | | 351.794 | 7.41219 |
| 0.157254 | -346600 | -7.8627 | | 346.6 | 7.8627 |
| 0.166264 | -340337 | -8.31321 | | 340.337 | 8.31321 |
| 0.168517 | -339788 | -8.42584 | | 339.788 | 8.42584 |
| 0.170769 | -338001 | -8.53846 | | 338.001 | 8.53846 |
| 0.174148 | -335071 | -8.7074 | | 335.071 | 8.7074 |
| 0.179216 | -330455 | -8.96082 | | 330.455 | 8.96082 |
| 0.184285 | -325994 | -9.21423 | | 325.994 | 9.21423 |
| 0.189353 | -321347 | -9.46764 | | 321.347 | 9.46764 |
| 0.194421 | -316491 | -9.72105 | | 316.491 | 9.72105 |
| 0.199489 | -311395 | -9.97446 | | 311.395 | 9.97446 |
| 0.204557 | -306050 | -10.2279 | | 306.05 | 10.2279 |
| 0.209626 | -300502 | -10.4813 | | 300.502 | 10.4813 |
| 0.214694 | -294807 | -10.7347 | | 294.807 | 10.7347 |
| 0.219762 | -289007 | -10.9881 | | 289.007 | 10.9881 |
| 0.22483 | -283126 | -11.2415 | | 283.126 | 11.2415 |
| 0.229898 | -277189 | -11.4949 | | 277.189 | 11.4949 |
| 0.237501 | -267331 | -11.875 | | 267.331 | 11.875 |
| 0.239401 | -267070 | -11.9701 | | 267.07 | 11.9701 |
| 0.241302 | -264751 | -12.0651 | | 264.751 | 12.0651 |
| 0.244153 | -261067 | -12.2076 | | 261.067 | 12.2076 |
| 0.248429 | -255530 | -12.4215 | | 255.53 | 12.4215 |
| 0.254844 | -247147 | -12.7422 | | 247.147 | 12.7422 |
| 0.264465 | -234231 | -13.2233 | | 234.231 | 13.2233 |
| 0.266871 | -235083 | -13.3435 | | 235.083 | 13.3435 |
| 0.269276 | -232149 | -13.4638 | | 232.149 | 13.4638 |
| 0.272884 | -227444 | -13.6442 | | 227.444 | 13.6442 |
| 0.278296 | -220402 | -13.9148 | | 220.402 | 13.9148 |
| 0.283709 | -214560 | -14.1854 | | 214.56 | 14.1854 |
| 0.289121 | -208876 | -14.456 | | 208.876 | 14.456 |
| 0.297239 | -199046 | -14.862 | | 199.046 | 14.862 |
| 0.309417 | -185396 | -15.4708 | | 185.396 | 15.4708 |
| 0.312461 | -189287 | -15.623 | | 189.287 | 15.623 |
| 0.315505 | -186225 | -15.7753 | | 186.225 | 15.7753 |
| 0.320072 | -181480 | -16.0036 | | 181.48 | 16.0036 |
| 0.326922 | -174493 | -16.3461 | | 174.493 | 16.3461 |
| 0.32735 | -177181 | -16.3675 | | 177.181 | 16.3675 |
| 0.327778 | -178251 | -16.3889 | | 178.251 | 16.3889 |
| 0.328206 | -178045 | -16.4103 | | 178.045 | 16.4103 |
| 0.328634 | -177753 | -16.4317 | | 177.753 | 16.4317 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *23 mm* | | | | | |
| $F_{u,fem}$ | 355.446 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -156179 | -0.5 | | 156.179 | 0.5 |
| 0.0125 | -194853 | -0.625 | | 194.853 | 0.625 |
| 0.01625 | -251723 | -0.8125 | | 251.723 | 0.8125 |
| 0.017656 | -271736 | -0.88281 | | 271.736 | 0.882813 |
| 0.019766 | -286093 | -0.98828 | | 286.093 | 0.988281 |
| 0.021875 | -288603 | -1.09375 | | 288.603 | 1.09375 |
| 0.023984 | -290558 | -1.19922 | | 290.558 | 1.19922 |
| 0.027148 | -293711 | -1.35742 | | 293.711 | 1.35742 |
| 0.031895 | -299329 | -1.59473 | | 299.329 | 1.59473 |
| 0.039014 | -308179 | -1.95068 | | 308.179 | 1.95068 |
| 0.046133 | -317638 | -2.30664 | | 317.638 | 2.30664 |
| 0.053252 | -325608 | -2.6626 | | 325.608 | 2.6626 |
| 0.063931 | -335065 | -3.19653 | | 335.065 | 3.19653 |
| 0.079949 | -345632 | -3.99744 | | 345.632 | 3.99744 |
| 0.095967 | -352140 | -4.79834 | | 352.14 | 4.79834 |
| 0.099971 | -353246 | -4.99857 | | 353.246 | 4.99857 |
| 0.103976 | -354134 | -5.19879 | | 354.134 | 5.19879 |
| 0.109983 | -355070 | -5.49913 | | 355.07 | 5.49913 |
| 0.118993 | -355446 | -5.94964 | | 355.446 | 5.94964 |
| 0.122372 | -355364 | -6.11858 | | 355.364 | 6.11858 |
| 0.12575 | -354999 | -6.28752 | | 354.999 | 6.28752 |
| 0.129129 | -354433 | -6.45646 | | 354.433 | 6.45646 |
| 0.132508 | -353671 | -6.6254 | | 353.671 | 6.6254 |
| 0.135887 | -352730 | -6.79434 | | 352.73 | 6.79434 |
| 0.140955 | -350860 | -7.04775 | | 350.86 | 7.04775 |
| 0.148557 | -347092 | -7.42787 | | 347.092 | 7.42787 |
| 0.15616 | -342678 | -7.80798 | | 342.678 | 7.80798 |
| 0.163762 | -337508 | -8.1881 | | 337.508 | 8.1881 |
| 0.171364 | -331496 | -8.56822 | | 331.496 | 8.56822 |
| 0.178967 | -324999 | -8.94833 | | 324.999 | 8.94833 |
| 0.186569 | -318113 | -9.32845 | | 318.113 | 9.32845 |
| 0.194171 | -310763 | -9.70857 | | 310.763 | 9.70857 |
| 0.201774 | -302859 | -10.0887 | | 302.859 | 10.0887 |
| 0.209376 | -294486 | -10.4688 | | 294.486 | 10.4688 |
| 0.216978 | -285811 | -10.8489 | | 285.811 | 10.8489 |
| 0.224581 | -276946 | -11.229 | | 276.946 | 11.229 |
| 0.232183 | -267948 | -11.6091 | | 267.948 | 11.6091 |
| 0.239785 | -258884 | -11.9893 | | 258.884 | 11.9893 |
| 0.247388 | -249785 | -12.3694 | | 249.785 | 12.3694 |
| 0.25499 | -240665 | -12.7495 | | 240.665 | 12.7495 |
| 0.25689 | -240911 | -12.8445 | | 240.911 | 12.8445 |
| 0.258791 | -238592 | -12.9396 | | 238.592 | 12.9396 |
| 0.261642 | -234883 | -13.0821 | | 234.883 | 13.0821 |
| 0.265918 | -229334 | -13.2959 | | 229.334 | 13.2959 |
| 0.272333 | -221084 | -13.6166 | | 221.084 | 13.6166 |
| 0.281954 | -208991 | -14.0977 | | 208.991 | 14.0977 |
| 0.296387 | -192047 | -14.8193 | | 192.047 | 14.8193 |
| 0.310819 | -180076 | -15.541 | | 180.076 | 15.541 |
| 0.325252 | -169215 | -16.2626 | | 169.215 | 16.2626 |
| 0.32886 | -173292 | -16.443 | | 173.292 | 16.443 |
| 0.332468 | -170099 | -16.6234 | | 170.099 | 16.6234 |
| 0.336076 | -167612 | -16.8038 | | 167.612 | 16.8038 |
| 0.341489 | -162537 | -17.0744 | | 162.537 | 17.0744 |
| 0.346901 | -158857 | -17.345 | | 158.857 | 17.345 |
| 0.347239 | -160526 | -17.362 | | 160.526 | 17.362 |
| 0.347577 | -161487 | -17.3789 | | 161.487 | 17.3789 |
| 0.347916 | -161847 | -17.3958 | | 161.847 | 17.3958 |
| 0.348254 | -161671 | -17.4127 | | 161.671 | 17.4127 |
| 0.348592 | -161476 | -17.4296 | | 161.476 | 17.4296 |
| 0.3491 | -161006 | -17.455 | | 161.006 | 17.455 |
| 0.349861 | -160310 | -17.493 | | 160.31 | 17.493 |
| 0.351002 | -159219 | -17.5501 | | 159.219 | 17.5501 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *24 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 351.237 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -155874 | -0.5 | | 155.874 | 0.5 |
| 0.0125 | -194435 | -0.625 | | 194.435 | 0.625 |
| 0.01625 | -251004 | -0.8125 | | 251.004 | 0.8125 |
| 0.017656 | -270666 | -0.88281 | | 270.666 | 0.882813 |
| 0.019766 | -282945 | -0.98828 | | 282.945 | 0.988281 |
| 0.021875 | -285417 | -1.09375 | | 285.417 | 1.09375 |
| 0.023984 | -287354 | -1.19922 | | 287.354 | 1.19922 |
| 0.027148 | -290519 | -1.35742 | | 290.519 | 1.35742 |
| 0.031895 | -296076 | -1.59473 | | 296.076 | 1.59473 |
| 0.039014 | -304834 | -1.95068 | | 304.834 | 1.95068 |
| 0.049692 | -318186 | -2.48462 | | 318.186 | 2.48462 |
| 0.060371 | -328650 | -3.01855 | | 328.65 | 3.01855 |
| 0.07105 | -336777 | -3.55249 | | 336.777 | 3.55249 |
| 0.087068 | -345355 | -4.35339 | | 345.355 | 4.35339 |
| 0.091072 | -346944 | -4.55362 | | 346.944 | 4.55362 |
| 0.095077 | -348285 | -4.75385 | | 348.285 | 4.75385 |
| 0.101084 | -349844 | -5.05418 | | 349.844 | 5.05418 |
| 0.110094 | -351237 | -5.50469 | | 351.237 | 5.50469 |
| 0.123609 | -350819 | -6.18045 | | 350.819 | 6.18045 |
| 0.126988 | -350615 | -6.34939 | | 350.615 | 6.34939 |
| 0.130367 | -349904 | -6.51834 | | 349.904 | 6.51834 |
| 0.133746 | -349020 | -6.68728 | | 349.02 | 6.68728 |
| 0.137124 | -347947 | -6.85622 | | 347.947 | 6.85622 |
| 0.142193 | -345854 | -7.10963 | | 345.854 | 7.10963 |
| 0.149795 | -341780 | -7.48974 | | 341.78 | 7.48974 |
| 0.157397 | -337143 | -7.86986 | | 337.143 | 7.86986 |
| 0.165 | -331677 | -8.24998 | | 331.677 | 8.24998 |
| 0.172602 | -325510 | -8.63009 | | 325.51 | 8.63009 |
| 0.180204 | -318944 | -9.01021 | | 318.944 | 9.01021 |
| 0.187806 | -312025 | -9.39032 | | 312.025 | 9.39032 |
| 0.195409 | -304674 | -9.77044 | | 304.674 | 9.77044 |
| 0.203011 | -296809 | -10.1506 | | 296.809 | 10.1506 |
| 0.210613 | -288503 | -10.5307 | | 288.503 | 10.5307 |
| 0.218216 | -279920 | -10.9108 | | 279.92 | 10.9108 |
| 0.225818 | -271156 | -11.2909 | | 271.156 | 11.2909 |
| 0.23342 | -262270 | -11.671 | | 262.27 | 11.671 |
| 0.241023 | -253317 | -12.0511 | | 253.317 | 12.0511 |
| 0.248625 | -244326 | -12.4313 | | 244.326 | 12.4313 |
| 0.250526 | -244377 | -12.5263 | | 244.377 | 12.5263 |
| 0.252426 | -242089 | -12.6213 | | 242.089 | 12.6213 |
| 0.255277 | -238438 | -12.7639 | | 238.438 | 12.7639 |
| 0.259553 | -232981 | -12.9777 | | 232.981 | 12.9777 |
| 0.265968 | -224855 | -13.2984 | | 224.855 | 13.2984 |
| 0.27559 | -212858 | -13.7795 | | 212.858 | 13.7795 |
| 0.285211 | -203111 | -14.2606 | | 203.111 | 14.2606 |
| 0.294833 | -193918 | -14.7416 | | 193.918 | 14.7416 |
| 0.298441 | -194081 | -14.9221 | | 194.081 | 14.9221 |
| 0.303853 | -188066 | -15.1927 | | 188.066 | 15.1927 |
| 0.311972 | -179757 | -15.5986 | | 179.757 | 15.5986 |
| 0.324149 | -167959 | -16.2075 | | 167.959 | 16.2075 |
| 0.336327 | -159276 | -16.8163 | | 159.276 | 16.8163 |
| 0.336897 | -163060 | -16.8449 | | 163.06 | 16.8449 |
| 0.337468 | -164932 | -16.8734 | | 164.932 | 16.8734 |
| 0.338039 | -165119 | -16.9019 | | 165.119 | 16.9019 |
| 0.33861 | -164763 | -16.9305 | | 164.763 | 16.9305 |
| 0.339181 | -164417 | -16.959 | | 164.417 | 16.959 |
| 0.340037 | -163665 | -17.0018 | | 163.665 | 17.0018 |
| 0.341321 | -162536 | -17.0661 | | 162.536 | 17.0661 |
| 0.343248 | -160806 | -17.1624 | | 160.806 | 17.1624 |
| 0.346137 | -158158 | -17.3069 | | 158.158 | 17.3069 |
| 0.350472 | -154021 | -17.5236 | | 154.021 | 17.5236 |
| 0.350743 | -155435 | -17.5372 | | 155.435 | 17.5372 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *25 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 347.183 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -155553 | -0.5 | | 155.553 | 0.5 |
| 0.0125 | -193992 | -0.625 | | 193.992 | 0.625 |
| 0.01625 | -250229 | -0.8125 | | 250.229 | 0.8125 |
| 0.017656 | -269480 | -0.88281 | | 269.48 | 0.882813 |
| 0.019766 | -279742 | -0.98828 | | 279.742 | 0.988281 |
| 0.021875 | -282157 | -1.09375 | | 282.157 | 1.09375 |
| 0.023984 | -284097 | -1.19922 | | 284.097 | 1.19922 |
| 0.027148 | -287268 | -1.35742 | | 287.268 | 1.35742 |
| 0.031895 | -292788 | -1.59473 | | 292.788 | 1.59473 |
| 0.039014 | -301419 | -1.95068 | | 301.419 | 1.95068 |
| 0.046133 | -310741 | -2.30664 | | 310.741 | 2.30664 |
| 0.053252 | -318608 | -2.6626 | | 318.608 | 2.6626 |
| 0.060371 | -325246 | -3.01855 | | 325.246 | 3.01855 |
| 0.07105 | -333288 | -3.55249 | | 333.288 | 3.55249 |
| 0.087068 | -341633 | -4.35339 | | 341.633 | 4.35339 |
| 0.091072 | -343153 | -4.55362 | | 343.153 | 4.55362 |
| 0.095077 | -344429 | -4.75385 | | 344.429 | 4.75385 |
| 0.101084 | -345922 | -5.05418 | | 345.922 | 5.05418 |
| 0.110094 | -347183 | -5.50469 | | 347.183 | 5.50469 |
| 0.123609 | -346491 | -6.18045 | | 346.491 | 6.18045 |
| 0.126988 | -346122 | -6.34939 | | 346.122 | 6.34939 |
| 0.130367 | -345328 | -6.51834 | | 345.328 | 6.51834 |
| 0.133746 | -344346 | -6.68728 | | 344.346 | 6.68728 |
| 0.137124 | -343173 | -6.85622 | | 343.173 | 6.85622 |
| 0.142193 | -340941 | -7.10963 | | 340.941 | 7.10963 |
| 0.149795 | -336633 | -7.48974 | | 336.633 | 7.48974 |
| 0.157397 | -331736 | -7.86986 | | 331.736 | 7.86986 |
| 0.165 | -325951 | -8.24998 | | 325.951 | 8.24998 |
| 0.172602 | -319586 | -8.63009 | | 319.586 | 8.63009 |
| 0.180204 | -312888 | -9.01021 | | 312.888 | 9.01021 |
| 0.187806 | -305895 | -9.39032 | | 305.895 | 9.39032 |
| 0.195409 | -298526 | -9.77044 | | 298.526 | 9.77044 |
| 0.203011 | -290676 | -10.1506 | | 290.676 | 10.1506 |
| 0.210613 | -282399 | -10.5307 | | 282.399 | 10.5307 |
| 0.218216 | -273856 | -10.9108 | | 273.856 | 10.9108 |
| 0.225818 | -265142 | -11.2909 | | 265.142 | 11.2909 |
| 0.23342 | -256330 | -11.671 | | 256.33 | 11.671 |
| 0.241023 | -247461 | -12.0511 | | 247.461 | 12.0511 |
| 0.248625 | -238607 | -12.4313 | | 238.607 | 12.4313 |
| 0.250526 | -238753 | -12.5263 | | 238.753 | 12.5263 |
| 0.252426 | -236499 | -12.6213 | | 236.499 | 12.6213 |
| 0.255277 | -232918 | -12.7639 | | 232.918 | 12.7639 |
| 0.259553 | -227575 | -12.9777 | | 227.575 | 12.9777 |
| 0.265968 | -219599 | -13.2984 | | 219.599 | 13.2984 |
| 0.27559 | -207705 | -13.7795 | | 207.705 | 13.7795 |
| 0.285211 | -197861 | -14.2606 | | 197.861 | 14.2606 |
| 0.294833 | -188426 | -14.7416 | | 188.426 | 14.7416 |
| 0.304455 | -179648 | -15.2227 | | 179.648 | 15.2227 |
| 0.30686 | -182406 | -15.343 | | 182.406 | 15.343 |
| 0.309265 | -179997 | -15.4633 | | 179.997 | 15.4633 |
| 0.312874 | -176219 | -15.6437 | | 176.219 | 15.6437 |
| 0.318286 | -170661 | -15.9143 | | 170.661 | 15.9143 |
| 0.326404 | -162527 | -16.3202 | | 162.527 | 16.3202 |
| 0.328434 | -166035 | -16.4217 | | 166.035 | 16.4217 |
| 0.328941 | -166289 | -16.4471 | | 166.289 | 16.4471 |
| 0.329449 | -165867 | -16.4724 | | 165.867 | 16.4724 |
| 0.33021 | -165133 | -16.5105 | | 165.133 | 16.5105 |
| 0.331351 | -164024 | -16.5676 | | 164.024 | 16.5676 |
| 0.333064 | -162334 | -16.6532 | | 162.334 | 16.6532 |
| 0.335632 | -159744 | -16.7816 | | 159.744 | 16.7816 |
| 0.335873 | -160954 | -16.7937 | | 160.954 | 16.7937 |
| 0.336114 | -161496 | -16.8057 | | 161.496 | 16.8057 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *26 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 343.235 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -155218 | -0.5 | | 155.218 | 0.5 |
| 0.0125 | -193534 | -0.625 | | 193.534 | 0.625 |
| 0.01625 | -249419 | -0.8125 | | 249.419 | 0.8125 |
| 0.02 | -276886 | -1 | | 276.886 | 1 |
| 0.02375 | -280669 | -1.1875 | | 280.669 | 1.1875 |
| 0.0275 | -284487 | -1.375 | | 284.487 | 1.375 |
| 0.03125 | -288905 | -1.5625 | | 288.905 | 1.5625 |
| 0.036875 | -295479 | -1.84375 | | 295.479 | 1.84375 |
| 0.045313 | -306307 | -2.26563 | | 306.307 | 2.26563 |
| 0.05375 | -315597 | -2.6875 | | 315.597 | 2.6875 |
| 0.062188 | -323244 | -3.10938 | | 323.244 | 3.10938 |
| 0.070625 | -329527 | -3.53125 | | 329.527 | 3.53125 |
| 0.083281 | -336461 | -4.16406 | | 336.461 | 4.16406 |
| 0.095938 | -340955 | -4.79688 | | 340.955 | 4.79688 |
| 0.108594 | -343235 | -5.42969 | | 343.235 | 5.42969 |
| 0.12125 | -343116 | -6.0625 | | 343.116 | 6.0625 |
| 0.133906 | -340059 | -6.69531 | | 340.059 | 6.69531 |
| 0.13707 | -339603 | -6.85352 | | 339.603 | 6.85352 |
| 0.140234 | -338380 | -7.01172 | | 338.38 | 7.01172 |
| 0.14498 | -336114 | -7.24902 | | 336.114 | 7.24902 |
| 0.1521 | -331943 | -7.60498 | | 331.943 | 7.60498 |
| 0.159219 | -327382 | -7.96094 | | 327.382 | 7.96094 |
| 0.166338 | -322084 | -8.31689 | | 322.084 | 8.31689 |
| 0.173457 | -316385 | -8.67285 | | 316.385 | 8.67285 |
| 0.180576 | -310456 | -9.02881 | | 310.456 | 9.02881 |
| 0.187695 | -304380 | -9.38477 | | 304.38 | 9.38477 |
| 0.194814 | -298186 | -9.74072 | | 298.186 | 9.74072 |
| 0.201934 | -291845 | -10.0967 | | 291.845 | 10.0967 |
| 0.209053 | -285265 | -10.4526 | | 285.265 | 10.4526 |
| 0.216172 | -278323 | -10.8086 | | 278.323 | 10.8086 |
| 0.223291 | -271019 | -11.1646 | | 271.019 | 11.1646 |
| 0.23041 | -263489 | -11.5205 | | 263.489 | 11.5205 |
| 0.237529 | -255831 | -11.8765 | | 255.831 | 11.8765 |
| 0.244648 | -248093 | -12.2324 | | 248.093 | 12.2324 |
| 0.251768 | -240347 | -12.5884 | | 240.347 | 12.5884 |
| 0.258887 | -232671 | -12.9443 | | 232.671 | 12.9443 |
| 0.266006 | -225058 | -13.3003 | | 225.058 | 13.3003 |
| 0.273125 | -217495 | -13.6563 | | 217.495 | 13.6563 |
| 0.280244 | -209999 | -14.0122 | | 209.999 | 14.0122 |
| 0.287363 | -202655 | -14.3682 | | 202.655 | 14.3682 |
| 0.289143 | -203808 | -14.4572 | | 203.808 | 14.4572 |
| 0.290923 | -201893 | -14.5461 | | 201.893 | 14.5461 |
| 0.293593 | -198831 | -14.6796 | | 198.831 | 14.6796 |
| 0.297597 | -194308 | -14.8799 | | 194.308 | 14.8799 |
| 0.303604 | -187698 | -15.1802 | | 187.698 | 15.1802 |
| 0.312614 | -178254 | -15.6307 | | 178.254 | 15.6307 |
| 0.326129 | -165226 | -16.3065 | | 165.226 | 16.3065 |
| 0.329508 | -169541 | -16.4754 | | 169.541 | 16.4754 |
| 0.332887 | -166584 | -16.6443 | | 166.584 | 16.6443 |
| 0.336266 | -164316 | -16.8133 | | 164.316 | 16.8133 |
| 0.341334 | -159682 | -17.0667 | | 159.682 | 17.0667 |
| 0.343234 | -160952 | -17.1617 | | 160.952 | 17.1617 |
| 0.346085 | -158037 | -17.3043 | | 158.037 | 17.3043 |
| 0.350362 | -154260 | -17.5181 | | 154.26 | 17.5181 |
| 0.351965 | -155776 | -17.5983 | | 155.776 | 17.5983 |
| 0.353569 | -154336 | -17.6784 | | 154.336 | 17.6784 |
| 0.355172 | -153452 | -17.7586 | | 153.452 | 17.7586 |
| 0.357578 | -151071 | -17.8789 | | 151.071 | 17.8789 |
| 0.357803 | -152106 | -17.8902 | | 152.106 | 17.8902 |
| 0.358029 | -152653 | -17.9014 | | 152.653 | 17.9014 |
| 0.358254 | -152799 | -17.9127 | | 152.799 | 17.9127 |
| 0.35848 | -152654 | -17.924 | | 152.654 | 17.924 |

| | | | | | |
|---|---|---|---|---|---|
| **S355** | | | | | |
| **1 hole** | | | | | |
| *27 mm* | | | | | |
| $F_{u,fem}$ | 339.322 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -154864 | -0.5 | | 154.864 | 0.5 |
| 0.0125 | -193041 | -0.625 | | 193.041 | 0.625 |
| 0.01625 | -248536 | -0.8125 | | 248.536 | 0.8125 |
| 0.017656 | -266797 | -0.88281 | | 266.797 | 0.882813 |
| 0.019766 | -273405 | -0.98828 | | 273.405 | 0.988281 |
| 0.021875 | -275740 | -1.09375 | | 275.74 | 1.09375 |
| 0.023984 | -277669 | -1.19922 | | 277.669 | 1.19922 |
| 0.027148 | -280868 | -1.35742 | | 280.868 | 1.35742 |
| 0.031895 | -286276 | -1.59473 | | 286.276 | 1.59473 |
| 0.039014 | -294695 | -1.95068 | | 294.695 | 1.95068 |
| 0.049692 | -307783 | -2.48462 | | 307.783 | 2.48462 |
| 0.060371 | -318184 | -3.01855 | | 318.184 | 3.01855 |
| 0.07105 | -326127 | -3.55249 | | 326.127 | 3.55249 |
| 0.087068 | -334156 | -4.35339 | | 334.156 | 4.35339 |
| 0.091072 | -335584 | -4.55362 | | 335.584 | 4.55362 |
| 0.095077 | -336771 | -4.75385 | | 336.771 | 4.75385 |
| 0.101084 | -338127 | -5.05418 | | 338.127 | 5.05418 |
| 0.110094 | -339182 | -5.50469 | | 339.182 | 5.50469 |
| 0.113473 | -339322 | -5.67363 | | 339.322 | 5.67363 |
| 0.118541 | -339135 | -5.92704 | | 339.135 | 5.92704 |
| 0.126143 | -337946 | -6.30716 | | 337.946 | 6.30716 |
| 0.133746 | -335753 | -6.68728 | | 335.753 | 6.68728 |
| 0.141348 | -332531 | -7.06739 | | 332.531 | 7.06739 |
| 0.14895 | -328344 | -7.44751 | | 328.344 | 7.44751 |
| 0.156552 | -323328 | -7.82762 | | 323.328 | 7.82762 |
| 0.164155 | -317419 | -8.20774 | | 317.419 | 8.20774 |
| 0.171757 | -311013 | -8.58786 | | 311.013 | 8.58786 |
| 0.179359 | -304320 | -8.96797 | | 304.32 | 8.96797 |
| 0.186962 | -297398 | -9.34809 | | 297.398 | 9.34809 |
| 0.194564 | -290193 | -9.72821 | | 290.193 | 9.72821 |
| 0.202166 | -282594 | -10.1083 | | 282.594 | 10.1083 |
| 0.209769 | -274574 | -10.4884 | | 274.574 | 10.4884 |
| 0.217371 | -266260 | -10.8686 | | 266.26 | 10.8686 |
| 0.224973 | -257781 | -11.2487 | | 257.781 | 11.2487 |
| 0.232576 | -249211 | -11.6288 | | 249.211 | 11.6288 |
| 0.240178 | -240609 | -12.0089 | | 240.609 | 12.0089 |
| 0.24778 | -232073 | -12.389 | | 232.073 | 12.389 |
| 0.255383 | -223612 | -12.7691 | | 223.612 | 12.7691 |
| 0.262985 | -215203 | -13.1493 | | 215.203 | 13.1493 |
| 0.270587 | -206878 | -13.5294 | | 206.878 | 13.5294 |
| 0.272488 | -207880 | -13.6244 | | 207.88 | 13.6244 |
| 0.274389 | -205734 | -13.7194 | | 205.734 | 13.7194 |
| 0.277239 | -202288 | -13.862 | | 202.288 | 13.862 |
| 0.281516 | -197155 | -14.0758 | | 197.155 | 14.0758 |
| 0.28793 | -189610 | -14.3965 | | 189.61 | 14.3965 |
| 0.294345 | -183720 | -14.7172 | | 183.72 | 14.7172 |
| 0.300759 | -178064 | -15.038 | | 178.064 | 15.038 |
| 0.310381 | -168053 | -15.519 | | 168.053 | 15.519 |
| 0.313989 | -169549 | -15.6994 | | 169.549 | 15.6994 |
| 0.319401 | -163808 | -15.9701 | | 163.808 | 15.9701 |
| 0.327519 | -156100 | -16.376 | | 156.1 | 16.376 |
| 0.329549 | -159704 | -16.4774 | | 159.704 | 16.4774 |
| 0.331579 | -157671 | -16.5789 | | 157.671 | 16.5789 |
| 0.333608 | -156404 | -16.6804 | | 156.404 | 16.6804 |
| 0.335638 | -155016 | -16.7819 | | 155.016 | 16.7819 |
| 0.338682 | -151895 | -16.9341 | | 151.895 | 16.9341 |
| 0.338872 | -152981 | -16.9436 | | 152.981 | 16.9436 |
| 0.339063 | -153616 | -16.9531 | | 153.616 | 16.9531 |
| 0.339253 | -154060 | -16.9626 | | 154.06 | 16.9626 |
| 0.339443 | -154154 | -16.9722 | | 154.154 | 16.9722 |
| 0.339729 | -153888 | -16.9864 | | 153.888 | 16.9864 |
| 0.340157 | -153484 | -17.0078 | | 153.484 | 17.0078 |

| | | | | | |
|---|---|---|---|---|---|
| **S355** | | | | | |
| **1 hole** | | | | | |
| *28 mm* | | | | | |
| $F_{u,fem}$ | 335.068 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -154496 | -0.5 | | 154.496 | 0.5 |
| 0.0125 | -192532 | -0.625 | | 192.532 | 0.625 |
| 0.01625 | -247605 | -0.8125 | | 247.605 | 0.8125 |
| 0.017656 | -265250 | -0.88281 | | 265.25 | 0.882813 |
| 0.019766 | -270258 | -0.98828 | | 270.258 | 0.988281 |
| 0.021875 | -272550 | -1.09375 | | 272.55 | 1.09375 |
| 0.023984 | -274470 | -1.19922 | | 274.47 | 1.19922 |
| 0.027148 | -277663 | -1.35742 | | 277.663 | 1.35742 |
| 0.031895 | -283028 | -1.59473 | | 283.028 | 1.59473 |
| 0.039014 | -291344 | -1.95068 | | 291.344 | 1.95068 |
| 0.049692 | -304321 | -2.48462 | | 304.321 | 2.48462 |
| 0.060371 | -314691 | -3.01855 | | 314.691 | 3.01855 |
| 0.07105 | -322580 | -3.55249 | | 322.58 | 3.55249 |
| 0.087068 | -330435 | -4.35339 | | 330.435 | 4.35339 |
| 0.093075 | -332409 | -4.65373 | | 332.409 | 4.65373 |
| 0.102085 | -334383 | -5.10424 | | 334.383 | 5.10424 |
| 0.1156 | -335068 | -5.78 | | 335.068 | 5.78 |
| 0.118979 | -334943 | -5.94894 | | 334.943 | 5.94894 |
| 0.122358 | -334528 | -6.11788 | | 334.528 | 6.11788 |
| 0.127426 | -333469 | -6.37129 | | 333.469 | 6.37129 |
| 0.132494 | -331997 | -6.62471 | | 331.997 | 6.62471 |
| 0.137562 | -330079 | -6.87812 | | 330.079 | 6.87812 |
| 0.145165 | -326153 | -7.25823 | | 326.153 | 7.25823 |
| 0.152767 | -321488 | -7.63835 | | 321.488 | 7.63835 |
| 0.160369 | -315936 | -8.01847 | | 315.936 | 8.01847 |
| 0.167972 | -309723 | -8.39858 | | 309.723 | 8.39858 |
| 0.175574 | -303178 | -8.7787 | | 303.178 | 8.7787 |
| 0.183176 | -296418 | -9.15881 | | 296.418 | 9.15881 |
| 0.190779 | -289455 | -9.53893 | | 289.455 | 9.53893 |
| 0.198381 | -282216 | -9.91905 | | 282.216 | 9.91905 |
| 0.205983 | -274599 | -10.2992 | | 274.599 | 10.2992 |
| 0.213586 | -266602 | -10.6793 | | 266.602 | 10.6793 |
| 0.221188 | -258362 | -11.0594 | | 258.362 | 11.0594 |
| 0.22879 | -249995 | -11.4395 | | 249.995 | 11.4395 |
| 0.236393 | -241559 | -11.8196 | | 241.559 | 11.8196 |
| 0.243995 | -233130 | -12.1997 | | 233.13 | 12.1997 |
| 0.251597 | -224710 | -12.5799 | | 224.71 | 12.5799 |
| 0.2592 | -216296 | -12.96 | | 216.296 | 12.96 |
| 0.2611 | -216830 | -13.055 | | 216.83 | 13.055 |
| 0.263001 | -214674 | -13.15 | | 214.674 | 13.15 |
| 0.265852 | -211210 | -13.2926 | | 211.21 | 13.2926 |
| 0.270128 | -206018 | -13.5064 | | 206.018 | 13.5064 |
| 0.276542 | -198311 | -13.8271 | | 198.311 | 13.8271 |
| 0.282957 | -192031 | -14.1478 | | 192.031 | 14.1478 |
| 0.289371 | -185977 | -14.4686 | | 185.977 | 14.4686 |
| 0.298993 | -175518 | -14.9496 | | 175.518 | 14.9496 |
| 0.313425 | -161304 | -15.6713 | | 161.304 | 15.6713 |
| 0.317034 | -165938 | -15.8517 | | 165.938 | 15.8517 |
| 0.320642 | -162741 | -16.0321 | | 162.741 | 16.0321 |
| 0.326054 | -157769 | -16.3027 | | 157.769 | 16.3027 |
| 0.334172 | -150399 | -16.7086 | | 150.399 | 16.7086 |
| 0.33468 | -153412 | -16.734 | | 153.412 | 16.734 |
| 0.335187 | -154945 | -16.7594 | | 154.945 | 16.7594 |
| 0.335694 | -154832 | -16.7847 | | 154.832 | 16.7847 |
| 0.336202 | -154519 | -16.8101 | | 154.519 | 16.8101 |
| 0.336709 | -154214 | -16.8355 | | 154.214 | 16.8355 |
| 0.33747 | -153527 | -16.8735 | | 153.527 | 16.8735 |
| 0.338612 | -152509 | -16.9306 | | 152.509 | 16.9306 |
| 0.340324 | -150940 | -17.0162 | | 150.94 | 17.0162 |
| 0.342893 | -148505 | -17.1447 | | 148.505 | 17.1447 |
| 0.345462 | -146919 | -17.2731 | | 146.919 | 17.2731 |
| 0.345622 | -147730 | -17.2811 | | 147.73 | 17.2811 |

