EXPERIMENTAL DETERMINATION OF THE EFFECTIVE ELASTIC CONSTANTS OF THIN PERFORATED PLATES

by

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Study project presented in partial
fulfilment of the requirements for
the degree of Master of Engineering
at the University of Stellenbosch.

Mr P.E. Dunaiski

Study leader

Stellenbosch February 1989

Declaration

I the undersigned hereby declare that the work contained in this study project is my own original work and has not previously in it's entirety or in part been submitted at any university for a degree.

Signed:

Date:

SYNOPSIS

An established procedure for analysing the stress in perforated plates is based on treating the perforated material as an equivalent solid material with modified elastic constants. In this investigation, thin perforated steel plates with ligament efficiencies of 0.074 and plate thickness to pitch ratios of 0.648 were tested. The effective Young's moduli and Poisson's ratios were determined for these perforated plates and compared to existing recommendations.

SAMEVATTING

n Vasgestelde prosedure vir die analiseering van die spanning in geperforeerde plate het beskouing van die geperforeerde materiaal as n ekwivalente soliede materiaal met gewysigde elastiese konstantes, as basis. In hierdie ondersoek is dun geperforeerde staalplate met perforasie-tussenstrokie tot steek verhoudings van 0.074 en plaatdikte tot steek verhoudings van 0.648, getoets. Die Elastisiteits modulus en Poisson verhouding is vasgestel vir die geperfoeerde plate en vergelyk met bestaande aanbevelings.

ACKNOWLEDGEMENTS

I wish to thank:

- Mr. P.E. Dunaiski for his assistance while conducting the experiments and for acting as supervisor.

- Mr. G. C. van Rooyen for his advice.

MASTER OF ENGINEERING COURSES

The following M. Eng. courses have successfully been completed by the candidate:

Code	Course	Credits
IW01	Linear Algebra	2
TW01	Vector Analysis	2
SB01	Concrete Technology	4
SB02	Concrete Structures	4
SB04	Steel Structures	4
SM01	Matrix Structural Analysis	4
SM02	Theory of Elasticity	4
SM03	Dynamics of Structures	4
SM08	Finite Element Methods	4
GG02	Foundation Design and Construction	4
DS02	Decision Theory and Risk Analysis	4
5SS7	Wood Design*	4
	Total:	44

* Completed at the University of Pretoria.

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NOTATION

b	plate width
E	Young's modulus of elasticity
h	thickness of a ligament
M	bending moment
m	bending moment per unit width
p	perforation pitch
t	plate thickness
ν	Poisson's ratio
$w,$	curvature
ϵ	strain

Suffixes

*	as a superscript denotes "effective"
eg. E^*	effective Young's modulus

1. INTRODUCTION

In the construction of tubular heat exchangers, reactor grids, boiler drums and some civil engineering structures, elastic steel plates pierced by numerous holes are encountered as stress-bearing elements of construction. An established procedure for analysing the stress in perforated plates is based on treating the perforated material as an equivalent solid material with modified elastic constants.

The purpose of this investigation was to experimentally determine these modified constants, referred to as the effective elastic constants, for thin perforated plates of specific dimensions.

Previous to this investigation, experiments had been conducted on thin perforated steel plates at the University of Stellenbosch. The effective elastic constants of the plates were determined, but due to certain problems which were encountered, it was decided to conduct more tests in order to obtain a higher degree of accuracy and a greater sample of results. In this way a significant contribution to the present knowledge of perforated plates could be made. Hence this study project.

2. BACKGROUND

2.1 The equivalent solid plate concept

The equivalent solid plate concept has been found to be quite useful in the design and analysis of perforated plates. The effective elastic constants are determined by equating strains in the equivalent solid material to the average strains in the perforated material. Therefore the stiffness of the perforated material is accurately modelled by replacing the elastic constants of the solid material with effective elastic constants, indicated by E* and ν* for Young's modulus and Poisson's ratio respectively.

The effective elastic constants depend on the pattern, size and pitch of the perforations. The equilateral triangular pattern shown in Figure 2.1 is used most often in perforated plates.

