RobustImpact

Robust impact design of steel and composite building structures

Grant Agreement Number: RFSR-CT-2012-00029

Drawings for producing the test specimens

Deliverable D.4.2

Authors:

University of Stuttgart:	Nadine Hoffmann Ulrike Kuhlmann
University of Liege:	Clara Huvelle Jean-François Demonceau Jean-Pierre Jaspart
Università degli Studi di Trento:	Nadia Baldassino Fabio Freddi Riccardo Zandonini
University of Aachen:	Benno Hoffmeister Jonas Korndörfer Carles Colomer Segura

Date: 28.03.2014

Table of Contents

PART C: CONTRIBUTION FROM THE UNIVERSITA' DEGLI STUDI DI TRENTO

PART D: CONTRIBUTION FROM THE UNIVERSITY OF AACHEN

1 INTRODUCTION

Within the RFCS project RobustImpact an experimental campaign, aimed at investigating the behaviour of framed steel and concrete composite structures under accidental loading conditions, was planned.

The residual strength of the damaged member after an impact as well as the dynamic interaction of the member with the surrounding structure will be experimentally investigated. The activation of alternate load paths will be also studied through tests on 3D slab and 2D-beam systems. Additional tests on composite joints, beam-to-column joints, column bases and T-stub tests under high speed loading and impact loading will contribute at investigating the influences of strain rate effect on the deformation capacity of the connections.

The partners involved in the experimental activities are:

- University of Stuttgart (USTUTT);

- University of Liege (ULg);

- Università degli Studi di Trento (UTRE);

- University of Aachen (RWTH).

This document collects the drawings prepared by the above mentioned partners for producing the test specimens.

The document is divided in four parts (parts A-D) each of them related to the contribution of one of the partners. In particular:

- Part A is related to the contribution from the University of Stuttgart;
- Part B refers to the contribution from the University of Liege;
- Part C collects the contribution from the Università degli Studi di Trento;
- Part D is related the contribution from the University of Aachen.

The four parts are in the following collected.

RobustImpact

Robust impact design of steel and composite building structures

Grant Agreement Number: RFSR-CT-2012-00029

Drawings for producing the test specimens

Contribution from the University of Stuttgart

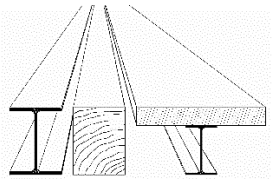
Deliverable D.4.2

Authors:

Nadine Hoffmann
Ulrike Kuhlmann

PART A

University of Stuttgart
Institute of Structural Design



Date: 17.03.2014

2 INTRODUCTION

Within the experimental tests planned to investigate at University of Stuttgart 6 test will be performed.

4 tests will be performed on composite joint tests with the objective to investigate the behaviour of the joint under high speed loading and the influence of the strain rate effect on the joints. The composite joint tests will be divided as follows:

- Two tests on positive moment joints
- Two tests on negative moment joints

Within these four tests two different speed loads will be investigated each for positive and negative moment joint respectively.

Additionally, two tests on 2D frames will be investigated at University of Stuttgart.

The detailed drawings for production of the test specimens are prepared by University of Stuttgart and sent to Arcelor Mittal.

In the following the pieces to be produced by Arcelor Mittal are reported, while the drawings are given in the Annex.

3 COMPOSITE JOINT TEST SPECIMENS

3.1 Joint tests series 1

Two test specimens for the positive composite joint tests (series 1) have to be produced. Therefore the following material is needed:

Test series 1	Material	Dimensions	Number of pieces
IPE 240	S355	2.675 m	4
HEB 220	S355	0.700 m	2
Endplate	S355	260 * 150 * 10 mm	4
Steel plate P1	S355	700 * 450 * 30 mm	4
Steel plate P2	S355	350 * 350 * 20 mm	8
Steel plate P8	S355	250 * 200 * 5 mm	16

3.2 Joint tests series 2

Two test specimens for the positive composite joint tests (series 2) have to be produced. Therefore the following material is needed:

Test series 2	Material	Dimensions	Number of pieces
IPE 240	S355	2.675 m	4
HEB 220	S355	0.700 m	2
Endplate	S355	260 * 150 * 10 mm	4
Steel plate P1	S355	700 * 450 * 30 mm	4
Steel plate P2	S355	350 * 350 * 20 mm	8
Steel plate P8	S355	250 * 200 * 5 mm	16

3.3 Test setup for joint tests

The test setup for the joint tests can be used for all the tests of both joint test series.

The following material is needed:

Test setup 1	Material	Dimensions	Number of pieces
HEB 220	S355	0.754 m	2
Steel plate P3	S355	320 * 220 * 20 mm	4
Steel plate P4	S355	220 * 220 * 20 mm	4
Steel plate P5	S355	270 * 220 * 20 mm	2

Test setup 2	Material	Dimensions	Number of pieces
Steel plate P6	S355	350 * 300 * 20 mm	4
Steel plate P7	S355	350 * 350 * 30 mm	2

4 FRAME TEST SPECIMENS

Two test specimens for the 2D frame tests have to be produced.

Therefore the following material is needed:

Frame tests	Material	Dimensions	Number of pieces
IPE 240	S355	4.760 m	4
IPE 240	S355	1.675 m	4
HEB 220	S355	0.700 m	2
HEB 220	S355	1.300 m	4
Endplate	S355	260 * 150 * 10 mm	12
Steel plate P1	S355	700 * 450 * 30 mm	4
Steel plate P2	S355	350 * 350 * 20 mm	8
Steel plate P8	S355	250 * 200 * 5 mm	16

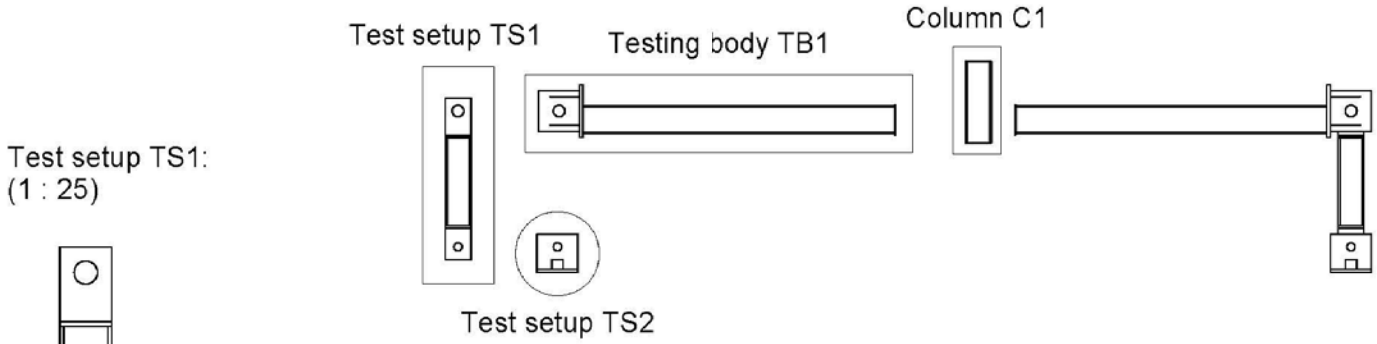
Test setup 1	Material	Dimensions	Number of pieces
HEB 220	S355	0.754 m	2
Steel plate P3	S355	320 * 220 * 20 mm	4
Steel plate P4	S355	220 * 220 * 20 mm	4
Steel plate P5	S355	270 * 220 * 20 mm	2

Test setup 2	Material	Dimensions	Number of pieces
Steel plate P6	S355	350 * 300 * 20 mm	8
Steel plate P7	S355	350 * 350 * 30 mm	4

.

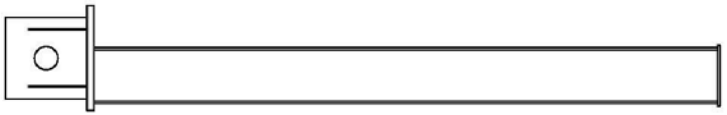
5 ANNEX: DRAWINGS FOR PRODUCING THE TEST SPECIMENS

Joint tests serie 1 (JT1)



Test setup TS1:
(1 : 25)

Testing body TB1:
(1 : 25)



Column C1:
(1 : 25)

Test setup TS2:
(1 : 25)

List of elements for 1 assembly	
Component	Quantity
C1	1
TB1	2
TS1	2
TS2	2

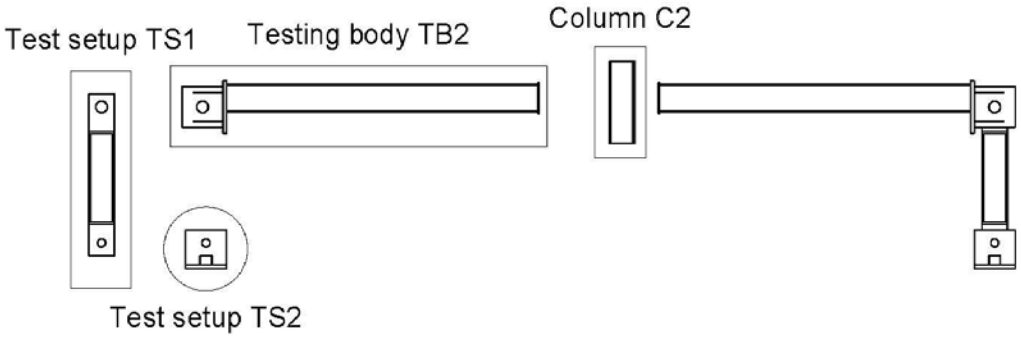
Material	Mass
S 355 JR	750.56 kg

Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de

Project: **RFSR-CT-2012-00029 RobustImpact**

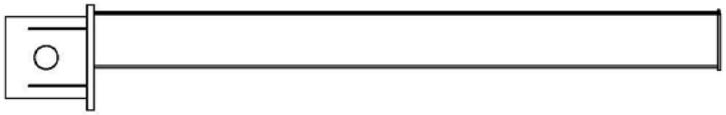
Layout: Joint Tests serie 1 JT1			Plan size: A4
Scale: 1 : 50 / 1 : 25	Plan No.: 1		Date: 06.06.2013
Drafter: **N. Hoffmann**	Version No.: 3		

Joint tests serie 2 (JT2)



Test setup TS1:
(1 : 25)

Testing body TB2:
(1 : 25)



Column C2:
(1 : 25)

Test setup TS2:
(1 : 25)

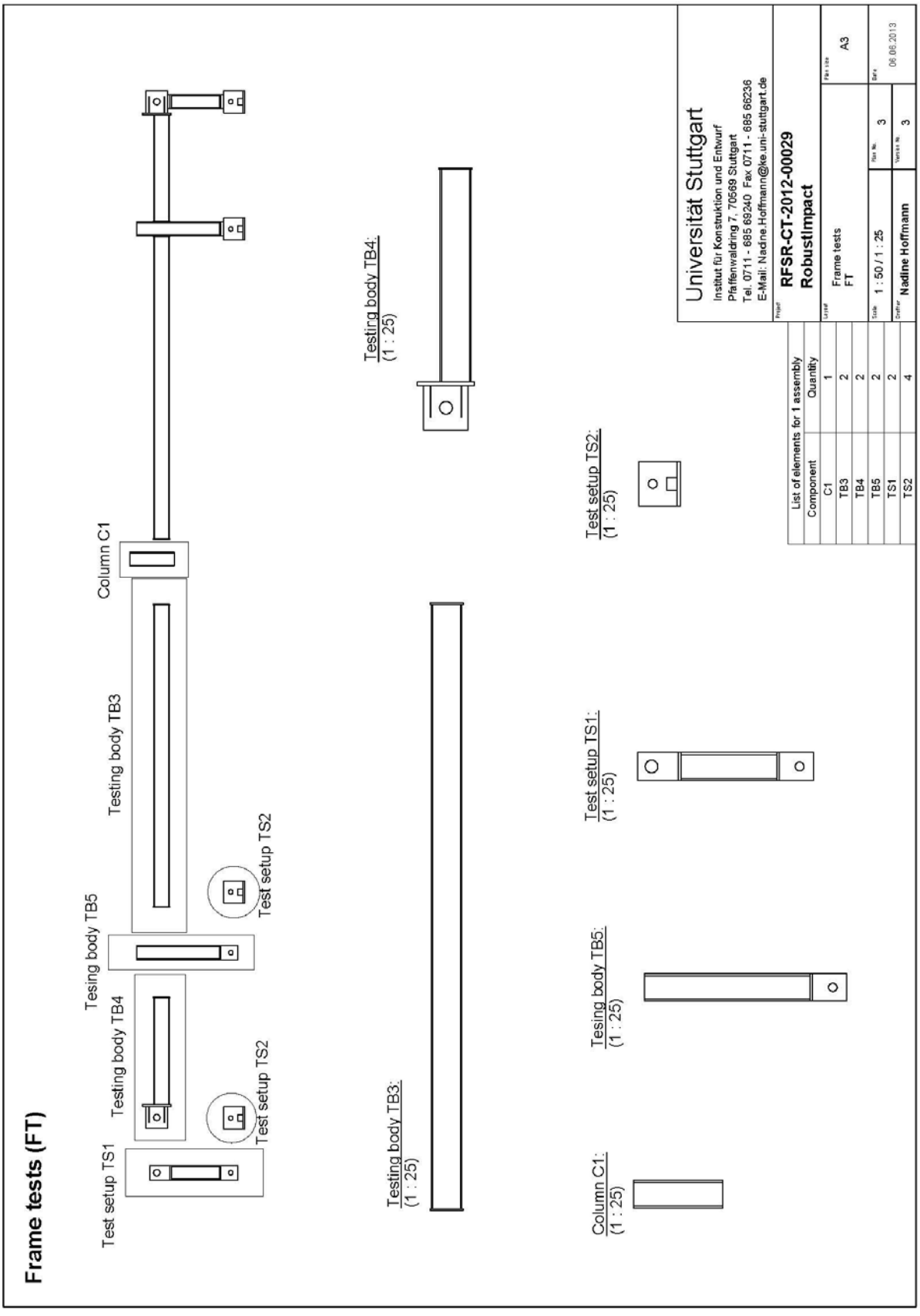
List of elements for 1 assembly	
Component	Quantity
C2	1
TB2	2
TS1	2
TS2	2

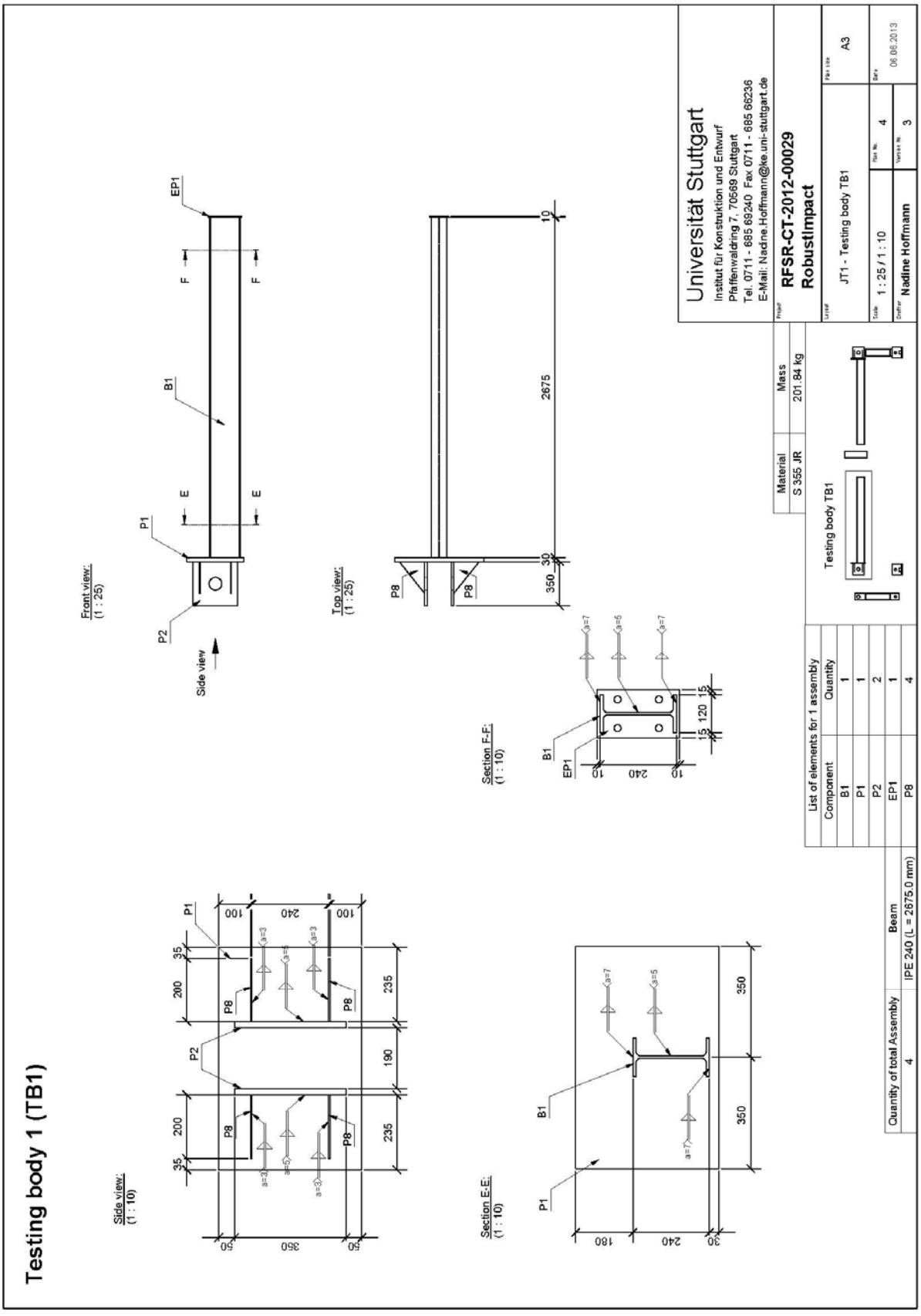
Material	Mass
S 355 JR	742.77 kg

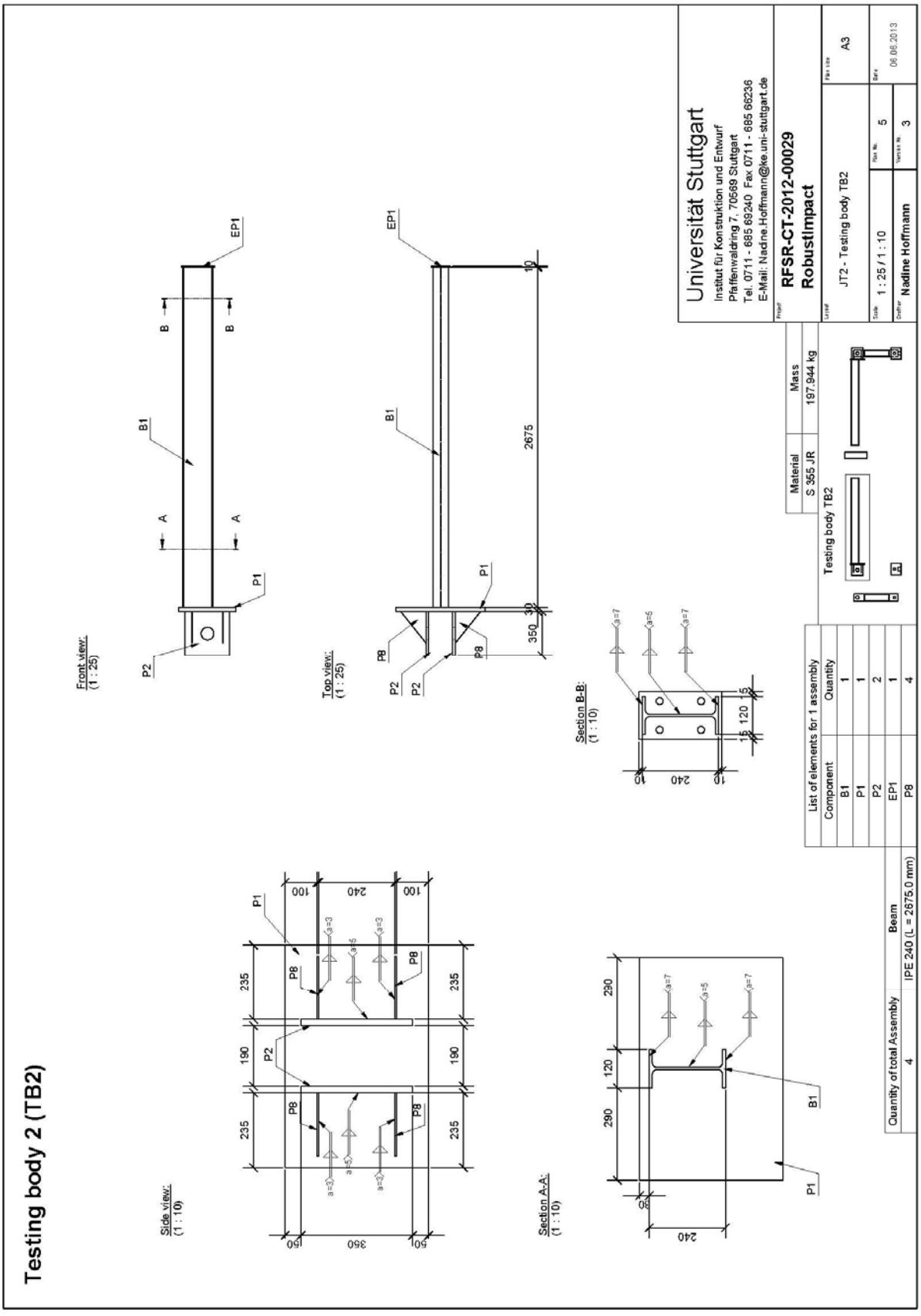
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de

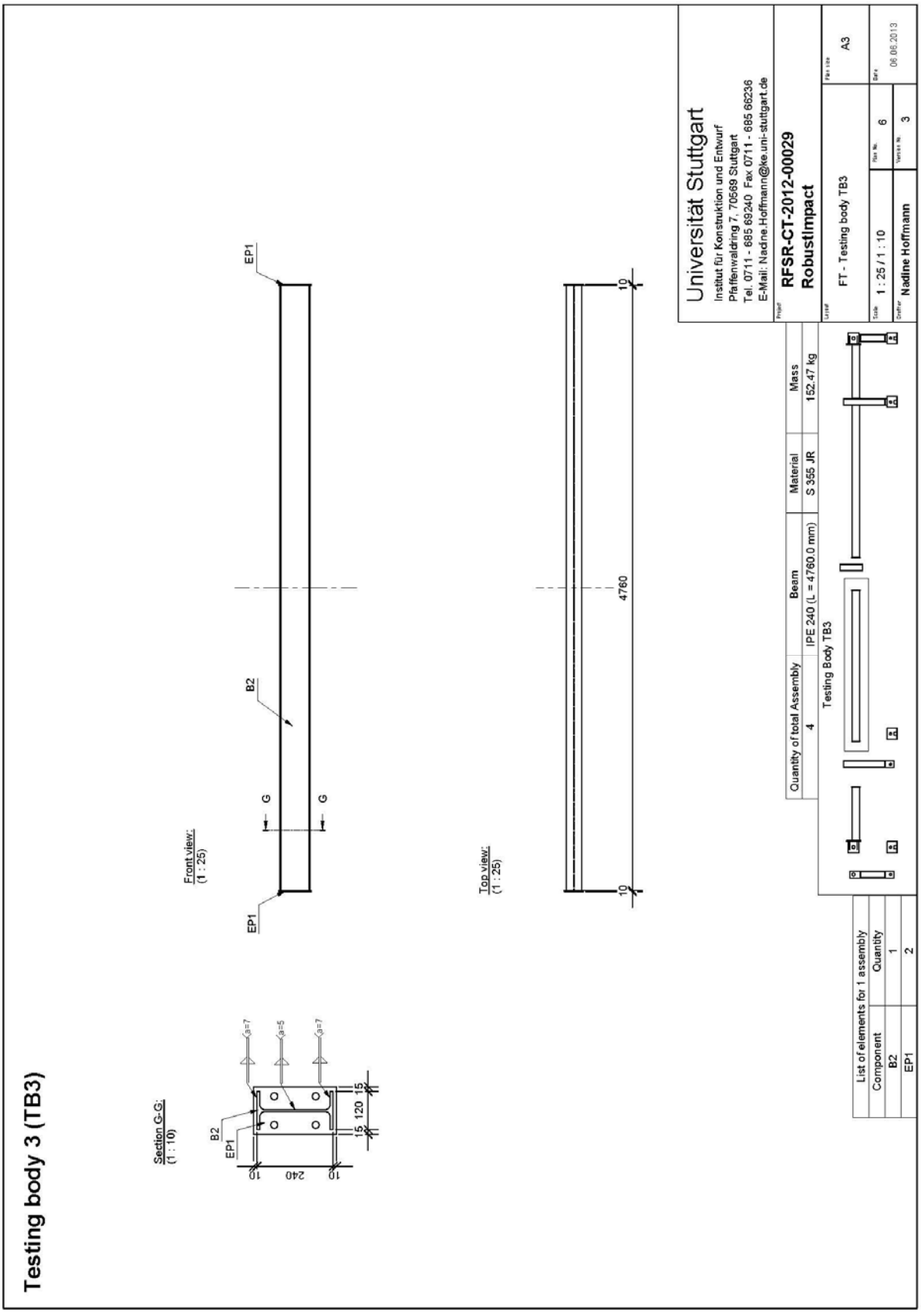
Project: **RFSR-CT-2012-00029 RobustImpact**

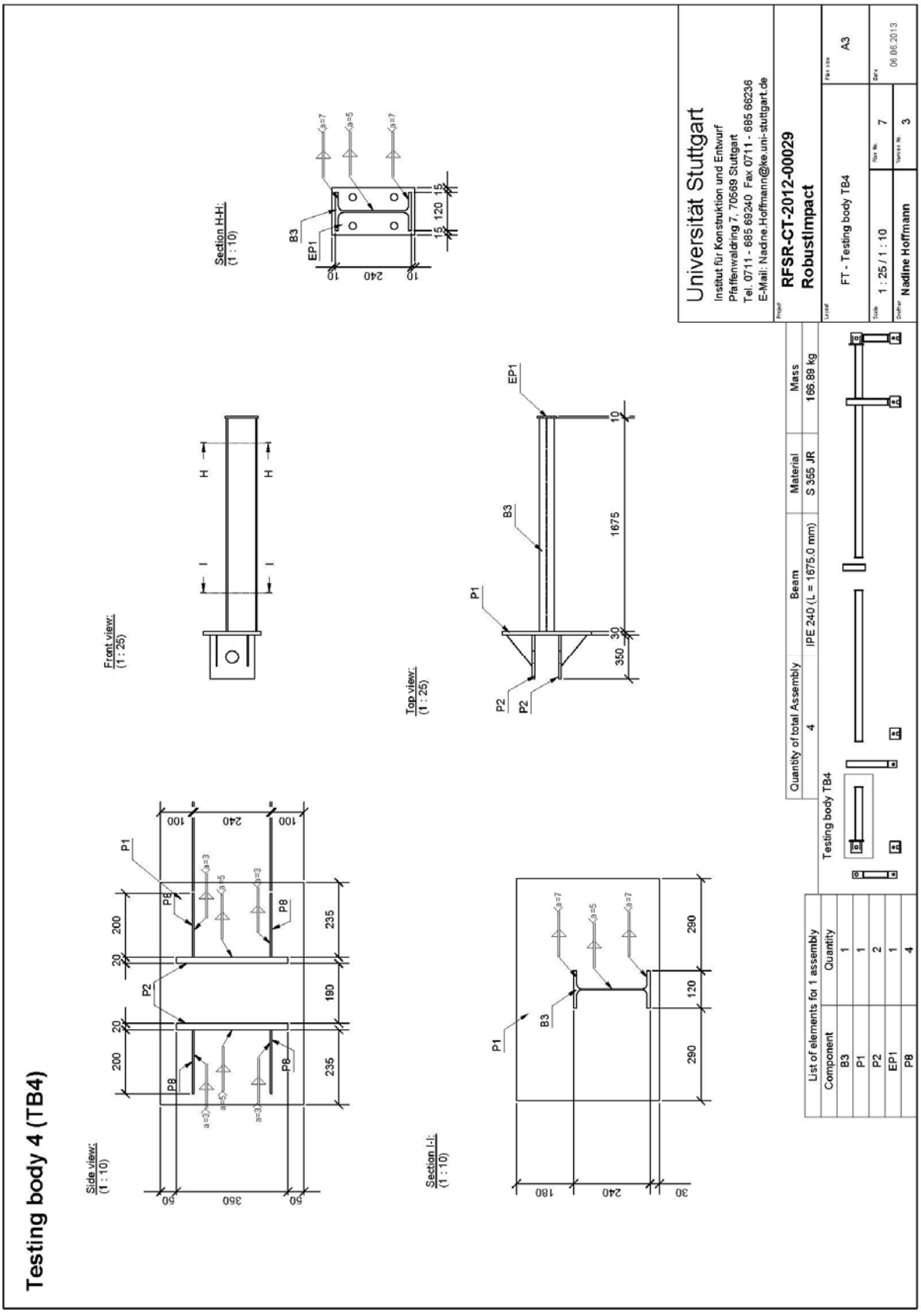
Layout: Joint tests serie 2 JT2			Plan size: A4
Scale: 1 : 50 / 1 : 25	Plan No.: 2		Date: 06.06.2013
Drafter: **N. Hoffmann**	Version No.: 3		

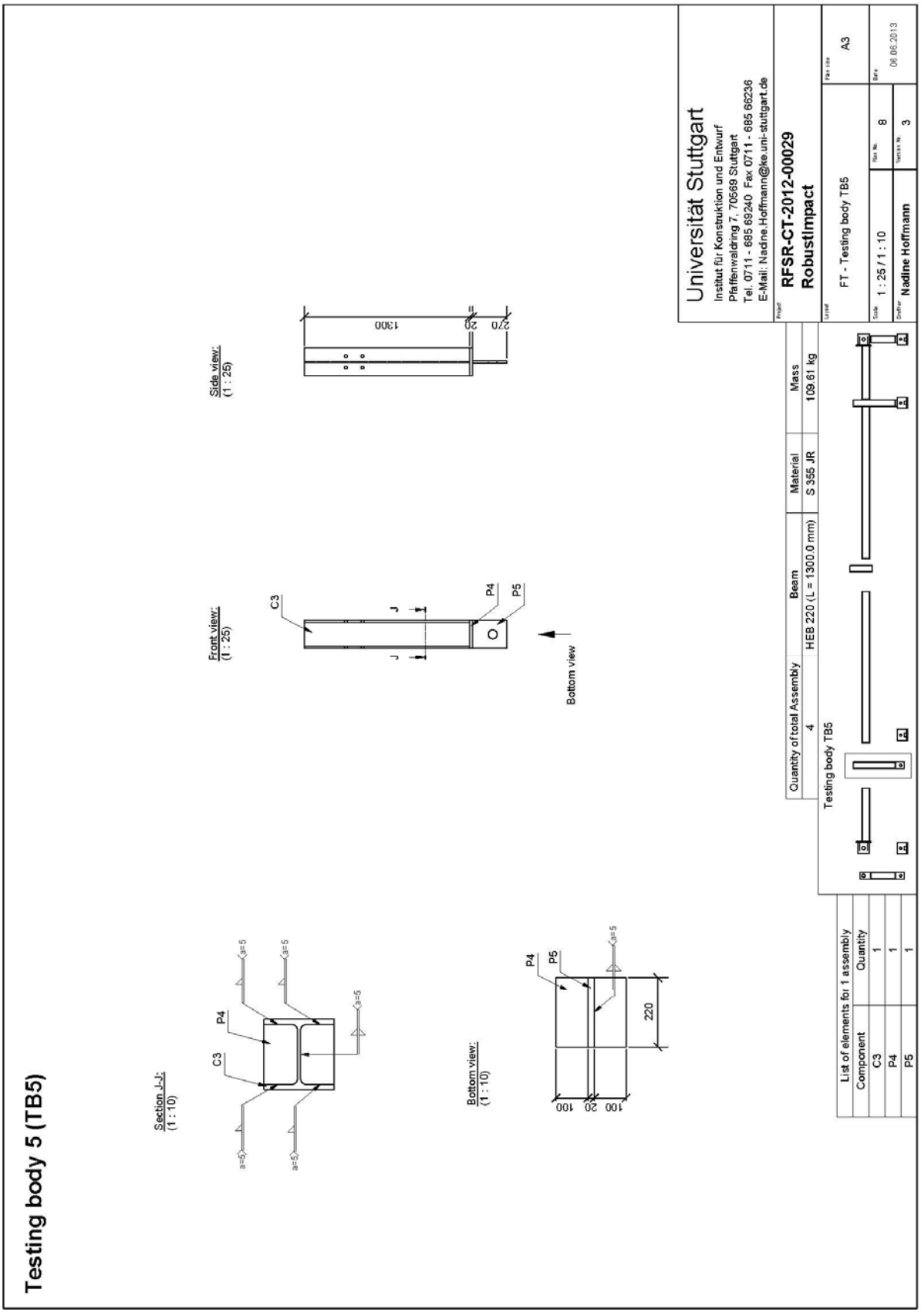

Frame tests (FT)
Test setup TS1
Testing body TB4
Tesing body TB5
Testing body TB3
Column C1
Test setup TS2
Test setup TS2
Testing body TB4:
(1 : 25)
Testing body TB3:
(1 : 25)
Test setup TS2:
(1 : 25)
Test setup TS1:
(1 : 25)
Tesing body TB5:
(1 : 25)
Column C1:
(1 : 25)
List of elements for 1 assembly
Component Quantity
C1 1
TB3 2
TB4 2
TB5 2
TS1 2
TS2 4
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ike.uni-stuttgart.de
Projekt RFSR-CT-2012-00029
RobustImpact
Inhalt Frame tests
FT
Plan size A3
Scale 1 : 50 / 1 : 25
Plan No. 3
Date 06.06.2013
Drafter Nadine Hoffmann
Version No. 3

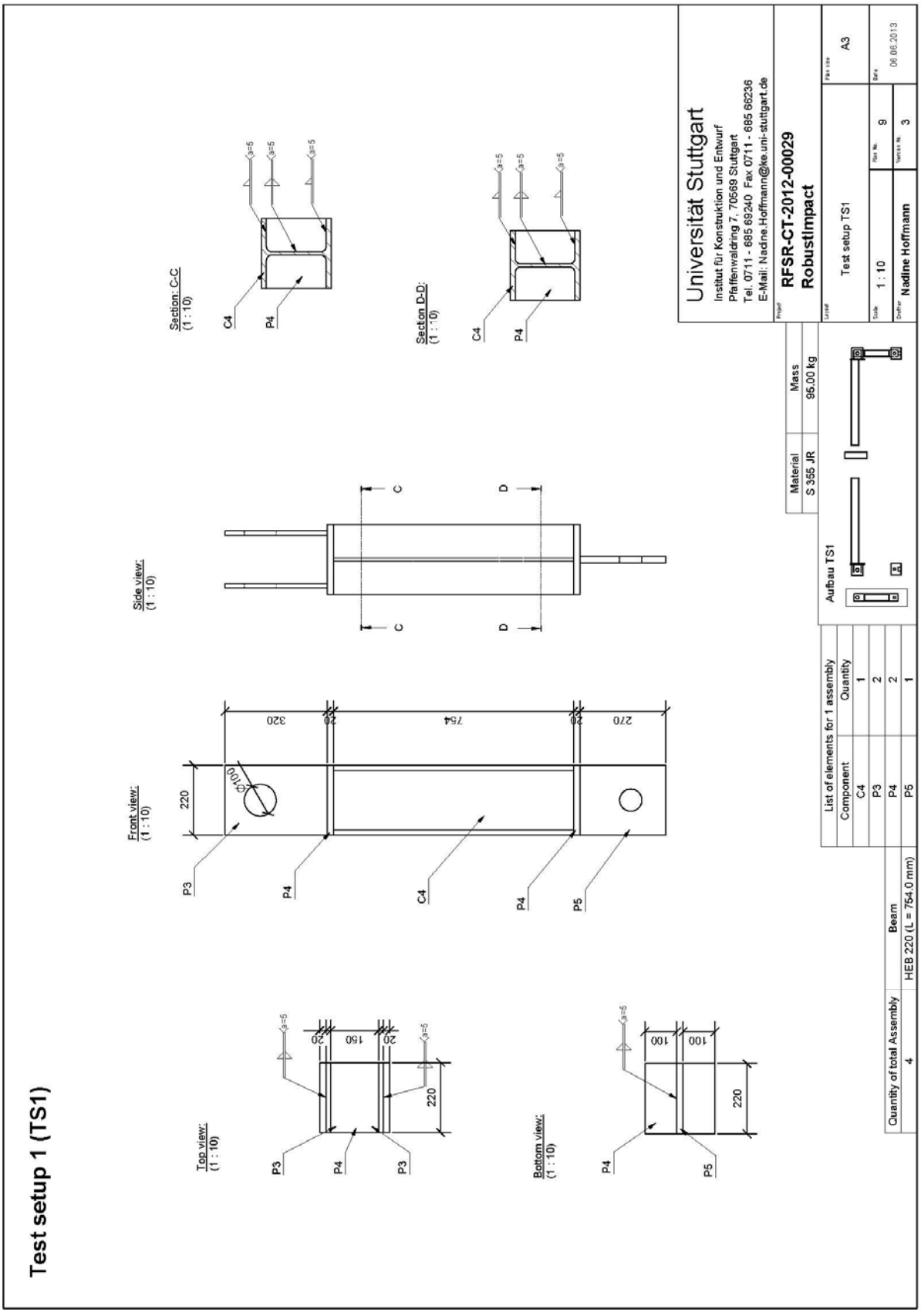

Testing body 1 (TB1)
Front view: (1 : 25)
Side view
Top view: (1 : 25)
Section F-F: (1 : 10)
Side view: (1 : 10)
Section E-E: (1 : 10)
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
RFSR-CT-2012-00029
RobustImpact
JT1 - Testing body TB1
A3
1 : 25 / 1 : 10
4
3
06.06.2013
Nadine Hoffmann
Material
S 355 JR
Mass
201.84 kg
Testing body TB1
List of elements for 1 assembly
Component
Quantity
B1
1
P1
1
P2
2
EP1
1
P8
4
Quantity of total Assembly
4
Beam
IPE 240 (L = 2675.0 mm)

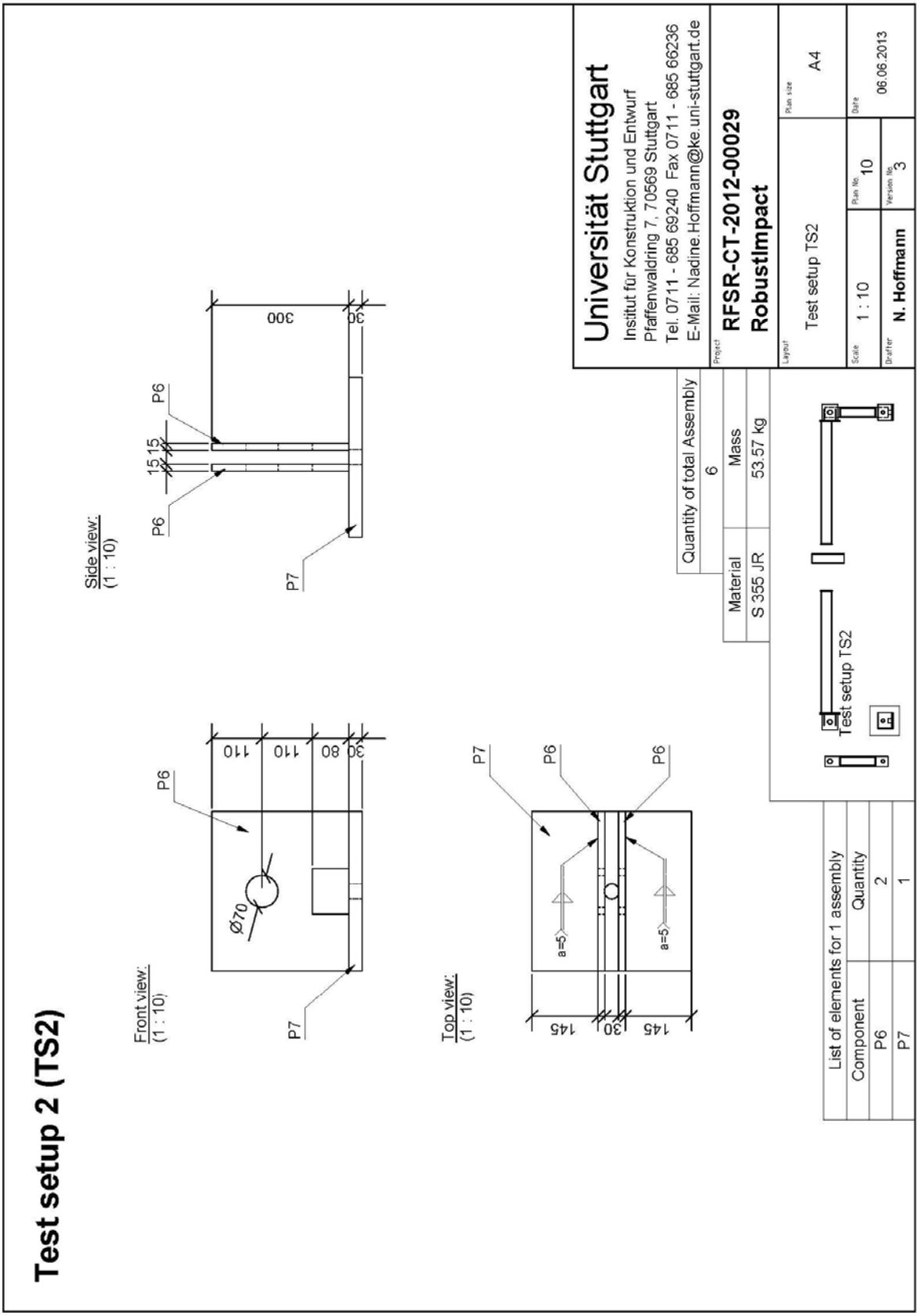

Testing body 2 (TB2)
Front view:
(1 : 25)
Top view:
(1 : 25)
Section B-B:
(1 : 10)
Side view:
(1 : 10)
Section A-A:
(1 : 10)
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ike.uni-stuttgart.de
RFSR-CT-2012-00029
RobustImpact
JT2 - Testing body TB2
A3
1 : 25 / 1 : 10
5
3
06.06.2013
Nadine Hoffmann
Testing body TB2
Material
S 355 JR
Mass
197.944 kg
List of elements for 1 assembly
Component
Quantity
B1
1
P1
1
P2
2
EP1
1
P8
4
Quantity of total Assembly
4
Beam
IPE 240 (L = 2675.0 mm)