| | | | | | |
|---|---|---|---|---|---|
| **S355** | | | | | |
| **1 hole** | | | | | |
| *29 mm* | | | | | |
| $F_{u,fem}$ | 331.215 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -154115 | -0.5 | | 154.115 | 0.5 |
| 0.0125 | -192004 | -0.625 | | 192.004 | 0.625 |
| 0.01625 | -246619 | -0.8125 | | 246.619 | 0.8125 |
| 0.02 | -267351 | -1 | | 267.351 | 1 |
| 0.02375 | -271033 | -1.1875 | | 271.033 | 1.1875 |
| 0.0275 | -274843 | -1.375 | | 274.843 | 1.375 |
| 0.03125 | -279152 | -1.5625 | | 279.152 | 1.5625 |
| 0.036875 | -285512 | -1.84375 | | 285.512 | 1.84375 |
| 0.038281 | -287286 | -1.91406 | | 287.286 | 1.91406 |
| 0.039688 | -289112 | -1.98438 | | 289.112 | 1.98438 |
| 0.041797 | -291875 | -2.08984 | | 291.875 | 2.08984 |
| 0.044961 | -295811 | -2.24805 | | 295.811 | 2.24805 |
| 0.049707 | -301202 | -2.48535 | | 301.202 | 2.48535 |
| 0.056826 | -308183 | -2.84131 | | 308.183 | 2.84131 |
| 0.067505 | -316704 | -3.37524 | | 316.704 | 3.37524 |
| 0.083523 | -325408 | -4.17615 | | 325.408 | 4.17615 |
| 0.087528 | -326979 | -4.37637 | | 326.979 | 4.37637 |
| 0.091532 | -328293 | -4.5766 | | 328.293 | 4.5766 |
| 0.097539 | -329838 | -4.87694 | | 329.838 | 4.87694 |
| 0.106549 | -331215 | -5.32745 | | 331.215 | 5.32745 |
| 0.120064 | -330930 | -6.00321 | | 330.93 | 6.00321 |
| 0.133579 | -327340 | -6.67897 | | 327.34 | 6.67897 |
| 0.136958 | -326689 | -6.84791 | | 326.689 | 6.84791 |
| 0.140337 | -325242 | -7.01685 | | 325.242 | 7.01685 |
| 0.145405 | -322613 | -7.27026 | | 322.613 | 7.27026 |
| 0.153008 | -317796 | -7.65038 | | 317.796 | 7.65038 |
| 0.16061 | -312385 | -8.03049 | | 312.385 | 8.03049 |
| 0.168212 | -306393 | -8.41061 | | 306.393 | 8.41061 |
| 0.175815 | -300125 | -8.79073 | | 300.125 | 8.79073 |
| 0.183417 | -293723 | -9.17084 | | 293.723 | 9.17084 |
| 0.191019 | -287271 | -9.55096 | | 287.271 | 9.55096 |
| 0.198622 | -280823 | -9.93108 | | 280.823 | 9.93108 |
| 0.206224 | -274406 | -10.3112 | | 274.406 | 10.3112 |
| 0.213826 | -268002 | -10.6913 | | 268.002 | 10.6913 |
| 0.221428 | -261566 | -11.0714 | | 261.566 | 11.0714 |
| 0.229031 | -254999 | -11.4515 | | 254.999 | 11.4515 |
| 0.236633 | -248153 | -11.8317 | | 248.153 | 11.8317 |
| 0.244235 | -240936 | -12.2118 | | 240.936 | 12.2118 |
| 0.251838 | -233482 | -12.5919 | | 233.482 | 12.5919 |
| 0.25944 | -225929 | -12.972 | | 225.929 | 12.972 |
| 0.267042 | -218380 | -13.3521 | | 218.38 | 13.3521 |
| 0.274645 | -210958 | -13.7322 | | 210.958 | 13.7322 |
| 0.282247 | -203684 | -14.1124 | | 203.684 | 14.1124 |
| 0.289849 | -196560 | -14.4925 | | 196.56 | 14.4925 |
| 0.297452 | -189594 | -14.8726 | | 189.594 | 14.8726 |
| 0.308855 | -177263 | -15.4428 | | 177.263 | 15.4428 |
| 0.311706 | -180110 | -15.5853 | | 180.11 | 15.5853 |
| 0.314557 | -177382 | -15.7278 | | 177.382 | 15.7278 |
| 0.318833 | -173056 | -15.9417 | | 173.056 | 15.9417 |
| 0.325248 | -166677 | -16.2624 | | 166.677 | 16.2624 |
| 0.331662 | -161951 | -16.5831 | | 161.951 | 16.5831 |
| 0.338077 | -157306 | -16.9038 | | 157.306 | 16.9038 |
| 0.344491 | -152833 | -17.2246 | | 152.833 | 17.2246 |
| 0.346897 | -154559 | -17.3448 | | 154.559 | 17.3448 |
| 0.349302 | -152498 | -17.4651 | | 152.498 | 17.4651 |
| 0.351707 | -151027 | -17.5854 | | 151.027 | 17.5854 |
| 0.355316 | -147431 | -17.7658 | | 147.431 | 17.7658 |
| 0.355541 | -148718 | -17.7771 | | 148.718 | 17.7771 |
| 0.355767 | -149507 | -17.7883 | | 149.507 | 17.7883 |
| 0.355992 | -150078 | -17.7996 | | 150.078 | 17.7996 |
| 0.356218 | -150135 | -17.8109 | | 150.135 | 17.8109 |
| 0.356443 | -150008 | -17.8222 | | 150.008 | 17.8222 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *30 mm* | | | | | |
| $F_{u,fem}$ | 327.453 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -153714 | -0.5 | | 153.714 | 0.5 |
| 0.0125 | -191442 | -0.625 | | 191.442 | 0.625 |
| 0.01625 | -245547 | -0.8125 | | 245.547 | 0.8125 |
| 0.02 | -264138 | -1 | | 264.138 | 1 |
| 0.02375 | -267808 | -1.1875 | | 267.808 | 1.1875 |
| 0.0275 | -271639 | -1.375 | | 271.639 | 1.375 |
| 0.03125 | -275896 | -1.5625 | | 275.896 | 1.5625 |
| 0.036875 | -282185 | -1.84375 | | 282.185 | 1.84375 |
| 0.0425 | -289188 | -2.125 | | 289.188 | 2.125 |
| 0.048125 | -295889 | -2.40625 | | 295.889 | 2.40625 |
| 0.056563 | -304332 | -2.82813 | | 304.332 | 2.82813 |
| 0.065 | -311359 | -3.25 | | 311.359 | 3.25 |
| 0.073438 | -316917 | -3.67188 | | 316.917 | 3.67188 |
| 0.086094 | -322733 | -4.30469 | | 322.733 | 4.30469 |
| 0.09084 | -324290 | -4.54199 | | 324.29 | 4.54199 |
| 0.097959 | -326023 | -4.89795 | | 326.023 | 4.89795 |
| 0.108638 | -327314 | -5.43188 | | 327.314 | 5.43188 |
| 0.112642 | -327453 | -5.63211 | | 327.453 | 5.63211 |
| 0.118649 | -327118 | -5.93245 | | 327.118 | 5.93245 |
| 0.127659 | -325383 | -6.38296 | | 325.383 | 6.38296 |
| 0.136669 | -322242 | -6.83347 | | 322.242 | 6.83347 |
| 0.145679 | -317699 | -7.28397 | | 317.699 | 7.28397 |
| 0.15469 | -311913 | -7.73448 | | 311.913 | 7.73448 |
| 0.156942 | -311285 | -7.84711 | | 311.285 | 7.84711 |
| 0.159195 | -309641 | -7.95974 | | 309.641 | 7.95974 |
| 0.162574 | -306928 | -8.12868 | | 306.928 | 8.12868 |
| 0.167642 | -302640 | -8.38209 | | 302.64 | 8.38209 |
| 0.175244 | -295872 | -8.7622 | | 295.872 | 8.7622 |
| 0.182846 | -289473 | -9.14232 | | 289.473 | 9.14232 |
| 0.190449 | -283029 | -9.52244 | | 283.029 | 9.52244 |
| 0.198051 | -276611 | -9.90255 | | 276.611 | 9.90255 |
| 0.205653 | -270253 | -10.2827 | | 270.253 | 10.2827 |
| 0.213256 | -263970 | -10.6628 | | 263.97 | 10.6628 |
| 0.220858 | -257760 | -11.0429 | | 257.76 | 11.0429 |
| 0.22846 | -251604 | -11.423 | | 251.604 | 11.423 |
| 0.236063 | -245455 | -11.8031 | | 245.455 | 11.8031 |
| 0.243665 | -239224 | -12.1832 | | 239.224 | 12.1832 |
| 0.251267 | -232770 | -12.5634 | | 232.77 | 12.5634 |
| 0.25887 | -225956 | -12.9435 | | 225.956 | 12.9435 |
| 0.266472 | -218896 | -13.3236 | | 218.896 | 13.3236 |
| 0.274074 | -211811 | -13.7037 | | 211.811 | 13.7037 |
| 0.281677 | -204739 | -14.0838 | | 204.739 | 14.0838 |
| 0.289279 | -197673 | -14.4639 | | 197.673 | 14.4639 |
| 0.296881 | -190634 | -14.8441 | | 190.634 | 14.8441 |
| 0.299732 | -190632 | -14.9866 | | 190.632 | 14.9866 |
| 0.304008 | -185861 | -15.2004 | | 185.861 | 15.2004 |
| 0.310423 | -179073 | -15.5211 | | 179.073 | 15.5211 |
| 0.316837 | -173782 | -15.8419 | | 173.782 | 15.8419 |
| 0.323252 | -168625 | -16.1626 | | 168.625 | 16.1626 |
| 0.332874 | -159130 | -16.6437 | | 159.13 | 16.6437 |
| 0.336482 | -161145 | -16.8241 | | 161.145 | 16.8241 |
| 0.341894 | -155402 | -17.0947 | | 155.402 | 17.0947 |
| 0.347306 | -151873 | -17.3653 | | 151.873 | 17.3653 |
| 0.352718 | -148062 | -17.6359 | | 148.062 | 17.6359 |
| 0.353057 | -150044 | -17.6528 | | 150.044 | 17.6528 |
| 0.353395 | -151225 | -17.6697 | | 151.225 | 17.6697 |
| 0.353733 | -151874 | -17.6867 | | 151.874 | 17.6867 |
| 0.354071 | -151724 | -17.7036 | | 151.724 | 17.7036 |
| 0.35441 | -151531 | -17.7205 | | 151.531 | 17.7205 |
| 0.354748 | -151334 | -17.7374 | | 151.334 | 17.7374 |
| 0.355255 | -150828 | -17.7628 | | 150.828 | 17.7628 |
| 0.356016 | -150101 | -17.8008 | | 150.101 | 17.8008 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *31 mm* | | | | | |
| $F_{u,fem}$ | 323.11 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -153294 | -0.5 | | 153.294 | 0.5 |
| 0.0125 | -190856 | -0.625 | | 190.856 | 0.625 |
| 0.01625 | -244404 | -0.8125 | | 244.404 | 0.8125 |
| 0.02 | -260973 | -1 | | 260.973 | 1 |
| 0.02375 | -264611 | -1.1875 | | 264.611 | 1.1875 |
| 0.0275 | -268424 | -1.375 | | 268.424 | 1.375 |
| 0.03125 | -272653 | -1.5625 | | 272.653 | 1.5625 |
| 0.036875 | -278870 | -1.84375 | | 278.87 | 1.84375 |
| 0.0425 | -285776 | -2.125 | | 285.776 | 2.125 |
| 0.048125 | -292415 | -2.40625 | | 292.415 | 2.40625 |
| 0.056563 | -300819 | -2.82813 | | 300.819 | 2.82813 |
| 0.069219 | -310644 | -3.46094 | | 310.644 | 3.46094 |
| 0.088203 | -319562 | -4.41016 | | 319.562 | 4.41016 |
| 0.092949 | -320936 | -4.64746 | | 320.936 | 4.64746 |
| 0.097695 | -321999 | -4.88477 | | 321.999 | 4.88477 |
| 0.104814 | -323005 | -5.24072 | | 323.005 | 5.24072 |
| 0.115493 | -323110 | -5.77466 | | 323.11 | 5.77466 |
| 0.119498 | -322820 | -5.97488 | | 322.82 | 5.97488 |
| 0.125504 | -321708 | -6.27522 | | 321.708 | 6.27522 |
| 0.131511 | -320005 | -6.57556 | | 320.005 | 6.57556 |
| 0.137518 | -317675 | -6.8759 | | 317.675 | 6.8759 |
| 0.143525 | -314772 | -7.17624 | | 314.772 | 7.17624 |
| 0.152535 | -308970 | -7.62675 | | 308.97 | 7.62675 |
| 0.154787 | -308335 | -7.73937 | | 308.335 | 7.73937 |
| 0.15704 | -306746 | -7.852 | | 306.746 | 7.852 |
| 0.160419 | -304108 | -8.02094 | | 304.108 | 8.02094 |
| 0.165487 | -299907 | -8.27435 | | 299.907 | 8.27435 |
| 0.173089 | -293240 | -8.65447 | | 293.24 | 8.65447 |
| 0.180692 | -286896 | -9.03458 | | 286.896 | 9.03458 |
| 0.188294 | -280489 | -9.4147 | | 280.489 | 9.4147 |
| 0.195896 | -274093 | -9.79482 | | 274.093 | 9.79482 |
| 0.203499 | -267740 | -10.1749 | | 267.74 | 10.1749 |
| 0.211101 | -261454 | -10.555 | | 261.454 | 10.555 |
| 0.218703 | -255238 | -10.9352 | | 255.238 | 10.9352 |
| 0.226306 | -249087 | -11.3153 | | 249.087 | 11.3153 |
| 0.233908 | -242966 | -11.6954 | | 242.966 | 11.6954 |
| 0.24151 | -236813 | -12.0755 | | 236.813 | 12.0755 |
| 0.249113 | -230513 | -12.4556 | | 230.513 | 12.4556 |
| 0.256715 | -223907 | -12.8357 | | 223.907 | 12.8357 |
| 0.264317 | -216978 | -13.2159 | | 216.978 | 13.2159 |
| 0.27192 | -209894 | -13.596 | | 209.894 | 13.596 |
| 0.279522 | -202745 | -13.9761 | | 202.745 | 13.9761 |
| 0.287124 | -195593 | -14.3562 | | 195.593 | 14.3562 |
| 0.289025 | -196539 | -14.4512 | | 196.539 | 14.4512 |
| 0.290925 | -194654 | -14.5463 | | 194.654 | 14.5463 |
| 0.293776 | -191629 | -14.6888 | | 191.629 | 14.6888 |
| 0.298053 | -187121 | -14.9026 | | 187.121 | 14.9026 |
| 0.304467 | -180426 | -15.2234 | | 180.426 | 15.2234 |
| 0.314089 | -170595 | -15.7044 | | 170.595 | 15.7044 |
| 0.32371 | -163092 | -16.1855 | | 163.092 | 16.1855 |
| 0.333332 | -155934 | -16.6666 | | 155.934 | 16.6666 |
| 0.33694 | -157470 | -16.847 | | 157.47 | 16.847 |
| 0.342352 | -152024 | -17.1176 | | 152.024 | 17.1176 |
| 0.347765 | -148560 | -17.3882 | | 148.56 | 17.3882 |
| 0.353177 | -144906 | -17.6588 | | 144.906 | 17.6588 |
| 0.355206 | -146835 | -17.7603 | | 146.835 | 17.7603 |
| 0.358251 | -143181 | -17.9125 | | 143.181 | 17.9125 |
| 0.361295 | -141498 | -18.0648 | | 141.498 | 18.0648 |
| 0.361485 | -142511 | -18.0743 | | 142.511 | 18.0743 |
| 0.361676 | -143182 | -18.0838 | | 143.182 | 18.0838 |
| 0.361866 | -143699 | -18.0933 | | 143.699 | 18.0933 |
| 0.362056 | -143959 | -18.1028 | | 143.959 | 18.1028 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *32 mm* | | | | | |
| $F_{u,fem}$ | 319.151 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -152855 | -0.5 | | 152.855 | 0.5 |
| 0.0125 | -190236 | -0.625 | | 190.236 | 0.625 |
| 0.01625 | -243162 | -0.8125 | | 243.162 | 0.8125 |
| 0.017656 | -254641 | -0.88281 | | 254.641 | 0.882813 |
| 0.019766 | -257606 | -0.98828 | | 257.606 | 0.988281 |
| 0.021875 | -259742 | -1.09375 | | 259.742 | 1.09375 |
| 0.023984 | -261633 | -1.19922 | | 261.633 | 1.19922 |
| 0.027148 | -264844 | -1.35742 | | 264.844 | 1.35742 |
| 0.031895 | -269993 | -1.59473 | | 269.993 | 1.59473 |
| 0.039014 | -277939 | -1.95068 | | 277.939 | 1.95068 |
| 0.049692 | -290381 | -2.48462 | | 290.381 | 2.48462 |
| 0.06571 | -304576 | -3.28552 | | 304.576 | 3.28552 |
| 0.081729 | -313438 | -4.08643 | | 313.438 | 4.08643 |
| 0.085733 | -314982 | -4.28665 | | 314.982 | 4.28665 |
| 0.09174 | -316792 | -4.58699 | | 316.792 | 4.58699 |
| 0.10075 | -318527 | -5.0375 | | 318.527 | 5.0375 |
| 0.10976 | -319151 | -5.48801 | | 319.151 | 5.48801 |
| 0.11877 | -318510 | -5.93851 | | 318.51 | 5.93851 |
| 0.12778 | -316437 | -6.38902 | | 316.437 | 6.38902 |
| 0.136791 | -312866 | -6.83953 | | 312.866 | 6.83953 |
| 0.145801 | -307873 | -7.29004 | | 307.873 | 7.29004 |
| 0.154811 | -301554 | -7.74055 | | 301.554 | 7.74055 |
| 0.157063 | -300831 | -7.85317 | | 300.831 | 7.85317 |
| 0.159316 | -299079 | -7.9658 | | 299.079 | 7.9658 |
| 0.162695 | -296224 | -8.13474 | | 296.224 | 8.13474 |
| 0.167763 | -291754 | -8.38815 | | 291.754 | 8.38815 |
| 0.175365 | -284738 | -8.76827 | | 284.738 | 8.76827 |
| 0.182968 | -278099 | -9.14839 | | 278.099 | 9.14839 |
| 0.19057 | -271368 | -9.5285 | | 271.368 | 9.5285 |
| 0.198172 | -264549 | -9.90862 | | 264.549 | 9.90862 |
| 0.205775 | -257584 | -10.2887 | | 257.584 | 10.2887 |
| 0.213377 | -250372 | -10.6688 | | 250.372 | 10.6688 |
| 0.220979 | -242855 | -11.049 | | 242.855 | 11.049 |
| 0.228582 | -235123 | -11.4291 | | 235.123 | 11.4291 |
| 0.236184 | -227292 | -11.8092 | | 227.292 | 11.8092 |
| 0.243786 | -219431 | -12.1893 | | 219.431 | 12.1893 |
| 0.245687 | -219563 | -12.2843 | | 219.563 | 12.2843 |
| 0.247587 | -217541 | -12.3794 | | 217.541 | 12.3794 |
| 0.250438 | -214311 | -12.5219 | | 214.311 | 12.5219 |
| 0.254715 | -209486 | -12.7357 | | 209.486 | 12.7357 |
| 0.261129 | -202250 | -13.0565 | | 202.25 | 13.0565 |
| 0.270751 | -191273 | -13.5375 | | 191.273 | 13.5375 |
| 0.274359 | -190781 | -13.7179 | | 190.781 | 13.7179 |
| 0.279771 | -184536 | -13.9886 | | 184.536 | 13.9886 |
| 0.281801 | -184485 | -14.09 | | 184.485 | 14.09 |
| 0.284845 | -181022 | -14.2423 | | 181.022 | 14.2423 |
| 0.289412 | -176054 | -14.4706 | | 176.054 | 14.4706 |
| 0.296261 | -168730 | -14.8131 | | 168.73 | 14.8131 |
| 0.303111 | -163139 | -15.1556 | | 163.139 | 15.1556 |
| 0.309961 | -157783 | -15.4981 | | 157.783 | 15.4981 |
| 0.320236 | -148087 | -16.0118 | | 148.087 | 16.0118 |
| 0.330511 | -141277 | -16.5255 | | 141.277 | 16.5255 |
| 0.333079 | -145521 | -16.654 | | 145.521 | 16.654 |
| 0.335648 | -143136 | -16.7824 | | 143.136 | 16.7824 |
| 0.338217 | -141653 | -16.9108 | | 141.653 | 16.9108 |
| 0.340785 | -140022 | -17.0393 | | 140.022 | 17.0393 |
| 0.341749 | -141153 | -17.0874 | | 141.153 | 17.0874 |
| 0.343193 | -139369 | -17.1597 | | 139.369 | 17.1597 |
| 0.344638 | -138721 | -17.2319 | | 138.721 | 17.2319 |
| 0.346083 | -137763 | -17.3042 | | 137.763 | 17.3042 |
| 0.346219 | -138415 | -17.3109 | | 138.415 | 17.3109 |
| 0.346354 | -138793 | -17.3177 | | 138.793 | 17.3177 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *33 mm* | | | | | |
| $F_{u,fem}$ | 315.328 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -152407 | -0.5 | | 152.407 | 0.5 |
| 0.0125 | -189603 | -0.625 | | 189.603 | 0.625 |
| 0.01625 | -241851 | -0.8125 | | 241.851 | 0.8125 |
| 0.02 | -254591 | -1 | | 254.591 | 1 |
| 0.02375 | -258182 | -1.1875 | | 258.182 | 1.1875 |
| 0.0275 | -262009 | -1.375 | | 262.009 | 1.375 |
| 0.03125 | -266140 | -1.5625 | | 266.14 | 1.5625 |
| 0.036875 | -272237 | -1.84375 | | 272.237 | 1.84375 |
| 0.045313 | -282131 | -2.26563 | | 282.131 | 2.26563 |
| 0.057969 | -294888 | -2.89844 | | 294.888 | 2.89844 |
| 0.070625 | -304306 | -3.53125 | | 304.306 | 3.53125 |
| 0.083281 | -310408 | -4.16406 | | 310.408 | 4.16406 |
| 0.088027 | -312023 | -4.40137 | | 312.023 | 4.40137 |
| 0.095147 | -313803 | -4.75732 | | 313.803 | 4.75732 |
| 0.105825 | -315164 | -5.29126 | | 315.164 | 5.29126 |
| 0.10983 | -315328 | -5.49149 | | 315.328 | 5.49149 |
| 0.115836 | -315062 | -5.79182 | | 315.062 | 5.79182 |
| 0.124847 | -313478 | -6.24233 | | 313.478 | 6.24233 |
| 0.133857 | -310479 | -6.69284 | | 310.479 | 6.69284 |
| 0.142867 | -306079 | -7.14335 | | 306.079 | 7.14335 |
| 0.151877 | -300393 | -7.59386 | | 300.393 | 7.59386 |
| 0.15413 | -299696 | -7.70648 | | 299.696 | 7.70648 |
| 0.156382 | -298083 | -7.81911 | | 298.083 | 7.81911 |
| 0.159761 | -295426 | -7.98805 | | 295.426 | 7.98805 |
| 0.164829 | -291202 | -8.24146 | | 291.202 | 8.24146 |
| 0.172432 | -284544 | -8.62158 | | 284.544 | 8.62158 |
| 0.180034 | -278256 | -9.00169 | | 278.256 | 9.00169 |
| 0.187636 | -271925 | -9.38181 | | 271.925 | 9.38181 |
| 0.195239 | -265595 | -9.76193 | | 265.595 | 9.76193 |
| 0.202841 | -259279 | -10.142 | | 259.279 | 10.142 |
| 0.210443 | -252964 | -10.5222 | | 252.964 | 10.5222 |
| 0.218046 | -246618 | -10.9023 | | 246.618 | 10.9023 |
| 0.225648 | -240175 | -11.2824 | | 240.175 | 11.2824 |
| 0.23325 | -233537 | -11.6625 | | 233.537 | 11.6625 |
| 0.240852 | -226622 | -12.0426 | | 226.622 | 12.0426 |
| 0.248455 | -219468 | -12.4227 | | 219.468 | 12.4227 |
| 0.256057 | -212220 | -12.8029 | | 212.22 | 12.8029 |
| 0.263659 | -204934 | -13.183 | | 204.934 | 13.183 |
| 0.271262 | -197628 | -13.5631 | | 197.628 | 13.5631 |
| 0.278864 | -190373 | -13.9432 | | 190.373 | 13.9432 |
| 0.280765 | -191180 | -14.0382 | | 191.18 | 14.0382 |
| 0.282665 | -189303 | -14.1333 | | 189.303 | 14.1333 |
| 0.285516 | -186292 | -14.2758 | | 186.292 | 14.2758 |
| 0.289792 | -181822 | -14.4896 | | 181.822 | 14.4896 |
| 0.296207 | -175219 | -14.8103 | | 175.219 | 14.8103 |
| 0.305829 | -165636 | -15.2914 | | 165.636 | 15.2914 |
| 0.31545 | -158393 | -15.7725 | | 158.393 | 15.7725 |
| 0.325072 | -151584 | -16.2536 | | 151.584 | 16.2536 |
| 0.32868 | -152762 | -16.434 | | 152.762 | 16.434 |
| 0.334092 | -147797 | -16.7046 | | 147.797 | 16.7046 |
| 0.342211 | -141097 | -17.1105 | | 141.097 | 17.1105 |
| 0.345255 | -142916 | -17.2627 | | 142.916 | 17.2627 |
| 0.349822 | -138577 | -17.4911 | | 138.577 | 17.4911 |
| 0.354388 | -136044 | -17.7194 | | 136.044 | 17.7194 |
| 0.354674 | -137484 | -17.7337 | | 137.484 | 17.7337 |
| 0.354959 | -138394 | -17.7479 | | 138.394 | 17.7479 |
| 0.355244 | -138795 | -17.7622 | | 138.795 | 17.7622 |
| 0.35553 | -138634 | -17.7765 | | 138.634 | 17.7765 |
| 0.355958 | -138294 | -17.7979 | | 138.294 | 17.7979 |
| 0.3566 | -137766 | -17.83 | | 137.766 | 17.83 |
| 0.357563 | -136953 | -17.8782 | | 136.953 | 17.8782 |
| 0.359008 | -135687 | -17.9504 | | 135.687 | 17.9504 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *34 mm* | | | | | |
| $F_{u,fem}$ | 311.222 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -151932 | -0.5 | | 151.932 | 0.5 |
| 0.0125 | -188933 | -0.625 | | 188.933 | 0.625 |
| 0.01625 | -240434 | -0.8125 | | 240.434 | 0.8125 |
| 0.017656 | -248500 | -0.88281 | | 248.5 | 0.882813 |
| 0.019766 | -251293 | -0.98828 | | 251.293 | 0.988281 |
| 0.02293 | -254278 | -1.14648 | | 254.278 | 1.14648 |
| 0.027676 | -258923 | -1.38379 | | 258.923 | 1.38379 |
| 0.034795 | -266508 | -1.73975 | | 266.508 | 1.73975 |
| 0.041914 | -274749 | -2.0957 | | 274.749 | 2.0957 |
| 0.049033 | -282843 | -2.45166 | | 282.843 | 2.45166 |
| 0.056152 | -289849 | -2.80762 | | 289.849 | 2.80762 |
| 0.066831 | -298253 | -3.34155 | | 298.253 | 3.34155 |
| 0.082849 | -306477 | -4.14246 | | 306.477 | 4.14246 |
| 0.086854 | -307867 | -4.34268 | | 307.867 | 4.34268 |
| 0.090858 | -308993 | -4.54291 | | 308.993 | 4.54291 |
| 0.096865 | -310257 | -4.84325 | | 310.257 | 4.84325 |
| 0.105875 | -311222 | -5.29375 | | 311.222 | 5.29375 |
| 0.11939 | -310292 | -5.96952 | | 310.292 | 5.96952 |
| 0.132906 | -306126 | -6.64528 | | 306.126 | 6.64528 |
| 0.136284 | -305229 | -6.81422 | | 305.229 | 6.81422 |
| 0.139663 | -303655 | -6.98316 | | 303.655 | 6.98316 |
| 0.144731 | -300860 | -7.23657 | | 300.86 | 7.23657 |
| 0.152334 | -295703 | -7.61669 | | 295.703 | 7.61669 |
| 0.159936 | -290012 | -7.9968 | | 290.012 | 7.9968 |
| 0.167538 | -284045 | -8.37692 | | 284.045 | 8.37692 |
| 0.175141 | -277968 | -8.75704 | | 277.968 | 8.75704 |
| 0.182743 | -271868 | -9.13715 | | 271.868 | 9.13715 |
| 0.190345 | -265788 | -9.51727 | | 265.788 | 9.51727 |
| 0.197948 | -259736 | -9.89738 | | 259.736 | 9.89738 |
| 0.20555 | -253718 | -10.2775 | | 253.718 | 10.2775 |
| 0.213152 | -247743 | -10.6576 | | 247.743 | 10.6576 |
| 0.220755 | -241807 | -11.0377 | | 241.807 | 11.0377 |
| 0.228357 | -235905 | -11.4178 | | 235.905 | 11.4178 |
| 0.235959 | -230024 | -11.798 | | 230.024 | 11.798 |
| 0.243562 | -224118 | -12.1781 | | 224.118 | 12.1781 |
| 0.251164 | -218108 | -12.5582 | | 218.108 | 12.5582 |
| 0.258766 | -211872 | -12.9383 | | 211.872 | 12.9383 |
| 0.266369 | -205291 | -13.3184 | | 205.291 | 13.3184 |
| 0.273971 | -198479 | -13.6985 | | 198.479 | 13.6985 |
| 0.275872 | -198878 | -13.7936 | | 198.878 | 13.7936 |
| 0.277772 | -197092 | -13.8886 | | 197.092 | 13.8886 |
| 0.280623 | -194219 | -14.0311 | | 194.219 | 14.0311 |
| 0.283474 | -191731 | -14.1737 | | 191.731 | 14.1737 |
| 0.286325 | -189242 | -14.3162 | | 189.242 | 14.3162 |
| 0.290601 | -184960 | -14.5301 | | 184.96 | 14.5301 |
| 0.297015 | -178601 | -14.8508 | | 178.601 | 14.8508 |
| 0.306637 | -169157 | -15.3319 | | 169.157 | 15.3319 |
| 0.32107 | -155368 | -16.0535 | | 155.368 | 16.0535 |
| 0.324678 | -158643 | -16.2339 | | 158.643 | 16.2339 |
| 0.328286 | -155587 | -16.4143 | | 155.587 | 16.4143 |
| 0.333698 | -150746 | -16.6849 | | 150.746 | 16.6849 |
| 0.341816 | -143600 | -17.0908 | | 143.6 | 17.0908 |
| 0.344861 | -145175 | -17.243 | | 145.175 | 17.243 |
| 0.346002 | -145397 | -17.3001 | | 145.397 | 17.3001 |
| 0.347715 | -143789 | -17.3857 | | 143.789 | 17.3857 |
| 0.350284 | -141604 | -17.5142 | | 141.604 | 17.5142 |
| 0.354137 | -138230 | -17.7068 | | 138.23 | 17.7068 |
| 0.355582 | -139675 | -17.7791 | | 139.675 | 17.7791 |
| 0.357026 | -138372 | -17.8513 | | 138.372 | 17.8513 |
| 0.358471 | -137626 | -17.9236 | | 137.626 | 17.9236 |
| 0.360639 | -135519 | -18.0319 | | 135.519 | 18.0319 |
| 0.36389 | -132370 | -18.1945 | | 132.37 | 18.1945 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *35 mm* | | | | | |
| $F_{u,fem}$ | 307.097 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -151443 | -0.5 | | 151.443 | 0.5 |
| 0.0125 | -188232 | -0.625 | | 188.232 | 0.625 |
| 0.015 | -223337 | -0.75 | | 223.337 | 0.75 |
| 0.01875 | -246794 | -0.9375 | | 246.794 | 0.9375 |
| 0.0225 | -250635 | -1.125 | | 250.635 | 1.125 |
| 0.02625 | -254235 | -1.3125 | | 254.235 | 1.3125 |
| 0.03 | -258294 | -1.5 | | 258.294 | 1.5 |
| 0.035625 | -264243 | -1.78125 | | 264.243 | 1.78125 |
| 0.044063 | -273774 | -2.20313 | | 273.774 | 2.20313 |
| 0.0525 | -282818 | -2.625 | | 282.818 | 2.625 |
| 0.060938 | -290305 | -3.04688 | | 290.305 | 3.04688 |
| 0.073594 | -298707 | -3.67969 | | 298.707 | 3.67969 |
| 0.092578 | -305392 | -4.62891 | | 305.392 | 4.62891 |
| 0.097324 | -306276 | -4.86621 | | 306.276 | 4.86621 |
| 0.10207 | -306846 | -5.10352 | | 306.846 | 5.10352 |
| 0.109189 | -307097 | -5.45947 | | 307.097 | 5.45947 |
| 0.119868 | -305920 | -5.99341 | | 305.92 | 5.99341 |
| 0.130547 | -302744 | -6.52734 | | 302.744 | 6.52734 |
| 0.141226 | -297509 | -7.06128 | | 297.509 | 7.06128 |
| 0.143895 | -296670 | -7.19476 | | 296.67 | 7.19476 |
| 0.146565 | -295113 | -7.32825 | | 295.113 | 7.32825 |
| 0.150569 | -292398 | -7.52847 | | 292.398 | 7.52847 |
| 0.156576 | -287755 | -7.82881 | | 287.755 | 7.82881 |
| 0.162583 | -283076 | -8.12915 | | 283.076 | 8.12915 |
| 0.16859 | -278256 | -8.42949 | | 278.256 | 8.42949 |
| 0.174597 | -273360 | -8.72983 | | 273.36 | 8.72983 |
| 0.183607 | -265248 | -9.18034 | | 265.248 | 9.18034 |
| 0.192617 | -257794 | -9.63084 | | 257.794 | 9.63084 |
| 0.201627 | -250357 | -10.0814 | | 250.357 | 10.0814 |
| 0.210637 | -242989 | -10.5319 | | 242.989 | 10.5319 |
| 0.219647 | -235698 | -10.9824 | | 235.698 | 10.9824 |
| 0.228658 | -228463 | -11.4329 | | 228.463 | 11.4329 |
| 0.237668 | -221211 | -11.8834 | | 221.211 | 11.8834 |
| 0.246678 | -213807 | -12.3339 | | 213.807 | 12.3339 |
| 0.255688 | -206094 | -12.7844 | | 206.094 | 12.7844 |
| 0.264698 | -198096 | -13.2349 | | 198.096 | 13.2349 |
| 0.266951 | -198645 | -13.3475 | | 198.645 | 13.3475 |
| 0.269203 | -196545 | -13.4602 | | 196.545 | 13.4602 |
| 0.271456 | -194582 | -13.5728 | | 194.582 | 13.5728 |
| 0.273708 | -192620 | -13.6854 | | 192.62 | 13.6854 |
| 0.277087 | -189243 | -13.8544 | | 189.243 | 13.8544 |
| 0.282155 | -184209 | -14.1078 | | 184.209 | 14.1078 |
| 0.289758 | -176652 | -14.4879 | | 176.652 | 14.4879 |
| 0.29736 | -170315 | -14.868 | | 170.315 | 14.868 |
| 0.304962 | -164050 | -15.2481 | | 164.05 | 15.2481 |
| 0.312565 | -157991 | -15.6282 | | 157.991 | 15.6282 |
| 0.314465 | -159831 | -15.7233 | | 159.831 | 15.7233 |
| 0.316366 | -158158 | -15.8183 | | 158.158 | 15.8183 |
| 0.319217 | -155504 | -15.9608 | | 155.504 | 15.9608 |
| 0.323493 | -151564 | -16.1747 | | 151.564 | 16.1747 |
| 0.329907 | -145743 | -16.4954 | | 145.743 | 16.4954 |
| 0.339529 | -137241 | -16.9765 | | 137.241 | 16.9765 |
| 0.341935 | -141271 | -17.0967 | | 141.271 | 17.0967 |
| 0.34434 | -139103 | -17.217 | | 139.103 | 17.217 |
| 0.346745 | -137737 | -17.3373 | | 137.737 | 17.3373 |
| 0.349151 | -136263 | -17.4575 | | 136.263 | 17.4575 |
| 0.352759 | -132904 | -17.6379 | | 132.904 | 17.6379 |
| 0.356367 | -130826 | -17.8184 | | 130.826 | 17.8184 |
| 0.356593 | -132141 | -17.8296 | | 132.141 | 17.8296 |
| 0.356818 | -132890 | -17.8409 | | 132.89 | 17.8409 |
| 0.357044 | -133450 | -17.8522 | | 133.45 | 17.8522 |
| 0.357269 | -133607 | -17.8635 | | 133.607 | 17.8635 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *36 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 303.124 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -150932 | -0.5 | | 150.932 | 0.5 |
| 0.0125 | -187502 | -0.625 | | 187.502 | 0.625 |
| 0.015 | -222216 | -0.75 | | 222.216 | 0.75 |
| 0.01875 | -243651 | -0.9375 | | 243.651 | 0.9375 |
| 0.0225 | -247442 | -1.125 | | 247.442 | 1.125 |
| 0.02625 | -251029 | -1.3125 | | 251.029 | 1.3125 |
| 0.03 | -255054 | -1.5 | | 255.054 | 1.5 |
| 0.035625 | -260944 | -1.78125 | | 260.944 | 1.78125 |
| 0.044063 | -270334 | -2.20313 | | 270.334 | 2.20313 |
| 0.056719 | -283099 | -2.83594 | | 283.099 | 2.83594 |
| 0.069375 | -292591 | -3.46875 | | 292.591 | 3.46875 |
| 0.082031 | -298682 | -4.10156 | | 298.682 | 4.10156 |
| 0.086777 | -300239 | -4.33887 | | 300.239 | 4.33887 |
| 0.091523 | -301453 | -4.57617 | | 301.453 | 4.57617 |
| 0.09627 | -302354 | -4.81348 | | 302.354 | 4.81348 |
| 0.103389 | -303124 | -5.16943 | | 303.124 | 5.16943 |
| 0.114067 | -302868 | -5.70337 | | 302.868 | 5.70337 |
| 0.124746 | -300737 | -6.2373 | | 300.737 | 6.2373 |
| 0.135425 | -296537 | -6.77124 | | 296.537 | 6.77124 |
| 0.146104 | -290410 | -7.30518 | | 290.41 | 7.30518 |
| 0.148773 | -289520 | -7.43866 | | 289.52 | 7.43866 |
| 0.151443 | -287704 | -7.57214 | | 287.704 | 7.57214 |
| 0.155447 | -284670 | -7.77237 | | 284.67 | 7.77237 |
| 0.161454 | -279732 | -8.07271 | | 279.732 | 8.07271 |
| 0.170464 | -271877 | -8.52322 | | 271.877 | 8.52322 |
| 0.179474 | -264441 | -8.97372 | | 264.441 | 8.97372 |
| 0.188485 | -256946 | -9.42423 | | 256.946 | 9.42423 |
| 0.197495 | -249471 | -9.87474 | | 249.471 | 9.87474 |
| 0.206505 | -242058 | -10.3252 | | 242.058 | 10.3252 |
| 0.215515 | -234732 | -10.7758 | | 234.732 | 10.7758 |
| 0.224525 | -227494 | -11.2263 | | 227.494 | 11.2263 |
| 0.233535 | -220305 | -11.6768 | | 220.305 | 11.6768 |
| 0.242546 | -213083 | -12.1273 | | 213.083 | 12.1273 |
| 0.251556 | -205683 | -12.5778 | | 205.683 | 12.5778 |
| 0.260566 | -197996 | -13.0283 | | 197.996 | 13.0283 |
| 0.262818 | -198476 | -13.1409 | | 198.476 | 13.1409 |
| 0.265071 | -196444 | -13.2536 | | 196.444 | 13.2536 |
| 0.267324 | -194528 | -13.3662 | | 194.528 | 13.3662 |
| 0.269576 | -192608 | -13.4788 | | 192.608 | 13.4788 |
| 0.272955 | -189301 | -13.6477 | | 189.301 | 13.6477 |
| 0.276334 | -186453 | -13.8167 | | 186.453 | 13.8167 |
| 0.279713 | -183593 | -13.9856 | | 183.593 | 13.9856 |
| 0.283091 | -180750 | -14.1546 | | 180.75 | 14.1546 |
| 0.28816 | -175769 | -14.408 | | 175.769 | 14.408 |
| 0.295762 | -168270 | -14.7881 | | 168.27 | 14.7881 |
| 0.303364 | -162083 | -15.1682 | | 162.083 | 15.1682 |
| 0.310967 | -156055 | -15.5483 | | 156.055 | 15.5483 |
| 0.318569 | -150329 | -15.9284 | | 150.329 | 15.9284 |
| 0.326171 | -144935 | -16.3086 | | 144.935 | 16.3086 |
| 0.333774 | -139847 | -16.6887 | | 139.847 | 16.6887 |
| 0.345177 | -130178 | -17.2589 | | 130.178 | 17.2589 |
| 0.348028 | -135043 | -17.4014 | | 135.043 | 17.4014 |
| 0.350879 | -132543 | -17.5439 | | 132.543 | 17.5439 |
| 0.35373 | -131039 | -17.6865 | | 131.039 | 17.6865 |
| 0.35658 | -129363 | -17.829 | | 129.363 | 17.829 |
| 0.35765 | -130703 | -17.8825 | | 130.703 | 17.8825 |
| 0.359253 | -128755 | -17.9627 | | 128.755 | 17.9627 |
| 0.360857 | -128123 | -18.0428 | | 128.123 | 18.0428 |
| 0.36246 | -127098 | -18.123 | | 127.098 | 18.123 |
| 0.364064 | -126134 | -18.2032 | | 126.134 | 18.2032 |
| 0.364139 | -126583 | -18.207 | | 126.583 | 18.207 |
| 0.364214 | -126878 | -18.2107 | | 126.878 | 18.2107 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *37 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 298.683 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -150394 | -0.5 | | 150.394 | 0.5 |
| 0.0125 | -186735 | -0.625 | | 186.735 | 0.625 |
| 0.01625 | -235389 | -0.8125 | | 235.389 | 0.8125 |
| 0.017656 | -239156 | -0.88281 | | 239.156 | 0.882813 |
| 0.019063 | -241017 | -0.95313 | | 241.017 | 0.953125 |
| 0.020469 | -242490 | -1.02344 | | 242.49 | 1.02344 |
| 0.022578 | -244370 | -1.12891 | | 244.37 | 1.12891 |
| 0.025742 | -247289 | -1.28711 | | 247.289 | 1.28711 |
| 0.030488 | -252215 | -1.52441 | | 252.215 | 1.52441 |
| 0.037607 | -259674 | -1.88037 | | 259.674 | 1.88037 |
| 0.048286 | -271407 | -2.41431 | | 271.407 | 2.41431 |
| 0.064304 | -285495 | -3.21521 | | 285.495 | 3.21521 |
| 0.080322 | -294217 | -4.01611 | | 294.217 | 4.01611 |
| 0.084327 | -295636 | -4.21634 | | 295.636 | 4.21634 |
| 0.090334 | -297250 | -4.51668 | | 297.25 | 4.51668 |
| 0.099344 | -298683 | -4.96719 | | 298.683 | 4.96719 |
| 0.112859 | -298566 | -5.64295 | | 298.566 | 5.64295 |
| 0.116238 | -298205 | -5.81189 | | 298.205 | 5.81189 |
| 0.119617 | -297583 | -5.98083 | | 297.583 | 5.98083 |
| 0.122995 | -296757 | -6.14977 | | 296.757 | 6.14977 |
| 0.126374 | -295729 | -6.31871 | | 295.729 | 6.31871 |
| 0.131442 | -293747 | -6.57212 | | 293.747 | 6.57212 |
| 0.139045 | -289898 | -6.95224 | | 289.898 | 6.95224 |
| 0.146647 | -285202 | -7.33235 | | 285.202 | 7.33235 |
| 0.154249 | -279503 | -7.71247 | | 279.503 | 7.71247 |
| 0.161852 | -273296 | -8.09259 | | 273.296 | 8.09259 |
| 0.169454 | -266874 | -8.4727 | | 266.874 | 8.4727 |
| 0.177056 | -260353 | -8.85282 | | 260.353 | 8.85282 |
| 0.184659 | -253809 | -9.23293 | | 253.809 | 9.23293 |
| 0.192261 | -247297 | -9.61305 | | 247.297 | 9.61305 |
| 0.199863 | -240860 | -9.99317 | | 240.86 | 9.99317 |
| 0.207466 | -234528 | -10.3733 | | 234.528 | 10.3733 |
| 0.215068 | -228313 | -10.7534 | | 228.313 | 10.7534 |
| 0.22267 | -222233 | -11.1335 | | 222.233 | 11.1335 |
| 0.230273 | -216280 | -11.5136 | | 216.28 | 11.5136 |
| 0.237875 | -210450 | -11.8937 | | 210.45 | 11.8937 |
| 0.245477 | -204722 | -12.2739 | | 204.722 | 12.2739 |
| 0.25308 | -199054 | -12.654 | | 199.054 | 12.654 |
| 0.260682 | -193395 | -13.0341 | | 193.395 | 13.0341 |
| 0.268284 | -187677 | -13.4142 | | 187.677 | 13.4142 |
| 0.275887 | -181795 | -13.7943 | | 181.795 | 13.7943 |
| 0.283489 | -175725 | -14.1744 | | 175.725 | 14.1744 |
| 0.291091 | -169595 | -14.5546 | | 169.595 | 14.5546 |
| 0.292992 | -170978 | -14.6496 | | 170.978 | 14.6496 |
| 0.294892 | -169292 | -14.7446 | | 169.292 | 14.7446 |
| 0.297743 | -166590 | -14.8872 | | 166.59 | 14.8872 |
| 0.30202 | -162566 | -15.101 | | 162.566 | 15.101 |
| 0.308434 | -156574 | -15.4217 | | 156.574 | 15.4217 |
| 0.318056 | -147700 | -15.9028 | | 147.7 | 15.9028 |
| 0.321664 | -149106 | -16.0832 | | 149.106 | 16.0832 |
| 0.327076 | -143713 | -16.3538 | | 143.713 | 16.3538 |
| 0.332488 | -140169 | -16.6244 | | 140.169 | 16.6244 |
| 0.3379 | -136489 | -16.895 | | 136.489 | 16.895 |
| 0.33993 | -138219 | -16.9965 | | 138.219 | 16.9965 |
| 0.342974 | -134753 | -17.1487 | | 134.753 | 17.1487 |
| 0.346019 | -133039 | -17.3009 | | 133.039 | 17.3009 |
| 0.349063 | -130962 | -17.4532 | | 130.962 | 17.4532 |
| 0.350205 | -132926 | -17.5102 | | 132.926 | 17.5102 |
| 0.351346 | -131355 | -17.5673 | | 131.355 | 17.5673 |
| 0.352488 | -130998 | -17.6244 | | 130.998 | 17.6244 |
| 0.35363 | -130084 | -17.6815 | | 130.084 | 17.6815 |
| 0.354771 | -129474 | -17.7386 | | 129.474 | 17.7386 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *38 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 294.915 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -149854 | -0.5 | | 149.854 | 0.5 |
| 0.0125 | -185946 | -0.625 | | 185.946 | 0.625 |
| 0.01625 | -233210 | -0.8125 | | 233.21 | 0.8125 |
| 0.02 | -238687 | -1 | | 238.687 | 1 |
| 0.02375 | -242134 | -1.1875 | | 242.134 | 1.1875 |
| 0.0275 | -245932 | -1.375 | | 245.932 | 1.375 |
| 0.033125 | -251751 | -1.65625 | | 251.751 | 1.65625 |
| 0.041563 | -260727 | -2.07813 | | 260.727 | 2.07813 |
| 0.054219 | -273653 | -2.71094 | | 273.653 | 2.71094 |
| 0.073203 | -287348 | -3.66016 | | 287.348 | 3.66016 |
| 0.080322 | -290531 | -4.01611 | | 290.531 | 4.01611 |
| 0.091001 | -293547 | -4.55005 | | 293.547 | 4.55005 |
| 0.10168 | -294915 | -5.08398 | | 294.915 | 5.08398 |
| 0.112358 | -294668 | -5.61792 | | 294.668 | 5.61792 |
| 0.123037 | -292534 | -6.15186 | | 292.534 | 6.15186 |
| 0.133716 | -288338 | -6.68579 | | 288.338 | 6.68579 |
| 0.144395 | -282259 | -7.21973 | | 282.259 | 7.21973 |
| 0.147064 | -281359 | -7.35321 | | 281.359 | 7.35321 |
| 0.149734 | -279565 | -7.48669 | | 279.565 | 7.48669 |
| 0.153738 | -276598 | -7.68692 | | 276.598 | 7.68692 |
| 0.159745 | -271772 | -7.98726 | | 271.772 | 7.98726 |
| 0.165752 | -267120 | -8.2876 | | 267.12 | 8.2876 |
| 0.171759 | -262396 | -8.58794 | | 262.396 | 8.58794 |
| 0.180769 | -254603 | -9.03844 | | 254.603 | 9.03844 |
| 0.189779 | -247379 | -9.48895 | | 247.379 | 9.48895 |
| 0.198789 | -240141 | -9.93946 | | 240.141 | 9.93946 |
| 0.207799 | -232935 | -10.39 | | 232.935 | 10.39 |
| 0.21681 | -225780 | -10.8405 | | 225.78 | 10.8405 |
| 0.22582 | -218690 | -11.291 | | 218.69 | 11.291 |
| 0.23483 | -211655 | -11.7415 | | 211.655 | 11.7415 |
| 0.24384 | -204613 | -12.192 | | 204.613 | 12.192 |
| 0.25285 | -197429 | -12.6425 | | 197.429 | 12.6425 |
| 0.255103 | -197721 | -12.7551 | | 197.721 | 12.7551 |
| 0.257355 | -195826 | -12.8678 | | 195.826 | 12.8678 |
| 0.260734 | -192739 | -13.0367 | | 192.739 | 13.0367 |
| 0.265802 | -188028 | -13.2901 | | 188.028 | 13.2901 |
| 0.270871 | -183830 | -13.5435 | | 183.83 | 13.5435 |
| 0.275939 | -179580 | -13.7969 | | 179.58 | 13.7969 |
| 0.281007 | -175324 | -14.0503 | | 175.324 | 14.0503 |
| 0.286075 | -171076 | -14.3038 | | 171.076 | 14.3038 |
| 0.287976 | -170840 | -14.3988 | | 170.84 | 14.3988 |
| 0.290827 | -168015 | -14.5413 | | 168.015 | 14.5413 |
| 0.295103 | -163915 | -14.7551 | | 163.915 | 14.7551 |
| 0.301517 | -157807 | -15.0759 | | 157.807 | 15.0759 |
| 0.307932 | -152925 | -15.3966 | | 152.925 | 15.3966 |
| 0.314346 | -148183 | -15.7173 | | 148.183 | 15.7173 |
| 0.323968 | -139713 | -16.1984 | | 139.713 | 16.1984 |
| 0.33359 | -133622 | -16.6795 | | 133.622 | 16.6795 |
| 0.335995 | -136672 | -16.7998 | | 136.672 | 16.7998 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

**S355**

**1 hole**

*39 mm*

$F_{u,fem}$ 290.944 kN

| Time | Load | Displacement | abs Load | abs Displacement |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0.01 | -149275 | -0.5 | 149.275 | 0.5 |
| 0.0125 | -185110 | -0.625 | 185.11 | 0.625 |
| 0.015 | -218428 | -0.75 | 218.428 | 0.75 |
| 0.0175 | -232650 | -0.875 | 232.65 | 0.875 |
| 0.02 | -235601 | -1 | 235.601 | 1 |
| 0.0225 | -237872 | -1.125 | 237.872 | 1.125 |
| 0.025 | -240161 | -1.25 | 240.161 | 1.25 |
| 0.02875 | -244008 | -1.4375 | 244.008 | 1.4375 |
| 0.034375 | -249729 | -1.71875 | 249.729 | 1.71875 |
| 0.042813 | -258659 | -2.14063 | 258.659 | 2.14063 |
| 0.055469 | -271244 | -2.77344 | 271.244 | 2.77344 |
| 0.068125 | -280790 | -3.40625 | 280.79 | 3.40625 |
| 0.080781 | -286922 | -4.03906 | 286.922 | 4.03906 |
| 0.093438 | -290082 | -4.67188 | 290.082 | 4.67188 |
| 0.106094 | -290944 | -5.30469 | 290.944 | 5.30469 |
| 0.11875 | -289323 | -5.9375 | 289.323 | 5.9375 |
| 0.131406 | -284773 | -6.57031 | 284.773 | 6.57031 |
| 0.13457 | -283747 | -6.72852 | 283.747 | 6.72852 |
| 0.137734 | -282147 | -6.88672 | 282.147 | 6.88672 |
| 0.14248 | -279391 | -7.12402 | 279.391 | 7.12402 |
| 0.1496 | -274332 | -7.47998 | 274.332 | 7.47998 |
| 0.156719 | -268870 | -7.83594 | 268.87 | 7.83594 |
| 0.163838 | -263035 | -8.19189 | 263.035 | 8.19189 |
| 0.170957 | -256905 | -8.54785 | 256.905 | 8.54785 |
| 0.178076 | -250527 | -8.90381 | 250.527 | 8.90381 |
| 0.185195 | -243913 | -9.25977 | 243.913 | 9.25977 |
| 0.192314 | -237076 | -9.61572 | 237.076 | 9.61572 |
| 0.199434 | -230050 | -9.97168 | 230.05 | 9.97168 |
| 0.206553 | -222891 | -10.3276 | 222.891 | 10.3276 |
| 0.213672 | -215645 | -10.6836 | 215.645 | 10.6836 |
| 0.220791 | -208371 | -11.0396 | 208.371 | 11.0396 |
| 0.22791 | -201101 | -11.3955 | 201.101 | 11.3955 |
| 0.235029 | -193836 | -11.7515 | 193.836 | 11.7515 |
| 0.242148 | -186612 | -12.1074 | 186.612 | 12.1074 |
| 0.243928 | -186676 | -12.1964 | 186.676 | 12.1964 |
| 0.245708 | -184871 | -12.2854 | 184.871 | 12.2854 |
| 0.248378 | -181982 | -12.4189 | 181.982 | 12.4189 |
| 0.252382 | -177682 | -12.6191 | 177.682 | 12.6191 |
| 0.258389 | -171343 | -12.9194 | 171.343 | 12.9194 |
| 0.267399 | -162183 | -13.37 | 162.183 | 13.37 |
| 0.280914 | -149540 | -14.0457 | 149.54 | 14.0457 |
| 0.29443 | -140514 | -14.7215 | 140.514 | 14.7215 |
| 0.307945 | -132563 | -15.3972 | 132.563 | 15.3972 |
| 0.32146 | -125505 | -16.073 | 125.505 | 16.073 |
| 0.334975 | -119062 | -16.7488 | 119.062 | 16.7488 |
| 0.338354 | -121952 | -16.9177 | 121.952 | 16.9177 |
| 0.341733 | -120063 | -17.0866 | 120.063 | 17.0866 |
| 0.345112 | -118597 | -17.2556 | 118.597 | 17.2556 |
| 0.35018 | -115473 | -17.509 | 115.473 | 17.509 |
| 0.350497 | -116743 | -17.5248 | 116.743 | 17.5248 |
| 0.350814 | -117327 | -17.5407 | 117.327 | 17.5407 |
| 0.35113 | -117387 | -17.5565 | 117.387 | 17.5565 |
| 0.351447 | -117276 | -17.5724 | 117.276 | 17.5724 |
| 0.351922 | -117015 | -17.5961 | 117.015 | 17.5961 |
| 0.352635 | -116604 | -17.6317 | 116.604 | 17.6317 |
| 0.353704 | -115968 | -17.6852 | 115.968 | 17.6852 |
| 0.355308 | -114976 | -17.7654 | 114.976 | 17.7654 |
| 0.355458 | -115461 | -17.7729 | 115.461 | 17.7729 |
| 0.355683 | -115630 | -17.7842 | 115.63 | 17.7842 |
| 0.355909 | -115554 | -17.7954 | 115.554 | 17.7954 |
| 0.356134 | -115463 | -17.8067 | 115.463 | 17.8067 |
| 0.35636 | -115376 | -17.818 | 115.376 | 17.818 |

**S355**

**1 hole**

*40 mm*

$F_{u,fem}$ 286.737 kN

| Time | Load | Displacement | abs Load | abs Displacement |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0.01 | -148672 | -0.5 | 148.672 | 0.5 |
| 0.0125 | -184229 | -0.625 | 184.229 | 0.625 |
| 0.015 | -216992 | -0.75 | 216.992 | 0.75 |
| 0.0175 | -229496 | -0.875 | 229.496 | 0.875 |
| 0.02 | -232388 | -1 | 232.388 | 1 |
| 0.0225 | -234629 | -1.125 | 234.629 | 1.125 |
| 0.025 | -236938 | -1.25 | 236.938 | 1.25 |
| 0.02875 | -240769 | -1.4375 | 240.769 | 1.4375 |
| 0.034375 | -246423 | -1.71875 | 246.423 | 1.71875 |
| 0.042813 | -255243 | -2.14063 | 255.243 | 2.14063 |
| 0.05125 | -263872 | -2.5625 | 263.872 | 2.5625 |
| 0.059688 | -271222 | -2.98438 | 271.222 | 2.98438 |
| 0.072344 | -279471 | -3.61719 | 279.471 | 3.61719 |
| 0.091328 | -285677 | -4.56641 | 285.677 | 4.56641 |
| 0.096074 | -286359 | -4.80371 | 286.359 | 4.80371 |
| 0.10082 | -286737 | -5.04102 | 286.737 | 5.04102 |
| 0.107939 | -286666 | -5.39697 | 286.666 | 5.39697 |
| 0.118618 | -284943 | -5.93091 | 284.943 | 5.93091 |
| 0.129297 | -281122 | -6.46484 | 281.122 | 6.46484 |
| 0.139976 | -275302 | -6.99878 | 275.302 | 6.99878 |
| 0.150654 | -267355 | -7.53271 | 267.355 | 7.53271 |
| 0.153324 | -266332 | -7.6662 | 266.332 | 7.6662 |
| 0.155994 | -264229 | -7.79968 | 264.229 | 7.79968 |
| 0.156995 | -263647 | -7.84974 | 263.647 | 7.84974 |
| 0.158496 | -262396 | -7.92482 | 262.396 | 7.92482 |
| 0.160749 | -260481 | -8.03745 | 260.481 | 8.03745 |
| 0.164128 | -257524 | -8.20639 | 257.524 | 8.20639 |
| 0.167507 | -254716 | -8.37533 | 254.716 | 8.37533 |
| 0.170885 | -251890 | -8.54427 | 251.89 | 8.54427 |
| 0.175954 | -247256 | -8.79768 | 247.256 | 8.79768 |
| 0.183556 | -240214 | -9.1778 | 240.214 | 9.1778 |
| 0.191158 | -233803 | -9.55792 | 233.803 | 9.55792 |
| 0.198761 | -227459 | -9.93803 | 227.459 | 9.93803 |
| 0.206363 | -221222 | -10.3181 | 221.222 | 10.3181 |
| 0.213965 | -215102 | -10.6983 | 215.102 | 10.6983 |
| 0.221568 | -209097 | -11.0784 | 209.097 | 11.0784 |
| 0.22917 | -203208 | -11.4585 | 203.208 | 11.4585 |
| 0.236772 | -197408 | -11.8386 | 197.408 | 11.8386 |
| 0.244375 | -191673 | -12.2187 | 191.673 | 12.2187 |
| 0.251977 | -185971 | -12.5988 | 185.971 | 12.5988 |
| 0.259579 | -180235 | -12.979 | 180.235 | 12.979 |
| 0.267182 | -174405 | -13.3591 | 174.405 | 13.3591 |
| 0.274784 | -168496 | -13.7392 | 168.496 | 13.7392 |
| 0.282386 | -162625 | -14.1193 | 162.625 | 14.1193 |
| 0.289989 | -156842 | -14.4994 | 156.842 | 14.4994 |
| 0.297591 | -151149 | -14.8795 | 151.149 | 14.8795 |
| 0.305193 | -145533 | -15.2597 | 145.533 | 15.2597 |
| 0.308044 | -146263 | -15.4022 | 146.263 | 15.4022 |
| 0.31232 | -142113 | -15.616 | 142.113 | 15.616 |
| 0.318735 | -136296 | -15.9367 | 136.296 | 15.9367 |
| 0.32114 | -137645 | -16.057 | 137.645 | 16.057 |
| 0.324748 | -133942 | -16.2374 | 133.942 | 16.2374 |
| 0.328357 | -131678 | -16.4178 | 131.678 | 16.4178 |
| 0.331965 | -129250 | -16.5982 | 129.25 | 16.5982 |
| 0.337377 | -123943 | -16.8688 | 123.943 | 16.8688 |
| 0.337715 | -126088 | -16.8858 | 126.088 | 16.8858 |
| 0.338053 | -127411 | -16.9027 | 127.411 | 16.9027 |
| 0.338392 | -127931 | -16.9196 | 127.931 | 16.9196 |
| 0.33873 | -127993 | -16.9365 | 127.993 | 16.9365 |
| 0.339068 | -127750 | -16.9534 | 127.75 | 16.9534 |
| 0.339406 | -127584 | -16.9703 | 127.584 | 16.9703 |
| 0.339914 | -127058 | -16.9957 | 127.058 | 16.9957 |

**S355**

**1 hole**

*41 mm*

$F_{u,fem}$ 282.817 kN

| Time | Load | Displacement | abs Load | abs Displacement |
|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 |
| 0.01 | -148059 | -0.5 | 148.059 | 0.5 |
| 0.0125 | -183330 | -0.625 | 183.33 | 0.625 |
| 0.015 | -215500 | -0.75 | 215.5 | 0.75 |
| 0.015938 | -223861 | -0.79688 | 223.861 | 0.796875 |
| 0.016875 | -225665 | -0.84375 | 225.665 | 0.84375 |
| 0.017813 | -226972 | -0.89063 | 226.972 | 0.890625 |
| 0.019219 | -228577 | -0.96094 | 228.577 | 0.960938 |
| 0.021328 | -230502 | -1.06641 | 230.502 | 1.06641 |
| 0.024492 | -233234 | -1.22461 | 233.234 | 1.22461 |
| 0.029238 | -237970 | -1.46191 | 237.97 | 1.46191 |
| 0.036357 | -245134 | -1.81787 | 245.134 | 1.81787 |
| 0.043477 | -252625 | -2.17383 | 252.625 | 2.17383 |
| 0.050596 | -259783 | -2.52979 | 259.783 | 2.52979 |
| 0.061274 | -268825 | -3.06372 | 268.825 | 3.06372 |
| 0.065279 | -271680 | -3.26395 | 271.68 | 3.26395 |
| 0.071286 | -275259 | -3.56429 | 275.259 | 3.56429 |
| 0.080296 | -279199 | -4.01479 | 279.199 | 4.01479 |
| 0.093811 | -282342 | -4.69056 | 282.342 | 4.69056 |
| 0.107326 | -282817 | -5.36632 | 282.817 | 5.36632 |
| 0.120842 | -280343 | -6.04208 | 280.343 | 6.04208 |
| 0.12422 | -279519 | -6.21102 | 279.519 | 6.21102 |
| 0.127599 | -278271 | -6.37996 | 278.271 | 6.37996 |
| 0.130978 | -276848 | -6.5489 | 276.848 | 6.5489 |
| 0.136046 | -274314 | -6.80231 | 274.314 | 6.80231 |
| 0.143649 | -269612 | -7.18243 | 269.612 | 7.18243 |
| 0.151251 | -264107 | -7.56254 | 264.107 | 7.56254 |
| 0.153151 | -263295 | -7.65757 | 263.295 | 7.65757 |
| 0.155052 | -261835 | -7.7526 | 261.835 | 7.7526 |
| 0.157903 | -259497 | -7.89515 | 259.497 | 7.89515 |
| 0.162179 | -255829 | -8.10896 | 255.829 | 8.10896 |
| 0.168594 | -249990 | -8.42968 | 249.99 | 8.42968 |
| 0.175008 | -244256 | -8.75041 | 244.256 | 8.75041 |
| 0.181423 | -238330 | -9.07113 | 238.33 | 9.07113 |
| 0.187837 | -232236 | -9.39185 | 232.236 | 9.39185 |
| 0.194252 | -225999 | -9.71258 | 225.999 | 9.71258 |
| 0.200666 | -219657 | -10.0333 | 219.657 | 10.0333 |
| 0.20708 | -213239 | -10.354 | 213.239 | 10.354 |
| 0.213495 | -206793 | -10.6747 | 206.793 | 10.6747 |
| 0.219909 | -200343 | -10.9955 | 200.343 | 10.9955 |
| 0.226324 | -193897 | -11.3162 | 193.897 | 11.3162 |
| 0.228729 | -192590 | -11.4365 | 192.59 | 11.4365 |
| 0.232337 | -188671 | -11.6169 | 188.671 | 11.6169 |
| 0.23775 | -182845 | -11.8875 | 182.845 | 11.8875 |
| 0.243162 | -177688 | -12.1581 | 177.688 | 12.1581 |
| 0.248574 | -172666 | -12.4287 | 172.666 | 12.4287 |
| 0.256692 | -164476 | -12.8346 | 164.476 | 12.8346 |
| 0.26887 | -152958 | -13.4435 | 152.958 | 13.4435 |
| 0.281047 | -144152 | -14.0524 | 144.152 | 14.0524 |
| 0.293225 | -136254 | -14.6612 | 136.254 | 14.6612 |
| 0.305402 | -129211 | -15.2701 | 129.211 | 15.2701 |
| 0.31758 | -122917 | -15.879 | 122.917 | 15.879 |
| 0.329757 | -117237 | -16.4879 | 117.237 | 16.4879 |
| 0.334324 | -117850 | -16.7162 | 117.85 | 16.7162 |
| 0.341173 | -113962 | -17.0587 | 113.962 | 17.0587 |
| 0.351448 | -108585 | -17.5724 | 108.585 | 17.5724 |
| 0.354017 | -110636 | -17.7008 | 110.636 | 17.7008 |
| 0.356586 | -109347 | -17.8293 | 109.347 | 17.8293 |
| 0.359154 | -108402 | -17.9577 | 108.402 | 17.9577 |
| 0.361723 | -107407 | -18.0861 | 107.407 | 18.0861 |
| 0.362686 | -107869 | -18.1343 | 107.869 | 18.1343 |
| 0.364131 | -106925 | -18.2066 | 106.925 | 18.2066 |
| 0.365576 | -106458 | -18.2788 | 106.458 | 18.2788 |

**S355**

**1 hole**

*42 mm*

$F_{u,fem}$ 278.824 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -147428 | -0.5 | | 147.428 | 0.5 |
| 0.0125 | -182391 | -0.625 | | 182.391 | 0.625 |
| 0.015 | -213914 | -0.75 | | 213.914 | 0.75 |
| 0.01875 | -224737 | -0.9375 | | 224.737 | 0.9375 |
| 0.0225 | -228239 | -1.125 | | 228.239 | 1.125 |
| 0.02625 | -231749 | -1.3125 | | 231.749 | 1.3125 |
| 0.03 | -235588 | -1.5 | | 235.588 | 1.5 |
| 0.035625 | -241207 | -1.78125 | | 241.207 | 1.78125 |
| 0.044063 | -249770 | -2.20313 | | 249.77 | 2.20313 |
| 0.056719 | -261561 | -2.83594 | | 261.561 | 2.83594 |
| 0.075703 | -273496 | -3.78516 | | 273.496 | 3.78516 |
| 0.082822 | -276121 | -4.14111 | | 276.121 | 4.14111 |
| 0.093501 | -278326 | -4.67505 | | 278.326 | 4.67505 |
| 0.10418 | -278824 | -5.20898 | | 278.824 | 5.20898 |
| 0.114858 | -277506 | -5.74292 | | 277.506 | 5.74292 |
| 0.125537 | -274118 | -6.27686 | | 274.118 | 6.27686 |
| 0.136216 | -268714 | -6.81079 | | 268.714 | 6.81079 |
| 0.146895 | -261382 | -7.34473 | | 261.382 | 7.34473 |
| 0.157573 | -252796 | -7.87866 | | 252.796 | 7.87866 |
| 0.168252 | -243609 | -8.4126 | | 243.609 | 8.4126 |
| 0.178931 | -234205 | -8.94653 | | 234.205 | 8.94653 |
| 0.189609 | -224875 | -9.48047 | | 224.875 | 9.48047 |
| 0.200288 | -215734 | -10.0144 | | 215.734 | 10.0144 |
| 0.210967 | -206854 | -10.5483 | | 206.854 | 10.5483 |
| 0.221646 | -198262 | -11.0823 | | 198.262 | 11.0823 |
| 0.232324 | -189974 | -11.6162 | | 189.974 | 11.6162 |
| 0.243003 | -181977 | -12.1501 | | 181.977 | 12.1501 |
| 0.253682 | -174245 | -12.6841 | | 174.245 | 12.6841 |
| 0.26436 | -166759 | -13.218 | | 166.759 | 13.218 |
| 0.275039 | -159427 | -13.752 | | 159.427 | 13.752 |
| 0.277709 | -160924 | -13.8854 | | 160.924 | 13.8854 |
| 0.280378 | -158952 | -14.0189 | | 158.952 | 14.0189 |
| 0.284383 | -155714 | -14.2191 | | 155.714 | 14.2191 |
| 0.29039 | -150885 | -14.5195 | | 150.885 | 14.5195 |
| 0.2994 | -143683 | -14.97 | | 143.683 | 14.97 |
| 0.30841 | -137874 | -15.4205 | | 137.874 | 15.4205 |
| 0.308973 | -141230 | -15.4487 | | 141.23 | 15.4487 |
| 0.309536 | -141379 | -15.4768 | | 141.379 | 15.4768 |
| 0.309677 | -141482 | -15.4839 | | 141.482 | 15.4839 |
| 0.309818 | -141387 | -15.4909 | | 141.387 | 15.4909 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

**S355**

**1 hole**

*43 mm*

$F_{u,fem}$ 274.837 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -146759 | -0.5 | | 146.759 | 0.5 |
| 0.0125 | -181395 | -0.625 | | 181.395 | 0.625 |
| 0.015 | -212201 | -0.75 | | 212.201 | 0.75 |
| 0.01875 | -221560 | -0.9375 | | 221.56 | 0.9375 |
| 0.0225 | -225015 | -1.125 | | 225.015 | 1.125 |
| 0.02625 | -228514 | -1.3125 | | 228.514 | 1.3125 |
| 0.03 | -232329 | -1.5 | | 232.329 | 1.5 |
| 0.035625 | -237889 | -1.78125 | | 237.889 | 1.78125 |
| 0.044063 | -246327 | -2.20313 | | 246.327 | 2.20313 |
| 0.056719 | -257941 | -2.83594 | | 257.941 | 2.83594 |
| 0.075703 | -269704 | -3.78516 | | 269.704 | 3.78516 |
| 0.080449 | -271521 | -4.02246 | | 271.521 | 4.02246 |
| 0.085195 | -272899 | -4.25977 | | 272.899 | 4.25977 |
| 0.092315 | -274254 | -4.61572 | | 274.254 | 4.61572 |
| 0.102993 | -274837 | -5.14966 | | 274.837 | 5.14966 |
| 0.113672 | -273601 | -5.68359 | | 273.601 | 5.68359 |
| 0.124351 | -270284 | -6.21753 | | 270.284 | 6.21753 |
| 0.135029 | -264915 | -6.75146 | | 264.915 | 6.75146 |
| 0.137699 | -263558 | -6.88495 | | 263.558 | 6.88495 |
| 0.140369 | -261848 | -7.01843 | | 261.848 | 7.01843 |
| 0.144373 | -259028 | -7.21866 | | 259.028 | 7.21866 |
| 0.15038 | -254393 | -7.519 | | 254.393 | 7.519 |
| 0.156387 | -249530 | -7.81934 | | 249.53 | 7.81934 |
| 0.162393 | -244404 | -8.11967 | | 244.404 | 8.11967 |
| 0.1684 | -239060 | -8.42001 | | 239.06 | 8.42001 |
| 0.174407 | -233532 | -8.72035 | | 233.532 | 8.72035 |
| 0.180414 | -227858 | -9.02069 | | 227.858 | 9.02069 |
| 0.186421 | -222065 | -9.32103 | | 222.065 | 9.32103 |
| 0.192427 | -216177 | -9.62137 | | 216.177 | 9.62137 |
| 0.198434 | -210221 | -9.92171 | | 210.221 | 9.92171 |
| 0.204441 | -204220 | -10.222 | | 204.22 | 10.222 |
| 0.210448 | -198186 | -10.5224 | | 198.186 | 10.5224 |
| 0.216454 | -192141 | -10.8227 | | 192.141 | 10.8227 |
| 0.218707 | -190577 | -10.9354 | | 190.577 | 10.9354 |
| 0.222086 | -187022 | -11.1043 | | 187.022 | 11.1043 |
| 0.227154 | -181737 | -11.3577 | | 181.737 | 11.3577 |
| 0.234756 | -173799 | -11.7378 | | 173.799 | 11.7378 |
| 0.237607 | -172224 | -11.8804 | | 172.224 | 11.8804 |
| 0.241884 | -167819 | -12.0942 | | 167.819 | 12.0942 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