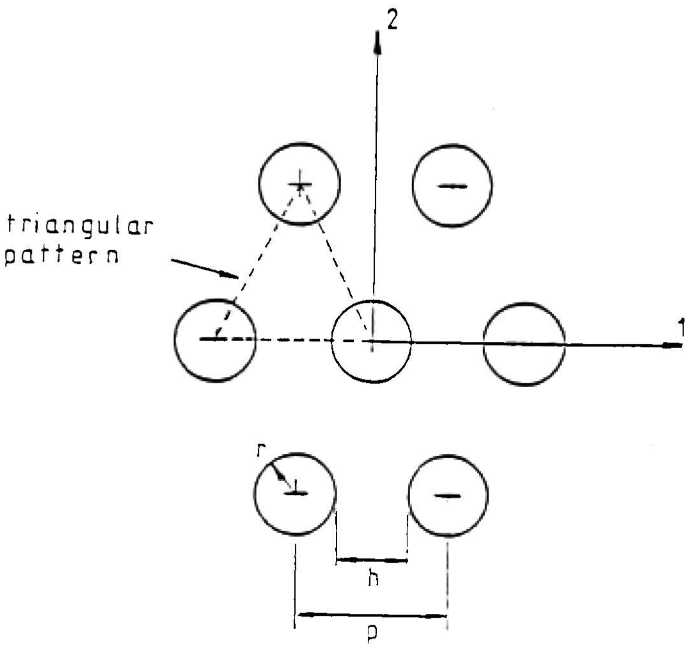


Figure 2.1 Equilateral triangular pattern.

The pattern is best described with the aid of two dimensionless parameters. The first of these is the ligament efficiency, h/p as shown in Figure 2.1 while the second parameter is the plate thickness to pitch ratio, t/p. These two parameters strongly influence the values of the effective elastic constants of the perforated plate.

2.2 ASME Code[1]

The Boiler and Pressure Vessel Code of the American Society of Mechanical Engineers has an article which contains a method for the analysis of perforated plates. The effective elastic constants are given in graphical form as reproduced in Figure 2.2 overleaf.