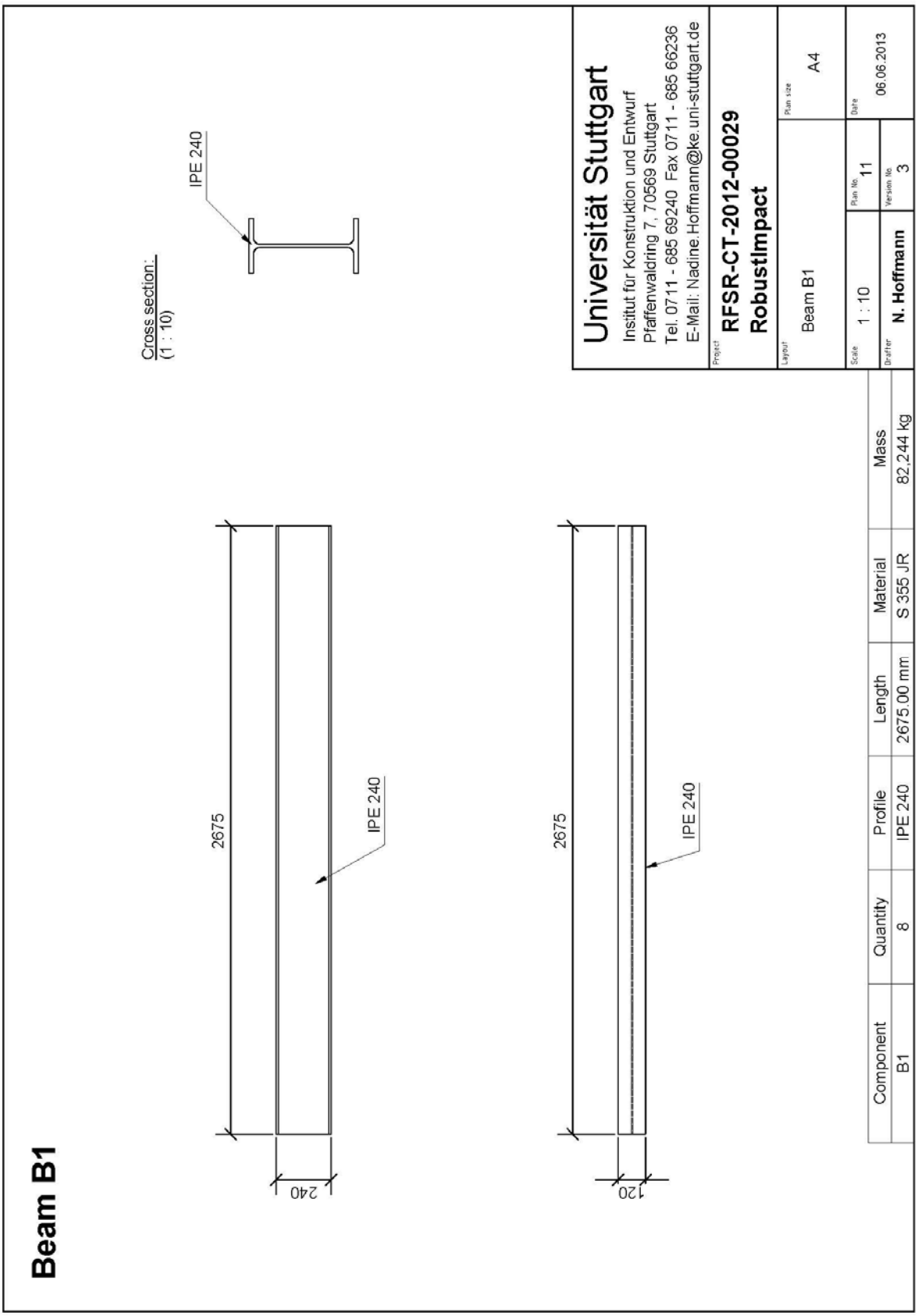

Testing body 3 (TB3)
Front view:
(1 : 25)
EP1
B2
G
G
EP1
Top view:
(1 : 25)
4760
10
10
Section G-G:
(1 : 10)
B2
EP1
a=7
a=5
a=7
15
120
15
15
240
15
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ike.uni-stuttgart.de
Projekt
RFSR-CT-2012-00029
RobustImpact
Inhalt
FT - Testing body TB3
Plan size
A3
Scale
1 : 25 / 1 : 10
Plan No.
6
Date
06.06.2013
Drafter
Nadine Hoffmann
Version No.
3
Quantity of total Assembly
4
Beam
IPE 240 (L = 4760.0 mm)
Material
S 355 JR
Mass
152.47 kg
Testing Body TB3
List of elements for 1 assembly
Component
Quantity
B2
1
EP1
2

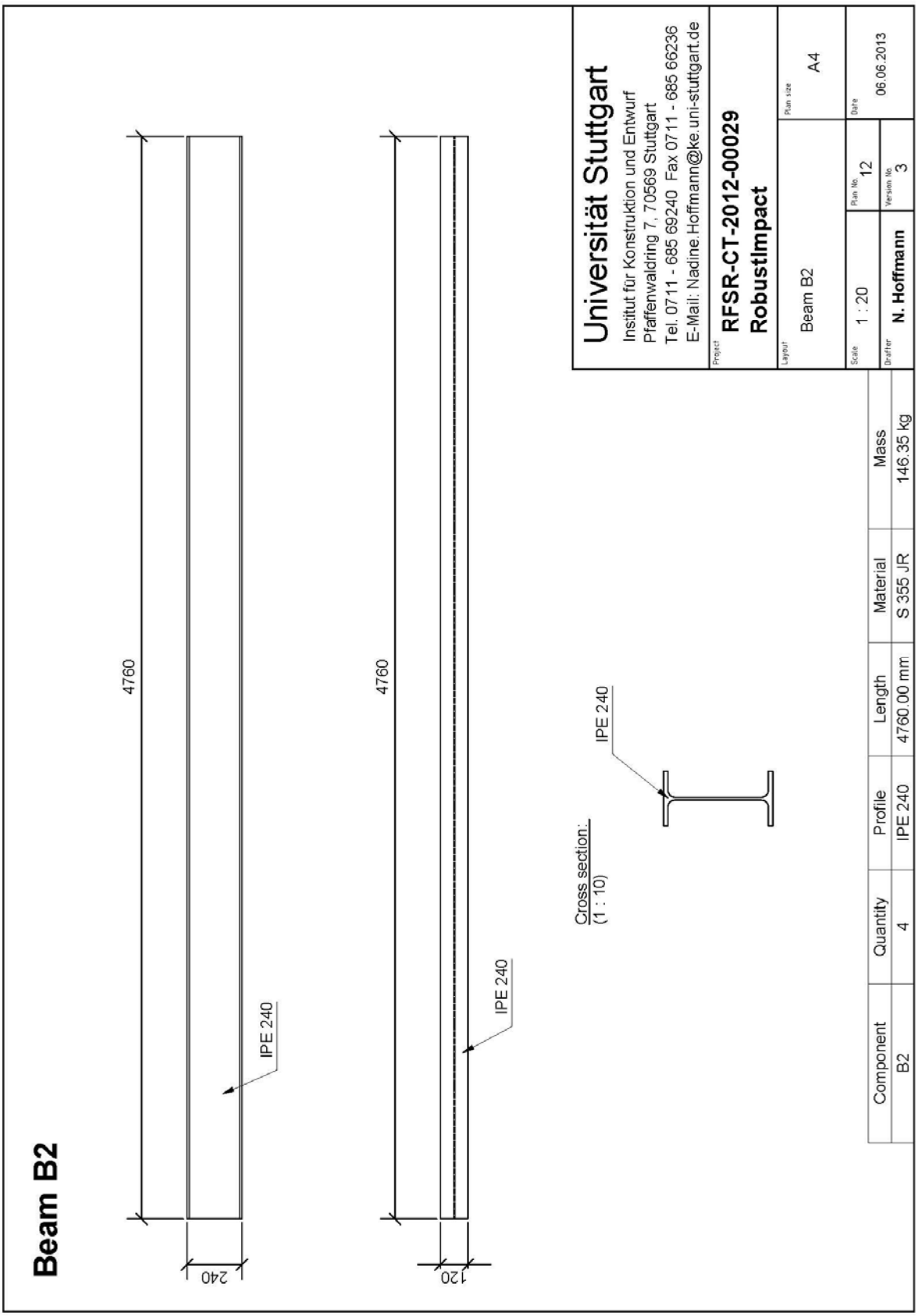

Testing body 4 (TB4)
Side view:
(1 : 10)
Front view:
(1 : 25)
Section H-H:
(1 : 10)
Top view:
(1 : 25)
Section I-I:
(1 : 10)
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ike.uni-stuttgart.de
RFSR-CT-2012-00029
RobustImpact
FT - Testing body TB4
A3
1 : 25 / 1 : 10
7
3
06.06.2013
Nadine Hoffmann
Quantity of total Assembly
4
Beam
IPE 240 (L = 1675.0 mm)
Material
S 355 JR
Mass
166.89 kg
Testing body TB4
List of elements for 1 assembly
Component
Quantity
B3
1
P1
1
P2
2
EP1
1
P8
4

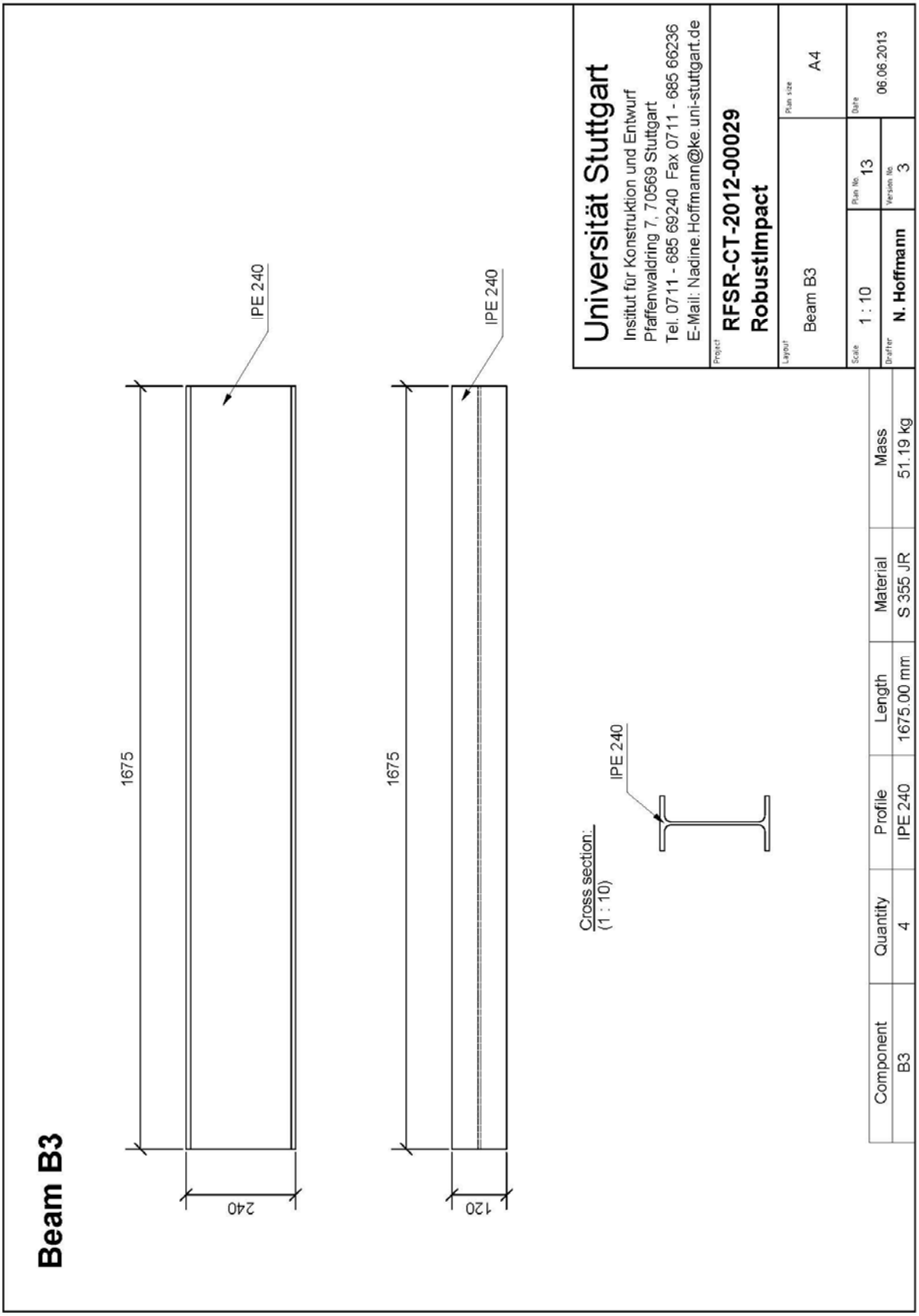

Testing body 5 (TB5)
Section J-J:
(1 : 10)
C3
P4
a=5
Front view:
(1 : 25)
C3
P4
P5
J
Side view:
(1 : 25)
1300
20
270
Bottom view
Bottom view:
(1 : 10)
P4
P5
220
100
20
100
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ike.uni-stuttgart.de
RFSR-CT-2012-00029
RobustImpact
FT - Testing body TB5
A3
1 : 25 / 1 : 10
8
3
06.06.2013
Nadine Hoffmann
Quantity of total Assembly
4
Beam
HEB 220 (L = 1300.0 mm)
Material
S 355 JR
Mass
109.61 kg
Testing body TB5
List of elements for 1 assembly
Component
Quantity
C3
1
P4
1
P5
1

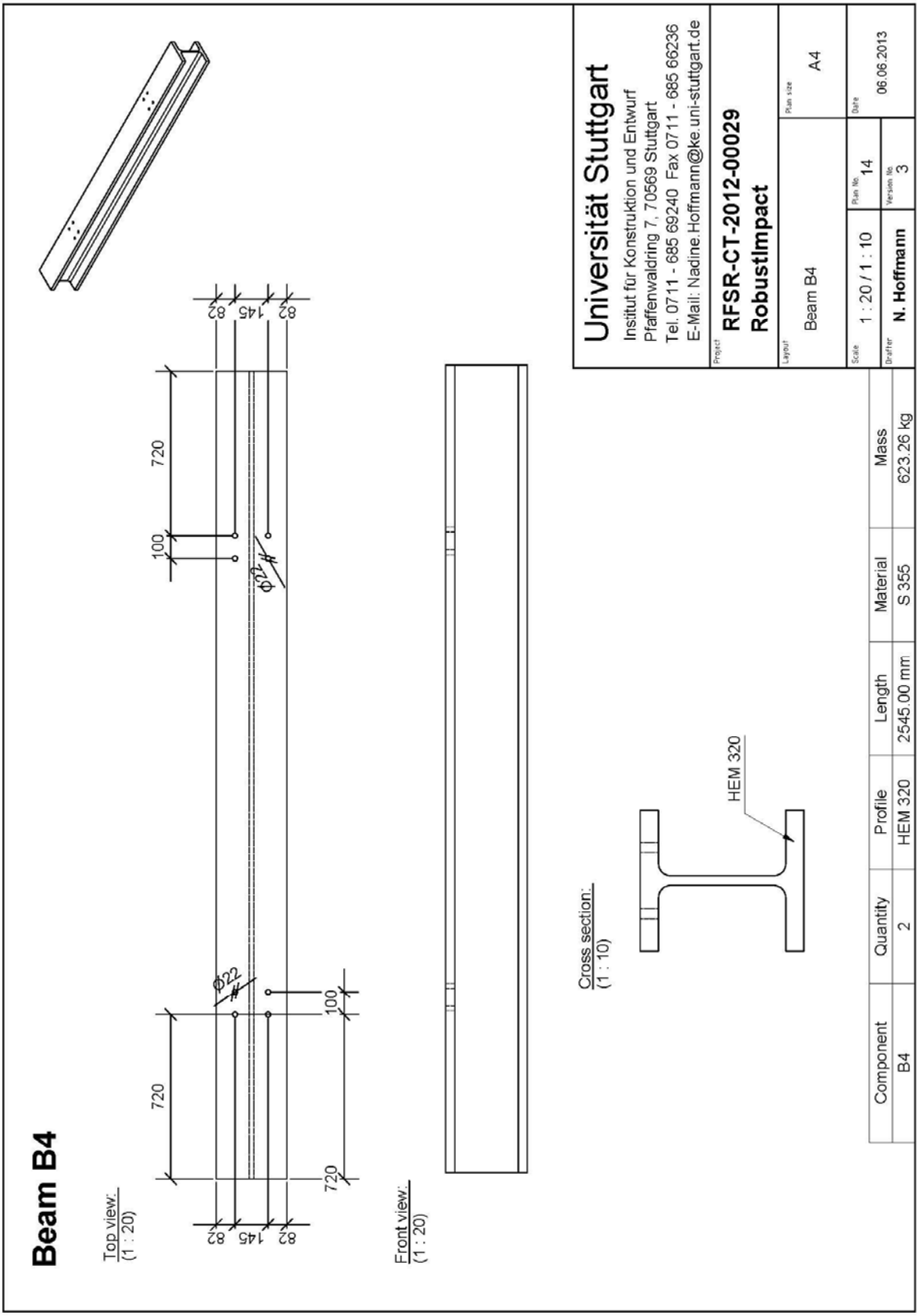

Test setup 1 (TS1)
Front view: (1 : 10)
Side view: (1 : 10)
Top view: (1 : 10)
Bottom view: (1 : 10)
Section C-C (1 : 10)
Section D-D (1 : 10)
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
RFSR-CT-2012-00029
RobustImpact
Test setup TS1
A3
1 : 10
9
3
06.06.2013
Nadine Hoffmann
Material
S 355 JR
Mass
96.00 kg
Aufbau TS1
List of elements for 1 assembly
Component
Quantity
C4
1
P3
2
P4
2
P5
1
Quantity of total Assembly
4
Beam
HEB 220 (L = 754.0 mm)

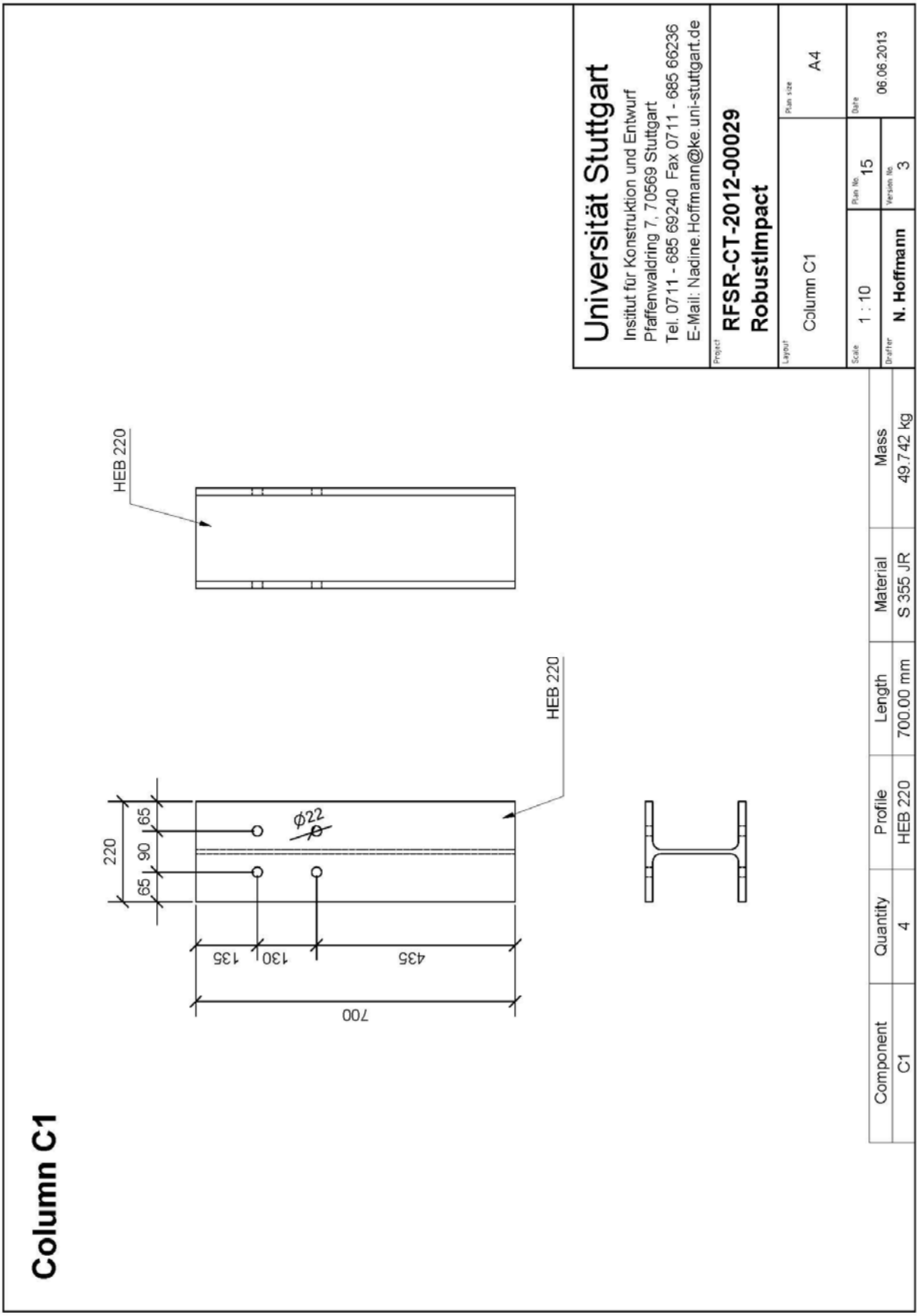

Test setup 2 (TS2)
Side view:
(1 : 10)
300
30
15 15
P6
P6
P7
Front view:
(1 : 10)
110
110
80
30
P6
Ø70
P7
Top view:
(1 : 10)
P7
P6
P6
a=5
a=5
145
30
145
Test setup TS2
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Test setup TS2
Plan size
A4
Scale
1 : 10
Plan No.
10
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3
Quantity of total Assembly
6
Material
S 355 JR
Mass
53.57 kg
List of elements for 1 assembly
Component
Quantity
P6
2
P7
1

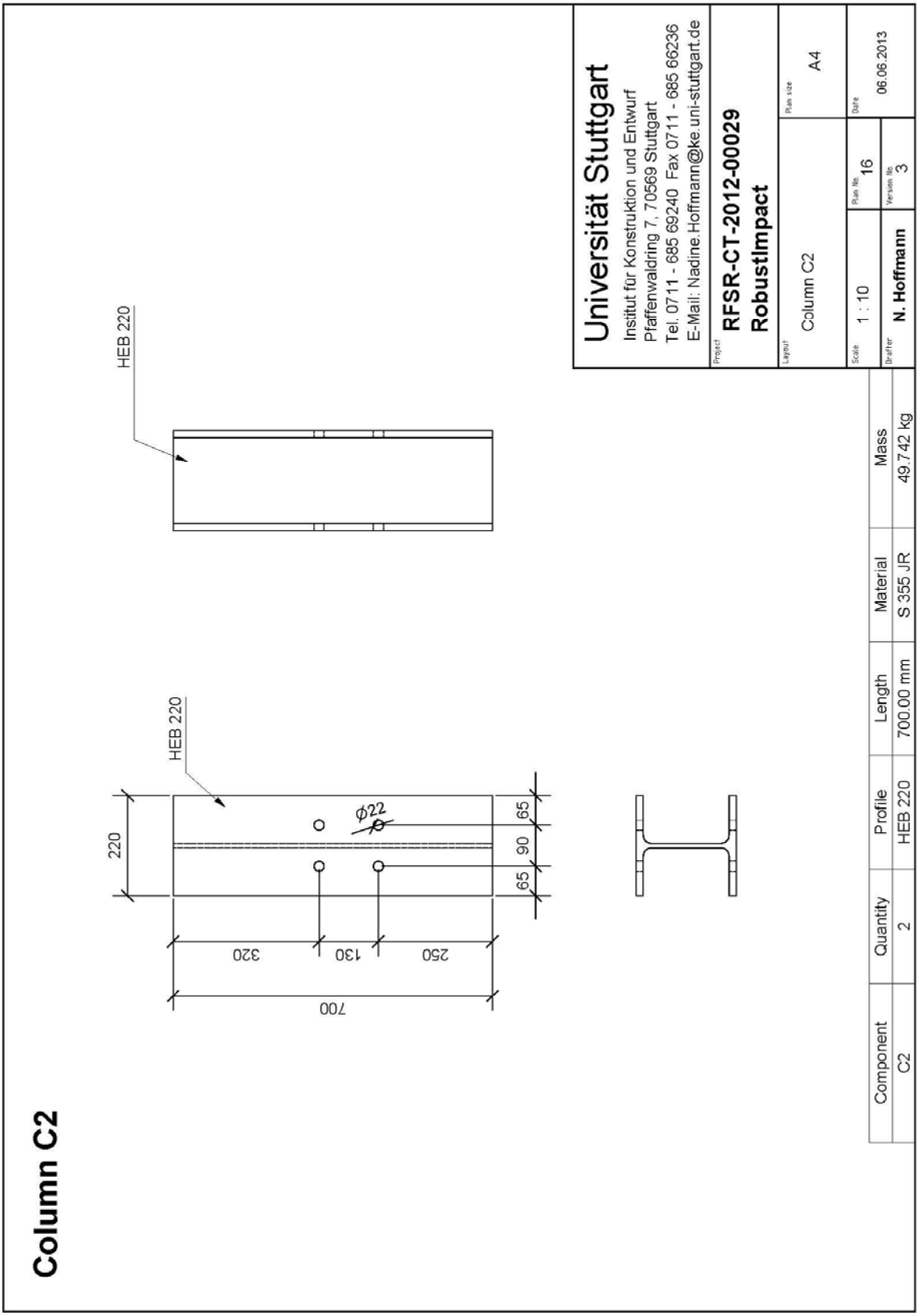

Beam B1
Cross section:
(1 : 10)
IPE 240
2675
IPE 240
240
2675
IPE 240
120
Component | Quantity | Profile | Length | Material | Mass
B1 | 8 | IPE 240 | 2675.00 mm | S 355 JR | 82,244 kg
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Beam B1
Plan size
A4
Scale
1 : 10
Plan No.
11
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3

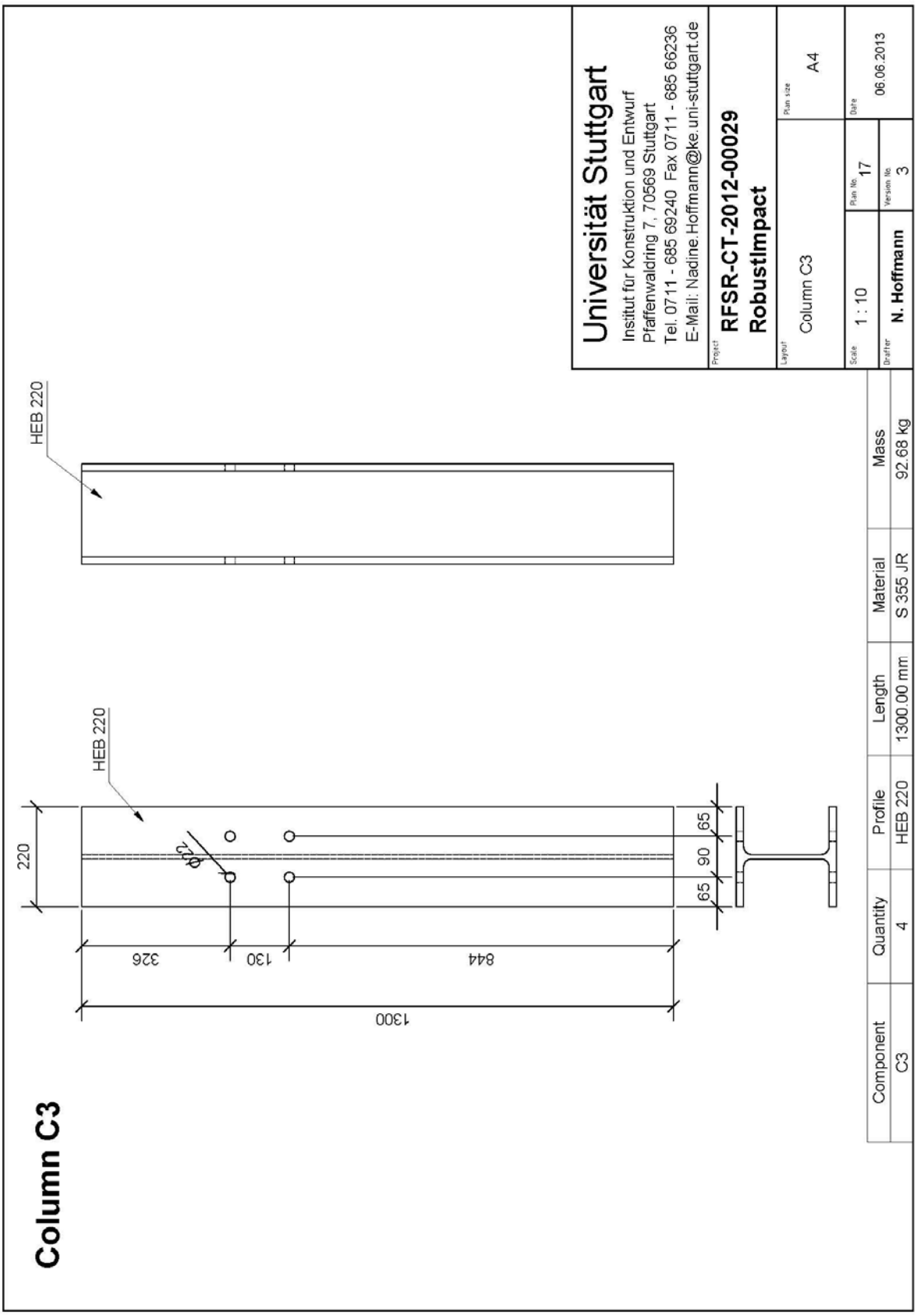

Beam B2
4760
IPE 240
240
4760
IPE 240
120
Cross section:
(1 : 10)
IPE 240
Component | Quantity | Profile | Length | Material | Mass
B2 | 4 | IPE 240 | 4760.00 mm | S 355 JR | 146.35 kg
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Beam B2
Plan size
A4
Scale 1 : 20
Plan No. 12
Date 06.06.2013
Drafter N. Hoffmann
Version No 3

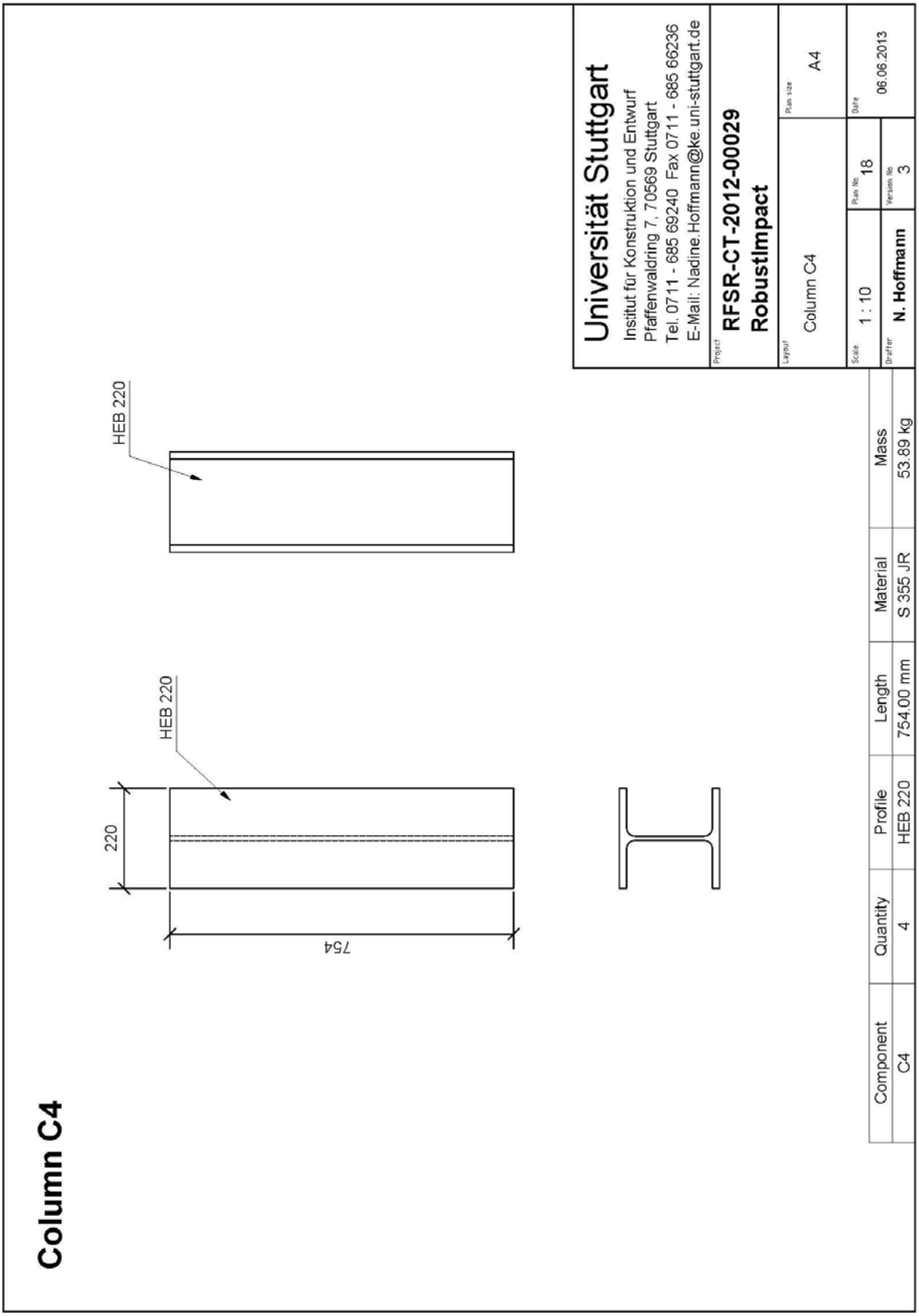

Beam B3
IPE 240
1675
240
IPE 240
1675
120
Cross section:
(1 : 10)
IPE 240
Component
B3
Quantity
4
Profile
IPE 240
Length
1675.00 mm
Material
S 355 JR
Mass
51.19 kg
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Beam B3
Plan size
A4
Scale
1 : 10
Plan No.
13
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3


Beam B4
Top view:
(1 : 20)
720
100
82
145
82
ϕ22
Front view:
(1 : 20)
Cross section:
(1 : 10)
HEM 320
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Beam B4
Plan size
A4
Scale
1 : 20 / 1 : 10
Plan No.
14
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3
Component | Quantity | Profile | Length | Material | Mass
B4 | 2 | HEM 320 | 2545.00 mm | S 355 | 623.26 kg

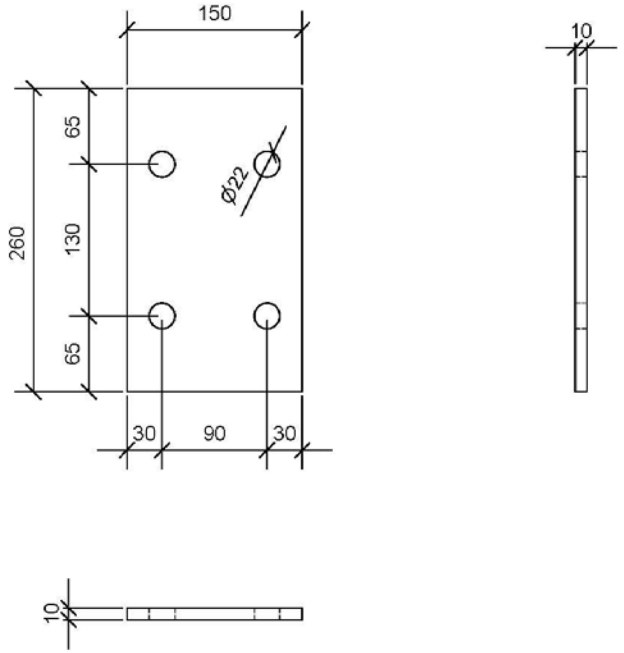

Column C1
HEB 220
HEB 220
220
65
90
65
ϕ22
135
130
435
700
Component | Quantity | Profile | Length | Material | Mass
C1 | 4 | HEB 220 | 700.00 mm | S 355 JR | 49.742 kg
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Column C1
Plan size
A4
Scale
1 : 10
Plan No.
15
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3


Column C2
HEB 220
HEB 220
220
ϕ22
65
90
65
320
130
250
700
Component | Quantity | Profile | Length | Material | Mass
C2 | 2 | HEB 220 | 700.00 mm | S 355 JR | 49.742 kg
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Column C2
Plan size
A4
Scale
1 : 10
Plan No.
16
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3


Column C3
HEB 220
HEB 220
220
22ø
65
90
65
326
130
844
1300
Component | Quantity | Profile | Length | Material | Mass
C3 | 4 | HEB 220 | 1300.00 mm | S 355 JR | 92.68 kg
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Column C3
Plan size
A4
Scale
1 : 10
Plan No.
17
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3


Column C4
HEB 220
HEB 220
220
754
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Column C4
Plan size
A4
Scale
1 : 10
Plan No.
18
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3
Component | Quantity | Profile | Length | Material | Mass
C4 | 4 | HEB 220 | 754.00 mm | S 355 JR | 53.89 kg