**S355**

**1 hole**

*44 mm*

$F_{u,fem}$ 270.861 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -146063 | -0.5 | | 146.063 | 0.5 |
| 0.0125 | -180354 | -0.625 | | 180.354 | 0.625 |
| 0.015 | -210328 | -0.75 | | 210.328 | 0.75 |
| 0.01875 | -218360 | -0.9375 | | 218.36 | 0.9375 |
| 0.0225 | -221773 | -1.125 | | 221.773 | 1.125 |
| 0.02625 | -225262 | -1.3125 | | 225.262 | 1.3125 |
| 0.03 | -229046 | -1.5 | | 229.046 | 1.5 |
| 0.035625 | -234555 | -1.78125 | | 234.555 | 1.78125 |
| 0.044063 | -242847 | -2.20313 | | 242.847 | 2.20313 |
| 0.056719 | -254315 | -2.83594 | | 254.315 | 2.83594 |
| 0.061465 | -258005 | -3.07324 | | 258.005 | 3.07324 |
| 0.068584 | -262602 | -3.4292 | | 262.602 | 3.4292 |
| 0.079263 | -267344 | -3.96313 | | 267.344 | 3.96313 |
| 0.083267 | -268570 | -4.16336 | | 268.57 | 4.16336 |
| 0.089274 | -269906 | -4.4637 | | 269.906 | 4.4637 |
| 0.098284 | -270861 | -4.91421 | | 270.861 | 4.91421 |
| 0.107294 | -270616 | -5.36472 | | 270.616 | 5.36472 |
| 0.116304 | -269076 | -5.81522 | | 269.076 | 5.81522 |
| 0.125315 | -266105 | -6.26573 | | 266.105 | 6.26573 |
| 0.134325 | -261828 | -6.71624 | | 261.828 | 6.71624 |
| 0.143335 | -256281 | -7.16675 | | 256.281 | 7.16675 |
| 0.152345 | -249785 | -7.61726 | | 249.785 | 7.61726 |
| 0.154598 | -248480 | -7.72988 | | 248.48 | 7.72988 |
| 0.15685 | -246793 | -7.84251 | | 246.793 | 7.84251 |
| 0.160229 | -244150 | -8.01145 | | 244.15 | 8.01145 |
| 0.165297 | -240042 | -8.26486 | | 240.042 | 8.26486 |
| 0.1729 | -233573 | -8.64498 | | 233.573 | 8.64498 |
| 0.180502 | -227143 | -9.02509 | | 227.143 | 9.02509 |
| 0.188104 | -220563 | -9.40521 | | 220.563 | 9.40521 |
| 0.195707 | -213864 | -9.78533 | | 213.864 | 9.78533 |
| 0.203309 | -207070 | -10.1654 | | 207.07 | 10.1654 |
| 0.210911 | -200204 | -10.5456 | | 200.204 | 10.5456 |
| 0.218514 | -193299 | -10.9257 | | 193.299 | 10.9257 |
| 0.226116 | -186416 | -11.3058 | | 186.416 | 11.3058 |
| 0.233718 | -179572 | -11.6859 | | 179.572 | 11.6859 |
| 0.24132 | -172777 | -12.066 | | 172.777 | 12.066 |
| 0.248923 | -166091 | -12.4461 | | 166.091 | 12.4461 |
| 0.256525 | -159631 | -12.8263 | | 159.631 | 12.8263 |
| 0.264127 | -153468 | -13.2064 | | 153.468 | 13.2064 |
| 0.27173 | -147628 | -13.5865 | | 147.628 | 13.5865 |
| 0.283133 | -138268 | -14.1567 | | 138.268 | 14.1567 |
| 0.28741 | -137837 | -14.3705 | | 137.837 | 14.3705 |
| 0.293824 | -132996 | -14.6912 | | 132.996 | 14.6912 |
| 0.303446 | -126361 | -15.1723 | | 126.361 | 15.1723 |
| 0.317878 | -117357 | -15.8939 | | 117.357 | 15.8939 |
| 0.321486 | -119178 | -16.0743 | | 119.178 | 16.0743 |
| 0.325095 | -117292 | -16.2547 | | 117.292 | 16.2547 |
| 0.330507 | -114258 | -16.5253 | | 114.258 | 16.5253 |
| 0.338625 | -109901 | -16.9313 | | 109.901 | 16.9313 |
| 0.350802 | -103744 | -17.5401 | | 103.744 | 17.5401 |
| 0.353847 | -105783 | -17.6923 | | 105.783 | 17.6923 |
| 0.356891 | -104396 | -17.8446 | | 104.396 | 17.8446 |
| 0.361458 | -102172 | -18.0729 | | 102.172 | 18.0729 |
| 0.36317 | -102743 | -18.1585 | | 102.743 | 18.1585 |
| 0.365739 | -101342 | -18.2869 | | 101.342 | 18.2869 |
| 0.368308 | -100495 | -18.4154 | | 100.495 | 18.4154 |
| 0.370876 | -99583.4 | -18.5438 | | 99.5834 | 18.5438 |
| 0.37184 | -100078 | -18.592 | | 100.078 | 18.592 |
| 0.373284 | -99175.6 | -18.6642 | | 99.1756 | 18.6642 |
| 0.374729 | -98757.2 | -18.7365 | | 98.7572 | 18.7365 |
| 0.376174 | -98226.9 | -18.8087 | | 98.2269 | 18.8087 |
| 0.376264 | -98537 | -18.8132 | | 98.537 | 18.8132 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *45 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 266.802 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -145360 | -0.5 | | 145.36 | 0.5 |
| 0.0125 | -179293 | -0.625 | | 179.293 | 0.625 |
| 0.01625 | -212295 | -0.8125 | | 212.295 | 0.8125 |
| 0.02 | -216478 | -1 | | 216.478 | 1 |
| 0.02375 | -219734 | -1.1875 | | 219.734 | 1.1875 |
| 0.0275 | -223342 | -1.375 | | 223.342 | 1.375 |
| 0.033125 | -228812 | -1.65625 | | 228.812 | 1.65625 |
| 0.041563 | -237052 | -2.07813 | | 237.052 | 2.07813 |
| 0.054219 | -248692 | -2.71094 | | 248.692 | 2.71094 |
| 0.073203 | -261115 | -3.66016 | | 261.115 | 3.66016 |
| 0.080322 | -263862 | -4.01611 | | 263.862 | 4.01611 |
| 0.091001 | -266202 | -4.55005 | | 266.202 | 4.55005 |
| 0.10168 | -266802 | -5.08398 | | 266.802 | 5.08398 |
| 0.112358 | -265620 | -5.61792 | | 265.62 | 5.61792 |
| 0.123037 | -262387 | -6.15186 | | 262.387 | 6.15186 |
| 0.133716 | -257126 | -6.68579 | | 257.126 | 6.68579 |
| 0.144395 | -249929 | -7.21973 | | 249.929 | 7.21973 |
| 0.155073 | -241548 | -7.75366 | | 241.548 | 7.75366 |
| 0.165752 | -232583 | -8.2876 | | 232.583 | 8.2876 |
| 0.176431 | -223354 | -8.82153 | | 223.354 | 8.82153 |
| 0.187109 | -214118 | -9.35547 | | 214.118 | 9.35547 |
| 0.197788 | -205008 | -9.8894 | | 205.008 | 9.8894 |
| 0.208467 | -196103 | -10.4233 | | 196.103 | 10.4233 |
| 0.219146 | -187491 | -10.9573 | | 187.491 | 10.9573 |
| 0.229824 | -179163 | -11.4912 | | 179.163 | 11.4912 |
| 0.240503 | -171136 | -12.0251 | | 171.136 | 12.0251 |
| 0.251182 | -163405 | -12.5591 | | 163.405 | 12.5591 |
| 0.26186 | -155903 | -13.093 | | 155.903 | 13.093 |
| 0.272539 | -148630 | -13.627 | | 148.63 | 13.627 |
| 0.283218 | -141513 | -14.1609 | | 141.513 | 14.1609 |
| 0.293896 | -134487 | -14.6948 | | 134.487 | 14.6948 |
| 0.304575 | -127605 | -15.2288 | | 127.605 | 15.2288 |
| 0.315254 | -120811 | -15.7627 | | 120.811 | 15.7627 |
| 0.325933 | -114037 | -16.2966 | | 114.037 | 16.2966 |
| 0.3266 | -118667 | -16.33 | | 118.667 | 16.33 |
| 0.327267 | -120250 | -16.3634 | | 120.25 | 16.3634 |
| 0.327935 | -119664 | -16.3967 | | 119.664 | 16.3967 |
| 0.328602 | -119335 | -16.4301 | | 119.335 | 16.4301 |
| 0.328853 | -119574 | -16.4426 | | 119.574 | 16.4426 |
| 0.328946 | -119611 | -16.4473 | | 119.611 | 16.4473 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
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| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *46 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 262.82 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -144611 | -0.5 | | 144.611 | 0.5 |
| 0.0125 | -178168 | -0.625 | | 178.168 | 0.625 |
| 0.015 | -206140 | -0.75 | | 206.14 | 0.75 |
| 0.0175 | -210843 | -0.875 | | 210.843 | 0.875 |
| 0.02 | -213366 | -1 | | 213.366 | 1 |
| 0.0225 | -215483 | -1.125 | | 215.483 | 1.125 |
| 0.02625 | -218869 | -1.3125 | | 218.869 | 1.3125 |
| 0.031875 | -224303 | -1.59375 | | 224.303 | 1.59375 |
| 0.0375 | -229851 | -1.875 | | 229.851 | 1.875 |
| 0.043125 | -235292 | -2.15625 | | 235.292 | 2.15625 |
| 0.051563 | -242898 | -2.57813 | | 242.898 | 2.57813 |
| 0.064219 | -252517 | -3.21094 | | 252.517 | 3.21094 |
| 0.083203 | -260726 | -4.16016 | | 260.726 | 4.16016 |
| 0.087949 | -261758 | -4.39746 | | 261.758 | 4.39746 |
| 0.092695 | -262449 | -4.63477 | | 262.449 | 4.63477 |
| 0.097441 | -262820 | -4.87207 | | 262.82 | 4.87207 |
| 0.104561 | -262748 | -5.22803 | | 262.748 | 5.22803 |
| 0.115239 | -261107 | -5.76196 | | 261.107 | 5.76196 |
| 0.125918 | -257500 | -6.2959 | | 257.5 | 6.2959 |
| 0.136597 | -252064 | -6.82983 | | 252.064 | 6.82983 |
| 0.147275 | -244922 | -7.36377 | | 244.922 | 7.36377 |
| 0.157954 | -236869 | -7.89771 | | 236.869 | 7.89771 |
| 0.168633 | -228302 | -8.43164 | | 228.302 | 8.43164 |
| 0.171302 | -227135 | -8.56512 | | 227.135 | 8.56512 |
| 0.173972 | -224997 | -8.69861 | | 224.997 | 8.69861 |
| 0.177977 | -221617 | -8.89883 | | 221.617 | 8.89883 |
| 0.183983 | -216440 | -9.19917 | | 216.44 | 9.19917 |
| 0.18999 | -211527 | -9.49951 | | 211.527 | 9.49951 |
| 0.195997 | -206604 | -9.79985 | | 206.604 | 9.79985 |
| 0.205007 | -198655 | -10.2504 | | 198.655 | 10.2504 |
| 0.214017 | -191292 | -10.7009 | | 191.292 | 10.7009 |
| 0.223027 | -183934 | -11.1514 | | 183.934 | 11.1514 |
| 0.232038 | -176587 | -11.6019 | | 176.587 | 11.6019 |
| 0.23429 | -176266 | -11.7145 | | 176.266 | 11.7145 |
| 0.236543 | -174413 | -11.8271 | | 174.413 | 11.8271 |
| 0.239922 | -171470 | -11.9961 | | 171.47 | 11.9961 |
| 0.24499 | -167061 | -12.2495 | | 167.061 | 12.2495 |
| 0.252592 | -160428 | -12.6296 | | 160.428 | 12.6296 |
| 0.260194 | -154487 | -13.0097 | | 154.487 | 13.0097 |
| 0.267797 | -148625 | -13.3898 | | 148.625 | 13.3898 |
| 0.275399 | -142940 | -13.77 | | 142.94 | 13.77 |
| 0.283001 | -137521 | -14.1501 | | 137.521 | 14.1501 |
| 0.290604 | -132407 | -14.5302 | | 132.407 | 14.5302 |
| 0.298206 | -127608 | -14.9103 | | 127.608 | 14.9103 |
| 0.30961 | -119590 | -15.4805 | | 119.59 | 15.4805 |
| 0.321013 | -113714 | -16.0506 | | 113.714 | 16.0506 |
| 0.323864 | -115682 | -16.1932 | | 115.682 | 16.1932 |
| 0.326715 | -114106 | -16.3357 | | 114.106 | 16.3357 |
| 0.330991 | -111556 | -16.5496 | | 111.556 | 16.5496 |
| 0.337406 | -107831 | -16.8703 | | 107.831 | 16.8703 |
| 0.34382 | -105141 | -17.191 | | 105.141 | 17.191 |
| 0.350234 | -102474 | -17.5117 | | 102.474 | 17.5117 |
| 0.35264 | -103535 | -17.632 | | 103.535 | 17.632 |
| 0.356248 | -101242 | -17.8124 | | 101.242 | 17.8124 |
| 0.359856 | -99939.8 | -17.9928 | | 99.9398 | 17.9928 |
| 0.363464 | -98494.7 | -18.1732 | | 98.4947 | 18.1732 |
| 0.367072 | -97035.2 | -18.3536 | | 97.0352 | 18.3536 |
| 0.367298 | -98003.9 | -18.3649 | | 98.0039 | 18.3649 |
| 0.367523 | -98557.8 | -18.3762 | | 98.5578 | 18.3762 |
| 0.367749 | -98854.6 | -18.3874 | | 98.8546 | 18.3874 |
| 0.367974 | -98881.8 | -18.3987 | | 98.8818 | 18.3987 |
| 0.3682 | -98891.2 | -18.41 | | 98.8912 | 18.41 |

| S355 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *47 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 258.672 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -143831 | -0.5 | | 143.831 | 0.5 |
| 0.0125 | -176978 | -0.625 | | 176.978 | 0.625 |
| 0.015 | -203676 | -0.75 | | 203.676 | 0.75 |
| 0.01875 | -208893 | -0.9375 | | 208.893 | 0.9375 |
| 0.0225 | -212156 | -1.125 | | 212.156 | 1.125 |
| 0.02625 | -215607 | -1.3125 | | 215.607 | 1.3125 |
| 0.031875 | -221005 | -1.59375 | | 221.005 | 1.59375 |
| 0.040313 | -229072 | -2.01563 | | 229.072 | 2.01563 |
| 0.04875 | -236849 | -2.4375 | | 236.849 | 2.4375 |
| 0.057188 | -243920 | -2.85938 | | 243.92 | 2.85938 |
| 0.069844 | -251971 | -3.49219 | | 251.971 | 3.49219 |
| 0.088828 | -257860 | -4.44141 | | 257.86 | 4.44141 |
| 0.093574 | -258425 | -4.67871 | | 258.425 | 4.67871 |
| 0.09832 | -258672 | -4.91602 | | 258.672 | 4.91602 |
| 0.103066 | -258578 | -5.15332 | | 258.578 | 5.15332 |
| 0.110186 | -257774 | -5.50928 | | 257.774 | 5.50928 |
| 0.117305 | -256117 | -5.86523 | | 256.117 | 5.86523 |
| 0.124424 | -253566 | -6.22119 | | 253.566 | 6.22119 |
| 0.131543 | -250222 | -6.57715 | | 250.222 | 6.57715 |
| 0.138662 | -246083 | -6.93311 | | 246.083 | 6.93311 |
| 0.145781 | -241287 | -7.28906 | | 241.287 | 7.28906 |
| 0.1529 | -236108 | -7.64502 | | 236.108 | 7.64502 |
| 0.16002 | -230683 | -8.00098 | | 230.683 | 8.00098 |
| 0.167139 | -225093 | -8.35693 | | 225.093 | 8.35693 |
| 0.174258 | -219395 | -8.71289 | | 219.395 | 8.71289 |
| 0.184937 | -210097 | -9.24683 | | 210.097 | 9.24683 |
| 0.195615 | -201398 | -9.78076 | | 201.398 | 9.78076 |
| 0.206294 | -192847 | -10.3147 | | 192.847 | 10.3147 |
| 0.216973 | -184505 | -10.8486 | | 184.505 | 10.8486 |
| 0.227651 | -176389 | -11.3826 | | 176.389 | 11.3826 |
| 0.23833 | -168521 | -11.9165 | | 168.521 | 11.9165 |
| 0.249009 | -160866 | -12.4504 | | 160.866 | 12.4504 |
| 0.259688 | -153408 | -12.9844 | | 153.408 | 12.9844 |
| 0.270366 | -146137 | -13.5183 | | 146.137 | 13.5183 |
| 0.281045 | -139000 | -14.0522 | | 139 | 14.0522 |
| 0.283715 | -140326 | -14.1857 | | 140.326 | 14.1857 |
| 0.286384 | -138453 | -14.3192 | | 138.453 | 14.3192 |
| 0.290389 | -135381 | -14.5194 | | 135.381 | 14.5194 |
| 0.296396 | -130820 | -14.8198 | | 130.82 | 14.8198 |
| 0.305406 | -124025 | -15.2703 | | 124.025 | 15.2703 |
| 0.314416 | -118652 | -15.7208 | | 118.652 | 15.7208 |
| 0.323426 | -113404 | -16.1713 | | 113.404 | 16.1713 |
| 0.332436 | -108349 | -16.6218 | | 108.349 | 16.6218 |
| 0.341446 | -103385 | -17.0723 | | 103.385 | 17.0723 |
| 0.343699 | -106906 | -17.1849 | | 106.906 | 17.1849 |
| 0.345951 | -105257 | -17.2976 | | 105.257 | 17.2976 |
| 0.34933 | -102753 | -17.4665 | | 102.753 | 17.4665 |
| 0.352709 | -101178 | -17.6355 | | 101.178 | 17.6355 |
| 0.356088 | -99521.9 | -17.8044 | | 99.5219 | 17.8044 |
| 0.356299 | -100753 | -17.815 | | 100.753 | 17.815 |
| 0.35651 | -101006 | -17.8255 | | 101.006 | 17.8255 |
| 0.356721 | -101064 | -17.8361 | | 101.064 | 17.8361 |
| 0.356933 | -101187 | -17.8466 | | 101.187 | 17.8466 |
| 0.357249 | -101156 | -17.8625 | | 101.156 | 17.8625 |
| 0.357725 | -101133 | -17.8862 | | 101.133 | 17.8862 |
| 0.357769 | -101337 | -17.8885 | | 101.337 | 17.8885 |
| 0.357814 | -101459 | -17.8907 | | 101.459 | 17.8907 |
| 0.357858 | -101490 | -17.8929 | | 101.49 | 17.8929 |
| 0.357903 | -101523 | -17.8951 | | 101.523 | 17.8951 |
| 0.357969 | -101523 | -17.8985 | | 101.523 | 17.8985 |
| 0.35807 | -101514 | -17.9035 | | 101.514 | 17.9035 |
| 0.35808 | -101564 | -17.904 | | 101.564 | 17.904 |

# 9. OUTPUT FINITE ELEMENT MODEL VS THEORY FOR STEEL GRADE S460

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *18 mm* | | | | | |
| $F_{u,fem}$ | 519.104 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -157523 | -0.5 | | 157.523 | 0.5 |
| 0.02 | -313104 | -1 | | 313.104 | 1 |
| 0.02375 | -358343 | -1.1875 | | 358.343 | 1.1875 |
| 0.0275 | -371793 | -1.375 | | 371.793 | 1.375 |
| 0.03125 | -385716 | -1.5625 | | 385.716 | 1.5625 |
| 0.035 | -398026 | -1.75 | | 398.026 | 1.75 |
| 0.03875 | -408583 | -1.9375 | | 408.583 | 1.9375 |
| 0.0425 | -418014 | -2.125 | | 418.014 | 2.125 |
| 0.048125 | -426442 | -2.40625 | | 426.442 | 2.40625 |
| 0.05375 | -428495 | -2.6875 | | 428.495 | 2.6875 |
| 0.059375 | -430938 | -2.96875 | | 430.938 | 2.96875 |
| 0.065 | -435024 | -3.25 | | 435.024 | 3.25 |
| 0.070625 | -439215 | -3.53125 | | 439.215 | 3.53125 |
| 0.07625 | -442627 | -3.8125 | | 442.627 | 3.8125 |
| 0.081875 | -445128 | -4.09375 | | 445.128 | 4.09375 |
| 0.090313 | -448817 | -4.51563 | | 448.817 | 4.51563 |
| 0.102969 | -455415 | -5.14844 | | 455.415 | 5.14844 |
| 0.121953 | -465109 | -6.09766 | | 465.109 | 6.09766 |
| 0.15043 | -480705 | -7.52148 | | 480.705 | 7.52148 |
| 0.193145 | -499849 | -9.65723 | | 499.849 | 9.65723 |
| 0.209163 | -505729 | -10.4581 | | 505.729 | 10.4581 |
| 0.23319 | -513216 | -11.6595 | | 513.216 | 11.6595 |
| 0.2422 | -515546 | -12.11 | | 515.546 | 12.11 |
| 0.255715 | -518181 | -12.7858 | | 518.181 | 12.7858 |
| 0.260783 | -518849 | -13.0392 | | 518.849 | 13.0392 |
| 0.262684 | -519032 | -13.1342 | | 519.032 | 13.1342 |
| 0.265535 | -519104 | -13.2767 | | 519.104 | 13.2767 |
| 0.268386 | -518992 | -13.4193 | | 518.992 | 13.4193 |
| 0.271237 | -518656 | -13.5618 | | 518.656 | 13.5618 |
| 0.274087 | -518114 | -13.7044 | | 518.114 | 13.7044 |
| 0.276938 | -517372 | -13.8469 | | 517.372 | 13.8469 |
| 0.281215 | -515821 | -14.0607 | | 515.821 | 14.0607 |
| 0.287629 | -512639 | -14.3815 | | 512.639 | 14.3815 |
| 0.297251 | -505726 | -14.8625 | | 505.726 | 14.8625 |
| 0.299656 | -505081 | -14.9828 | | 505.081 | 14.9828 |
| 0.302062 | -503094 | -15.1031 | | 503.094 | 15.1031 |
| 0.30567 | -499671 | -15.2835 | | 499.671 | 15.2835 |
| 0.311082 | -493835 | -15.5541 | | 493.835 | 15.5541 |
| 0.316494 | -487903 | -15.8247 | | 487.903 | 15.8247 |
| 0.321906 | -481558 | -16.0953 | | 481.558 | 16.0953 |
| 0.327319 | -474719 | -16.3659 | | 474.719 | 16.3659 |
| 0.332731 | -467238 | -16.6365 | | 467.238 | 16.6365 |
| 0.338143 | -459142 | -16.9071 | | 459.142 | 16.9071 |
| 0.343555 | -450608 | -17.1778 | | 450.608 | 17.1778 |
| 0.348967 | -441771 | -17.4484 | | 441.771 | 17.4484 |
| 0.35438 | -432696 | -17.719 | | 432.696 | 17.719 |
| 0.359792 | -423428 | -17.9896 | | 423.428 | 17.9896 |
| 0.365204 | -414009 | -18.2602 | | 414.009 | 18.2602 |
| 0.370616 | -404484 | -18.5308 | | 404.484 | 18.5308 |
| 0.378734 | -388704 | -18.9367 | | 388.704 | 18.9367 |
| 0.380764 | -388135 | -19.0382 | | 388.135 | 19.0382 |
| 0.382794 | -384406 | -19.1397 | | 384.406 | 19.1397 |
| 0.385838 | -378584 | -19.2919 | | 378.584 | 19.2919 |
| 0.390404 | -369852 | -19.5202 | | 369.852 | 19.5202 |
| 0.397254 | -356703 | -19.8627 | | 356.703 | 19.8627 |
| 0.407529 | -336662 | -20.3765 | | 336.662 | 20.3765 |
| 0.411382 | -335329 | -20.5691 | | 335.329 | 20.5691 |
| 0.417162 | -324088 | -20.8581 | | 324.088 | 20.8581 |
| 0.419329 | -323621 | -20.9664 | | 323.621 | 20.9664 |
| 0.42258 | -317484 | -21.129 | | 317.484 | 21.129 |
| 0.427456 | -308760 | -21.3728 | | 308.76 | 21.3728 |
| 0.432333 | -301680 | -21.6166 | | 301.68 | 21.6166 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *19 mm* | | | | | |
| $F_{u,fem}$ | 512.91 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -157296 | -0.5 | | 157.296 | 0.5 |
| 0.02 | -312421 | -1 | | 312.421 | 1 |
| 0.02375 | -354963 | -1.1875 | | 354.963 | 1.1875 |
| 0.0275 | -368548 | -1.375 | | 368.548 | 1.375 |
| 0.03125 | -382335 | -1.5625 | | 382.335 | 1.5625 |
| 0.035 | -394543 | -1.75 | | 394.543 | 1.75 |
| 0.03875 | -405079 | -1.9375 | | 405.079 | 1.9375 |
| 0.044375 | -418830 | -2.21875 | | 418.83 | 2.21875 |
| 0.052813 | -428160 | -2.64063 | | 428.16 | 2.64063 |
| 0.06125 | -431392 | -3.0625 | | 431.392 | 3.0625 |
| 0.069688 | -437486 | -3.48438 | | 437.486 | 3.48438 |
| 0.078125 | -442725 | -3.90625 | | 442.725 | 3.90625 |
| 0.086563 | -446378 | -4.32813 | | 446.378 | 4.32813 |
| 0.099219 | -452327 | -4.96094 | | 452.327 | 4.96094 |
| 0.118203 | -461951 | -5.91016 | | 461.951 | 5.91016 |
| 0.14668 | -477168 | -7.33398 | | 477.168 | 7.33398 |
| 0.189395 | -496506 | -9.46973 | | 496.506 | 9.46973 |
| 0.205413 | -502272 | -10.2706 | | 502.272 | 10.2706 |
| 0.22944 | -509287 | -11.472 | | 509.287 | 11.472 |
| 0.23845 | -511338 | -11.9225 | | 511.338 | 11.9225 |
| 0.251965 | -512883 | -12.5983 | | 512.883 | 12.5983 |
| 0.257033 | -512910 | -12.8517 | | 512.91 | 12.8517 |
| 0.262102 | -512025 | -13.1051 | | 512.025 | 13.1051 |
| 0.26717 | -510510 | -13.3585 | | 510.51 | 13.3585 |
| 0.272238 | -508467 | -13.6119 | | 508.467 | 13.6119 |
| 0.27984 | -503923 | -13.992 | | 503.923 | 13.992 |
| 0.287443 | -498334 | -14.3721 | | 498.334 | 14.3721 |
| 0.295045 | -491467 | -14.7522 | | 491.467 | 14.7522 |
| 0.296946 | -490777 | -14.8473 | | 490.777 | 14.8473 |
| 0.298846 | -488796 | -14.9423 | | 488.796 | 14.9423 |
| 0.301697 | -485568 | -15.0848 | | 485.568 | 15.0848 |
| 0.305973 | -480467 | -15.2987 | | 480.467 | 15.2987 |
| 0.31025 | -475464 | -15.5125 | | 475.464 | 15.5125 |
| 0.314526 | -470172 | -15.7263 | | 470.172 | 15.7263 |
| 0.318802 | -464543 | -15.9401 | | 464.543 | 15.9401 |
| 0.323079 | -458537 | -16.1539 | | 458.537 | 16.1539 |
| 0.327355 | -452189 | -16.3677 | | 452.189 | 16.3677 |
| 0.331631 | -445579 | -16.5816 | | 445.579 | 16.5816 |
| 0.335907 | -438774 | -16.7954 | | 438.774 | 16.7954 |
| 0.340184 | -431816 | -17.0092 | | 431.816 | 17.0092 |
| 0.34446 | -424730 | -17.223 | | 424.73 | 17.223 |
| 0.350875 | -413063 | -17.5437 | | 413.063 | 17.5437 |
| 0.360496 | -394978 | -18.0248 | | 394.978 | 18.0248 |
| 0.362902 | -394068 | -18.1451 | | 394.068 | 18.1451 |
| 0.365307 | -389740 | -18.2654 | | 389.74 | 18.2654 |
| 0.368915 | -382955 | -18.4458 | | 382.955 | 18.4458 |
| 0.374327 | -372718 | -18.7164 | | 372.718 | 18.7164 |
| 0.382446 | -357061 | -19.1223 | | 357.061 | 19.1223 |
| 0.38549 | -355018 | -19.2745 | | 355.018 | 19.2745 |
| 0.390057 | -346082 | -19.5028 | | 346.082 | 19.5028 |
| 0.396906 | -332814 | -19.8453 | | 332.814 | 19.8453 |
| 0.403756 | -321570 | -20.1878 | | 321.57 | 20.1878 |
| 0.410606 | -310753 | -20.5303 | | 310.753 | 20.5303 |
| 0.417456 | -300582 | -20.8728 | | 300.582 | 20.8728 |
| 0.427731 | -283451 | -21.3865 | | 283.451 | 21.3865 |
| 0.431584 | -284506 | -21.5792 | | 284.506 | 21.5792 |
| 0.437363 | -275135 | -21.8682 | | 275.135 | 21.8682 |
| 0.43953 | -275760 | -21.9765 | | 275.76 | 21.9765 |
| 0.442781 | -270683 | -22.1391 | | 270.683 | 22.1391 |
| 0.447658 | -263828 | -22.3829 | | 263.828 | 22.3829 |
| 0.449487 | -264477 | -22.4743 | | 264.477 | 22.4743 |
| 0.451315 | -262119 | -22.5658 | | 262.119 | 22.5658 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *20 mm* | | | | | |
| $F_{u,fem}$ | 505.519 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -157053 | -0.5 | | 157.053 | 0.5 |
| 0.02 | -311670 | -1 | | 311.67 | 1 |
| 0.02375 | -351550 | -1.1875 | | 351.55 | 1.1875 |
| 0.0275 | -365193 | -1.375 | | 365.193 | 1.375 |
| 0.03125 | -378968 | -1.5625 | | 378.968 | 1.5625 |
| 0.035 | -391000 | -1.75 | | 391 | 1.75 |
| 0.03875 | -401434 | -1.9375 | | 401.434 | 1.9375 |
| 0.0425 | -410848 | -2.125 | | 410.848 | 2.125 |
| 0.048125 | -423022 | -2.40625 | | 423.022 | 2.40625 |
| 0.056563 | -428946 | -2.82813 | | 428.946 | 2.82813 |
| 0.065 | -433012 | -3.25 | | 433.012 | 3.25 |
| 0.073438 | -438899 | -3.67188 | | 438.899 | 3.67188 |
| 0.081875 | -443583 | -4.09375 | | 443.583 | 4.09375 |
| 0.090313 | -447136 | -4.51563 | | 447.136 | 4.51563 |
| 0.09875 | -451059 | -4.9375 | | 451.059 | 4.9375 |
| 0.111406 | -457633 | -5.57031 | | 457.633 | 5.57031 |
| 0.130391 | -466967 | -6.51953 | | 466.967 | 6.51953 |
| 0.158867 | -481481 | -7.94336 | | 481.481 | 7.94336 |
| 0.201582 | -498493 | -10.0791 | | 498.493 | 10.0791 |
| 0.2176 | -503089 | -10.88 | | 503.089 | 10.88 |
| 0.241627 | -505519 | -12.0814 | | 505.519 | 12.0814 |
| 0.247634 | -505331 | -12.3817 | | 505.331 | 12.3817 |
| 0.253641 | -503340 | -12.682 | | 503.34 | 12.682 |
| 0.259648 | -500593 | -12.9824 | | 500.593 | 12.9824 |
| 0.265654 | -497026 | -13.2827 | | 497.026 | 13.2827 |
| 0.274664 | -489473 | -13.7332 | | 489.473 | 13.7332 |
| 0.276917 | -488910 | -13.8458 | | 488.91 | 13.8458 |
| 0.27917 | -486815 | -13.9585 | | 486.815 | 13.9585 |
| 0.282548 | -483237 | -14.1274 | | 483.237 | 14.1274 |
| 0.287617 | -477419 | -14.3808 | | 477.419 | 14.3808 |
| 0.292685 | -471695 | -14.6342 | | 471.695 | 14.6342 |
| 0.297753 | -465707 | -14.8877 | | 465.707 | 14.8877 |
| 0.302821 | -459441 | -15.1411 | | 459.441 | 15.1411 |
| 0.307889 | -452795 | -15.3945 | | 452.795 | 15.3945 |
| 0.312958 | -445670 | -15.6479 | | 445.67 | 15.6479 |
| 0.318026 | -438077 | -15.9013 | | 438.077 | 15.9013 |
| 0.323094 | -430144 | -16.1547 | | 430.144 | 16.1547 |
| 0.328162 | -421977 | -16.4081 | | 421.977 | 16.4081 |
| 0.333231 | -413636 | -16.6615 | | 413.636 | 16.6615 |
| 0.338299 | -405160 | -16.9149 | | 405.16 | 16.9149 |
| 0.345901 | -391056 | -17.2951 | | 391.056 | 17.2951 |
| 0.353503 | -377953 | -17.6752 | | 377.953 | 17.6752 |
| 0.361106 | -364654 | -18.0553 | | 364.654 | 18.0553 |
| 0.368708 | -351295 | -18.4354 | | 351.295 | 18.4354 |
| 0.370609 | -351726 | -18.5304 | | 351.726 | 18.5304 |
| 0.372509 | -348267 | -18.6255 | | 348.267 | 18.6255 |
| 0.37536 | -342866 | -18.768 | | 342.866 | 18.768 |
| 0.378211 | -338165 | -18.9105 | | 338.165 | 18.9105 |
| 0.381062 | -333479 | -19.0531 | | 333.479 | 19.0531 |
| 0.385338 | -325506 | -19.2669 | | 325.506 | 19.2669 |
| 0.391753 | -313772 | -19.5876 | | 313.772 | 19.5876 |
| 0.401374 | -296722 | -20.0687 | | 296.722 | 20.0687 |
| 0.404982 | -297323 | -20.2491 | | 297.323 | 20.2491 |
| 0.410395 | -287798 | -20.5197 | | 287.798 | 20.5197 |
| 0.415807 | -280935 | -20.7903 | | 280.935 | 20.7903 |
| 0.421219 | -274091 | -21.061 | | 274.091 | 21.061 |
| 0.423249 | -274698 | -21.1624 | | 274.698 | 21.1624 |
| 0.425278 | -271856 | -21.2639 | | 271.856 | 21.2639 |
| 0.427308 | -269495 | -21.3654 | | 269.495 | 21.3654 |
| 0.428069 | -269758 | -21.4034 | | 269.758 | 21.4034 |
| 0.42921 | -267900 | -21.4605 | | 267.9 | 21.4605 |
| 0.430923 | -265441 | -21.5461 | | 265.441 | 21.5461 |

| **S460** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *21 mm* | | | | | |
| $F_{u,fem}$ | 500.676 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -156798 | -0.5 | | 156.798 | 0.5 |
| 0.02 | -310884 | -1 | | 310.884 | 1 |
| 0.02375 | -348187 | -1.1875 | | 348.187 | 1.1875 |
| 0.0275 | -361868 | -1.375 | | 361.868 | 1.375 |
| 0.03125 | -375532 | -1.5625 | | 375.532 | 1.5625 |
| 0.035 | -387458 | -1.75 | | 387.458 | 1.75 |
| 0.03875 | -397842 | -1.9375 | | 397.842 | 1.9375 |
| 0.0425 | -407176 | -2.125 | | 407.176 | 2.125 |
| 0.048125 | -419455 | -2.40625 | | 419.455 | 2.40625 |
| 0.056563 | -428910 | -2.82813 | | 428.91 | 2.82813 |
| 0.065 | -432024 | -3.25 | | 432.024 | 3.25 |
| 0.073438 | -437763 | -3.67188 | | 437.763 | 3.67188 |
| 0.081875 | -442641 | -4.09375 | | 442.641 | 4.09375 |
| 0.090313 | -446247 | -4.51563 | | 446.247 | 4.51563 |
| 0.102969 | -451983 | -5.14844 | | 451.983 | 5.14844 |
| 0.121953 | -461262 | -6.09766 | | 461.262 | 6.09766 |
| 0.15043 | -475459 | -7.52148 | | 475.459 | 7.52148 |
| 0.193145 | -493088 | -9.65723 | | 493.088 | 9.65723 |
| 0.209163 | -497722 | -10.4581 | | 497.722 | 10.4581 |
| 0.215169 | -499129 | -10.7585 | | 499.129 | 10.7585 |
| 0.22418 | -500676 | -11.209 | | 500.676 | 11.209 |
| 0.237695 | -499837 | -11.8847 | | 499.837 | 11.8847 |
| 0.241074 | -499641 | -12.0537 | | 499.641 | 12.0537 |
| 0.244452 | -498551 | -12.2226 | | 498.551 | 12.2226 |
| 0.247831 | -497239 | -12.3916 | | 497.239 | 12.3916 |
| 0.25121 | -495682 | -12.5605 | | 495.682 | 12.5605 |
| 0.256278 | -492630 | -12.8139 | | 492.63 | 12.8139 |
| 0.263881 | -486691 | -13.194 | | 486.691 | 13.194 |
| 0.271483 | -479884 | -13.5741 | | 479.884 | 13.5741 |
| 0.279085 | -471706 | -13.9543 | | 471.706 | 13.9543 |
| 0.280986 | -470970 | -14.0493 | | 470.97 | 14.0493 |
| 0.282886 | -468746 | -14.1443 | | 468.746 | 14.1443 |
| 0.285737 | -465139 | -14.2869 | | 465.139 | 14.2869 |
| 0.290014 | -459435 | -14.5007 | | 459.435 | 14.5007 |
| 0.29429 | -453783 | -14.7145 | | 453.783 | 14.7145 |
| 0.298566 | -447777 | -14.9283 | | 447.777 | 14.9283 |
| 0.302842 | -441462 | -15.1421 | | 441.462 | 15.1421 |
| 0.307119 | -434902 | -15.3559 | | 434.902 | 15.3559 |
| 0.311395 | -428156 | -15.5698 | | 428.156 | 15.5698 |
| 0.315671 | -421263 | -15.7836 | | 421.263 | 15.7836 |
| 0.319948 | -414251 | -15.9974 | | 414.251 | 15.9974 |
| 0.326362 | -402712 | -16.3181 | | 402.712 | 16.3181 |
| 0.332777 | -391821 | -16.6388 | | 391.821 | 16.6388 |
| 0.339191 | -380775 | -16.9596 | | 380.775 | 16.9596 |
| 0.345606 | -369661 | -17.2803 | | 369.661 | 17.2803 |
| 0.35202 | -358492 | -17.601 | | 358.492 | 17.601 |
| 0.358434 | -347344 | -17.9217 | | 347.344 | 17.9217 |
| 0.364849 | -336407 | -18.2424 | | 336.407 | 18.2424 |
| 0.371263 | -325810 | -18.5632 | | 325.81 | 18.5632 |
| 0.380885 | -308078 | -19.0443 | | 308.078 | 19.0443 |
| 0.395318 | -283443 | -19.7659 | | 283.443 | 19.7659 |
| 0.40975 | -266054 | -20.4875 | | 266.054 | 20.4875 |
| 0.416966 | -263616 | -20.8483 | | 263.616 | 20.8483 |
| 0.419673 | -263412 | -20.9836 | | 263.412 | 20.9836 |
| 0.423732 | -257608 | -21.1866 | | 257.608 | 21.1866 |
| 0.42982 | -249658 | -21.491 | | 249.658 | 21.491 |
| 0.432104 | -250378 | -21.6052 | | 250.378 | 21.6052 |
| 0.434387 | -247623 | -21.7193 | | 247.623 | 21.7193 |
| 0.43667 | -245359 | -21.8335 | | 245.359 | 21.8335 |
| 0.440095 | -240961 | -22.0048 | | 240.961 | 22.0048 |
| 0.441379 | -241672 | -22.069 | | 241.672 | 22.069 |
| 0.442664 | -240078 | -22.1332 | | 240.078 | 22.1332 |

| **S460** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *22 mm* | | | | | |
| $F_{u,fem}$ | 495.255 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -156528 | -0.5 | | 156.528 | 0.5 |
| 0.02 | -310034 | -1 | | 310.034 | 1 |
| 0.0225 | -341058 | -1.125 | | 341.058 | 1.125 |
| 0.025 | -349252 | -1.25 | | 349.252 | 1.25 |
| 0.0275 | -358686 | -1.375 | | 358.686 | 1.375 |
| 0.03 | -367824 | -1.5 | | 367.824 | 1.5 |
| 0.03375 | -380151 | -1.6875 | | 380.151 | 1.6875 |
| 0.039375 | -395734 | -1.96875 | | 395.734 | 1.96875 |
| 0.047813 | -414917 | -2.39063 | | 414.917 | 2.39063 |
| 0.060469 | -429611 | -3.02344 | | 429.611 | 3.02344 |
| 0.073125 | -436234 | -3.65625 | | 436.234 | 3.65625 |
| 0.076289 | -438309 | -3.81445 | | 438.309 | 3.81445 |
| 0.079453 | -440180 | -3.97266 | | 440.18 | 3.97266 |
| 0.082617 | -441921 | -4.13086 | | 441.921 | 4.13086 |
| 0.087363 | -444079 | -4.36816 | | 444.079 | 4.36816 |
| 0.094482 | -446984 | -4.72412 | | 446.984 | 4.72412 |
| 0.105161 | -451793 | -5.25806 | | 451.793 | 5.25806 |
| 0.121179 | -459546 | -6.05896 | | 459.546 | 6.05896 |
| 0.145206 | -470916 | -7.26031 | | 470.916 | 7.26031 |
| 0.181247 | -486274 | -9.06235 | | 486.274 | 9.06235 |
| 0.194762 | -490580 | -9.73811 | | 490.58 | 9.73811 |
| 0.19983 | -491951 | -9.99152 | | 491.951 | 9.99152 |
| 0.207433 | -493689 | -10.3716 | | 493.689 | 10.3716 |
| 0.218836 | -495145 | -10.9418 | | 495.145 | 10.9418 |
| 0.223113 | -495255 | -11.1556 | | 495.255 | 11.1556 |
| 0.227389 | -494794 | -11.3694 | | 494.794 | 11.3694 |
| 0.231665 | -493836 | -11.5833 | | 493.836 | 11.5833 |
| 0.235941 | -492416 | -11.7971 | | 492.416 | 11.7971 |
| 0.240218 | -490604 | -12.0109 | | 490.604 | 12.0109 |
| 0.246632 | -486831 | -12.3316 | | 486.831 | 12.3316 |
| 0.249038 | -485736 | -12.4519 | | 485.736 | 12.4519 |
| 0.252646 | -482981 | -12.6323 | | 482.981 | 12.6323 |
| 0.258058 | -478237 | -12.9029 | | 478.237 | 12.9029 |
| 0.266176 | -469573 | -13.3088 | | 469.573 | 13.3088 |
| 0.268206 | -468788 | -13.4103 | | 468.788 | 13.4103 |
| 0.270235 | -466520 | -13.5118 | | 466.52 | 13.5118 |
| 0.27328 | -462844 | -13.664 | | 462.844 | 13.664 |
| 0.277846 | -457074 | -13.8923 | | 457.074 | 13.8923 |
| 0.282413 | -451449 | -14.1206 | | 451.449 | 14.1206 |
| 0.286979 | -445517 | -14.349 | | 445.517 | 14.349 |
| 0.291546 | -439242 | -14.5773 | | 439.242 | 14.5773 |
| 0.296113 | -432606 | -14.8056 | | 432.606 | 14.8056 |
| 0.300679 | -425668 | -15.034 | | 425.668 | 15.034 |
| 0.305246 | -418508 | -15.2623 | | 418.508 | 15.2623 |
| 0.309812 | -411186 | -15.4906 | | 411.186 | 15.4906 |
| 0.314379 | -403740 | -15.7189 | | 403.74 | 15.7189 |
| 0.321229 | -391428 | -16.0614 | | 391.428 | 16.0614 |
| 0.328078 | -379873 | -16.4039 | | 379.873 | 16.4039 |
| 0.334928 | -368155 | -16.7464 | | 368.155 | 16.7464 |
| 0.341778 | -356382 | -17.0889 | | 356.382 | 17.0889 |
| 0.348628 | -344724 | -17.4314 | | 344.724 | 17.4314 |
| 0.355478 | -333324 | -17.7739 | | 333.324 | 17.7739 |
| 0.362327 | -322212 | -18.1164 | | 322.212 | 18.1164 |
| 0.372602 | -303467 | -18.6301 | | 303.467 | 18.6301 |
| 0.376455 | -302869 | -18.8228 | | 302.869 | 18.8228 |
| 0.382235 | -292521 | -19.1117 | | 292.521 | 19.1117 |
| 0.390904 | -278053 | -19.5452 | | 278.053 | 19.5452 |
| 0.399573 | -266881 | -19.9787 | | 266.881 | 19.9787 |
| 0.408243 | -256251 | -20.4121 | | 256.251 | 20.4121 |
| 0.416912 | -246311 | -20.8456 | | 246.311 | 20.8456 |
| 0.420163 | -247656 | -21.0081 | | 247.656 | 21.0081 |
| 0.423414 | -243513 | -21.1707 | | 243.513 | 21.1707 |

| **S460** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *23 mm* | | | | | |
| $F_{u,fem}$ | 488.847 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -156245 | -0.5 | | 156.245 | 0.5 |
| 0.02 | -309129 | -1 | | 309.129 | 1 |
| 0.0225 | -337811 | -1.125 | | 337.811 | 1.125 |
| 0.025 | -346013 | -1.25 | | 346.013 | 1.25 |
| 0.0275 | -355346 | -1.375 | | 355.346 | 1.375 |
| 0.03 | -364426 | -1.5 | | 364.426 | 1.5 |
| 0.03375 | -376626 | -1.6875 | | 376.626 | 1.6875 |
| 0.0375 | -387337 | -1.875 | | 387.337 | 1.875 |
| 0.04125 | -396701 | -2.0625 | | 396.701 | 2.0625 |
| 0.046875 | -409146 | -2.34375 | | 409.146 | 2.34375 |
| 0.055313 | -424647 | -2.76563 | | 424.647 | 2.76563 |
| 0.058477 | -428160 | -2.92383 | | 428.16 | 2.92383 |
| 0.063223 | -430111 | -3.16113 | | 430.111 | 3.16113 |
| 0.070342 | -433067 | -3.51709 | | 433.067 | 3.51709 |
| 0.081021 | -439727 | -4.05103 | | 439.727 | 4.05103 |
| 0.091699 | -444772 | -4.58496 | | 444.772 | 4.58496 |
| 0.102378 | -449211 | -5.1189 | | 449.211 | 5.1189 |
| 0.118396 | -456849 | -5.9198 | | 456.849 | 5.9198 |
| 0.142423 | -467564 | -7.12115 | | 467.564 | 7.12115 |
| 0.178464 | -482338 | -8.92319 | | 482.338 | 8.92319 |
| 0.191979 | -486368 | -9.59895 | | 486.368 | 9.59895 |
| 0.212252 | -488847 | -10.6126 | | 488.847 | 10.6126 |
| 0.21732 | -488760 | -10.866 | | 488.76 | 10.866 |
| 0.222388 | -487547 | -11.1194 | | 487.547 | 11.1194 |
| 0.227457 | -485702 | -11.3728 | | 485.702 | 11.3728 |
| 0.232525 | -483293 | -11.6262 | | 483.293 | 11.6262 |
| 0.237593 | -480282 | -11.8796 | | 480.282 | 11.8796 |
| 0.245195 | -474115 | -12.2598 | | 474.115 | 12.2598 |
| 0.252798 | -467085 | -12.6399 | | 467.085 | 12.6399 |
| 0.2604 | -458774 | -13.02 | | 458.774 | 13.02 |
| 0.268002 | -449666 | -13.4001 | | 449.666 | 13.4001 |
| 0.269903 | -448955 | -13.4951 | | 448.955 | 13.4951 |
| 0.271803 | -446515 | -13.5902 | | 446.515 | 13.5902 |
| 0.274654 | -442577 | -13.7327 | | 442.577 | 13.7327 |
| 0.278931 | -436382 | -13.9465 | | 436.382 | 13.9465 |
| 0.283207 | -430324 | -14.1603 | | 430.324 | 14.1603 |
| 0.287483 | -423979 | -14.3742 | | 423.979 | 14.3742 |
| 0.291759 | -417419 | -14.588 | | 417.419 | 14.588 |
| 0.296036 | -410698 | -14.8018 | | 410.698 | 14.8018 |
| 0.300312 | -403853 | -15.0156 | | 403.853 | 15.0156 |
| 0.306727 | -392528 | -15.3363 | | 392.528 | 15.3363 |
| 0.313141 | -381892 | -15.6571 | | 381.892 | 15.6571 |
| 0.319555 | -371096 | -15.9778 | | 371.096 | 15.9778 |
| 0.32597 | -360235 | -16.2985 | | 360.235 | 16.2985 |
| 0.332384 | -349423 | -16.6192 | | 349.423 | 16.6192 |
| 0.342006 | -331459 | -17.1003 | | 331.459 | 17.1003 |
| 0.351628 | -315675 | -17.5814 | | 315.675 | 17.5814 |
| 0.354033 | -316911 | -17.7017 | | 316.911 | 17.7017 |
| 0.357641 | -310114 | -17.8821 | | 310.114 | 17.8821 |
| 0.363054 | -300432 | -18.1527 | | 300.432 | 18.1527 |
| 0.365083 | -300106 | -18.2542 | | 300.106 | 18.2542 |
| 0.368127 | -294552 | -18.4064 | | 294.552 | 18.4064 |
| 0.372694 | -286682 | -18.6347 | | 286.682 | 18.6347 |
| 0.379544 | -275153 | -18.9772 | | 275.153 | 18.9772 |
| 0.386394 | -266326 | -19.3197 | | 266.326 | 19.3197 |
| 0.393243 | -257844 | -19.6622 | | 257.844 | 19.6622 |
| 0.395812 | -258658 | -19.7906 | | 258.658 | 19.7906 |
| 0.399665 | -252611 | -19.9833 | | 252.611 | 19.9833 |
| 0.405445 | -244564 | -20.2722 | | 244.564 | 20.2722 |
| 0.407612 | -245810 | -20.3806 | | 245.81 | 20.3806 |
| 0.410863 | -240859 | -20.5432 | | 240.859 | 20.5432 |
| 0.41574 | -234418 | -20.787 | | 234.418 | 20.787 |

## S460

### 1 hole

*24 mm*

| | | | | | |
|---|---|---|---|---|---|
| Fu,fem | 483.615 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -155949 | -0.5 | | 155.949 | 0.5 |
| 0.02 | -308157 | -1 | | 308.157 | 1 |
| 0.0225 | -334481 | -1.125 | | 334.481 | 1.125 |
| 0.025 | -342761 | -1.25 | | 342.761 | 1.25 |
| 0.0275 | -351990 | -1.375 | | 351.99 | 1.375 |
| 0.03 | -361002 | -1.5 | | 361.002 | 1.5 |
| 0.0325 | -369240 | -1.625 | | 369.24 | 1.625 |
| 0.03625 | -380278 | -1.8125 | | 380.278 | 1.8125 |
| 0.041875 | -394366 | -2.09375 | | 394.366 | 2.09375 |
| 0.0475 | -406496 | -2.375 | | 406.496 | 2.375 |
| 0.053125 | -417347 | -2.65625 | | 417.347 | 2.65625 |
| 0.061563 | -428712 | -3.07813 | | 428.712 | 3.07813 |
| 0.07 | -431638 | -3.5 | | 431.638 | 3.5 |
| 0.078438 | -436789 | -3.92188 | | 436.789 | 3.92188 |
| 0.086875 | -441536 | -4.34375 | | 441.536 | 4.34375 |
| 0.095313 | -445141 | -4.76563 | | 445.141 | 4.76563 |
| 0.107969 | -450341 | -5.39844 | | 450.341 | 5.39844 |
| 0.126953 | -458909 | -6.34766 | | 458.909 | 6.34766 |
| 0.145938 | -466941 | -7.29688 | | 466.941 | 7.29688 |
| 0.164922 | -474644 | -8.24609 | | 474.644 | 8.24609 |
| 0.193398 | -482563 | -9.66992 | | 482.563 | 9.66992 |
| 0.200518 | -483615 | -10.0259 | | 483.615 | 10.0259 |
| 0.207637 | -483562 | -10.3818 | | 483.562 | 10.3818 |
| 0.214756 | -482140 | -10.7378 | | 482.14 | 10.7378 |
| 0.221875 | -479413 | -11.0938 | | 479.413 | 11.0938 |
| 0.228994 | -475512 | -11.4497 | | 475.512 | 11.4497 |
| 0.236113 | -470369 | -11.8057 | | 470.369 | 11.8057 |
| 0.243232 | -464149 | -12.1616 | | 464.149 | 12.1616 |
| 0.250352 | -456749 | -12.5176 | | 456.749 | 12.5176 |
| 0.257471 | -448598 | -12.8735 | | 448.598 | 12.8735 |
| 0.26459 | -439882 | -13.2295 | | 439.882 | 13.2295 |
| 0.271709 | -430518 | -13.5854 | | 430.518 | 13.5854 |
| 0.278828 | -420374 | -13.9414 | | 420.374 | 13.9414 |
| 0.285947 | -409542 | -14.2974 | | 409.542 | 14.2974 |
| 0.293066 | -398254 | -14.6533 | | 398.254 | 14.6533 |
| 0.300186 | -386660 | -15.0093 | | 386.66 | 15.0093 |
| 0.307305 | -374861 | -15.3652 | | 374.861 | 15.3652 |
| 0.314424 | -362930 | -15.7212 | | 362.93 | 15.7212 |
| 0.321543 | -350982 | -16.0771 | | 350.982 | 16.0771 |
| 0.328662 | -339051 | -16.4331 | | 339.051 | 16.4331 |
| 0.335781 | -327115 | -16.7891 | | 327.115 | 16.7891 |
| 0.3429 | -315245 | -17.145 | | 315.245 | 17.145 |
| 0.34468 | -316102 | -17.234 | | 316.102 | 17.234 |
| 0.34646 | -313018 | -17.323 | | 313.018 | 17.323 |
| 0.34913 | -308195 | -17.4565 | | 308.195 | 17.4565 |
| 0.353134 | -300998 | -17.6567 | | 300.998 | 17.6567 |
| 0.359141 | -290370 | -17.957 | | 290.37 | 17.957 |
| 0.368151 | -275040 | -18.4076 | | 275.04 | 18.4076 |
| 0.381666 | -254069 | -19.0833 | | 254.069 | 19.0833 |
| 0.395182 | -239626 | -19.7591 | | 239.626 | 19.7591 |
| 0.408697 | -226105 | -20.4348 | | 226.105 | 20.4348 |
| 0.412076 | -231886 | -20.6038 | | 231.886 | 20.6038 |
| 0.415454 | -227530 | -20.7727 | | 227.53 | 20.7727 |
| 0.418833 | -224539 | -20.9417 | | 224.539 | 20.9417 |
| 0.423901 | -218056 | -21.1951 | | 218.056 | 21.1951 |
| 0.424218 | -219877 | -21.2109 | | 219.877 | 21.2109 |
| 0.424535 | -220857 | -21.2267 | | 220.857 | 21.2267 |
| 0.424852 | -221471 | -21.2426 | | 221.471 | 21.2426 |
| 0.425327 | -221151 | -21.2663 | | 221.151 | 21.2663 |
| 0.425802 | -220751 | -21.2901 | | 220.751 | 21.2901 |
| 0.426277 | -220350 | -21.3139 | | 220.35 | 21.3139 |
| 0.42699 | -219469 | -21.3495 | | 219.469 | 21.3495 |