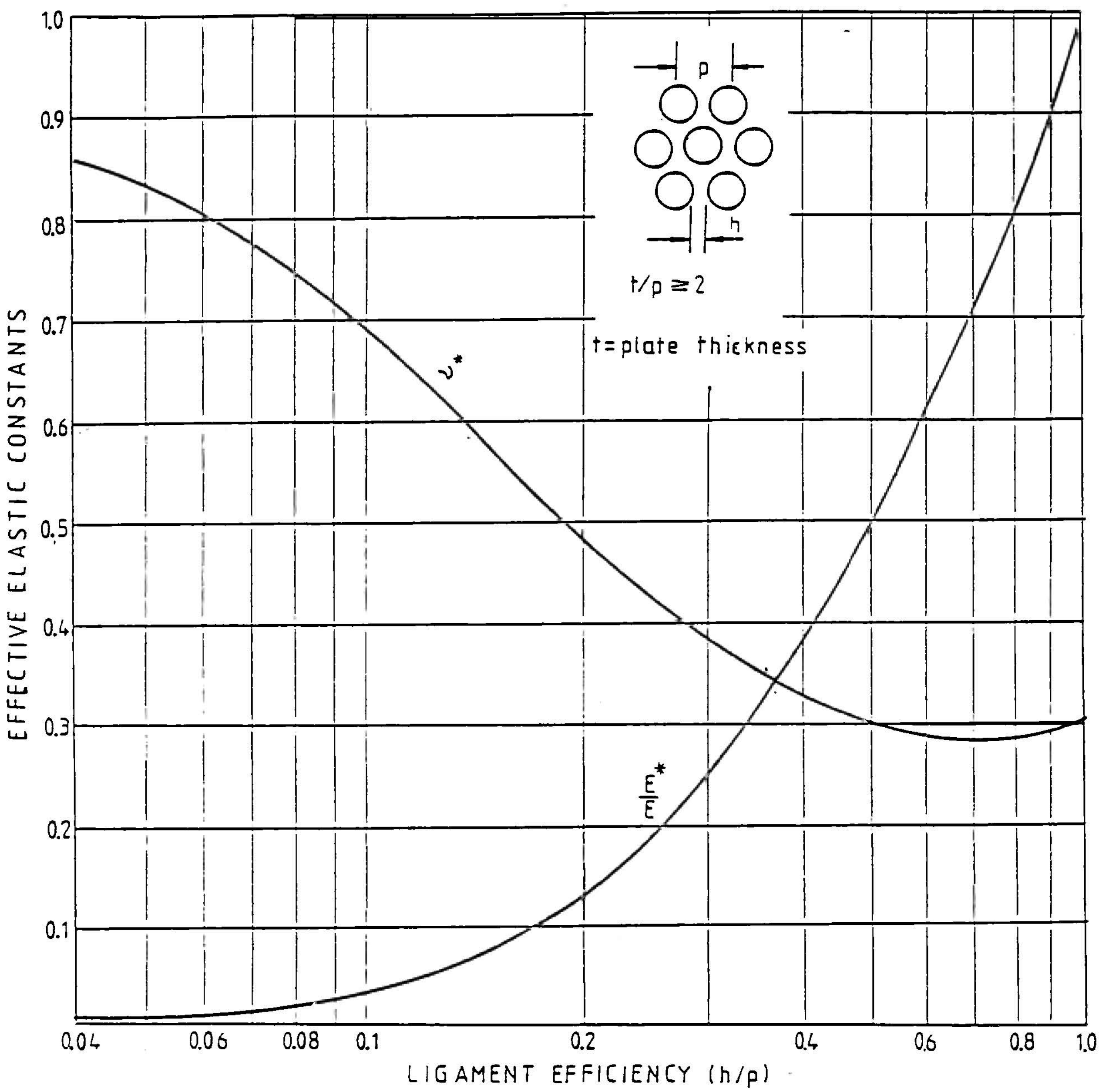


Figure 2.2 Effective elastic constants as given in the ASME code.

The graph shown in Figure 2.2 applies only to perforated plates which satisfy the following conditions:

1) The holes are in an array of equilateral triangles.
2) The holes are circular.
3) There are 19 or more holes.

4) The ligament efficiency, h/p, is equal to or greater than 0.05.

5) The plate is equal to or thicker than twice the pitch ($t/p \geq 2$).

The last condition concerning plate thickness, excludes many perforated plates, since many which are used in nuclear and industrial components are much thinner than prescribed by the ASME Code. For this reason , researchers were prompted to perform tests on thin perforated plates in order to determine their effective elastic properties. These experiments and their results will be dealt with in the sub-section 2.3 to follow.

2.3 Research done on thin perforated plates

A significant contribution to the present knowledge of thin perforated plates was made by W.J. O'Donnell[2]. He performed experiments on specimens having triangular-and square penetration patterns with ligament efficiencies of 0.5, 0.2, and 0.1. The pitch of the hole patterns was 12.5 mm for all the specimens. The thickness to pitch ratios ranged from 3.5 for the thickest specimens to 0.25 for the thinnest. The specimens consisted of perforated plates about 62.5 mm wide and 1500 mm long.

The effective elastic modulus ratios, E*/E, obtained by O'Donnell are summarised in Figure 2.3 overleaf.