Endplate EP1



Component	Quantity	Thickness	Material	Mass
EP 1	20	10.00 mm	S 355 JR	3.06 kg

Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de

Project: **RFSR-CT-2012-00029 RobustImpact**

Layout	Plan size
Endplate EP1	A4

Scale	Plan No.	Date
1 : 5	19	06.06.2013
Drafter: **N. Hoffmann**	Version No. 3	

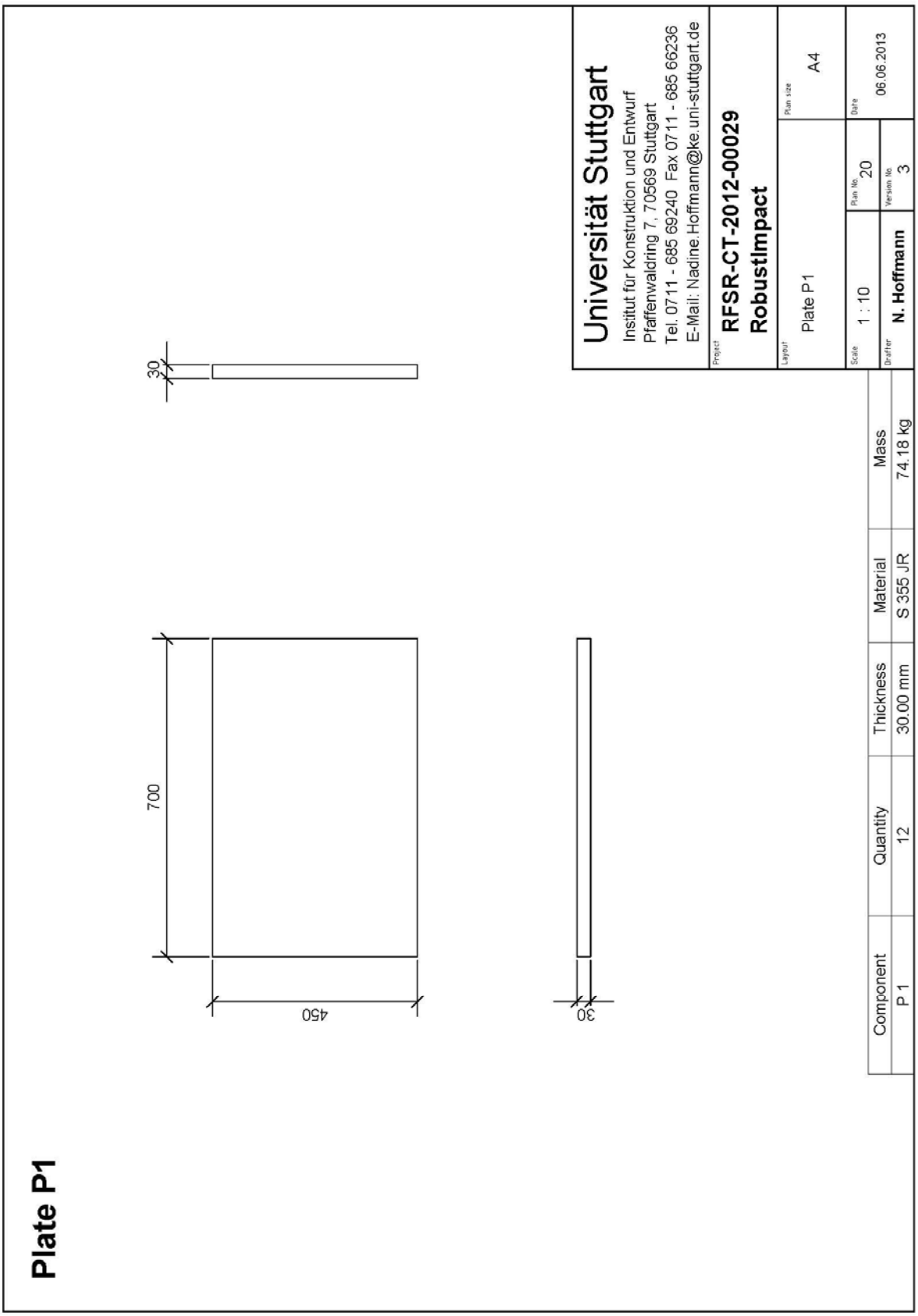


Plate P1
30
700
450
30
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Plate P1
Plan size
A4
Scale
1 : 10
Plan No.
20
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3
Component
Quantity
Thickness
Material
Mass
P 1
12
30.00 mm
S 355 JR
74.18 kg

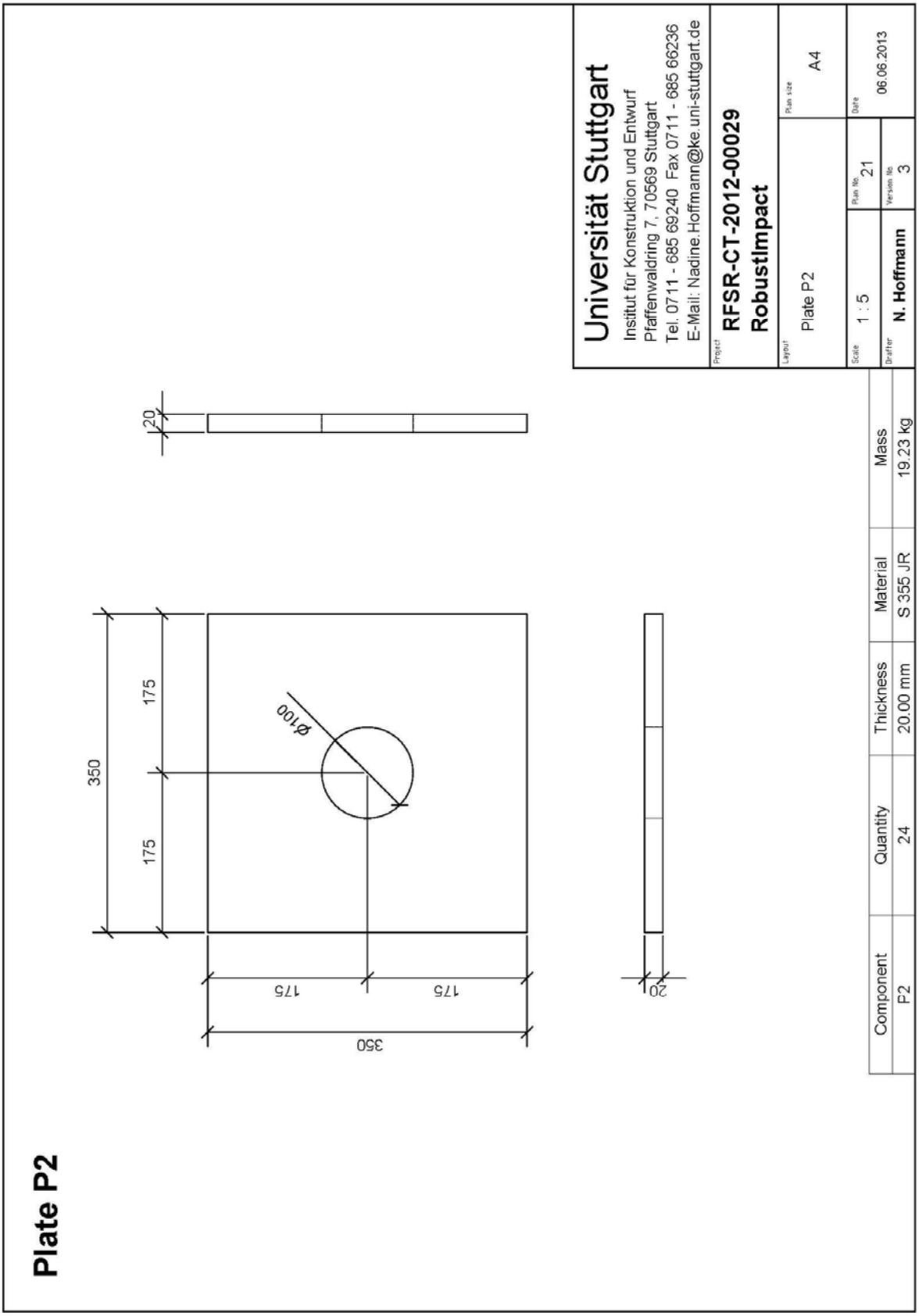


Plate P2
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Plate P2
Plan size
A4
Scale
1 : 5
Plan No.
21
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3
Component
Quantity
Thickness
Material
Mass
P2
24
20.00 mm
S 355 JR
19.23 kg
20
350
175
175
Ø100
175
175
350
20

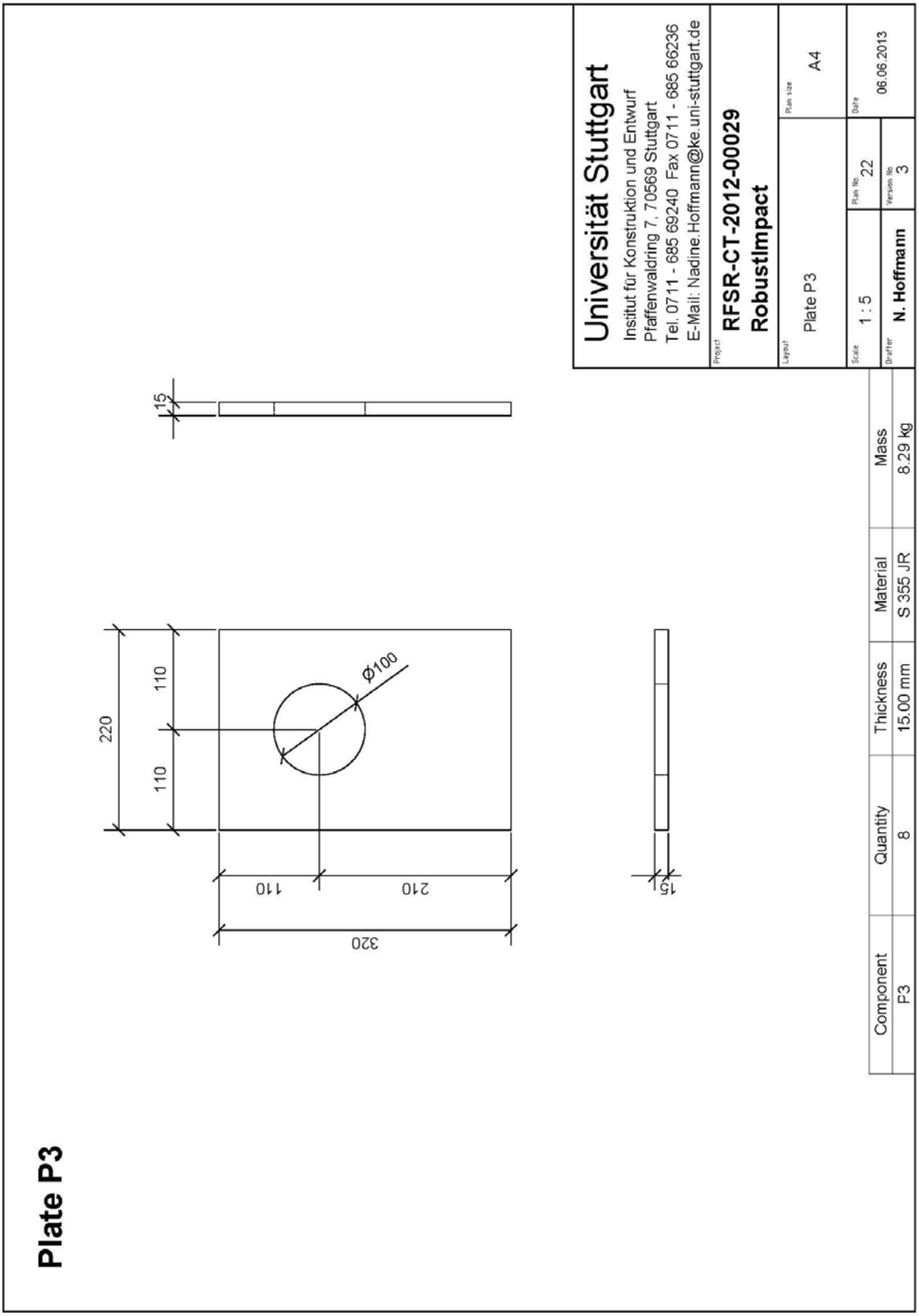


Plate P3
15
220
110
110
Ø100
110
210
320
15
Component
P3
Quantity
8
Thickness
15.00 mm
Material
S 355 JR
Mass
8.29 kg
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Plate P3
Plan size
A4
Scale
1 : 5
Plan No.
22
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3

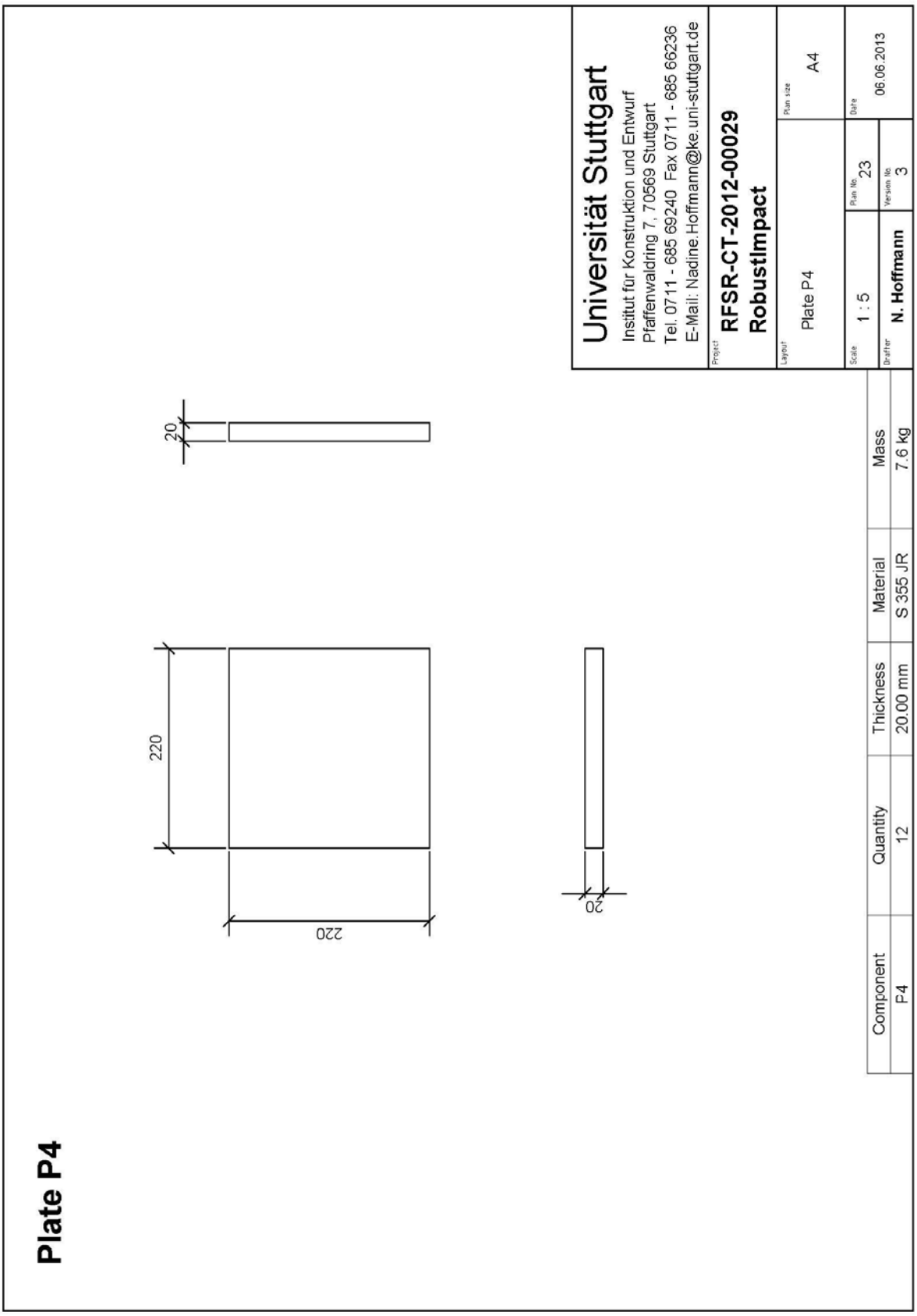


Plate P4
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Plate P4
Plan size
A4
Scale
1 : 5
Plan No.
23
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3
Component
Quantity
Thickness
Material
Mass
P4
12
20.00 mm
S 355 JR
7.6 kg
220
220
20
20

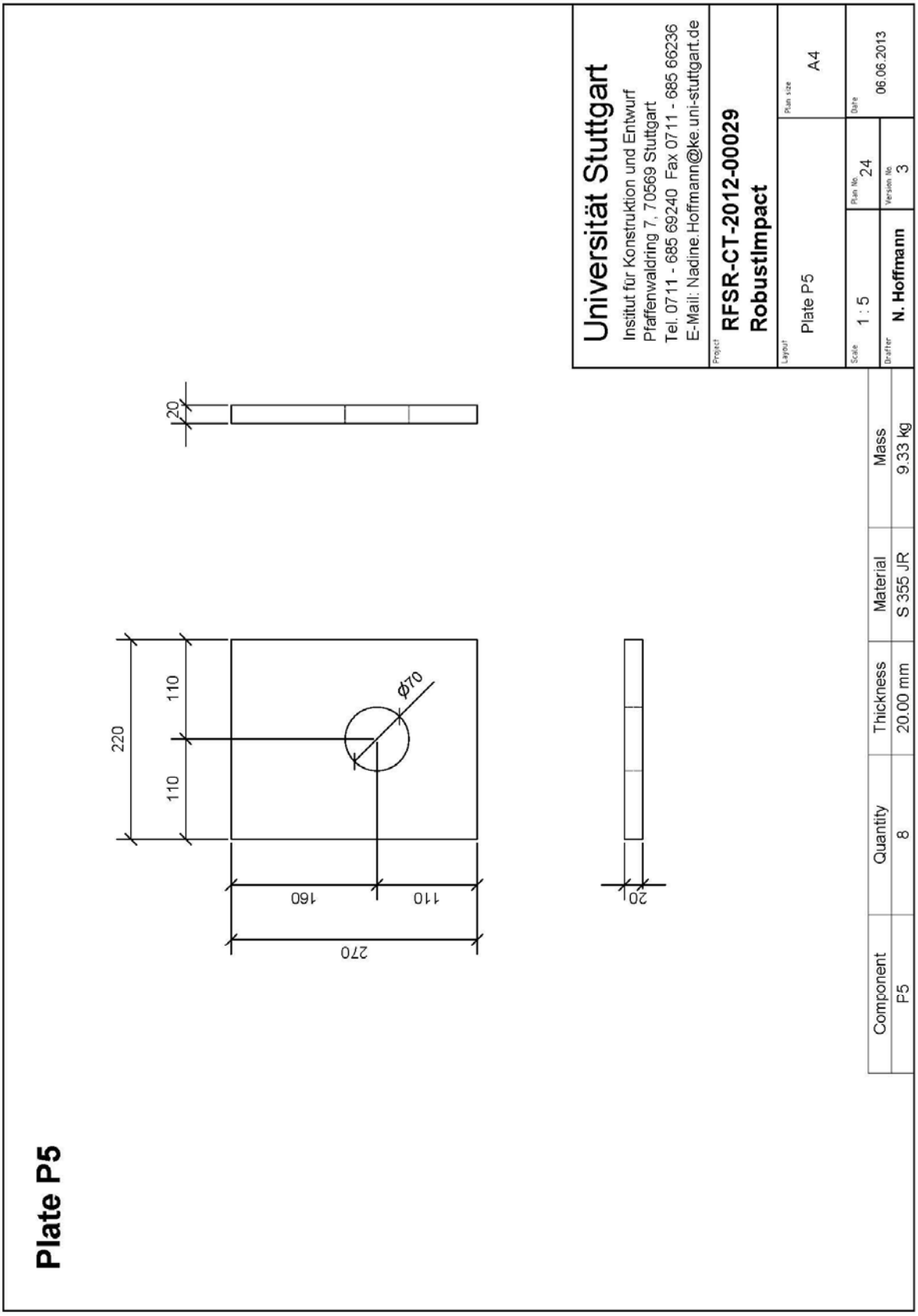


Plate P5
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Plate P5
Plan size
A4
Scale
1 : 5
Plan No.
24
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3
Component
Quantity
Thickness
Material
Mass
P5
8
20.00 mm
S 355 JR
9.33 kg
220
110
110
Ø70
160
110
270
20
20

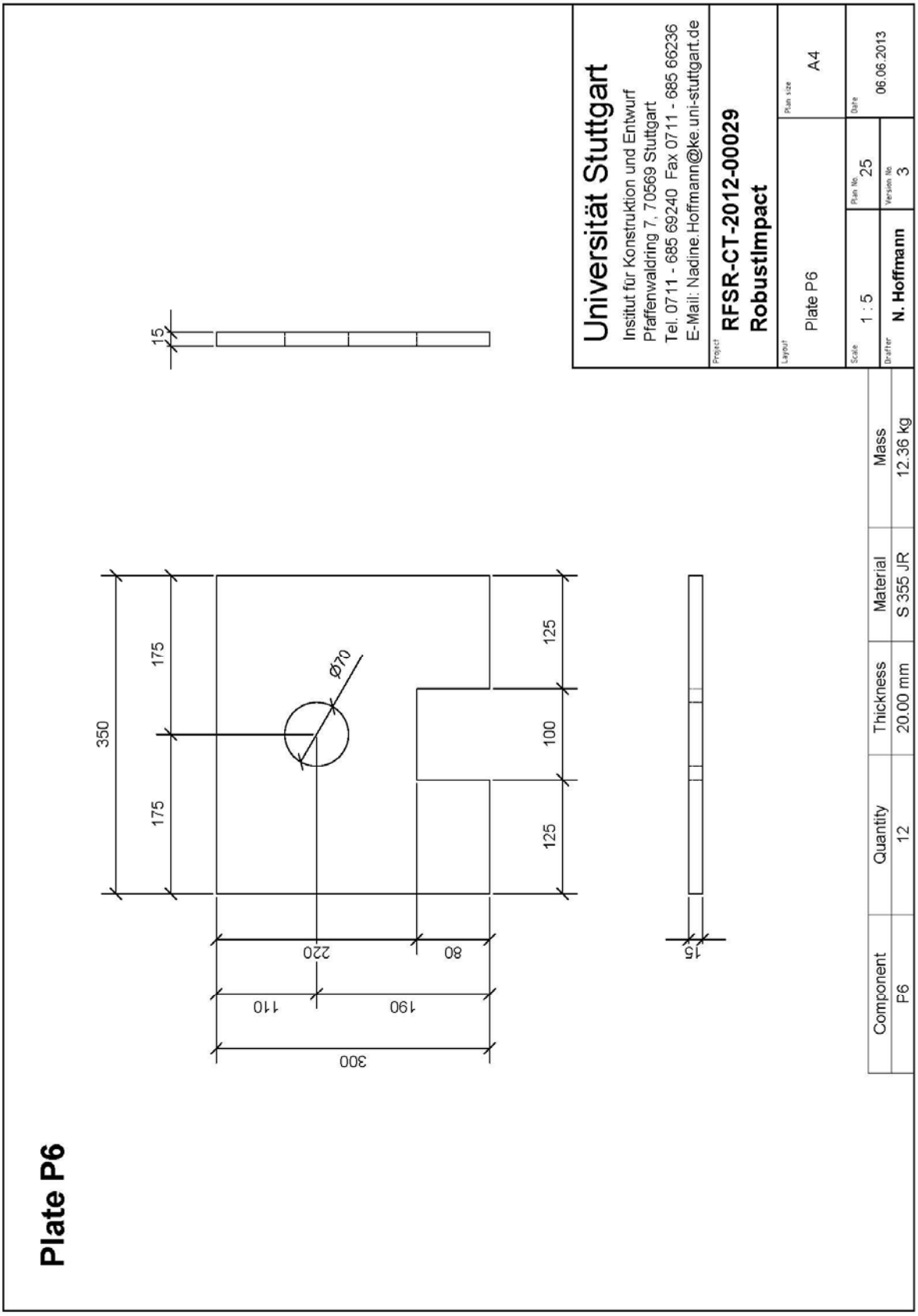


Plate P6
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Plate P6
Plan size
A4
Scale
1 : 5
Plan No.
25
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3
Component | Quantity | Thickness | Material | Mass
P6 | 12 | 20.00 mm | S 355 JR | 12.36 kg
15
350
175
175
Ø70
125
100
125
220
80
110
190
300
15

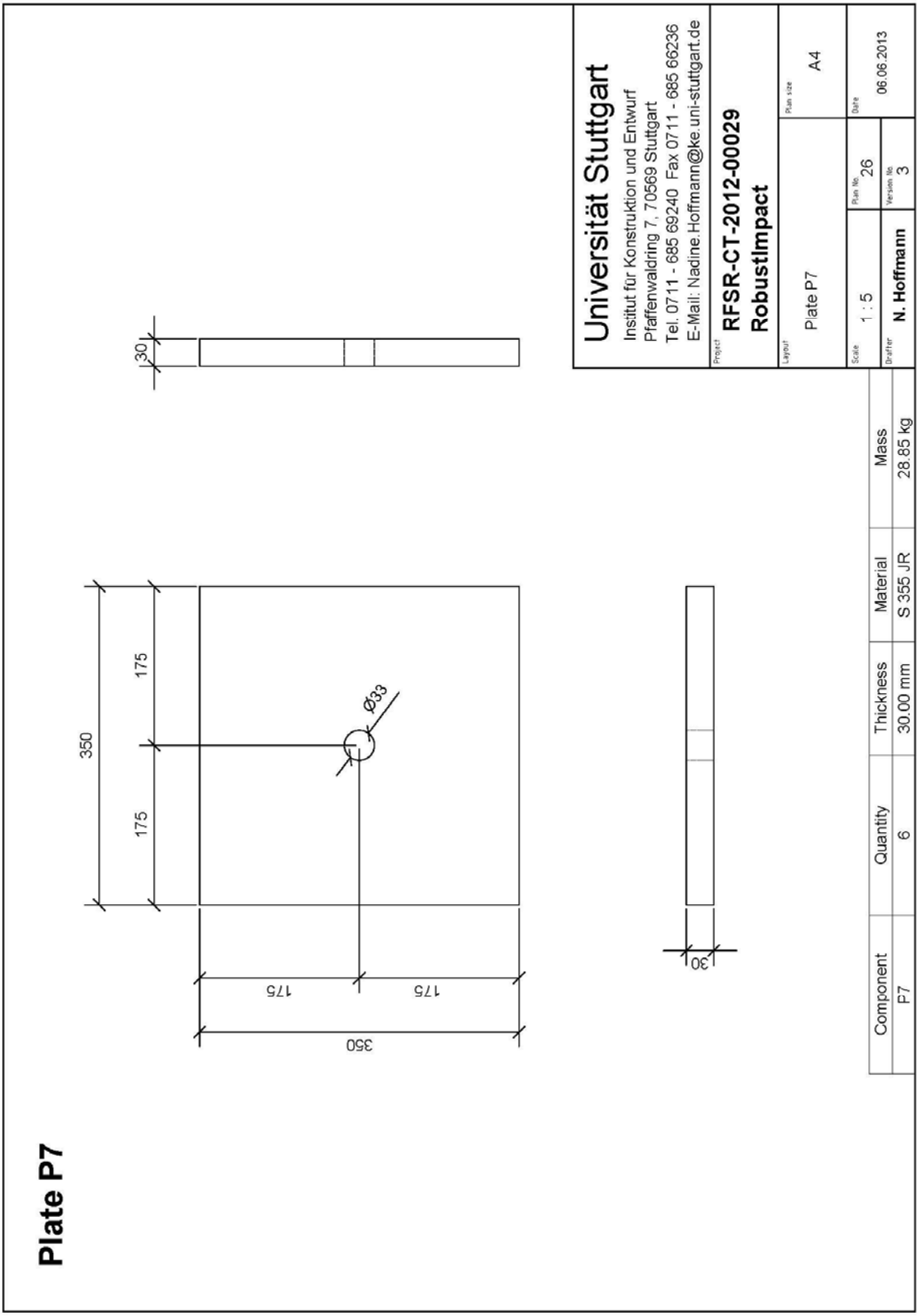


Plate P7
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Plate P7
Plan size
A4
Scale
1 : 5
Plan No.
26
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3
Component
Quantity
Thickness
Material
Mass
P7
6
30.00 mm
S 355 JR
28.85 kg
350
175
175
Ø33
175
175
350
30
30

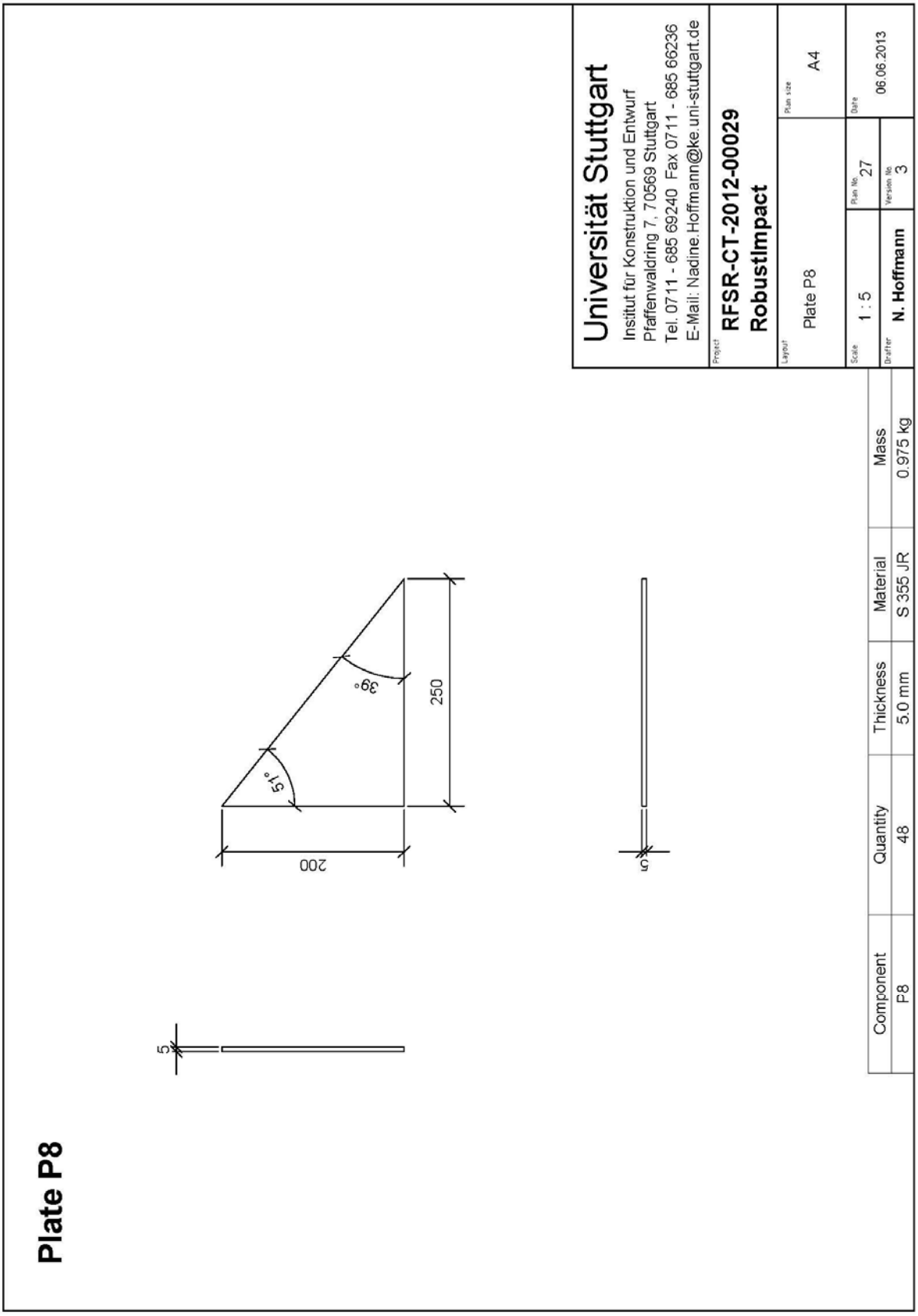


Plate P8
5
200
250
51°
39°
5
Component
P8
Quantity
48
Thickness
5.0 mm
Material
S 355 JR
Mass
0.975 kg
Universität Stuttgart
Institut für Konstruktion und Entwurf
Pfaffenwaldring 7, 70569 Stuttgart
Tel. 0711 - 685 69240 Fax 0711 - 685 66236
E-Mail: Nadine.Hoffmann@ke.uni-stuttgart.de
Project
RFSR-CT-2012-00029
RobustImpact
Layout
Plate P8
Plan size
A4
Scale
1 : 5
Plan No.
27
Date
06.06.2013
Drafter
N. Hoffmann
Version No.
3

RobustImpact

Robust impact design of steel and composite building structures

Grant Agreement Number: RFSR-CT-2012-00029

Drawings for producing the test specimens

Contribution from the University of Liege

Deliverable D.4.2

Authors:

Clara Huvelle
Jean-François Demonceau
Jean-Pierre Jaspart

PART B

Date: 07.01.2014

6 INTRODUCTION

In the test campaign planned at the University of Liege, 44 impact tests will be conducted:

- 22 on beam-to-column joints
- 22 on column bases

These assemblies will be impacted by a mass dropped from a certain height.

The aim of these tests is to observe the ability of the joints to absorb energy by plastic deformation.

The 22 tests on beam-to-column joints are divided as follows:

- 5 for which the failure will develop in the end-plate in bending (1 static test and 4 impact tests with 4 different level of energy) (“EPB”)
- 5 for which the failure will develop in the column flange in bending (1 static test and 4 impact tests with 4 different level of energy) (“CFB”)
- 4 for which the failure will develop in the beam flange in compression (1 static test and 3 impact tests with 3 different level of energy) (“BFC”)
- 4 for which the failure will develop in the column web compression (1 static test and 3 impact tests with 3 different level of energy) (“CWC”)
- 4 for which the failure will develop as in a real joint, activating 2 different components (1 static test and 3 impact tests with 3 different level of energy) (“Real joint”)

The 22 tests on column bases are divided as follows:

- 6 tests for which the failure happens in the concrete, in a ductile mode (“duct_conc_1”)
- 6 tests for which the failure happens in the concrete, in a ductile mode (“duct_conc_2”)
- 5 tests for which the failure happens in the concrete, in a fragile mode (“frag_conc_1”)
- 5 tests for which the failure happens in the steel end-plate (“duct_steel”)

The detailed drawings for the production of the specimen have been produced by ULg and sent to ArcelorMittal.

In the following sections, a list of the pieces to be produced is given. All the drawings are reported in the annexes.

7 BEAM-TO-COLUMN JOINTS

7.0 Supports

Drawing A.0.1

Description	Number of pieces
Steel plates 300x300x30	4

7.1 EPB (5 specimens)

Drawings A.1.1 --> A.1.3

Description	Number of pieces
<u>Steel beam profile</u>	10
IPE180, length: 730 – Steel S355	10
End-plate: 210x120x8 – Steel S355	10
Stiffeners : 164x34x20 – Steel S355	2*2*5=20
Plates: 110x200x30 – Steel S355	2*5=10
<u>Steel column profile</u>	5
HEB140, length: 460 – Steel S355	5
Repartition plate: 130x140x50 – Steel S355	5
<u>Joint</u>	
Bolts M16, 10.9	4*2*5 = 40

7.2 CFB (5 specimens)

Drawings A.2.1 --> A.2.3

Description	Number of pieces
Steel beam profile	10
IPE180, length: 730 – Steel S355	10
End-plate: 220x120x18 – Steel S355	10
Reinforcement plate (beam flange): 150x79x6 – Steel S355	10
Stiffeners : 164x34x20 – Steel S355	2*2*5=20
Plates: 110x200x30 – Steel S355	2*5=10
Steel column profile	5
HEB140, length: 460 – Steel S355	5
Repartition plate: 130x140x50 – Steel S355	5
Joint	
Bolts M16, 10.9	4*2*5 = 40

7.3 BFC (4 specimens)

Drawings A.3.1 --> A.3.3

Description	Number of pieces
Steel beam profile	8
IPE180, length: 730 – Steel S355	8
Stiffeners : 164x34x20 – Steel S355	2*2*4=16
Plates: 110x200x30 – Steel S355	2*4=8
Steel column profile	4
HEB140, length: 460 – Steel S355	4
Repartition plate: 130x140x50 – Steel S355	4
Stiffeners: 116x54.5x12 – Steel S355	2*2*4=16

7.4 CWC (4 specimens)

Drawings A.4.1 --> A.4.3

Description	Number of pieces
Steel beam profile	8
IPE180, length: 710 – Steel S355	8
Stiffeners : 164x34x20 – Steel S355	2*2*4 = 16
Plates: 110x200x30 – Steel S355	2*4=8
Steel column profile	4
IPE180, length: 540 – Steel S355	4
Repartition plate: 170x91x50– Steel S355	4
Stiffeners: 164x34x10 – Steel S355	2*4=8

7.5 Real joint (4 specimens)

Drawings A.5.1 --> A.5.3

Description	Number of pieces
Steel beam profile	8
IPE180, length: 730 – Steel S355	8
End-plate: 210x120x15 – Steel S355	8
Stiffeners : 164x34x20 – Steel S355	2*2*4 = 16
Plates: 110x200x30 – Steel S355	2*4=8
Steel column profile	4
HEB140, length: 760 – Steel S355	4
Repartition plate: 130x140x50 – Steel S355	4
Joint	
Bolts M16, 10.9	2*4*4 = 32

8 COLUMN BASES

8.0 Mass

One masse needed, drawing B.0.1, used for all the tests (minimum weight: 75 kg)

8.1 duct_conc_1 – duct_conc_2 – frag_conc_1

The difference between these 3 configurations is in the scheme of reinforcement, not given here.