## S460

### 1 hole

*25 mm*

| | | | | | |
|---|---|---|---|---|---|
| Fu,fem | 477.7 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -155636 | -0.5 | | 155.636 | 0.5 |
| 0.02 | -307092 | -1 | | 307.092 | 1 |
| 0.02375 | -334865 | -1.1875 | | 334.865 | 1.1875 |
| 0.0275 | -348507 | -1.375 | | 348.507 | 1.375 |
| 0.03125 | -361585 | -1.5625 | | 361.585 | 1.5625 |
| 0.035 | -373131 | -1.75 | | 373.131 | 1.75 |
| 0.040625 | -387595 | -2.03125 | | 387.595 | 2.03125 |
| 0.04625 | -399951 | -2.3125 | | 399.951 | 2.3125 |
| 0.051875 | -410961 | -2.59375 | | 410.961 | 2.59375 |
| 0.060313 | -424722 | -3.01563 | | 424.722 | 3.01563 |
| 0.072969 | -432042 | -3.64844 | | 432.042 | 3.64844 |
| 0.085625 | -439237 | -4.28125 | | 439.237 | 4.28125 |
| 0.098281 | -445045 | -4.91406 | | 445.045 | 4.91406 |
| 0.110937 | -450043 | -5.54688 | | 450.043 | 5.54688 |
| 0.129922 | -458264 | -6.49609 | | 458.264 | 6.49609 |
| 0.158398 | -469254 | -7.91992 | | 469.254 | 7.91992 |
| 0.169077 | -472837 | -8.45386 | | 472.837 | 8.45386 |
| 0.185095 | -476790 | -9.25476 | | 476.79 | 9.25476 |
| 0.191102 | -477700 | -9.5551 | | 477.7 | 9.5551 |
| 0.200112 | -477680 | -10.0056 | | 477.68 | 10.0056 |
| 0.203491 | -477291 | -10.1745 | | 477.291 | 10.1745 |
| 0.20687 | -476481 | -10.3435 | | 476.481 | 10.3435 |
| 0.210249 | -475374 | -10.5124 | | 475.374 | 10.5124 |
| 0.213627 | -474014 | -10.6814 | | 474.014 | 10.6814 |
| 0.218696 | -471353 | -10.9348 | | 471.353 | 10.9348 |
| 0.226298 | -465927 | -11.3149 | | 465.927 | 11.3149 |
| 0.2339 | -459366 | -11.695 | | 459.366 | 11.695 |
| 0.241503 | -451435 | -12.0751 | | 451.435 | 12.0751 |
| 0.249105 | -442602 | -12.4552 | | 442.602 | 12.4552 |
| 0.256707 | -433197 | -12.8354 | | 433.197 | 12.8354 |
| 0.26431 | -423162 | -13.2155 | | 423.162 | 13.2155 |
| 0.271912 | -412308 | -13.5956 | | 412.308 | 13.5956 |
| 0.279514 | -400686 | -13.9757 | | 400.686 | 13.9757 |
| 0.287117 | -388570 | -14.3558 | | 388.57 | 14.3558 |
| 0.294719 | -376154 | -14.7359 | | 376.154 | 14.7359 |
| 0.302321 | -363532 | -15.1161 | | 363.532 | 15.1161 |
| 0.309923 | -350808 | -15.4962 | | 350.808 | 15.4962 |
| 0.317526 | -338018 | -15.8763 | | 338.018 | 15.8763 |
| 0.325128 | -325188 | -16.2564 | | 325.188 | 16.2564 |
| 0.33273 | -312560 | -16.6365 | | 312.56 | 16.6365 |
| 0.340333 | -300412 | -17.0166 | | 300.412 | 17.0166 |
| 0.347935 | -288834 | -17.3968 | | 288.834 | 17.3968 |
| 0.359339 | -269387 | -17.9669 | | 269.387 | 17.9669 |
| 0.363615 | -270322 | -18.1807 | | 270.322 | 18.1807 |
| 0.370029 | -259845 | -18.5015 | | 259.845 | 18.5015 |
| 0.379651 | -246071 | -18.9826 | | 246.071 | 18.9826 |
| 0.383259 | -247521 | -19.163 | | 247.521 | 19.163 |
| 0.388671 | -239549 | -19.4336 | | 239.549 | 19.4336 |
| 0.39679 | -229061 | -19.8395 | | 229.061 | 19.8395 |
| 0.399834 | -230896 | -19.9917 | | 230.896 | 19.9917 |
| 0.400976 | -230813 | -20.0488 | | 230.813 | 20.0488 |
| 0.402688 | -228454 | -20.1344 | | 228.454 | 20.1344 |
| 0.405257 | -225249 | -20.2628 | | 225.249 | 20.2628 |
| 0.40911 | -220312 | -20.4555 | | 220.312 | 20.4555 |
| 0.412963 | -216801 | -20.6481 | | 216.801 | 20.6481 |
| 0.413204 | -218024 | -20.6602 | | 218.024 | 20.6602 |
| 0.413445 | -218758 | -20.6722 | | 218.758 | 20.6722 |
| 0.413685 | -219296 | -20.6843 | | 219.296 | 20.6843 |
| 0.414047 | -219291 | -20.7023 | | 219.291 | 20.7023 |
| 0.414408 | -218940 | -20.7204 | | 218.94 | 20.7204 |
| 0.414769 | -218648 | -20.7384 | | 218.648 | 20.7384 |
| 0.415311 | -217916 | -20.7655 | | 217.916 | 20.7655 |

## S460

### 1 hole

*26 mm*

| | | | | | |
|---|---|---|---|---|---|
| Fu,fem | 472.767 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -155309 | -0.5 | | 155.309 | 0.5 |
| 0.02 | -305986 | -1 | | 305.986 | 1 |
| 0.0225 | -327693 | -1.125 | | 327.693 | 1.125 |
| 0.025 | -336207 | -1.25 | | 336.207 | 1.25 |
| 0.0275 | -345254 | -1.375 | | 345.254 | 1.375 |
| 0.03 | -354070 | -1.5 | | 354.07 | 1.5 |
| 0.0325 | -362112 | -1.625 | | 362.112 | 1.625 |
| 0.035 | -369541 | -1.75 | | 369.541 | 1.75 |
| 0.03875 | -379463 | -1.9375 | | 379.463 | 1.9375 |
| 0.044375 | -392111 | -2.21875 | | 392.111 | 2.21875 |
| 0.052813 | -408592 | -2.64063 | | 408.592 | 2.64063 |
| 0.055977 | -414147 | -2.79883 | | 414.147 | 2.79883 |
| 0.060723 | -421698 | -3.03613 | | 421.698 | 3.03613 |
| 0.067842 | -429216 | -3.39209 | | 429.216 | 3.39209 |
| 0.074961 | -431935 | -3.74805 | | 431.935 | 3.74805 |
| 0.08208 | -435707 | -4.104 | | 435.707 | 4.104 |
| 0.089199 | -439438 | -4.45996 | | 439.438 | 4.45996 |
| 0.096318 | -442912 | -4.81592 | | 442.912 | 4.81592 |
| 0.103437 | -445656 | -5.17188 | | 445.656 | 5.17188 |
| 0.114116 | -449656 | -5.70581 | | 449.656 | 5.70581 |
| 0.130134 | -456259 | -6.50671 | | 456.259 | 6.50671 |
| 0.154161 | -464908 | -7.70807 | | 464.908 | 7.70807 |
| 0.163172 | -467775 | -8.15858 | | 467.775 | 8.15858 |
| 0.176687 | -471161 | -8.83434 | | 471.161 | 8.83434 |
| 0.181755 | -472098 | -9.08775 | | 472.098 | 9.08775 |
| 0.189357 | -472767 | -9.46787 | | 472.767 | 9.46787 |
| 0.200761 | -471033 | -10.038 | | 471.033 | 10.038 |
| 0.212164 | -465919 | -10.6082 | | 465.919 | 10.6082 |
| 0.215015 | -465241 | -10.7508 | | 465.241 | 10.7508 |
| 0.217866 | -463447 | -10.8933 | | 463.447 | 10.8933 |
| 0.222142 | -460219 | -11.1071 | | 460.219 | 11.1071 |
| 0.228557 | -454465 | -11.4278 | | 454.465 | 11.4278 |
| 0.230962 | -453069 | -11.5481 | | 453.069 | 11.5481 |
| 0.23457 | -449214 | -11.7285 | | 449.214 | 11.7285 |
| 0.239983 | -443034 | -11.9991 | | 443.034 | 11.9991 |
| 0.245395 | -436997 | -12.2697 | | 436.997 | 12.2697 |
| 0.250807 | -430758 | -12.5403 | | 430.758 | 12.5403 |
| 0.256219 | -424370 | -12.811 | | 424.37 | 12.811 |
| 0.261631 | -417838 | -13.0816 | | 417.838 | 13.0816 |
| 0.267044 | -411140 | -13.3522 | | 411.14 | 13.3522 |
| 0.272456 | -404211 | -13.6228 | | 404.211 | 13.6228 |
| 0.277868 | -396966 | -13.8934 | | 396.966 | 13.8934 |
| 0.28328 | -389357 | -14.164 | | 389.357 | 14.164 |
| 0.288692 | -381451 | -14.4346 | | 381.451 | 14.4346 |
| 0.294105 | -373353 | -14.7052 | | 373.353 | 14.7052 |
| 0.299517 | -365114 | -14.9758 | | 365.114 | 14.9758 |
| 0.304929 | -356786 | -15.2464 | | 356.786 | 15.2464 |
| 0.310341 | -348400 | -15.5171 | | 348.4 | 15.5171 |
| 0.315753 | -339965 | -15.7877 | | 339.965 | 15.7877 |
| 0.321166 | -331509 | -16.0583 | | 331.509 | 16.0583 |
| 0.323195 | -330166 | -16.1598 | | 330.166 | 16.1598 |
| 0.32624 | -324826 | -16.312 | | 324.826 | 16.312 |
| 0.330806 | -317047 | -16.5403 | | 317.047 | 16.5403 |
| 0.337656 | -305451 | -16.8828 | | 305.451 | 16.8828 |
| 0.347931 | -288319 | -17.3965 | | 288.319 | 17.3965 |
| 0.363343 | -263619 | -18.1671 | | 263.619 | 18.1671 |
| 0.367196 | -267987 | -18.3598 | | 267.987 | 18.3598 |
| 0.371049 | -262533 | -18.5524 | | 262.533 | 18.5524 |
| 0.376828 | -254209 | -18.8414 | | 254.209 | 18.8414 |
| 0.385498 | -242173 | -19.2749 | | 242.173 | 19.2749 |
| 0.388749 | -243262 | -19.4374 | | 243.262 | 19.4374 |
| 0.393625 | -236319 | -19.6813 | | 236.319 | 19.6813 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *27 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 466.529 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -154968 | -0.5 | | 154.968 | 0.5 |
| 0.02 | -304748 | -1 | | 304.748 | 1 |
| 0.0225 | -324216 | -1.125 | | 324.216 | 1.125 |
| 0.025 | -332853 | -1.25 | | 332.853 | 1.25 |
| 0.0275 | -341804 | -1.375 | | 341.804 | 1.375 |
| 0.03125 | -354541 | -1.5625 | | 354.541 | 1.5625 |
| 0.035 | -365826 | -1.75 | | 365.826 | 1.75 |
| 0.03875 | -375658 | -1.9375 | | 375.658 | 1.9375 |
| 0.044375 | -388128 | -2.21875 | | 388.128 | 2.21875 |
| 0.052813 | -404363 | -2.64063 | | 404.363 | 2.64063 |
| 0.065469 | -423938 | -3.27344 | | 423.938 | 3.27344 |
| 0.084453 | -435099 | -4.22266 | | 435.099 | 4.22266 |
| 0.103437 | -443977 | -5.17188 | | 443.977 | 5.17188 |
| 0.122422 | -450887 | -6.12109 | | 450.887 | 6.12109 |
| 0.141406 | -457915 | -7.07031 | | 457.915 | 7.07031 |
| 0.160391 | -463345 | -8.01953 | | 463.345 | 8.01953 |
| 0.16751 | -464953 | -8.37549 | | 464.953 | 8.37549 |
| 0.178188 | -466401 | -8.90942 | | 466.401 | 8.90942 |
| 0.182193 | -466529 | -9.10965 | | 466.529 | 9.10965 |
| 0.186198 | -466247 | -9.30988 | | 466.247 | 9.30988 |
| 0.190202 | -465513 | -9.5101 | | 465.513 | 9.5101 |
| 0.196209 | -463525 | -9.81044 | | 463.525 | 9.81044 |
| 0.202216 | -460721 | -10.1108 | | 460.721 | 10.1108 |
| 0.208222 | -457036 | -10.4111 | | 457.036 | 10.4111 |
| 0.214229 | -452426 | -10.7115 | | 452.426 | 10.7115 |
| 0.220236 | -447007 | -11.0118 | | 447.007 | 11.0118 |
| 0.226243 | -440702 | -11.3121 | | 440.702 | 11.3121 |
| 0.232249 | -433847 | -11.6125 | | 433.847 | 11.6125 |
| 0.238256 | -426682 | -11.9128 | | 426.682 | 11.9128 |
| 0.244263 | -419297 | -12.2132 | | 419.297 | 12.2132 |
| 0.25027 | -411711 | -12.5135 | | 411.711 | 12.5135 |
| 0.256277 | -403878 | -12.8138 | | 403.878 | 12.8138 |
| 0.262283 | -395697 | -13.1142 | | 395.697 | 13.1142 |
| 0.26829 | -387087 | -13.4145 | | 387.087 | 13.4145 |
| 0.274297 | -378089 | -13.7148 | | 378.089 | 13.7148 |
| 0.280304 | -368836 | -14.0152 | | 368.836 | 14.0152 |
| 0.28631 | -359420 | -14.3155 | | 359.42 | 14.3155 |
| 0.292317 | -349912 | -14.6159 | | 349.912 | 14.6159 |
| 0.298324 | -340346 | -14.9162 | | 340.346 | 14.9162 |
| 0.300577 | -338647 | -15.0288 | | 338.647 | 15.0288 |
| 0.303955 | -332625 | -15.1978 | | 332.625 | 15.1978 |
| 0.309024 | -323754 | -15.4512 | | 323.754 | 15.4512 |
| 0.316626 | -310454 | -15.8313 | | 310.454 | 15.8313 |
| 0.328029 | -290402 | -16.4015 | | 290.402 | 16.4015 |
| 0.33088 | -292386 | -16.544 | | 292.386 | 16.544 |
| 0.333731 | -287792 | -16.6866 | | 287.792 | 16.6866 |
| 0.338007 | -280609 | -16.9004 | | 280.609 | 16.9004 |
| 0.344422 | -269816 | -17.2211 | | 269.816 | 17.2211 |
| 0.346827 | -269976 | -17.3414 | | 269.976 | 17.3414 |
| 0.350435 | -263757 | -17.5218 | | 263.757 | 17.5218 |
| 0.355848 | -255116 | -17.7924 | | 255.116 | 17.7924 |
| 0.363966 | -242607 | -18.1983 | | 242.607 | 18.1983 |
| 0.376143 | -225329 | -18.8072 | | 225.329 | 18.8072 |
| 0.388321 | -213186 | -19.416 | | 213.186 | 19.416 |
| 0.391365 | -219754 | -19.5683 | | 219.754 | 19.5683 |
| 0.39441 | -215310 | -19.7205 | | 215.31 | 19.7205 |
| 0.397454 | -212731 | -19.8727 | | 212.731 | 19.8727 |
| 0.400498 | -209751 | -20.0249 | | 209.751 | 20.0249 |
| 0.400784 | -211233 | -20.0392 | | 211.233 | 20.0392 |
| 0.401069 | -212018 | -20.0535 | | 212.018 | 20.0535 |
| 0.401355 | -212186 | -20.0677 | | 212.186 | 20.0677 |
| 0.401783 | -211572 | -20.0891 | | 211.572 | 20.0891 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *28 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 460.66 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -154611 | -0.5 | | 154.611 | 0.5 |
| 0.02 | -303450 | -1 | | 303.45 | 1 |
| 0.0225 | -320846 | -1.125 | | 320.846 | 1.125 |
| 0.025 | -329544 | -1.25 | | 329.544 | 1.25 |
| 0.0275 | -338396 | -1.375 | | 338.396 | 1.375 |
| 0.03 | -346997 | -1.5 | | 346.997 | 1.5 |
| 0.03375 | -358628 | -1.6875 | | 358.628 | 1.6875 |
| 0.039375 | -373341 | -1.96875 | | 373.341 | 1.96875 |
| 0.045 | -385442 | -2.25 | | 385.442 | 2.25 |
| 0.050625 | -396288 | -2.53125 | | 396.288 | 2.53125 |
| 0.059063 | -410590 | -2.95313 | | 410.59 | 2.95313 |
| 0.071719 | -426896 | -3.58594 | | 426.896 | 3.58594 |
| 0.084375 | -433258 | -4.21875 | | 433.258 | 4.21875 |
| 0.097031 | -439298 | -4.85156 | | 439.298 | 4.85156 |
| 0.109687 | -444412 | -5.48438 | | 444.412 | 5.48438 |
| 0.122344 | -448700 | -6.11719 | | 448.7 | 6.11719 |
| 0.141328 | -454955 | -7.06641 | | 454.955 | 7.06641 |
| 0.148447 | -457004 | -7.42236 | | 457.004 | 7.42236 |
| 0.159126 | -459402 | -7.9563 | | 459.402 | 7.9563 |
| 0.175144 | -460660 | -8.7572 | | 460.66 | 8.7572 |
| 0.181151 | -459933 | -9.05754 | | 459.933 | 9.05754 |
| 0.187158 | -458069 | -9.35788 | | 458.069 | 9.35788 |
| 0.193164 | -455343 | -9.65822 | | 455.343 | 9.65822 |
| 0.199171 | -451737 | -9.95856 | | 451.737 | 9.95856 |
| 0.205178 | -447199 | -10.2589 | | 447.199 | 10.2589 |
| 0.211185 | -441851 | -10.5592 | | 441.851 | 10.5592 |
| 0.217191 | -435625 | -10.8596 | | 435.625 | 10.8596 |
| 0.223198 | -428825 | -11.1599 | | 428.825 | 11.1599 |
| 0.229205 | -421711 | -11.4603 | | 421.711 | 11.4603 |
| 0.235212 | -414385 | -11.7606 | | 414.385 | 11.7606 |
| 0.241219 | -406891 | -12.0609 | | 406.891 | 12.0609 |
| 0.247225 | -399211 | -12.3613 | | 399.211 | 12.3613 |
| 0.253232 | -391276 | -12.6616 | | 391.276 | 12.6616 |
| 0.259239 | -382990 | -12.9619 | | 382.99 | 12.9619 |
| 0.265246 | -374308 | -13.2623 | | 374.308 | 13.2623 |
| 0.271252 | -365308 | -13.5626 | | 365.308 | 13.5626 |
| 0.277259 | -356114 | -13.863 | | 356.114 | 13.863 |
| 0.283266 | -346810 | -14.1633 | | 346.81 | 14.1633 |
| 0.289273 | -337440 | -14.4636 | | 337.44 | 14.4636 |
| 0.29528 | -328053 | -14.764 | | 328.053 | 14.764 |
| 0.30429 | -312358 | -15.2145 | | 312.358 | 15.2145 |
| 0.3133 | -298416 | -15.665 | | 298.416 | 15.665 |
| 0.32231 | -284400 | -16.1155 | | 284.4 | 16.1155 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *29 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 455.44 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -154241 | -0.5 | | 154.241 | 0.5 |
| 0.02 | -302069 | -1 | | 302.069 | 1 |
| 0.0225 | -317525 | -1.125 | | 317.525 | 1.125 |
| 0.025 | -326239 | -1.25 | | 326.239 | 1.25 |
| 0.0275 | -335010 | -1.375 | | 335.01 | 1.375 |
| 0.03 | -343479 | -1.5 | | 343.479 | 1.5 |
| 0.0325 | -351315 | -1.625 | | 351.315 | 1.625 |
| 0.035 | -358577 | -1.75 | | 358.577 | 1.75 |
| 0.03875 | -368138 | -1.9375 | | 368.138 | 1.9375 |
| 0.044375 | -380236 | -2.21875 | | 380.236 | 2.21875 |
| 0.052813 | -396030 | -2.64063 | | 396.03 | 2.64063 |
| 0.065469 | -415506 | -3.27344 | | 415.506 | 3.27344 |
| 0.084453 | -431666 | -4.22266 | | 431.666 | 4.22266 |
| 0.103437 | -439779 | -5.17188 | | 439.779 | 5.17188 |
| 0.122422 | -446386 | -6.12109 | | 446.386 | 6.12109 |
| 0.141406 | -451750 | -7.07031 | | 451.75 | 7.07031 |
| 0.160391 | -455120 | -8.01953 | | 455.12 | 8.01953 |
| 0.165137 | -455440 | -8.25684 | | 455.44 | 8.25684 |
| 0.169883 | -455149 | -8.49414 | | 455.149 | 8.49414 |
| 0.174629 | -454277 | -8.73145 | | 454.277 | 8.73145 |
| 0.179375 | -452814 | -8.96875 | | 452.814 | 8.96875 |
| 0.184121 | -450836 | -9.20605 | | 450.836 | 9.20605 |
| 0.188867 | -448343 | -9.44336 | | 448.343 | 9.44336 |
| 0.195986 | -443219 | -9.79932 | | 443.219 | 9.79932 |
| 0.203105 | -437171 | -10.1553 | | 437.171 | 10.1553 |
| 0.210225 | -429981 | -10.5112 | | 429.981 | 10.5112 |
| 0.217344 | -422098 | -10.8672 | | 422.098 | 10.8672 |
| 0.224463 | -413862 | -11.2231 | | 413.862 | 11.2231 |
| 0.231582 | -405444 | -11.5791 | | 405.444 | 11.5791 |
| 0.238701 | -396940 | -11.9351 | | 396.94 | 11.9351 |
| 0.24582 | -388402 | -12.291 | | 388.402 | 12.291 |
| 0.252939 | -379822 | -12.647 | | 379.822 | 12.647 |
| 0.260059 | -371118 | -13.0029 | | 371.118 | 13.0029 |
| 0.267178 | -362126 | -13.3589 | | 362.126 | 13.3589 |
| 0.274297 | -352668 | -13.7148 | | 352.668 | 13.7148 |
| 0.281416 | -342739 | -14.0708 | | 342.739 | 14.0708 |
| 0.288535 | -332538 | -14.4268 | | 332.538 | 14.4268 |
| 0.295654 | -322223 | -14.7827 | | 322.223 | 14.7827 |
| 0.302773 | -311831 | -15.1387 | | 311.831 | 15.1387 |
| 0.309893 | -301412 | -15.4946 | | 301.412 | 15.4946 |
| 0.311672 | -302020 | -15.5836 | | 302.02 | 15.5836 |
| 0.313452 | -299273 | -15.6726 | | 299.273 | 15.6726 |
| 0.316122 | -294973 | -15.8061 | | 294.973 | 15.8061 |
| 0.320126 | -288564 | -16.0063 | | 288.564 | 16.0063 |
| 0.326133 | -279047 | -16.3067 | | 279.047 | 16.3067 |
| 0.335143 | -265049 | -16.7572 | | 265.049 | 16.7572 |
| 0.348659 | -245108 | -17.4329 | | 245.108 | 17.4329 |
| 0.362174 | -230512 | -18.1087 | | 230.512 | 18.1087 |
| 0.375689 | -217014 | -18.7845 | | 217.014 | 18.7845 |
| 0.389204 | -204542 | -19.4602 | | 204.542 | 19.4602 |
| 0.390049 | -209579 | -19.5024 | | 209.579 | 19.5024 |
| 0.390894 | -212387 | -19.5447 | | 212.387 | 19.5447 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

## S460
### 1 hole
*30 mm*

$F_{u,fem}$ 449.637 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -153853 | -0.5 | | 153.853 | 0.5 |
| 0.0125 | -191981 | -0.625 | | 191.981 | 0.625 |
| 0.01625 | -248070 | -0.8125 | | 248.07 | 0.8125 |
| 0.021875 | -312253 | -1.09375 | | 312.253 | 1.09375 |
| 0.0275 | -331410 | -1.375 | | 331.41 | 1.375 |
| 0.033125 | -349454 | -1.65625 | | 349.454 | 1.65625 |
| 0.03875 | -364243 | -1.9375 | | 364.243 | 1.9375 |
| 0.044375 | -376213 | -2.21875 | | 376.213 | 2.21875 |
| 0.05 | -386862 | -2.5 | | 386.862 | 2.5 |
| 0.055625 | -396497 | -2.78125 | | 396.497 | 2.78125 |
| 0.064063 | -409132 | -3.20313 | | 409.132 | 3.20313 |
| 0.076719 | -424058 | -3.83594 | | 424.058 | 3.83594 |
| 0.095703 | -434131 | -4.78516 | | 434.131 | 4.78516 |
| 0.114688 | -441430 | -5.73438 | | 441.43 | 5.73438 |
| 0.133672 | -446559 | -6.68359 | | 446.559 | 6.68359 |
| 0.152656 | -449472 | -7.63281 | | 449.472 | 7.63281 |
| 0.157402 | -449637 | -7.87012 | | 449.637 | 7.87012 |
| 0.162148 | -449187 | -8.10742 | | 449.187 | 8.10742 |
| 0.166895 | -448139 | -8.34473 | | 448.139 | 8.34473 |
| 0.171641 | -446507 | -8.58203 | | 446.507 | 8.58203 |
| 0.176387 | -444371 | -8.81934 | | 444.371 | 8.81934 |
| 0.181133 | -441708 | -9.05664 | | 441.708 | 9.05664 |
| 0.188252 | -436331 | -9.4126 | | 436.331 | 9.4126 |
| 0.195371 | -430004 | -9.76855 | | 430.004 | 9.76855 |
| 0.20249 | -422541 | -10.1245 | | 422.541 | 10.1245 |
| 0.209609 | -414505 | -10.4805 | | 414.505 | 10.4805 |
| 0.216729 | -406178 | -10.8364 | | 406.178 | 10.8364 |
| 0.223848 | -397718 | -11.1924 | | 397.718 | 11.1924 |
| 0.230967 | -389229 | -11.5483 | | 389.229 | 11.5483 |
| 0.238086 | -380781 | -11.9043 | | 380.781 | 11.9043 |
| 0.245205 | -372419 | -12.2603 | | 372.419 | 12.2603 |
| 0.252324 | -364161 | -12.6162 | | 364.161 | 12.6162 |
| 0.259443 | -356013 | -12.9722 | | 356.013 | 12.9722 |
| 0.266562 | -347962 | -13.3281 | | 347.962 | 13.3281 |
| 0.273682 | -339961 | -13.6841 | | 339.961 | 13.6841 |
| 0.280801 | -331924 | -14.04 | | 331.924 | 14.04 |
| 0.28792 | -323701 | -14.396 | | 323.701 | 14.396 |
| 0.295039 | -315075 | -14.752 | | 315.075 | 14.752 |
| 0.302158 | -305960 | -15.1079 | | 305.96 | 15.1079 |
| 0.309277 | -296656 | -15.4639 | | 296.656 | 15.4639 |
| 0.316396 | -287371 | -15.8198 | | 287.371 | 15.8198 |
| 0.323516 | -278119 | -16.1758 | | 278.119 | 16.1758 |
| 0.330635 | -268891 | -16.5317 | | 268.891 | 16.5317 |
| 0.333304 | -268807 | -16.6652 | | 268.807 | 16.6652 |
| 0.337309 | -262443 | -16.8654 | | 262.443 | 16.8654 |
| 0.343316 | -253379 | -17.1658 | | 253.379 | 17.1658 |
| 0.349322 | -246162 | -17.4661 | | 246.162 | 17.4661 |
| 0.355329 | -239055 | -17.7665 | | 239.055 | 17.7665 |
| 0.364339 | -226026 | -18.217 | | 226.026 | 18.217 |
| 0.367718 | -228706 | -18.3859 | | 228.706 | 18.3859 |
| 0.372786 | -220715 | -18.6393 | | 220.715 | 18.6393 |
| 0.377855 | -216058 | -18.8927 | | 216.058 | 18.8927 |
| 0.382923 | -210984 | -19.1461 | | 210.984 | 19.1461 |
| 0.384824 | -213645 | -19.2412 | | 213.645 | 19.2412 |
| 0.386724 | -210781 | -19.3362 | | 210.781 | 19.3362 |
| 0.388625 | -209358 | -19.4312 | | 209.358 | 19.4312 |
| 0.390525 | -207501 | -19.5263 | | 207.501 | 19.5263 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

## S460
### 1 hole
*31 mm*

$F_{u,fem}$ 442.884 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -153449 | -0.5 | | 153.449 | 0.5 |
| 0.0125 | -191447 | -0.625 | | 191.447 | 0.625 |
| 0.01625 | -247241 | -0.8125 | | 247.241 | 0.8125 |
| 0.021875 | -308864 | -1.09375 | | 308.864 | 1.09375 |
| 0.0275 | -327960 | -1.375 | | 327.96 | 1.375 |
| 0.033125 | -345791 | -1.65625 | | 345.791 | 1.65625 |
| 0.03875 | -360390 | -1.9375 | | 360.39 | 1.9375 |
| 0.044375 | -372221 | -2.21875 | | 372.221 | 2.21875 |
| 0.05 | -382707 | -2.5 | | 382.707 | 2.5 |
| 0.055625 | -392192 | -2.78125 | | 392.192 | 2.78125 |
| 0.064063 | -404640 | -3.20313 | | 404.64 | 3.20313 |
| 0.076719 | -419661 | -3.83594 | | 419.661 | 3.83594 |
| 0.095703 | -431626 | -4.78516 | | 431.626 | 4.78516 |
| 0.114688 | -438530 | -5.73438 | | 438.53 | 5.73438 |
| 0.133672 | -442884 | -6.68359 | | 442.884 | 6.68359 |
| 0.152656 | -442237 | -7.63281 | | 442.237 | 7.63281 |
| 0.157402 | -441446 | -7.87012 | | 441.446 | 7.87012 |
| 0.162148 | -439504 | -8.10742 | | 439.504 | 8.10742 |
| 0.166895 | -437052 | -8.34473 | | 437.052 | 8.34473 |
| 0.171641 | -434056 | -8.58203 | | 434.056 | 8.58203 |
| 0.17876 | -428113 | -8.93799 | | 428.113 | 8.93799 |
| 0.181429 | -426569 | -9.07147 | | 426.569 | 9.07147 |
| 0.185434 | -422503 | -9.2717 | | 422.503 | 9.2717 |
| 0.191441 | -415729 | -9.57204 | | 415.729 | 9.57204 |
| 0.197448 | -409032 | -9.87238 | | 409.032 | 9.87238 |
| 0.203454 | -402113 | -10.1727 | | 402.113 | 10.1727 |
| 0.212464 | -390485 | -10.6232 | | 390.485 | 10.6232 |
| 0.221475 | -379799 | -11.0737 | | 379.799 | 11.0737 |
| 0.230485 | -369150 | -11.5242 | | 369.15 | 11.5242 |
| 0.239495 | -358647 | -11.9747 | | 358.647 | 11.9747 |
| 0.248505 | -348330 | -12.4253 | | 348.33 | 12.4253 |
| 0.257515 | -338211 | -12.8758 | | 338.211 | 12.8758 |
| 0.266525 | -328262 | -13.3263 | | 328.262 | 13.3263 |
| 0.275536 | -318390 | -13.7768 | | 318.39 | 13.7768 |
| 0.284546 | -308347 | -14.2273 | | 308.347 | 14.2273 |
| 0.293556 | -297727 | -14.6778 | | 297.727 | 14.6778 |
| 0.295808 | -298848 | -14.7904 | | 298.848 | 14.7904 |
| 0.298061 | -295843 | -14.903 | | 295.843 | 14.903 |
| 0.300314 | -293104 | -15.0157 | | 293.104 | 15.0157 |
| 0.302566 | -290312 | -15.1283 | | 290.312 | 15.1283 |
| 0.304819 | -287499 | -15.2409 | | 287.499 | 15.2409 |
| 0.307071 | -284673 | -15.3536 | | 284.673 | 15.3536 |
| 0.309324 | -281840 | -15.4662 | | 281.84 | 15.4662 |
| 0.311576 | -279004 | -15.5788 | | 279.004 | 15.5788 |
| 0.314955 | -273967 | -15.7478 | | 273.967 | 15.7478 |
| 0.320023 | -266437 | -16.0012 | | 266.437 | 16.0012 |
| 0.325091 | -260241 | -16.2546 | | 260.241 | 16.2546 |
| 0.33016 | -254051 | -16.508 | | 254.051 | 16.508 |
| 0.337762 | -242887 | -16.8881 | | 242.887 | 16.8881 |
| 0.349165 | -226653 | -17.4583 | | 226.653 | 17.4583 |
| 0.360569 | -214561 | -18.0285 | | 214.561 | 18.0285 |
| 0.36342 | -220922 | -18.171 | | 220.922 | 18.171 |
| 0.366271 | -216559 | -18.3135 | | 216.559 | 18.3135 |
| 0.369122 | -214081 | -18.4561 | | 214.081 | 18.4561 |
| 0.371972 | -211236 | -18.5986 | | 211.236 | 18.5986 |
| 0.376249 | -204988 | -18.8124 | | 204.988 | 18.8124 |
| 0.380525 | -201164 | -19.0263 | | 201.164 | 19.0263 |
| 0.380792 | -202823 | -19.0396 | | 202.823 | 19.0396 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

## S460
### 1 hole
*32 mm*

$F_{u,fem}$ 437.949 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -153025 | -0.5 | | 153.025 | 0.5 |
| 0.02 | -297190 | -1 | | 297.19 | 1 |
| 0.0225 | -307492 | -1.125 | | 307.492 | 1.125 |
| 0.025 | -316114 | -1.25 | | 316.114 | 1.25 |
| 0.0275 | -324588 | -1.375 | | 324.588 | 1.375 |
| 0.03 | -332761 | -1.5 | | 332.761 | 1.5 |
| 0.03375 | -343862 | -1.6875 | | 343.862 | 1.6875 |
| 0.039375 | -357918 | -1.96875 | | 357.918 | 1.96875 |
| 0.047813 | -374568 | -2.39063 | | 374.568 | 2.39063 |
| 0.060469 | -395068 | -3.02344 | | 395.068 | 3.02344 |
| 0.079453 | -417468 | -3.97266 | | 417.468 | 3.97266 |
| 0.10793 | -432571 | -5.39648 | | 432.571 | 5.39648 |
| 0.115049 | -434715 | -5.75244 | | 434.715 | 5.75244 |
| 0.122168 | -436430 | -6.1084 | | 436.43 | 6.1084 |
| 0.132847 | -437842 | -6.64233 | | 437.842 | 6.64233 |
| 0.136851 | -437949 | -6.84256 | | 437.949 | 6.84256 |
| 0.140856 | -437650 | -7.04279 | | 437.65 | 7.04279 |
| 0.14486 | -436931 | -7.24301 | | 436.931 | 7.24301 |
| 0.150867 | -434947 | -7.54335 | | 434.947 | 7.54335 |
| 0.156874 | -432126 | -7.84369 | | 432.126 | 7.84369 |
| 0.162881 | -428405 | -8.14403 | | 428.405 | 8.14403 |
| 0.168887 | -423749 | -8.44437 | | 423.749 | 8.44437 |
| 0.17114 | -422294 | -8.55699 | | 422.294 | 8.55699 |
| 0.174519 | -419082 | -8.72593 | | 419.082 | 8.72593 |
| 0.179587 | -413577 | -8.97935 | | 413.577 | 8.97935 |
| 0.184655 | -407939 | -9.23276 | | 407.939 | 9.23276 |
| 0.189723 | -402052 | -9.48617 | | 402.052 | 9.48617 |
| 0.194792 | -396018 | -9.73958 | | 396.018 | 9.73958 |
| 0.202394 | -385944 | -10.1197 | | 385.944 | 10.1197 |
| 0.209996 | -376561 | -10.4998 | | 376.561 | 10.4998 |
| 0.217599 | -367107 | -10.8799 | | 367.107 | 10.8799 |
| 0.225201 | -357601 | -11.26 | | 357.601 | 11.26 |
| 0.232803 | -347954 | -11.6402 | | 347.954 | 11.6402 |
| 0.240405 | -338000 | -12.0203 | | 338 | 12.0203 |
| 0.248008 | -327599 | -12.4004 | | 327.599 | 12.4004 |
| 0.25561 | -316848 | -12.7805 | | 316.848 | 12.7805 |
| 0.263212 | -305941 | -13.1606 | | 305.941 | 13.1606 |
| 0.270815 | -295041 | -13.5407 | | 295.041 | 13.5407 |
| 0.278417 | -284237 | -13.9209 | | 284.237 | 13.9209 |
| 0.286019 | -273496 | -14.301 | | 273.496 | 14.301 |
| 0.28887 | -272695 | -14.4435 | | 272.695 | 14.4435 |
| 0.293147 | -265617 | -14.6573 | | 265.617 | 14.6573 |
| 0.299561 | -255331 | -14.9781 | | 255.331 | 14.9781 |
| 0.305976 | -246880 | -15.2988 | | 246.88 | 15.2988 |
| 0.31239 | -238652 | -15.6195 | | 238.652 | 15.6195 |
| 0.322012 | -224224 | -16.1006 | | 224.224 | 16.1006 |
| 0.32562 | -226128 | -16.281 | | 226.128 | 16.281 |
| 0.331032 | -217862 | -16.5516 | | 217.862 | 16.5516 |
| 0.33915 | -207149 | -16.9575 | | 207.149 | 16.9575 |
| 0.342195 | -209804 | -17.1097 | | 209.804 | 17.1097 |
| 0.346761 | -202975 | -17.3381 | | 202.975 | 17.3381 |
| 0.351328 | -199131 | -17.5664 | | 199.131 | 17.5664 |
| 0.355894 | -194891 | -17.7947 | | 194.891 | 17.7947 |
| 0.357607 | -197346 | -17.8803 | | 197.346 | 17.8803 |
| 0.360175 | -192873 | -18.0088 | | 192.873 | 18.0088 |
| 0.362744 | -191241 | -18.1372 | | 191.241 | 18.1372 |
| 0.365313 | -188724 | -18.2656 | | 188.724 | 18.2656 |
| 0.367882 | -186406 | -18.3941 | | 186.406 | 18.3941 |
| 0.368042 | -187375 | -18.4021 | | 187.375 | 18.4021 |
| 0.368203 | -187999 | -18.4101 | | 187.999 | 18.4101 |
| 0.368363 | -188531 | -18.4182 | | 188.531 | 18.4182 |
| 0.368604 | -189056 | -18.4302 | | 189.056 | 18.4302 |

## S460

### 1 hole

*33 mm*

$F_{u,fem}$ 432.552 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -152595 | -0.5 | | 152.595 | 0.5 |
| 0.02 | -295243 | -1 | | 295.243 | 1 |
| 0.0225 | -304203 | -1.125 | | 304.203 | 1.125 |
| 0.025 | -312752 | -1.25 | | 312.752 | 1.25 |
| 0.0275 | -321131 | -1.375 | | 321.131 | 1.375 |
| 0.03 | -329198 | -1.5 | | 329.198 | 1.5 |
| 0.03375 | -340166 | -1.6875 | | 340.166 | 1.6875 |
| 0.039375 | -354023 | -1.96875 | | 354.023 | 1.96875 |
| 0.047813 | -370441 | -2.39063 | | 370.441 | 2.39063 |
| 0.060469 | -390650 | -3.02344 | | 390.65 | 3.02344 |
| 0.079453 | -412718 | -3.97266 | | 412.718 | 3.97266 |
| 0.098438 | -425733 | -4.92188 | | 425.733 | 4.92188 |
| 0.103184 | -427716 | -5.15918 | | 427.716 | 5.15918 |
| 0.10793 | -429279 | -5.39648 | | 429.279 | 5.39648 |
| 0.115049 | -431041 | -5.75244 | | 431.041 | 5.75244 |
| 0.125728 | -432552 | -6.28638 | | 432.552 | 6.28638 |
| 0.141746 | -430430 | -7.08728 | | 430.43 | 7.08728 |
| 0.14575 | -429506 | -7.28751 | | 429.506 | 7.28751 |
| 0.149755 | -427741 | -7.48773 | | 427.741 | 7.48773 |
| 0.153759 | -425603 | -7.68796 | | 425.603 | 7.68796 |
| 0.157764 | -423077 | -7.88818 | | 423.077 | 7.88818 |
| 0.16377 | -418295 | -8.18852 | | 418.295 | 8.18852 |
| 0.172781 | -409050 | -8.63903 | | 409.05 | 8.63903 |
| 0.181791 | -399045 | -9.08954 | | 399.045 | 9.08954 |
| 0.190801 | -388541 | -9.54005 | | 388.541 | 9.54005 |
| 0.199811 | -377865 | -9.99055 | | 377.865 | 9.99055 |
| 0.208821 | -367140 | -10.4411 | | 367.14 | 10.4411 |
| 0.217831 | -356383 | -10.8916 | | 356.383 | 10.8916 |
| 0.226842 | -345533 | -11.3421 | | 345.533 | 11.3421 |
| 0.235852 | -334420 | -11.7926 | | 334.42 | 11.7926 |
| 0.244862 | -322797 | -12.2431 | | 322.797 | 12.2431 |
| 0.253872 | -310601 | -12.6936 | | 310.601 | 12.6936 |
| 0.262882 | -298099 | -13.1441 | | 298.099 | 13.1441 |
| 0.271892 | -285504 | -13.5946 | | 285.504 | 13.5946 |
| 0.280903 | -272828 | -14.0451 | | 272.828 | 14.0451 |
| 0.283155 | -274003 | -14.1578 | | 274.003 | 14.1578 |
| 0.285408 | -270663 | -14.2704 | | 270.663 | 14.2704 |
| 0.288786 | -265405 | -14.4393 | | 265.405 | 14.4393 |
| 0.293855 | -257531 | -14.6927 | | 257.531 | 14.6927 |
| 0.298923 | -251038 | -14.9461 | | 251.038 | 14.9461 |
| 0.303991 | -244656 | -15.1996 | | 244.656 | 15.1996 |
| 0.311593 | -233482 | -15.5797 | | 233.482 | 15.5797 |
| 0.319196 | -225083 | -15.9598 | | 225.083 | 15.9598 |
| 0.326798 | -217031 | -16.3399 | | 217.031 | 16.3399 |
| 0.338202 | -202651 | -16.9101 | | 202.651 | 16.9101 |
| 0.349605 | -192810 | -17.4803 | | 192.81 | 17.4803 |
| 0.352456 | -198799 | -17.6228 | | 198.799 | 17.6228 |
| 0.355307 | -195095 | -17.7653 | | 195.095 | 17.7653 |
| 0.358158 | -193023 | -17.9079 | | 193.023 | 17.9079 |
| 0.361009 | -190640 | -18.0504 | | 190.64 | 18.0504 |
| 0.365285 | -185287 | -18.2642 | | 185.287 | 18.2642 |
| 0.365552 | -186811 | -18.2776 | | 186.811 | 18.2776 |
| 0.365819 | -187801 | -18.291 | | 187.801 | 18.291 |
| 0.366087 | -188621 | -18.3043 | | 188.621 | 18.3043 |
| 0.366488 | -189128 | -18.3244 | | 189.128 | 18.3244 |
| 0.367089 | -188299 | -18.3544 | | 188.299 | 18.3544 |
| 0.36769 | -187982 | -18.3845 | | 187.982 | 18.3845 |
| 0.368292 | -187489 | -18.4146 | | 187.489 | 18.4146 |
| 0.369194 | -186315 | -18.4597 | | 186.315 | 18.4597 |
| 0.370547 | -184634 | -18.5273 | | 184.634 | 18.5273 |
| 0.370674 | -185227 | -18.5337 | | 185.227 | 18.5337 |
| 0.3708 | -185628 | -18.54 | | 185.628 | 18.54 |

## S460

### 1 hole

*34 mm*

$F_{u,fem}$ 427.254 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -152139 | -0.5 | | 152.139 | 0.5 |
| 0.0125 | -189705 | -0.625 | | 189.705 | 0.625 |
| 0.01625 | -244505 | -0.8125 | | 244.505 | 0.8125 |
| 0.021875 | -298771 | -1.09375 | | 298.771 | 1.09375 |
| 0.0275 | -317514 | -1.375 | | 317.514 | 1.375 |
| 0.033125 | -334657 | -1.65625 | | 334.657 | 1.65625 |
| 0.03875 | -348722 | -1.9375 | | 348.722 | 1.9375 |
| 0.044375 | -360139 | -2.21875 | | 360.139 | 2.21875 |
| 0.052813 | -374728 | -2.64063 | | 374.728 | 2.64063 |
| 0.065469 | -392809 | -3.27344 | | 392.809 | 3.27344 |
| 0.084453 | -412111 | -4.22266 | | 412.111 | 4.22266 |
| 0.091572 | -417228 | -4.57861 | | 417.228 | 4.57861 |
| 0.102251 | -422712 | -5.11255 | | 422.712 | 5.11255 |
| 0.11293 | -425973 | -5.64648 | | 425.973 | 5.64648 |
| 0.123608 | -427254 | -6.18042 | | 427.254 | 6.18042 |
| 0.134287 | -426063 | -6.71436 | | 426.063 | 6.71436 |
| 0.144966 | -421909 | -7.24829 | | 421.909 | 7.24829 |
| 0.155645 | -414773 | -7.78223 | | 414.773 | 7.78223 |
| 0.158314 | -413722 | -7.91571 | | 413.722 | 7.91571 |
| 0.160984 | -411539 | -8.04919 | | 411.539 | 8.04919 |
| 0.164988 | -407741 | -8.24942 | | 407.741 | 8.24942 |
| 0.170995 | -401190 | -8.54976 | | 401.19 | 8.54976 |
| 0.177002 | -394678 | -8.8501 | | 394.678 | 8.8501 |
| 0.183009 | -387992 | -9.15044 | | 387.992 | 9.15044 |
| 0.192019 | -376826 | -9.60094 | | 376.826 | 9.60094 |
| 0.201029 | -366648 | -10.0515 | | 366.648 | 10.0515 |
| 0.210039 | -356464 | -10.502 | | 356.464 | 10.502 |
| 0.219049 | -346327 | -10.9525 | | 346.327 | 10.9525 |
| 0.22806 | -336237 | -11.403 | | 336.237 | 11.403 |
| 0.23707 | -326169 | -11.8535 | | 326.169 | 11.8535 |
| 0.24608 | -316063 | -12.304 | | 316.063 | 12.304 |
| 0.25509 | -305733 | -12.7545 | | 305.733 | 12.7545 |
| 0.2641 | -294869 | -13.205 | | 294.869 | 13.205 |
| 0.27311 | -283333 | -13.6555 | | 283.333 | 13.6555 |
| 0.282121 | -271463 | -14.106 | | 271.463 | 14.106 |
| 0.284373 | -272278 | -14.2187 | | 272.278 | 14.2187 |
| 0.286626 | -269133 | -14.3313 | | 269.133 | 14.3313 |
| 0.290004 | -264208 | -14.5002 | | 264.208 | 14.5002 |
| 0.295073 | -256860 | -14.7536 | | 256.86 | 14.7536 |
| 0.302675 | -245922 | -15.1337 | | 245.922 | 15.1337 |
| 0.310277 | -236915 | -15.5139 | | 236.915 | 15.5139 |
| 0.31788 | -228125 | -15.894 | | 228.125 | 15.894 |
| 0.329283 | -212845 | -16.4642 | | 212.845 | 16.4642 |
| 0.333559 | -214367 | -16.678 | | 214.367 | 16.678 |
| 0.339974 | -205615 | -16.9987 | | 205.615 | 16.9987 |
| 0.346388 | -199818 | -17.3194 | | 199.818 | 17.3194 |
| 0.352803 | -193923 | -17.6401 | | 193.923 | 17.6401 |
| 0.355208 | -195903 | -17.7604 | | 195.903 | 17.7604 |
| 0.35611 | -195993 | -17.8055 | | 195.993 | 17.8055 |
| 0.357463 | -194228 | -17.8732 | | 194.228 | 17.8732 |
| 0.359493 | -191911 | -17.9746 | | 191.911 | 17.9746 |
| 0.362537 | -188295 | -18.1269 | | 188.295 | 18.1269 |
| 0.367104 | -182714 | -18.3552 | | 182.714 | 18.3552 |
| 0.37167 | -179079 | -18.5835 | | 179.079 | 18.5835 |
| 0.371956 | -180695 | -18.5978 | | 180.695 | 18.5978 |
| 0.372241 | -181634 | -18.6121 | | 181.634 | 18.6121 |
| 0.372527 | -182444 | -18.6263 | | 182.444 | 18.6263 |
| 0.372955 | -183178 | -18.6477 | | 183.178 | 18.6477 |
| 0.373383 | -183081 | -18.6691 | | 183.081 | 18.6691 |
| 0.373811 | -182710 | -18.6905 | | 182.71 | 18.6905 |
| 0.374239 | -182472 | -18.712 | | 182.472 | 18.712 |
| 0.374667 | -182092 | -18.7334 | | 182.092 | 18.7334 |