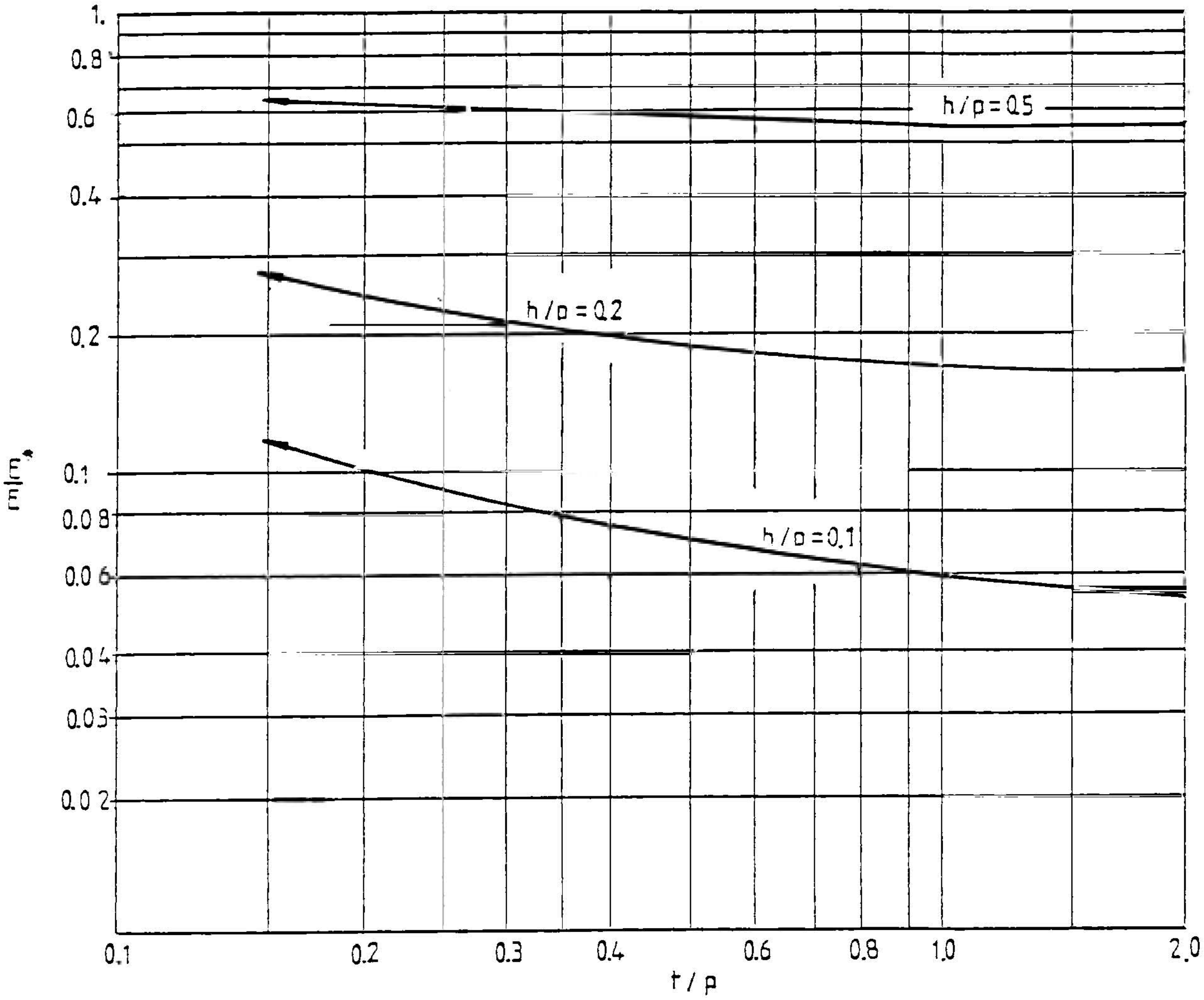


Figure 2.3 Effective elastic moduli ratios.

The effective Poisson's ratios were also determined and are reproduced in Figure 2.4 overleaf.