Description	Number of pieces
<u>Steel profile</u>	6+6+5 = 17
HEB140, length: 1000 – Steel S355	17
Stiffener: 116x54.5x30 – Steel S355	17*2 = 34
<u>Joint</u>	
End-plate: 300x200x30 – Steel S355	17
Bolts M24, 10.9	4*17 = 68
Embedded plate: 300x200x30 – Steel S355 with studs (drawing B.1.4) and treaded bars welded on it (drawing B.1.3)	17

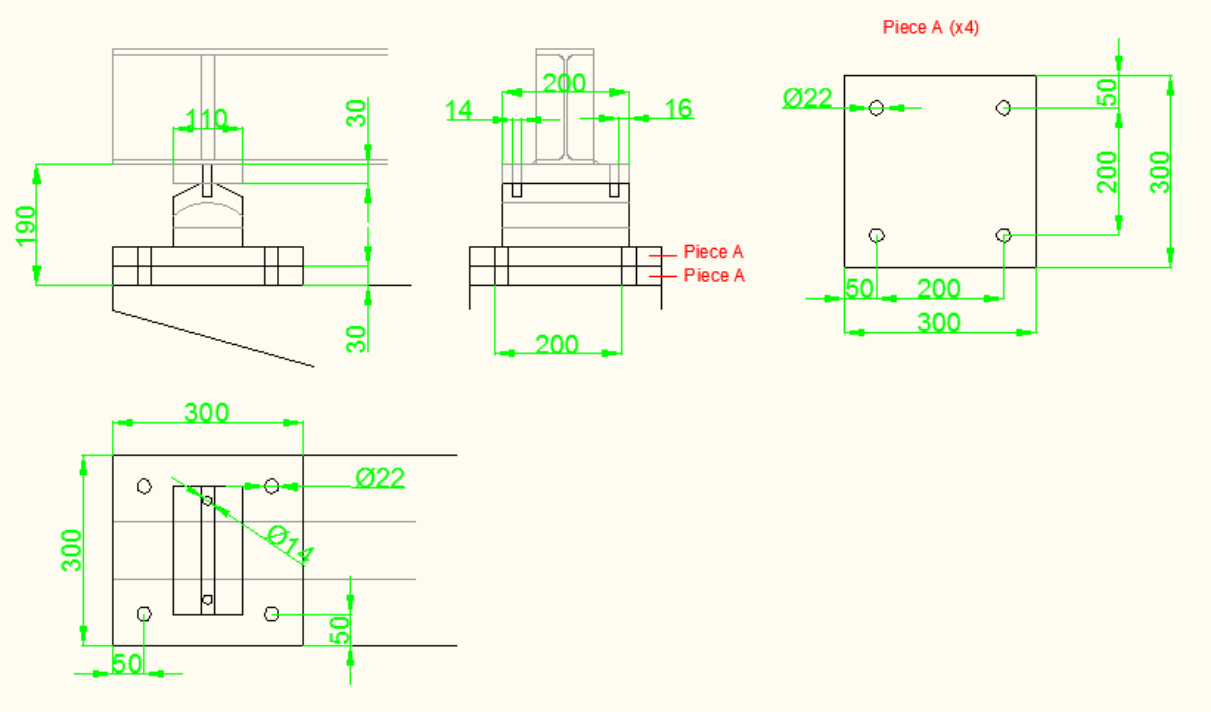
8.2 duct_steel

Description	Number of pieces
<u>Steel profile</u>	5
HEB140, length: 1000 – Steel S355	5
Stiffener: 116x54.5x30– Steel S355	5*2 = 10
<u>Joint</u>	
End-plate: 260x150x10 – Steel S355	5
Bolts M12, 10.9	4*5 = 20
Embedded plate: 300x200x30 – Steel S355 with studs (drawing B.1.4) and treaded bars welded on it (drawing B.2.3)	5

9 ANNEX A: BEAM-TO-COLUMN JOINTS

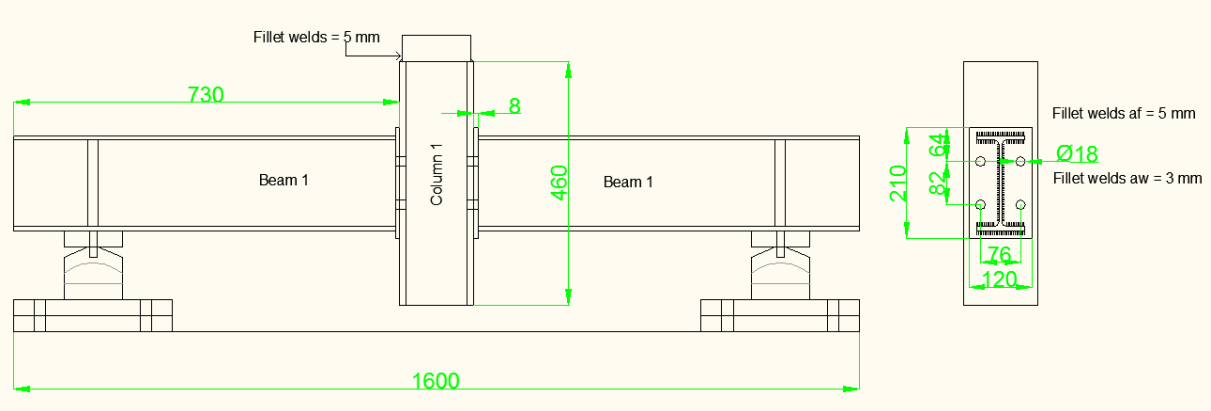
9.0 Supports

Only piece A has to be provided (x4)

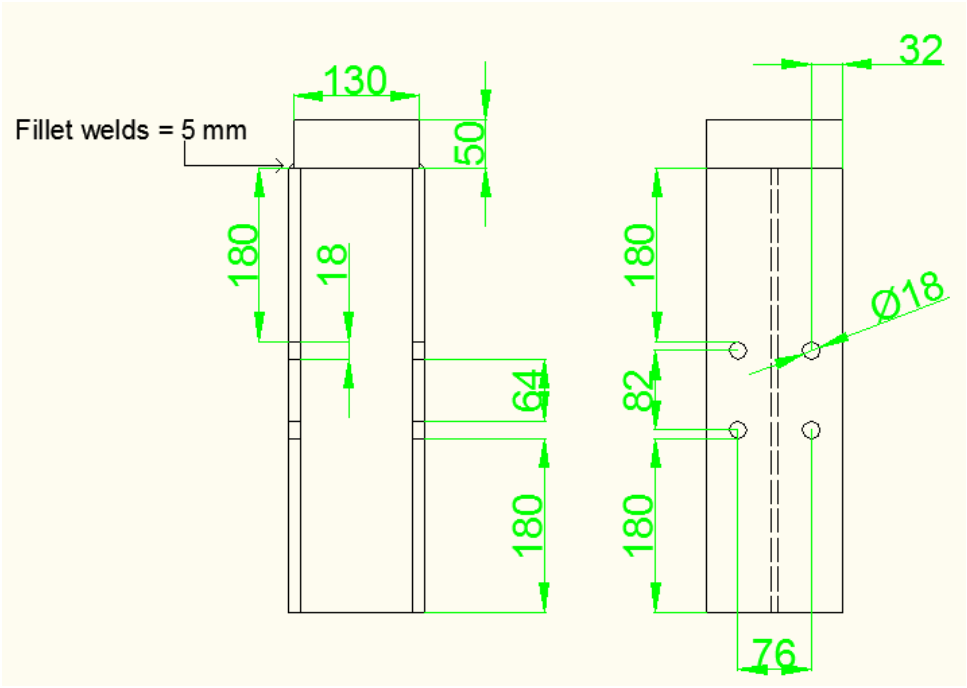


A.0.1

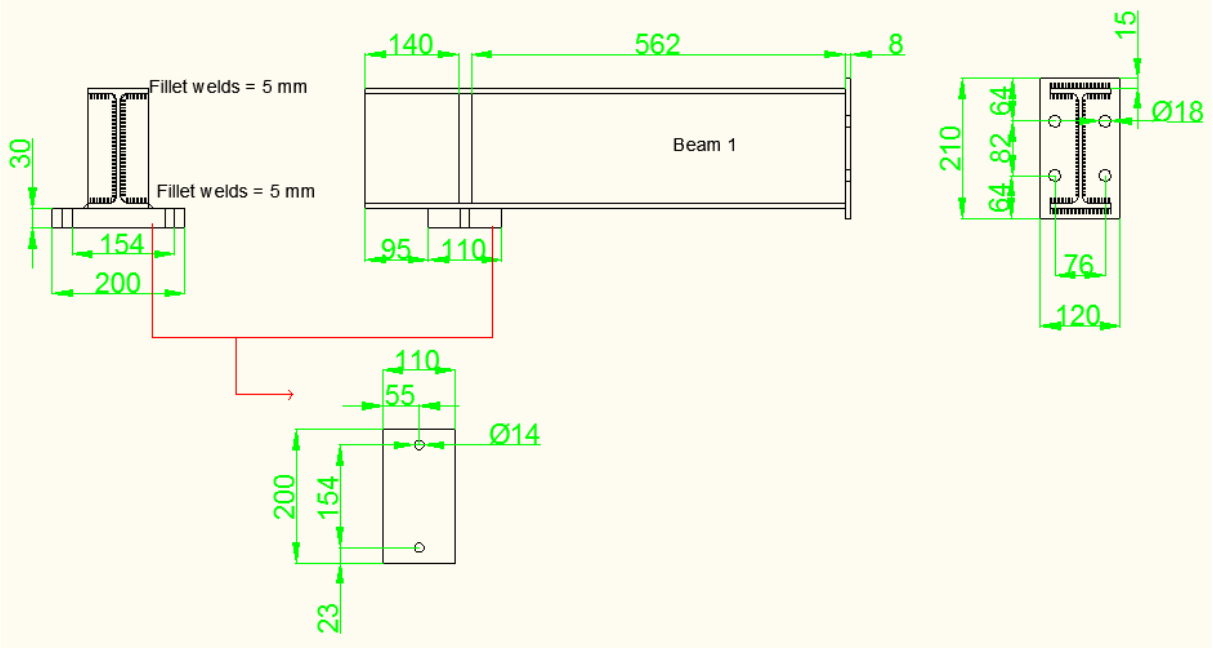
9.1 EPB (x5)



A.1.1: General configuration (x5)

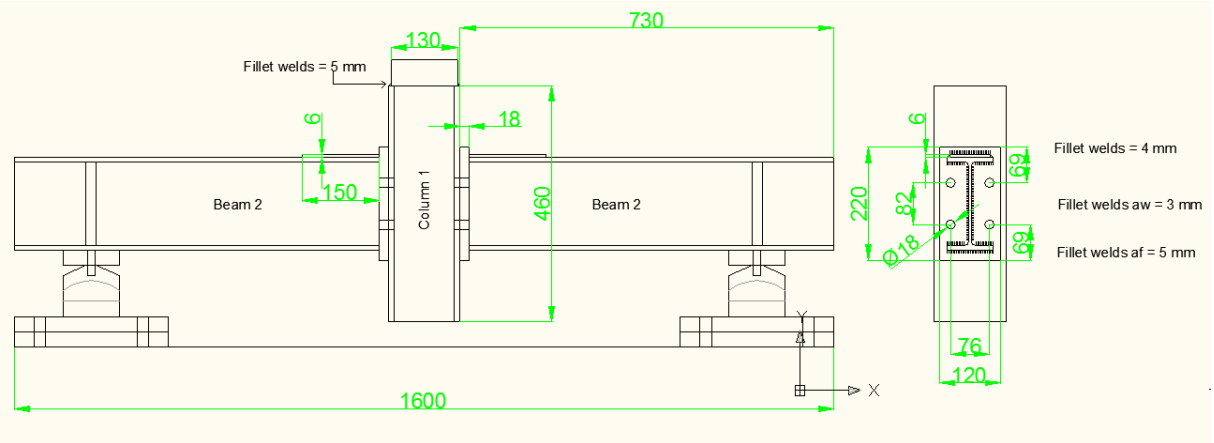


A.1.2: Column 1 (x5)



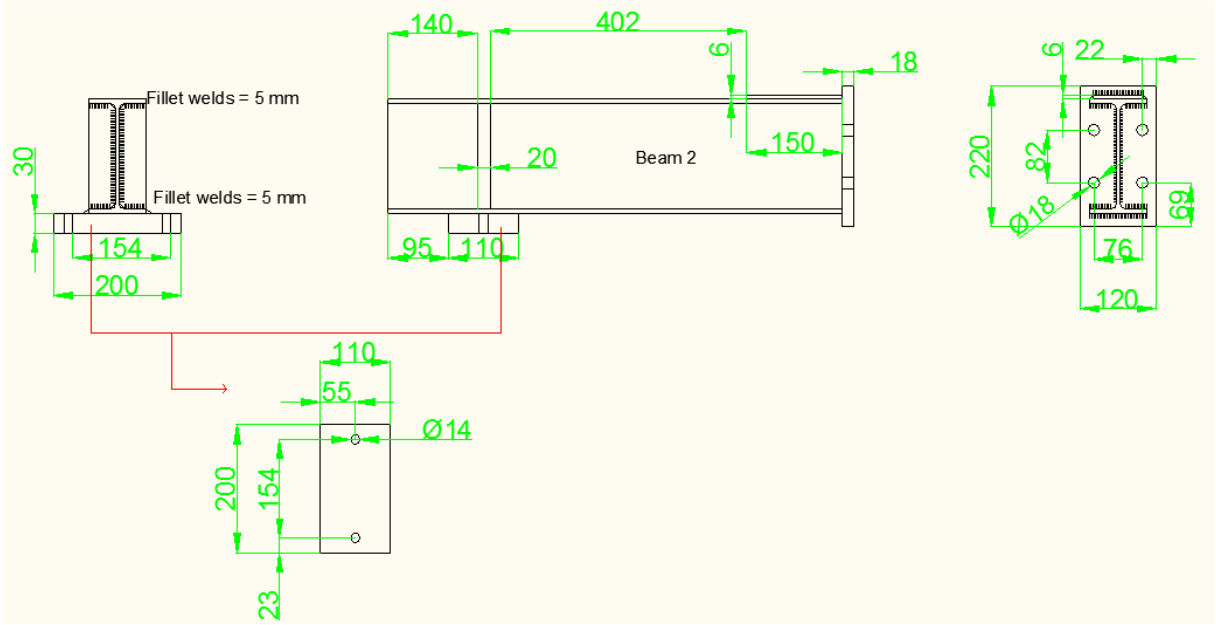
A.1.3: Beam 1 (x10)

9.2 CFB (x5)



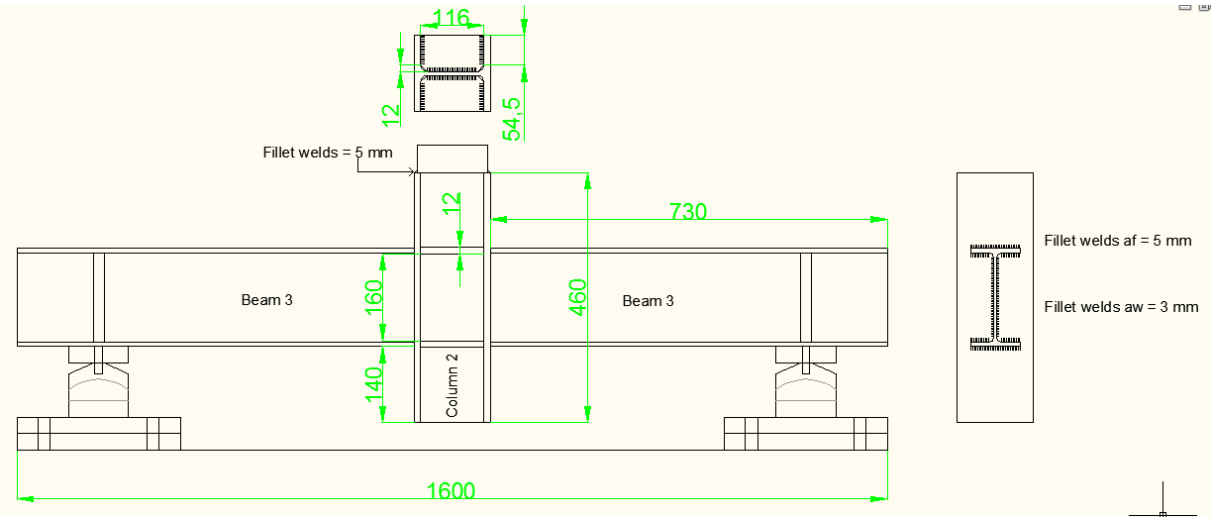
A.2.1: General configuration (x5)

A.2.2: Column 1 (x5) --> confer drawing A.1.2

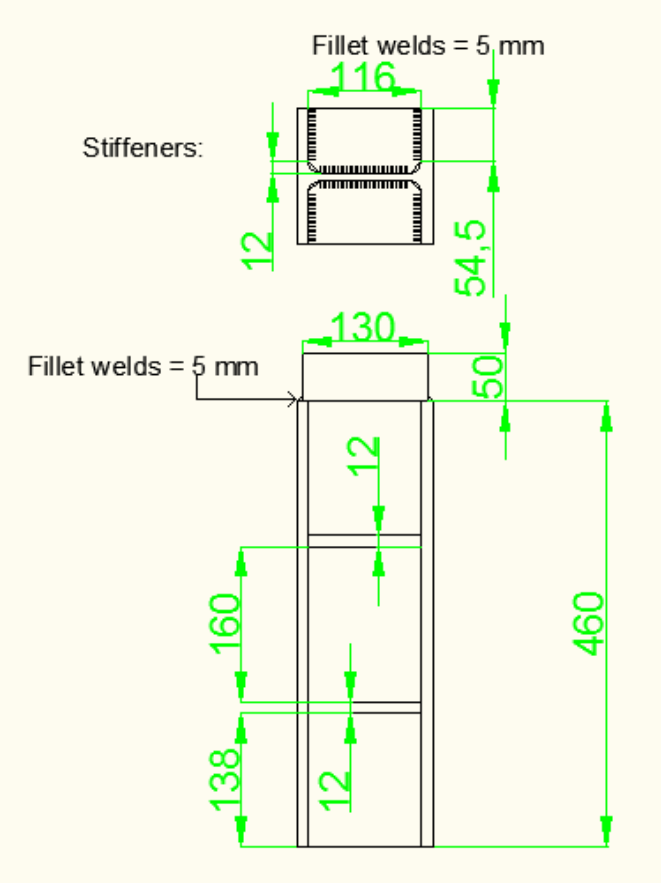


A.2.3: Beam 2 (x10)

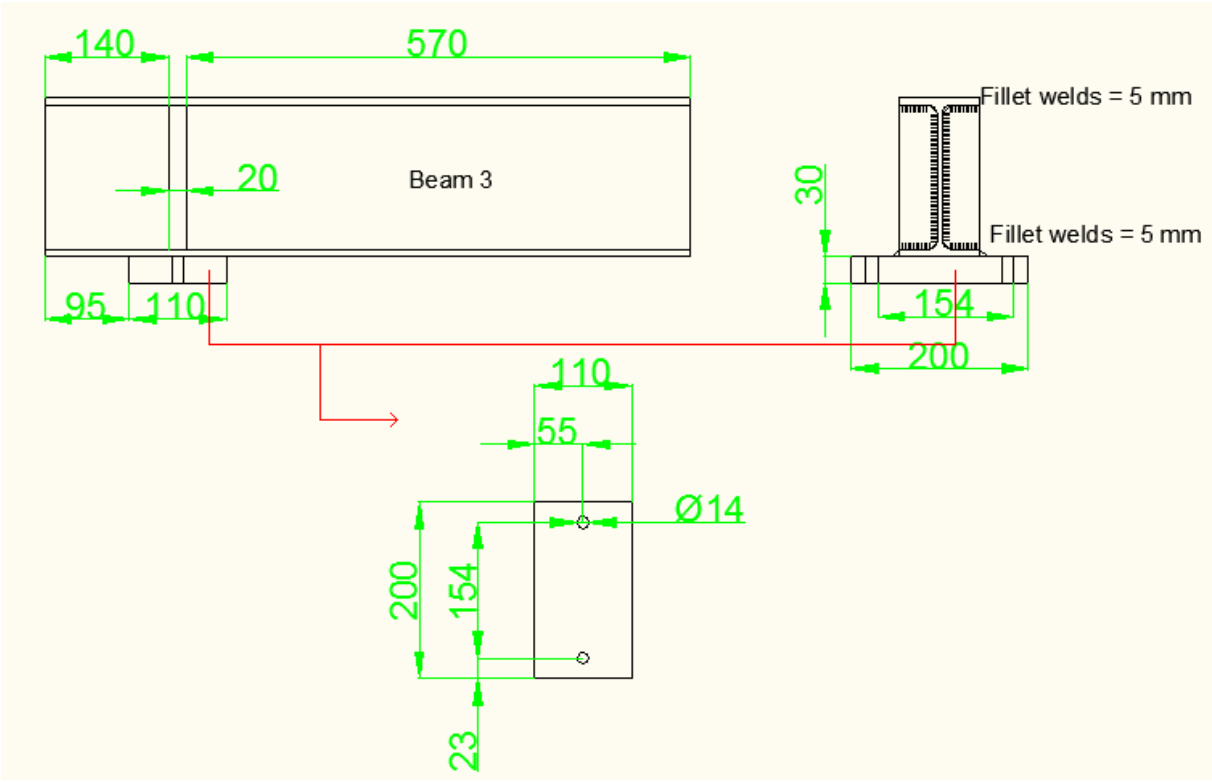
9.3 BFC (x4)



A.3.1: General configuration (x4)

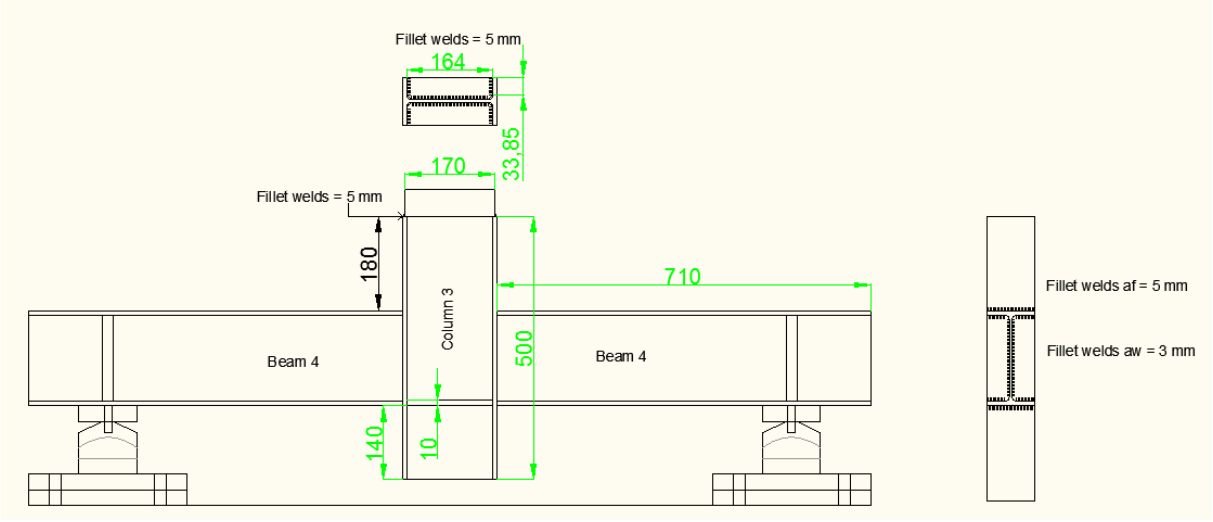


A.3.2: Column 2 (x4)

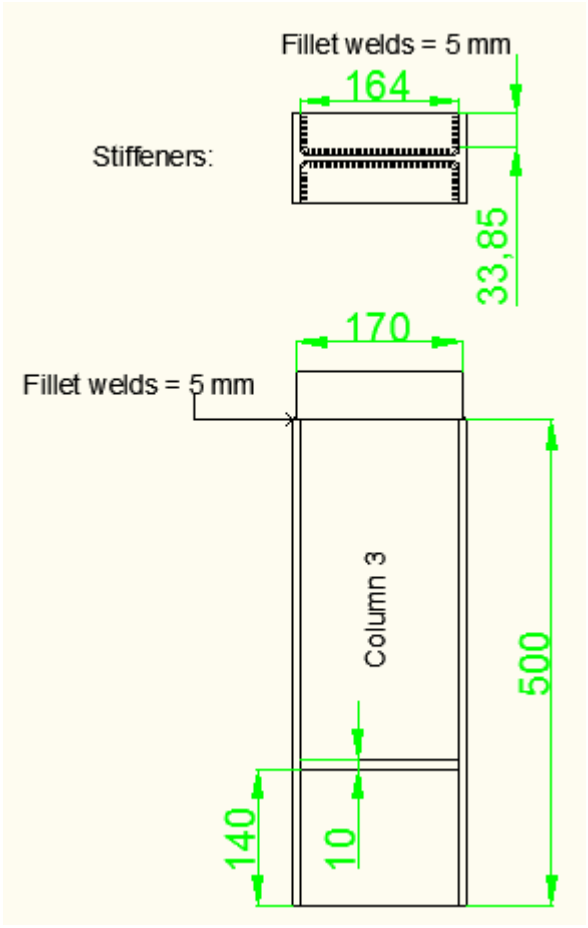


A.3.3: Beam 3 (x8)

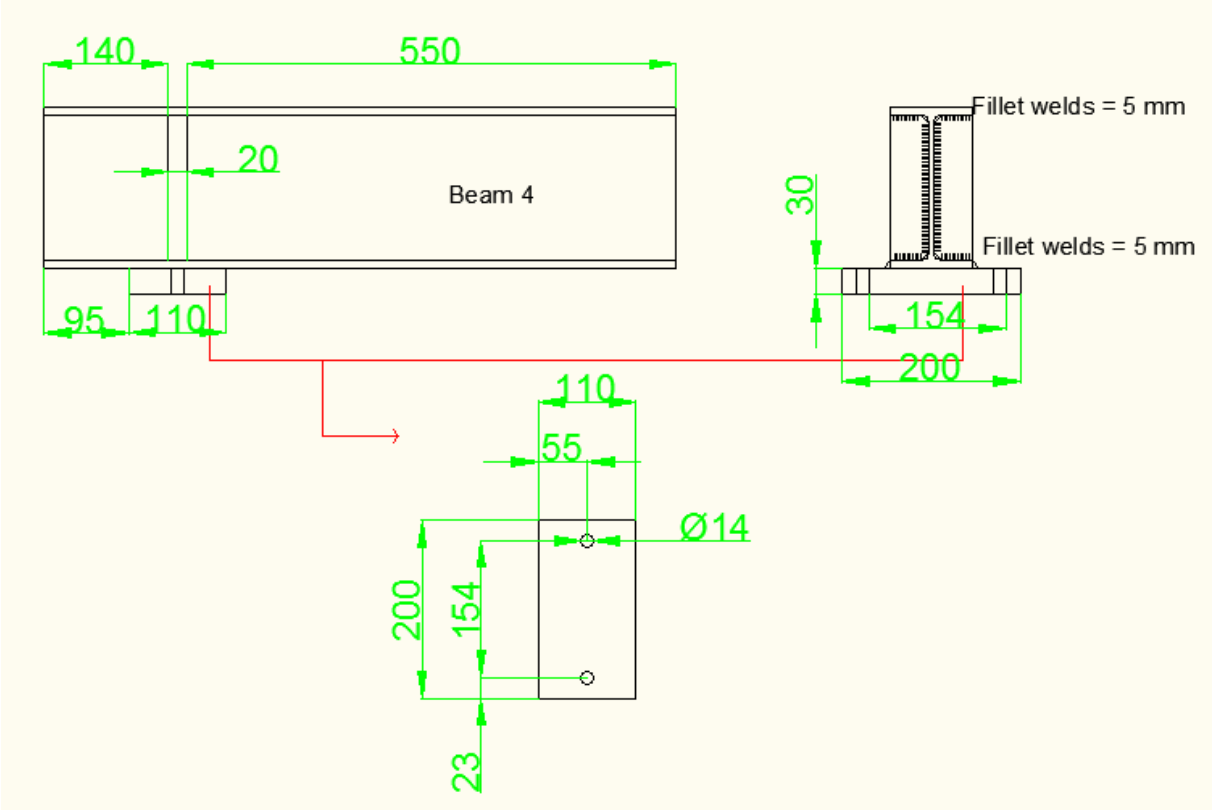
9.4 CWC (x4)



A.4.1: General configuration (x4)

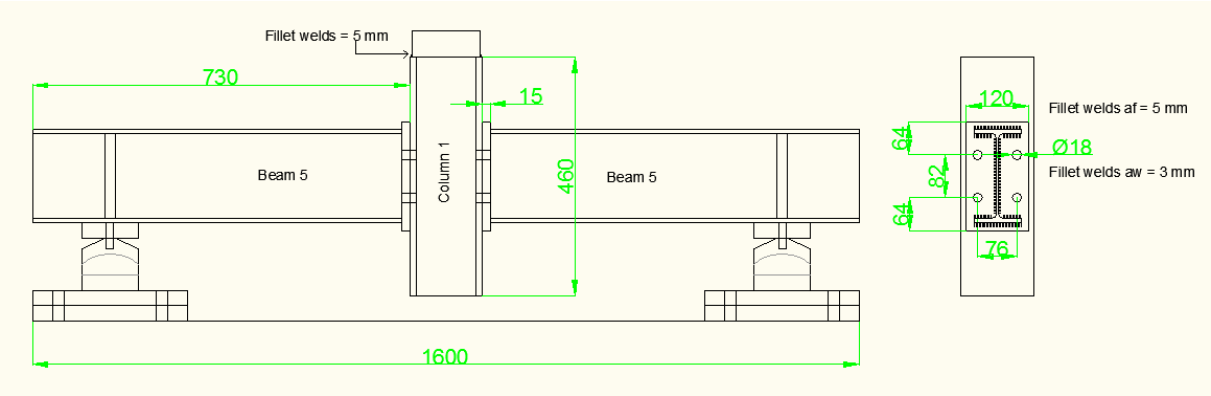


A.4.2: Column 3 (x4)



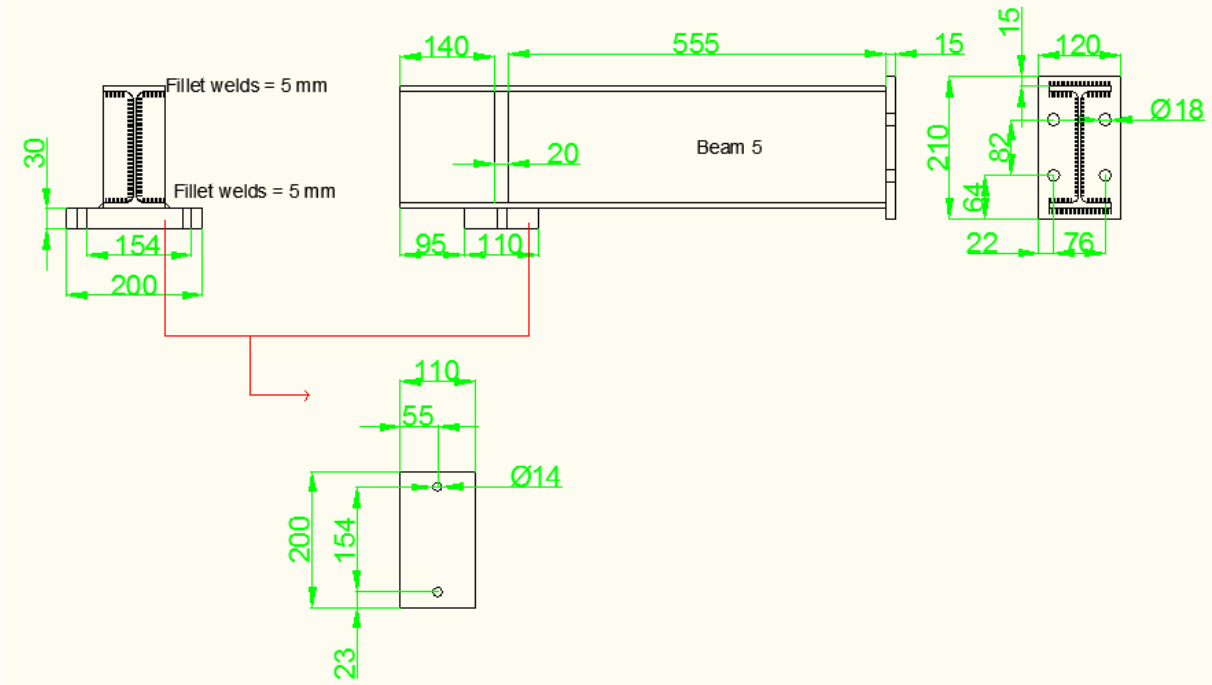
A.4.3: Beam 4 (x8)

9.5 Real joint (x4)



A.5.1: General configuration (x4)

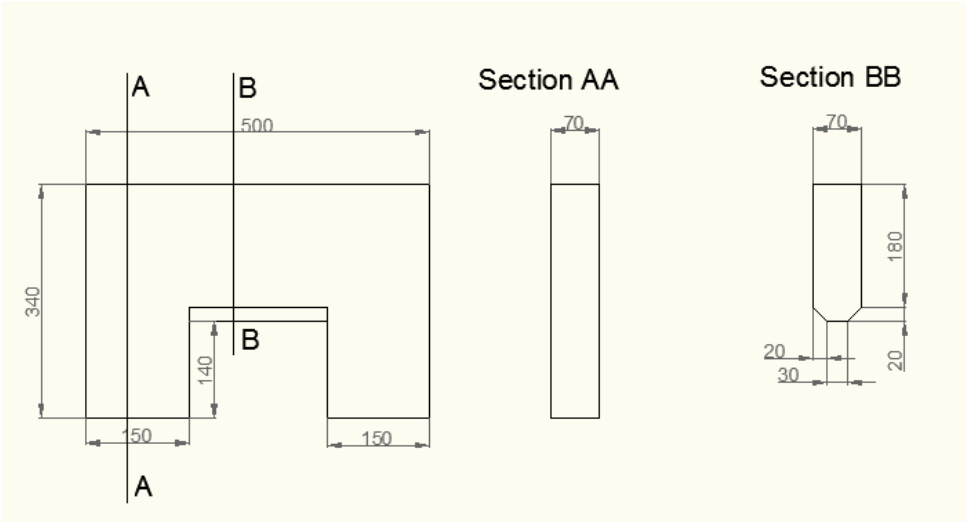
A.5.2: Column 1 (confer drawing A.1.2) (x4)



A.5.3: Beam 5 (x8)

10 ANNEX B: COLUMN BASES

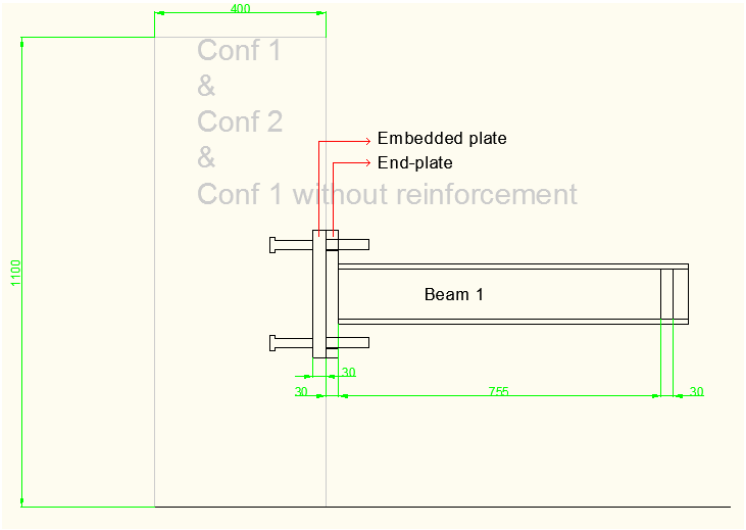
10.0 Mass



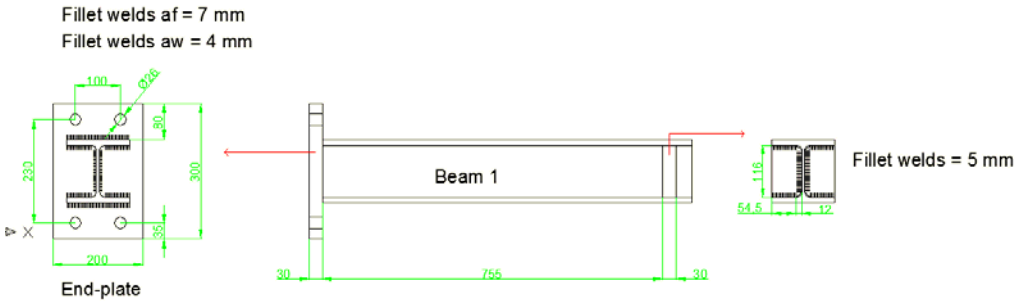
B.0.1

(around 75 kg)

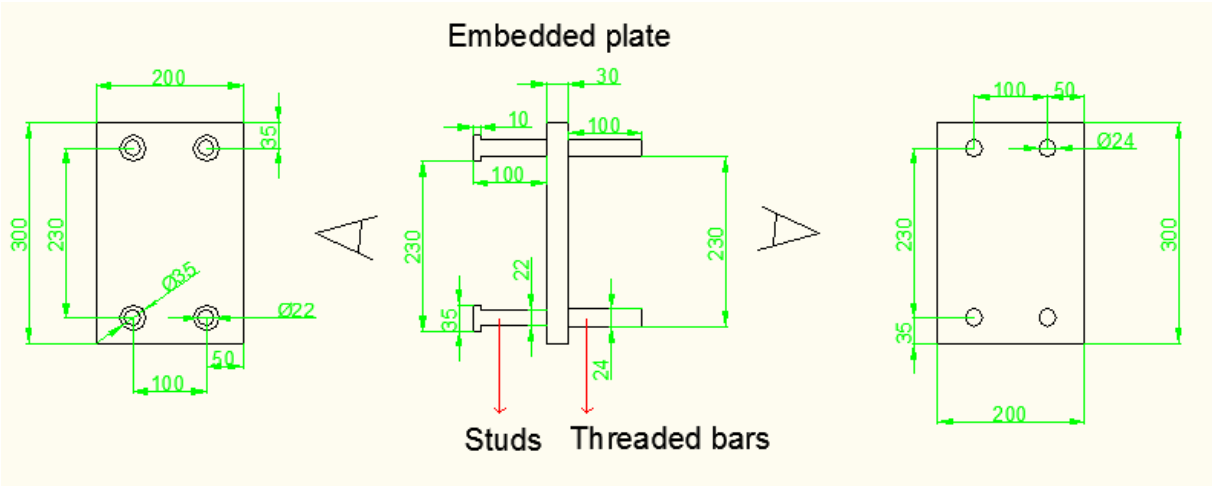
10.1 duct_conc_1 – duct_conc_2 – frag_conc_1



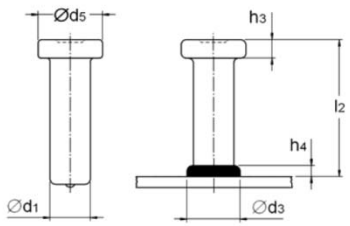
B.1.1 General view of the specimen



B.1.2 Beam 1



B.1.3 Embedded plate



d_1	l_2	h_4[1]	d_5	d_3[1]	h_3	Artikel-Nr. [2] Part-no. No. d'article No. articulo	Masse Mass Poids Peso kg/100	Keramikring Ceramic ferrule Bague réfractaire Cerámica	Bolzenhalter Chuck Mandrin Porta espárrago
19	50	6	32	23	10	017-0001-001	16,11	UF 19 (SN 19)	350-0060-000
	60					017-0002-001	18,2		
	75					017-0004-001	21,67		
	80					017-0005-001	22,7		
	90					017-0006-001	25,4		
	100					017-0007-001	27,23		
	125					017-0008-001	32,80		
	150					017-0010-001	38,36		
	175					017-0011-001	43,93		
	200					017-0012-001	49,49		
	225					017-0031-001	55,06		
	250					017-0079-001	60,62		
	275					017-0037-001	66,18		
	300					017-0079-001	71,75		
	350					017-0082-001	82,88		
	400					017-0032-001	94,01		
	525					017-0034-001	121,83		
22	50	6	35	29	10	017-0040-001	20	UF 22 (SN 22)	350-0061-000
	75					017-0042-001	28,44		
	90					017-0043-001	32,8		
	100					017-0044-001	35,90		
	125					017-0047-001	43,36		
	150					017-0048-001	50,82		
	175					017-0049-001	58,28		
	200					017-0050-001	65,74		
	225					017-0060-001	73,20		
	250					017-0058-001	80,66		
	300					017-0074-001	95,58		
	350					017-0101-001	110,50		
	400					017-0102-001	125,42		
	450					017-0105-001	140,34		
	525					017-0066-001	162,72		

B.1.4 Studs

Studs KÖCO SD, DIN EN ISO 13918 (n° of the article: 017-0044-001)

d_1 = 22 mm

d_5 = 35 mm

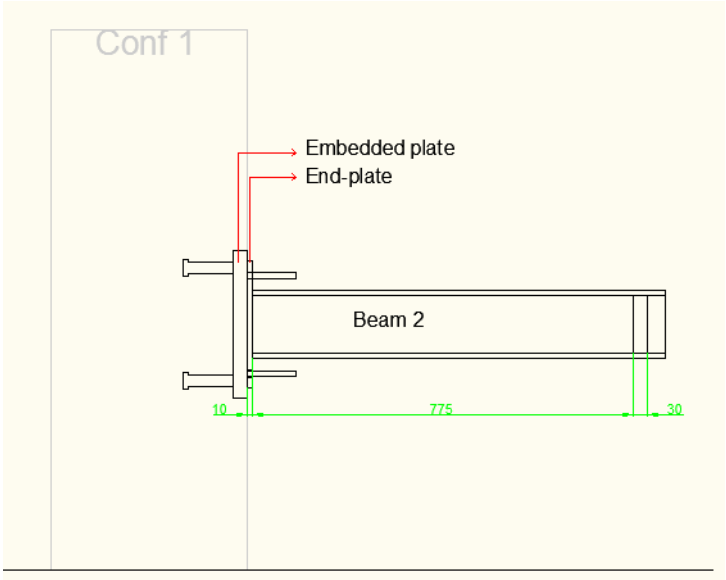
d_3 = 29 mm

h_3 = 10 mm

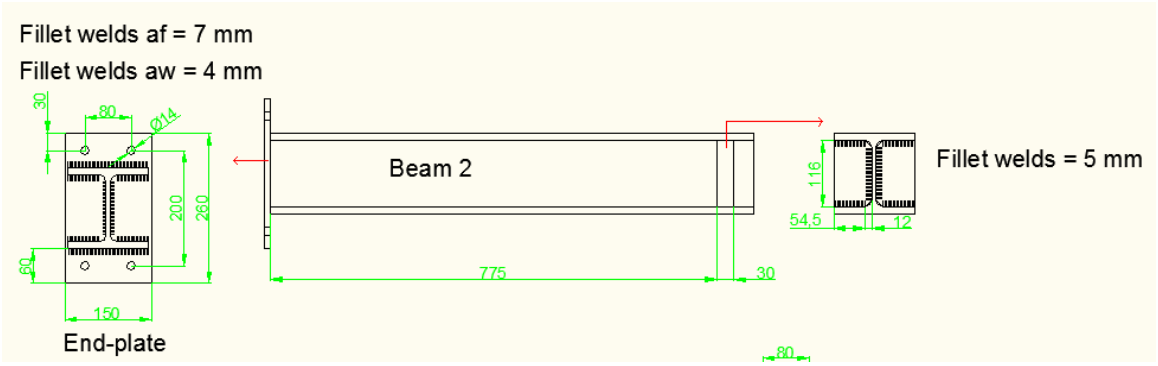
h_4 = 6 mm

l_2 = 100 mm

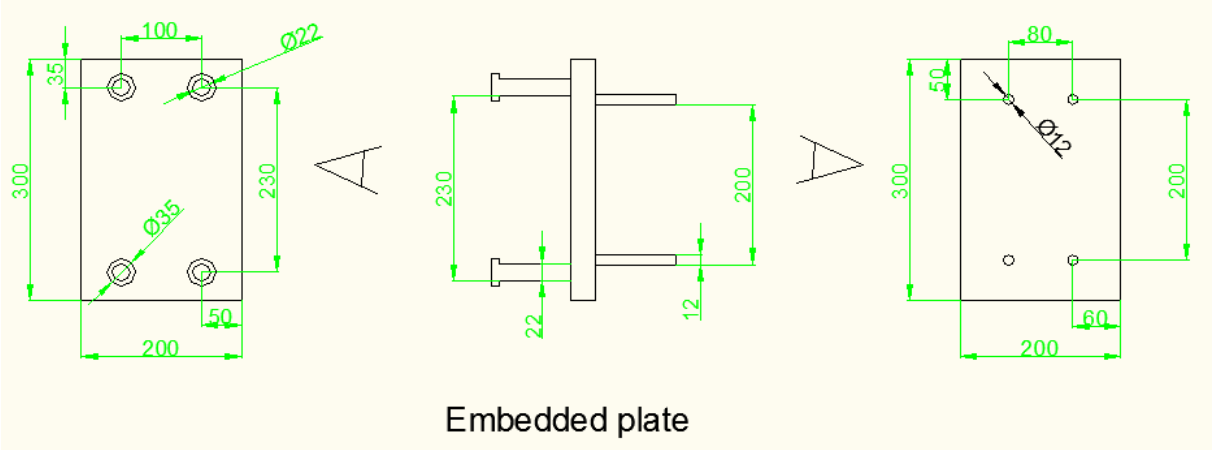
10.2 duct_steel



B.2.1 General view of the specimen



B.2.2 Beam 2



B.2.3 Embedded plate

RobustImpact

Robust impact design of steel and composite building structures

Grant Agreement Number: RFSR-CT-2012-00029

Drawings for producing the test specimens

Contribution from the Università degli Studi di Trento

Deliverable D.4.2

Authors:

Nadia Baldassino
Fabio Freddi
Riccardo Zandonini

PART C

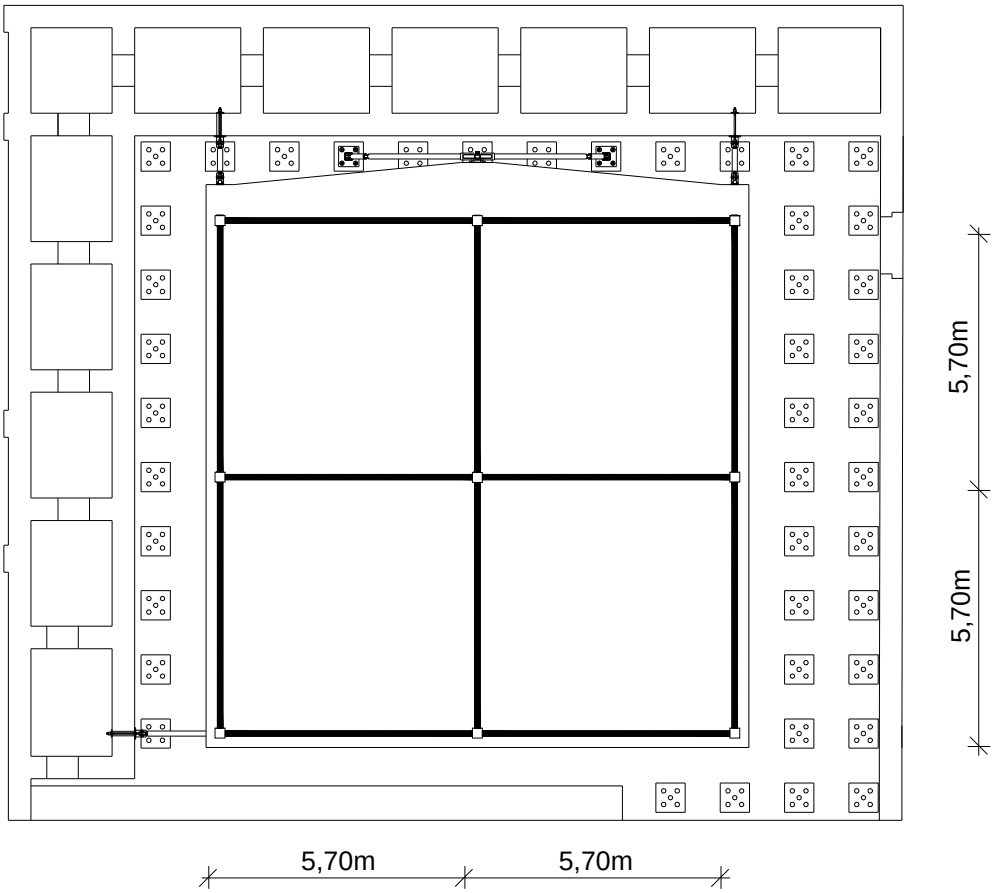
UNIVERSITÀ DEGLI STUDI DI TRENTO

Date: 18.03.2014

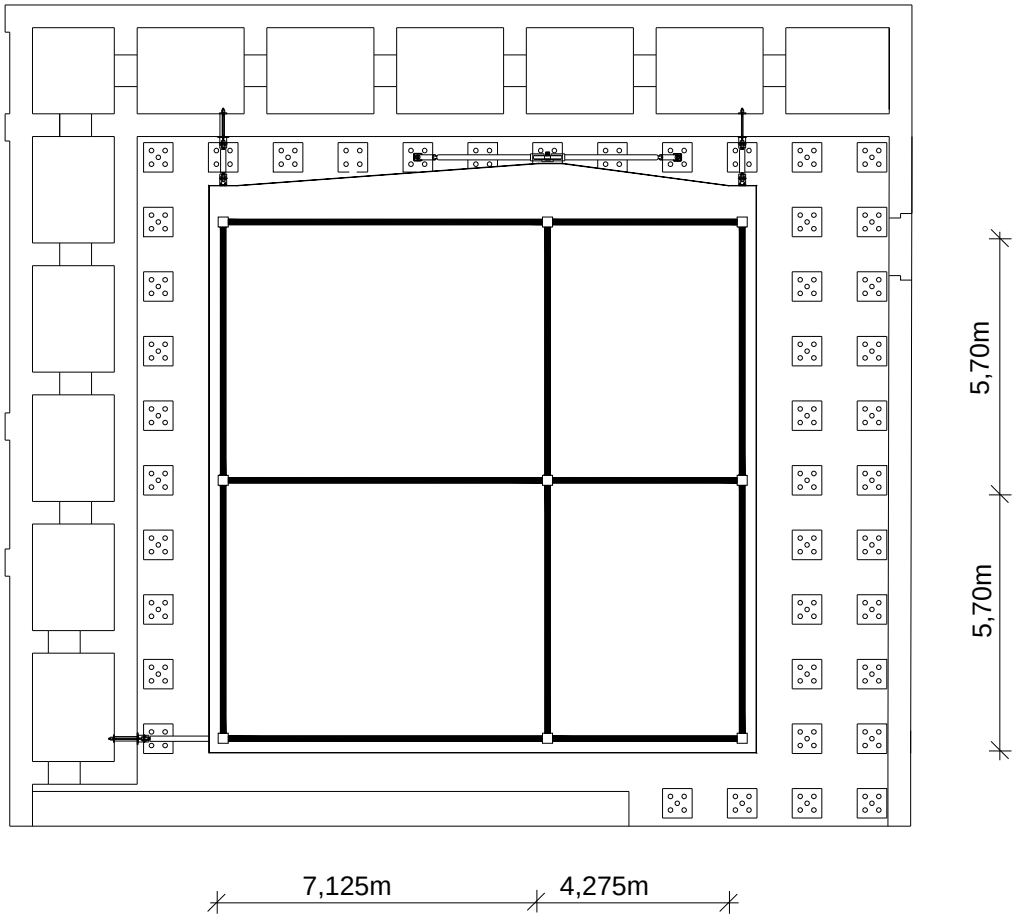
11 INTRODUCTION

The tests' campaign planned by the Università degli Studi di Trento (UTRE) comprises of:

- 2 full-scale tests on specimens representative of steel and concrete composite structures.
  At this aim two steel and concrete composite structures, characterised by the same overall dimensions, have been designed. One of the two structures is characterised by a symmetric configuration of the columns, i.e., the position of the columns defines a square grid (symmetric structure). An asymmetric configurations of the columns in one direction characterises the second structure (asymmetric configuration).The same steel profiles, connections and slab thickness have been considered for both the structures. The main difference between the two configurations lies in the rebars (diameter and layout) of the slab.
  From the reference structures two representative substructure characterised by the same overall dimensions but by a symmetric and an asymmetric configuration, respectively, have been identified. The substructures will be built in laboratory (Figs.1.1 and 1.2) and tested reproducing the collapse of a central column. The aim of the tests is to investigate the influence of the biaxial membrane effect associated with the concrete slab in a framed structure when the collapse of a column happens.
- 20 tensile tests on T-stubs related to the beam-to-column joint adopted in the reference structures and in the full-scale specimens. T-stubs associated to both the column (10 specimens) and the end-plate (10 specimens) will be tested. The tests will be performed at two different speed loading aiming at investigating the influence of strain rate effects on the joint deformation capacity. As a reference also quasi-static tests will be carried out.



Figures 1.1: Symmetric full-scale specimen.



Figures 1.2: Asymmetric full-scale specimen.

The drawings for the production of the specimens have been produced by UTRE and sent to ArcelorMittal, to local fabricators and to local companies, depending on the material to be provided.

In the following sections, a list of the pieces to be produced is given. All the drawings are reported in the annexes A-D.

12 FULL-SCALE TESTS

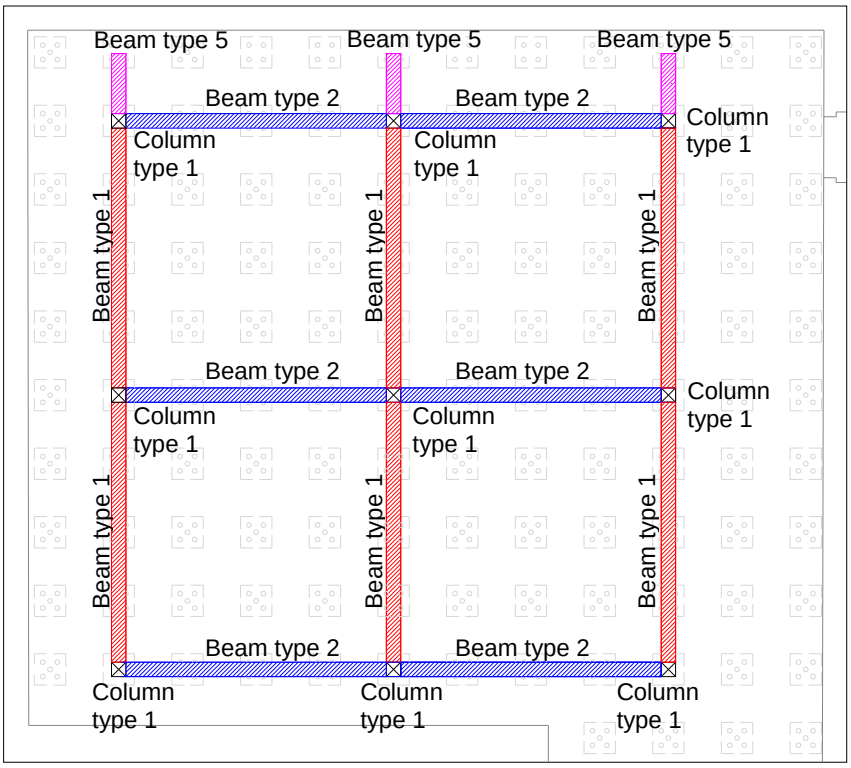
12.1 Steel components

Table 2.1 summarises the steel components needed for the construction of steel skeleton of the full-scale specimens.

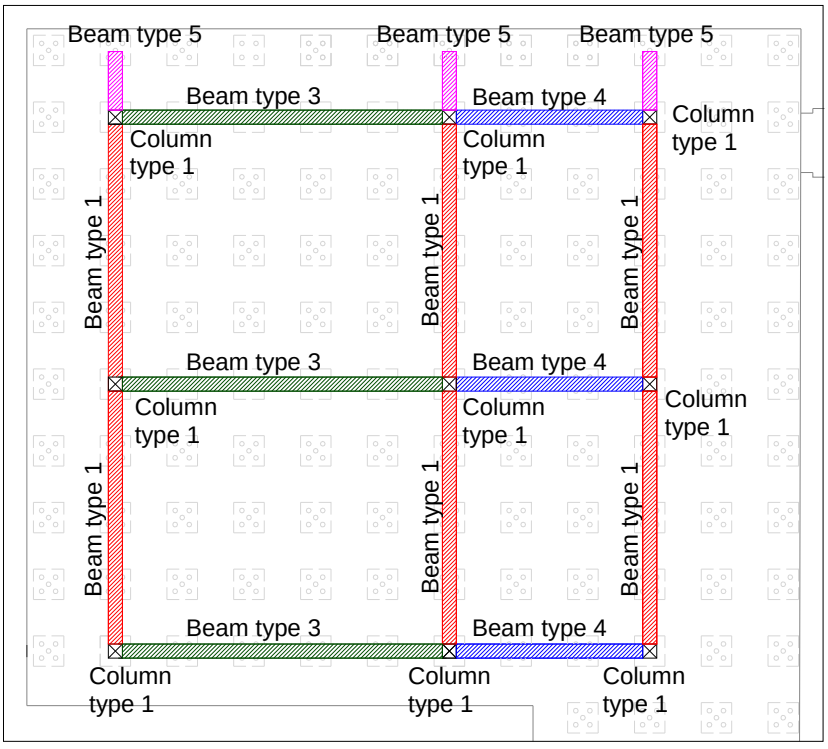
Table 2.1: Summary of the steel components for the steel skeleton of the full-scale specimens.

DESCRIPTION	DRAWING NAME	NUMBER OF PIECES	SPEC. CONFIGURATION	
			Symmetric	Asymmetric
Summary of the steel components	FST 01	-	X	X
COLUMNS TYPE 1				
Steel profile HEB220 length 5500mm	FST 02-09	18	X	X
Steel plate type B 400x400x30mm	FST 03-09	18	X	X
Steel plate type C 220x220x20mm	FST 03-09	18	X	X
Column assembly	FST 09	-	X	X
BEAMS				
Beam type 1 Steel profile IPE240 length 5460mm	FST 04	12	X	X
Beam type 2 Steel profile IPE240 length 5670mm	FST 05	6	X	
Beam type 3 Steel profile IPE240 length 7095mm	FST 06	3		X
Beam type 4 Steel profile IPE240 length 4246mm	FST 07	3		X
Beam type 5 Steel profile IPE240 length 1500mm	FST 08	6	X	X
Steel plate type A	FST 03-04-05-06-07-08	54	X	X

Figures 2.1 and 2.2 provide a plan view of the two full-scale specimens (steel skeleton) which allows identifying the position of the various steel components.
The drawings for the production of the profiles needed for the steel skeleton of both the specimens (Annex A) have been produced by UTRE and sent to ArcelorMittal.



Figures 2.1: Steel profiles for the symmetric full-scale specimen.



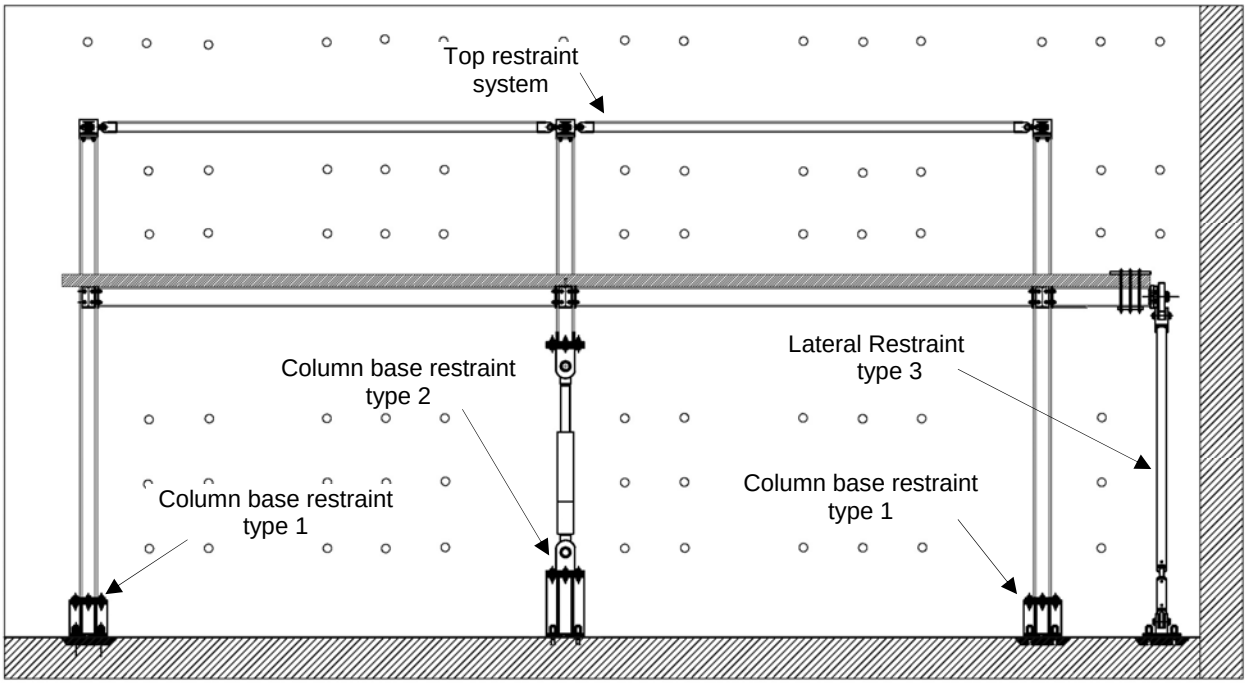
Figures 2.2: Steel profiles for the asymmetric full-scale specimen.

12.2 Restraints

In order to reproduce the effect provided by the remaining part of the structure and the base connections, the specimens will be restrained to both the floor slab and the vertical walls of the laboratory. Ai this aim suitable restraints were identified trough FE numerical investigations and accordingly designed. Furthermore, the columns of the specimens, at their upper ends, will be connected together in order to reproduce the effect provided by the levels of the structure above the one considered in the tests.

Figures 2.3-2.5 allow identifying the position of the restraints.

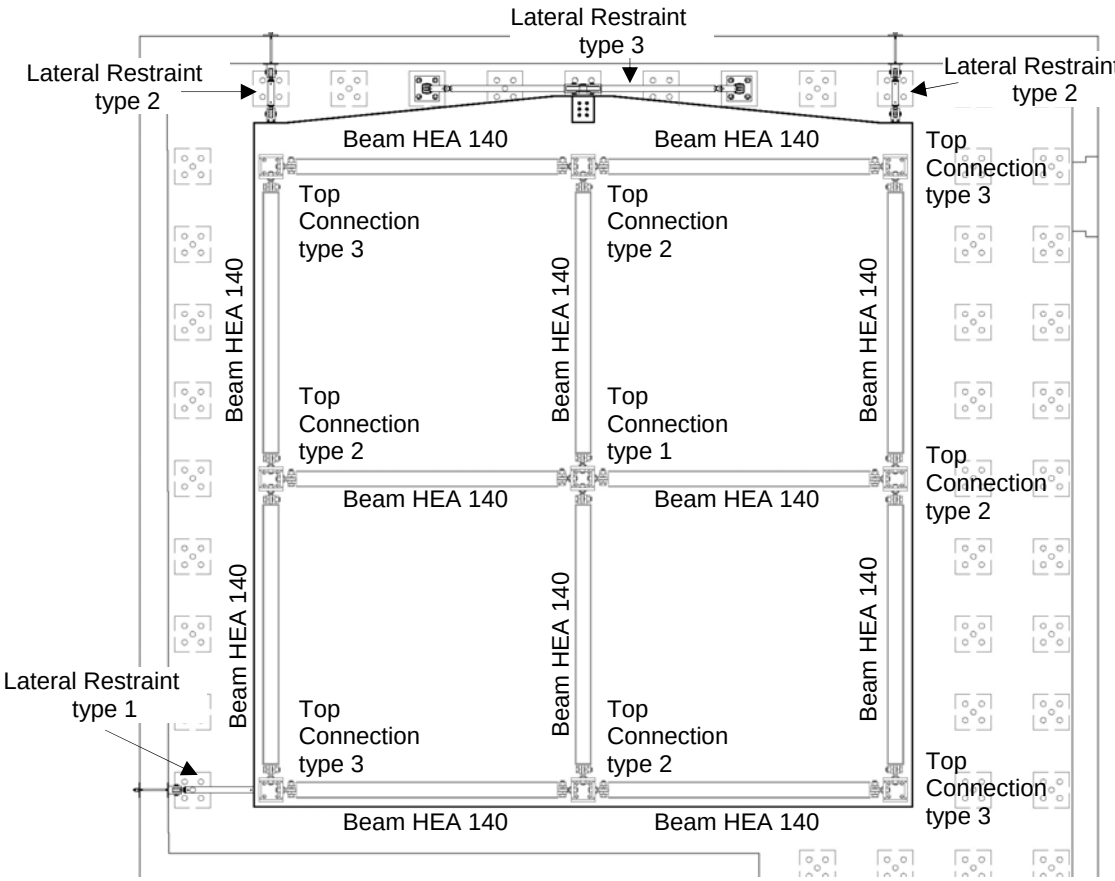
The main drawings related to the restraints are summarised in Table 2.2 and collected in Annex B. The drawings for the production of the restraints (Annex B) have been produced by UTRE and sent to local fabricators.



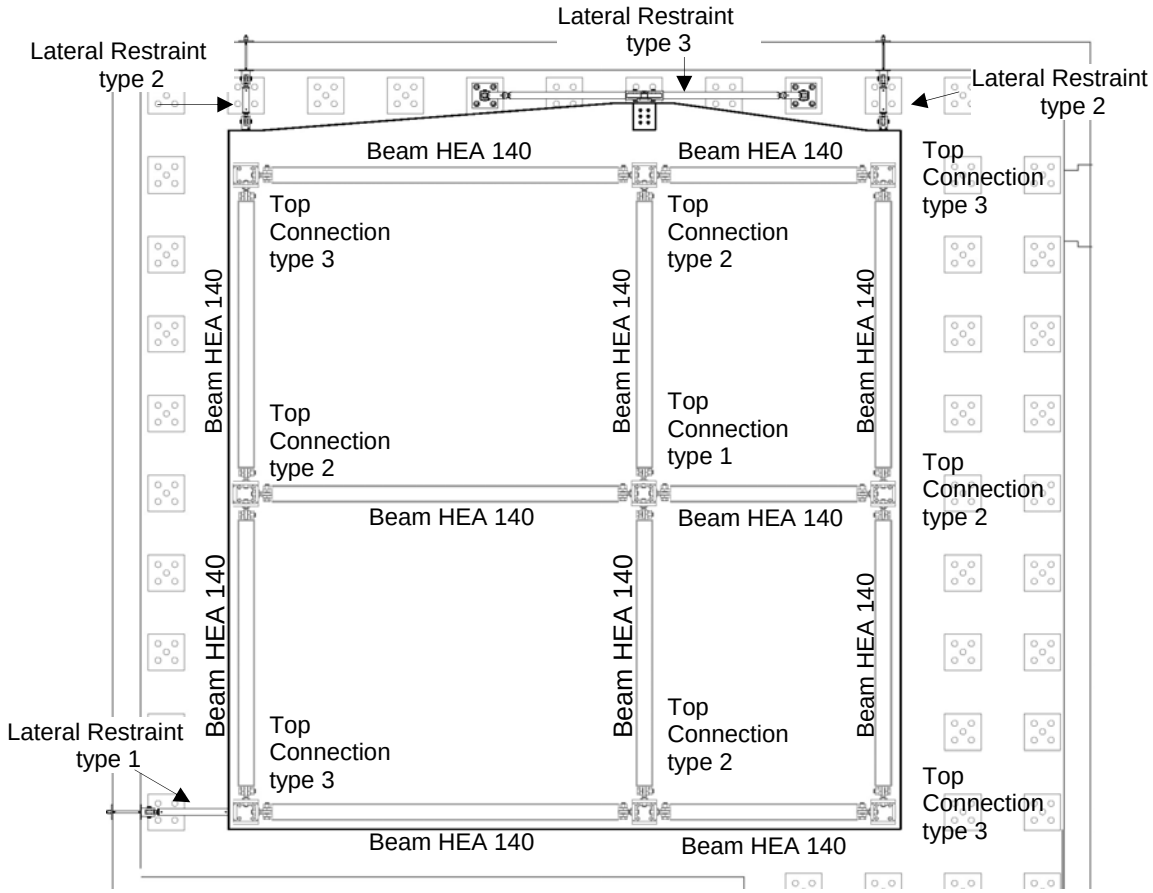
Figures 2.3: Restraints configuration for the full-scale specimens.

Table 2.2: Summary of the restraints

DESCRIPTION	DRAWING NAME	NUMBER OF PIECES	SPECIMEN'S CONFIGURATION	
			Symmetric	Asymmetric
RESTRAINTS AT THE COLUMN'S BASE				
Column Base Restraint type 1	CBR1	8	X	X
Column Base Restraint type 2	CBR2	1	X	X
LATERAL RESTRAINTS				
Lateral Restraint type 1	LR1	1	X	X
Lateral Restraint type 2	LR2	2	X	X
Lateral Restraint type 3	LR3	1	X	X
TOP COLUMN RESTRAINTS				
Top connection type 1	TC1	1	X	X
Top connection type 2	TC2	4	X	X
Top connection type 3	TC3	4	X	X



Figures 2.4: Restraints for the symmetric full-scale specimen.



Figures 2.5: Restraints for the asymmetric full-scale specimen.

12.3 Rebars

The reinforcement of the slabs of the two full-scale specimens is realized with an electrowelded wire mesh located on both the upper and the lower sides of the slab and additional rebars added where required by the design calculations.

A summary of the reinforcement needed for the slabs of the two full-scale specimens is reported in Tables 2.3-2.7. In detail:

- Tables 2.3 summarises the electrowelded wire mesh required for both the specimens;
- Tables 2.4 and 2.5 list the additional rebars for the symmetric specimen, for the lower and the upper side, respectively;
- Tables 2.6 and 2.7 collect the additional rebars for the asymmetric specimen, related to the lower and the upper side, respectively.

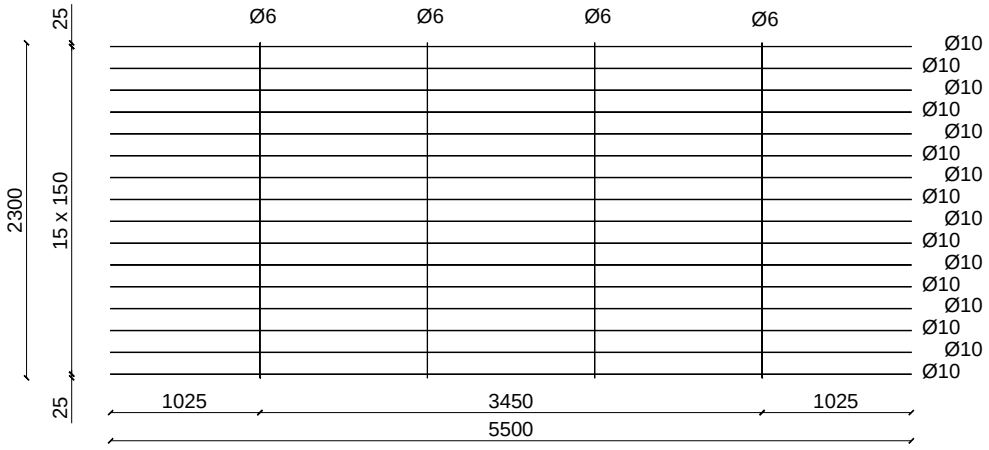
A detailed description of the layout of the rebars for both the specimens is presented in Annex C.

Tables 2.3-2.7 and the drawings of Annex C have been sent to a local Company for their production.

Table 2.3: Summary of the electrowelded wires for the full-scale specimens (symmetric and asymmetric configuration).

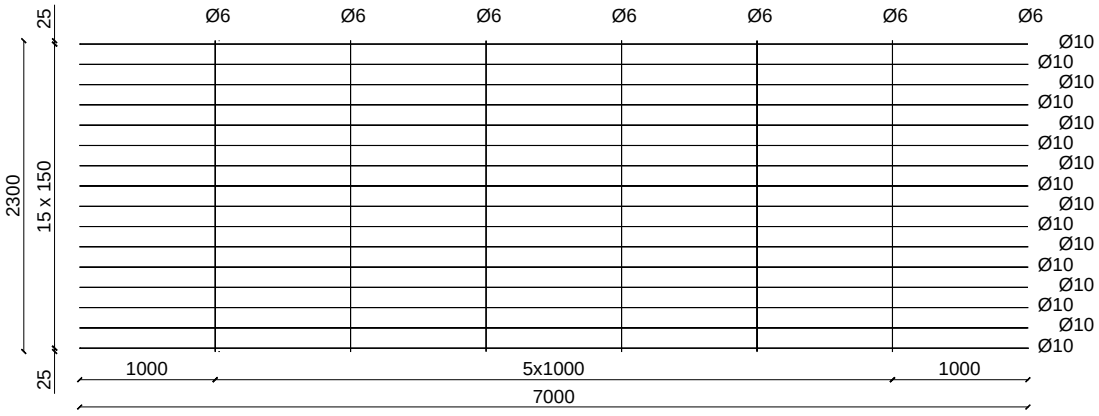
ELECTROWELDED WIRES

MESH TYPE 1



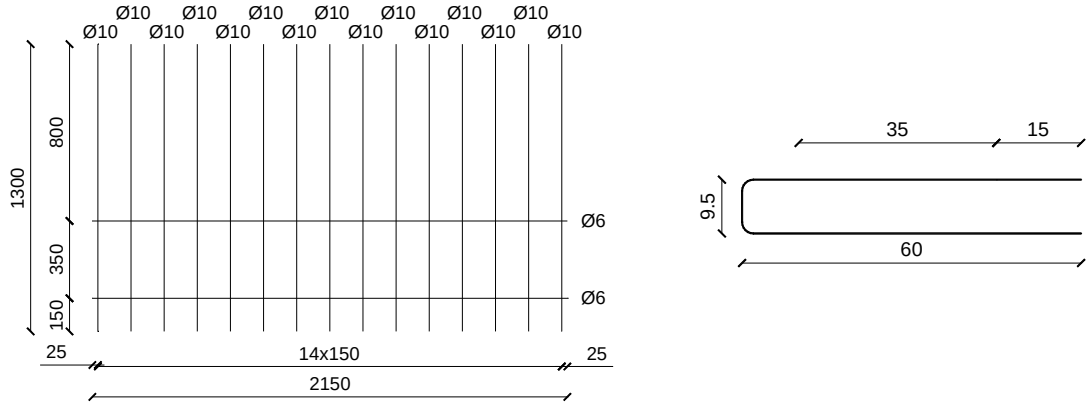
N° panels	Dimensions mm	Nominal unitary weight kgf	Nominal total weight kgf
22	5500x2300	57,882	1273

MESH TYPE 2



N° panels	Dimensions mm	Nominal unitary weight kgf	Nominal total weight kgf
62	7000x2300	74,493	4619

MESH TYPE 3



N° panels	Dimensions mm	Nominal unitary weight kgf	Nominal total weight kgf
44	2150x1300	12,976	571

Table 2.4: Summary of the rebars for the symmetric configuration - Lower side

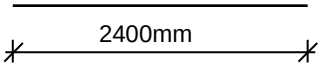
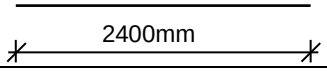
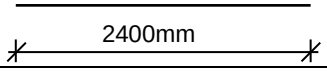
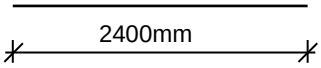
SLAB REBARS - LOWER SIDE - SYMMETRIC CONFIGURATION					
Position	Shape	Diameter mm	Length mm	Quantity n°	Nominal weight kgf
Pos. C		10	2400	22	33
Pos. D		10	2400	8	12
Pos. E		10	2400	30	44
Pos. F		10	2400	8	12
Total nominal weight (kgf)					153

Table 2.5: Summary of the rebars for the symmetric configuration - Upper side

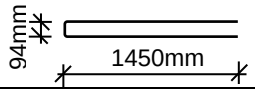
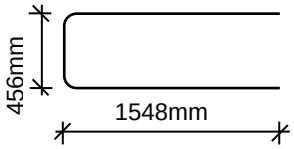
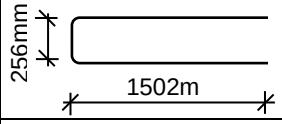
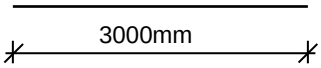
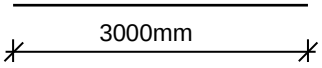
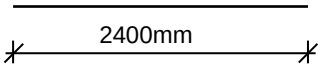
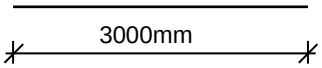
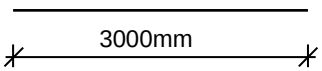
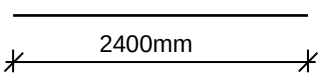
SLAB REBARS - UPPER SIDE - SYMMETRIC CONFIGURATION					
Position	Shape	Diameter mm	Length mm	Quantity n°	Nominal kgf
Pos. A		10	3000	28	52
Pos. G1		16	3500	3	17
Pos. G2		16	3200	3	15
Pos. H		16	3000	24	114
Pos. I		16	3000	48	227
Pos. L		10	2400	92	136
Pos. M		16	3000	12	57
Pos. N		16	3000	44	206
Pos. O		10	2400	35	52
Total nominal weight (kgf)					878

Table 2.6: Summary of the rebars for the asymmetric configuration - Lower side

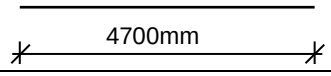
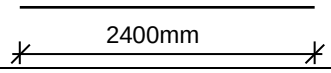
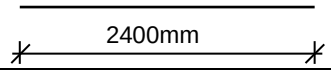
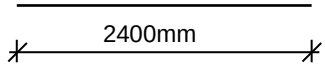
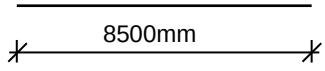
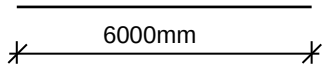
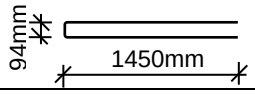
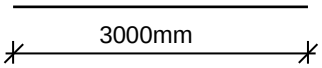
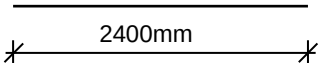
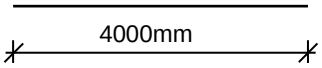
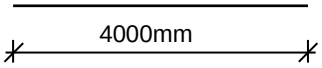
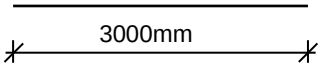
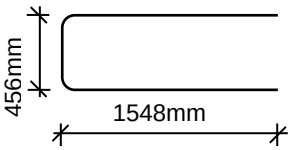
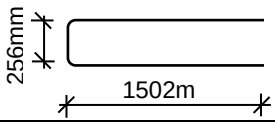
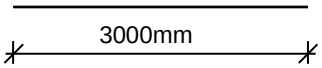
SLAB REBARS - LOWER SIDE - ASYMMETRIC CONFIGURATION					
Position	Shape	Diameter mm	Length mm	Quantity n°	Nominal weight kgf
Pos. C		10	4700	41	119
Pos. D		10	2400	8	12
Pos. E		10	2400	21	31
Pos. F		10	2400	8	12
Pos. G		10	8500	8	42
Pos. H		10	6000	76	281
Total nominal weight (kgf)					527

Table 2.7: Summary of the rebars for the asymmetric configuration - Upper side

SLAB REBARS - UPPER SIDE - ASYMMETRIC CONFIGURATION					
Position	Shape	Diameter mm	Length mm	Quantity n°	Nominal kgf
Pos. A		10	3000	28	52
Pos. I		16	3000	40	189
Pos. L		10	2400	98	145
Pos. M		16	4000	12	76
Pos. N		16	4000	45	284
Pos. O		10	3000	35	65
Pos. P1		16	3500	3	17
Pos. G2		16	3200	3	15
Pos. Q		16	3000	24	114
Total nominal weight (kgf)					957

13 T-STUB TESTS

The tensile tests on T-stubs will be related to the beam-to-column joints adopted in the reference structures and in the full-scale specimens. A total of twenty tests will be performed: ten of them will investigate the behaviour of the column and the remaining, the end-plate response (Tab. 2.8).

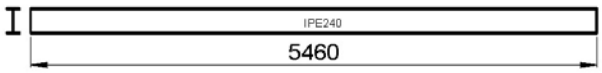
A detailed description of the specimens is presented in Annex D. The drawings of Annex D have been sent to a ArcelorMittal for the production.

Table 2.8: Summary of the material for the T-stub tests.

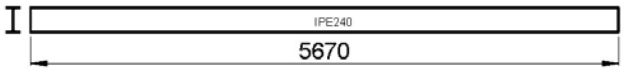
DESCRIPTION	DRAWING NAME	NUMBER OF PIECES
Summary of the material for T-stub tests	TST 01	-
COLUMN'S T-STUB		
Column T-stubs (column HEB220)	TST03A-TST03B	10
END-PLATE T-STUB		
End-Plate T-stubs	TST02	10

14 ANNEX A: FULL-SCALE TESTS - STEEL COMPONENTS

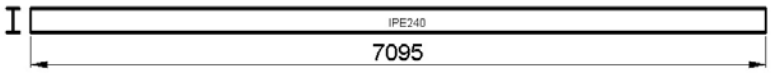
Beam Type 1 Number of pieces - 12



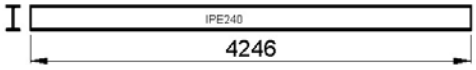
Beam Type 2 Number of pieces - 6



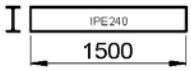
Beam Type 3 Number of pieces - 3



Beam Type 4 Number of pieces - 3



Beam Type 5 Number of pieces - 6



Column type 1 Number of pieces - 18

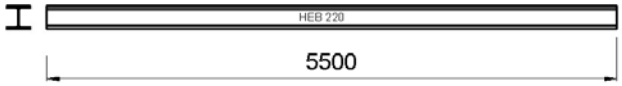


Plate type A Number of pieces - 54

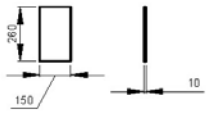


Plate type B Number of pieces - 18

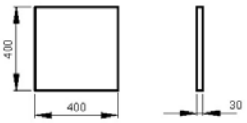
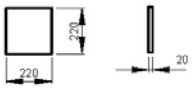


Plate type C Number of pieces - 18



Shear Connector SD 3/4" x 4"; Mild Steel; 1182 Headed studs

D=19 ;H=31.75 ;A=9.52 ;L=100

Name		Steel Grade	Dimensions [mm]	Weight [t]	Number of pieces	Total Weight [t]	Drawing No.
Beam type 1	IPE 240	S 355 JR	240x120x5460	0.168	12	2.011	FST 04
Beam type 2	IPE 240	S 355 JR	240x120x5670	0.174	6	1.044	FST 05
Beam type 3	IPE 240	S 355 JR	240x120x7095	0.218	3	0.653	FST 06
Beam type 4	IPE 240	S 355 JR	240x120x4246	0.130	3	0.391	FST 07
Beam type 5	IPE 240	S 355 JR	240x120x1500	0.046	6	0.276	FST 08
Column type 1	HEB 220	S 355 JR	220x220x5500	0.393	18	7.079	FST 02-09
Plate type A		S 355 JR	260x150x10	0.003	54	0.165	FST 03-04-05-06-07-08
Plate type B		S 355 JR	400x400x30	0.038	18	0.678	FST 03-09
Plate type C		S 355 JR	220x220x20	0.007	18	0.137	FST 03-09
Shear Coonectors	SD 3/4"x 4"	---	D=19; H=31.75; A=9.52; L=100	---	1182	---	FST 04-05-06-07-08
					Total	12.434	

UNIVERSITÀ DEGLI STUDI DI TRENTO
DIPARTIMENTO DI INGEGNERIA MECCANICA E STRUTTURALE
Laboratorio Prove Materiali e Strutture

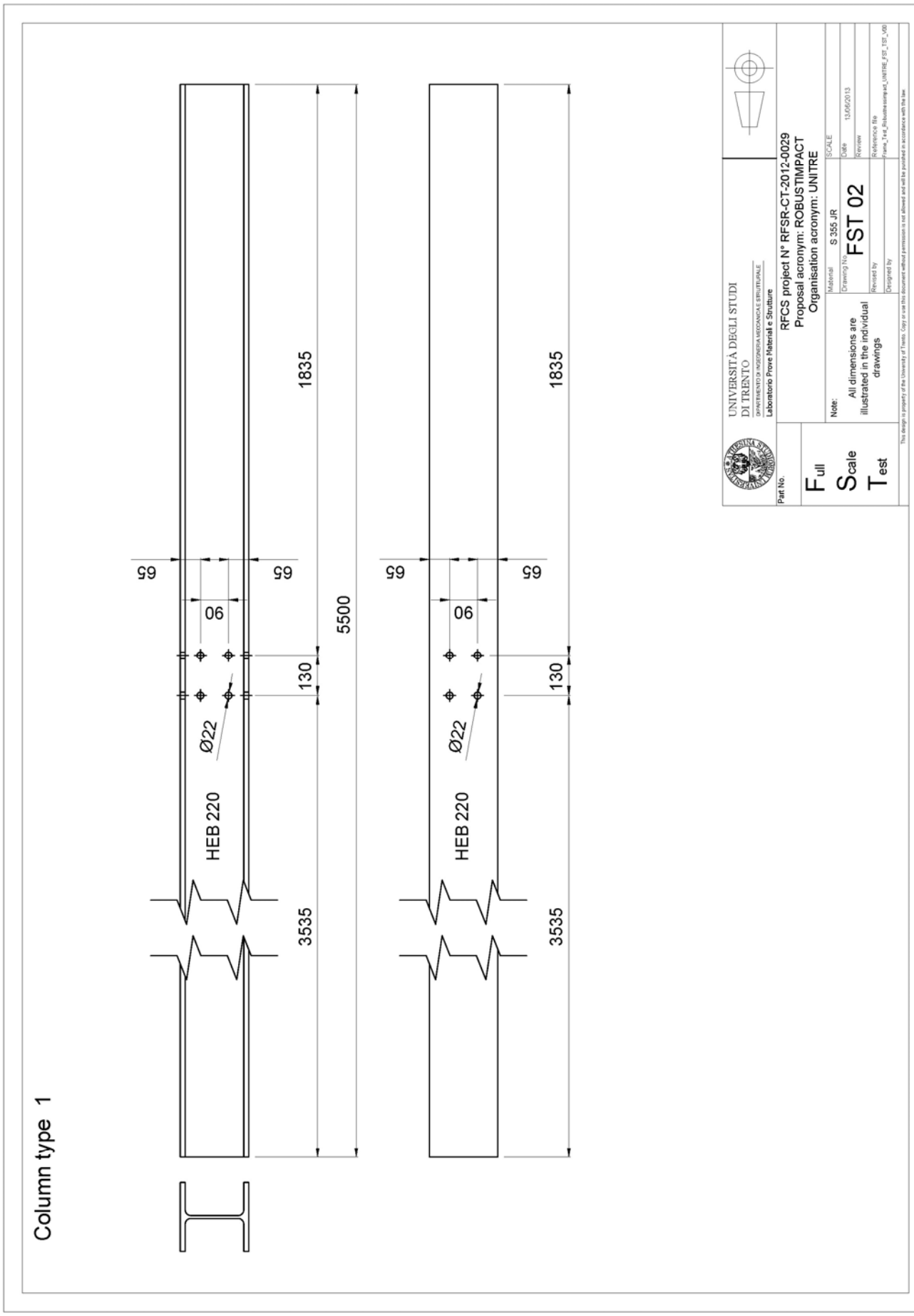
Part No.