## S460

### 1 hole

*35 mm*

$F_{u,fem}$ 421.352 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -151670 | -0.5 | | 151.67 | 0.5 |
| 0.0125 | -189074 | -0.625 | | 189.074 | 0.625 |
| 0.01625 | -243506 | -0.8125 | | 243.506 | 0.8125 |
| 0.021875 | -295419 | -1.09375 | | 295.419 | 1.09375 |
| 0.0275 | -313993 | -1.375 | | 313.993 | 1.375 |
| 0.033125 | -330924 | -1.65625 | | 330.924 | 1.65625 |
| 0.03875 | -344810 | -1.9375 | | 344.81 | 1.9375 |
| 0.044375 | -356045 | -2.21875 | | 356.045 | 2.21875 |
| 0.05 | -365894 | -2.5 | | 365.894 | 2.5 |
| 0.055625 | -374783 | -2.78125 | | 374.783 | 2.78125 |
| 0.064063 | -386458 | -3.20313 | | 386.458 | 3.20313 |
| 0.076719 | -400574 | -3.83594 | | 400.574 | 3.83594 |
| 0.095703 | -414536 | -4.78516 | | 414.536 | 4.78516 |
| 0.102822 | -417793 | -5.14111 | | 417.793 | 5.14111 |
| 0.109941 | -420042 | -5.49707 | | 420.042 | 5.49707 |
| 0.117061 | -421352 | -5.85303 | | 421.352 | 5.85303 |
| 0.127739 | -421311 | -6.38696 | | 421.311 | 6.38696 |
| 0.131744 | -420740 | -6.58719 | | 420.74 | 6.58719 |
| 0.137751 | -418909 | -6.88753 | | 418.909 | 6.88753 |
| 0.143757 | -416254 | -7.18787 | | 416.254 | 7.18787 |
| 0.149764 | -412718 | -7.4882 | | 412.718 | 7.4882 |
| 0.155771 | -408301 | -7.78854 | | 408.301 | 7.78854 |
| 0.164781 | -399383 | -8.23905 | | 399.383 | 8.23905 |
| 0.167034 | -398406 | -8.35168 | | 398.406 | 8.35168 |
| 0.169286 | -396046 | -8.46431 | | 396.046 | 8.46431 |
| 0.172665 | -392197 | -8.63325 | | 392.197 | 8.63325 |
| 0.177733 | -386129 | -8.88666 | | 386.129 | 8.88666 |
| 0.185335 | -376644 | -9.26677 | | 376.644 | 9.26677 |
| 0.192938 | -367775 | -9.64689 | | 367.775 | 9.64689 |
| 0.20054 | -358849 | -10.027 | | 358.849 | 10.027 |
| 0.208142 | -349948 | -10.4071 | | 349.948 | 10.4071 |
| 0.215745 | -341100 | -10.7872 | | 341.1 | 10.7872 |
| 0.223347 | -332317 | -11.1674 | | 332.317 | 11.1674 |
| 0.230949 | -323591 | -11.5475 | | 323.591 | 11.5475 |
| 0.238552 | -314876 | -11.9276 | | 314.876 | 11.9276 |
| 0.246154 | -306074 | -12.3077 | | 306.074 | 12.3077 |
| 0.253756 | -297051 | -12.6878 | | 297.051 | 12.6878 |
| 0.261359 | -287698 | -13.0679 | | 287.698 | 13.0679 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| **S460** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *36 mm* | | | | | |
| $F_{u,fem}$ | 416.046 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -151179 | -0.5 | | 151.179 | 0.5 |
| 0.0125 | -188419 | -0.625 | | 188.419 | 0.625 |
| 0.01625 | -242456 | -0.8125 | | 242.456 | 0.8125 |
| 0.021875 | -292088 | -1.09375 | | 292.088 | 1.09375 |
| 0.0275 | -310462 | -1.375 | | 310.462 | 1.375 |
| 0.033125 | -327175 | -1.65625 | | 327.175 | 1.65625 |
| 0.03875 | -340871 | -1.9375 | | 340.871 | 1.9375 |
| 0.044375 | -351958 | -2.21875 | | 351.958 | 2.21875 |
| 0.052813 | -366128 | -2.64063 | | 366.128 | 2.64063 |
| 0.065469 | -383611 | -3.27344 | | 383.611 | 3.27344 |
| 0.084453 | -402220 | -4.22266 | | 402.22 | 4.22266 |
| 0.091572 | -407149 | -4.57861 | | 407.149 | 4.57861 |
| 0.102251 | -412394 | -5.11255 | | 412.394 | 5.11255 |
| 0.11293 | -415338 | -5.64648 | | 415.338 | 5.64648 |
| 0.123608 | -416046 | -6.18042 | | 416.046 | 6.18042 |
| 0.134287 | -414020 | -6.71436 | | 414.02 | 6.71436 |
| 0.144966 | -409047 | -7.24829 | | 409.047 | 7.24829 |
| 0.155645 | -401025 | -7.78223 | | 401.025 | 7.78223 |
| 0.158314 | -399869 | -7.91571 | | 399.869 | 7.91571 |
| 0.160984 | -397434 | -8.04919 | | 397.434 | 8.04919 |
| 0.164988 | -393292 | -8.24942 | | 393.292 | 8.24942 |
| 0.170995 | -386419 | -8.54976 | | 386.419 | 8.54976 |
| 0.180005 | -375349 | -9.00027 | | 375.349 | 9.00027 |
| 0.189016 | -364835 | -9.45078 | | 364.835 | 9.45078 |
| 0.198026 | -354203 | -9.90128 | | 354.203 | 9.90128 |
| 0.207036 | -343588 | -10.3518 | | 343.588 | 10.3518 |
| 0.216046 | -333061 | -10.8023 | | 333.061 | 10.8023 |
| 0.225056 | -322665 | -11.2528 | | 322.665 | 11.2528 |
| 0.234066 | -312408 | -11.7033 | | 312.408 | 11.7033 |
| 0.243076 | -302235 | -12.1538 | | 302.235 | 12.1538 |
| 0.252087 | -292032 | -12.6043 | | 292.032 | 12.6043 |
| 0.261097 | -281579 | -13.0548 | | 281.579 | 13.0548 |
| 0.270107 | -270729 | -13.5053 | | 270.729 | 13.5053 |
| 0.279117 | -259690 | -13.9559 | | 259.69 | 13.9559 |
| 0.288127 | -248619 | -14.4064 | | 248.619 | 14.4064 |
| 0.297137 | -237584 | -14.8569 | | 237.584 | 14.8569 |
| 0.306148 | -226756 | -15.3074 | | 226.756 | 15.3074 |
| 0.315158 | -216383 | -15.7579 | | 216.383 | 15.7579 |
| 0.31741 | -219553 | -15.8705 | | 219.553 | 15.8705 |
| 0.319663 | -216582 | -15.9831 | | 216.582 | 15.9831 |
| 0.323042 | -212132 | -16.1521 | | 212.132 | 16.1521 |
| 0.32811 | -205565 | -16.4055 | | 205.565 | 16.4055 |
| 0.335712 | -196010 | -16.7856 | | 196.01 | 16.7856 |
| 0.343315 | -189293 | -17.1657 | | 189.293 | 17.1657 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| **S460** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *37 mm* | | | | | |
| $F_{u,fem}$ | 409.719 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -150668 | -0.5 | | 150.668 | 0.5 |
| 0.0125 | -187732 | -0.625 | | 187.732 | 0.625 |
| 0.01625 | -241351 | -0.8125 | | 241.351 | 0.8125 |
| 0.021875 | -288707 | -1.09375 | | 288.707 | 1.09375 |
| 0.0275 | -306863 | -1.375 | | 306.863 | 1.375 |
| 0.033125 | -323376 | -1.65625 | | 323.376 | 1.65625 |
| 0.03875 | -336885 | -1.9375 | | 336.885 | 1.9375 |
| 0.047188 | -352752 | -2.35938 | | 352.752 | 2.35938 |
| 0.059844 | -371822 | -2.99219 | | 371.822 | 2.99219 |
| 0.078828 | -392695 | -3.94141 | | 392.695 | 3.94141 |
| 0.107305 | -408095 | -5.36523 | | 408.095 | 5.36523 |
| 0.114424 | -409448 | -5.72119 | | 409.448 | 5.72119 |
| 0.121543 | -409719 | -6.07715 | | 409.719 | 6.07715 |
| 0.128662 | -408791 | -6.43311 | | 408.791 | 6.43311 |
| 0.139341 | -404648 | -6.96704 | | 404.648 | 6.96704 |
| 0.15002 | -397426 | -7.50098 | | 397.426 | 7.50098 |
| 0.152689 | -396167 | -7.63446 | | 396.167 | 7.63446 |
| 0.155359 | -393911 | -7.76794 | | 393.911 | 7.76794 |
| 0.159363 | -390007 | -7.96817 | | 390.007 | 7.96817 |
| 0.16537 | -383260 | -8.26851 | | 383.26 | 8.26851 |
| 0.171377 | -376442 | -8.56885 | | 376.442 | 8.56885 |
| 0.177384 | -369376 | -8.86919 | | 369.376 | 8.86919 |
| 0.18339 | -362189 | -9.16953 | | 362.189 | 9.16953 |
| 0.192401 | -350189 | -9.62003 | | 350.189 | 9.62003 |
| 0.201411 | -339240 | -10.0705 | | 339.24 | 10.0705 |
| 0.210421 | -328380 | -10.521 | | 328.38 | 10.521 |
| 0.219431 | -317730 | -10.9716 | | 317.73 | 10.9716 |
| 0.228441 | -307331 | -11.4221 | | 307.331 | 11.4221 |
| 0.237451 | -297197 | -11.8726 | | 297.197 | 11.8726 |
| 0.246462 | -287321 | -12.3231 | | 287.321 | 12.3231 |
| 0.255472 | -277654 | -12.7736 | | 277.654 | 12.7736 |
| 0.264482 | -268107 | -13.2241 | | 268.107 | 13.2241 |
| 0.273492 | -258555 | -13.6746 | | 258.555 | 13.6746 |
| 0.282502 | -248755 | -14.1251 | | 248.755 | 14.1251 |
| 0.291512 | -238606 | -14.5756 | | 238.606 | 14.5756 |
| 0.293765 | -241052 | -14.6882 | | 241.052 | 14.6882 |
| 0.296018 | -238093 | -14.8009 | | 238.093 | 14.8009 |
| 0.299396 | -233551 | -14.9698 | | 233.551 | 14.9698 |
| 0.302775 | -229948 | -15.1388 | | 229.948 | 15.1388 |
| 0.306154 | -226293 | -15.3077 | | 226.293 | 15.3077 |
| 0.311222 | -219450 | -15.5611 | | 219.45 | 15.5611 |
| 0.318824 | -209377 | -15.9412 | | 209.377 | 15.9412 |
| 0.330228 | -194277 | -16.5114 | | 194.277 | 16.5114 |
| 0.333079 | -201036 | -16.6539 | | 201.036 | 16.6539 |
| 0.33593 | -196652 | -16.7965 | | 196.652 | 16.7965 |
| 0.338781 | -194254 | -16.939 | | 194.254 | 16.939 |
| 0.341631 | -191462 | -17.0816 | | 191.462 | 17.0816 |
| 0.345908 | -185248 | -17.2954 | | 185.248 | 17.2954 |
| 0.347511 | -188875 | -17.3756 | | 188.875 | 17.3756 |
| 0.349115 | -185769 | -17.4558 | | 185.769 | 17.4558 |
| 0.350719 | -184951 | -17.5359 | | 184.951 | 17.5359 |
| 0.352322 | -183170 | -17.6161 | | 183.17 | 17.6161 |
| 0.353926 | -181872 | -17.6963 | | 181.872 | 17.6963 |
| 0.355529 | -180186 | -17.7765 | | 180.186 | 17.7765 |
| 0.357133 | -178807 | -17.8567 | | 178.807 | 17.8567 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| **S460** | | | | | |
|---|---|---|---|---|---|
| **1 hole** | | | | | |
| *38 mm* | | | | | |
| $F_{u,fem}$ | 404.908 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -150155 | -0.5 | | 150.155 | 0.5 |
| 0.0125 | -187033 | -0.625 | | 187.033 | 0.625 |
| 0.01625 | -240215 | -0.8125 | | 240.215 | 0.8125 |
| 0.021875 | -285396 | -1.09375 | | 285.396 | 1.09375 |
| 0.0275 | -303356 | -1.375 | | 303.356 | 1.375 |
| 0.033125 | -319675 | -1.65625 | | 319.675 | 1.65625 |
| 0.03875 | -332920 | -1.9375 | | 332.92 | 1.9375 |
| 0.044375 | -343786 | -2.21875 | | 343.786 | 2.21875 |
| 0.05 | -353180 | -2.5 | | 353.18 | 2.5 |
| 0.058438 | -365536 | -2.92188 | | 365.536 | 2.92188 |
| 0.071094 | -380647 | -3.55469 | | 380.647 | 3.55469 |
| 0.090078 | -396053 | -4.50391 | | 396.053 | 4.50391 |
| 0.097197 | -399829 | -4.85986 | | 399.829 | 4.85986 |
| 0.107876 | -403489 | -5.3938 | | 403.489 | 5.3938 |
| 0.118555 | -404908 | -5.92773 | | 404.908 | 5.92773 |
| 0.129233 | -403810 | -6.46167 | | 403.81 | 6.46167 |
| 0.139912 | -399782 | -6.99561 | | 399.782 | 6.99561 |
| 0.150591 | -392791 | -7.52954 | | 392.791 | 7.52954 |
| 0.16127 | -382856 | -8.06348 | | 382.856 | 8.06348 |
| 0.163939 | -381801 | -8.19696 | | 381.801 | 8.19696 |
| 0.166609 | -379050 | -8.33044 | | 379.05 | 8.33044 |
| 0.170613 | -374546 | -8.53067 | | 374.546 | 8.53067 |
| 0.17662 | -367458 | -8.83101 | | 367.458 | 8.83101 |
| 0.18563 | -356474 | -9.28152 | | 356.474 | 9.28152 |
| 0.194641 | -346221 | -9.73203 | | 346.221 | 9.73203 |
| 0.203651 | -335885 | -10.1825 | | 335.885 | 10.1825 |
| 0.212661 | -325548 | -10.633 | | 325.548 | 10.633 |
| 0.221671 | -315247 | -11.0835 | | 315.247 | 11.0835 |
| 0.230681 | -304996 | -11.5341 | | 304.996 | 11.5341 |
| 0.239691 | -294774 | -11.9846 | | 294.774 | 11.9846 |
| 0.248701 | -284477 | -12.4351 | | 284.477 | 12.4351 |
| 0.257712 | -273888 | -12.8856 | | 273.888 | 12.8856 |
| 0.259964 | -274311 | -12.9982 | | 274.311 | 12.9982 |
| 0.262217 | -271466 | -13.1108 | | 271.466 | 13.1108 |
| 0.265596 | -266921 | -13.2798 | | 266.921 | 13.2798 |
| 0.268974 | -262897 | -13.4487 | | 262.897 | 13.4487 |
| 0.272353 | -258823 | -13.6177 | | 258.823 | 13.6177 |
| 0.275732 | -254747 | -13.7866 | | 254.747 | 13.7866 |
| 0.2808 | -247704 | -14.04 | | 247.704 | 14.04 |
| 0.288402 | -236991 | -14.4201 | | 236.991 | 14.4201 |
| 0.296005 | -227844 | -14.8002 | | 227.844 | 14.8002 |
| 0.303607 | -218869 | -15.1804 | | 218.869 | 15.1804 |
| 0.311209 | -210347 | -15.5605 | | 210.347 | 15.5605 |
| 0.318812 | -202314 | -15.9406 | | 202.314 | 15.9406 |
| 0.330215 | -188098 | -16.5108 | | 188.098 | 16.5108 |
| 0.341619 | -178372 | -17.0809 | | 178.372 | 17.0809 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *39 mm* | | | | | |
| $F_{u,fem}$ | 399.187 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -149603 | -0.5 | | 149.603 | 0.5 |
| 0.0125 | -186292 | -0.625 | | 186.292 | 0.625 |
| 0.01625 | -239010 | -0.8125 | | 239.01 | 0.8125 |
| 0.02 | -276564 | -1 | | 276.564 | 1 |
| 0.02375 | -288110 | -1.1875 | | 288.11 | 1.1875 |
| 0.0275 | -299813 | -1.375 | | 299.813 | 1.375 |
| 0.03125 | -310804 | -1.5625 | | 310.804 | 1.5625 |
| 0.035 | -320556 | -1.75 | | 320.556 | 1.75 |
| 0.040625 | -332655 | -2.03125 | | 332.655 | 2.03125 |
| 0.049063 | -347407 | -2.45313 | | 347.407 | 2.45313 |
| 0.061719 | -365205 | -3.08594 | | 365.205 | 3.08594 |
| 0.074375 | -379031 | -3.71875 | | 379.031 | 3.71875 |
| 0.087031 | -389084 | -4.35156 | | 389.084 | 4.35156 |
| 0.106016 | -397531 | -5.30078 | | 397.531 | 5.30078 |
| 0.110762 | -398595 | -5.53809 | | 398.595 | 5.53809 |
| 0.115508 | -399187 | -5.77539 | | 399.187 | 5.77539 |
| 0.122627 | -399174 | -6.13135 | | 399.174 | 6.13135 |
| 0.133306 | -396677 | -6.66528 | | 396.677 | 6.66528 |
| 0.143984 | -391306 | -7.19922 | | 391.306 | 7.19922 |
| 0.154663 | -382901 | -7.73315 | | 382.901 | 7.73315 |
| 0.157333 | -381537 | -7.86664 | | 381.537 | 7.86664 |
| 0.160002 | -378981 | -8.00012 | | 378.981 | 8.00012 |
| 0.164007 | -374715 | -8.20035 | | 374.715 | 8.20035 |
| 0.168011 | -370393 | -8.40057 | | 370.393 | 8.40057 |
| 0.172016 | -365874 | -8.6008 | | 365.874 | 8.6008 |
| 0.176021 | -361186 | -8.80103 | | 361.186 | 8.80103 |
| 0.182027 | -353303 | -9.10136 | | 353.303 | 9.10136 |
| 0.188034 | -345675 | -9.4017 | | 345.675 | 9.4017 |
| 0.194041 | -337767 | -9.70204 | | 337.767 | 9.70204 |
| 0.200048 | -329625 | -10.0024 | | 329.625 | 10.0024 |
| 0.206054 | -321273 | -10.3027 | | 321.273 | 10.3027 |
| 0.212061 | -312761 | -10.6031 | | 312.761 | 10.6031 |
| 0.218068 | -304139 | -10.9034 | | 304.139 | 10.9034 |
| 0.224075 | -295442 | -11.2037 | | 295.442 | 11.2037 |
| 0.230081 | -286731 | -11.5041 | | 286.731 | 11.5041 |
| 0.239092 | -272353 | -11.9546 | | 272.353 | 11.9546 |
| 0.248102 | -259208 | -12.4051 | | 259.208 | 12.4051 |
| 0.250354 | -259388 | -12.5177 | | 259.388 | 12.5177 |
| 0.252607 | -256069 | -12.6303 | | 256.069 | 12.6303 |
| 0.255986 | -250823 | -12.7993 | | 250.823 | 12.7993 |
| 0.261054 | -243021 | -13.0527 | | 243.021 | 13.0527 |
| 0.268656 | -231602 | -13.4328 | | 231.602 | 13.4328 |
| 0.28006 | -215457 | -14.003 | | 215.457 | 14.003 |
| 0.291463 | -203507 | -14.5732 | | 203.507 | 14.5732 |
| 0.302867 | -192859 | -15.1433 | | 192.859 | 15.1433 |
| 0.31427 | -183430 | -15.7135 | | 183.43 | 15.7135 |
| 0.325674 | -174942 | -16.2837 | | 174.942 | 16.2837 |
| 0.32995 | -176313 | -16.4975 | | 176.313 | 16.4975 |
| 0.336364 | -170199 | -16.8182 | | 170.199 | 16.8182 |
| 0.342779 | -166158 | -17.1389 | | 166.158 | 17.1389 |
| 0.349193 | -162032 | -17.4597 | | 162.032 | 17.4597 |
| 0.351599 | -163367 | -17.5799 | | 163.367 | 17.5799 |
| 0.354004 | -161438 | -17.7002 | | 161.438 | 17.7002 |
| 0.35641 | -160082 | -17.8205 | | 160.082 | 17.8205 |
| 0.358815 | -158592 | -17.9408 | | 158.592 | 17.9408 |
| 0.359041 | -159392 | -17.952 | | 159.392 | 17.952 |
| 0.359266 | -159743 | -17.9633 | | 159.743 | 17.9633 |
| 0.359492 | -159742 | -17.9746 | | 159.742 | 17.9746 |
| 0.359717 | -159633 | -17.9859 | | 159.633 | 17.9859 |
| 0.359943 | -159514 | -17.9971 | | 159.514 | 17.9971 |
| 0.360168 | -159391 | -18.0084 | | 159.391 | 18.0084 |
| 0.360506 | -159102 | -18.0253 | | 159.102 | 18.0253 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *40 mm* | | | | | |
| $F_{u,fem}$ | 393.383 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -149032 | -0.5 | | 149.032 | 0.5 |
| 0.0125 | -185518 | -0.625 | | 185.518 | 0.625 |
| 0.01625 | -237737 | -0.8125 | | 237.737 | 0.8125 |
| 0.021875 | -278631 | -1.09375 | | 278.631 | 1.09375 |
| 0.0275 | -296140 | -1.375 | | 296.14 | 1.375 |
| 0.033125 | -311992 | -1.65625 | | 311.992 | 1.65625 |
| 0.03875 | -324884 | -1.9375 | | 324.884 | 1.9375 |
| 0.044375 | -335389 | -2.21875 | | 335.389 | 2.21875 |
| 0.052813 | -348735 | -2.64063 | | 348.735 | 2.64063 |
| 0.065469 | -365052 | -3.27344 | | 365.052 | 3.27344 |
| 0.084453 | -382222 | -4.22266 | | 382.222 | 4.22266 |
| 0.091572 | -386652 | -4.57861 | | 386.652 | 4.57861 |
| 0.102251 | -391171 | -5.11255 | | 391.171 | 5.11255 |
| 0.11293 | -393383 | -5.64648 | | 393.383 | 5.64648 |
| 0.123608 | -393199 | -6.18042 | | 393.199 | 6.18042 |
| 0.134287 | -390112 | -6.71436 | | 390.112 | 6.71436 |
| 0.144966 | -384005 | -7.24829 | | 384.005 | 7.24829 |
| 0.155645 | -374755 | -7.78223 | | 374.755 | 7.78223 |
| 0.158314 | -373086 | -7.91571 | | 373.086 | 7.91571 |
| 0.160984 | -370358 | -8.04919 | | 370.358 | 8.04919 |
| 0.164988 | -365879 | -8.24942 | | 365.879 | 8.24942 |
| 0.170995 | -358532 | -8.54976 | | 358.532 | 8.54976 |
| 0.177002 | -351373 | -8.8501 | | 351.373 | 8.8501 |
| 0.183009 | -344101 | -9.15044 | | 344.101 | 9.15044 |
| 0.189016 | -336802 | -9.45078 | | 336.802 | 9.45078 |
| 0.195022 | -329523 | -9.75111 | | 329.523 | 9.75111 |
| 0.201029 | -322294 | -10.0515 | | 322.294 | 10.0515 |
| 0.207036 | -315146 | -10.3518 | | 315.146 | 10.3518 |
| 0.213043 | -308094 | -10.6521 | | 308.094 | 10.6521 |
| 0.222053 | -296339 | -11.1026 | | 296.339 | 11.1026 |
| 0.231063 | -286210 | -11.5531 | | 286.21 | 11.5531 |
| 0.240073 | -276241 | -12.0037 | | 276.241 | 12.0037 |
| 0.249083 | -266447 | -12.4542 | | 266.447 | 12.4542 |
| 0.258093 | -256756 | -12.9047 | | 256.756 | 12.9047 |
| 0.267104 | -247026 | -13.3552 | | 247.026 | 13.3552 |
| 0.276114 | -237122 | -13.8057 | | 237.122 | 13.8057 |
| 0.278366 | -238917 | -13.9183 | | 238.917 | 13.9183 |
| 0.280619 | -236131 | -14.0309 | | 236.131 | 14.0309 |
| 0.283998 | -231750 | -14.1999 | | 231.75 | 14.1999 |
| 0.287376 | -228156 | -14.3688 | | 228.156 | 14.3688 |
| 0.290755 | -224518 | -14.5378 | | 224.518 | 14.5378 |
| 0.294134 | -220911 | -14.7067 | | 220.911 | 14.7067 |
| 0.299202 | -214286 | -14.9601 | | 214.286 | 14.9601 |
| 0.306805 | -204411 | -15.3402 | | 204.411 | 15.3402 |
| 0.314407 | -196580 | -15.7203 | | 196.58 | 15.7203 |
| 0.322009 | -188652 | -16.1005 | | 188.652 | 16.1005 |
| 0.329612 | -180938 | -16.4806 | | 180.938 | 16.4806 |
| 0.337214 | -173454 | -16.8607 | | 173.454 | 16.8607 |
| 0.337689 | -176793 | -16.8845 | | 176.793 | 16.8845 |
| 0.338164 | -178959 | -16.9082 | | 178.959 | 16.9082 |
| 0.338639 | -179997 | -16.932 | | 179.997 | 16.932 |
| 0.339114 | -179776 | -16.9557 | | 179.776 | 16.9557 |
| 0.33959 | -179325 | -16.9795 | | 179.325 | 16.9795 |
| 0.340065 | -178958 | -17.0032 | | 178.958 | 17.0032 |
| 0.340777 | -177961 | -17.0389 | | 177.961 | 17.0389 |
| 0.341847 | -176579 | -17.0923 | | 176.579 | 17.0923 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *41 mm* | | | | | |
| $F_{u,fem}$ | 388.144 | kN | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -148450 | -0.5 | | 148.45 | 0.5 |
| 0.0125 | -184726 | -0.625 | | 184.726 | 0.625 |
| 0.01625 | -236434 | -0.8125 | | 236.434 | 0.8125 |
| 0.02 | -269741 | -1 | | 269.741 | 1 |
| 0.02375 | -281235 | -1.1875 | | 281.235 | 1.1875 |
| 0.0275 | -292612 | -1.375 | | 292.612 | 1.375 |
| 0.03125 | -303274 | -1.5625 | | 303.274 | 1.5625 |
| 0.035 | -312762 | -1.75 | | 312.762 | 1.75 |
| 0.040625 | -324500 | -2.03125 | | 324.5 | 2.03125 |
| 0.049063 | -338865 | -2.45313 | | 338.865 | 2.45313 |
| 0.061719 | -356062 | -3.08594 | | 356.062 | 3.08594 |
| 0.074375 | -369355 | -3.71875 | | 369.355 | 3.71875 |
| 0.087031 | -378979 | -4.35156 | | 378.979 | 4.35156 |
| 0.106016 | -386783 | -5.30078 | | 386.783 | 5.30078 |
| 0.110762 | -387707 | -5.53809 | | 387.707 | 5.53809 |
| 0.115508 | -388144 | -5.77539 | | 388.144 | 5.77539 |
| 0.122627 | -387885 | -6.13135 | | 387.885 | 6.13135 |
| 0.133306 | -385003 | -6.66528 | | 385.003 | 6.66528 |
| 0.143984 | -379244 | -7.19922 | | 379.244 | 7.19922 |
| 0.154663 | -370443 | -7.73315 | | 370.443 | 7.73315 |
| 0.157333 | -368974 | -7.86664 | | 368.974 | 7.86664 |
| 0.160002 | -366321 | -8.00012 | | 366.321 | 8.00012 |
| 0.164007 | -361938 | -8.20035 | | 361.938 | 8.20035 |
| 0.168011 | -357504 | -8.40057 | | 357.504 | 8.40057 |
| 0.172016 | -352870 | -8.6008 | | 352.87 | 8.6008 |
| 0.176021 | -348069 | -8.80103 | | 348.069 | 8.80103 |
| 0.182027 | -340059 | -9.10136 | | 340.059 | 9.10136 |
| 0.188034 | -332283 | -9.4017 | | 332.283 | 9.4017 |
| 0.194041 | -324259 | -9.70204 | | 324.259 | 9.70204 |
| 0.200048 | -316032 | -10.0024 | | 316.032 | 10.0024 |
| 0.206054 | -307642 | -10.3027 | | 307.642 | 10.3027 |
| 0.212061 | -299133 | -10.6031 | | 299.133 | 10.6031 |
| 0.218068 | -290547 | -10.9034 | | 290.547 | 10.9034 |
| 0.224075 | -281944 | -11.2037 | | 281.944 | 11.2037 |
| 0.230081 | -273340 | -11.5041 | | 273.34 | 11.5041 |
| 0.232334 | -271558 | -11.6167 | | 271.558 | 11.6167 |
| 0.235713 | -266299 | -11.7856 | | 266.299 | 11.7856 |
| 0.240781 | -258467 | -12.0391 | | 258.467 | 12.0391 |
| 0.242682 | -257216 | -12.1341 | | 257.216 | 12.1341 |
| 0.245532 | -252804 | -12.2766 | | 252.804 | 12.2766 |
| 0.249809 | -246355 | -12.4904 | | 246.355 | 12.4904 |
| 0.256223 | -236838 | -12.8112 | | 236.838 | 12.8112 |
| 0.265845 | -223067 | -13.2922 | | 223.067 | 13.2922 |
| 0.275467 | -212045 | -13.7733 | | 212.045 | 13.7733 |
| 0.285088 | -201898 | -14.2544 | | 201.898 | 14.2544 |
| 0.299521 | -185716 | -14.976 | | 185.716 | 14.976 |
| 0.313953 | -174326 | -15.6977 | | 174.326 | 15.6977 |
| 0.328386 | -164257 | -16.4193 | | 164.257 | 16.4193 |
| 0.342818 | -155300 | -17.1409 | | 155.3 | 17.1409 |
| 0.346427 | -158914 | -17.3213 | | 158.914 | 17.3213 |
| 0.350035 | -156300 | -17.5017 | | 156.3 | 17.5017 |
| 0.353643 | -154333 | -17.6821 | | 154.333 | 17.6821 |
| 0.359055 | -150225 | -17.9528 | | 150.225 | 17.9528 |
| 0.359393 | -151625 | -17.9697 | | 151.625 | 17.9697 |
| 0.359732 | -152309 | -17.9866 | | 152.309 | 17.9866 |
| 0.36007 | -152504 | -18.0035 | | 152.504 | 18.0035 |
| 0.360408 | -152350 | -18.0204 | | 152.35 | 18.0204 |
| 0.360746 | -152193 | -18.0373 | | 152.193 | 18.0373 |
| 0.361085 | -152026 | -18.0542 | | 152.026 | 18.0542 |
| 0.361592 | -151666 | -18.0796 | | 151.666 | 18.0796 |
| 0.362353 | -151129 | -18.1177 | | 151.129 | 18.1177 |
| 0.363495 | -150303 | -18.1747 | | 150.303 | 18.1747 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *42 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 382.516 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -147852 | -0.5 | | 147.852 | 0.5 |
| 0.0125 | -183910 | -0.625 | | 183.91 | 0.625 |
| 0.01625 | -235059 | -0.8125 | | 235.059 | 0.8125 |
| 0.021875 | -271905 | -1.09375 | | 271.905 | 1.09375 |
| 0.0275 | -288952 | -1.375 | | 288.952 | 1.375 |
| 0.033125 | -304366 | -1.65625 | | 304.366 | 1.65625 |
| 0.03875 | -316867 | -1.9375 | | 316.867 | 1.9375 |
| 0.047188 | -331654 | -2.35938 | | 331.654 | 2.35938 |
| 0.059844 | -349243 | -2.99219 | | 349.243 | 2.99219 |
| 0.06459 | -354807 | -3.22949 | | 354.807 | 3.22949 |
| 0.071709 | -362155 | -3.58545 | | 362.155 | 3.58545 |
| 0.082388 | -370922 | -4.11938 | | 370.922 | 4.11938 |
| 0.098406 | -379381 | -4.92029 | | 379.381 | 4.92029 |
| 0.10241 | -380679 | -5.12051 | | 380.679 | 5.12051 |
| 0.106415 | -381658 | -5.32074 | | 381.658 | 5.32074 |
| 0.112422 | -382516 | -5.62108 | | 382.516 | 5.62108 |
| 0.121432 | -382327 | -6.07159 | | 382.327 | 6.07159 |
| 0.134947 | -377960 | -6.74735 | | 377.96 | 6.74735 |
| 0.138326 | -376450 | -6.91629 | | 376.45 | 6.91629 |
| 0.141705 | -374412 | -7.08523 | | 374.412 | 7.08523 |
| 0.146773 | -370750 | -7.33864 | | 370.75 | 7.33864 |
| 0.154375 | -363976 | -7.71876 | | 363.976 | 7.71876 |
| 0.161977 | -356060 | -8.09887 | | 356.06 | 8.09887 |
| 0.16958 | -347439 | -8.47899 | | 347.439 | 8.47899 |
| 0.177182 | -338384 | -8.85911 | | 338.384 | 8.85911 |
| 0.184784 | -329092 | -9.23922 | | 329.092 | 9.23922 |
| 0.192387 | -319725 | -9.61934 | | 319.725 | 9.61934 |
| 0.199989 | -310430 | -9.99945 | | 310.43 | 9.99945 |
| 0.207591 | -301267 | -10.3796 | | 301.267 | 10.3796 |
| 0.215194 | -292278 | -10.7597 | | 292.278 | 10.7597 |
| 0.222796 | -283497 | -11.1398 | | 283.497 | 11.1398 |
| 0.230398 | -274935 | -11.5199 | | 274.935 | 11.5199 |
| 0.238001 | -266604 | -11.9 | | 266.604 | 11.9 |
| 0.245603 | -258506 | -12.2802 | | 258.506 | 12.2802 |
| 0.257007 | -244864 | -12.8503 | | 244.864 | 12.8503 |
| 0.26841 | -233622 | -13.4205 | | 233.622 | 13.4205 |
| 0.279813 | -222658 | -13.9907 | | 222.658 | 13.9907 |
| 0.291217 | -211981 | -14.5608 | | 211.981 | 14.5608 |
| 0.294068 | -214735 | -14.7034 | | 214.735 | 14.7034 |
| 0.296919 | -211706 | -14.8459 | | 211.706 | 14.8459 |
| 0.301195 | -206954 | -15.0598 | | 206.954 | 15.0598 |
| 0.307609 | -199880 | -15.3805 | | 199.88 | 15.3805 |
| 0.317231 | -189246 | -15.8616 | | 189.246 | 15.8616 |
| 0.326853 | -180818 | -16.3426 | | 180.818 | 16.3426 |
| 0.327454 | -184822 | -16.3727 | | 184.822 | 16.3727 |
| 0.328056 | -186776 | -16.4028 | | 186.776 | 16.4028 |
| 0.328657 | -186283 | -16.4328 | | 186.283 | 16.4328 |
| 0.329258 | -185801 | -16.4629 | | 185.801 | 16.4629 |
| 0.32986 | -185310 | -16.493 | | 185.31 | 16.493 |
| 0.330085 | -185515 | -16.5043 | | 185.515 | 16.5043 |
| 0.330423 | -185052 | -16.5212 | | 185.052 | 16.5212 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *43 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 376.901 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -147225 | -0.5 | | 147.225 | 0.5 |
| 0.0125 | -183045 | -0.625 | | 183.045 | 0.625 |
| 0.01625 | -233613 | -0.8125 | | 233.613 | 0.8125 |
| 0.02 | -262889 | -1 | | 262.889 | 1 |
| 0.02375 | -274314 | -1.1875 | | 274.314 | 1.1875 |
| 0.0275 | -285348 | -1.375 | | 285.348 | 1.375 |
| 0.03125 | -295716 | -1.5625 | | 295.716 | 1.5625 |
| 0.036875 | -308956 | -1.84375 | | 308.956 | 1.84375 |
| 0.045313 | -324365 | -2.26563 | | 324.365 | 2.26563 |
| 0.057969 | -342366 | -2.89844 | | 342.366 | 2.89844 |
| 0.076953 | -361784 | -3.84766 | | 361.784 | 3.84766 |
| 0.095938 | -373084 | -4.79688 | | 373.084 | 4.79688 |
| 0.100684 | -374725 | -5.03418 | | 374.725 | 5.03418 |
| 0.10543 | -375923 | -5.27148 | | 375.923 | 5.27148 |
| 0.110176 | -376677 | -5.50879 | | 376.677 | 5.50879 |
| 0.117295 | -376901 | -5.86475 | | 376.901 | 5.86475 |
| 0.127974 | -374858 | -6.39868 | | 374.858 | 6.39868 |
| 0.138652 | -369792 | -6.93262 | | 369.792 | 6.93262 |
| 0.149331 | -361634 | -7.46655 | | 361.634 | 7.46655 |
| 0.152001 | -359606 | -7.60004 | | 359.606 | 7.60004 |
| 0.15467 | -357028 | -7.73352 | | 357.028 | 7.73352 |
| 0.158675 | -352816 | -7.93375 | | 352.816 | 7.93375 |
| 0.162679 | -348426 | -8.13397 | | 348.426 | 8.13397 |
| 0.166684 | -343827 | -8.3342 | | 343.827 | 8.3342 |
| 0.172691 | -336329 | -8.63454 | | 336.329 | 8.63454 |
| 0.178698 | -328697 | -8.93488 | | 328.697 | 8.93488 |
| 0.184704 | -320787 | -9.23521 | | 320.787 | 9.23521 |
| 0.190711 | -312661 | -9.53555 | | 312.661 | 9.53555 |
| 0.196718 | -304367 | -9.83589 | | 304.367 | 9.83589 |
| 0.202725 | -295940 | -10.1362 | | 295.94 | 10.1362 |
| 0.208731 | -287419 | -10.4366 | | 287.419 | 10.4366 |
| 0.214738 | -278839 | -10.7369 | | 278.839 | 10.7369 |
| 0.220745 | -270216 | -11.0372 | | 270.216 | 11.0372 |
| 0.226752 | -261613 | -11.3376 | | 261.613 | 11.3376 |
| 0.232758 | -253125 | -11.6379 | | 253.125 | 11.6379 |
| 0.238765 | -244753 | -11.9383 | | 244.753 | 11.9383 |
| 0.247775 | -231055 | -12.3888 | | 231.055 | 12.3888 |
| 0.248339 | -233458 | -12.4169 | | 233.458 | 12.4169 |
| 0.248902 | -232659 | -12.4451 | | 232.659 | 12.4451 |
| 0.249465 | -231939 | -12.4732 | | 231.939 | 12.4732 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

| S460 | | | | | |
|---|---|---|---|---|---|
| 1 hole | | | | | |
| *44 mm* | | | | | |
| | | | | | |
| $F_{u,fem}$ | 371.458 | kN | | | |
| | | | | | |
| Time | Load | Displacement | | abs Load | abs Displacement |
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -146566 | -0.5 | | 146.566 | 0.5 |
| 0.0125 | -182142 | -0.625 | | 182.142 | 0.625 |
| 0.01625 | -232086 | -0.8125 | | 232.086 | 0.8125 |
| 0.02 | -259436 | -1 | | 259.436 | 1 |
| 0.02375 | -270782 | -1.1875 | | 270.782 | 1.1875 |
| 0.0275 | -281654 | -1.375 | | 281.654 | 1.375 |
| 0.03125 | -291843 | -1.5625 | | 291.843 | 1.5625 |
| 0.036875 | -304844 | -1.84375 | | 304.844 | 1.84375 |
| 0.045313 | -320098 | -2.26563 | | 320.098 | 2.26563 |
| 0.05375 | -332432 | -2.6875 | | 332.432 | 2.6875 |
| 0.062188 | -342755 | -3.10938 | | 342.755 | 3.10938 |
| 0.074844 | -355165 | -3.74219 | | 355.165 | 3.74219 |
| 0.093828 | -367022 | -4.69141 | | 367.022 | 4.69141 |
| 0.100947 | -369512 | -5.04736 | | 369.512 | 5.04736 |
| 0.108066 | -371007 | -5.40332 | | 371.007 | 5.40332 |
| 0.115186 | -371458 | -5.75928 | | 371.458 | 5.75928 |
| 0.125864 | -369940 | -6.29321 | | 369.94 | 6.29321 |
| 0.136543 | -365588 | -6.82715 | | 365.588 | 6.82715 |
| 0.147222 | -358374 | -7.36108 | | 358.374 | 7.36108 |
| 0.149891 | -356511 | -7.49457 | | 356.511 | 7.49457 |
| 0.152561 | -354204 | -7.62805 | | 354.204 | 7.62805 |
| 0.156566 | -350424 | -7.82828 | | 350.424 | 7.82828 |
| 0.162572 | -344259 | -8.12862 | | 344.259 | 8.12862 |
| 0.168579 | -337861 | -8.42896 | | 337.861 | 8.42896 |
| 0.174586 | -331218 | -8.72929 | | 331.218 | 8.72929 |
| 0.180593 | -324394 | -9.02963 | | 324.394 | 9.02963 |
| 0.186599 | -317437 | -9.32997 | | 317.437 | 9.32997 |
| 0.192606 | -310383 | -9.63031 | | 310.383 | 9.63031 |
| 0.198613 | -303265 | -9.93065 | | 303.265 | 9.93065 |
| 0.20462 | -296110 | -10.231 | | 296.11 | 10.231 |
| 0.210627 | -288931 | -10.5313 | | 288.931 | 10.5313 |
| 0.216633 | -281730 | -10.8317 | | 281.73 | 10.8317 |
| 0.22264 | -274506 | -11.132 | | 274.506 | 11.132 |
| 0.228647 | -267256 | -11.4323 | | 267.256 | 11.4323 |
| 0.237657 | -255393 | -11.8829 | | 255.393 | 11.8829 |
| 0.246667 | -244414 | -12.3334 | | 244.414 | 12.3334 |
| 0.255677 | -233523 | -12.7839 | | 233.523 | 12.7839 |
| 0.264688 | -222947 | -13.2344 | | 222.947 | 13.2344 |
| 0.273698 | -212694 | -13.6849 | | 212.694 | 13.6849 |
| 0.282708 | -202762 | -14.1354 | | 202.762 | 14.1354 |
| 0.291718 | -193213 | -14.5859 | | 193.213 | 14.5859 |
| 0.300728 | -184180 | -15.0364 | | 184.18 | 15.0364 |
| 0.309738 | -175807 | -15.4869 | | 175.807 | 15.4869 |
| 0.318748 | -168154 | -15.9374 | | 168.154 | 15.9374 |
| 0.327759 | -161180 | -16.3879 | | 161.18 | 16.3879 |
| 0.336769 | -154793 | -16.8384 | | 154.793 | 16.8384 |
| 0.340148 | -156269 | -17.0074 | | 156.269 | 17.0074 |
| 0.345216 | -151452 | -17.2608 | | 151.452 | 17.2608 |
| 0.350284 | -148479 | -17.5142 | | 148.479 | 17.5142 |
| 0.355352 | -145405 | -17.7676 | | 145.405 | 17.7676 |
| 0.357253 | -146891 | -17.8626 | | 146.891 | 17.8626 |
| 0.360104 | -144014 | -18.0052 | | 144.014 | 18.0052 |
| 0.362955 | -142622 | -18.1477 | | 142.622 | 18.1477 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

## S460
### 1 hole
*45 mm*

$F_{u,fem}$ 365.875 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -145912 | -0.5 | | 145.912 | 0.5 |
| 0.0125 | -181233 | -0.625 | | 181.233 | 0.625 |
| 0.01625 | -230546 | -0.8125 | | 230.546 | 0.8125 |
| 0.021875 | -261667 | -1.09375 | | 261.667 | 1.09375 |
| 0.0275 | -278004 | -1.375 | | 278.004 | 1.375 |
| 0.033125 | -292696 | -1.65625 | | 292.696 | 1.65625 |
| 0.03875 | -304573 | -1.9375 | | 304.573 | 1.9375 |
| 0.047188 | -318869 | -2.35938 | | 318.869 | 2.35938 |
| 0.059844 | -335497 | -2.99219 | | 335.497 | 2.99219 |
| 0.078828 | -353370 | -3.94141 | | 353.37 | 3.94141 |
| 0.085947 | -358068 | -4.29736 | | 358.068 | 4.29736 |
| 0.096626 | -362977 | -4.8313 | | 362.977 | 4.8313 |
| 0.112644 | -365875 | -5.6322 | | 365.875 | 5.6322 |
| 0.128662 | -362853 | -6.43311 | | 362.853 | 6.43311 |
| 0.132667 | -361344 | -6.63333 | | 361.344 | 6.63333 |
| 0.136671 | -359234 | -6.83356 | | 359.234 | 6.83356 |
| 0.140676 | -356702 | -7.03378 | | 356.702 | 7.03378 |
| 0.146682 | -352097 | -7.33412 | | 352.097 | 7.33412 |
| 0.155693 | -343328 | -7.78463 | | 343.328 | 7.78463 |
| 0.164703 | -333448 | -8.23514 | | 333.448 | 8.23514 |
| 0.173713 | -322894 | -8.68565 | | 322.894 | 8.68565 |
| 0.182723 | -311958 | -9.13615 | | 311.958 | 9.13615 |
| 0.191733 | -300900 | -9.58666 | | 300.9 | 9.58666 |
| 0.200743 | -289924 | -10.0372 | | 289.924 | 10.0372 |
| 0.209754 | -279083 | -10.4877 | | 279.083 | 10.4877 |
| 0.218764 | -268469 | -10.9382 | | 268.469 | 10.9382 |
| 0.227774 | -258164 | -11.3887 | | 258.164 | 11.3887 |
| 0.236784 | -248159 | -11.8392 | | 248.159 | 11.8392 |
| 0.245794 | -238454 | -12.2897 | | 238.454 | 12.2897 |
| 0.254804 | -229062 | -12.7402 | | 229.062 | 12.7402 |
| 0.263815 | -219930 | -13.1907 | | 219.93 | 13.1907 |
| 0.272825 | -211044 | -13.6412 | | 211.044 | 13.6412 |
| 0.281835 | -202382 | -14.0917 | | 202.382 | 14.0917 |
| 0.290845 | -193866 | -14.5423 | | 193.866 | 14.5423 |
| 0.294224 | -194887 | -14.7112 | | 194.887 | 14.7112 |
| 0.299292 | -188564 | -14.9646 | | 188.564 | 14.9646 |
| 0.306894 | -179829 | -15.3447 | | 179.829 | 15.3447 |
| 0.314497 | -173210 | -15.7248 | | 173.21 | 15.7248 |
| 0.322099 | -166454 | -16.105 | | 166.454 | 16.105 |
| 0.329701 | -159743 | -16.4851 | | 159.743 | 16.4851 |
| 0.337304 | -153049 | -16.8652 | | 153.049 | 16.8652 |
| 0.337779 | -156674 | -16.8889 | | 156.674 | 16.8889 |
| 0.337898 | -157363 | -16.8949 | | 157.363 | 16.8949 |
| 0.338016 | -157980 | -16.9008 | | 157.98 | 16.9008 |
| 0.338195 | -158737 | -16.9097 | | 158.737 | 16.9097 |
| 0.338462 | -159611 | -16.9231 | | 159.611 | 16.9231 |
| 0.338863 | -160228 | -16.9431 | | 160.228 | 16.9431 |
| 0.339264 | -159767 | -16.9632 | | 159.767 | 16.9632 |
| 0.339665 | -159537 | -16.9832 | | 159.537 | 16.9832 |
| 0.340065 | -159219 | -17.0033 | | 159.219 | 17.0033 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |
| | | | | 0 | 0 |

## S460
### 1 hole
*46 mm*

$F_{u,fem}$ 360.41 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -145210 | -0.5 | | 145.21 | 0.5 |
| 0.0125 | -180261 | -0.625 | | 180.261 | 0.625 |
| 0.01625 | -228887 | -0.8125 | | 228.887 | 0.8125 |
| 0.021875 | -258235 | -1.09375 | | 258.235 | 1.09375 |
| 0.0275 | -274313 | -1.375 | | 274.313 | 1.375 |
| 0.033125 | -288749 | -1.65625 | | 288.749 | 1.65625 |
| 0.03875 | -300426 | -1.9375 | | 300.426 | 1.9375 |
| 0.047188 | -314479 | -2.35938 | | 314.479 | 2.35938 |
| 0.059844 | -330924 | -2.99219 | | 330.924 | 2.99219 |
| 0.078828 | -348409 | -3.94141 | | 348.409 | 3.94141 |
| 0.085947 | -352992 | -4.29736 | | 352.992 | 4.29736 |
| 0.096626 | -357745 | -4.8313 | | 357.745 | 4.8313 |
| 0.107305 | -360229 | -5.36523 | | 360.229 | 5.36523 |
| 0.117983 | -360410 | -5.89917 | | 360.41 | 5.89917 |
| 0.128662 | -357952 | -6.43311 | | 357.952 | 6.43311 |
| 0.139341 | -352674 | -6.96704 | | 352.674 | 6.96704 |
| 0.15002 | -344600 | -7.50098 | | 344.6 | 7.50098 |
| 0.152689 | -342680 | -7.63446 | | 342.68 | 7.63446 |
| 0.155359 | -340219 | -7.76794 | | 340.219 | 7.76794 |
| 0.159363 | -336272 | -7.96817 | | 336.272 | 7.96817 |
| 0.16537 | -329944 | -8.26851 | | 329.944 | 8.26851 |
| 0.171377 | -323516 | -8.56885 | | 323.516 | 8.56885 |
| 0.177384 | -316891 | -8.86919 | | 316.891 | 8.86919 |
| 0.18339 | -310132 | -9.16953 | | 310.132 | 9.16953 |
| 0.189397 | -303284 | -9.46986 | | 303.284 | 9.46986 |
| 0.195404 | -296394 | -9.7702 | | 296.394 | 9.7702 |
| 0.201411 | -289508 | -10.0705 | | 289.508 | 10.0705 |
| 0.207418 | -282646 | -10.3709 | | 282.646 | 10.3709 |
| 0.216428 | -271512 | -10.8214 | | 271.512 | 10.8214 |
| 0.225438 | -261408 | -11.2719 | | 261.408 | 11.2719 |
| 0.234448 | -251402 | -11.7224 | | 251.402 | 11.7224 |
| 0.243458 | -241522 | -12.1729 | | 241.522 | 12.1729 |
| 0.252468 | -231754 | -12.6234 | | 231.754 | 12.6234 |
| 0.261479 | -222047 | -13.0739 | | 222.047 | 13.0739 |
| 0.270489 | -212430 | -13.5244 | | 212.43 | 13.5244 |
| 0.279499 | -203063 | -13.9749 | | 203.063 | 13.9749 |
| 0.288509 | -194055 | -14.4255 | | 194.055 | 14.4255 |
| 0.297519 | -185421 | -14.876 | | 185.421 | 14.876 |
| 0.306529 | -177162 | -15.3265 | | 177.162 | 15.3265 |
| 0.309908 | -177179 | -15.4954 | | 177.179 | 15.4954 |
| 0.314976 | -171721 | -15.7488 | | 171.721 | 15.7488 |
| 0.322579 | -164099 | -16.1289 | | 164.099 | 16.1289 |
| 0.32543 | -164883 | -16.2715 | | 164.883 | 16.2715 |
| 0.329706 | -160441 | -16.4853 | | 160.441 | 16.4853 |
| 0.33612 | -154413 | -16.806 | | 154.413 | 16.806 |
| 0.345742 | -145609 | -17.2871 | | 145.609 | 17.2871 |
| 0.34935 | -147994 | -17.4675 | | 147.994 | 17.4675 |
| 0.354762 | -142485 | -17.7381 | | 142.485 | 17.7381 |
| 0.360175 | -139428 | -18.0087 | | 139.428 | 18.0087 |
| 0.365587 | -136061 | -18.2793 | | 136.061 | 18.2793 |
| 0.370999 | -132778 | -18.55 | | 132.778 | 18.55 |
| 0.371337 | -134752 | -18.5669 | | 134.752 | 18.5669 |
| 0.371676 | -135910 | -18.5838 | | 135.91 | 18.5838 |
| 0.372014 | -136730 | -18.6007 | | 136.73 | 18.6007 |
| 0.372352 | -137074 | -18.6176 | | 137.074 | 18.6176 |
| 0.37269 | -136966 | -18.6345 | | 136.966 | 18.6345 |
| 0.373198 | -136414 | -18.6599 | | 136.414 | 18.6599 |
| 0.373229 | -136567 | -18.6615 | | 136.567 | 18.6615 |
| 0.373261 | -136661 | -18.6631 | | 136.661 | 18.6631 |
| 0.373293 | -136688 | -18.6646 | | 136.688 | 18.6646 |
| 0.373325 | -136707 | -18.6662 | | 136.707 | 18.6662 |
| 0.373372 | -136717 | -18.6686 | | 136.717 | 18.6686 |

## S460
### 1 hole
*47 mm*

$F_{u,fem}$ 354.763 kN

| Time | Load | Displacement | | abs Load | abs Displacement |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | 0 | 0 |
| 0.01 | -144487 | -0.5 | | 144.487 | 0.5 |
| 0.0125 | -179250 | -0.625 | | 179.25 | 0.625 |
| 0.01625 | -227157 | -0.8125 | | 227.157 | 0.8125 |
| 0.021875 | -254741 | -1.09375 | | 254.741 | 1.09375 |
| 0.0275 | -270577 | -1.375 | | 270.577 | 1.375 |
| 0.033125 | -284756 | -1.65625 | | 284.756 | 1.65625 |
| 0.03875 | -296254 | -1.9375 | | 296.254 | 1.9375 |
| 0.047188 | -310084 | -2.35938 | | 310.084 | 2.35938 |
| 0.059844 | -326248 | -2.99219 | | 326.248 | 2.99219 |
| 0.078828 | -343348 | -3.94141 | | 343.348 | 3.94141 |
| 0.085947 | -347808 | -4.29736 | | 347.808 | 4.29736 |
| 0.096626 | -352352 | -4.8313 | | 352.352 | 4.8313 |
| 0.112644 | -354763 | -5.6322 | | 354.763 | 5.6322 |
| 0.116649 | -354608 | -5.83243 | | 354.608 | 5.83243 |
| 0.120653 | -354060 | -6.03265 | | 354.06 | 6.03265 |
| 0.12666 | -352464 | -6.33299 | | 352.464 | 6.33299 |
| 0.132667 | -350016 | -6.63333 | | 350.016 | 6.63333 |
| 0.138673 | -346659 | -6.93367 | | 346.659 | 6.93367 |
| 0.14468 | -342459 | -7.23401 | | 342.459 | 7.23401 |
| 0.15369 | -334376 | -7.68452 | | 334.376 | 7.68452 |
| 0.162701 | -325146 | -8.13503 | | 325.146 | 8.13503 |
| 0.171711 | -315202 | -8.58553 | | 315.202 | 8.58553 |
| 0.180721 | -304828 | -9.03604 | | 304.828 | 9.03604 |
| 0.189731 | -294234 | -9.48655 | | 294.234 | 9.48655 |
| 0.198741 | -283638 | -9.93706 | | 283.638 | 9.93706 |
| 0.207751 | -273168 | -10.3876 | | 273.168 | 10.3876 |
| 0.216761 | -262894 | -10.8381 | | 262.894 | 10.8381 |
| 0.225772 | -252854 | -11.2886 | | 252.854 | 11.2886 |
| 0.234782 | -243064 | -11.7391 | | 243.064 | 11.7391 |
| 0.243792 | -233547 | -12.1896 | | 233.547 | 12.1896 |
| 0.252802 | -224259 | -12.6401 | | 224.259 | 12.6401 |
| 0.261812 | -215190 | -13.0906 | | 215.19 | 13.0906 |
| 0.270822 | -206338 | -13.5411 | | 206.338 | 13.5411 |
| 0.279833 | -197650 | -13.9916 | | 197.65 | 13.9916 |
| 0.288843 | -189132 | -14.4421 | | 189.132 | 14.4421 |
| 0.297853 | -180848 | -14.8926 | | 180.848 | 14.8926 |
| 0.306863 | -172764 | -15.3432 | | 172.764 | 15.3432 |
| 0.315873 | -164882 | -15.7937 | | 164.882 | 15.7937 |
| 0.324883 | -157299 | -16.2442 | | 157.299 | 16.2442 |
| 0.333894 | -149943 | -16.6947 | | 149.943 | 16.6947 |
| 0.342904 | -142664 | -17.1452 | | 142.664 | 17.1452 |
| 0.345156 | -148562 | -17.2578 | | 148.562 | 17.2578 |
| 0.347409 | -145648 | -17.3704 | | 145.648 | 17.3704 |
| 0.349661 | -144289 | -17.4831 | | 144.289 | 17.4831 |
| 0.351914 | -142657 | -17.5957 | | 142.657 | 17.5957 |
| 0.355293 | -138702 | -17.7646 | | 138.702 | 17.7646 |
| 0.355504 | -139467 | -17.7752 | | 139.467 | 17.7752 |
| 0.355715 | -139375 | -17.7858 | | 139.375 | 17.7858 |
| 0.355926 | -139584 | -17.7963 | | 139.584 | 17.7963 |
| 0.356243 | -139496 | -17.8122 | | 139.496 | 17.8122 |
| 0.356718 | -139479 | -17.8359 | | 139.479 | 17.8359 |
| 0.357431 | -139355 | -17.8715 | | 139.355 | 17.8715 |
| 0.3585 | -139047 | -17.925 | | 139.047 | 17.925 |
| 0.358567 | -139578 | -17.9283 | | 139.578 | 17.9283 |
| 0.358634 | -140018 | -17.9317 | | 140.018 | 17.9317 |
| 0.3587 | -140360 | -17.935 | | 140.36 | 17.935 |
| 0.358767 | -140619 | -17.9384 | | 140.619 | 17.9384 |
| 0.358867 | -140579 | -17.9434 | | 140.579 | 17.9434 |
| 0.359018 | -140620 | -17.9509 | | 140.62 | 17.9509 |
| 0.359243 | -140521 | -17.9622 | | 140.521 | 17.9622 |
| 0.359257 | -140608 | -17.9629 | | 140.608 | 17.9629 |
| 0.359271 | -140600 | -17.9636 | | 140.6 | 17.9636 |

# 10. MONTE CARLO SIMULATION SCRIPT

## 10.1. Simulated factor determined with shifted lognormal distribution

```
% clear all
% clc
%
num_samp=1000000;
%
cor=0.75;
fyn=235;
fun=360;
tn=8;
  bn=110;
  % d0n=60;
  %
  FUnominal=(fun*(bn-d0n));
  %
  fym=fyn*1.25;
  fum=fun*1.2;
  tm=tn*0.975;
  bm=bn*1;
  d0m=d0n*1;
  %
  fyst=fym*(5.5/100);
  fust=fum*(4.5/100);
  tst=tm*(2.5/100);
  bst=bm*(0.9/100);
  d0st=d0m*(0.5/100);
  %
  %
  ActFactorm=0.96114;
  ActFactorst=0.00548;
  %
  shifted=1.02820;
  SimFactormum=-4.8627;
  SimFactorsigmam=0.74389;
  SimFactormust=0.13814;
  SimFactorsigmast=0.10031;
  %
  % p1=0.0666;
  % p2=1.0177;
  % SimFactorst=0.00075;
  %
  fy=icdf('normal',rand(1,num_samp),fym,fyst);
  test1=sum(fy<fyn);
  fy(fy<fyn)=icdf('normal',rand(1),fym,fyst);
  fy(fy<fyn)=icdf('normal',rand(1),fym,fyst);
  test2=sum(fy<fyn);
  if test2~=0
      display("error: check fy")
  end
  %
  fu=cor*fy+sqrt(1-cor^2)*icdf('normal',rand(1,num_samp),fum,fust);
  test3=sum(fy>fu);
```

```
if test3~=0
fu(fy>fu)=cor*fy+sqrt(1-cor^2)*icdf('normal',rand(1,test3),fum,fust);
end
%
test4=sum(fy>fu);
if test4~=0
    display("error: check fu")
end
%
ActFactor=(icdf('normal',rand(1,num_samp),ActFactorm,ActFactorst));
%
b=icdf('normal',rand(1,num_samp),bm,bst);
d0=icdf('normal',rand(1,num_samp),d0m,d0st);
t=icdf('normal',rand(1,num_samp),tm,tst);
%
db=(d0./b);
%
SimFactormu=icdf('normal',rand(1,num_samp),SimFactormum,SimFactormust);
SimFactorsigma=icdf('normal',rand(1,num_samp),SimFactorsigmam,SimFactorsigmast);
SimFactor=(icdf('lognormal',rand(1,num_samp),SimFactormu,SimFactorsigma))+(shifted);
%
ModelFactor=(ActFactor.*SimFactor);
%
%
FUsim=(fu.*ModelFactor.*(b-d0));
FYsim=(fy.*b);
%
FailuresOption1=sum((FYsim>FUsim)&((FUnominal*tn)>(FUsim.*(t))));
FailuresOption2=sum((FYsim>FUsim)&((1.5*FUnominal*tn)>(FUsim.*(t))));
%
R=(FUsim./FYsim);
%
Rmean=mean(R);
Rmedian=median(R);
Rmode=mode(round(R,2));
Rst=std(R);
R<=1;
FailuresOption3=sum(ans);
```