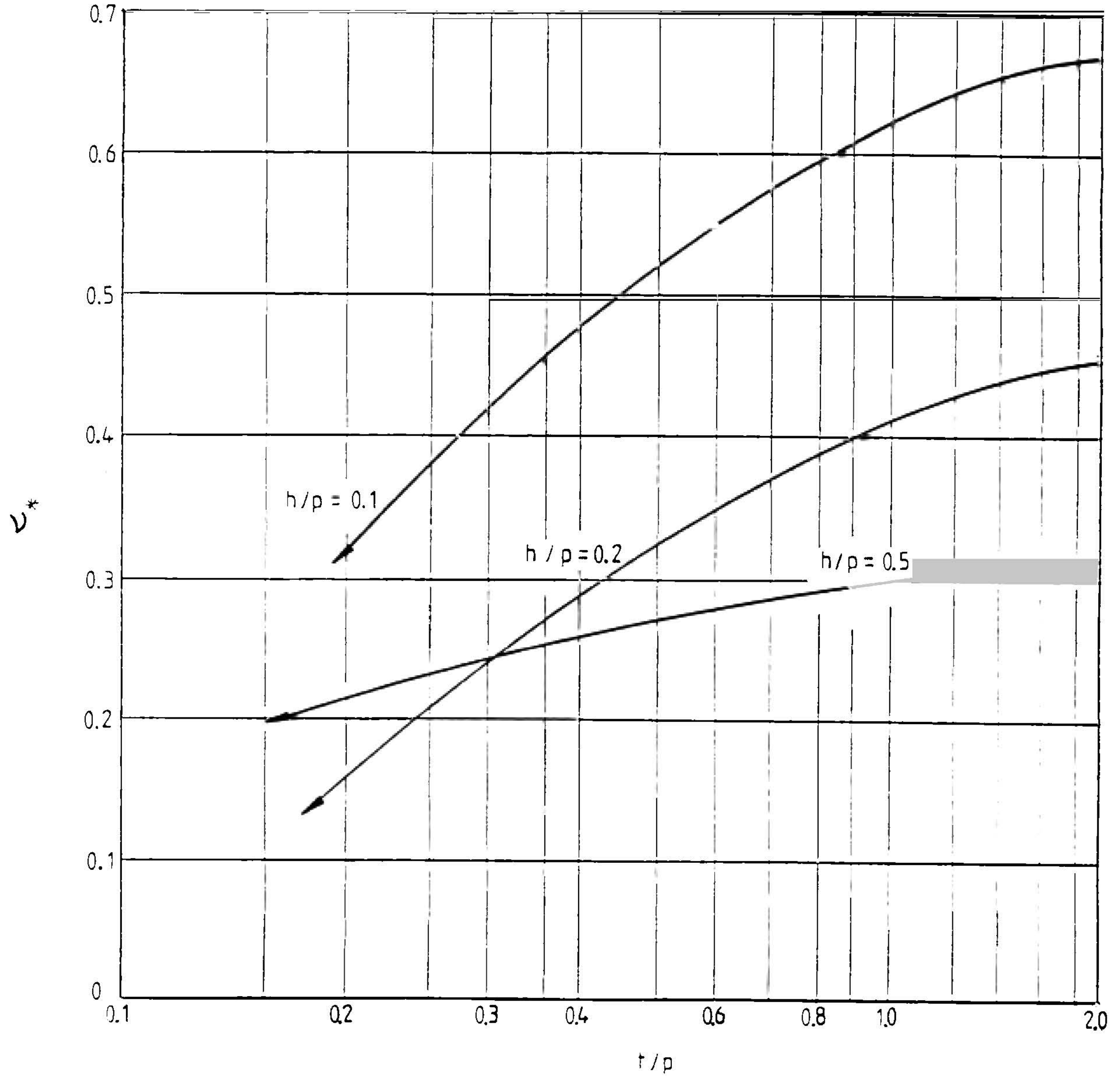


Figure 2.4 Effective Poisson's ratios.

Except for the tests done by O'Donnell, very little experimental work has been published on the experimental determination of the effective elastic constants of thin perforated plates. There seemed to be a shift from experimental work to finite element analysis. In 1974, Slot and Branca published a paper which describes a finite element method which can be used to generate numerical solutions to determine the effective material properties of perforated plates[3]. Numerous papers have been published using finite element methods, the most recent by Meijers (1986)[4].

These publications are however, of little use to the engineer who has a limited knowledge of finite element methods. The designer who is faced with the problem of a thin perforated plate, either needs set guidelines to follow, or in the absence of these he will have to conduct his own experiments in order to determine the effective elastic constants of the thin perforated plates. It was due the latter set of circumstances that tests were performed at the University of Stellenbosch.

2.4 Experiments done at the University of Stellenbosch

The Institute for Structural Engineering at the University of Stellenbosch needed to perform a structural analysis of a industrial structure which consisted of, amongst other components, perforated plates. The thickness of the plates was such that they were not covered by the ASME Boiler and Pressure Vessel Code. It was therefore necessary to perform a series of experiments in order to determine the effective elastic constants of the perforated plates. The experiments were conducted by Dunaiski, du Preez and van Rooyen[5].

Although the effective elastic constants were obtained, certain problems were encountered during the experiments. They hoped to obtain, amongst other readings, the displacements along both the longitudinal and transverse directions of the plates, which would be used to calculate the longitudinal and transverse curvatures. As a result of the plate's size and loading conditions, the relative vertical displacements in the transverse direction of the plate were approximately one percent of the absolute displacements. Two HBM W50 LVDT displacement transducers were used to measure the transverse displacements. Unfortunately, these transducers do not have a high enough resolution, and unsatisfactory results were obtained.