Full Scale Test

RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE

Note: All dimensions are illustrated in the individual drawings

Material
Drawing No. FST 01
Revised by
Designed by
SCALE
Date 13/06/2013
Review
Reference file


Column type 1
HEB 220
Ø22
90
65
65
130
1835
5500
3535
HEB 220
Ø22
90
65
65
130
1835
3535
UNIVERSITÀ DEGLI STUDI
DI TRENTO
Laboratorio Prove Materiali e Strutture
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Part No.
Full Scale Test
Note:
All dimensions are illustrated in the individual drawings
Material
S 355 JR
Drawing No.
FST 02
SCALE
Date
13/06/2013
Revision
Revised by
Designed by
Reference file

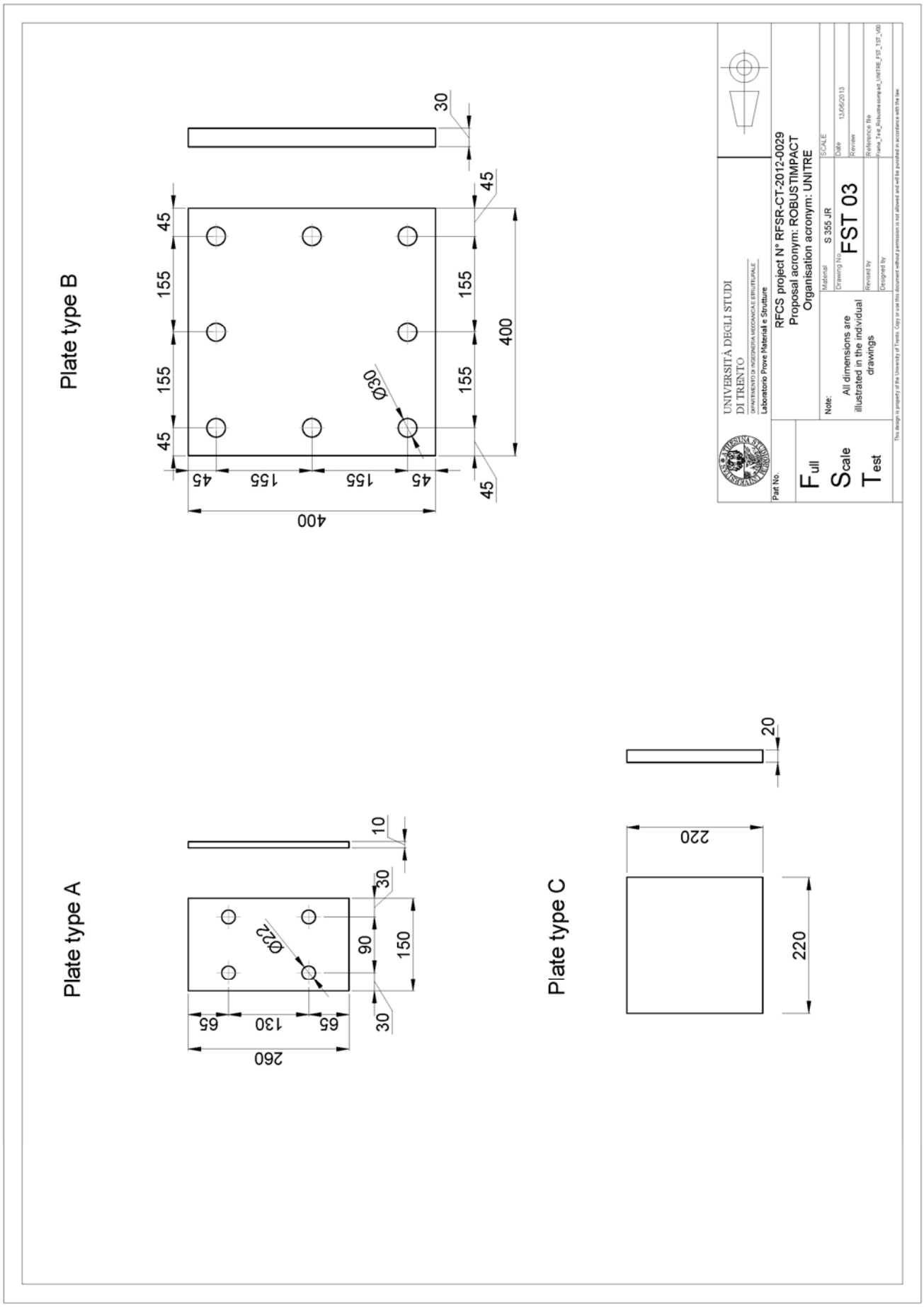
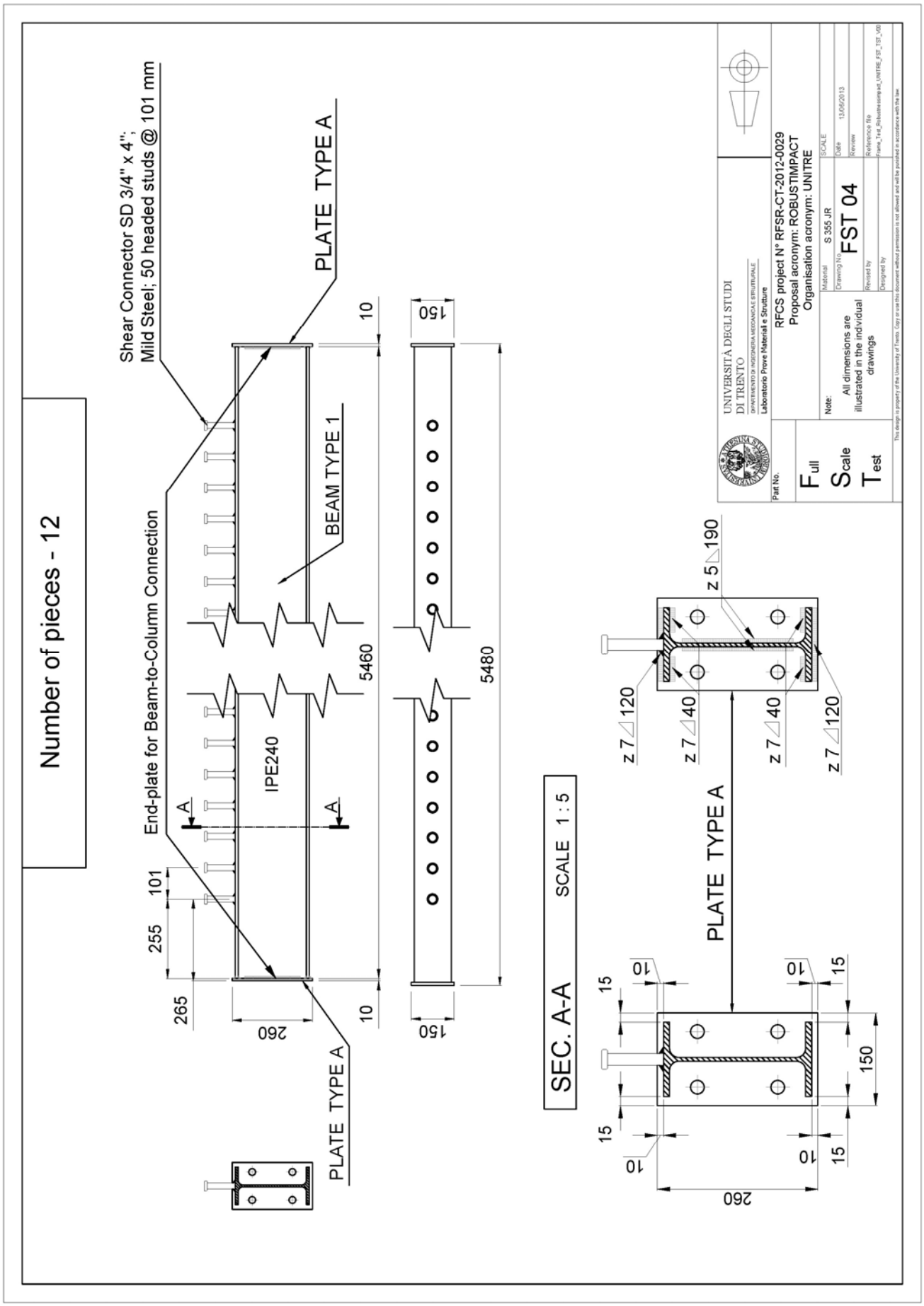
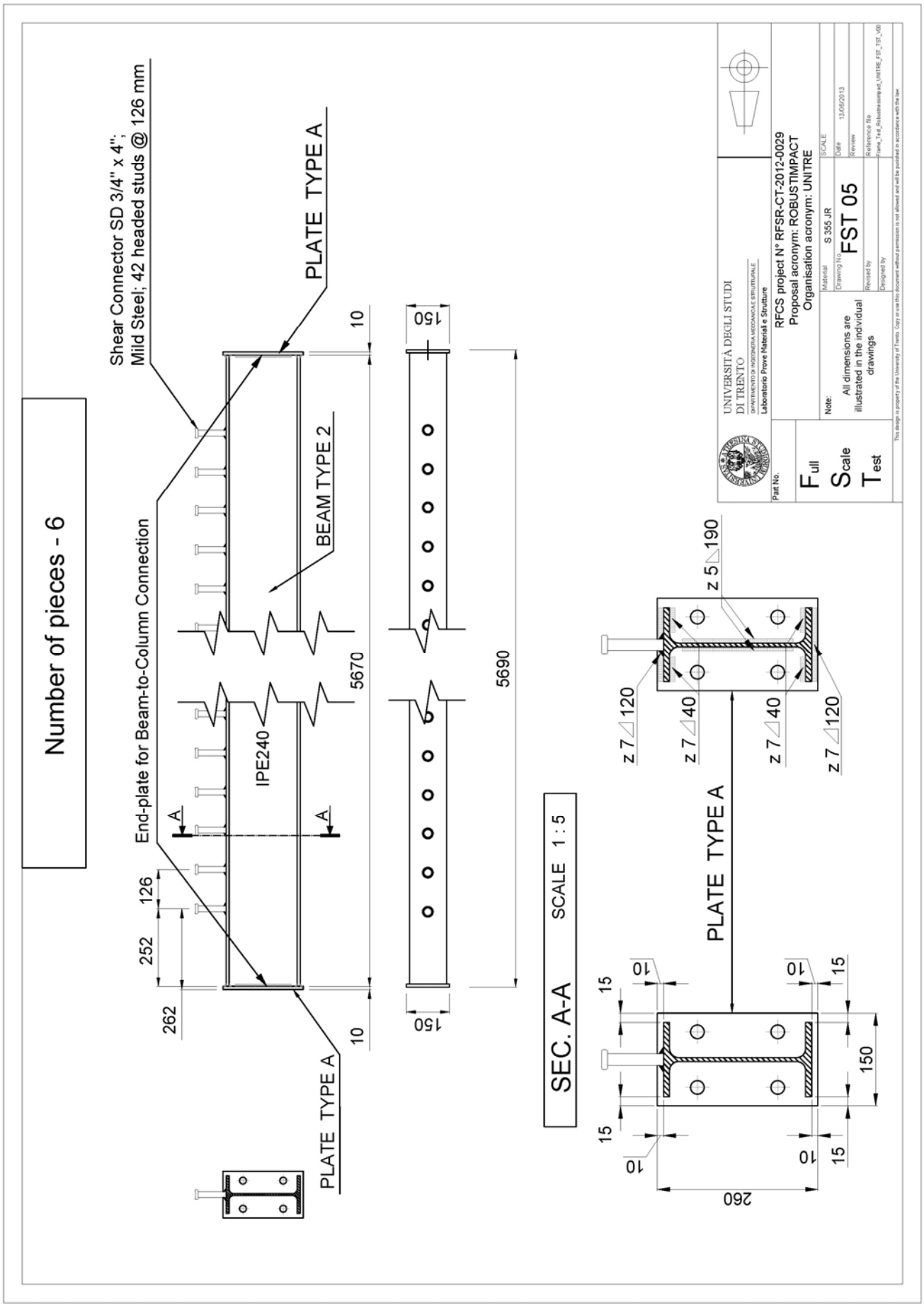
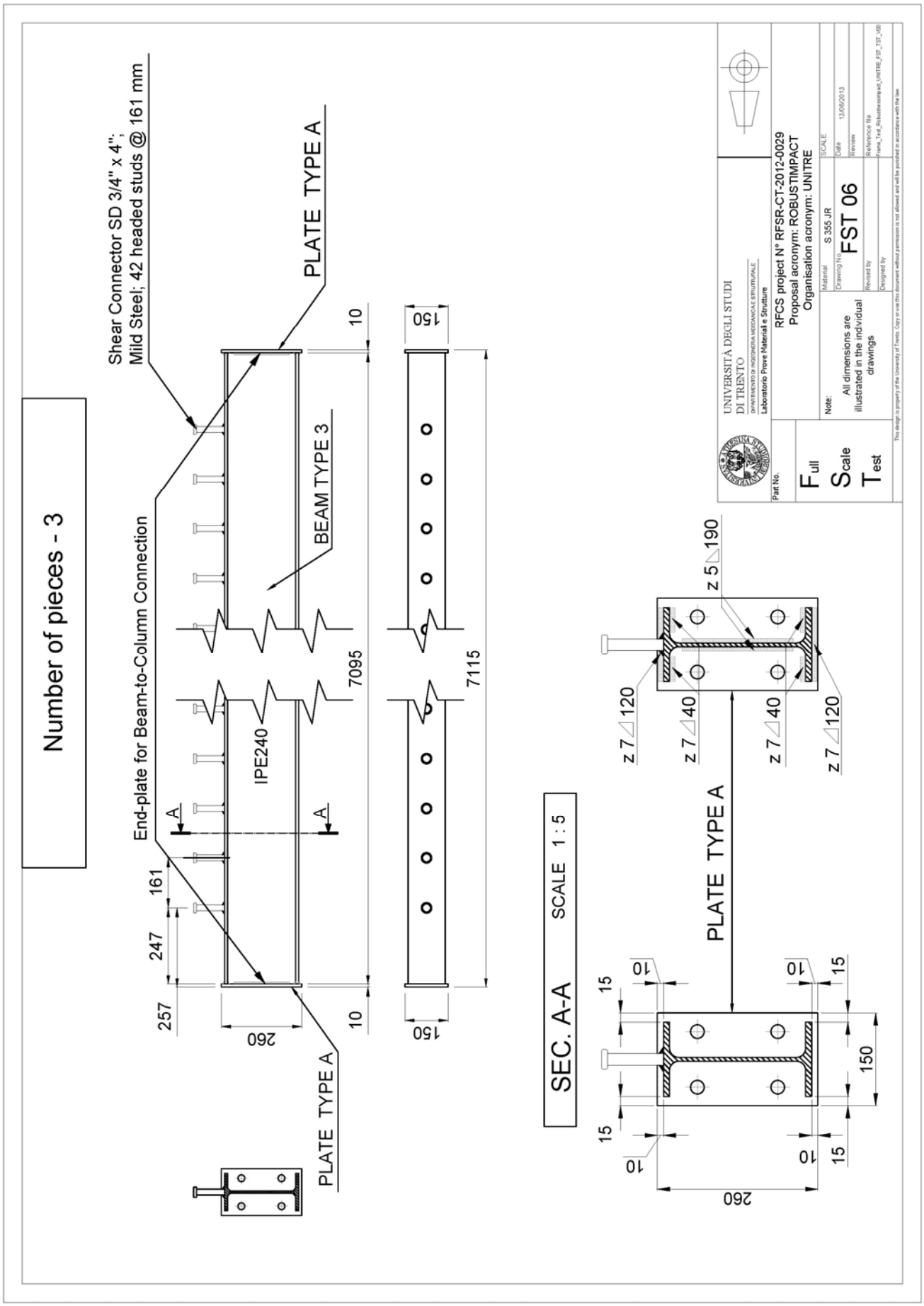
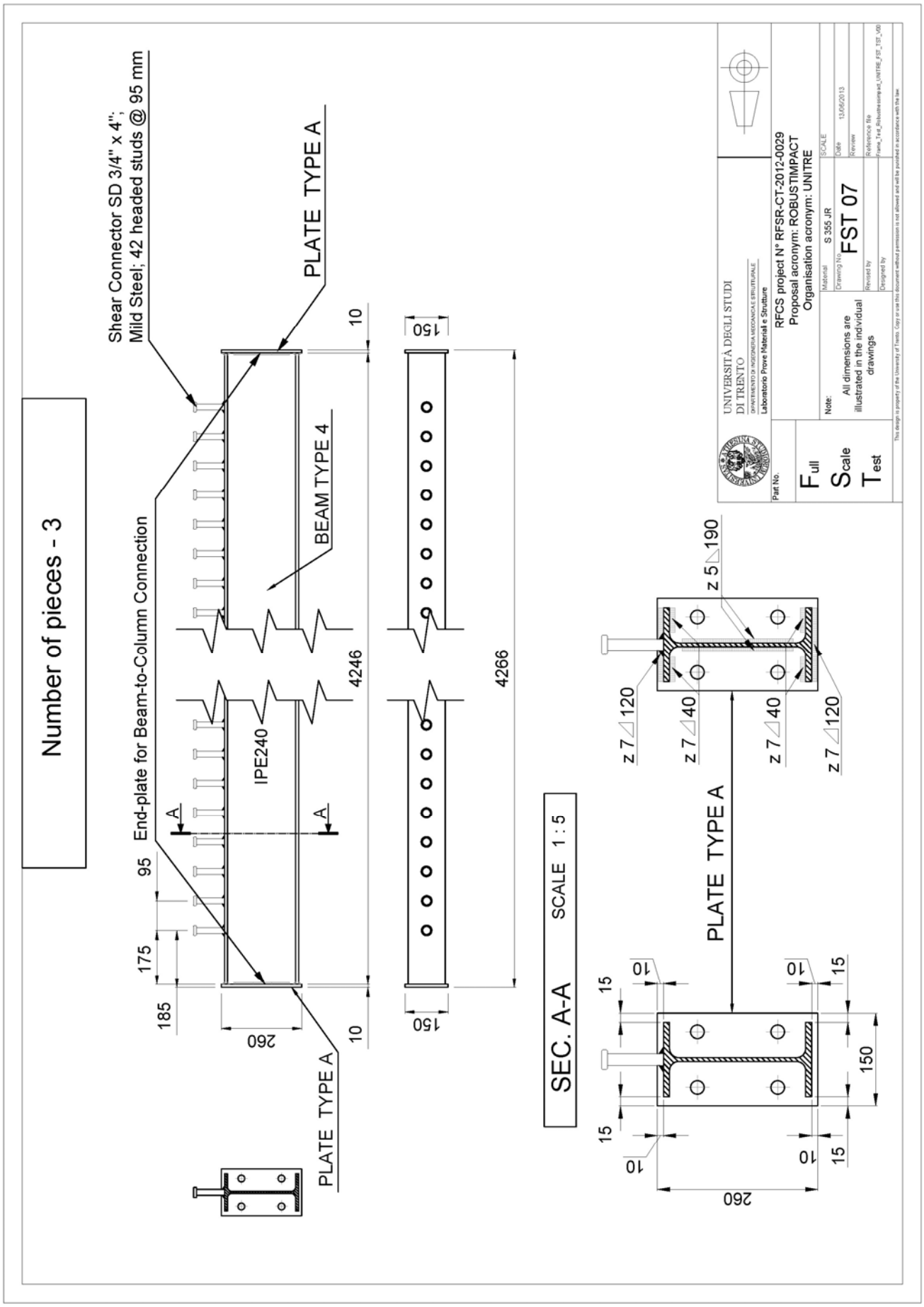


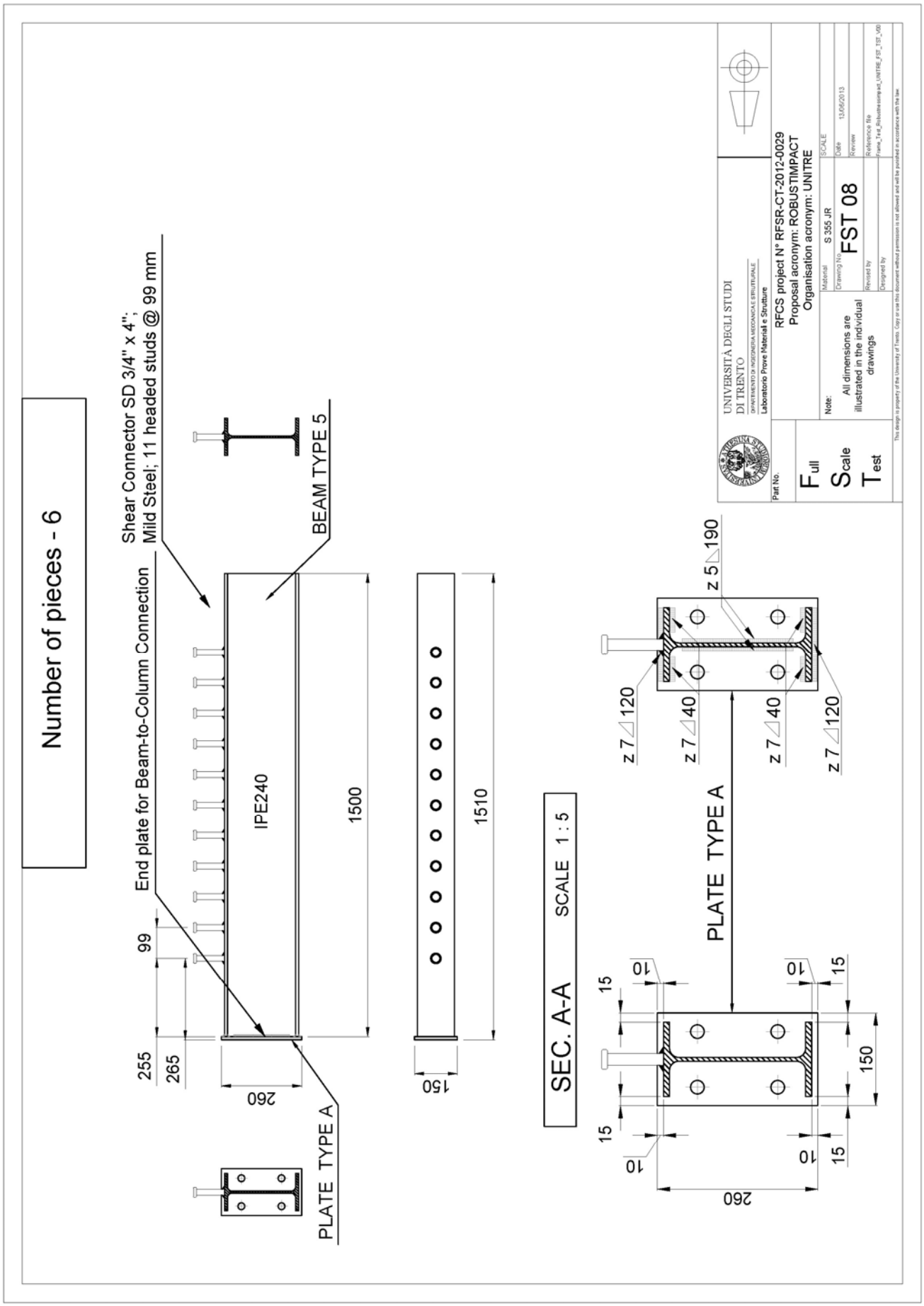
Plate type B
30
45
155
155
155
155
45
45
400
Ø30
45
155
155
45
400
Plate type A
10
30
Ø22
90
150
30
65
130
65
260
Plate type C
20
220
220
UNIVERSITÀ DEGLI STUDI DI TRENTO
DIPARTIMENTO DI INGEGNERIA MECCANICHE E STRUTTURALE
Laboratorio Prove Materiali e Strutture
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Part No.
Full Scale Test
Note:
All dimensions are illustrated in the individual drawings
Material S 355 JR
SCALE
Drawing No. FST 03
Date 13/06/2013
Revised by
Designed by
Reference file
Review
This design is property of the University of Trento. Copy or use this document without permission is not allowed and will be punished in accordance with the law

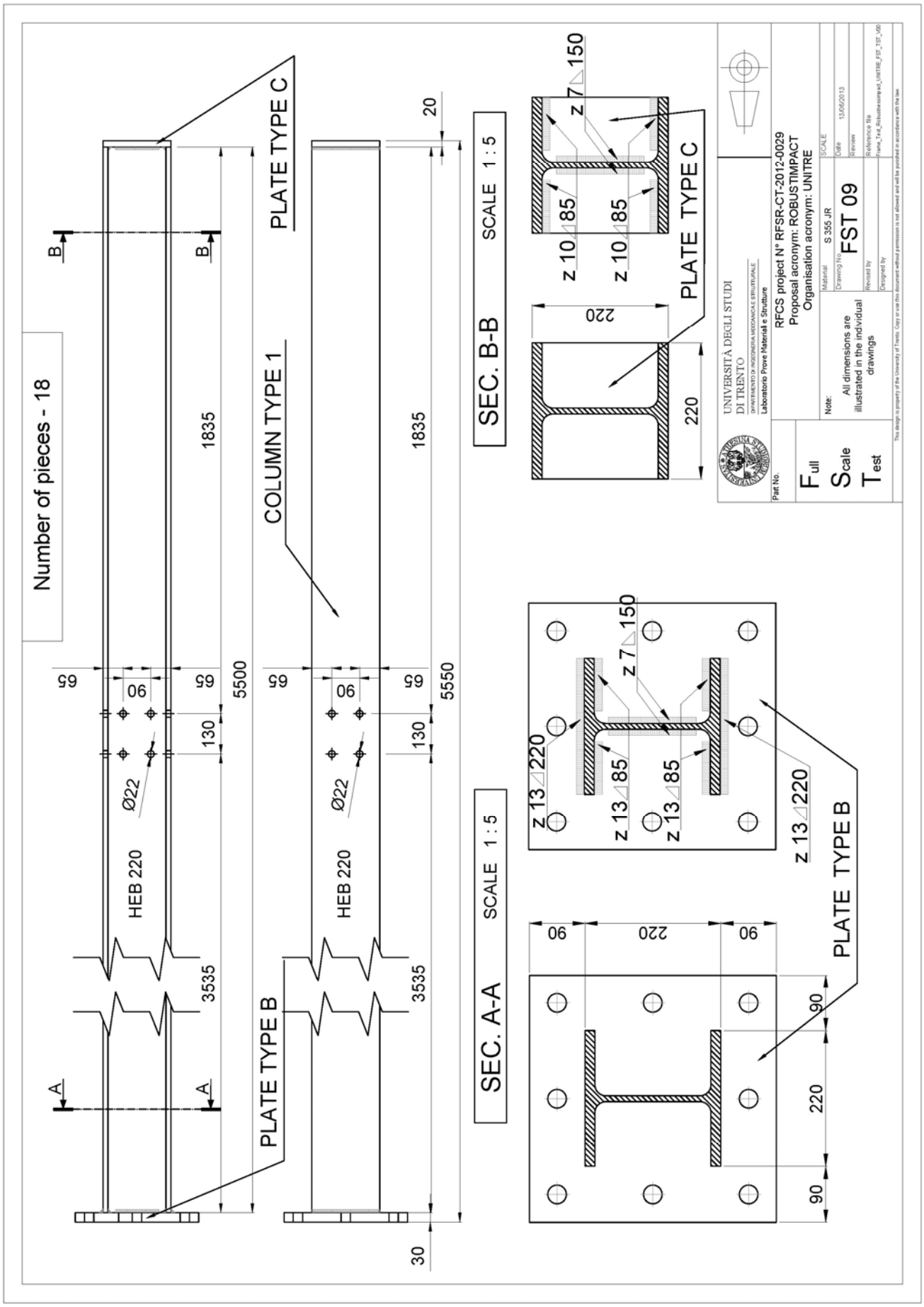

Number of pieces - 12
Shear Connector SD 3/4" x 4";
Mild Steel; 50 headed studs @ 101 mm
End-plate for Beam-to-Column Connection
PLATE TYPE A
BEAM TYPE 1
IPE240
PLATE TYPE A
5460
5480
10
150
101
255
265
260
A
SEC. A-A
SCALE 1 : 5
z 5△190
z 7△120
z 7△40
PLATE TYPE A
15
150
260
UNIVERSITÀ DEGLI STUDI DI TRENTO
Laboratorio Prove Materiali e Strutture
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Full Scale Test
Note:
All dimensions are illustrated in the individual drawings
Material S 355 JR
Drawing No. FST 04
Date 13/06/2013
Revised by
Designed by


Number of pieces - 6
Shear Connector SD 3/4" x 4";
Mild Steel; 42 headed studs @ 126 mm
PLATE TYPE A
BEAM TYPE 2
End-plate for Beam-to-Column Connection
IPE240
PLATE TYPE A
5670
5690
10
150
126
252
262
A
SEC. A-A
SCALE 1 : 5
z 5△190
z 7△120
z 7△40
PLATE TYPE A
260
150
15
UNIVERSITÀ DEGLI STUDI DI TRENTO
Laboratorio Prove Materiali e Strutture
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Material S 355 JR
Drawing No. FST 05
Date 13/06/2013
Review
Full Scale Test
All dimensions are illustrated in the individual drawings

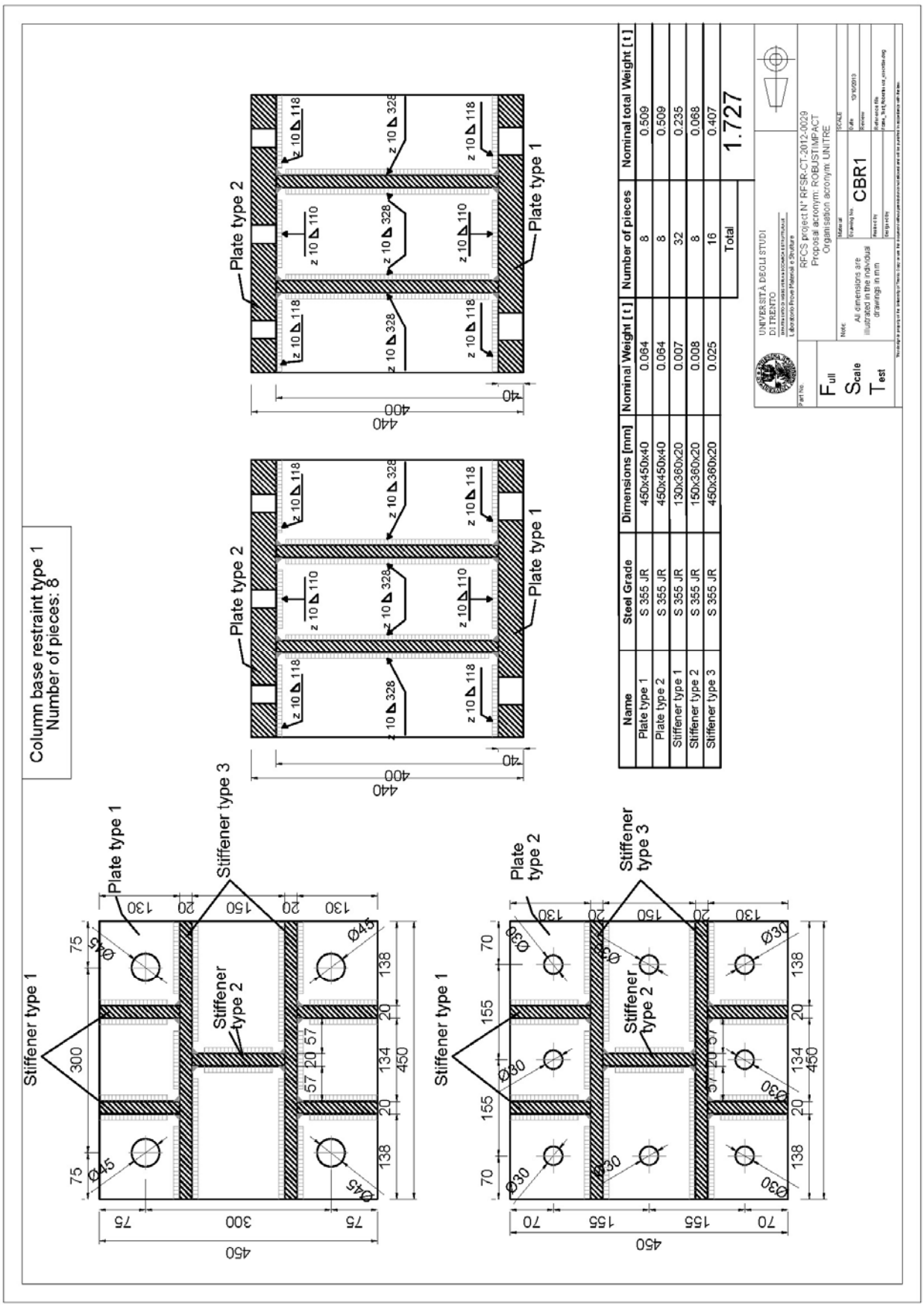

Number of pieces - 3
Shear Connector SD 3/4" x 4";
Mild Steel; 42 headed studs @ 161 mm
PLATE TYPE A
End-plate for Beam-to-Column Connection
BEAM TYPE 3
IPE240
PLATE TYPE A
SEC. A-A SCALE 1 : 5
PLATE TYPE A
UNIVERSITÀ DEGLI STUDI DI TRENTO
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
FST 06
S 355 JR
All dimensions are illustrated in the individual drawings
Full Scale Test

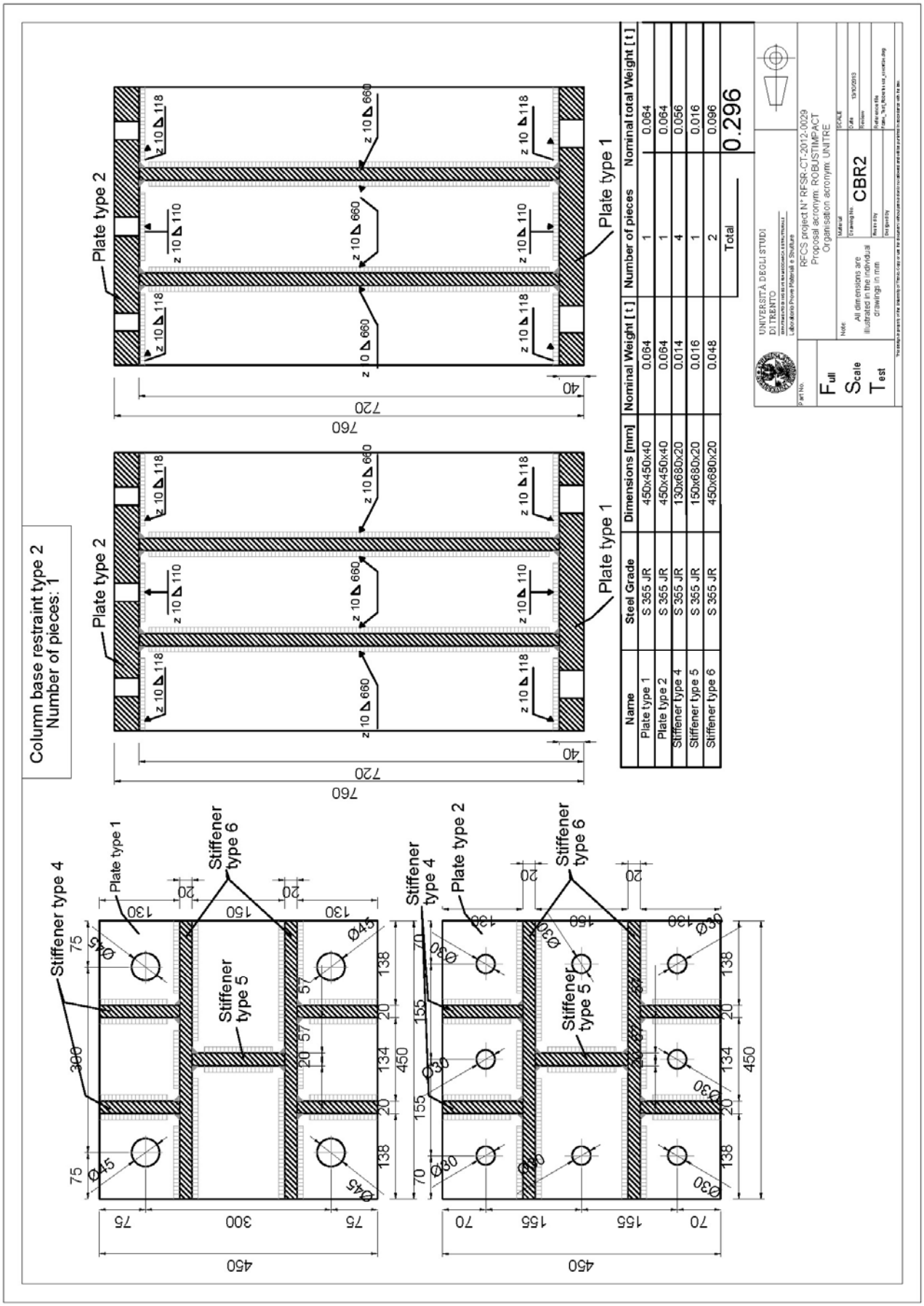

Number of pieces - 3
Shear Connector SD 3/4" x 4";
Mild Steel; 42 headed studs @ 95 mm
PLATE TYPE A
BEAM TYPE 4
End-plate for Beam-to-Column Connection
IPE240
PLATE TYPE A
4246
4266
95
175
185
260
10
150
SEC. A-A
SCALE 1 : 5
z 5△190
z 7△120
z 7△40
PLATE TYPE A
UNIVERSITÀ DEGLI STUDI DI TRENTO
Laboratorio Prove Materiali e Strutture
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Full Scale Test
Note: All dimensions are illustrated in the individual drawings
Material S 355 JR
Drawing No. FST 07
Date 13/06/2013
Review
Revised by
Designed by
Reference file