### 10.2. Simulated factor determined with relation $d_0/b$ ratio

```
% clear all
% clc
%
num_samp=1000000;
%
cor=0.75;
fyn=235;
fun=360;
tn=8;
bn=110;
% d0n=60;
%
FUnominal=(fun*(bn-d0n));
%
fym=fyn*1.25;
fum=fun*1.2;
tm=tn*0.975;
bm=bn*1;
d0m=d0n*1;
%
fyst=fym*(5.5/100);
fust=fum*(4.5/100);
tst=tm*(2.5/100);
bst=bm*(0.9/100);
d0st=d0m*(0.5/100);
%
ActFactorm=0.96114;
ActFactorst=0.00548;
%
% SimFactormu=-0.000010119843763771;
% SimFactorst=0.000749578;
%
% shifted=0;
p1=0.0666;
p2=1.0177;
SimFactorst=0.00075;
%
fy=icdf('normal',rand(1,num_samp),fym,fyst);
test1=sum(fy<fyn);
fy(fy<fyn)=icdf('normal',rand(1),fym,fyst);
fy(fy<fyn)=icdf('normal',rand(1),fym,fyst);
test2=sum(fy<fyn);
if test2~=0
    display("error: check fy")
end
%
fu=cor*fy+sqrt(1-cor^2)*icdf('normal',rand(1,num_samp),fum,fust);
test3=sum(fy>fu);
if test3~=0
fu(fy>fu)=cor*fy+sqrt(1-cor^2)*icdf('normal',rand(1,test3),fum,fust);
end
%
```

```
test4=sum(fy>fu);
if test4~=0
    display("error: check fu")
end
%
ActFactor=(icdf('normal',rand(1,num_samp),ActFactorm,ActFactorst));
%
b=icdf('normal',rand(1,num_samp),bm,bst);
d0=icdf('normal',rand(1,num_samp),d0m,d0st);
t=icdf('normal',rand(1,num_samp),tm,tst);
%
db=(d0./b);
%
% SimFactormu=icdf('normal',rand(1,num_samp),SimFactormum,SimFactormust);
% SimFactorsigma=icdf('normal',rand(1,num_samp),SimFactorsigmam,SimFactorsigmast);
%
SimFactor=(icdf('normal',rand(1,num_samp),0,SimFactorst))+(p1*db+p2);
%
ModelFactor=(ActFactor.*SimFactor);
%
FUsim=(fu.*ModelFactor.*(b-d0));
FYsim=(fy.*b);
%
FailuresOption1=sum((FYsim>FUsim)&((FUnominal*tn)>(FUsim.*(t))));
FailuresOption2=sum((FYsim>FUsim)&((1.5*FUnominal*tn)>(FUsim.*(t))));
%
R=(FUsim./FYsim);
%
Rmean=mean(R);
Rmedian=median(R);
Rmode=mode(round(R,2));
Rst=std(R);
R<=1;
FailuresOption3=sum(ans);
```

## 11. LOOP SCRIPT FOR MONTE CARLO SIMULATION

```
clear all
clc
%
    Totaal_d0n=[];
    Totaal_bn=[];
    Totaal_fyn=[];
    Totaal_fun=[];
    Totaal_cor=[];
    Totaal_num_samp=[];
%
    Totaal_FUnominal=[];
    Totaal_FailuresOption1=[];
    Totaal_FailuresOption2=[];
    Totaal_FailuresOption3=[];
%
    Totaal_Rmean=[];
    Totaal_Rmode=[];
    Totaal_Rmedian=[];
    Totaal_Rst=[];
%
for d0n = 46:0.1:47;
% for d0n = 37.1:0.1:37.9;
    run('S235t16lognormal')
    %
    %
    Totaal_d0n=[Totaal_d0n,d0n];
    Totaal_bn=[Totaal_bn,bn];
    Totaal_fyn=[Totaal_fyn,fyn];
    Totaal_fun=[Totaal_fun,fun];
    Totaal_cor=[Totaal_cor,cor];
    Totaal_num_samp=[Totaal_num_samp,num_samp];
    %
    Totaal_FUnominal=[Totaal_FUnominal,FUnominal];
    Totaal_FailuresOption1=[Totaal_FailuresOption1,FailuresOption1];
    Totaal_FailuresOption2=[Totaal_FailuresOption2,FailuresOption2];
    Totaal_FailuresOption3=[Totaal_FailuresOption3,FailuresOption3];
    %
    Totaal_Rmean=[Totaal_Rmean,Rmean];
    Totaal_Rmode=[Totaal_Rmode,Rmode];
    Totaal_Rmedian=[Totaal_Rmedian,Rmedian];
    Totaal_Rst=[Totaal_Rst,Rst];
   %
end
%
%
    Totaal_d0n=Totaal_d0n';
    Totaal_bn=Totaal_bn';
    Totaal_fyn=Totaal_fyn';
    Totaal_fun=Totaal_fun';
    Totaal_cor=Totaal_cor';
    Totaal_num_samp=Totaal_num_samp';
%
    Totaal_FUnominal=Totaal_FUnominal';
    Totaal_FailuresOption1=Totaal_FailuresOption1';
    Totaal_FailuresOption2=Totaal_FailuresOption2';
    Totaal_FailuresOption3=Totaal_FailuresOption3';
%
    Totaal_Rmean=Totaal_Rmean';
    Totaal_Rmode=Totaal_Rmode';
    Totaal_Rmedian=Totaal_Rmedian';
    Totaal_Rst=Totaal_Rst';
%
%
Totaaltabel=[Totaal_d0n,Totaal_bn,Totaal_fyn,Totaal_fun,Totaal_cor,Totaal_num_samp,Totaal_FUnominal,Totaal_FailuresOption1,Totaal_FailuresOption2,Totaal_FailuresOption3,Totaal_Rmean,Totaal_Rmode,Totaal_Rmedian,Totaal_Rst];
```

```
%
%
save('voorbeeld_totaaltabel', 'Totaaltabel')
clear all
load('voorbeeld_totaaltabel')
```

# 12. MONTE CARLO SIMULATION RESULTS

## 12.1. Simulated factor determined with shifted lognormal distribution

| | | | | | | | | Failure option 1 | | | Failure option 2 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 291 | 1,183 | unity <1 | Ym | | unity <1 | Ym | |
| | d0n | bn | fyn | fun | num_samp | FailuresOption1 | FailuresOption2 | | | | | | |
| | | | | | | | | | | | | | |
| | | | | | | | | | 0.8 | | | 1.003 | |
| S235 t16 Shifted Lognormal Distribution | 25.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.844771 | 0.675817 | correct | 0.845 | 0.847 | correct |
| | 26.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.854828 | 0.683862 | correct | 0.855 | 0.857 | correct |
| | 27.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.865127 | 0.692102 | correct | 0.865 | 0.868 | correct |
| | 28.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.875678 | 0.700542 | correct | 0.876 | 0.878 | correct |
| | 29.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.886488 | 0.709191 | correct | 0.886 | 0.889 | correct |
| | 30.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.897569 | 0.718056 | correct | 0.898 | 0.900 | correct |
| | 31.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.908931 | 0.727145 | correct | 0.909 | 0.912 | correct |
| | 32.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.920584 | 0.736467 | correct | 0.921 | 0.923 | correct |
| | 33.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.93254 | 0.746032 | correct | 0.933 | 0.935 | correct |
| | 34.0 | 110 | 235 | 360 | 1,000,000 | 0 | 5 | 0.94481 | 0.755848 | correct | 0.945 | 0.948 | correct |
| | 35.0 | 110 | 235 | 360 | 1,000,000 | 0 | 20 | 0.957407 | 0.765926 | correct | 0.957 | 0.960 | correct |
| | 36.0 | 110 | 235 | 360 | 1,000,000 | 0 | 87 | 0.970345 | 0.776276 | correct | 0.970 | 0.973 | correct |
| | 37.0 | 110 | 235 | 360 | 1,000,000 | 0 | 334 | 0.983638 | 0.78691 | correct | 0.984 | 0.987 | correct |
| | 37.1 | 110 | 235 | 360 | 1,000,000 | 0 | 427 | 0.984987 | 0.78799 | correct | 0.985 | 0.988 | correct |
| | 37.2 | 110 | 235 | 360 | 1,000,000 | 0 | 471 | 0.98634 | 0.789072 | correct | 0.986 | 0.989 | correct |
| | 37.3 | 110 | 235 | 360 | 1,000,000 | 0 | 548 | 0.987697 | 0.790157 | correct | 0.988 | 0.991 | correct |
| | 37.4 | 110 | 235 | 360 | 1,000,000 | 0 | 567 | 0.989057 | 0.791246 | correct | 0.989 | 0.992 | correct |
| | 37.5 | 110 | 235 | 360 | 1,000,000 | 0 | 733 | 0.990421 | 0.792337 | correct | 0.990 | 0.993 | correct |
| | 37.6 | 110 | 235 | 360 | 1,000,000 | 0 | 793 | 0.991789 | 0.793432 | correct | 0.992 | 0.995 | correct |
| | 37.7 | 110 | 235 | 360 | 1,000,000 | 0 | 880 | 0.993161 | 0.794529 | correct | 0.993 | 0.996 | correct |
| | 37.8 | 110 | 235 | 360 | 1,000,000 | 0 | 1,051 | 0.994537 | 0.795629 | correct | 0.995 | 0.998 | correct |
| | 37.9 | 110 | 235 | 360 | 1,000,000 | 0 | 1,159 | 0.995916 | 0.796733 | correct | 0.996 | 0.999 | correct |
| | 38.0 | 110 | 235 | 360 | 1,000,000 | 0 | 1,270 | 0.997299 | 0.79784 | correct | 0.997 | 1.000 | correct |
| | 39.0 | 110 | 235 | 360 | 1,000,000 | 0 | 4,316 | 1.011346 | 0.809077 | correct | 1.011 | 1.014 | correct |
| | 40.0 | 110 | 235 | 360 | 1,000,000 | 0 | 11,869 | 1.025794 | 0.820635 | correct | 1.026 | 1.029 | correct |
| | 41.0 | 110 | 235 | 360 | 1,000,000 | 0 | 30,083 | 1.04066 | 0.832528 | correct | 1.041 | 1.044 | correct |
| | 42.0 | 110 | 235 | 360 | 1,000,000 | 0 | 65,414 | 1.055964 | 0.844771 | correct | 1.056 | 1.059 | correct |
| | 43.0 | 110 | 235 | 360 | 1,000,000 | 0 | 127,640 | 1.071725 | 0.85738 | correct | 1.072 | 1.075 | correct |
| | 44.0 | 110 | 235 | 360 | 1,000,000 | 0 | 221,534 | 1.087963 | 0.87037 | correct | 1.088 | 1.091 | correct |
| | 45.0 | 110 | 235 | 360 | 1,000,000 | 0 | 346,171 | 1.104701 | 0.883761 | correct | 1.105 | 1.108 | correct |
| | 46.0 | 110 | 235 | 360 | 1,000,000 | 0 | 488,603 | 1.121962 | 0.897569 | correct | 1.122 | 1.125 | correct |
| | 47.0 | 110 | 235 | 360 | 1,000,000 | 0 | 629,034 | 1.139771 | 0.911817 | correct | 1.140 | 1.143 | correct |
| | 48.0 | 110 | 235 | 360 | 1,000,000 | 0 | 752,879 | 1.158154 | 0.926523 | correct | 1.158 | 1.162 | correct |
| | 49.0 | 110 | 235 | 360 | 1,000,000 | 0 | 845,576 | 1.17714 | 0.941712 | correct | 1.177 | 1.181 | correct |
| | 50.0 | 110 | 235 | 360 | 1,000,000 | 0 | 907,536 | 1.196759 | 0.957407 | correct | 1.197 | 1.200 | correct |
| | 51.0 | 110 | 235 | 360 | 1,000,000 | 0 | 943,194 | 1.217043 | 0.973635 | correct | 1.217 | 1.221 | correct |
| | 52.0 | 110 | 235 | 360 | 1,000,000 | 0 | 961,735 | 1.238027 | 0.990421 | correct | 1.238 | 1.242 | correct |
| | 53.0 | 110 | 235 | 360 | 1,000,000 | 0 | 970,164 | 1.259747 | 1.007797 | wrong | 1.260 | 1.264 | correct |
| | 54.0 | 110 | 235 | 360 | 1,000,000 | 0 | 973,004 | 1.282242 | 1.025794 | wrong | 1.282 | 1.286 | correct |
| | 55.0 | 110 | 235 | 360 | 1,000,000 | 0 | 974,028 | 1.305556 | 1.044444 | wrong | 1.306 | 1.309 | correct |
| | 56.0 | 110 | 235 | 360 | 1,000,000 | 0 | 974,460 | 1.329733 | 1.063786 | wrong | 1.330 | 1.334 | correct |
| | 57.0 | 110 | 235 | 360 | 1,000,000 | 0 | 973,651 | 1.354822 | 1.083857 | wrong | 1.355 | 1.359 | correct |
| | 58.0 | 110 | 235 | 360 | 1,000,000 | 0 | 973,522 | 1.380876 | 1.104701 | wrong | 1.381 | 1.385 | correct |
| | 59.0 | 110 | 235 | 360 | 1,000,000 | 0 | 973,028 | 1.407952 | 1.126362 | wrong | 1.408 | 1.412 | correct |
| | 60.0 | 110 | 235 | 360 | 1,000,000 | 0 | 972,576 | 1.436111 | 1.148889 | wrong | 1.436 | 1.440 | correct |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 0.8 | | | | 1.025 | |
| S235 t40 Shifted Lognormal Distribution | 25.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.808824 | 0.647059 | correct | | 0.809 | 0.829 | correct |
| | 26.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.818452 | 0.654762 | correct | | 0.818 | 0.839 | correct |
| | 27.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.828313 | 0.662651 | correct | | 0.828 | 0.849 | correct |
| | 28.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.838415 | 0.670732 | correct | | 0.838 | 0.859 | correct |
| | 29.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.848765 | 0.679012 | correct | | 0.849 | 0.870 | correct |
| | 30.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.859375 | 0.6875 | correct | | 0.859 | 0.881 | correct |
| | 31.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.870253 | 0.696203 | correct | | 0.870 | 0.892 | correct |
| | 32.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.88141 | 0.705128 | correct | | 0.881 | 0.903 | correct |
| | 33.0 | 110 | 225 | 360 | 1,000,000 | 0 | 1 | | 0.892857 | 0.714286 | correct | | 0.893 | 0.915 | correct |
| | 34.0 | 110 | 225 | 360 | 1,000,000 | 0 | 1 | | 0.904605 | 0.723684 | correct | | 0.905 | 0.927 | correct |
| | 35.0 | 110 | 225 | 360 | 1,000,000 | 0 | 2 | | 0.916667 | 0.733333 | correct | | 0.917 | 0.940 | correct |
| | 36.0 | 110 | 225 | 360 | 1,000,000 | 0 | 7 | | 0.929054 | 0.743243 | correct | | 0.929 | 0.952 | correct |
| | 37.0 | 110 | 225 | 360 | 1,000,000 | 0 | 37 | | 0.941781 | 0.753425 | correct | | 0.942 | 0.965 | correct |
| | 38.0 | 110 | 225 | 360 | 1,000,000 | 0 | 159 | | 0.954861 | 0.763889 | correct | | 0.955 | 0.979 | correct |
| | 39.0 | 110 | 225 | 360 | 1,000,000 | 0 | 601 | | 0.96831 | 0.774648 | correct | | 0.968 | 0.993 | correct |
| | 39.1 | 110 | 225 | 360 | 1,000,000 | 0 | 764 | | 0.969676 | 0.77574 | correct | | 0.970 | 0.994 | correct |
| | 39.2 | 110 | 225 | 360 | 1,000,000 | 0 | 771 | | 0.971045 | 0.776836 | correct | | 0.971 | 0.995 | correct |
| | 39.3 | 110 | 225 | 360 | 1,000,000 | 0 | 901 | | 0.972419 | 0.777935 | correct | | 0.972 | 0.997 | correct |
| | 39.4 | 110 | 225 | 360 | 1,000,000 | 0 | 1,008 | | 0.973796 | 0.779037 | correct | | 0.974 | 0.998 | correct |
| | 39.5 | 110 | 225 | 360 | 1,000,000 | 0 | 1,143 | | 0.975177 | 0.780142 | correct | | 0.975 | 1.000 | correct |
| | 39.6 | 110 | 225 | 360 | 1,000,000 | 0 | 1,215 | | 0.976563 | 0.78125 | correct | | 0.977 | 1.001 | correct |
| | 39.7 | 110 | 225 | 360 | 1,000,000 | 0 | 1,452 | | 0.977952 | 0.782361 | correct | | 0.978 | 1.002 | correct |
| | 39.8 | 110 | 225 | 360 | 1,000,000 | 0 | 1,644 | | 0.979345 | 0.783476 | correct | | 0.979 | 1.004 | correct |
| | 39.9 | 110 | 225 | 360 | 1,000,000 | 0 | 1,967 | | 0.980742 | 0.784593 | correct | | 0.981 | 1.005 | correct |
| | 40.0 | 110 | 225 | 360 | 1,000,000 | 0 | 2,169 | | 0.982143 | 0.785714 | correct | | 0.982 | 1.007 | correct |
| | 41.0 | 110 | 225 | 360 | 1,000,000 | 0 | 6,611 | | 0.996377 | 0.797101 | correct | | 0.996 | 1.021 | correct |
| | 42.0 | 110 | 225 | 360 | 1,000,000 | 0 | 17,785 | | 1.011029 | 0.808824 | correct | | 1.011 | 1.036 | correct |
| | 43.0 | 110 | 225 | 360 | 1,000,000 | 0 | 42,390 | | 1.026119 | 0.820896 | correct | | 1.026 | 1.052 | correct |
| | 44.0 | 110 | 225 | 360 | 1,000,000 | 0 | 89,193 | | 1.041667 | 0.833333 | correct | | 1.042 | 1.068 | correct |
| | 45.0 | 110 | 225 | 360 | 1,000,000 | 0 | 165,033 | | 1.057692 | 0.846154 | correct | | 1.058 | 1.084 | correct |
| | 46.0 | 110 | 225 | 360 | 1,000,000 | 0 | 274,950 | | 1.074219 | 0.859375 | correct | | 1.074 | 1.101 | correct |
| | 47.0 | 110 | 225 | 360 | 1,000,000 | 0 | 411,813 | | 1.09127 | 0.873016 | correct | | 1.091 | 1.119 | correct |
| | 48.0 | 110 | 225 | 360 | 1,000,000 | 0 | 558,665 | | 1.108871 | 0.887097 | correct | | 1.109 | 1.137 | correct |
| | 49.0 | 110 | 225 | 360 | 1,000,000 | 0 | 696,051 | | 1.127049 | 0.901639 | correct | | 1.127 | 1.155 | correct |
| | 50.0 | 110 | 225 | 360 | 1,000,000 | 0 | 809,563 | | 1.145833 | 0.916667 | correct | | 1.146 | 1.174 | correct |
| | 51.0 | 110 | 225 | 360 | 1,000,000 | 0 | 890,129 | | 1.165254 | 0.932203 | correct | | 1.165 | 1.194 | correct |
| | 52.0 | 110 | 225 | 360 | 1,000,000 | 0 | 941,422 | | 1.185345 | 0.948276 | correct | | 1.185 | 1.215 | correct |
| | 53.0 | 110 | 225 | 360 | 1,000,000 | 0 | 968,791 | | 1.20614 | 0.964912 | correct | | 1.206 | 1.236 | correct |
| | 54.0 | 110 | 225 | 360 | 1,000,000 | 0 | 981,841 | | 1.227679 | 0.982143 | correct | | 1.228 | 1.258 | correct |
| | 55.0 | 110 | 225 | 360 | 1,000,000 | 0 | 987,702 | | 1.25 | 1 | correct | | 1.250 | 1.281 | correct |
| | 56.0 | 110 | 225 | 360 | 1,000,000 | 0 | 989,234 | | 1.273148 | 1.018519 | wrong | | 1.273 | 1.305 | correct |
| | 57.0 | 110 | 225 | 360 | 1,000,000 | 0 | 989,942 | | 1.29717 | 1.037736 | wrong | | 1.297 | 1.330 | correct |
| | 58.0 | 110 | 225 | 360 | 1,000,000 | 0 | 989,960 | | 1.322115 | 1.057692 | wrong | | 1.322 | 1.355 | correct |
| | 59.0 | 110 | 225 | 360 | 1,000,000 | 0 | 989,638 | | 1.348039 | 1.078431 | wrong | | 1.348 | 1.382 | correct |
| | 60.0 | 110 | 225 | 360 | 1,000,000 | 0 | 989,589 | | 1.375 | 1.1 | wrong | | 1.375 | 1.409 | correct |

| | | | | | | | | | | 0.8 | | | | 1.000 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S235 t63 Shifted Lognormal Distribution** | 25.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.772876 | 0.618301 | correct | | 0.773 | 0.773 | correct |
| | 26.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.782077 | 0.625661 | correct | | 0.782 | 0.782 | correct |
| | 27.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.791499 | 0.633199 | correct | | 0.791 | 0.791 | correct |
| | 28.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.801152 | 0.640921 | correct | | 0.801 | 0.801 | correct |
| | 29.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.811043 | 0.648834 | correct | | 0.811 | 0.811 | correct |
| | 30.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.821181 | 0.656944 | correct | | 0.821 | 0.821 | correct |
| | 31.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.831575 | 0.66526 | correct | | 0.832 | 0.832 | correct |
| | 32.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.842236 | 0.673789 | correct | | 0.842 | 0.842 | correct |
| | 33.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.853175 | 0.68254 | correct | | 0.853 | 0.853 | correct |
| | 34.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.864401 | 0.69152 | correct | | 0.864 | 0.864 | correct |
| | 35.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.875926 | 0.700741 | correct | | 0.876 | 0.876 | correct |
| | 36.0 | 110 | 215 | 360 | 1,000,000 | 0 | 1 | | 0.887763 | 0.71021 | correct | | 0.888 | 0.888 | correct |
| | 37.0 | 110 | 215 | 360 | 1,000,000 | 0 | 3 | | 0.899924 | 0.719939 | correct | | 0.900 | 0.900 | correct |
| | 38.0 | 110 | 215 | 360 | 1,000,000 | 0 | 17 | | 0.912423 | 0.729938 | correct | | 0.912 | 0.912 | correct |
| | 39.0 | 110 | 215 | 360 | 1,000,000 | 0 | 48 | | 0.925274 | 0.740219 | correct | | 0.925 | 0.925 | correct |
| | 40.0 | 110 | 215 | 360 | 1,000,000 | 0 | 270 | | 0.938492 | 0.750794 | correct | | 0.938 | 0.938 | correct |
| | 41.0 | 110 | 215 | 360 | 1,000,000 | 0 | 961 | | 0.952093 | 0.761675 | correct | | 0.952 | 0.952 | correct |
| | 41.1 | 110 | 215 | 360 | 1,000,000 | 0 | 1,044 | | 0.953475 | 0.76278 | correct | | 0.953 | 0.953 | correct |
| | 41.2 | 110 | 215 | 360 | 1,000,000 | 0 | 1,242 | | 0.954861 | 0.763889 | correct | | 0.955 | 0.955 | wrong |
| | 41.3 | 110 | 215 | 360 | 1,000,000 | 0 | 1,437 | | 0.956251 | 0.765001 | correct | | 0.956 | 0.956 | wrong |
| | 41.4 | 110 | 215 | 360 | 1,000,000 | 0 | 1,602 | | 0.957645 | 0.766116 | correct | | 0.958 | 0.958 | wrong |
| | 41.5 | 110 | 215 | 360 | 1,000,000 | 0 | 1,768 | | 0.959043 | 0.767234 | correct | | 0.959 | 0.959 | wrong |
| | 41.6 | 110 | 215 | 360 | 1,000,000 | 0 | 2,051 | | 0.960445 | 0.768356 | correct | | 0.960 | 0.960 | wrong |
| | 41.7 | 110 | 215 | 360 | 1,000,000 | 0 | 2,234 | | 0.961851 | 0.769481 | correct | | 0.962 | 0.962 | wrong |
| | 41.8 | 110 | 215 | 360 | 1,000,000 | 0 | 2,500 | | 0.963262 | 0.770609 | correct | | 0.963 | 0.963 | wrong |
| | 41.9 | 110 | 215 | 360 | 1,000,000 | 0 | 3,002 | | 0.964676 | 0.771741 | correct | | 0.965 | 0.965 | wrong |
| | 42.0 | 110 | 215 | 360 | 1,000,000 | 0 | 3,247 | | 0.966095 | 0.772876 | correct | | 0.966 | 0.966 | wrong |
| | 43.0 | 110 | 215 | 360 | 1,000,000 | 0 | 9,530 | | 0.980514 | 0.784411 | correct | | 0.981 | 0.981 | wrong |
| | 44.0 | 110 | 215 | 360 | 1,000,000 | 0 | 24,371 | | 0.99537 | 0.796296 | correct | | 0.995 | 0.995 | wrong |
| | 45.0 | 110 | 215 | 360 | 1,000,000 | 0 | 55,402 | | 1.010684 | 0.808547 | correct | | 1.011 | 1.011 | correct |
| | 46.0 | 110 | 215 | 360 | 1,000,000 | 0 | 112,792 | | 1.026476 | 0.821181 | correct | | 1.026 | 1.026 | correct |
| | 47.0 | 110 | 215 | 360 | 1,000,000 | 0 | 202,300 | | 1.042769 | 0.834215 | correct | | 1.043 | 1.043 | correct |
| | 48.0 | 110 | 215 | 360 | 1,000,000 | 0 | 323,769 | | 1.059588 | 0.84767 | correct | | 1.060 | 1.060 | correct |
| | 49.0 | 110 | 215 | 360 | 1,000,000 | 0 | 467,973 | | 1.076958 | 0.861566 | correct | | 1.077 | 1.077 | correct |
| | 50.0 | 110 | 215 | 360 | 1,000,000 | 0 | 615,976 | | 1.094907 | 0.875926 | correct | | 1.095 | 1.095 | correct |
| | 51.0 | 110 | 215 | 360 | 1,000,000 | 0 | 748,081 | | 1.113465 | 0.890772 | correct | | 1.113 | 1.113 | correct |
| | 52.0 | 110 | 215 | 360 | 1,000,000 | 0 | 849,816 | | 1.132663 | 0.90613 | correct | | 1.133 | 1.133 | correct |
| | 53.0 | 110 | 215 | 360 | 1,000,000 | 0 | 919,667 | | 1.152534 | 0.922027 | correct | | 1.153 | 1.153 | correct |
| | 54.0 | 110 | 215 | 360 | 1,000,000 | 0 | 960,249 | | 1.173115 | 0.938492 | correct | | 1.173 | 1.173 | correct |
| | 55.0 | 110 | 215 | 360 | 1,000,000 | 0 | 981,609 | | 1.194444 | 0.955556 | correct | | 1.194 | 1.194 | correct |
| | 56.0 | 110 | 215 | 360 | 1,000,000 | 0 | 990,951 | | 1.216564 | 0.973251 | correct | | 1.217 | 1.217 | correct |
| | 57.0 | 110 | 215 | 360 | 1,000,000 | 0 | 994,745 | | 1.239518 | 0.991614 | correct | | 1.240 | 1.240 | correct |
| | 58.0 | 110 | 215 | 360 | 1,000,000 | 0 | 996,091 | | 1.263355 | 1.010684 | wrong | | 1.263 | 1.263 | correct |
| | 59.0 | 110 | 215 | 360 | 1,000,000 | 0 | 996,501 | | 1.288126 | 1.030501 | wrong | | 1.288 | 1.288 | correct |
| | 60.0 | 110 | 215 | 360 | 1,000,000 | 0 | 996,407 | | 1.313889 | 1.051111 | wrong | | 1.314 | 1.314 | correct |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 0.7 | | | | 0.972 | |
| **S355 t16 Shifted Lognormal Distribution** | 15.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.87458 | 0.612206 | correct | | 0.875 | 0.850 | correct |
| | 16.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.883884 | 0.618719 | correct | | 0.884 | 0.859 | correct |
| | 17.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.893388 | 0.625372 | correct | | 0.893 | 0.868 | correct |
| | 18.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.903099 | 0.632169 | correct | | 0.903 | 0.878 | correct |
| | 19.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.913023 | 0.639116 | correct | | 0.913 | 0.887 | correct |
| | 20.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.923168 | 0.646217 | correct | | 0.923 | 0.897 | correct |
| | 21.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.933541 | 0.653478 | correct | | 0.934 | 0.907 | correct |
| | 22.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.944149 | 0.660904 | correct | | 0.944 | 0.918 | correct |
| | 23.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.955001 | 0.668501 | correct | | 0.955 | 0.928 | correct |
| | 24.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.966106 | 0.676274 | correct | | 0.966 | 0.939 | correct |
| | 25.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | | 0.977472 | 0.68423 | correct | | 0.977 | 0.950 | correct |
| | 26.0 | 110 | 355 | 470 | 1,000,000 | 0 | 4 | | 0.989108 | 0.692376 | correct | | 0.989 | 0.961 | correct |
| | 27.0 | 110 | 355 | 470 | 1,000,000 | 0 | 25 | | 1.001025 | 0.700718 | correct | | 1.001 | 0.973 | correct |
| | 28.0 | 110 | 355 | 470 | 1,000,000 | 0 | 142 | | 1.013233 | 0.709263 | correct | | 1.013 | 0.985 | correct |
| | 29.0 | 110 | 355 | 470 | 1,000,000 | 0 | 868 | | 1.025742 | 0.718019 | correct | | 1.026 | 0.997 | correct |
| | 29.1 | 110 | 355 | 470 | 1,000,000 | 0 | 956 | | 1.02701 | 0.718907 | correct | | 1.027 | 0.998 | correct |
| | 29.2 | 110 | 355 | 470 | 1,000,000 | 0 | 1,081 | | 1.028281 | 0.719797 | correct | | 1.028 | 0.999 | correct |
| | 29.3 | 110 | 355 | 470 | 1,000,000 | 0 | 1,330 | | 1.029555 | 0.720689 | correct | | 1.030 | 1.001 | correct |
| | 29.4 | 110 | 355 | 470 | 1,000,000 | 0 | 1,532 | | 1.030833 | 0.721583 | correct | | 1.031 | 1.002 | correct |
| | 29.5 | 110 | 355 | 470 | 1,000,000 | 0 | 1,762 | | 1.032113 | 0.722479 | correct | | 1.032 | 1.003 | correct |
| | 29.6 | 110 | 355 | 470 | 1,000,000 | 0 | 2,035 | | 1.033397 | 0.723378 | correct | | 1.033 | 1.004 | correct |
| | 29.7 | 110 | 355 | 470 | 1,000,000 | 0 | 2,361 | | 1.034684 | 0.724279 | correct | | 1.035 | 1.006 | correct |
| | 29.8 | 110 | 355 | 470 | 1,000,000 | 0 | 2,650 | | 1.035974 | 0.725182 | correct | | 1.036 | 1.007 | correct |
| | 29.9 | 110 | 355 | 470 | 1,000,000 | 0 | 3,042 | | 1.037267 | 0.726087 | correct | | 1.037 | 1.008 | correct |
| | 30.0 | 110 | 355 | 470 | 1,000,000 | 0 | 3,554 | | 1.038564 | 0.726995 | correct | | 1.039 | 1.009 | correct |
| | 31.0 | 110 | 355 | 470 | 1,000,000 | 0 | 12,007 | | 1.05171 | 0.736197 | correct | | 1.052 | 1.022 | correct |
| | 32.0 | 110 | 355 | 470 | 1,000,000 | 0 | 34,212 | | 1.065194 | 0.745636 | correct | | 1.065 | 1.035 | correct |
| | 33.0 | 110 | 355 | 470 | 1,000,000 | 0 | 82,654 | | 1.079027 | 0.755319 | correct | | 1.079 | 1.049 | correct |
| | 34.0 | 110 | 355 | 470 | 1,000,000 | 0 | 168,811 | | 1.093225 | 0.765258 | correct | | 1.093 | 1.063 | correct |
| | 35.0 | 110 | 355 | 470 | 1,000,000 | 0 | 298,311 | | 1.107801 | 0.775461 | correct | | 1.108 | 1.077 | correct |
| | 36.0 | 110 | 355 | 470 | 1,000,000 | 0 | 455,632 | | 1.122772 | 0.78594 | correct | | 1.123 | 1.091 | correct |
| | 37.0 | 110 | 355 | 470 | 1,000,000 | 0 | 620,226 | | 1.138152 | 0.796706 | correct | | 1.138 | 1.106 | correct |
| | 38.0 | 110 | 355 | 470 | 1,000,000 | 0 | 764,811 | | 1.15396 | 0.807772 | correct | | 1.154 | 1.122 | correct |
| | 39.0 | 110 | 355 | 470 | 1,000,000 | 0 | 870,086 | | 1.170213 | 0.819149 | correct | | 1.170 | 1.137 | correct |
| | 40.0 | 110 | 355 | 470 | 1,000,000 | 0 | 937,221 | | 1.18693 | 0.830851 | correct | | 1.187 | 1.154 | correct |
| | 41.0 | 110 | 355 | 470 | 1,000,000 | 0 | 973,002 | | 1.204132 | 0.842892 | correct | | 1.204 | 1.170 | correct |
| | 42.0 | 110 | 355 | 470 | 1,000,000 | 0 | 989,477 | | 1.22184 | 0.855288 | correct | | 1.222 | 1.188 | correct |
| | 43.0 | 110 | 355 | 470 | 1,000,000 | 0 | 995,888 | | 1.240076 | 0.868053 | correct | | 1.240 | 1.205 | correct |
| | 44.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998,149 | | 1.258865 | 0.881206 | correct | | 1.259 | 1.224 | correct |
| | 45.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998,786 | | 1.278232 | 0.894763 | correct | | 1.278 | 1.242 | correct |
| | 46.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998,979 | | 1.298205 | 0.908743 | correct | | 1.298 | 1.262 | correct |
| | 47.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998,896 | | 1.318811 | 0.923168 | correct | | 1.319 | 1.282 | correct |
| | 48.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998,903 | | 1.340082 | 0.938058 | correct | | 1.340 | 1.303 | correct |
| | 49.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998,925 | | 1.362051 | 0.953436 | correct | | 1.362 | 1.324 | correct |
| | 50.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998,884 | | 1.384752 | 0.969326 | correct | | 1.385 | 1.346 | correct |

| | | | | | | | | | | 0.7 | | | | 0.986 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S355 t40 Shifted Lognormal Distribution** | 15.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.849944 | 0.594961 | correct | | 0.850 | 0.838 | correct |
| | 16.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.858986 | 0.60129 | correct | | 0.859 | 0.847 | correct |
| | 17.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.868222 | 0.607756 | correct | | 0.868 | 0.856 | correct |
| | 18.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.87766 | 0.614362 | correct | | 0.878 | 0.865 | correct |
| | 19.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.887304 | 0.621113 | correct | | 0.887 | 0.875 | correct |
| | 20.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.897163 | 0.628014 | correct | | 0.897 | 0.885 | correct |
| | 21.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.907244 | 0.635071 | correct | | 0.907 | 0.895 | correct |
| | 22.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.917553 | 0.642287 | correct | | 0.918 | 0.905 | correct |
| | 23.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.9281 | 0.64967 | correct | | 0.928 | 0.915 | correct |
| | 24.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.938892 | 0.657224 | correct | | 0.939 | 0.926 | correct |
| | 25.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.949937 | 0.664956 | correct | | 0.950 | 0.937 | correct |
| | 26.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | | 0.961246 | 0.672872 | correct | | 0.961 | 0.948 | correct |
| | 27.0 | 110 | 345 | 470 | 1,000,000 | 0 | 2 | | 0.972827 | 0.680979 | correct | | 0.973 | 0.959 | correct |
| | 28.0 | 110 | 345 | 470 | 1,000,000 | 0 | 35 | | 0.984691 | 0.689284 | correct | | 0.985 | 0.971 | correct |
| | 29.0 | 110 | 345 | 470 | 1,000,000 | 0 | 132 | | 0.996848 | 0.697794 | correct | | 0.997 | 0.983 | correct |
| | 30.0 | 110 | 345 | 470 | 1,000,000 | 0 | 694 | | 1.009309 | 0.706516 | correct | | 1.009 | 0.995 | correct |
| | 30.1 | 110 | 345 | 470 | 1,000,000 | 0 | 861 | | 1.010572 | 0.7074 | correct | | 1.011 | 0.996 | correct |
| | 30.2 | 110 | 345 | 470 | 1,000,000 | 0 | 996 | | 1.011838 | 0.708287 | correct | | 1.012 | 0.998 | correct |
| | 30.3 | 110 | 345 | 470 | 1,000,000 | 0 | 1,161 | | 1.013108 | 0.709175 | correct | | 1.013 | 0.999 | correct |
| | 30.4 | 110 | 345 | 470 | 1,000,000 | 0 | 1,345 | | 1.01438 | 0.710066 | correct | | 1.014 | 1.000 | correct |
| | 30.5 | 110 | 345 | 470 | 1,000,000 | 0 | 1,536 | | 1.015656 | 0.710959 | correct | | 1.016 | 1.001 | correct |
| | 30.6 | 110 | 345 | 470 | 1,000,000 | 0 | 1,836 | | 1.016936 | 0.711855 | correct | | 1.017 | 1.003 | correct |
| | 30.7 | 110 | 345 | 470 | 1,000,000 | 0 | 2,007 | | 1.018218 | 0.712753 | correct | | 1.018 | 1.004 | correct |
| | 30.8 | 110 | 345 | 470 | 1,000,000 | 0 | 2,287 | | 1.019504 | 0.713652 | correct | | 1.020 | 1.005 | correct |
| | 30.9 | 110 | 345 | 470 | 1,000,000 | 0 | 2,644 | | 1.020792 | 0.714555 | correct | | 1.021 | 1.007 | correct |
| | 31.0 | 110 | 345 | 470 | 1,000,000 | 0 | 3,073 | | 1.022085 | 0.715459 | correct | | 1.022 | 1.008 | correct |
| | 32.0 | 110 | 345 | 470 | 1,000,000 | 0 | 10,805 | | 1.035188 | 0.724632 | correct | | 1.035 | 1.021 | correct |
| | 33.0 | 110 | 345 | 470 | 1,000,000 | 0 | 31,202 | | 1.048632 | 0.734043 | correct | | 1.049 | 1.034 | correct |
| | 34.0 | 110 | 345 | 470 | 1,000,000 | 0 | 76,393 | | 1.06243 | 0.743701 | correct | | 1.062 | 1.048 | correct |
| | 35.0 | 110 | 345 | 470 | 1,000,000 | 0 | 158,882 | | 1.076596 | 0.753617 | correct | | 1.077 | 1.062 | correct |
| | 36.0 | 110 | 345 | 470 | 1,000,000 | 0 | 283,037 | | 1.091144 | 0.763801 | correct | | 1.091 | 1.076 | correct |
| | 37.0 | 110 | 345 | 470 | 1,000,000 | 0 | 439,778 | | 1.106092 | 0.774264 | correct | | 1.106 | 1.091 | correct |
| | 38.0 | 110 | 345 | 470 | 1,000,000 | 0 | 605,850 | | 1.121454 | 0.785018 | correct | | 1.121 | 1.106 | correct |
| | 39.0 | 110 | 345 | 470 | 1,000,000 | 0 | 752,638 | | 1.137249 | 0.796074 | correct | | 1.137 | 1.121 | correct |
| | 40.0 | 110 | 345 | 470 | 1,000,000 | 0 | 862,980 | | 1.153495 | 0.807447 | correct | | 1.153 | 1.137 | correct |
| | 41.0 | 110 | 345 | 470 | 1,000,000 | 0 | 933,296 | | 1.170213 | 0.819149 | correct | | 1.170 | 1.154 | correct |
| | 42.0 | 110 | 345 | 470 | 1,000,000 | 0 | 971,173 | | 1.187422 | 0.831195 | correct | | 1.187 | 1.171 | correct |
| | 43.0 | 110 | 345 | 470 | 1,000,000 | 0 | 989,140 | | 1.205144 | 0.843601 | correct | | 1.205 | 1.188 | correct |
| | 44.0 | 110 | 345 | 470 | 1,000,000 | 0 | 996,312 | | 1.223404 | 0.856383 | correct | | 1.223 | 1.206 | correct |
| | 45.0 | 110 | 345 | 470 | 1,000,000 | 0 | 998,731 | | 1.242226 | 0.869558 | correct | | 1.242 | 1.225 | correct |
| | 46.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999,420 | | 1.261636 | 0.883145 | correct | | 1.262 | 1.244 | correct |
| | 47.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999,559 | | 1.281662 | 0.897163 | correct | | 1.282 | 1.264 | correct |
| | 48.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999,587 | | 1.302334 | 0.911633 | correct | | 1.302 | 1.284 | correct |
| | 49.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999,582 | | 1.323683 | 0.926578 | correct | | 1.324 | 1.305 | correct |
| | 50.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999,568 | | 1.345745 | 0.942021 | correct | | 1.346 | 1.327 | correct |

| | | | | | | | | | | 0.7 | | | | 1.002 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S355 t63 Shifted Lognormal Distribution** | 15.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.825308 | 0.577716 | correct | | 0.825 | 0.827 | correct |
| | 16.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.834088 | 0.583861 | correct | | 0.834 | 0.836 | correct |
| | 17.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.843057 | 0.59014 | correct | | 0.843 | 0.845 | correct |
| | 18.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.85222 | 0.596554 | correct | | 0.852 | 0.854 | correct |
| | 19.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.861585 | 0.60311 | correct | | 0.862 | 0.863 | correct |
| | 20.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.871158 | 0.609811 | correct | | 0.871 | 0.873 | correct |
| | 21.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.880947 | 0.616663 | correct | | 0.881 | 0.883 | correct |
| | 22.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.890957 | 0.62367 | correct | | 0.891 | 0.893 | correct |
| | 23.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.901198 | 0.630839 | correct | | 0.901 | 0.903 | correct |
| | 24.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.911677 | 0.638174 | correct | | 0.912 | 0.914 | correct |
| | 25.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.922403 | 0.645682 | correct | | 0.922 | 0.924 | correct |
| | 26.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.933384 | 0.653369 | correct | | 0.933 | 0.935 | correct |
| | 27.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | | 0.94463 | 0.661241 | correct | | 0.945 | 0.947 | correct |
| | 28.0 | 110 | 335 | 470 | 1,000,000 | 0 | 1 | | 0.956149 | 0.669305 | correct | | 0.956 | 0.958 | correct |
| | 29.0 | 110 | 335 | 470 | 1,000,000 | 0 | 17 | | 0.967954 | 0.677568 | correct | | 0.968 | 0.970 | correct |
| | 30.0 | 110 | 335 | 470 | 1,000,000 | 0 | 113 | | 0.980053 | 0.686037 | correct | | 0.980 | 0.982 | correct |
| | 31.0 | 110 | 335 | 470 | 1,000,000 | 0 | 581 | | 0.992459 | 0.694721 | correct | | 0.992 | 0.994 | correct |
| | 31.1 | 110 | 335 | 470 | 1,000,000 | 0 | 693 | | 0.993717 | 0.695602 | correct | | 0.994 | 0.996 | correct |
| | 31.2 | 110 | 335 | 470 | 1,000,000 | 0 | 857 | | 0.994978 | 0.696485 | correct | | 0.995 | 0.997 | correct |
| | 31.3 | 110 | 335 | 470 | 1,000,000 | 0 | 959 | | 0.996242 | 0.697369 | correct | | 0.996 | 0.998 | correct |
| | 31.4 | 110 | 335 | 470 | 1,000,000 | 0 | 1,162 | | 0.99751 | 0.698257 | correct | | 0.998 | 1.000 | correct |
| | 31.5 | 110 | 335 | 470 | 1,000,000 | 0 | 1,305 | | 0.99878 | 0.699146 | correct | | 0.999 | 1.001 | correct |
| | 31.6 | 110 | 335 | 470 | 1,000,000 | 0 | 1,525 | | 1.000054 | 0.700038 | correct | | 1.000 | 1.002 | correct |
| | 31.7 | 110 | 335 | 470 | 1,000,000 | 0 | 1,702 | | 1.001331 | 0.700932 | correct | | 1.001 | 1.003 | correct |
| | 31.8 | 110 | 335 | 470 | 1,000,000 | 0 | 1,902 | | 1.002612 | 0.701828 | correct | | 1.003 | 1.005 | correct |
| | 31.9 | 110 | 335 | 470 | 1,000,000 | 0 | 2,336 | | 1.003896 | 0.702727 | correct | | 1.004 | 1.006 | correct |
| | 32.0 | 110 | 335 | 470 | 1,000,000 | 0 | 2,474 | | 1.005183 | 0.703628 | correct | | 1.005 | 1.007 | correct |
| | 33.0 | 110 | 335 | 470 | 1,000,000 | 0 | 9,229 | | 1.018237 | 0.712766 | correct | | 1.018 | 1.020 | correct |
| | 34.0 | 110 | 335 | 470 | 1,000,000 | 0 | 27,557 | | 1.031635 | 0.722144 | correct | | 1.032 | 1.034 | correct |
| | 35.0 | 110 | 335 | 470 | 1,000,000 | 0 | 68,214 | | 1.04539 | 0.731773 | correct | | 1.045 | 1.047 | correct |
| | 36.0 | 110 | 335 | 470 | 1,000,000 | 0 | 144,950 | | 1.059517 | 0.741662 | correct | | 1.060 | 1.062 | correct |
| | 37.0 | 110 | 335 | 470 | 1,000,000 | 0 | 264,457 | | 1.074031 | 0.751822 | correct | | 1.074 | 1.076 | correct |
| | 38.0 | 110 | 335 | 470 | 1,000,000 | 0 | 418,566 | | 1.088948 | 0.762264 | correct | | 1.089 | 1.091 | correct |
| | 39.0 | 110 | 335 | 470 | 1,000,000 | 0 | 586,076 | | 1.104285 | 0.773 | correct | | 1.104 | 1.106 | correct |
| | 40.0 | 110 | 335 | 470 | 1,000,000 | 0 | 735,854 | | 1.120061 | 0.784043 | correct | | 1.120 | 1.122 | correct |
| | 41.0 | 110 | 335 | 470 | 1,000,000 | 0 | 851,615 | | 1.136294 | 0.795405 | correct | | 1.136 | 1.139 | correct |
| | 42.0 | 110 | 335 | 470 | 1,000,000 | 0 | 926,813 | | 1.153004 | 0.807103 | correct | | 1.153 | 1.155 | correct |
| | 43.0 | 110 | 335 | 470 | 1,000,000 | 0 | 968,072 | | 1.170213 | 0.819149 | correct | | 1.170 | 1.173 | correct |
| | 44.0 | 110 | 335 | 470 | 1,000,000 | 0 | 987,871 | | 1.187943 | 0.83156 | correct | | 1.188 | 1.190 | correct |
| | 45.0 | 110 | 335 | 470 | 1,000,000 | 0 | 995,918 | | 1.206219 | 0.844354 | correct | | 1.206 | 1.209 | correct |
| | 46.0 | 110 | 335 | 470 | 1,000,000 | 0 | 998,797 | | 1.225066 | 0.857547 | correct | | 1.225 | 1.228 | correct |
| | 47.0 | 110 | 335 | 470 | 1,000,000 | 0 | 999,570 | | 1.244512 | 0.871158 | correct | | 1.245 | 1.247 | correct |
| | 48.0 | 110 | 335 | 470 | 1,000,000 | 0 | 999,782 | | 1.264585 | 0.885209 | correct | | 1.265 | 1.267 | correct |
| | 49.0 | 110 | 335 | 470 | 1,000,000 | 0 | 999,848 | | 1.285316 | 0.899721 | correct | | 1.285 | 1.288 | correct |
| | 50.0 | 110 | 335 | 470 | 1,000,000 | 0 | 999,848 | | 1.306738 | 0.914716 | correct | | 1.307 | 1.309 | correct |

| | | | | | | | | | | 0.7 | | | | 0.900 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S460 t16 Shifted Lognormal Distribution** | 10.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 0.937037 | 0.655926 | correct | | 0.937 | 0.843 | correct |
| | 11.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 0.946502 | 0.662551 | correct | | 0.947 | 0.852 | correct |
| | 12.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 0.95616 | 0.669312 | correct | | 0.956 | 0.861 | correct |
| | 13.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 0.966018 | 0.676212 | correct | | 0.966 | 0.869 | correct |
| | 14.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 0.97608 | 0.683256 | correct | | 0.976 | 0.878 | correct |
| | 15.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 0.986355 | 0.690448 | correct | | 0.986 | 0.888 | correct |
| | 16.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 0.996848 | 0.697794 | correct | | 0.997 | 0.897 | correct |
| | 17.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 1.007567 | 0.705297 | correct | | 1.008 | 0.907 | correct |
| | 18.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 1.018519 | 0.712963 | correct | | 1.019 | 0.917 | correct |
| | 19.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 1.029711 | 0.720798 | correct | | 1.030 | 0.927 | correct |
| | 20.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 1.041152 | 0.728807 | correct | | 1.041 | 0.937 | correct |
| | 21.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 1.052851 | 0.736995 | correct | | 1.053 | 0.948 | correct |
| | 22.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | | 1.064815 | 0.74537 | correct | | 1.065 | 0.958 | correct |
| | 23.0 | 110 | 460 | 540 | 1,000,000 | 0 | 6 | | 1.077054 | 0.753938 | correct | | 1.077 | 0.969 | correct |
| | 24.0 | 110 | 460 | 540 | 1,000,000 | 0 | 62 | | 1.089578 | 0.762705 | correct | | 1.090 | 0.981 | correct |
| | 25.0 | 110 | 460 | 540 | 1,000,000 | 0 | 388 | | 1.102397 | 0.771678 | correct | | 1.102 | 0.992 | correct |
| | 25.1 | 110 | 460 | 540 | 1,000,000 | 0 | 448 | | 1.103695 | 0.772586 | correct | | 1.104 | 0.993 | correct |
| | 25.2 | 110 | 460 | 540 | 1,000,000 | 0 | 570 | | 1.104997 | 0.773498 | correct | | 1.105 | 0.994 | correct |
| | 25.3 | 110 | 460 | 540 | 1,000,000 | 0 | 676 | | 1.106301 | 0.774411 | correct | | 1.106 | 0.996 | correct |
| | 25.4 | 110 | 460 | 540 | 1,000,000 | 0 | 777 | | 1.107609 | 0.775326 | correct | | 1.108 | 0.997 | correct |
| | 25.5 | 110 | 460 | 540 | 1,000,000 | 0 | 868 | | 1.10892 | 0.776244 | correct | | 1.109 | 0.998 | correct |
| | 25.6 | 110 | 460 | 540 | 1,000,000 | 0 | 1,150 | | 1.110233 | 0.777163 | correct | | 1.110 | 0.999 | correct |
| | 25.7 | 110 | 460 | 540 | 1,000,000 | 0 | 1,263 | | 1.11155 | 0.778085 | correct | | 1.112 | 1.000 | correct |
| | 25.8 | 110 | 460 | 540 | 1,000,000 | 0 | 1,507 | | 1.112871 | 0.779009 | correct | | 1.113 | 1.002 | correct |
| | 25.9 | 110 | 460 | 540 | 1,000,000 | 0 | 1,671 | | 1.114194 | 0.779936 | correct | | 1.114 | 1.003 | correct |
| | 26.0 | 110 | 460 | 540 | 1,000,000 | 0 | 2,034 | | 1.11552 | 0.780864 | correct | | 1.116 | 1.004 | correct |
| | 27.0 | 110 | 460 | 540 | 1,000,000 | 0 | 7,885 | | 1.12896 | 0.790272 | correct | | 1.129 | 1.016 | correct |
| | 28.0 | 110 | 460 | 540 | 1,000,000 | 0 | 25,808 | | 1.142728 | 0.79991 | correct | | 1.143 | 1.028 | correct |
| | 29.0 | 110 | 460 | 540 | 1,000,000 | 0 | 68,582 | | 1.156836 | 0.809785 | correct | | 1.157 | 1.041 | correct |
| | 30.0 | 110 | 460 | 540 | 1,000,000 | 0 | 151,946 | | 1.171296 | 0.819907 | correct | | 1.171 | 1.054 | correct |
| | 31.0 | 110 | 460 | 540 | 1,000,000 | 0 | 284,708 | | 1.186123 | 0.830286 | correct | | 1.186 | 1.068 | correct |
| | 32.0 | 110 | 460 | 540 | 1,000,000 | 0 | 452,238 | | 1.20133 | 0.840931 | correct | | 1.201 | 1.081 | correct |
| | 33.0 | 110 | 460 | 540 | 1,000,000 | 0 | 630,600 | | 1.216931 | 0.851852 | correct | | 1.217 | 1.095 | correct |
| | 34.0 | 110 | 460 | 540 | 1,000,000 | 0 | 781,830 | | 1.232943 | 0.86306 | correct | | 1.233 | 1.110 | correct |
| | 35.0 | 110 | 460 | 540 | 1,000,000 | 0 | 887,697 | | 1.249383 | 0.874568 | correct | | 1.249 | 1.124 | correct |
| | 36.0 | 110 | 460 | 540 | 1,000,000 | 0 | 949,590 | | 1.266266 | 0.886386 | correct | | 1.266 | 1.140 | correct |
| | 37.0 | 110 | 460 | 540 | 1,000,000 | 0 | 979,876 | | 1.283612 | 0.898529 | correct | | 1.284 | 1.155 | correct |
| | 38.0 | 110 | 460 | 540 | 1,000,000 | 0 | 991,318 | | 1.30144 | 0.911008 | correct | | 1.301 | 1.171 | correct |
| | 39.0 | 110 | 460 | 540 | 1,000,000 | 0 | 994,937 | | 1.31977 | 0.923839 | correct | | 1.320 | 1.188 | correct |
| | 40.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995,720 | | 1.338624 | 0.937037 | correct | | 1.339 | 1.205 | correct |
| | 41.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995,769 | | 1.358025 | 0.950617 | correct | | 1.358 | 1.222 | correct |
| | 42.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995,705 | | 1.377996 | 0.964597 | correct | | 1.378 | 1.240 | correct |
| | 43.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995,628 | | 1.398563 | 0.978994 | correct | | 1.399 | 1.259 | correct |
| | 44.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995,570 | | 1.419753 | 0.993827 | correct | | 1.420 | 1.278 | correct |
| | 45.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995,424 | | 1.441595 | 1.009117 | wrong | | 1.442 | 1.297 | correct |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 0.7 | | | | 0.922 | |
| S460 t40 Shifted Lognormal Distribution | 10.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.896296 | 0.627407 | correct | | 0.896 | 0.826 | correct |
| | 11.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.90535 | 0.633745 | correct | | 0.905 | 0.835 | correct |
| | 12.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.914588 | 0.640212 | correct | | 0.915 | 0.843 | correct |
| | 13.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.924017 | 0.646812 | correct | | 0.924 | 0.852 | correct |
| | 14.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.933642 | 0.653549 | correct | | 0.934 | 0.861 | correct |
| | 15.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.94347 | 0.660429 | correct | | 0.943 | 0.870 | correct |
| | 16.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.953507 | 0.667455 | correct | | 0.954 | 0.879 | correct |
| | 17.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.963759 | 0.674632 | correct | | 0.964 | 0.889 | correct |
| | 18.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.974235 | 0.681965 | correct | | 0.974 | 0.898 | correct |
| | 19.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.984941 | 0.689459 | correct | | 0.985 | 0.908 | correct |
| | 20.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.995885 | 0.697119 | correct | | 0.996 | 0.918 | correct |
| | 21.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 1.007074 | 0.704952 | correct | | 1.007 | 0.929 | correct |
| | 22.0 | 110 | 440 | 540 | 1,000,000 | 0 | 1 | | 1.018519 | 0.712963 | correct | | 1.019 | 0.939 | correct |
| | 23.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 1.030226 | 0.721158 | correct | | 1.030 | 0.950 | correct |
| | 24.0 | 110 | 440 | 540 | 1,000,000 | 0 | 3 | | 1.042205 | 0.729543 | correct | | 1.042 | 0.961 | correct |
| | 25.0 | 110 | 440 | 540 | 1,000,000 | 0 | 15 | | 1.054466 | 0.738126 | correct | | 1.054 | 0.972 | correct |
| | 26.0 | 110 | 440 | 540 | 1,000,000 | 0 | 110 | | 1.067019 | 0.746914 | correct | | 1.067 | 0.984 | correct |
| | 27.0 | 110 | 440 | 540 | 1,000,000 | 0 | 664 | | 1.079875 | 0.755913 | correct | | 1.080 | 0.996 | correct |
| | 27.1 | 110 | 440 | 540 | 1,000,000 | 0 | 781 | | 1.081178 | 0.756824 | correct | | 1.081 | 0.997 | correct |
| | 27.2 | 110 | 440 | 540 | 1,000,000 | 0 | 929 | | 1.082483 | 0.757738 | correct | | 1.082 | 0.998 | correct |
| | 27.3 | 110 | 440 | 540 | 1,000,000 | 0 | 1,079 | | 1.083792 | 0.758655 | correct | | 1.084 | 0.999 | correct |
| | 27.4 | 110 | 440 | 540 | 1,000,000 | 0 | 1,214 | | 1.085104 | 0.759573 | correct | | 1.085 | 1.000 | correct |
| | 27.5 | 110 | 440 | 540 | 1,000,000 | 0 | 1,491 | | 1.08642 | 0.760494 | correct | | 1.086 | 1.002 | correct |
| | 27.6 | 110 | 440 | 540 | 1,000,000 | 0 | 1,696 | | 1.087738 | 0.761417 | correct | | 1.088 | 1.003 | correct |
| | 27.7 | 110 | 440 | 540 | 1,000,000 | 0 | 1,953 | | 1.08906 | 0.762342 | correct | | 1.089 | 1.004 | correct |
| | 27.8 | 110 | 440 | 540 | 1,000,000 | 0 | 2,269 | | 1.090385 | 0.763269 | correct | | 1.090 | 1.005 | correct |
| | 27.9 | 110 | 440 | 540 | 1,000,000 | 0 | 2,654 | | 1.091713 | 0.764199 | correct | | 1.092 | 1.007 | correct |
| | 28.0 | 110 | 440 | 540 | 1,000,000 | 0 | 3,085 | | 1.093044 | 0.765131 | correct | | 1.093 | 1.008 | correct |
| | 29.0 | 110 | 440 | 540 | 1,000,000 | 0 | 11,470 | | 1.106539 | 0.774577 | correct | | 1.107 | 1.020 | correct |
| | 30.0 | 110 | 440 | 540 | 1,000,000 | 0 | 34,641 | | 1.12037 | 0.784259 | correct | | 1.120 | 1.033 | correct |
| | 31.0 | 110 | 440 | 540 | 1,000,000 | 0 | 88,547 | | 1.134552 | 0.794187 | correct | | 1.135 | 1.046 | correct |
| | 32.0 | 110 | 440 | 540 | 1,000,000 | 0 | 184,745 | | 1.149098 | 0.804368 | correct | | 1.149 | 1.059 | correct |
| | 33.0 | 110 | 440 | 540 | 1,000,000 | 0 | 331,354 | | 1.164021 | 0.814815 | correct | | 1.164 | 1.073 | correct |
| | 34.0 | 110 | 440 | 540 | 1,000,000 | 0 | 506,280 | | 1.179337 | 0.825536 | correct | | 1.179 | 1.087 | correct |
| | 35.0 | 110 | 440 | 540 | 1,000,000 | 0 | 678,817 | | 1.195062 | 0.836543 | correct | | 1.195 | 1.102 | correct |
| | 36.0 | 110 | 440 | 540 | 1,000,000 | 0 | 818,902 | | 1.211211 | 0.847848 | correct | | 1.211 | 1.117 | correct |
| | 37.0 | 110 | 440 | 540 | 1,000,000 | 0 | 912,286 | | 1.227803 | 0.859462 | correct | | 1.228 | 1.132 | correct |
| | 38.0 | 110 | 440 | 540 | 1,000,000 | 0 | 963,932 | | 1.244856 | 0.871399 | correct | | 1.245 | 1.148 | correct |
| | 39.0 | 110 | 440 | 540 | 1,000,000 | 0 | 987,523 | | 1.262389 | 0.883672 | correct | | 1.262 | 1.164 | correct |
| | 40.0 | 110 | 440 | 540 | 1,000,000 | 0 | 996,268 | | 1.280423 | 0.896296 | correct | | 1.280 | 1.181 | correct |
| | 41.0 | 110 | 440 | 540 | 1,000,000 | 0 | 998,737 | | 1.29898 | 0.909286 | correct | | 1.299 | 1.198 | correct |
| | 42.0 | 110 | 440 | 540 | 1,000,000 | 0 | 999,238 | | 1.318083 | 0.922658 | correct | | 1.318 | 1.215 | correct |
| | 43.0 | 110 | 440 | 540 | 1,000,000 | 0 | 999,285 | | 1.337756 | 0.936429 | correct | | 1.338 | 1.233 | correct |
| | 44.0 | 110 | 440 | 540 | 1,000,000 | 0 | 999,290 | | 1.358025 | 0.950617 | correct | | 1.358 | 1.252 | correct |
| | 45.0 | 110 | 440 | 540 | 1,000,000 | 0 | 999,284 | | 1.378917 | 0.965242 | correct | | 1.379 | 1.271 | correct |