It was then decided to perform additional tests on these perforated plates, using better instrumentation. These experiments and their results will be described in the sections to follow.

3. EXPERIMENTAL METHOD AND INSTRUMENTATION

3.1 Experimental setup

The test specimens were loaded in four point bending, as illustrated in Figure 3.1 below.

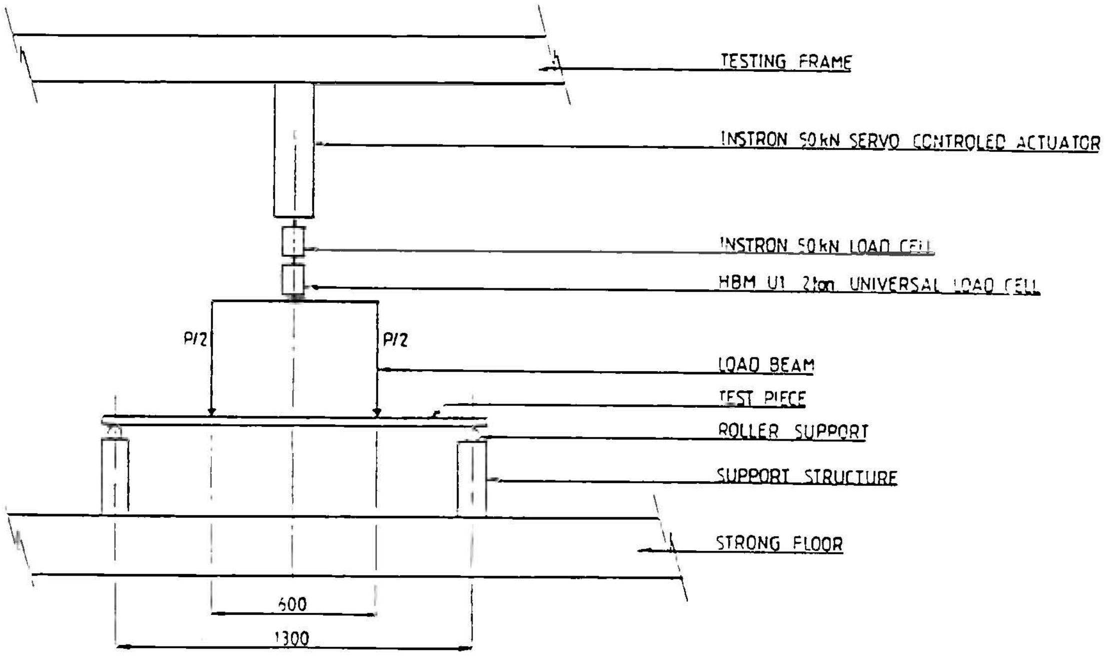


Figure 3.1 Experimental setup.

The load was applied by an Instron 50 kN servo controlled actuator hanging from a test frame. The load was spread by a longitudinal spreader beam resulting in two equal loads 600 mm apart. The plate was supported on roller supports with a span of 1300 mm. Figure 3.2 overleaf shows a perforated plate in position. The roller supports, spreader beam and test specimen can clearly be seen.