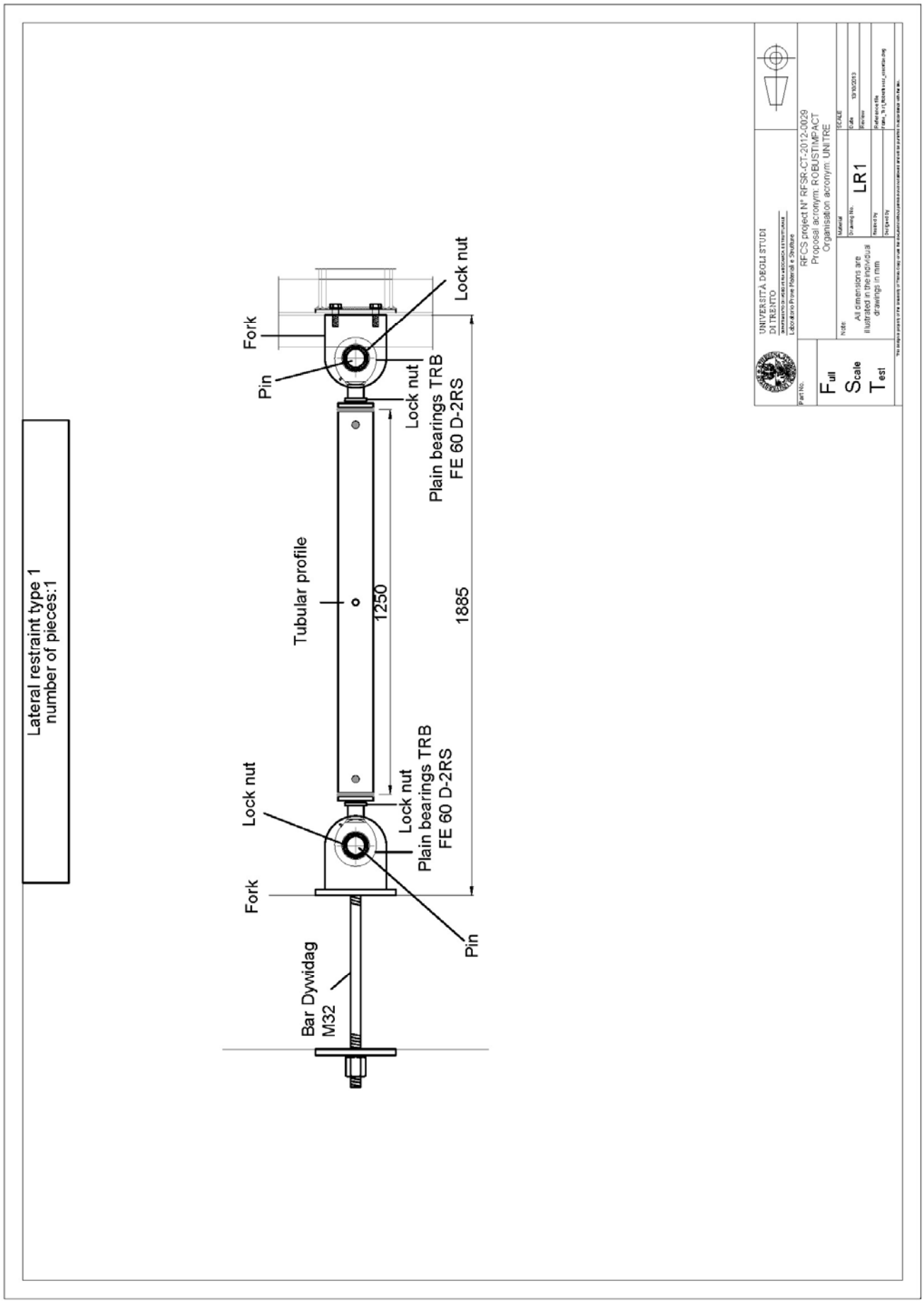

Number of pieces - 6
Shear Connector SD 3/4" x 4";
Mild Steel; 11 headed studs @ 99 mm
End plate for Beam-to-Column Connection
BEAM TYPE 5
IPE240
1500
1510
99
255
265
260
150
PLATE TYPE A
SEC. A-A SCALE 1 : 5
z 5△190
z 7△120
z 7△40
z 7△40
z 7△120
PLATE TYPE A
15
10
150
260
UNIVERSITÀ DEGLI STUDI DI TRENTO
Laboratorio Prove Materiali e Strutture
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Full Scale Test
Material S 355 JR
Drawing No. FST 08
Note: All dimensions are illustrated in the individual drawings
Date 13/06/2013
Review
Revised by
Designed by
Reference file

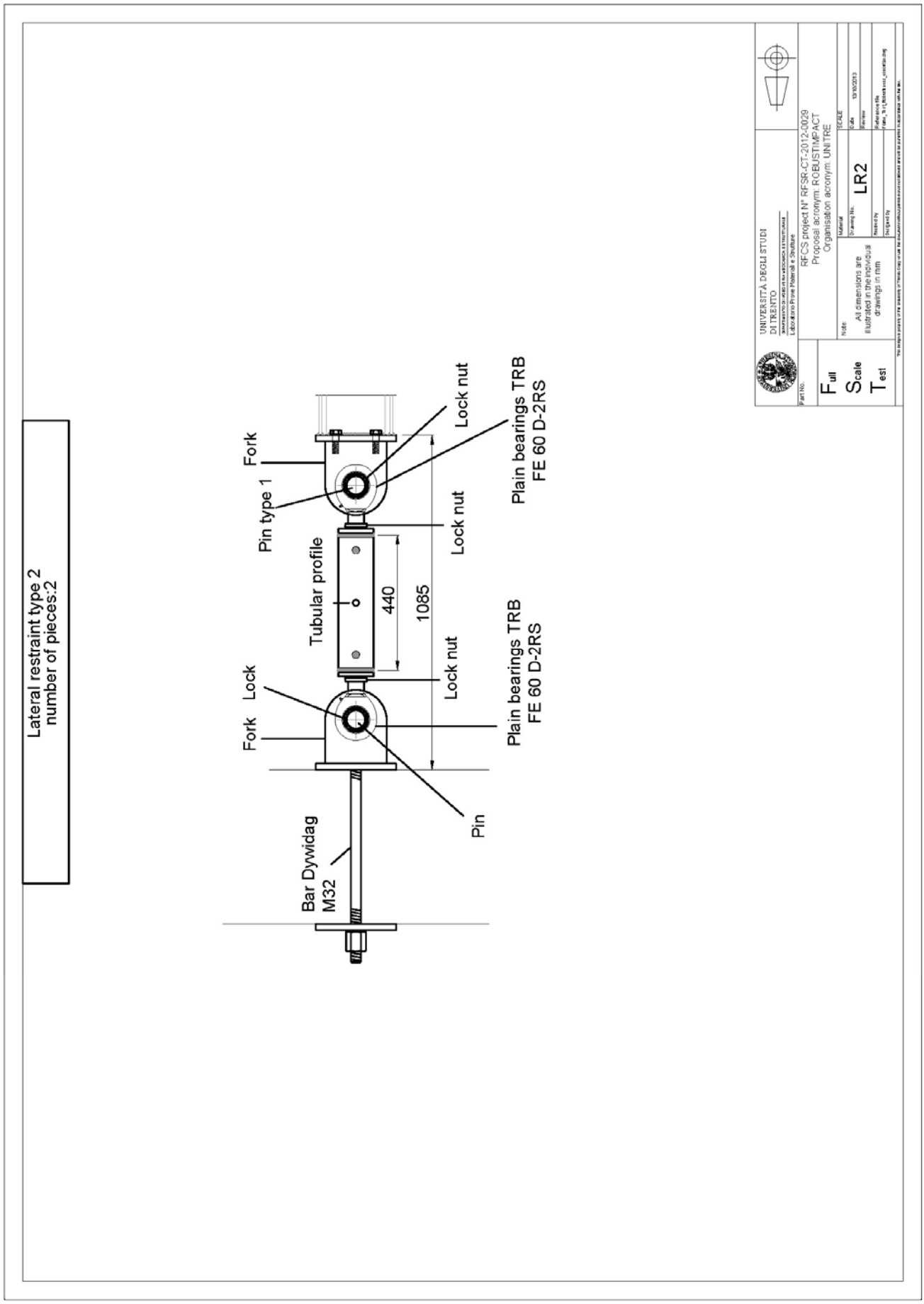

Number of pieces - 18
COLUMN TYPE 1
PLATE TYPE B
PLATE TYPE C
HEB 220
1835
3535
5500
5550
20
30
65
90
130
Ø22
A
B
SEC. A-A SCALE 1 : 5
SEC. B-B SCALE 1 : 5
z 13 220
z 13 85
z 7 150
z 10 85
220
UNIVERSITÀ DEGLI STUDI DI TRENTO
DIPARTIMENTO DI INGEGNERIA MECCANICHE E STRUTTURALE
Laboratorio Prove Materiali e Strutture
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Part No.
Material S 355 JR
Note: All dimensions are illustrated in the individual drawings
Drawing No. FST 09
SCALE
Date 13/06/2013
Review
Revised by
Designed by
Reference file
Full Scale Test

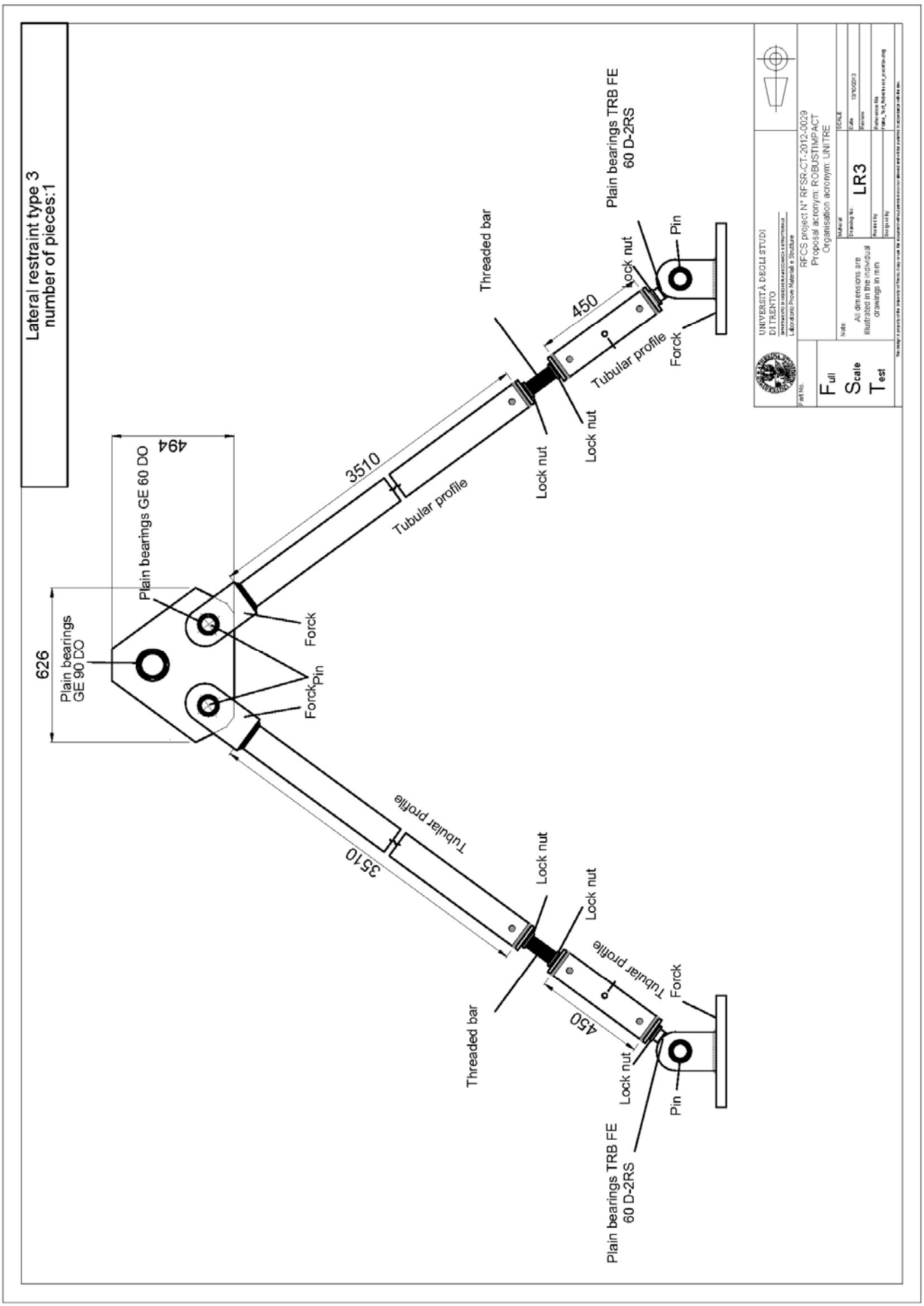
15 ANNEX B: RESTRAINTS

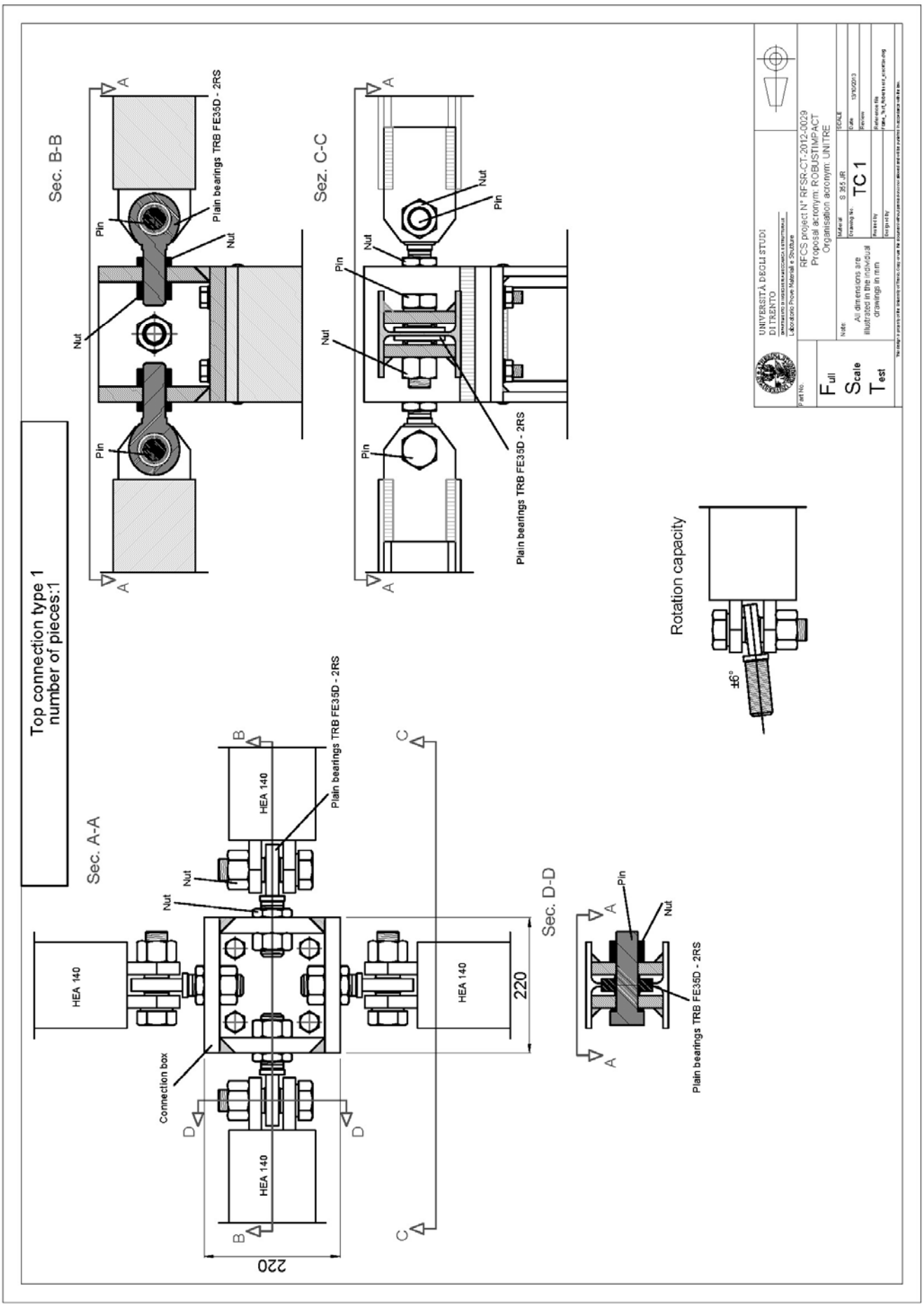


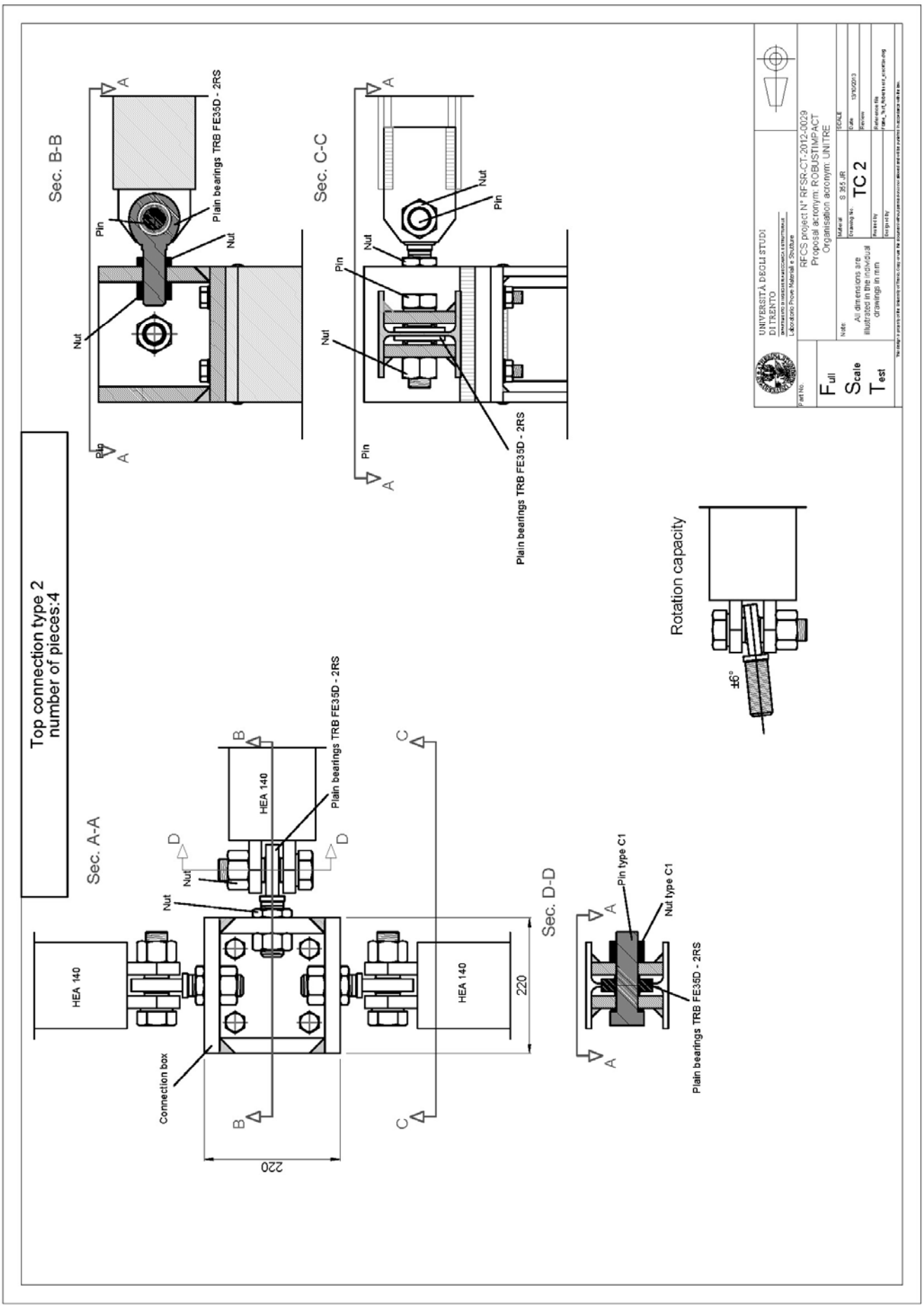

Column base restraint type 2
Number of pieces: 1
Plate type 2
Plate type 1
Stiffener type 4
Stiffener type 5
Stiffener type 6
760
720
40
450
300
75
155
70
130
150
20
138
134
57
155
Name | Steel Grade | Dimensions [mm] | Nominal Weight [t] | Number of pieces | Nominal total Weight [t]
Plate type 1 | S 355 JR | 450x450x40 | 0.064 | 1 | 0.064
Plate type 2 | S 355 JR | 450x450x40 | 0.064 | 1 | 0.064
Stiffener type 4 | S 355 JR | 130x680x20 | 0.014 | 4 | 0.056
Stiffener type 5 | S 355 JR | 150x680x20 | 0.016 | 1 | 0.016
Stiffener type 6 | S 355 JR | 450x680x20 | 0.048 | 2 | 0.096
Total 0.296
UNIVERSITÀ DEGLI STUDI DI TRENTO
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
CBR2
Full
Scale
Test
All dimensions are illustrated in the individual drawings in mm

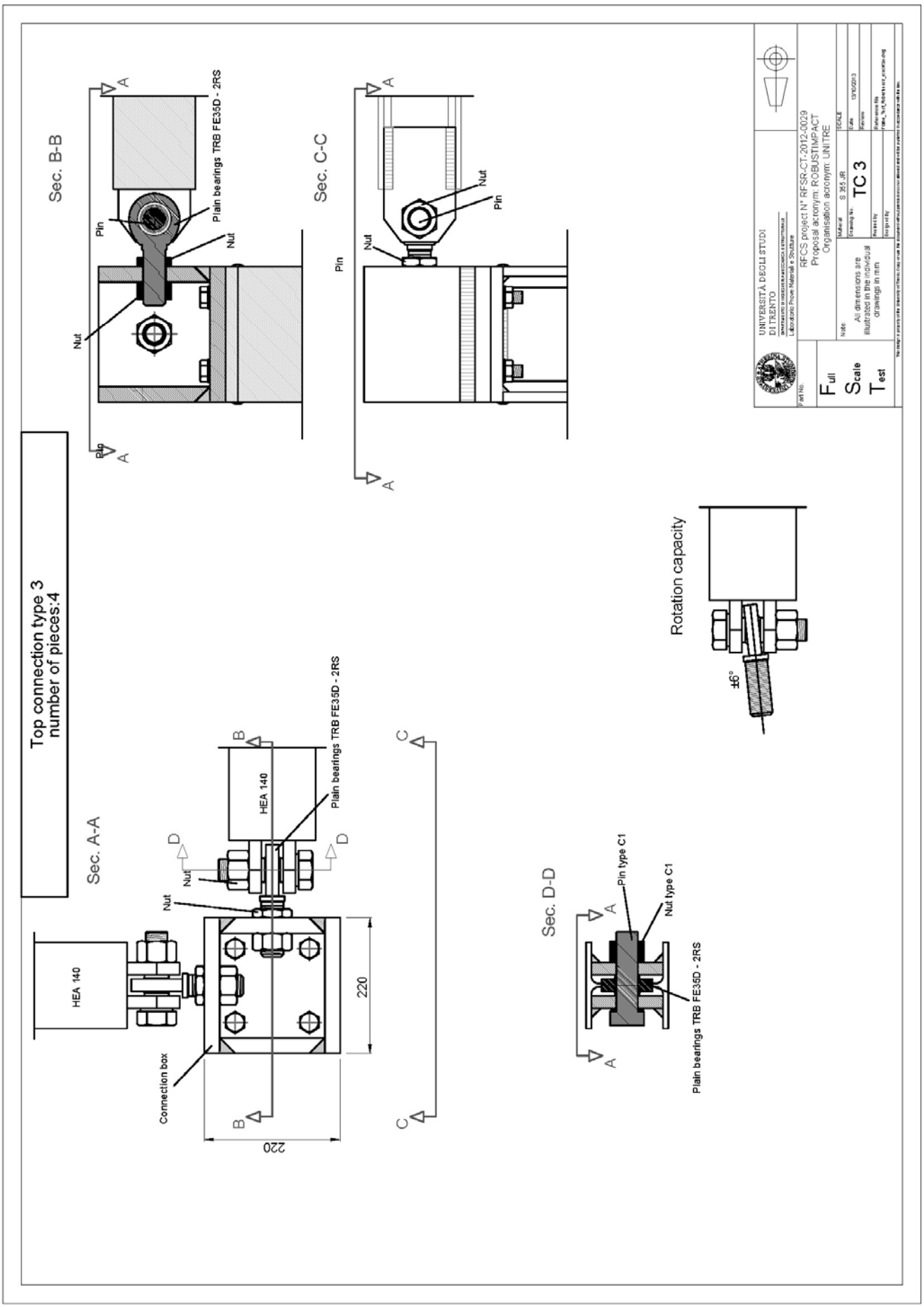

Lateral restraint type 1
number of pieces:1
Fork
Pin
Lock nut
Lock nut
Plain bearings TRB
FE 60 D-2RS
Tubular profile
1250
1885
Lock nut
Lock nut
Plain bearings TRB
FE 60 D-2RS
Fork
Pin
Bar Dywidag
M32
UNIVERSITÀ DEGLI STUDI
DI TRENTO
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Full
Scale
Test
All dimensions are
illustrated in the individual
drawings in mm
LR1


Lateral restraint type 2
number of pieces:2
Fork
Pin type 1
Lock nut
Plain bearings TRB
FE 60 D-2RS
Lock nut
Tubular profile
440
1085
Lock nut
Plain bearings TRB
FE 60 D-2RS
Lock
Fork
Pin
Bar Dywidag
M32
UNIVERSITÀ DEGLI STUDI
DI TRENTO
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Full
Scale
Test
All dimensions are
illustrated in the individual
drawings in mm
LR2

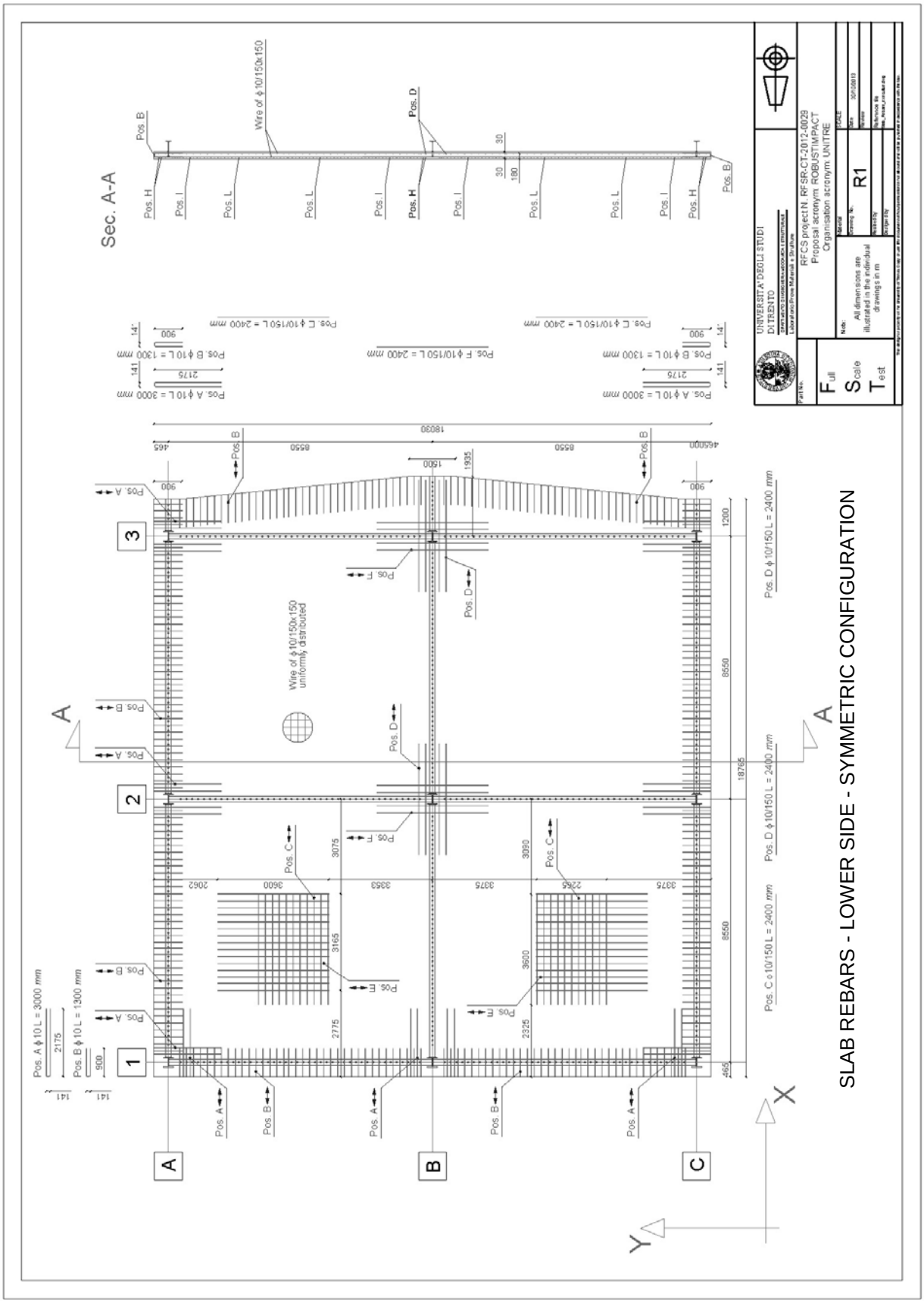

Lateral restraint type 3
number of pieces:1
494
Plain bearings GE 60 DO
626
Plain bearings GE 90 DO
Forck
Pin
Forck
3510
Tubular profile
Threaded bar
Lock nut
Lock nut
450
Tubular profile
Plain bearings TRB FE 60 D-2RS
Lock nut
Pin
Forck
Tubular profile
3510
Lock nut
Lock nut
Threaded bar
450
Tubular profile
Forck
Lock nut
Pin
Plain bearings TRB FE 60 D-2RS
UNIVERSITÀ DEGLI STUDI DI TRENTO
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Full
Scale
Test
All dimensions are illustrated in the individual drawings in mm
LR3

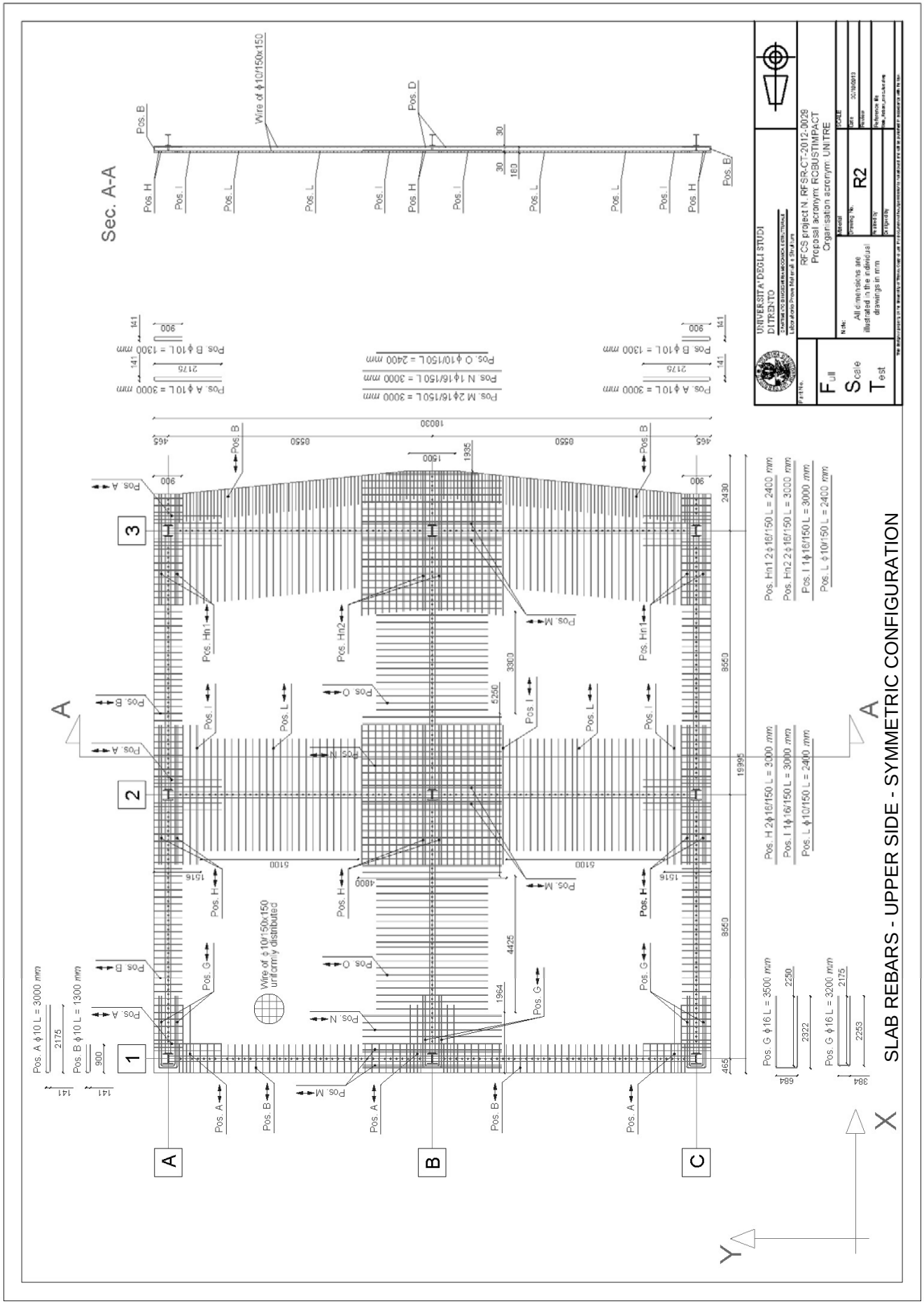

Top connection type 1
number of pieces:1
Sec. B-B
Sez. C-C
Sec. A-A
Sec. D-D
Rotation capacity
±6°
Plain bearings TRB FE35D - 2RS
Pin
Nut
HEA 140
Connection box
220
UNIVERSITÀ DEGLI STUDI DI TRENTO
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
TC 1
Full Scale Test

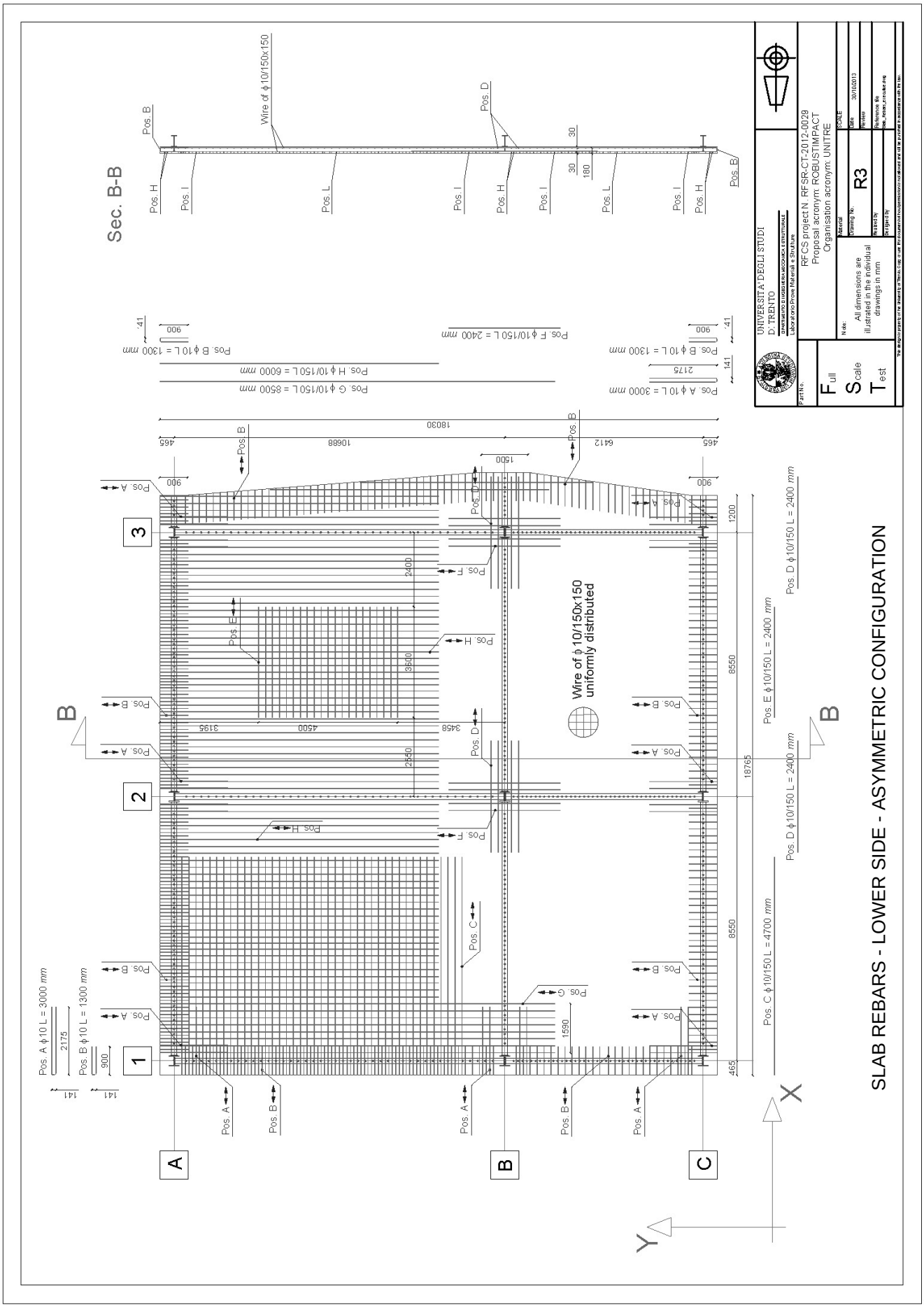

Top connection type 2
number of pieces:4
Sec. A-A
Sec. B-B
Sec. C-C
Sec. D-D
HEA 140
HEA 140
HEA 140
Plain bearings TRB FE35D - 2RS
Plain bearings TRB FE35D - 2RS
Plain bearings TRB FE35D - 2RS
Plain bearings TRB FE35D - 2RS
Nut
Pin
Connection box
220
220
Pin type C1
Nut type C1
Rotation capacity
±6°
UNIVERSITÀ DEGLI STUDI
DI TRENTO
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
TC 2
Full
Scale
Test

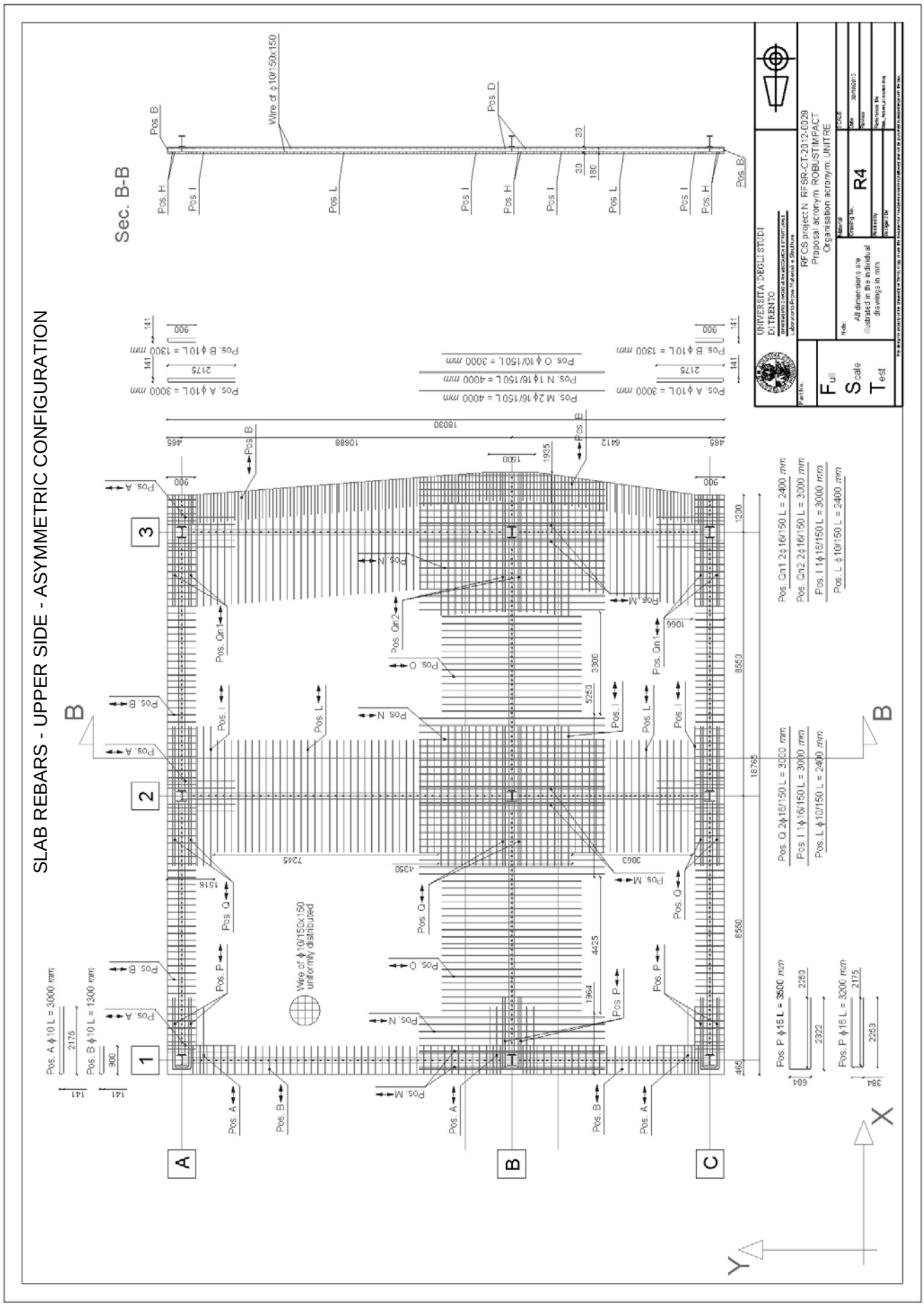

Top connection type 3
number of pieces:4
Sec. B-B
Plain bearings TRB FE35D - 2RS
Pin
Nut
Sec. C-C
Sec. A-A
HEA 140
Plain bearings TRB FE35D - 2RS
Nut
Connection box
220
Sec. D-D
Pin type C1
Nut type C1
Plain bearings TRB FE35D - 2RS
Rotation capacity
±6°
UNIVERSITÀ DEGLI STUDI
DI TRENTO
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
TC 3
Full
Scale
Test