## S460 t63 Shifted Lognormal Distribution

| | | | | | | | | 0.7 | | | 0.933 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.875926 | 0.613148 | correct | 0.876 | 0.817 | correct |
| 11.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.884774 | 0.619342 | correct | 0.885 | 0.825 | correct |
| 12.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.893802 | 0.625661 | correct | 0.894 | 0.834 | correct |
| 13.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.903016 | 0.632111 | correct | 0.903 | 0.843 | correct |
| 14.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.912423 | 0.638696 | correct | 0.912 | 0.851 | correct |
| 15.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.922027 | 0.645419 | correct | 0.922 | 0.860 | correct |
| 16.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.931836 | 0.652285 | correct | 0.932 | 0.869 | correct |
| 17.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.941856 | 0.659299 | correct | 0.942 | 0.879 | correct |
| 18.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.952093 | 0.666465 | correct | 0.952 | 0.888 | correct |
| 19.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.962556 | 0.673789 | correct | 0.963 | 0.898 | correct |
| 20.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.973251 | 0.681276 | correct | 0.973 | 0.908 | correct |
| 21.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.984186 | 0.688931 | correct | 0.984 | 0.918 | correct |
| 22.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.99537 | 0.696759 | correct | 0.995 | 0.929 | correct |
| 23.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 1.006811 | 0.704768 | correct | 1.007 | 0.939 | correct |
| 24.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 1.018519 | 0.712963 | correct | 1.019 | 0.950 | correct |
| 25.0 | 110 | 430 | 540 | 1,000,000 | 0 | 1 | 1.030501 | 0.721351 | correct | 1.031 | 0.961 | correct |
| 26.0 | 110 | 430 | 540 | 1,000,000 | 0 | 15 | 1.042769 | 0.729938 | correct | 1.043 | 0.973 | correct |
| 27.0 | 110 | 430 | 540 | 1,000,000 | 0 | 144 | 1.055332 | 0.738733 | correct | 1.055 | 0.985 | correct |
| 28.0 | 110 | 430 | 540 | 1,000,000 | 0 | 777 | 1.068202 | 0.747742 | correct | 1.068 | 0.997 | correct |
| 28.1 | 110 | 430 | 540 | 1,000,000 | 0 | 948 | 1.069507 | 0.748655 | correct | 1.070 | 0.998 | correct |
| 28.2 | 110 | 430 | 540 | 1,000,000 | 0 | 1,158 | 1.070814 | 0.74957 | correct | 1.071 | 0.999 | correct |
| 28.3 | 110 | 430 | 540 | 1,000,000 | 0 | 1,281 | 1.072125 | 0.750487 | correct | 1.072 | 1.000 | correct |
| 28.4 | 110 | 430 | 540 | 1,000,000 | 0 | 1,507 | 1.073439 | 0.751407 | correct | 1.073 | 1.002 | correct |
| 28.5 | 110 | 430 | 540 | 1,000,000 | 0 | 1,750 | 1.074756 | 0.752329 | correct | 1.075 | 1.003 | correct |
| 28.6 | 110 | 430 | 540 | 1,000,000 | 0 | 2,044 | 1.076076 | 0.753253 | correct | 1.076 | 1.004 | correct |
| 28.7 | 110 | 430 | 540 | 1,000,000 | 0 | 2,322 | 1.0774 | 0.75418 | correct | 1.077 | 1.005 | correct |
| 28.8 | 110 | 430 | 540 | 1,000,000 | 0 | 2,732 | 1.078727 | 0.755109 | correct | 1.079 | 1.006 | correct |
| 28.9 | 110 | 430 | 540 | 1,000,000 | 0 | 3,117 | 1.080057 | 0.75604 | correct | 1.080 | 1.008 | correct |
| 29.0 | 110 | 430 | 540 | 1,000,000 | 0 | 3,566 | 1.08139 | 0.756973 | correct | 1.081 | 1.009 | correct |
| 30.0 | 110 | 430 | 540 | 1,000,000 | 0 | 13,309 | 1.094907 | 0.766435 | correct | 1.095 | 1.022 | correct |
| 31.0 | 110 | 430 | 540 | 1,000,000 | 0 | 39,159 | 1.108767 | 0.776137 | correct | 1.109 | 1.034 | correct |
| 32.0 | 110 | 430 | 540 | 1,000,000 | 0 | 96,849 | 1.122982 | 0.786087 | correct | 1.123 | 1.048 | correct |
| 33.0 | 110 | 430 | 540 | 1,000,000 | 0 | 199,474 | 1.137566 | 0.796296 | correct | 1.138 | 1.061 | correct |
| 34.0 | 110 | 430 | 540 | 1,000,000 | 0 | 350,280 | 1.152534 | 0.806774 | correct | 1.153 | 1.075 | correct |
| 35.0 | 110 | 430 | 540 | 1,000,000 | 0 | 526,709 | 1.167901 | 0.817531 | correct | 1.168 | 1.090 | correct |
| 36.0 | 110 | 430 | 540 | 1,000,000 | 0 | 696,257 | 1.183684 | 0.828579 | correct | 1.184 | 1.104 | correct |
| 37.0 | 110 | 430 | 540 | 1,000,000 | 0 | 832,402 | 1.199899 | 0.839929 | correct | 1.200 | 1.120 | correct |
| 38.0 | 110 | 430 | 540 | 1,000,000 | 0 | 920,449 | 1.216564 | 0.851595 | correct | 1.217 | 1.135 | correct |
| 39.0 | 110 | 430 | 540 | 1,000,000 | 0 | 968,389 | 1.233698 | 0.863589 | correct | 1.234 | 1.151 | correct |
| 40.0 | 110 | 430 | 540 | 1,000,000 | 0 | 989,620 | 1.251323 | 0.875926 | correct | 1.251 | 1.167 | correct |
| 41.0 | 110 | 430 | 540 | 1,000,000 | 0 | 997,057 | 1.269458 | 0.888621 | correct | 1.269 | 1.184 | correct |
| 42.0 | 110 | 430 | 540 | 1,000,000 | 0 | 999,292 | 1.288126 | 0.901688 | correct | 1.288 | 1.202 | correct |
| 43.0 | 110 | 430 | 540 | 1,000,000 | 0 | 999,700 | 1.307352 | 0.915146 | correct | 1.307 | 1.220 | correct |
| 44.0 | 110 | 430 | 540 | 1,000,000 | 0 | 999,702 | 1.32716 | 0.929012 | correct | 1.327 | 1.238 | correct |
| 45.0 | 110 | 430 | 540 | 1,000,000 | 0 | 999,744 | 1.347578 | 0.943305 | correct | 1.348 | 1.257 | correct |

## 12.2. Simulated factor determined with relation $d_0/b$ ratio

| | | | | | | | | ***Failure option 1*** | | | ***Failure option 2*** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 291 | 1183 | unity <1 | Ym | | unity <1 | Ym | |
| | d0n | bn | fyn | fun | num_samp | FailuresOption1 | FailuresOption2 | | | | | | |
| | | | | | | | | | 0.6 | | | 0.999 | |
| **S235 t16 Correlation** | 20.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.79784 | 0.478704 | correct | 0.79784 | 0.797042 | correct |
| | 21.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.806804 | 0.484082 | correct | 0.806804 | 0.805997 | correct |
| | 22.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.815972 | 0.489583 | correct | 0.815972 | 0.815156 | correct |
| | 23.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.825351 | 0.495211 | correct | 0.825351 | 0.824526 | correct |
| | 24.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.834948 | 0.500969 | correct | 0.834948 | 0.834113 | correct |
| | 25.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.844771 | 0.506863 | correct | 0.844771 | 0.843926 | correct |
| | 26.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.854828 | 0.512897 | correct | 0.854828 | 0.853973 | correct |
| | 27.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.865127 | 0.519076 | correct | 0.865127 | 0.864262 | correct |
| | 28.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.875678 | 0.525407 | correct | 0.875678 | 0.874802 | correct |
| | 29.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.886488 | 0.531893 | correct | 0.886488 | 0.885602 | correct |
| | 30.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.897569 | 0.538542 | correct | 0.897569 | 0.896672 | correct |
| | 31.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.908931 | 0.545359 | correct | 0.908931 | 0.908022 | correct |
| | 32.0 | 110 | 235 | 360 | 1,000,000 | 0 | 1 | 0.920584 | 0.55235 | correct | 0.920584 | 0.919663 | correct |
| | 33.0 | 110 | 235 | 360 | 1,000,000 | 0 | 0 | 0.93254 | 0.559524 | correct | 0.93254 | 0.931607 | correct |
| | 34.0 | 110 | 235 | 360 | 1,000,000 | 0 | 2 | 0.94481 | 0.566886 | correct | 0.94481 | 0.943865 | correct |
| | 35.0 | 110 | 235 | 360 | 1,000,000 | 0 | 7 | 0.957407 | 0.574444 | correct | 0.957407 | 0.95645 | correct |
| | 36.0 | 110 | 235 | 360 | 1,000,000 | 0 | 64 | 0.970345 | 0.582207 | correct | 0.970345 | 0.969375 | correct |
| | 37.0 | 110 | 235 | 360 | 1,000,000 | 0 | 282 | 0.983638 | 0.590183 | correct | 0.983638 | 0.982654 | correct |
| | 38.0 | 110 | 235 | 360 | 1,000,000 | 0 | 888 | 0.997299 | 0.59838 | correct | 0.997299 | 0.996302 | correct |
| | 38.1 | 110 | 235 | 360 | 1,000,000 | 0 | 1033 | 0.998686 | 0.599212 | correct | 0.998686 | 0.997688 | correct |
| | 38.2 | 110 | 235 | 360 | 1,000,000 | 0 | 1141 | 1.000077 | 0.600046 | correct | 1.000077 | 0.999077 | correct |
| | 38.3 | 110 | 235 | 360 | 1,000,000 | 0 | 1290 | 1.001472 | 0.600883 | correct | 1.001472 | 1.000471 | correct |
| | 38.4 | 110 | 235 | 360 | 1,000,000 | 0 | 1431 | 1.002871 | 0.601723 | correct | 1.002871 | 1.001868 | correct |
| | 38.5 | 110 | 235 | 360 | 1,000,000 | 0 | 1679 | 1.004274 | 0.602564 | correct | 1.004274 | 1.003269 | correct |
| | 38.6 | 110 | 235 | 360 | 1,000,000 | 0 | 1770 | 1.00568 | 0.603408 | correct | 1.00568 | 1.004674 | correct |
| | 38.7 | 110 | 235 | 360 | 1,000,000 | 0 | 2098 | 1.007091 | 0.604254 | correct | 1.007091 | 1.006083 | correct |
| | 38.8 | 110 | 235 | 360 | 1,000,000 | 0 | 2332 | 1.008505 | 0.605103 | correct | 1.008505 | 1.007496 | correct |
| | 38.9 | 110 | 235 | 360 | 1,000,000 | 0 | 2533 | 1.009923 | 0.605954 | correct | 1.009923 | 1.008914 | correct |
| | 39.0 | 110 | 235 | 360 | 1,000,000 | 0 | 2908 | 1.011346 | 0.606808 | correct | 1.011346 | 1.010335 | correct |
| | 40.0 | 110 | 235 | 360 | 1,000,000 | 0 | 8489 | 1.025794 | 0.615476 | correct | 1.025794 | 1.024768 | correct |
| | 41.0 | 110 | 235 | 360 | 1,000,000 | 0 | 21376 | 1.04066 | 0.624396 | correct | 1.04066 | 1.03962 | correct |
| | 42.0 | 110 | 235 | 360 | 1,000,000 | 0 | 48795 | 1.055964 | 0.633578 | correct | 1.055964 | 1.054908 | correct |
| | 43.0 | 110 | 235 | 360 | 1,000,000 | 0 | 97452 | 1.071725 | 0.643035 | correct | 1.071725 | 1.070653 | correct |
| | 44.0 | 110 | 235 | 360 | 1,000,000 | 0 | 177063 | 1.087963 | 0.652778 | correct | 1.087963 | 1.086875 | correct |
| | 45.0 | 110 | 235 | 360 | 1,000,000 | 0 | 286296 | 1.104701 | 0.662821 | correct | 1.104701 | 1.103596 | correct |
| | 46.0 | 110 | 235 | 360 | 1,000,000 | 0 | 418912 | 1.121962 | 0.673177 | correct | 1.121962 | 1.12084 | correct |
| | 47.0 | 110 | 235 | 360 | 1,000,000 | 0 | 559640 | 1.139771 | 0.683862 | correct | 1.139771 | 1.138631 | correct |
| | 48.0 | 110 | 235 | 360 | 1,000,000 | 0 | 691981 | 1.158154 | 0.694892 | correct | 1.158154 | 1.156996 | correct |
| | 49.0 | 110 | 235 | 360 | 1,000,000 | 0 | 797360 | 1.17714 | 0.706284 | correct | 1.17714 | 1.175963 | correct |
| | 50.0 | 110 | 235 | 360 | 1,000,000 | 0 | 872241 | 1.196759 | 0.718056 | correct | 1.196759 | 1.195563 | correct |
| | 51.0 | 110 | 235 | 360 | 1,000,000 | 0 | 918542 | 1.217043 | 0.730226 | correct | 1.217043 | 1.215826 | correct |
| | 52.0 | 110 | 235 | 360 | 1,000,000 | 0 | 943298 | 1.238027 | 0.742816 | correct | 1.238027 | 1.236789 | correct |
| | 53.0 | 110 | 235 | 360 | 1,000,000 | 0 | 954659 | 1.259747 | 0.755848 | correct | 1.259747 | 1.258487 | correct |
| | 54.0 | 110 | 235 | 360 | 1,000,000 | 0 | 958479 | 1.282242 | 0.769345 | correct | 1.282242 | 1.28096 | correct |
| | 55.0 | 110 | 235 | 360 | 1,000,000 | 0 | 958740 | 1.305556 | 0.783333 | correct | 1.305556 | 1.30425 | correct |

| | | | | | | | | | | 0.6 | | | | 1.02 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| S235 t40 Correlation | 20.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.763889 | 0.458333 | correct | | 0.763889 | 0.779167 | correct |
| | 21.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.772472 | 0.463483 | correct | | 0.772472 | 0.787921 | correct |
| | 22.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.78125 | 0.46875 | correct | | 0.78125 | 0.796875 | correct |
| | 23.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.79023 | 0.474138 | correct | | 0.79023 | 0.806034 | correct |
| | 24.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.799419 | 0.479651 | correct | | 0.799419 | 0.815407 | correct |
| | 25.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.808824 | 0.485294 | correct | | 0.808824 | 0.825 | correct |
| | 26.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.818452 | 0.491071 | correct | | 0.818452 | 0.834821 | correct |
| | 27.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.828313 | 0.496988 | correct | | 0.828313 | 0.84488 | correct |
| | 28.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.838415 | 0.503049 | correct | | 0.838415 | 0.855183 | correct |
| | 29.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.848765 | 0.509259 | correct | | 0.848765 | 0.865741 | correct |
| | 30.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.859375 | 0.515625 | correct | | 0.859375 | 0.876563 | correct |
| | 31.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.870253 | 0.522152 | correct | | 0.870253 | 0.887658 | correct |
| | 32.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.88141 | 0.528846 | correct | | 0.88141 | 0.899038 | correct |
| | 33.0 | 110 | 225 | 360 | 1,000,000 | 0 | 0 | | 0.892857 | 0.535714 | correct | | 0.892857 | 0.910714 | correct |
| | 34.0 | 110 | 225 | 360 | 1,000,000 | 0 | 1 | | 0.904605 | 0.542763 | correct | | 0.904605 | 0.922697 | correct |
| | 35.0 | 110 | 225 | 360 | 1,000,000 | 0 | 1 | | 0.916667 | 0.55 | correct | | 0.916667 | 0.935 | correct |
| | 36.0 | 110 | 225 | 360 | 1,000,000 | 0 | 6 | | 0.929054 | 0.557432 | correct | | 0.929054 | 0.947635 | correct |
| | 37.0 | 110 | 225 | 360 | 1,000,000 | 0 | 24 | | 0.941781 | 0.565068 | correct | | 0.941781 | 0.960616 | correct |
| | 38.0 | 110 | 225 | 360 | 1,000,000 | 0 | 111 | | 0.954861 | 0.572917 | correct | | 0.954861 | 0.973958 | correct |
| | 39.0 | 110 | 225 | 360 | 1,000,000 | 0 | 381 | | 0.96831 | 0.580986 | correct | | 0.96831 | 0.987676 | correct |
| | 39.1 | 110 | 225 | 360 | 1,000,000 | 0 | 453 | | 0.969676 | 0.581805 | correct | | 0.969676 | 0.989069 | correct |
| | 39.2 | 110 | 225 | 360 | 1,000,000 | 0 | 528 | | 0.971045 | 0.582627 | correct | | 0.971045 | 0.990466 | correct |
| | 39.3 | 110 | 225 | 360 | 1,000,000 | 0 | 578 | | 0.972419 | 0.583451 | correct | | 0.972419 | 0.991867 | correct |
| | 39.4 | 110 | 225 | 360 | 1,000,000 | 0 | 660 | | 0.973796 | 0.584278 | correct | | 0.973796 | 0.993272 | correct |
| | 39.5 | 110 | 225 | 360 | 1,000,000 | 0 | 751 | | 0.975177 | 0.585106 | correct | | 0.975177 | 0.994681 | correct |
| | 39.6 | 110 | 225 | 360 | 1,000,000 | 0 | 854 | | 0.976563 | 0.585938 | correct | | 0.976563 | 0.996094 | correct |
| | 39.7 | 110 | 225 | 360 | 1,000,000 | 0 | 990 | | 0.977952 | 0.586771 | correct | | 0.977952 | 0.997511 | correct |
| | 39.8 | 110 | 225 | 360 | 1,000,000 | 0 | 1055 | | 0.979345 | 0.587607 | correct | | 0.979345 | 0.998932 | correct |
| | 39.9 | 110 | 225 | 360 | 1,000,000 | 0 | 1204 | | 0.980742 | 0.588445 | correct | | 0.980742 | 1.000357 | correct |
| | 40.0 | 110 | 225 | 360 | 1,000,000 | 0 | 1358 | | 0.982143 | 0.589286 | correct | | 0.982143 | 1.001786 | correct |
| | 41.0 | 110 | 225 | 360 | 1,000,000 | 0 | 4254 | | 0.996377 | 0.597826 | correct | | 0.996377 | 1.016304 | correct |
| | 42.0 | 110 | 225 | 360 | 1,000,000 | 0 | 12067 | | 1.011029 | 0.606618 | correct | | 1.011029 | 1.03125 | correct |
| | 43.0 | 110 | 225 | 360 | 1,000,000 | 0 | 29331 | | 1.026119 | 0.615672 | correct | | 1.026119 | 1.046642 | correct |
| | 44.0 | 110 | 225 | 360 | 1,000,000 | 0 | 64478 | | 1.041667 | 0.625 | correct | | 1.041667 | 1.0625 | correct |
| | 45.0 | 110 | 225 | 360 | 1,000,000 | 0 | 125270 | | 1.057692 | 0.634615 | correct | | 1.057692 | 1.078846 | correct |
| | 46.0 | 110 | 225 | 360 | 1,000,000 | 0 | 218652 | | 1.074219 | 0.644531 | correct | | 1.074219 | 1.095703 | correct |
| | 47.0 | 110 | 225 | 360 | 1,000,000 | 0 | 340235 | | 1.09127 | 0.654762 | correct | | 1.09127 | 1.113095 | correct |
| | 48.0 | 110 | 225 | 360 | 1,000,000 | 0 | 481512 | | 1.108871 | 0.665323 | correct | | 1.108871 | 1.131048 | correct |
| | 49.0 | 110 | 225 | 360 | 1,000,000 | 0 | 625893 | | 1.127049 | 0.67623 | correct | | 1.127049 | 1.14959 | correct |
| | 50.0 | 110 | 225 | 360 | 1,000,000 | 0 | 752595 | | 1.145833 | 0.6875 | correct | | 1.145833 | 1.16875 | correct |
| | 51.0 | 110 | 225 | 360 | 1,000,000 | 0 | 848711 | | 1.165254 | 0.699153 | correct | | 1.165254 | 1.188559 | correct |
| | 52.0 | 110 | 225 | 360 | 1,000,000 | 0 | 914051 | | 1.185345 | 0.711207 | correct | | 1.185345 | 1.209052 | correct |
| | 53.0 | 110 | 225 | 360 | 1,000,000 | 0 | 951944 | | 1.20614 | 0.723684 | correct | | 1.20614 | 1.230263 | correct |
| | 54.0 | 110 | 225 | 360 | 1,000,000 | 0 | 970803 | | 1.227679 | 0.736607 | correct | | 1.227679 | 1.252232 | correct |
| | 55.0 | 110 | 225 | 360 | 1,000,000 | 0 | 979198 | | 1.25 | 0.75 | correct | | 1.25 | 1.275 | correct |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | 0.6 | | | | 1.042 | | |
| **S235 t63 Correlation** | 20.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.729938 | 0.437963 | correct | | 0.729938 | 0.760596 | correct | |
| | 21.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.73814 | 0.442884 | correct | | 0.73814 | 0.769142 | correct | |
| | 22.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.746528 | 0.447917 | correct | | 0.746528 | 0.777882 | correct | |
| | 23.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.755109 | 0.453065 | correct | | 0.755109 | 0.786823 | correct | |
| | 24.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.763889 | 0.458333 | correct | | 0.763889 | 0.795972 | correct | |
| | 25.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.772876 | 0.463725 | correct | | 0.772876 | 0.805337 | correct | |
| | 26.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.782077 | 0.469246 | correct | | 0.782077 | 0.814924 | correct | |
| | 27.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.791499 | 0.4749 | correct | | 0.791499 | 0.824742 | correct | |
| | 28.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.801152 | 0.480691 | correct | | 0.801152 | 0.8348 | correct | |
| | 29.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.811043 | 0.486626 | correct | | 0.811043 | 0.845106 | correct | |
| | 30.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.821181 | 0.492708 | correct | | 0.821181 | 0.85567 | correct | |
| | 31.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.831575 | 0.498945 | correct | | 0.831575 | 0.866501 | correct | |
| | 32.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.842236 | 0.505342 | correct | | 0.842236 | 0.87761 | correct | |
| | 33.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.853175 | 0.511905 | correct | | 0.853175 | 0.889008 | correct | |
| | 34.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.864401 | 0.51864 | correct | | 0.864401 | 0.900705 | correct | |
| | 35.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.875926 | 0.525556 | correct | | 0.875926 | 0.912715 | correct | |
| | 36.0 | 110 | 215 | 360 | 1,000,000 | 0 | 0 | | 0.887763 | 0.532658 | correct | | 0.887763 | 0.925049 | correct | |
| | 37.0 | 110 | 215 | 360 | 1,000,000 | 0 | 2 | | 0.899924 | 0.539954 | correct | | 0.899924 | 0.937721 | correct | |
| | 38.0 | 110 | 215 | 360 | 1,000,000 | 0 | 9 | | 0.912423 | 0.547454 | correct | | 0.912423 | 0.950745 | correct | |
| | 39.0 | 110 | 215 | 360 | 1,000,000 | 0 | 33 | | 0.925274 | 0.555164 | correct | | 0.925274 | 0.964135 | correct | |
| | 40.0 | 110 | 215 | 360 | 1,000,000 | 0 | 140 | | 0.938492 | 0.563095 | correct | | 0.938492 | 0.977909 | correct | |
| | 41.0 | 110 | 215 | 360 | 1,000,000 | 0 | 554 | | 0.952093 | 0.571256 | correct | | 0.952093 | 0.992081 | correct | |
| | 41.1 | 110 | 215 | 360 | 1,000,000 | 0 | 664 | | 0.953475 | 0.572085 | correct | | 0.953475 | 0.993521 | correct | |
| | 41.2 | 110 | 215 | 360 | 1,000,000 | 0 | 689 | | 0.954861 | 0.572917 | correct | | 0.954861 | 0.994965 | correct | |
| | 41.3 | 110 | 215 | 360 | 1,000,000 | 0 | 809 | | 0.956251 | 0.573751 | correct | | 0.956251 | 0.996414 | correct | |
| | 41.4 | 110 | 215 | 360 | 1,000,000 | 0 | 917 | | 0.957645 | 0.574587 | correct | | 0.957645 | 0.997866 | correct | |
| | 41.5 | 110 | 215 | 360 | 1,000,000 | 0 | 1099 | | 0.959043 | 0.575426 | correct | | 0.959043 | 0.999323 | correct | |
| | 41.6 | 110 | 215 | 360 | 1,000,000 | 0 | 1233 | | 0.960445 | 0.576267 | correct | | 0.960445 | 1.000784 | correct | |
| | 41.7 | 110 | 215 | 360 | 1,000,000 | 0 | 1291 | | 0.961851 | 0.577111 | correct | | 0.961851 | 1.002249 | correct | |
| | 41.8 | 110 | 215 | 360 | 1,000,000 | 0 | 1535 | | 0.963262 | 0.577957 | correct | | 0.963262 | 1.003719 | correct | |
| | 41.9 | 110 | 215 | 360 | 1,000,000 | 0 | 1784 | | 0.964676 | 0.578806 | correct | | 0.964676 | 1.005193 | correct | |
| | 42.0 | 110 | 215 | 360 | 1,000,000 | 0 | 1964 | | 0.966095 | 0.579657 | correct | | 0.966095 | 1.006671 | correct | |
| | 43.0 | 110 | 215 | 360 | 1,000,000 | 0 | 5866 | | 0.980514 | 0.588308 | correct | | 0.980514 | 1.021696 | correct | |
| | 44.0 | 110 | 215 | 360 | 1,000,000 | 0 | 15658 | | 0.99537 | 0.597222 | correct | | 0.99537 | 1.037176 | correct | |
| | 45.0 | 110 | 215 | 360 | 1,000,000 | 0 | 37691 | | 1.010684 | 0.60641 | correct | | 1.010684 | 1.053132 | correct | |
| | 46.0 | 110 | 215 | 360 | 1,000,000 | 0 | 80065 | | 1.026476 | 0.615885 | correct | | 1.026476 | 1.069588 | correct | |
| | 47.0 | 110 | 215 | 360 | 1,000,000 | 0 | 151738 | | 1.042769 | 0.625661 | correct | | 1.042769 | 1.086565 | correct | |
| | 48.0 | 110 | 215 | 360 | 1,000,000 | 0 | 255708 | | 1.059588 | 0.635753 | correct | | 1.059588 | 1.104091 | correct | |
| | 49.0 | 110 | 215 | 360 | 1,000,000 | 0 | 386304 | | 1.076958 | 0.646175 | correct | | 1.076958 | 1.12219 | correct | |
| | 50.0 | 110 | 215 | 360 | 1,000,000 | 0 | 534102 | | 1.094907 | 0.656944 | correct | | 1.094907 | 1.140894 | correct | |
| | 51.0 | 110 | 215 | 360 | 1,000,000 | 0 | 676315 | | 1.113465 | 0.668079 | correct | | 1.113465 | 1.160231 | correct | |
| | 52.0 | 110 | 215 | 360 | 1,000,000 | 0 | 795895 | | 1.132663 | 0.679598 | correct | | 1.132663 | 1.180235 | correct | |
| | 53.0 | 110 | 215 | 360 | 1,000,000 | 0 | 883087 | | 1.152534 | 0.69152 | correct | | 1.152534 | 1.200941 | correct | |
| | 54.0 | 110 | 215 | 360 | 1,000,000 | 0 | 939055 | | 1.173115 | 0.703869 | correct | | 1.173115 | 1.222386 | correct | |
| | 55.0 | 110 | 215 | 360 | 1,000,000 | 0 | 969923 | | 1.194444 | 0.716667 | correct | | 1.194444 | 1.244611 | correct | |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 0.6 | | | 0.973 | |
| S355 t16 Correlation | 15.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.87458 | 0.524748 | correct | 0.87458 | 0.850966 | correct |
| | 16.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.883884 | 0.53033 | correct | 0.883884 | 0.860019 | correct |
| | 17.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.893388 | 0.536033 | correct | 0.893388 | 0.869267 | correct |
| | 18.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.903099 | 0.541859 | correct | 0.903099 | 0.878715 | correct |
| | 19.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.913023 | 0.547814 | correct | 0.913023 | 0.888372 | correct |
| | 20.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.923168 | 0.553901 | correct | 0.923168 | 0.898242 | correct |
| | 21.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.933541 | 0.560124 | correct | 0.933541 | 0.908335 | correct |
| | 22.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.944149 | 0.566489 | correct | 0.944149 | 0.918657 | correct |
| | 23.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.955001 | 0.573001 | correct | 0.955001 | 0.929216 | correct |
| | 24.0 | 110 | 355 | 470 | 1,000,000 | 0 | 0 | 0.966106 | 0.579664 | correct | 0.966106 | 0.940021 | correct |
| | 25.0 | 110 | 355 | 470 | 1,000,000 | 0 | 1 | 0.977472 | 0.586483 | correct | 0.977472 | 0.95108 | correct |
| | 26.0 | 110 | 355 | 470 | 1,000,000 | 0 | 9 | 0.989108 | 0.593465 | correct | 0.989108 | 0.962402 | correct |
| | 27.0 | 110 | 355 | 470 | 1,000,000 | 0 | 51 | 1.001025 | 0.600615 | correct | 1.001025 | 0.973998 | correct |
| | 28.0 | 110 | 355 | 470 | 1,000,000 | 0 | 189 | 1.013233 | 0.60794 | correct | 1.013233 | 0.985876 | correct |
| | 29.0 | 110 | 355 | 470 | 1,000,000 | 0 | 934 | 1.025742 | 0.615445 | correct | 1.025742 | 0.998047 | correct |
| | 29.1 | 110 | 355 | 470 | 1,000,000 | 0 | 997 | 1.02701 | 0.616206 | correct | 1.02701 | 0.999281 | correct |
| | 29.2 | 110 | 355 | 470 | 1,000,000 | 0 | 1218 | 1.028281 | 0.616969 | correct | 1.028281 | 1.000517 | correct |
| | 29.3 | 110 | 355 | 470 | 1,000,000 | 0 | 1393 | 1.029555 | 0.617733 | correct | 1.029555 | 1.001757 | correct |
| | 29.4 | 110 | 355 | 470 | 1,000,000 | 0 | 1685 | 1.030833 | 0.6185 | correct | 1.030833 | 1.003 | correct |
| | 29.5 | 110 | 355 | 470 | 1,000,000 | 0 | 1941 | 1.032113 | 0.619268 | correct | 1.032113 | 1.004246 | correct |
| | 29.6 | 110 | 355 | 470 | 1,000,000 | 0 | 2241 | 1.033397 | 0.620038 | correct | 1.033397 | 1.005495 | correct |
| | 29.7 | 110 | 355 | 470 | 1,000,000 | 0 | 2442 | 1.034684 | 0.62081 | correct | 1.034684 | 1.006747 | correct |
| | 29.8 | 110 | 355 | 470 | 1,000,000 | 0 | 2872 | 1.035974 | 0.621584 | correct | 1.035974 | 1.008003 | correct |
| | 29.9 | 110 | 355 | 470 | 1,000,000 | 0 | 3303 | 1.037267 | 0.62236 | correct | 1.037267 | 1.009261 | correct |
| | 30.0 | 110 | 355 | 470 | 1,000,000 | 0 | 3758 | 1.038564 | 0.623138 | correct | 1.038564 | 1.010523 | correct |
| | 31.0 | 110 | 355 | 470 | 1,000,000 | 0 | 12494 | 1.05171 | 0.631026 | correct | 1.05171 | 1.023314 | correct |
| | 32.0 | 110 | 355 | 470 | 1,000,000 | 0 | 35324 | 1.065194 | 0.639116 | correct | 1.065194 | 1.036433 | correct |
| | 33.0 | 110 | 355 | 470 | 1,000,000 | 0 | 84365 | 1.079027 | 0.647416 | correct | 1.079027 | 1.049894 | correct |
| | 34.0 | 110 | 355 | 470 | 1,000,000 | 0 | 170975 | 1.093225 | 0.655935 | correct | 1.093225 | 1.063708 | correct |
| | 35.0 | 110 | 355 | 470 | 1,000,000 | 0 | 300194 | 1.107801 | 0.664681 | correct | 1.107801 | 1.077891 | correct |
| | 36.0 | 110 | 355 | 470 | 1,000,000 | 0 | 459670 | 1.122772 | 0.673663 | correct | 1.122772 | 1.092457 | correct |
| | 37.0 | 110 | 355 | 470 | 1,000,000 | 0 | 623516 | 1.138152 | 0.682891 | correct | 1.138152 | 1.107422 | correct |
| | 38.0 | 110 | 355 | 470 | 1,000,000 | 0 | 766918 | 1.15396 | 0.692376 | correct | 1.15396 | 1.122803 | correct |
| | 39.0 | 110 | 355 | 470 | 1,000,000 | 0 | 872350 | 1.170213 | 0.702128 | correct | 1.170213 | 1.138617 | correct |
| | 40.0 | 110 | 355 | 470 | 1,000,000 | 0 | 938017 | 1.18693 | 0.712158 | correct | 1.18693 | 1.154883 | correct |
| | 41.0 | 110 | 355 | 470 | 1,000,000 | 0 | 974077 | 1.204132 | 0.722479 | correct | 1.204132 | 1.17162 | correct |
| | 42.0 | 110 | 355 | 470 | 1,000,000 | 0 | 990199 | 1.22184 | 0.733104 | correct | 1.22184 | 1.18885 | correct |
| | 43.0 | 110 | 355 | 470 | 1,000,000 | 0 | 996492 | 1.240076 | 0.744046 | correct | 1.240076 | 1.206594 | correct |
| | 44.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998502 | 1.258865 | 0.755319 | correct | 1.258865 | 1.224876 | correct |
| | 45.0 | 110 | 355 | 470 | 1,000,000 | 0 | 999028 | 1.278232 | 0.766939 | correct | 1.278232 | 1.24372 | correct |
| | 46.0 | 110 | 355 | 470 | 1,000,000 | 0 | 999104 | 1.298205 | 0.778923 | correct | 1.298205 | 1.263153 | correct |
| | 47.0 | 110 | 355 | 470 | 1,000,000 | 0 | 999121 | 1.318811 | 0.791287 | correct | 1.318811 | 1.283203 | correct |
| | 48.0 | 110 | 355 | 470 | 1,000,000 | 0 | 999054 | 1.340082 | 0.804049 | correct | 1.340082 | 1.3039 | correct |
| | 49.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998991 | 1.362051 | 0.817231 | correct | 1.362051 | 1.325276 | correct |
| | 50.0 | 110 | 355 | 470 | 1,000,000 | 0 | 998889 | 1.384752 | 0.830851 | correct | 1.384752 | 1.347363 | correct |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 0.6 | | | 0.988 | |
| S355 t40 Correlation | 15.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.849944 | 0.509966 | correct | 0.849944 | 0.839745 | correct |
| | 16.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.858986 | 0.515392 | correct | 0.858986 | 0.848678 | correct |
| | 17.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.868222 | 0.520933 | correct | 0.868222 | 0.857804 | correct |
| | 18.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.87766 | 0.526596 | correct | 0.87766 | 0.867128 | correct |
| | 19.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.887304 | 0.532383 | correct | 0.887304 | 0.876657 | correct |
| | 20.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.897163 | 0.538298 | correct | 0.897163 | 0.886397 | correct |
| | 21.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.907244 | 0.544346 | correct | 0.907244 | 0.896357 | correct |
| | 22.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.917553 | 0.550532 | correct | 0.917553 | 0.906543 | correct |
| | 23.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.9281 | 0.55686 | correct | 0.9281 | 0.916963 | correct |
| | 24.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.938892 | 0.563335 | correct | 0.938892 | 0.927625 | correct |
| | 25.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.949937 | 0.569962 | correct | 0.949937 | 0.938538 | correct |
| | 26.0 | 110 | 345 | 470 | 1,000,000 | 0 | 0 | 0.961246 | 0.576748 | correct | 0.961246 | 0.949711 | correct |
| | 27.0 | 110 | 345 | 470 | 1,000,000 | 0 | 4 | 0.972827 | 0.583696 | correct | 0.972827 | 0.961154 | correct |
| | 28.0 | 110 | 345 | 470 | 1,000,000 | 0 | 20 | 0.984691 | 0.590815 | correct | 0.984691 | 0.972875 | correct |
| | 29.0 | 110 | 345 | 470 | 1,000,000 | 0 | 140 | 0.996848 | 0.598109 | correct | 0.996848 | 0.984886 | correct |
| | 30.0 | 110 | 345 | 470 | 1,000,000 | 0 | 799 | 1.009309 | 0.605585 | correct | 1.009309 | 0.997197 | correct |
| | 30.1 | 110 | 345 | 470 | 1,000,000 | 0 | 888 | 1.010572 | 0.606343 | correct | 1.010572 | 0.998445 | correct |
| | 30.2 | 110 | 345 | 470 | 1,000,000 | 0 | 1001 | 1.011838 | 0.607103 | correct | 1.011838 | 0.999696 | correct |
| | 30.3 | 110 | 345 | 470 | 1,000,000 | 0 | 1235 | 1.013108 | 0.607865 | correct | 1.013108 | 1.00095 | correct |
| | 30.4 | 110 | 345 | 470 | 1,000,000 | 0 | 1380 | 1.01438 | 0.608628 | correct | 1.01438 | 1.002208 | correct |
| | 30.5 | 110 | 345 | 470 | 1,000,000 | 0 | 1632 | 1.015656 | 0.609394 | correct | 1.015656 | 1.003468 | correct |
| | 30.6 | 110 | 345 | 470 | 1,000,000 | 0 | 1891 | 1.016936 | 0.610161 | correct | 1.016936 | 1.004732 | correct |
| | 30.7 | 110 | 345 | 470 | 1,000,000 | 0 | 2070 | 1.018218 | 0.610931 | correct | 1.018218 | 1.005999 | correct |
| | 30.8 | 110 | 345 | 470 | 1,000,000 | 0 | 2391 | 1.019504 | 0.611702 | correct | 1.019504 | 1.00727 | correct |
| | 30.9 | 110 | 345 | 470 | 1,000,000 | 0 | 2832 | 1.020792 | 0.612475 | correct | 1.020792 | 1.008543 | correct |
| | 31.0 | 110 | 345 | 470 | 1,000,000 | 0 | 3110 | 1.022085 | 0.613251 | correct | 1.022085 | 1.00982 | correct |
| | 32.0 | 110 | 345 | 470 | 1,000,000 | 0 | 11067 | 1.035188 | 0.621113 | correct | 1.035188 | 1.022766 | correct |
| | 33.0 | 110 | 345 | 470 | 1,000,000 | 0 | 31855 | 1.048632 | 0.629179 | correct | 1.048632 | 1.036049 | correct |
| | 34.0 | 110 | 345 | 470 | 1,000,000 | 0 | 76908 | 1.06243 | 0.637458 | correct | 1.06243 | 1.049681 | correct |
| | 35.0 | 110 | 345 | 470 | 1,000,000 | 0 | 159680 | 1.076596 | 0.645957 | correct | 1.076596 | 1.063677 | correct |
| | 36.0 | 110 | 345 | 470 | 1,000,000 | 0 | 283404 | 1.091144 | 0.654687 | correct | 1.091144 | 1.078051 | correct |
| | 37.0 | 110 | 345 | 470 | 1,000,000 | 0 | 441001 | 1.106092 | 0.663655 | correct | 1.106092 | 1.092818 | correct |
| | 38.0 | 110 | 345 | 470 | 1,000,000 | 0 | 606424 | 1.121454 | 0.672872 | correct | 1.121454 | 1.107996 | correct |
| | 39.0 | 110 | 345 | 470 | 1,000,000 | 0 | 753551 | 1.137249 | 0.682349 | correct | 1.137249 | 1.123602 | correct |
| | 40.0 | 110 | 345 | 470 | 1,000,000 | 0 | 863615 | 1.153495 | 0.692097 | correct | 1.153495 | 1.139653 | correct |
| | 41.0 | 110 | 345 | 470 | 1,000,000 | 0 | 933555 | 1.170213 | 0.702128 | correct | 1.170213 | 1.15617 | correct |
| | 42.0 | 110 | 345 | 470 | 1,000,000 | 0 | 971973 | 1.187422 | 0.712453 | correct | 1.187422 | 1.173173 | correct |
| | 43.0 | 110 | 345 | 470 | 1,000,000 | 0 | 989587 | 1.205144 | 0.723087 | correct | 1.205144 | 1.190683 | correct |
| | 44.0 | 110 | 345 | 470 | 1,000,000 | 0 | 996622 | 1.223404 | 0.734043 | correct | 1.223404 | 1.208723 | correct |
| | 45.0 | 110 | 345 | 470 | 1,000,000 | 0 | 998916 | 1.242226 | 0.745336 | correct | 1.242226 | 1.227319 | correct |
| | 46.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999586 | 1.261636 | 0.756981 | correct | 1.261636 | 1.246496 | correct |
| | 47.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999744 | 1.281662 | 0.768997 | correct | 1.281662 | 1.266282 | correct |
| | 48.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999720 | 1.302334 | 0.7814 | correct | 1.302334 | 1.286706 | correct |
| | 49.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999697 | 1.323683 | 0.79421 | correct | 1.323683 | 1.307799 | correct |
| | 50.0 | 110 | 345 | 470 | 1,000,000 | 0 | 999689 | 1.345745 | 0.807447 | correct | 1.345745 | 1.329596 | correct |