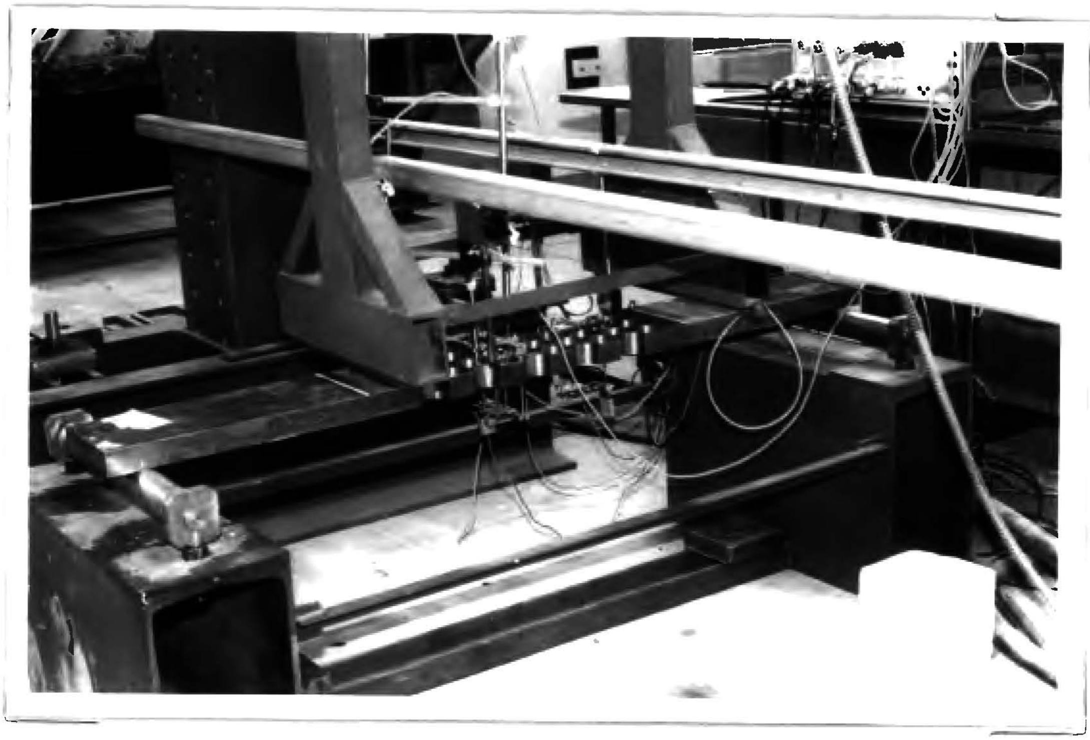


Figure 3.2 Test specimens in position on the testing apparatus.

3.2 Load measurement

The load was measured by a HBM U1 2 ton load cell with a load capacity of 19.62 kN.

3.3 Displacement measurement

The following displacement transducers were used to measure the displacements:

1) 2 HBM W50 LVDT transducers with a nominal displacement of ±50 mm.

2) 1 HBM W100 LVDT transducer with a nominal displacement of ±100 mm.

The displacement transducers are indicated in Figure 3.3, with the HBM W100 transducer positioned in the centre of the plate.

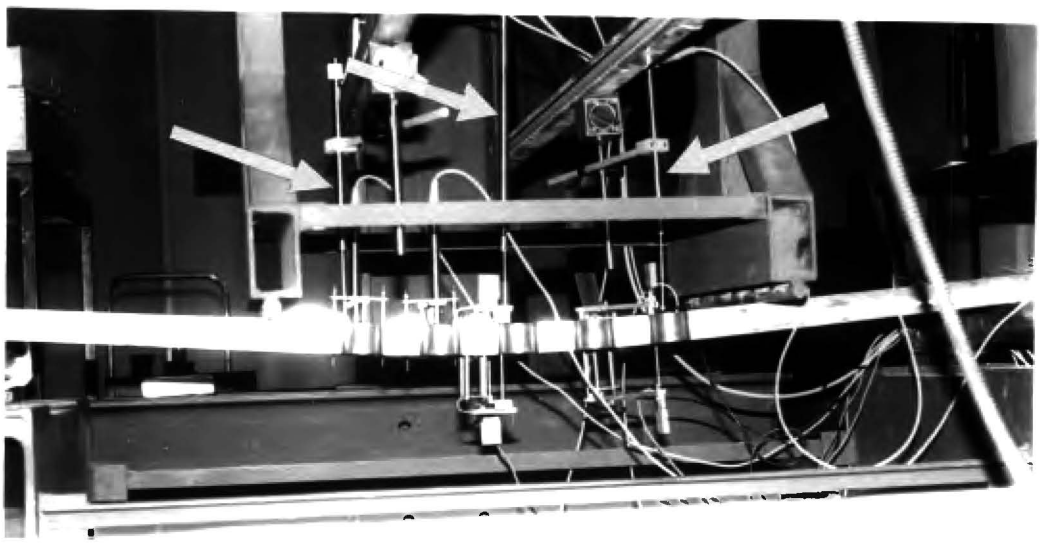


Figure 3.3 Position of displacement transducers.