16 ANNEX C: SLAB'S REINFORCEMENT




SLAB REBARS - UPPER SIDE - SYMMETRIC CONFIGURATION
Sec. A-A
UNIVERSITA' DEGLI STUDI DI TRENTO
RFCS project N. RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
R2
Full Scale Test
All dimensions are illustrated in the individual drawings in mm
Wire of ϕ10/150x150 uniformly distributed
Pos. A ϕ10 L = 3000 mm
Pos. B ϕ10 L = 1300 mm
Pos. G ϕ16 L = 3500 mm
Pos. G ϕ16 L = 3200 mm
Pos. H 2ϕ16/150 L = 3000 mm
Pos. I 1ϕ16/150 L = 3000 mm
Pos. L ϕ10/150 L = 2400 mm
Pos. Hn1 2ϕ16/150 L = 2400 mm
Pos. Hn2 2ϕ16/150 L = 3000 mm
Pos. I 1ϕ16/150 L = 3000 mm
Pos. L ϕ10/150 L = 2400 mm
Pos. M 2ϕ16/150 L = 3000 mm
Pos. N 1ϕ16/150 L = 3000 mm
Pos. O ϕ10/150 L = 2400 mm
Pos. A ϕ10 L = 3000 mm
Pos. B ϕ10 L = 1300 mm
A
B
C
1
2
3
X
Y


SLAB REBARS - LOWER SIDE - ASYMMETRIC CONFIGURATION
Sec. B-B
Wire of ϕ10/150x150 uniformly distributed
Pos. A ϕ10 L = 3000 mm
Pos. B ϕ10 L = 1300 mm
Pos. C ϕ10/150 L = 4700 mm
Pos. D ϕ10/150 L = 2400 mm
Pos. E ϕ10/150 L = 2400 mm
Pos. F ϕ10/150 L = 2400 mm
Pos. G ϕ10/150 L = 8500 mm
Pos. H ϕ10/150 L = 6000 mm
UNIVERSITA' DEGLI STUDI D.: TRENTO
RFCS project N. RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
All dimensions are illustrated in the individual drawings in mm
R3
Full Scale Test


SLAB REBARS - UPPER SIDE - ASYMMETRIC CONFIGURATION
Sec. B-B
UNIVERSITÀ DEGLI STUDI DI TRENTO
RFCS project N. RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
R4
Full Scale Test
All dimensions are indicated in the individual drawings in mm
Wire of ϕ10/150x150 uniformly distributed
Pos. A ϕ10 L = 3000 mm
Pos. B ϕ10 L = 1300 mm
Pos. P ϕ16 L = 3500 mm
Pos. P ϕ16 L = 3200 mm
Pos. Qn1 2ϕ16/150 L = 2400 mm
Pos. Qn2 2ϕ16/150 L = 3000 mm
Pos. I 1ϕ16/150 L = 3000 mm
Pos. L ϕ10/150 L = 2400 mm
Pos. Q 2ϕ16/150 L = 3000 mm
Pos. I 1ϕ16/150 L = 3000 mm
Pos. L ϕ10/150 L = 2400 mm
Pos. A ϕ10 L = 3000 mm
Pos. B ϕ10 L = 1300 mm
Pos. O ϕ10/150 L = 3000 mm
Pos. N 1ϕ16/150 L = 4000 mm
Pos. M 2ϕ16/150 L = 4000 mm
X
Y
A
B
C
1
2
3

17 ANNEX D: T-STUB TESTS

Column T-stub

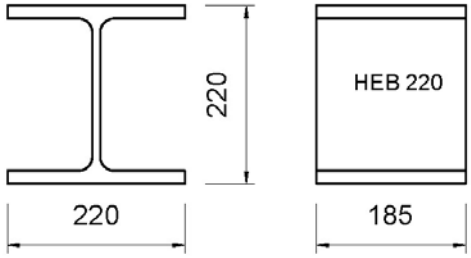


Plate type D

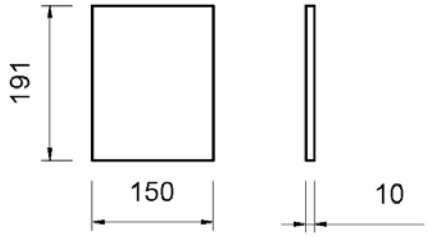
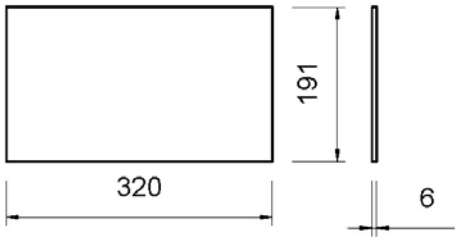


Plate type E



Name	Steel Grade	Dimensions [mm]	Weight [kgf]	Number of pieces	Total Weight [kgf]	Drawing No.
Column T-Stub	S 355 JR	220x220x185	13.23	10	132.28	TST 03A-03B
Plate type D	S 355 JR	191x150x10	2.25	10	22.49	TST 02
Plate type E	S 355 JR	191x320x6	2.88	10	28.79	TST 02
				Total	184	

UNIVERSITÀ DEGLI STUDI DI TRENTO
DIPARTIMENTO DI INGEGNERIA MECCANICA E STRUTTURALE
Laboratorio Prove Materiali e Strutture

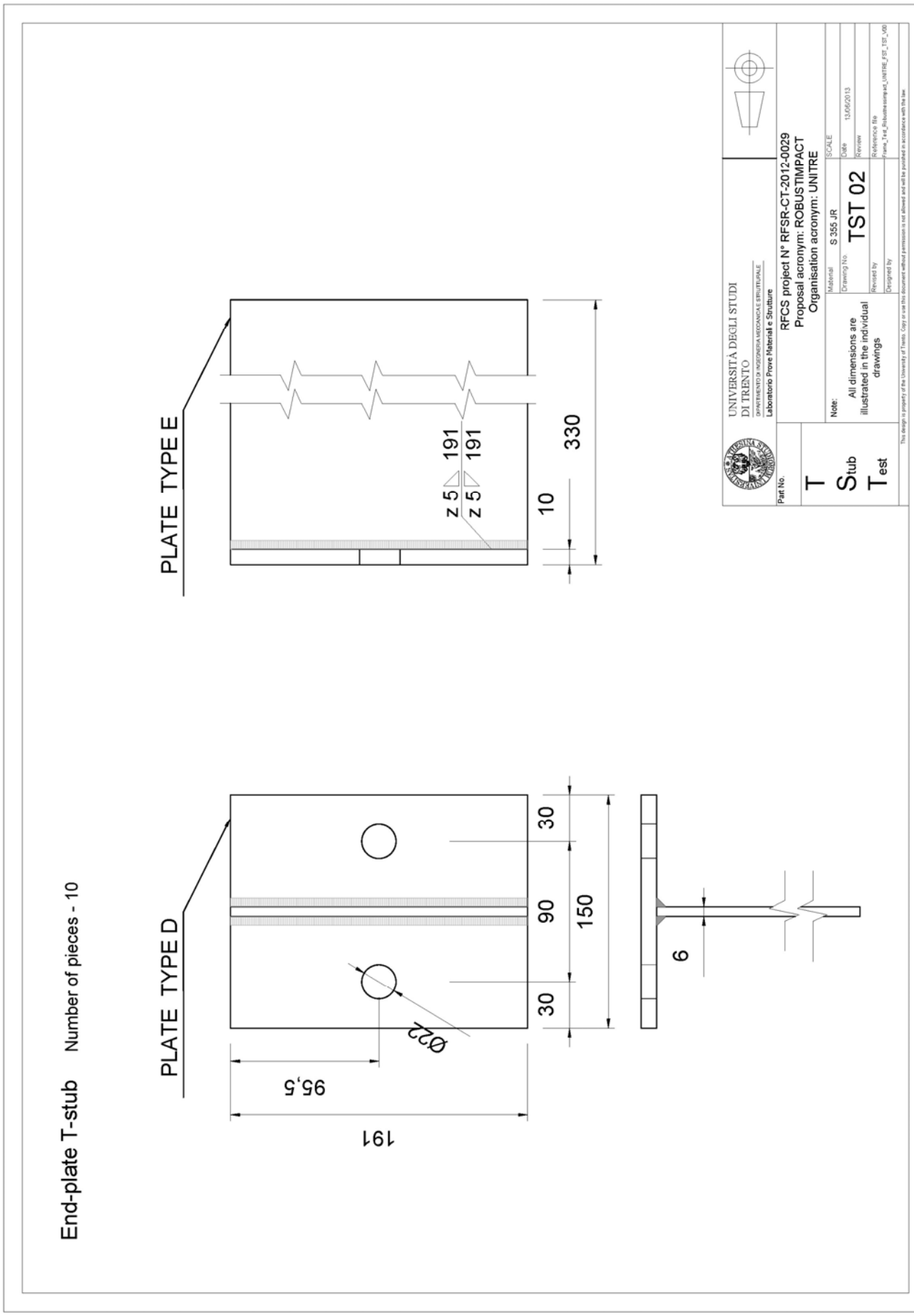
Part No.

T Stub Test

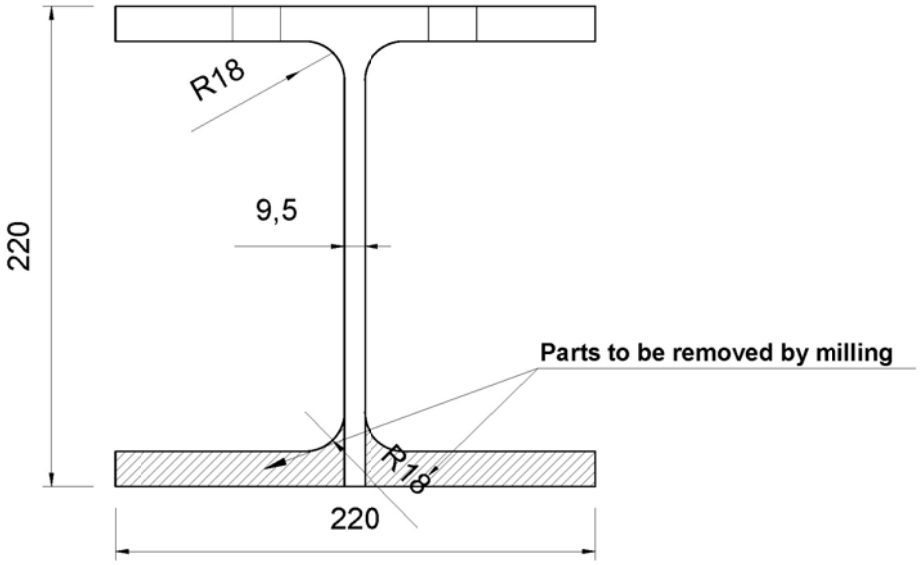
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE

Note: All dimensions are illustrated in the individual drawings

Material S 355 JR
Drawing No. TST 01
Revised by
Designed by
SCALE
Date 13/09/2013
Review
Reference file Frame_Test_Robustimpact_UNITRE_FST_TST_V00


End-plate T-stub Number of pieces - 10
PLATE TYPE D
191
95,5
Ø22
30
90
150
30
6
PLATE TYPE E
z 5
191
z 5
191
10
330
UNIVERSITÀ DEGLI STUDI DI TRENTO
DIPARTIMENTO DI INGEGNERIA MECCANICA E STRUTTURALE
Laboratorio Prove Materiali e Strutture
RFCS project N° RFSR-CT-2012-0029
Proposal acronym: ROBUSTIMPACT
Organisation acronym: UNITRE
Part No.
T Stub Test
Note:
All dimensions are illustrated in the individual drawings
Material S 355 JR
SCALE
Drawing No TST 02
Date 13/06/2013
Revised by
Reviewed by
Reference file
Designed by
This design is property of the University of Trento. Copy or use this document without permission is not allowed and will be punished in accordance with the law

Column T-stub Number of pieces - 10



UNIVERSITÀ DEGLI STUDI DI TRENTO
DIPARTIMENTO DI INGEGNERIA MECCANICA E STRUTTURALE
Laboratorio Prove Materiali e Strutture

Part No. T Stub Test	RFCS project N° RFSR-CT-2012-0029 Proposal acronym: ROBUSTIMPACT Organisation acronym: UNITRE		
Note: All dimensions are illustrated in the individual drawings	Material S 355 JR		SCALE
	Drawing No TST 03B		Date 13/06/2013
			Review
	Revised by		Reference file Frame_Test_Robustmeimpact_UNITRE_FST_TST_V00
	Designed by		

RobustImpact

Robust impact design of steel and composite building structures

Grant Agreement Number: RFSR-CT-2012-00029

Drawings for producing the test specimens

Contribution from the University of Aachen

Deliverable D.4.2

Authors:

Benno Hoffmeister
Jonas Korndörfer
Carles Colomer Segura

PART D

Date: 25.03.2014

18 INTRODUCTION

At the Institute for Steel Structures crash tests on columns are carried out to investigate the residual strength of the damaged member after the impact. The aim is to determine the dynamic response of the member during the impact as well as the dynamic interaction of the member with the surrounding structure. Furthermore, special attention on the strength and deformation demand of the joints is paid.

The test program consists of six tests in total with three different test configurations. Series 1 consist of a simple supported element as reference for pure member behaviour. In series 2, the dynamic interaction between the impacted member and an attached mass at the column head is investigated. It is expected that during the impact, the inertia of the mass provides some axial restrain, but after the impact, the downwards accelerated mass pushes on the column. In both cases, real hinges will be used. Series 3 represents a column within a real structure considering a mass at column head, the stiffness of the surrounding structure as well as realistic semi-strength beam-to-column and column foot connections. In each series, one specimen will be tested subjected to a kinetic energy, which causes moderate and strong plastic deformations respectively. Table 18-1 gives a summary of the test program and the varied parameters.

Table 18-1: Overview of the test program at RWTH Aachen

No.	Type of connection	Mass at column head [to]	Initial velocity [km/h]
1-1	real hinge	-	29
1-2	real hinge	-	36
2-1	real hinge	7 to	29
2-2	real hinge	7 to	36
3-1	semi-strength	7 to	29
3-2	semi-strength	7 to	36

The detailed drawings needed for the production of the specimens and the support structure have been prepared at the RWTH Aachen and are presented in the following.

19 SETUP FOR TEST SERIES 1 & 2

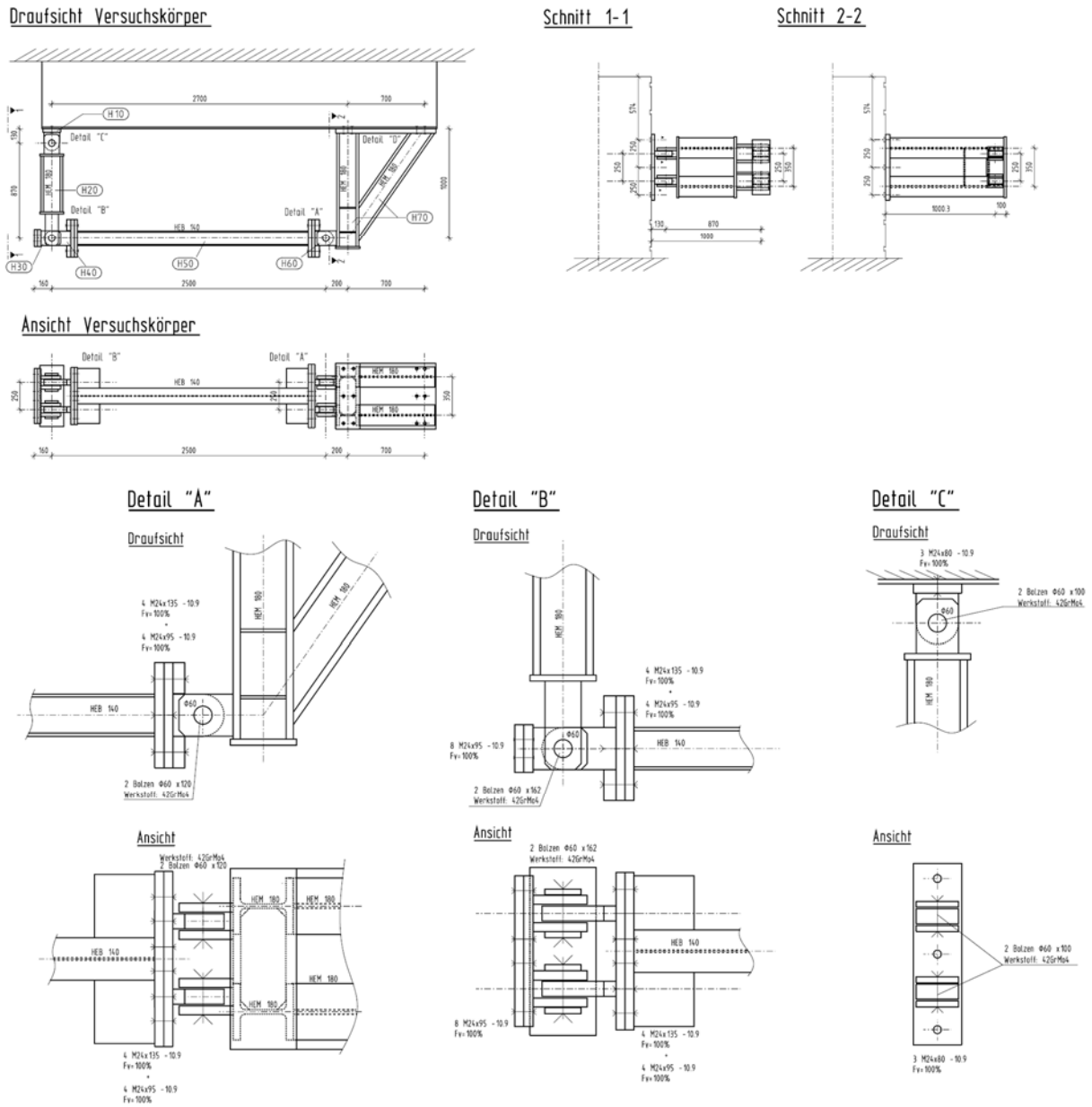


Figure 19-1: Drawings of the test setup for test series 1 & 2

20 SETUP FOR TEST SERIES 3

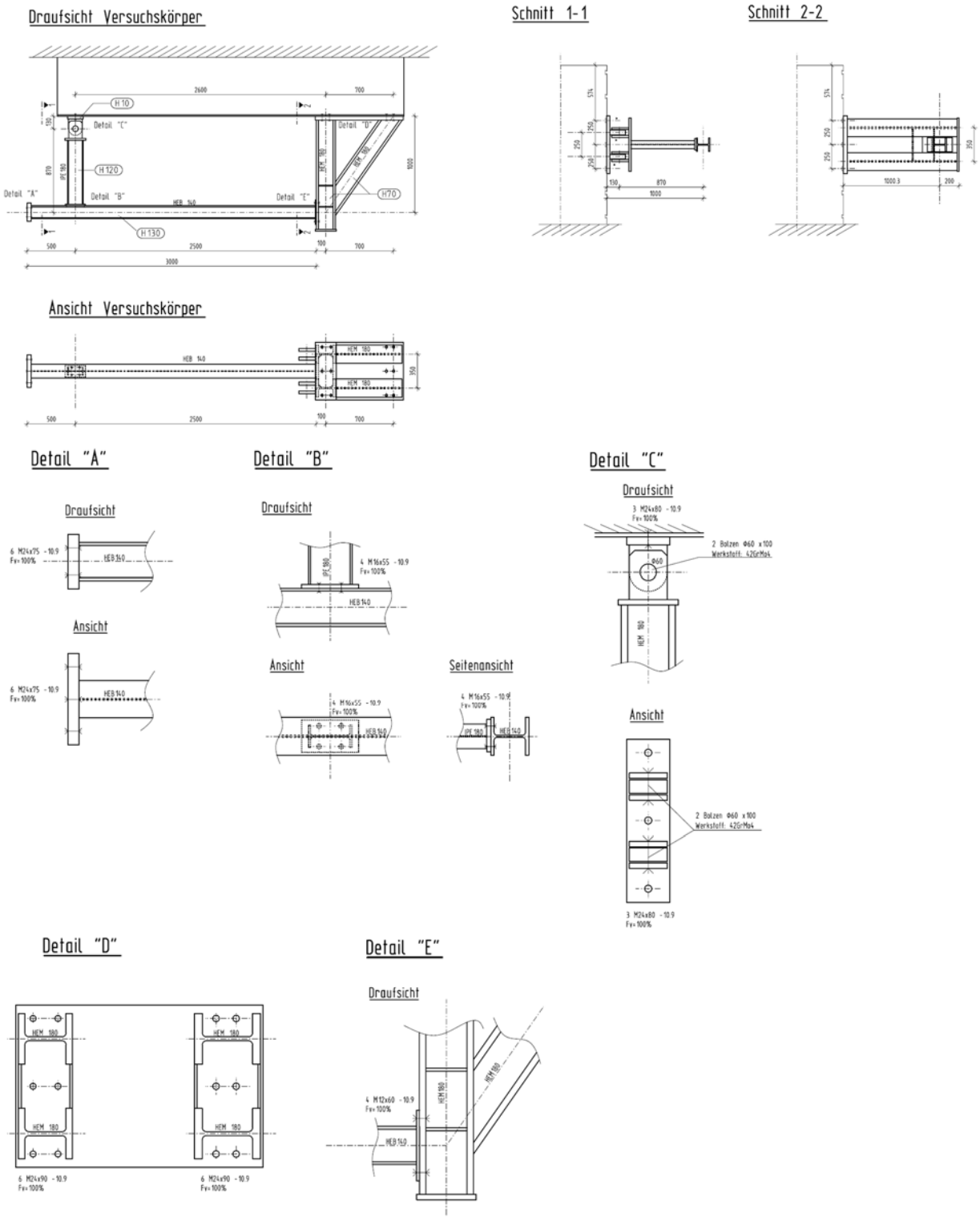


Figure 20-1: Drawings of the test setup for test series 3

21 ASSEMBLY GROUPS

21.1 H10

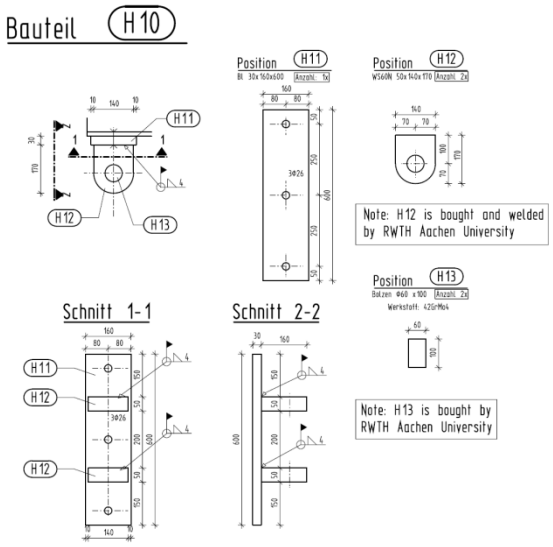


Figure 21-1: Assembly group H10

21.2 H20

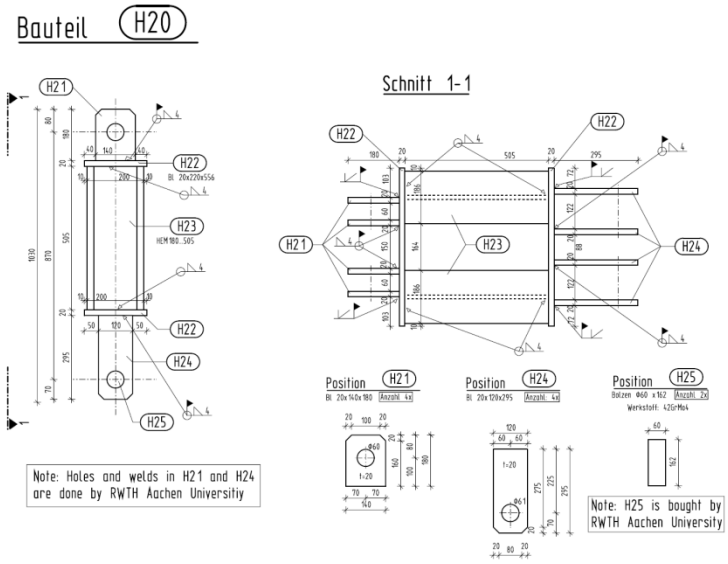


Figure 21-2: Assembly group H20

21.3 H30

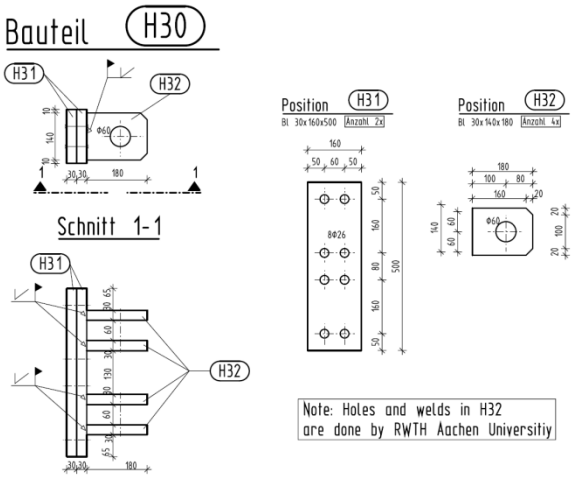


Figure 21-3: Assembly group H30

21.4 H40

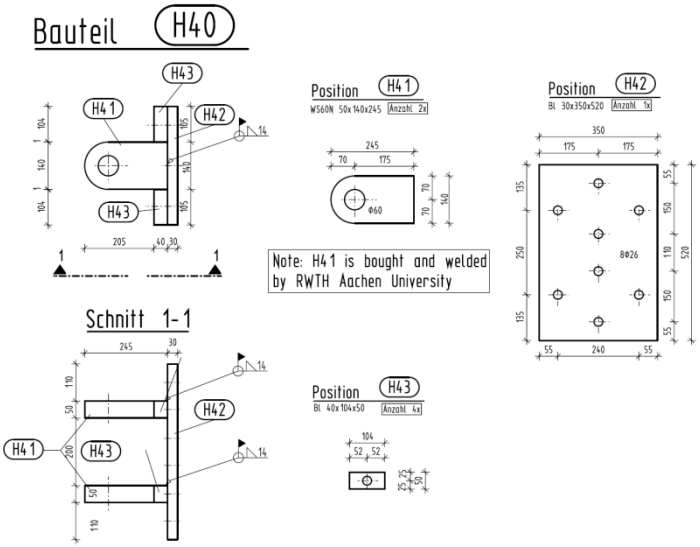


Figure 21-4: Assembly group H40

21.5 H50

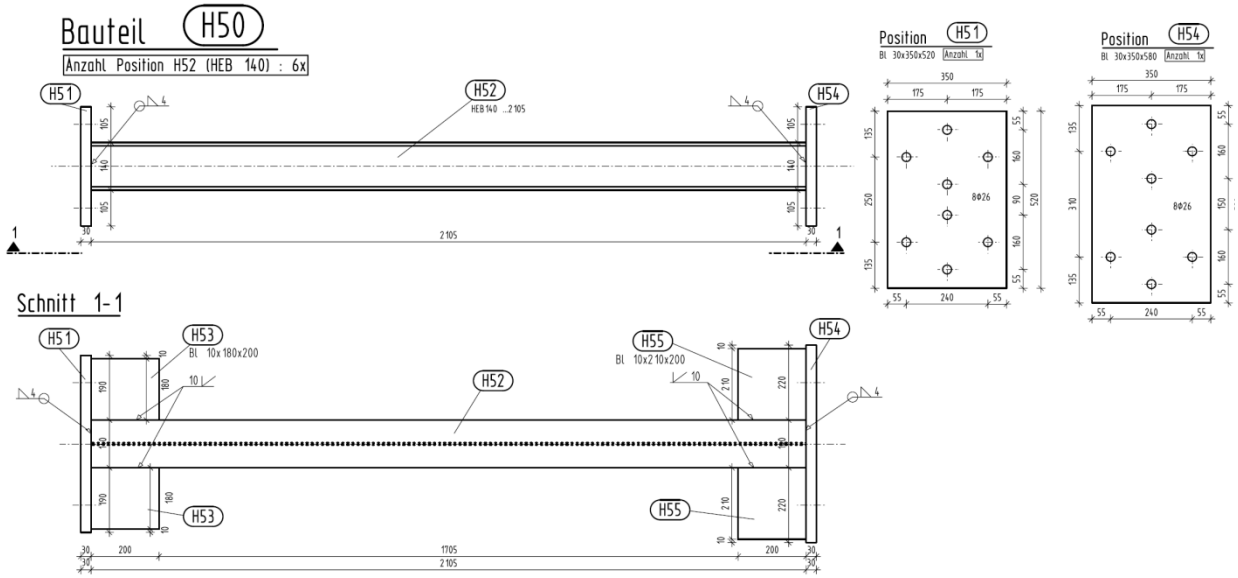


Figure 21-5: Assembly group H50

21.6 H60

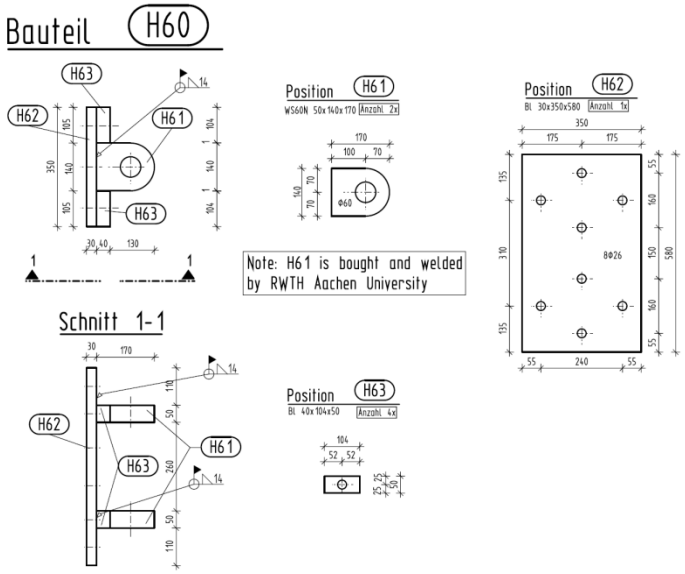


Figure 21-6: Assembly group H60

21.7 H70

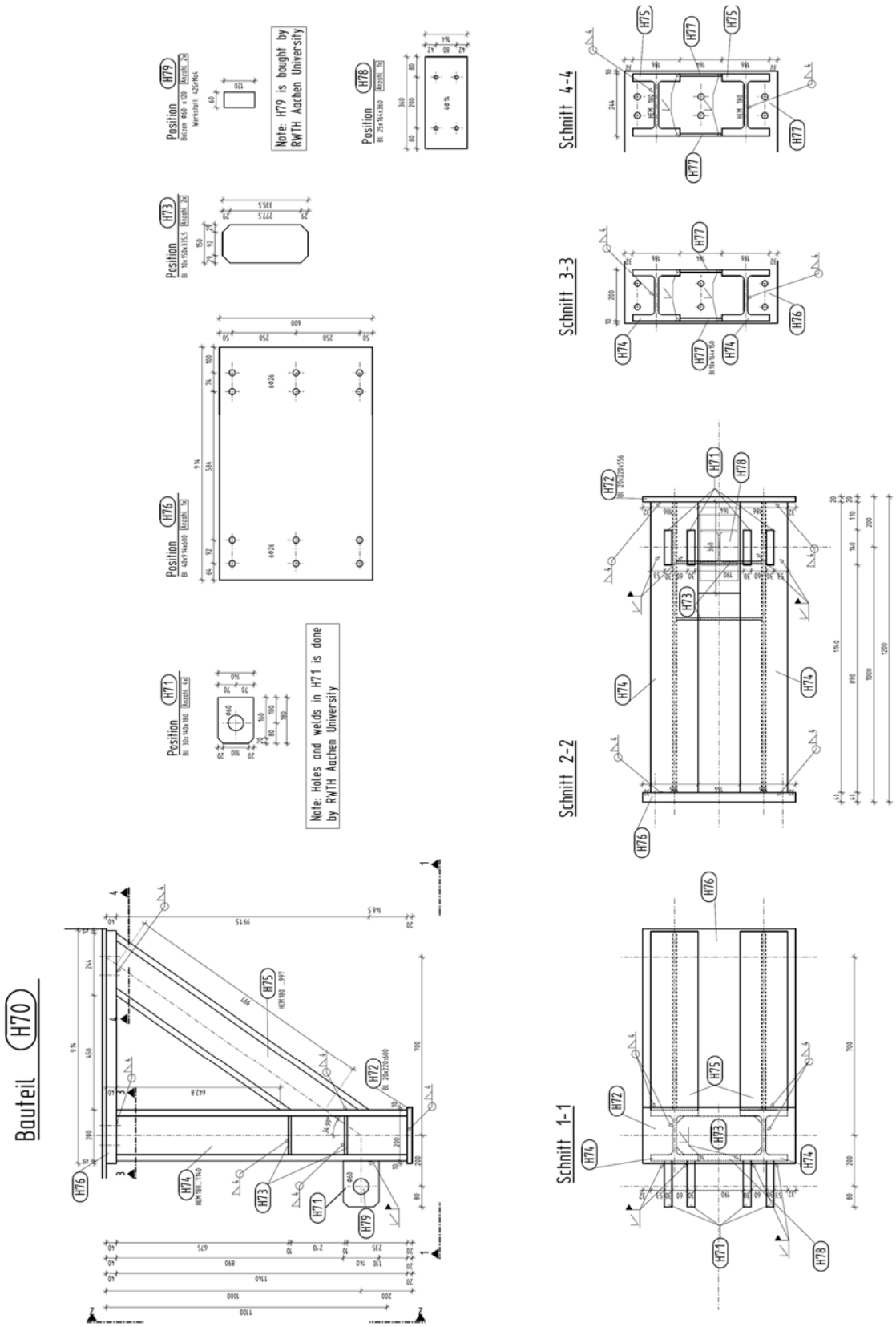


Figure 21-7: Assembly group H70

21.8 H120

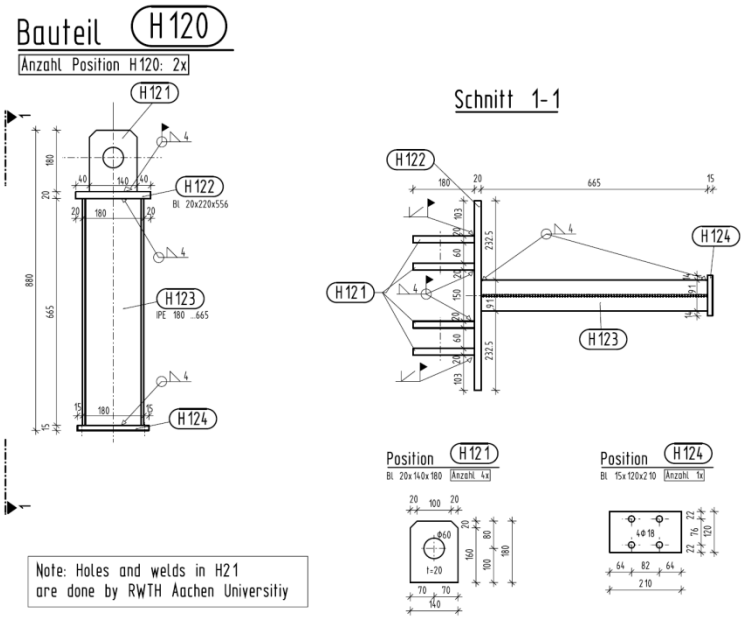


Figure 21-8: Assembly group H120

21.9 H130

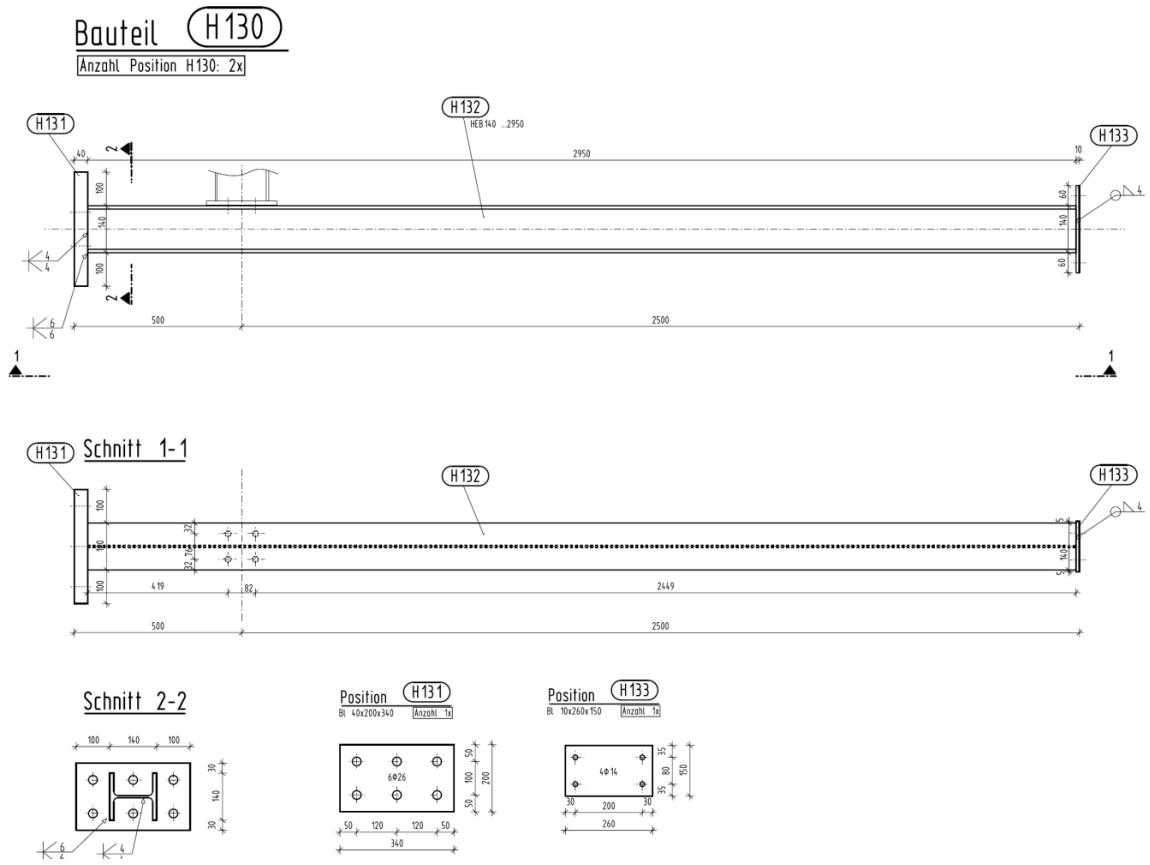


Figure 21-9: Assembly group H130