## S355 t63 Correlation

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 0.6 | | | 1.002 | |
| 15.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.825308 | 0.495185 | correct | 0.825308 | 0.826959 | correct |
| 16.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.834088 | 0.500453 | correct | 0.834088 | 0.835756 | correct |
| 17.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.843057 | 0.505834 | correct | 0.843057 | 0.844743 | correct |
| 18.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.85222 | 0.511332 | correct | 0.85222 | 0.853925 | correct |
| 19.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.861585 | 0.516951 | correct | 0.861585 | 0.863308 | correct |
| 20.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.871158 | 0.522695 | correct | 0.871158 | 0.872901 | correct |
| 21.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.880947 | 0.528568 | correct | 0.880947 | 0.882709 | correct |
| 22.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.890957 | 0.534574 | correct | 0.890957 | 0.892739 | correct |
| 23.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.901198 | 0.540719 | correct | 0.901198 | 0.903001 | correct |
| 24.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.911677 | 0.547006 | correct | 0.911677 | 0.913501 | correct |
| 25.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.922403 | 0.553442 | correct | 0.922403 | 0.924248 | correct |
| 26.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.933384 | 0.56003 | correct | 0.933384 | 0.935251 | correct |
| 27.0 | 110 | 335 | 470 | 1,000,000 | 0 | 0 | 0.94463 | 0.566778 | correct | 0.94463 | 0.946519 | correct |
| 28.0 | 110 | 335 | 470 | 1,000,000 | 0 | 3 | 0.956149 | 0.57369 | correct | 0.956149 | 0.958062 | correct |
| 29.0 | 110 | 335 | 470 | 1,000,000 | 0 | 13 | 0.967954 | 0.580772 | correct | 0.967954 | 0.96989 | correct |
| 30.0 | 110 | 335 | 470 | 1,000,000 | 0 | 141 | 0.980053 | 0.588032 | correct | 0.980053 | 0.982013 | correct |
| 31.0 | 110 | 335 | 470 | 1,000,000 | 0 | 629 | 0.992459 | 0.595475 | correct | 0.992459 | 0.994444 | correct |
| 31.1 | 110 | 335 | 470 | 1,000,000 | 0 | 724 | 0.993717 | 0.59623 | correct | 0.993717 | 0.995704 | correct |
| 31.2 | 110 | 335 | 470 | 1,000,000 | 0 | 768 | 0.994978 | 0.596987 | correct | 0.994978 | 0.996968 | correct |
| 31.3 | 110 | 335 | 470 | 1,000,000 | 0 | 991 | 0.996242 | 0.597745 | correct | 0.996242 | 0.998235 | correct |
| 31.4 | 110 | 335 | 470 | 1,000,000 | 0 | 1147 | 0.99751 | 0.598506 | correct | 0.99751 | 0.999505 | correct |
| 31.5 | 110 | 335 | 470 | 1,000,000 | 0 | 1249 | 0.99878 | 0.599268 | correct | 0.99878 | 1.000778 | correct |
| 31.6 | 110 | 335 | 470 | 1,000,000 | 0 | 1566 | 1.000054 | 0.600033 | correct | 1.000054 | 1.002054 | correct |
| 31.7 | 110 | 335 | 470 | 1,000,000 | 0 | 1715 | 1.001331 | 0.600799 | correct | 1.001331 | 1.003334 | correct |
| 31.8 | 110 | 335 | 470 | 1,000,000 | 0 | 1912 | 1.002612 | 0.601567 | correct | 1.002612 | 1.004617 | correct |
| 31.9 | 110 | 335 | 470 | 1,000,000 | 0 | 2253 | 1.003896 | 0.602337 | correct | 1.003896 | 1.005904 | correct |
| 32.0 | 110 | 335 | 470 | 1,000,000 | 0 | 2588 | 1.005183 | 0.60311 | correct | 1.005183 | 1.007193 | correct |
| 33.0 | 110 | 335 | 470 | 1,000,000 | 0 | 9129 | 1.018237 | 0.610942 | correct | 1.018237 | 1.020274 | correct |
| 34.0 | 110 | 335 | 470 | 1,000,000 | 0 | 27235 | 1.031635 | 0.618981 | correct | 1.031635 | 1.033698 | correct |
| 35.0 | 110 | 335 | 470 | 1,000,000 | 0 | 68583 | 1.04539 | 0.627234 | correct | 1.04539 | 1.047481 | correct |
| 36.0 | 110 | 335 | 470 | 1,000,000 | 0 | 144623 | 1.059517 | 0.63571 | correct | 1.059517 | 1.061636 | correct |
| 37.0 | 110 | 335 | 470 | 1,000,000 | 0 | 264003 | 1.074031 | 0.644419 | correct | 1.074031 | 1.076179 | correct |
| 38.0 | 110 | 335 | 470 | 1,000,000 | 0 | 416672 | 1.088948 | 0.653369 | correct | 1.088948 | 1.091126 | correct |
| 39.0 | 110 | 335 | 470 | 1,000,000 | 0 | 583907 | 1.104285 | 0.662571 | correct | 1.104285 | 1.106494 | correct |
| 40.0 | 110 | 335 | 470 | 1,000,000 | 0 | 734631 | 1.120061 | 0.672036 | correct | 1.120061 | 1.122301 | correct |
| 41.0 | 110 | 335 | 470 | 1,000,000 | 0 | 850588 | 1.136294 | 0.681776 | correct | 1.136294 | 1.138566 | correct |
| 42.0 | 110 | 335 | 470 | 1,000,000 | 0 | 926571 | 1.153004 | 0.691802 | correct | 1.153004 | 1.15531 | correct |
| 43.0 | 110 | 335 | 470 | 1,000,000 | 0 | 968392 | 1.170213 | 0.702128 | correct | 1.170213 | 1.172553 | correct |
| 44.0 | 110 | 335 | 470 | 1,000,000 | 0 | 988260 | 1.187943 | 0.712766 | correct | 1.187943 | 1.190319 | correct |
| 45.0 | 110 | 335 | 470 | 1,000,000 | 0 | 996253 | 1.206219 | 0.723732 | correct | 1.206219 | 1.208632 | correct |
| 46.0 | 110 | 335 | 470 | 1,000,000 | 0 | 999033 | 1.225066 | 0.73504 | correct | 1.225066 | 1.227517 | correct |
| 47.0 | 110 | 335 | 470 | 1,000,000 | 0 | 999728 | 1.244512 | 0.746707 | correct | 1.244512 | 1.247001 | correct |
| 48.0 | 110 | 335 | 470 | 1,000,000 | 0 | 999907 | 1.264585 | 0.758751 | correct | 1.264585 | 1.267114 | correct |
| 49.0 | 110 | 335 | 470 | 1,000,000 | 0 | 999920 | 1.285316 | 0.771189 | correct | 1.285316 | 1.287886 | correct |
| 50.0 | 110 | 335 | 470 | 1,000,000 | 0 | 999923 | 1.306738 | 0.784043 | correct | 1.306738 | 1.309351 | correct |

| | | | | | | | | | 0.6 | | | 0.9 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S460 t16 Correlation** | 10.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 0.937037 | 0.562222 | correct | 0.937037 | 0.843333 | correct |
| | 11.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 0.946502 | 0.567901 | correct | 0.946502 | 0.851852 | correct |
| | 12.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 0.95616 | 0.573696 | correct | 0.95616 | 0.860544 | correct |
| | 13.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 0.966018 | 0.579611 | correct | 0.966018 | 0.869416 | correct |
| | 14.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 0.97608 | 0.585648 | correct | 0.97608 | 0.878472 | correct |
| | 15.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 0.986355 | 0.591813 | correct | 0.986355 | 0.887719 | correct |
| | 16.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 0.996848 | 0.598109 | correct | 0.996848 | 0.897163 | correct |
| | 17.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 1.007567 | 0.60454 | correct | 1.007567 | 0.90681 | correct |
| | 18.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 1.018519 | 0.611111 | correct | 1.018519 | 0.916667 | correct |
| | 19.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 1.029711 | 0.617827 | correct | 1.029711 | 0.92674 | correct |
| | 20.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 1.041152 | 0.624691 | correct | 1.041152 | 0.937037 | correct |
| | 21.0 | 110 | 460 | 540 | 1,000,000 | 0 | 1 | 1.052851 | 0.63171 | correct | 1.052851 | 0.947566 | correct |
| | 22.0 | 110 | 460 | 540 | 1,000,000 | 0 | 0 | 1.064815 | 0.638889 | correct | 1.064815 | 0.958333 | correct |
| | 23.0 | 110 | 460 | 540 | 1,000,000 | 0 | 12 | 1.077054 | 0.646232 | correct | 1.077054 | 0.969349 | correct |
| | 24.0 | 110 | 460 | 540 | 1,000,000 | 0 | 73 | 1.089578 | 0.653747 | correct | 1.089578 | 0.98062 | correct |
| | 25.0 | 110 | 460 | 540 | 1,000,000 | 0 | 438 | 1.102397 | 0.661438 | correct | 1.102397 | 0.992157 | correct |
| | 25.1 | 110 | 460 | 540 | 1,000,000 | 0 | 480 | 1.103695 | 0.662217 | correct | 1.103695 | 0.993325 | correct |
| | 25.2 | 110 | 460 | 540 | 1,000,000 | 0 | 568 | 1.104997 | 0.662998 | correct | 1.104997 | 0.994497 | correct |
| | 25.3 | 110 | 460 | 540 | 1,000,000 | 0 | 662 | 1.106301 | 0.663781 | correct | 1.106301 | 0.995671 | correct |
| | 25.4 | 110 | 460 | 540 | 1,000,000 | 0 | 800 | 1.107609 | 0.664565 | correct | 1.107609 | 0.996848 | correct |
| | 25.5 | 110 | 460 | 540 | 1,000,000 | 0 | 947 | 1.10892 | 0.665352 | correct | 1.10892 | 0.998028 | correct |
| | 25.6 | 110 | 460 | 540 | 1,000,000 | 0 | 1057 | 1.110233 | 0.66614 | correct | 1.110233 | 0.99921 | correct |
| | 25.7 | 110 | 460 | 540 | 1,000,000 | 0 | 1242 | 1.11155 | 0.66693 | correct | 1.11155 | 1.000395 | correct |
| | 25.8 | 110 | 460 | 540 | 1,000,000 | 0 | 1450 | 1.112871 | 0.667722 | correct | 1.112871 | 1.001584 | correct |
| | 25.9 | 110 | 460 | 540 | 1,000,000 | 0 | 1691 | 1.114194 | 0.668516 | correct | 1.114194 | 1.002774 | correct |
| | 26.0 | 110 | 460 | 540 | 1,000,000 | 0 | 2098 | 1.11552 | 0.669312 | correct | 1.11552 | 1.003968 | correct |
| | 27.0 | 110 | 460 | 540 | 1,000,000 | 0 | 8204 | 1.12896 | 0.677376 | correct | 1.12896 | 1.016064 | correct |
| | 28.0 | 110 | 460 | 540 | 1,000,000 | 0 | 26066 | 1.142728 | 0.685637 | correct | 1.142728 | 1.028455 | correct |
| | 29.0 | 110 | 460 | 540 | 1,000,000 | 0 | 69645 | 1.156836 | 0.694102 | correct | 1.156836 | 1.041152 | correct |
| | 30.0 | 110 | 460 | 540 | 1,000,000 | 0 | 154094 | 1.171296 | 0.702778 | correct | 1.171296 | 1.054167 | correct |
| | 31.0 | 110 | 460 | 540 | 1,000,000 | 0 | 285838 | 1.186123 | 0.711674 | correct | 1.186123 | 1.067511 | correct |
| | 32.0 | 110 | 460 | 540 | 1,000,000 | 0 | 456246 | 1.20133 | 0.720798 | correct | 1.20133 | 1.081197 | correct |
| | 33.0 | 110 | 460 | 540 | 1,000,000 | 0 | 632672 | 1.216931 | 0.730159 | correct | 1.216931 | 1.095238 | correct |
| | 34.0 | 110 | 460 | 540 | 1,000,000 | 0 | 781718 | 1.232943 | 0.739766 | correct | 1.232943 | 1.109649 | correct |
| | 35.0 | 110 | 460 | 540 | 1,000,000 | 0 | 889165 | 1.249383 | 0.74963 | correct | 1.249383 | 1.124444 | correct |
| | 36.0 | 110 | 460 | 540 | 1,000,000 | 0 | 950216 | 1.266266 | 0.75976 | correct | 1.266266 | 1.13964 | correct |
| | 37.0 | 110 | 460 | 540 | 1,000,000 | 0 | 979808 | 1.283612 | 0.770167 | correct | 1.283612 | 1.155251 | correct |
| | 38.0 | 110 | 460 | 540 | 1,000,000 | 0 | 991225 | 1.30144 | 0.780864 | correct | 1.30144 | 1.171296 | correct |
| | 39.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995024 | 1.31977 | 0.791862 | correct | 1.31977 | 1.187793 | correct |
| | 40.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995777 | 1.338624 | 0.803175 | correct | 1.338624 | 1.204762 | correct |
| | 41.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995841 | 1.358025 | 0.814815 | correct | 1.358025 | 1.222222 | correct |
| | 42.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995776 | 1.377996 | 0.826797 | correct | 1.377996 | 1.240196 | correct |
| | 43.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995554 | 1.398563 | 0.839138 | correct | 1.398563 | 1.258706 | correct |
| | 44.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995573 | 1.419753 | 0.851852 | correct | 1.419753 | 1.277778 | correct |
| | 45.0 | 110 | 460 | 540 | 1,000,000 | 0 | 995422 | 1.441595 | 0.864957 | correct | 1.441595 | 1.297436 | correct |

| | | | | | | | | | | 0.6 | | | | 0.922 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **S460 t40 Correlation** | 10.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.896296 | 0.537778 | correct | | 0.896296 | 0.826385 | correct |
| | 11.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.90535 | 0.54321 | correct | | 0.90535 | 0.834733 | correct |
| | 12.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.914588 | 0.548753 | correct | | 0.914588 | 0.84325 | correct |
| | 13.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.924017 | 0.55441 | correct | | 0.924017 | 0.851943 | correct |
| | 14.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.933642 | 0.560185 | correct | | 0.933642 | 0.860818 | correct |
| | 15.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.94347 | 0.566082 | correct | | 0.94347 | 0.869879 | correct |
| | 16.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.953507 | 0.572104 | correct | | 0.953507 | 0.879133 | correct |
| | 17.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.963759 | 0.578256 | correct | | 0.963759 | 0.888586 | correct |
| | 18.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.974235 | 0.584541 | correct | | 0.974235 | 0.898245 | correct |
| | 19.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.984941 | 0.590965 | correct | | 0.984941 | 0.908116 | correct |
| | 20.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 0.995885 | 0.597531 | correct | | 0.995885 | 0.918206 | correct |
| | 21.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 1.007074 | 0.604245 | correct | | 1.007074 | 0.928523 | correct |
| | 22.0 | 110 | 440 | 540 | 1,000,000 | 0 | 0 | | 1.018519 | 0.611111 | correct | | 1.018519 | 0.939074 | correct |
| | 23.0 | 110 | 440 | 540 | 1,000,000 | 0 | 1 | | 1.030226 | 0.618135 | correct | | 1.030226 | 0.949868 | correct |
| | 24.0 | 110 | 440 | 540 | 1,000,000 | 0 | 1 | | 1.042205 | 0.625323 | correct | | 1.042205 | 0.960913 | correct |
| | 25.0 | 110 | 440 | 540 | 1,000,000 | 0 | 19 | | 1.054466 | 0.63268 | correct | | 1.054466 | 0.972218 | correct |
| | 26.0 | 110 | 440 | 540 | 1,000,000 | 0 | 98 | | 1.067019 | 0.640212 | correct | | 1.067019 | 0.983792 | correct |
| | 27.0 | 110 | 440 | 540 | 1,000,000 | 0 | 659 | | 1.079875 | 0.647925 | correct | | 1.079875 | 0.995645 | correct |
| | 27.1 | 110 | 440 | 540 | 1,000,000 | 0 | 780 | | 1.081178 | 0.648707 | correct | | 1.081178 | 0.996846 | correct |
| | 27.2 | 110 | 440 | 540 | 1,000,000 | 0 | 1050 | | 1.082483 | 0.64949 | correct | | 1.082483 | 0.99805 | correct |
| | 27.3 | 110 | 440 | 540 | 1,000,000 | 0 | 1116 | | 1.083792 | 0.650275 | correct | | 1.083792 | 0.999257 | correct |
| | 27.4 | 110 | 440 | 540 | 1,000,000 | 0 | 1299 | | 1.085104 | 0.651063 | correct | | 1.085104 | 1.000466 | correct |
| | 27.5 | 110 | 440 | 540 | 1,000,000 | 0 | 1477 | | 1.08642 | 0.651852 | correct | | 1.08642 | 1.001679 | correct |
| | 27.6 | 110 | 440 | 540 | 1,000,000 | 0 | 1708 | | 1.087738 | 0.652643 | correct | | 1.087738 | 1.002895 | correct |
| | 27.7 | 110 | 440 | 540 | 1,000,000 | 0 | 2032 | | 1.08906 | 0.653436 | correct | | 1.08906 | 1.004113 | correct |
| | 27.8 | 110 | 440 | 540 | 1,000,000 | 0 | 2366 | | 1.090385 | 0.654231 | correct | | 1.090385 | 1.005335 | correct |
| | 27.9 | 110 | 440 | 540 | 1,000,000 | 0 | 2647 | | 1.091713 | 0.655028 | correct | | 1.091713 | 1.006559 | correct |
| | 28.0 | 110 | 440 | 540 | 1,000,000 | 0 | 3227 | | 1.093044 | 0.655827 | correct | | 1.093044 | 1.007787 | correct |
| | 29.0 | 110 | 440 | 540 | 1,000,000 | 0 | 11508 | | 1.106539 | 0.663923 | correct | | 1.106539 | 1.020229 | correct |
| | 30.0 | 110 | 440 | 540 | 1,000,000 | 0 | 35875 | | 1.12037 | 0.672222 | correct | | 1.12037 | 1.032981 | correct |
| | 31.0 | 110 | 440 | 540 | 1,000,000 | 0 | 89595 | | 1.134552 | 0.680731 | correct | | 1.134552 | 1.046057 | correct |
| | 32.0 | 110 | 440 | 540 | 1,000,000 | 0 | 188212 | | 1.149098 | 0.689459 | correct | | 1.149098 | 1.059468 | correct |
| | 33.0 | 110 | 440 | 540 | 1,000,000 | 0 | 332684 | | 1.164021 | 0.698413 | correct | | 1.164021 | 1.073228 | correct |
| | 34.0 | 110 | 440 | 540 | 1,000,000 | 0 | 507789 | | 1.179337 | 0.707602 | correct | | 1.179337 | 1.087349 | correct |
| | 35.0 | 110 | 440 | 540 | 1,000,000 | 0 | 680366 | | 1.195062 | 0.717037 | correct | | 1.195062 | 1.101847 | correct |
| | 36.0 | 110 | 440 | 540 | 1,000,000 | 0 | 819144 | | 1.211211 | 0.726727 | correct | | 1.211211 | 1.116737 | correct |
| | 37.0 | 110 | 440 | 540 | 1,000,000 | 0 | 913926 | | 1.227803 | 0.736682 | correct | | 1.227803 | 1.132035 | correct |
| | 38.0 | 110 | 440 | 540 | 1,000,000 | 0 | 964333 | | 1.244856 | 0.746914 | correct | | 1.244856 | 1.147757 | correct |
| | 39.0 | 110 | 440 | 540 | 1,000,000 | 0 | 987913 | | 1.262389 | 0.757433 | correct | | 1.262389 | 1.163923 | correct |
| | 40.0 | 110 | 440 | 540 | 1,000,000 | 0 | 996309 | | 1.280423 | 0.768254 | correct | | 1.280423 | 1.18055 | correct |
| | 41.0 | 110 | 440 | 540 | 1,000,000 | 0 | 998768 | | 1.29898 | 0.779388 | correct | | 1.29898 | 1.19766 | correct |
| | 42.0 | 110 | 440 | 540 | 1,000,000 | 0 | 999293 | | 1.318083 | 0.79085 | correct | | 1.318083 | 1.215272 | correct |
| | 43.0 | 110 | 440 | 540 | 1,000,000 | 0 | 999302 | | 1.337756 | 0.802653 | correct | | 1.337756 | 1.233411 | correct |
| | 44.0 | 110 | 440 | 540 | 1,000,000 | 0 | 999326 | | 1.358025 | 0.814815 | correct | | 1.358025 | 1.252099 | correct |
| | 45.0 | 110 | 440 | 540 | 1,000,000 | 0 | 999273 | | 1.378917 | 0.82735 | correct | | 1.378917 | 1.271362 | correct |

## S460 t63 Correlation

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | 0.6 | | | 0.933 | |
| 10.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.875926 | 0.525556 | correct | 0.875926 | 0.817239 | correct |
| 11.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.884774 | 0.530864 | correct | 0.884774 | 0.825494 | correct |
| 12.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.893802 | 0.536281 | correct | 0.893802 | 0.833917 | correct |
| 13.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.903016 | 0.54181 | correct | 0.903016 | 0.842514 | correct |
| 14.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.912423 | 0.547454 | correct | 0.912423 | 0.851291 | correct |
| 15.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.922027 | 0.553216 | correct | 0.922027 | 0.860251 | correct |
| 16.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.931836 | 0.559102 | correct | 0.931836 | 0.869403 | correct |
| 17.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.941856 | 0.565114 | correct | 0.941856 | 0.878751 | correct |
| 18.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.952093 | 0.571256 | correct | 0.952093 | 0.888303 | correct |
| 19.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.962556 | 0.577534 | correct | 0.962556 | 0.898065 | correct |
| 20.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.973251 | 0.583951 | correct | 0.973251 | 0.908043 | correct |
| 21.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.984186 | 0.590512 | correct | 0.984186 | 0.918246 | correct |
| 22.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 0.99537 | 0.597222 | correct | 0.99537 | 0.928681 | correct |
| 23.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 1.006811 | 0.604087 | correct | 1.006811 | 0.939355 | correct |
| 24.0 | 110 | 430 | 540 | 1,000,000 | 0 | 0 | 1.018519 | 0.611111 | correct | 1.018519 | 0.950278 | correct |
| 25.0 | 110 | 430 | 540 | 1,000,000 | 0 | 3 | 1.030501 | 0.618301 | correct | 1.030501 | 0.961458 | correct |
| 26.0 | 110 | 430 | 540 | 1,000,000 | 0 | 19 | 1.042769 | 0.625661 | correct | 1.042769 | 0.972903 | correct |
| 27.0 | 110 | 430 | 540 | 1,000,000 | 0 | 144 | 1.055332 | 0.633199 | correct | 1.055332 | 0.984625 | correct |
| 28.0 | 110 | 430 | 540 | 1,000,000 | 0 | 826 | 1.068202 | 0.640921 | correct | 1.068202 | 0.996633 | correct |
| 28.1 | 110 | 430 | 540 | 1,000,000 | 0 | 924 | 1.069507 | 0.641704 | correct | 1.069507 | 0.99785 | correct |
| 28.2 | 110 | 430 | 540 | 1,000,000 | 0 | 1113 | 1.070814 | 0.642488 | correct | 1.070814 | 0.99907 | correct |
| 28.3 | 110 | 430 | 540 | 1,000,000 | 0 | 1287 | 1.072125 | 0.643275 | correct | 1.072125 | 1.000292 | correct |
| 28.4 | 110 | 430 | 540 | 1,000,000 | 0 | 1600 | 1.073439 | 0.644063 | correct | 1.073439 | 1.001518 | correct |
| 28.5 | 110 | 430 | 540 | 1,000,000 | 0 | 1772 | 1.074756 | 0.644853 | correct | 1.074756 | 1.002747 | correct |
| 28.6 | 110 | 430 | 540 | 1,000,000 | 0 | 2088 | 1.076076 | 0.645646 | correct | 1.076076 | 1.003979 | correct |
| 28.7 | 110 | 430 | 540 | 1,000,000 | 0 | 2436 | 1.0774 | 0.64644 | correct | 1.0774 | 1.005214 | correct |
| 28.8 | 110 | 430 | 540 | 1,000,000 | 0 | 2852 | 1.078727 | 0.647236 | correct | 1.078727 | 1.006452 | correct |
| 28.9 | 110 | 430 | 540 | 1,000,000 | 0 | 3157 | 1.080057 | 0.648034 | correct | 1.080057 | 1.007693 | correct |
| 29.0 | 110 | 430 | 540 | 1,000,000 | 0 | 3676 | 1.08139 | 0.648834 | correct | 1.08139 | 1.008937 | correct |
| 30.0 | 110 | 430 | 540 | 1,000,000 | 0 | 13372 | 1.094907 | 0.656944 | correct | 1.094907 | 1.021549 | correct |
| 31.0 | 110 | 430 | 540 | 1,000,000 | 0 | 39708 | 1.108767 | 0.66526 | correct | 1.108767 | 1.03448 | correct |
| 32.0 | 110 | 430 | 540 | 1,000,000 | 0 | 97480 | 1.122982 | 0.673789 | correct | 1.122982 | 1.047742 | correct |
| 33.0 | 110 | 430 | 540 | 1,000,000 | 0 | 200944 | 1.137566 | 0.68254 | correct | 1.137566 | 1.061349 | correct |
| 34.0 | 110 | 430 | 540 | 1,000,000 | 0 | 352072 | 1.152534 | 0.69152 | correct | 1.152534 | 1.075314 | correct |
| 35.0 | 110 | 430 | 540 | 1,000,000 | 0 | 527806 | 1.167901 | 0.700741 | correct | 1.167901 | 1.089652 | correct |
| 36.0 | 110 | 430 | 540 | 1,000,000 | 0 | 698920 | 1.183684 | 0.71021 | correct | 1.183684 | 1.104377 | correct |
| 37.0 | 110 | 430 | 540 | 1,000,000 | 0 | 833667 | 1.199899 | 0.719939 | correct | 1.199899 | 1.119505 | correct |
| 38.0 | 110 | 430 | 540 | 1,000,000 | 0 | 921703 | 1.216564 | 0.729938 | correct | 1.216564 | 1.135054 | correct |
| 39.0 | 110 | 430 | 540 | 1,000,000 | 0 | 968380 | 1.233698 | 0.740219 | correct | 1.233698 | 1.151041 | correct |
| 40.0 | 110 | 430 | 540 | 1,000,000 | 0 | 989563 | 1.251323 | 0.750794 | correct | 1.251323 | 1.167484 | correct |
| 41.0 | 110 | 430 | 540 | 1,000,000 | 0 | 997279 | 1.269458 | 0.761675 | correct | 1.269458 | 1.184404 | correct |
| 42.0 | 110 | 430 | 540 | 1,000,000 | 0 | 999266 | 1.288126 | 0.772876 | correct | 1.288126 | 1.201822 | correct |
| 43.0 | 110 | 430 | 540 | 1,000,000 | 0 | 999714 | 1.307352 | 0.784411 | correct | 1.307352 | 1.21976 | correct |
| 44.0 | 110 | 430 | 540 | 1,000,000 | 0 | 999731 | 1.32716 | 0.796296 | correct | 1.32716 | 1.238241 | correct |
| 45.0 | 110 | 430 | 540 | 1,000,000 | 0 | 999737 | 1.347578 | 0.808547 | correct | 1.347578 | 1.257291 | correct |

# 13. OUTPUT FINITE ELEMENT MODEL VISUALIZATIONS

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | **S235** | | | | |
| | | | | **1 hole** | | | | |
| | | | | *27.8 mm* | | | | |
| $F_{u,fem}$ | 226.236 | kN | | | | | | |
| Time | Load | Displacement | Displacement left | Displacement right | | global strain | abs Load | abs Displacement |
| 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| 0.0025 | -38701.1 | -0.125 | -0.04396 | -0.08104 | | 0.023683 | 38.7011 | 0.125 |
| 0.005 | -77369.9 | -0.25 | -0.08789 | -0.16211 | | 0.047393 | 77.3699 | 0.25 |
| 0.00875 | -134062 | -0.4375 | -0.15211 | -0.28539 | | 0.085103 | 134.062 | 0.4375 |
| 0.009688 | -147215 | -0.48438 | -0.16688 | -0.3175 | | 0.096183 | 147.215 | 0.484375 |
| 0.010625 | -154756 | -0.53125 | -0.1752 | -0.35605 | | 0.115483 | 154.756 | 0.53125 |
| 0.011563 | -155591 | -0.57813 | -0.17615 | -0.40198 | | 0.144211 | 155.591 | 0.578125 |
| 0.0125 | -156143 | -0.625 | -0.17678 | -0.44822 | | 0.173334 | 156.143 | 0.625 |
| 0.013906 | -156930 | -0.69531 | -0.17769 | -0.51762 | | 0.217066 | 156.93 | 0.695313 |
| 0.016016 | -157978 | -0.80078 | -0.17892 | -0.62186 | | 0.282853 | 157.978 | 0.800781 |
| 0.01918 | -159451 | -0.95898 | -0.18063 | -0.77835 | | 0.381684 | 159.451 | 0.958984 |
| 0.023926 | -162269 | -1.19629 | -0.18389 | -1.0124 | | 0.529059 | 162.269 | 1.19629 |
| 0.031045 | -167081 | -1.55225 | -0.18942 | -1.36282 | | 0.749299 | 167.081 | 1.55225 |
| 0.038164 | -172723 | -1.9082 | -0.19595 | -1.71225 | | 0.968262 | 172.723 | 1.9082 |
| 0.045283 | -178529 | -2.26416 | -0.2032 | -2.06096 | | 1.186312 | 178.529 | 2.26416 |
| 0.055962 | -185871 | -2.7981 | -0.21392 | -2.58422 | | 1.513602 | 185.871 | 2.7981 |
| 0.058632 | -187581 | -2.93158 | -0.21661 | -2.71501 | | 1.595404 | 187.581 | 2.93158 |
| 0.061301 | -189211 | -3.06506 | -0.21921 | -2.84588 | | 1.677315 | 189.211 | 3.06506 |
| 0.065306 | -191532 | -3.26529 | -0.22299 | -3.04229 | | 1.800319 | 191.532 | 3.26529 |
| 0.071313 | -194797 | -3.56563 | -0.2284 | -3.33722 | | 1.985199 | 194.797 | 3.56563 |
| 0.073565 | -195982 | -3.67826 | -0.23035 | -3.44791 | | 2.054636 | 195.982 | 3.67826 |
| 0.076944 | -197634 | -3.8472 | -0.23245 | -3.61474 | | 2.159826 | 197.634 | 3.8472 |
| 0.082012 | -199960 | -4.10061 | -0.23754 | -3.86306 | | 2.315145 | 199.96 | 4.10061 |
| 0.089615 | -203262 | -4.48072 | -0.24548 | -4.23524 | | 2.547738 | 203.262 | 4.48072 |
| 0.101018 | -207620 | -5.0509 | -0.29505 | -4.75579 | | 2.848496 | 207.62 | 5.0509 |
| 0.112421 | -209853 | -5.62107 | -0.4179 | -5.20291 | | 3.055562 | 209.853 | 5.62107 |
| 0.123825 | -210657 | -6.19125 | -0.59152 | -5.59988 | | 3.198184 | 210.657 | 6.19125 |
| 0.135228 | -211197 | -6.76142 | -0.78051 | -5.98093 | | 3.32083 | 211.197 | 6.76142 |
| 0.146632 | -211685 | -7.33159 | -0.97724 | -6.35461 | | 3.433828 | 211.685 | 7.33159 |
| 0.163737 | -212759 | -8.18686 | -1.28443 | -6.90267 | | 3.587637 | 212.759 | 8.18686 |
| 0.180842 | -214556 | -9.04212 | -1.57766 | -7.46531 | | 3.759674 | 214.556 | 9.04212 |
| 0.197948 | -216170 | -9.89738 | -1.86524 | -8.03265 | | 3.938321 | 216.17 | 9.89738 |
| 0.215053 | -217481 | -10.7526 | -2.18253 | -8.57124 | | 4.079636 | 217.481 | 10.7526 |
| 0.232158 | -218549 | -11.6079 | -2.51291 | -9.09707 | | 4.204444 | 218.549 | 11.6079 |
| 0.257816 | -220492 | -12.8908 | -2.98394 | -9.90879 | | 4.421999 | 220.492 | 12.8908 |
| 0.296303 | -223618 | -14.8151 | -3.64899 | -11.1666 | | 4.800517 | 223.618 | 14.8151 |
| 0.334789 | -226236 | -16.7395 | -4.22971 | -12.5087 | | 5.286711 | 226.236 | 16.7395 |
| 0.344411 | -225364 | -17.2206 | -4.22886 | -12.9907 | | 5.595045 | 225.364 | 17.2206 |
| 0.354033 | -221302 | -17.7016 | -4.22395 | -13.4766 | | 5.908461 | 221.302 | 17.7016 |
| 0.363654 | -216007 | -18.1827 | -4.21761 | -13.9641 | | 6.223812 | 216.007 | 18.1827 |
| 0.36606 | -215179 | -18.303 | -4.21663 | -14.0853 | | 6.301833 | 215.179 | 18.303 |
| 0.368465 | -213806 | -18.4233 | -4.215 | -14.2072 | | 6.380715 | 213.806 | 18.4233 |
| 0.372073 | -211595 | -18.6037 | -4.21236 | -14.3903 | | 6.499323 | 211.595 | 18.6037 |
| 0.377486 | -208107 | -18.8743 | -4.20821 | -14.665 | | 6.677388 | 208.107 | 18.8743 |
| 0.382898 | -204722 | -19.1449 | -4.20418 | -14.9397 | | 6.855377 | 204.722 | 19.1449 |
| 0.38831 | -201268 | -19.4155 | -4.20008 | -15.2144 | | 7.03341 | 201.268 | 19.4155 |
| 0.393722 | -197741 | -19.6861 | -4.1959 | -15.4892 | | 7.211558 | 197.741 | 19.6861 |
| 0.399134 | -194121 | -19.9567 | -4.1916 | -15.7641 | | 7.389847 | 194.121 | 19.9567 |
| 0.404547 | -190376 | -20.2273 | -4.18716 | -16.0392 | | 7.568352 | 190.376 | 20.2273 |
| 0.409959 | -186495 | -20.4979 | -4.18256 | -16.3145 | | 7.747088 | 186.495 | 20.4979 |
| 0.415371 | -182509 | -20.7686 | -4.17784 | -16.5898 | | 7.9259 | 182.509 | 20.7686 |
| 0.420783 | -178464 | -21.0392 | -4.17306 | -16.8653 | | 8.104879 | 178.464 | 21.0392 |
| 0.426196 | -174389 | -21.3098 | -4.16824 | -17.1408 | | 8.283883 | 174.389 | 21.3098 |
| 0.431608 | -170307 | -21.5804 | -4.16343 | -17.4163 | | 8.46288 | 170.307 | 21.5804 |
| 0.43702 | -166227 | -21.851 | -4.15863 | -17.6918 | | 8.641871 | 166.227 | 21.851 |
| 0.442432 | -162156 | -22.1216 | -4.15384 | -17.9674 | | 8.82092 | 162.156 | 22.1216 |
| 0.444462 | -161381 | -22.2231 | -4.15294 | -18.0698 | | 8.886884 | 161.381 | 22.2231 |
| 0.447506 | -158877 | -22.3753 | -4.14999 | -18.2251 | | 8.987937 | 158.877 | 22.3753 |
| 0.452073 | -155154 | -22.6036 | -4.14561 | -18.4579 | | 9.139393 | 155.154 | 22.6036 |
| 0.458922 | -149610 | -22.9461 | -4.1391 | -18.8073 | | 9.366667 | 149.61 | 22.9461 |
| 0.469197 | -141407 | -23.4599 | -4.12947 | -19.3312 | | 9.707363 | 141.407 | 23.4599 |
| 0.484609 | -129416 | -24.2305 | -4.11542 | -20.1172 | | 10.21825 | 129.416 | 24.2305 |
| 0.488462 | -130948 | -24.4231 | -4.11727 | -20.3083 | | 10.3391 | 130.948 | 24.4231 |
| 0.492315 | -128450 | -24.6158 | -4.11435 | -20.5042 | | 10.46606 | 128.45 | 24.6158 |
| 0.498095 | -124366 | -24.9047 | -4.10956 | -20.7985 | | 10.65705 | 124.366 | 24.9047 |
| 0.506764 | -118429 | -25.3382 | -4.10261 | -21.2399 | | 10.94335 | 118.429 | 25.3382 |
| 0.515433 | -113831 | -25.7717 | -4.09725 | -21.6798 | | 11.22768 | 113.831 | 25.7717 |
| 0.524103 | -109451 | -26.2051 | -4.09214 | -22.1193 | | 11.5116 | 109.451 | 26.2051 |
| 0.532772 | -105303 | -26.6386 | -4.08729 | -22.5586 | | 11.79522 | 105.303 | 26.6386 |
| 0.541441 | -101337 | -27.0721 | -4.08265 | -22.9976 | | 12.07851 | 101.337 | 27.0721 |
| 0.543609 | -103182 | -27.1804 | -4.08486 | -23.1039 | | 12.14498 | 103.182 | 27.1804 |
| 0.544421 | -103232 | -27.2211 | -4.08492 | -23.1446 | | 12.17093 | 103.232 | 27.2211 |
| 0.54564 | -102497 | -27.282 | -4.08406 | -23.2065 | | 12.21101 | 102.497 | 27.282 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | | **S235** | | | | |
| | | | | **1 hole** | | | | |
| | | | | *36.0 mm* | | | | |
| $F_{u,fem}$ | 202.107 | kN | | | | | | |
| Time | Load | Displacement | Displacement left | Displacement right | | global strain | abs Load | abs Displacement |
| 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 |
| 0.0025 | -37834.9 | -0.125 | -0.04276 | -0.08224 | | 0.025209 | 37.8349 | 0.125 |
| 0.005 | -75609.7 | -0.25 | -0.08546 | -0.16454 | | 0.050492 | 75.6097 | 0.25 |
| 0.00875 | -129474 | -0.4375 | -0.14596 | -0.29154 | | 0.092968 | 129.474 | 0.4375 |
| 0.009688 | -138596 | -0.48438 | -0.15601 | -0.32837 | | 0.110066 | 138.596 | 0.484375 |
| 0.010625 | -139689 | -0.53125 | -0.15721 | -0.37404 | | 0.138463 | 139.689 | 0.53125 |
| 0.011563 | -140243 | -0.57813 | -0.15783 | -0.4203 | | 0.16761 | 140.243 | 0.578125 |
| 0.0125 | -140771 | -0.625 | -0.15842 | -0.46658 | | 0.19678 | 140.771 | 0.625 |
| 0.013906 | -141519 | -0.69531 | -0.15928 | -0.53603 | | 0.24058 | 141.519 | 0.695313 |
| 0.016016 | -142502 | -0.80078 | -0.16043 | -0.64036 | | 0.306469 | 142.502 | 0.800781 |
| 0.01918 | -143885 | -0.95898 | -0.16205 | -0.79694 | | 0.405423 | 143.885 | 0.958984 |
| 0.023926 | -146534 | -1.19629 | -0.16514 | -1.03115 | | 0.553008 | 146.534 | 1.19629 |
| 0.031045 | -150863 | -1.55225 | -0.17016 | -1.38209 | | 0.773902 | 150.863 | 1.55225 |
| 0.038164 | -155840 | -1.9082 | -0.17585 | -1.73235 | | 0.993932 | 155.84 | 1.9082 |
| 0.045283 | -161334 | -2.26416 | -0.18225 | -2.08192 | | 1.213072 | 161.334 | 2.26416 |
| 0.055962 | -168890 | -2.7981 | -0.19189 | -2.60621 | | 1.541715 | 168.89 | 2.7981 |
| 0.059966 | -171482 | -2.99832 | -0.19557 | -2.80275 | | 1.664865 | 171.482 | 2.99832 |
| 0.065973 | -174965 | -3.29866 | -0.20078 | -3.0979 | | 1.850011 | 174.965 | 3.29866 |
| 0.074983 | -179440 | -3.74917 | -0.20801 | -3.54116 | | 2.128449 | 179.44 | 3.74917 |
| 0.078362 | -181056 | -3.91811 | -0.21058 | -3.70752 | | 2.233037 | 181.056 | 3.91811 |
| 0.08343 | -183347 | -4.17152 | -0.21429 | -3.95723 | | 2.390126 | 183.347 | 4.17152 |
| 0.091033 | -186532 | -4.55164 | -0.21947 | -4.33217 | | 2.626247 | 186.532 | 4.55164 |
| 0.102436 | -190920 | -5.12181 | -0.22646 | -4.89535 | | 2.981413 | 190.92 | 5.12181 |
| 0.119541 | -196627 | -5.97707 | -0.24029 | -5.73678 | | 3.509889 | 196.627 | 5.97707 |
| 0.136647 | -200770 | -6.83233 | -0.25426 | -6.57807 | | 4.038194 | 200.77 | 6.83233 |
| 0.140923 | -201456 | -7.04615 | -0.25763 | -6.7885 | | 4.170416 | 201.456 | 7.04615 |
| 0.145199 | -201906 | -7.25996 | -0.26026 | -6.99967 | | 4.303584 | 201.906 | 7.25996 |
| 0.151614 | -202107 | -7.58069 | -0.26217 | -7.31846 | | 4.505931 | 202.107 | 7.58069 |
| 0.161235 | -200283 | -8.06177 | -0.25998 | -7.80173 | | 4.81593 | 200.283 | 8.06177 |
| 0.170857 | -196026 | -8.54286 | -0.25505 | -8.28778 | | 5.129459 | 196.026 | 8.54286 |
| 0.180479 | -190768 | -9.02394 | -0.24902 | -8.77492 | | 5.444382 | 190.768 | 9.02394 |
| 0.182884 | -189974 | -9.14421 | -0.24812 | -8.8961 | | 5.522338 | 189.974 | 9.14421 |
| 0.18529 | -188625 | -9.26448 | -0.24658 | -9.01791 | | 5.601105 | 188.625 | 9.26448 |
| 0.188898 | -186451 | -9.44489 | -0.2441 | -9.20081 | | 5.719485 | 186.451 | 9.44489 |
| 0.19431 | -183000 | -9.7155 | -0.24016 | -9.47537 | | 5.897323 | 183 | 9.7155 |
| 0.199722 | -179696 | -9.98611 | -0.23641 | -9.74976 | | 6.074938 | 179.696 | 9.98611 |
| 0.205134 | -176389 | -10.2567 | -0.23265 | -10.0242 | | 6.252585 | 176.389 | 10.2567 |
| 0.210547 | -173095 | -10.5273 | -0.22891 | -10.2985 | | 6.430132 | 173.095 | 10.5273 |
| 0.215959 | -169827 | -10.7979 | -0.22521 | -10.5729 | | 6.607722 | 169.827 | 10.7979 |
| 0.224077 | -164496 | -11.2039 | -0.21916 | -10.9848 | | 6.874612 | 164.496 | 11.2039 |
| 0.232195 | -159735 | -11.6098 | -0.21377 | -11.3962 | | 7.140761 | 159.735 | 11.6098 |
| 0.240314 | -155075 | -12.0157 | -0.2085 | -11.8074 | | 7.406708 | 155.075 | 12.0157 |
| 0.248432 | -150538 | -12.4216 | -0.20337 | -12.2184 | | 7.672434 | 150.538 | 12.4216 |
| 0.25655 | -146131 | -12.8275 | -0.19839 | -12.6293 | | 7.938001 | 146.131 | 12.8275 |
| 0.264669 | -141858 | -13.2334 | -0.19357 | -13.0401 | | 8.203405 | 141.858 | 13.2334 |
| 0.272787 | -137702 | -13.6393 | -0.18888 | -13.4507 | | 8.468595 | 137.702 | 13.6393 |
| 0.280905 | -133644 | -14.0453 | -0.18431 | -13.8613 | | 8.733713 | 133.644 | 14.0453 |
| 0.289024 | -129659 | -14.4512 | -0.17982 | -14.2717 | | 8.998649 | 129.659 | 14.4512 |
| 0.297142 | -125703 | -14.8571 | -0.17536 | -14.6821 | | 9.263562 | 125.703 | 14.8571 |
| 0.30526 | -121715 | -15.263 | -0.17088 | -15.0926 | | 9.528559 | 121.715 | 15.263 |
| 0.313378 | -117655 | -15.6689 | -0.16631 | -15.5031 | | 9.793609 | 117.655 | 15.6689 |
| 0.315408 | -118459 | -15.7704 | -0.16725 | -15.6036 | | 9.857183 | 118.459 | 15.7704 |
| 0.317438 | -117381 | -15.8719 | -0.16603 | -15.7063 | | 9.923543 | 117.381 | 15.8719 |
| 0.320482 | -115559 | -16.0241 | -0.16397 | -15.8606 | | 10.02339 | 115.559 | 16.0241 |
| 0.323526 | -114062 | -16.1763 | -0.16228 | -16.0145 | | 10.12274 | 114.062 | 16.1763 |
| 0.326571 | -112553 | -16.3285 | -0.16058 | -16.1684 | | 10.22211 | 112.553 | 16.3285 |
| 0.329615 | -111048 | -16.4808 | -0.15888 | -16.3223 | | 10.32147 | 111.048 | 16.4808 |
| 0.332659 | -109551 | -16.633 | -0.15719 | -16.4761 | | 10.42076 | 109.551 | 16.633 |
| 0.335704 | -108063 | -16.7852 | -0.15551 | -16.63 | | 10.52011 | 108.063 | 16.7852 |
| 0.338748 | -106585 | -16.9374 | -0.15384 | -16.7839 | | 10.61945 | 106.585 | 16.9374 |
| 0.341792 | -105119 | -17.0896 | -0.15218 | -16.9377 | | 10.71872 | 105.119 | 17.0896 |
| 0.344837 | -103666 | -17.2418 | -0.15054 | -17.0916 | | 10.81805 | 103.666 | 17.2418 |
| 0.349403 | -100873 | -17.4702 | -0.14738 | -17.323 | | 10.96783 | 100.873 | 17.4702 |
| 0.356253 | -96685 | -17.8127 | -0.14265 | -17.6703 | | 11.19263 | 96.685 | 17.8127 |
| 0.358822 | -97556 | -17.9411 | -0.14367 | -17.7977 | | 11.27333 | 97.556 | 17.9411 |
| 0.362675 | -94998.2 | -18.1337 | -0.14077 | -17.9932 | | 11.40002 | 94.9982 | 18.1337 |
| 0.368454 | -91373.1 | -18.4227 | -0.13668 | -18.2864 | | 11.58986 | 91.3731 | 18.4227 |
| 0.369899 | -93407 | -18.495 | -0.13903 | -18.3563 | | 11.633 | 93.407 | 18.495 |
| 0.370261 | -93694.1 | -18.513 | -0.13936 | -18.374 | | 11.64409 | 93.6941 | 18.513 |
| 0.370802 | -93295 | -18.5401 | -0.1389 | -18.4015 | | 11.66194 | 93.295 | 18.5401 |
| 0.371615 | -92784.7 | -18.5808 | -0.13832 | -18.4428 | | 11.68868 | 92.7847 | 18.5808 |
| 0.372834 | -91982.9 | -18.6417 | -0.13742 | -18.5046 | | 11.72873 | 91.9829 | 18.6417 |
| 0.374663 | -90731.1 | -18.7331 | -0.136 | -18.5975 | | 11.78895 | 90.7311 | 18.7331 |

**S235**

**1 hole**

*42.7 mm*

$F_{u,fem}$ 183.628 kN

| Time | Load | Displacement | Displacement left | Displacement right | global strain | abs Load | abs Displacement |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0025 | -36914.5 | -0.125 | -0.04148 | -0.08352 | 0.026841 | 36.9145 | 0.125 |
| 0.005 | -73715.5 | -0.25 | -0.08284 | -0.16716 | 0.053847 | 73.7155 | 0.25 |
| 0.005938 | -87201.3 | -0.29688 | -0.09794 | -0.19893 | 0.064492 | 87.2013 | 0.296875 |
| 0.007344 | -106608 | -0.36719 | -0.11955 | -0.24763 | 0.081788 | 106.608 | 0.367188 |
| 0.009453 | -126320 | -0.47266 | -0.14122 | -0.33144 | 0.121469 | 126.32 | 0.472656 |
| 0.011563 | -127686 | -0.57813 | -0.14269 | -0.43543 | 0.186941 | 127.686 | 0.578125 |
| 0.013672 | -128784 | -0.68359 | -0.14392 | -0.53967 | 0.252714 | 128.784 | 0.683594 |
| 0.015781 | -129750 | -0.78906 | -0.14503 | -0.64403 | 0.318644 | 129.75 | 0.789063 |
| 0.018945 | -131083 | -0.94727 | -0.14659 | -0.80067 | 0.417681 | 131.083 | 0.947266 |
| 0.023691 | -133580 | -1.18457 | -0.14951 | -1.03506 | 0.565487 | 133.58 | 1.18457 |
| 0.030811 | -137621 | -1.54053 | -0.15423 | -1.38629 | 0.786758 | 137.621 | 1.54053 |
| 0.03793 | -142121 | -1.89648 | -0.15943 | -1.73705 | 1.007423 | 142.121 | 1.89648 |
| 0.045049 | -147083 | -2.25244 | -0.16509 | -2.08735 | 1.2275 | 147.083 | 2.25244 |
| 0.052168 | -152134 | -2.6084 | -0.17105 | -2.43734 | 1.447184 | 152.134 | 2.6084 |
| 0.062847 | -158945 | -3.14233 | -0.1798 | -2.96253 | 1.776966 | 158.945 | 3.14233 |
| 0.066851 | -161274 | -3.34256 | -0.18304 | -3.15952 | 1.900688 | 161.274 | 3.34256 |
| 0.072858 | -164342 | -3.6429 | -0.1876 | -3.45529 | 2.086645 | 164.342 | 3.6429 |
| 0.081868 | -168242 | -4.09341 | -0.19384 | -3.89955 | 2.366357 | 168.242 | 4.09341 |
| 0.090878 | -171689 | -4.54391 | -0.19939 | -4.3445 | 2.646939 | 171.689 | 4.54391 |
| 0.099889 | -174757 | -4.99442 | -0.20433 | -4.79007 | 2.928314 | 174.757 | 4.99442 |
| 0.113404 | -178653 | -5.67019 | -0.21048 | -5.45969 | 3.351987 | 178.653 | 5.67019 |
| 0.126919 | -181789 | -6.34595 | -0.21516 | -6.13077 | 3.77753 | 181.789 | 6.34595 |
| 0.140434 | -183515 | -7.02171 | -0.21776 | -6.80392 | 4.205719 | 183.515 | 7.02171 |
| 0.143813 | -183628 | -7.19065 | -0.21797 | -6.97266 | 4.31334 | 183.628 | 7.19065 |
| 0.147192 | -183571 | -7.35959 | -0.21795 | -7.14162 | 4.421244 | 183.571 | 7.35959 |
| 0.15226 | -182861 | -7.613 | -0.21711 | -7.39587 | 4.584138 | 182.861 | 7.613 |
| 0.159862 | -180084 | -7.99312 | -0.21385 | -7.77924 | 4.831027 | 180.084 | 7.99312 |
| 0.167465 | -176367 | -8.37323 | -0.20958 | -8.16363 | 5.079212 | 176.367 | 8.37323 |
| 0.175067 | -172102 | -8.75335 | -0.20472 | -8.54861 | 5.328152 | 172.102 | 8.75335 |
| 0.182669 | -167446 | -9.13347 | -0.19944 | -8.93402 | 5.57764 | 167.446 | 9.13347 |
| 0.190272 | -162495 | -9.51358 | -0.19382 | -9.31977 | 5.827552 | 162.495 | 9.51358 |
| 0.197874 | -157354 | -9.8937 | -0.18801 | -9.70574 | 6.077735 | 157.354 | 9.8937 |
| 0.205476 | -152122 | -10.2738 | -0.1821 | -10.0918 | 6.328035 | 152.122 | 10.2738 |
| 0.213079 | -146859 | -10.6539 | -0.17616 | -10.478 | 6.578441 | 146.859 | 10.6539 |
| 0.220681 | -141599 | -11.034 | -0.17024 | -10.8641 | 6.828776 | 141.599 | 11.034 |
| 0.228283 | -136346 | -11.4142 | -0.16433 | -11.2503 | 7.079165 | 136.346 | 11.4142 |
| 0.235886 | -131107 | -11.7943 | -0.15844 | -11.6365 | 7.329539 | 131.107 | 11.7943 |
| 0.243488 | -125900 | -12.1744 | -0.1526 | -12.0227 | 7.579884 | 125.9 | 12.1744 |
| 0.25109 | -120719 | -12.5545 | -0.1468 | -12.4089 | 7.830205 | 120.719 | 12.5545 |
| 0.252991 | -120368 | -12.6495 | -0.14643 | -12.5044 | 7.891425 | 120.368 | 12.6495 |
| 0.254891 | -119087 | -12.7446 | -0.14499 | -12.6009 | 7.953963 | 119.087 | 12.7446 |
| 0.257742 | -117053 | -12.8871 | -0.14272 | -12.7459 | 8.048011 | 117.053 | 12.8871 |
| 0.262019 | -114018 | -13.1009 | -0.13932 | -12.9633 | 8.189004 | 114.018 | 13.1009 |
| 0.268433 | -109534 | -13.4217 | -0.13431 | -13.2894 | 8.400443 | 109.534 | 13.4217 |
| 0.274848 | -105593 | -13.7424 | -0.12991 | -13.6149 | 8.611102 | 105.593 | 13.7424 |
| 0.281262 | -101790 | -14.0631 | -0.12568 | -13.9403 | 8.821597 | 101.79 | 14.0631 |
| 0.290884 | -95632.8 | -14.5442 | -0.11882 | -14.4291 | 9.138113 | 95.6328 | 14.5442 |
| 0.291485 | -97323.8 | -14.5743 | -0.12076 | -14.4572 | 9.154817 | 97.3238 | 14.5743 |
| 0.292086 | -96987.9 | -14.6043 | -0.12038 | -14.4876 | 9.174469 | 96.9879 | 14.6043 |
| 0.292688 | -96679.7 | -14.6344 | -0.12004 | -14.5181 | 9.194164 | 96.6797 | 14.6344 |
| 0.29359 | -96145.1 | -14.6795 | -0.11944 | -14.5638 | 9.223729 | 96.1451 | 14.6795 |
| 0.294943 | -95342.7 | -14.7471 | -0.11854 | -14.6325 | 9.268171 | 95.3427 | 14.7471 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |
| | | | | | 0 | 0 | 0 |

**S235**

**1 hole**

*46.1 mm*

$F_{u,fem}$ 174.289 kN

| Time | Load | Displacement | Displacement left | Displacement right | global strain | abs Load | abs Displacement |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 0.0025 | -36363.8 | -0.125 | -0.04072 | -0.08428 | 0.027817 | 36.3638 | 0.125 |
| 0.005 | -72567.8 | -0.25 | -0.08125 | -0.16875 | 0.055875 | 72.5678 | 0.25 |
| 0.005938 | -85731.5 | -0.29688 | -0.09592 | -0.20095 | 0.067072 | 85.7315 | 0.296875 |
| 0.007344 | -104404 | -0.36719 | -0.11658 | -0.2506 | 0.085585 | 104.404 | 0.367188 |
| 0.009453 | -120177 | -0.47266 | -0.13378 | -0.33887 | 0.130969 | 120.177 | 0.472656 |
| 0.011563 | -121376 | -0.57813 | -0.13505 | -0.44307 | 0.196693 | 121.376 | 0.578125 |
| 0.013672 | -122435 | -0.68359 | -0.13623 | -0.54736 | 0.262531 | 122.435 | 0.683594 |
| 0.015781 | -123365 | -0.78906 | -0.1373 | -0.65176 | 0.328522 | 123.365 | 0.789063 |
| 0.018945 | -124652 | -0.94727 | -0.13879 | -0.80847 | 0.427635 | 124.652 | 0.947266 |
| 0.023691 | -127097 | -1.18457 | -0.14165 | -1.04292 | 0.575526 | 127.097 | 1.18457 |
| 0.030811 | -131013 | -1.54053 | -0.14622 | -1.3943 | 0.796985 | 131.013 | 1.54053 |
| 0.03793 | -135328 | -1.89648 | -0.15123 | -1.74525 | 1.017895 | 135.328 | 1.89648 |
| 0.045049 | -139982 | -2.25244 | -0.15656 | -2.09587 | 1.238386 | 139.982 | 2.25244 |
| 0.055728 | -147135 | -2.78638 | -0.16494 | -2.62143 | 1.568638 | 147.135 | 2.78638 |
| 0.066406 | -153560 | -3.32031 | -0.1732 | -3.1471 | 1.89904 | 153.56 | 3.32031 |
| 0.077085 | -158822 | -3.85425 | -0.18087 | -3.67337 | 2.230204 | 158.822 | 3.85425 |
| 0.087764 | -163017 | -4.38818 | -0.18754 | -4.20064 | 2.562646 | 163.017 | 4.38818 |
| 0.091768 | -164428 | -4.58841 | -0.1898 | -4.3986 | 2.687609 | 164.428 | 4.58841 |
| 0.097775 | -166378 | -4.88875 | -0.19294 | -4.69579 | 2.875381 | 166.378 | 4.88875 |
| 0.106785 | -168939 | -5.33926 | -0.19709 | -5.14215 | 3.157764 | 168.939 | 5.33926 |
| 0.1203 | -172023 | -6.01502 | -0.202 | -5.813 | 3.583014 | 172.023 | 6.01502 |
| 0.133816 | -174143 | -6.69078 | -0.20524 | -6.48552 | 4.010394 | 174.143 | 6.69078 |
| 0.147331 | -174289 | -7.36654 | -0.20568 | -7.16085 | 4.441363 | 174.289 | 7.36654 |
| 0.15071 | -173722 | -7.53548 | -0.205 | -7.33047 | 4.55011 | 173.722 | 7.53548 |
| 0.154088 | -172748 | -7.70442 | -0.20384 | -7.50056 | 4.659464 | 172.748 | 7.70442 |
| 0.157467 | -171522 | -7.87336 | -0.20242 | -7.67093 | 4.769166 | 171.522 | 7.87336 |
| 0.160846 | -170128 | -8.0423 | -0.20082 | -7.84147 | 4.87909 | 170.128 | 8.0423 |
| 0.165914 | -167773 | -8.29572 | -0.19813 | -8.09757 | 5.044342 | 167.773 | 8.29572 |
| 0.173517 | -163815 | -8.67583 | -0.19365 | -8.48217 | 5.292798 | 163.815 | 8.67583 |
| 0.181119 | -159615 | -9.05595 | -0.18891 | -8.86703 | 5.541584 | 159.615 | 9.05595 |
| 0.188721 | -155186 | -9.43606 | -0.18392 | -9.25215 | 5.790695 | 155.186 | 9.43606 |
| 0.196324 | -150591 | -9.81618 | -0.17875 | -9.63745 | 6.040036 | 150.591 | 9.81618 |
| 0.203926 | -145906 | -10.1963 | -0.17349 | -10.0229 | 6.289533 | 145.906 | 10.1963 |
| 0.211528 | -141212 | -10.5764 | -0.16823 | -10.4083 | 6.538999 | 141.212 | 10.5764 |
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| 0.234335 | -127410 | -11.7168 | -0.15278 | -11.5643 | 7.28705 | 127.41 | 11.7168 |
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| 0.24954 | -118527 | -12.477 | -0.14286 | -12.3347 | 7.785337 | 118.527 | 12.477 |
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| 0.28375 | -100793 | -14.1875 | -0.12316 | -14.0659 | 8.903413 | 100.793 | 14.1875 |
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| 0.326157 | -80148.9 | -16.3079 | -0.10023 | -16.2107 | 10.28765 | 80.1489 | 16.3079 |
| 0.335779 | -76562.3 | -16.7889 | -0.09625 | -16.696 | 10.60009 | 76.5623 | 16.7889 |
| 0.3454 | -73253.5 | -17.27 | -0.09258 | -17.181 | 10.91214 | 73.2535 | 17.27 |
| 0.355022 | -70193.5 | -17.7511 | -0.08918 | -17.6657 | 11.22383 | 70.1935 | 17.7511 |
| 0.364644 | -67330.3 | -18.2322 | -0.086 | -18.1502 | 11.53525 | 67.3303 | 18.2322 |
| 0.374266 | -64591.7 | -18.7133 | -0.08294 | -18.6347 | 11.84659 | 64.5917 | 18.7133 |
| 0.37607 | -67156.4 | -18.8035 | -0.08588 | -18.7212 | 11.89995 | 67.1564 | 18.8035 |
| 0.377874 | -66408.7 | -18.8937 | -0.085 | -18.8128 | 11.95901 | 66.4087 | 18.8937 |
| 0.379678 | -66003.4 | -18.9839 | -0.08457 | -18.9031 | 12.01694 | 66.0034 | 18.9839 |
| 0.381482 | -65516.4 | -19.0741 | -0.084 | -18.9941 | 12.07541 | 65.5164 | 19.0741 |
| 0.382835 | -65439.4 | -19.1417 | -0.08394 | -19.0616 | 12.11856 | 65.4394 | 19.1417 |
| 0.384864 | -64440.1 | -19.2432 | -0.08278 | -19.1649 | 12.18526 | 64.4401 | 19.2432 |
| 0.38496 | -64892.8 | -19.248 | -0.08329 | -19.1691 | 12.18762 | 64.8928 | 19.248 |
| 0.385055 | -65160.5 | -19.2527 | -0.0836 | -19.1735 | 12.19023 | 65.1605 | 19.2527 |
| 0.38515 | -65247.4 | -19.2575 | -0.0837 | -19.1781 | 12.1931 | 65.2474 | 19.2575 |
| 0.385245 | -65297.3 | -19.2622 | -0.08377 | -19.1826 | 12.19593 | 65.2973 | 19.2622 |
| 0.38534 | -65345.7 | -19.267 | -0.08384 | -19.1872 | 12.19883 | 65.3457 | 19.267 |
| 0.385483 | -65372.7 | -19.2741 | -0.08388 | -19.1942 | 12.20327 | 65.3727 | 19.2741 |
| 0.385697 | -65318.8 | -19.2848 | -0.08382 | -19.205 | 12.21021 | 65.3188 | 19.2848 |
| 0.385911 | -65273.7 | -19.2955 | -0.08377 | -19.2157 | 12.21707 | 65.2737 | 19.2955 |
| 0.386125 | -65220.2 | -19.3062 | -0.0837 | -19.2265 | 12.22401 | 65.2202 | 19.3062 |
| 0.386446 | -65058.4 | -19.3223 | -0.08352 | -19.2427 | 12.23447 | 65.0584 | 19.3223 |