3.4 Strain measurement

The strain in the perforated plate was measured by HBM DD1 strain transducers. The DD1 strain transducer has a nominal displacement of ±2.0 mm and a maximum linearity error of 0.5% as related to the nominal output signal. The average strain over the base length is calculated by dividing the measured displacement by the base length. The base lengths of the transducers were modified to 108.0 mm and 93.53 mm to coincide with the spacing of the holes of the perforated plate in the transverse and longitudinal directions respectively. Two of the strain transducers, indicated in Figure 3.4 are measuring strains in the transverse and longitudinal directions.

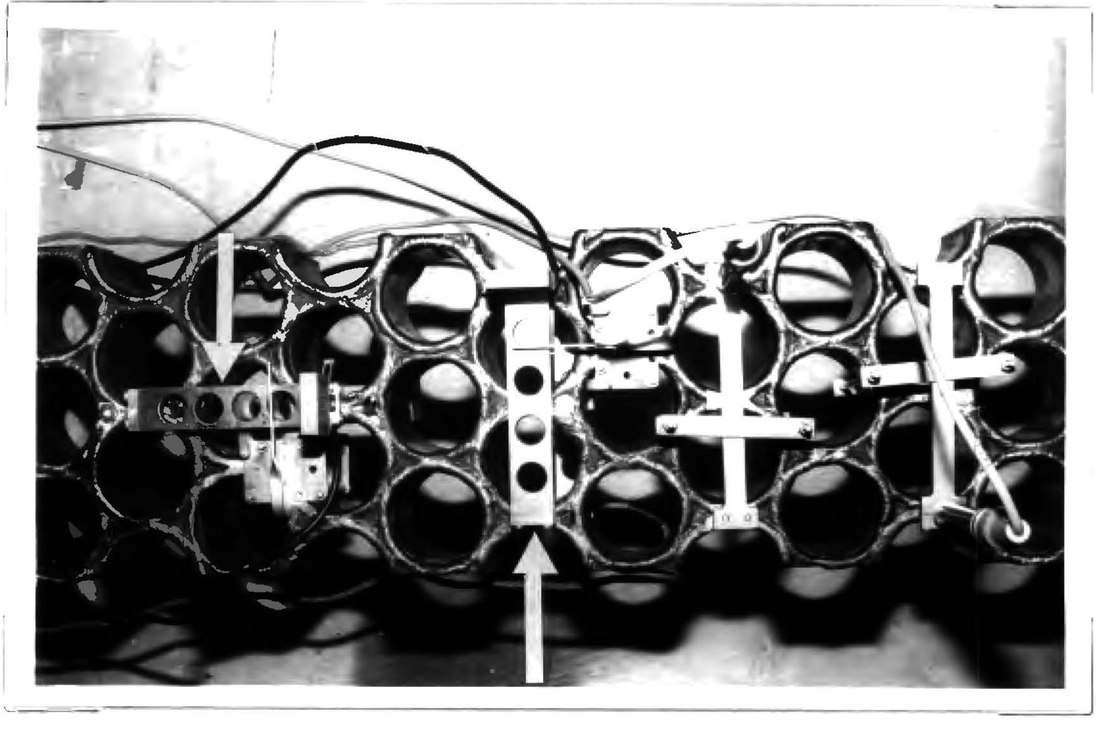


Figure 3.4 DD1 strain transducers.

Because some of the plates tested had pipes protruding from the perforations, two of the DD1 transducers had to be modified to fit between the pipes. This was done by extending the lengths of the measurement points of the transducers. Figure 3.5 on the next page shows a perforated plate without pipes. The two transducers with extended measurement points can be seen below the plate.

Figure 3.5 Modified strain transducers.

Because the strain transducers had been modified in the manner described above, it was necessary to calibrate them in order to obtain accurate readings. This was done by mounting the transducers and two KYOWA KFC-10-C1 strain gauges on a steel beam with a precisely machined cross-section. These results have been published in a report[6]. In this way, a calibration constant for each strain transducer was obtained.

3.5 Transverse curvature measurement

As stated in sub-section 2.4, problems had been experienced in measuring relative transverse displacements in previous tests. It was now decided to use HBM W 5TK displacement transducers with a nominal displacement of ±5 mm. These displacement transducers can be seen in Figure 3.6 below.

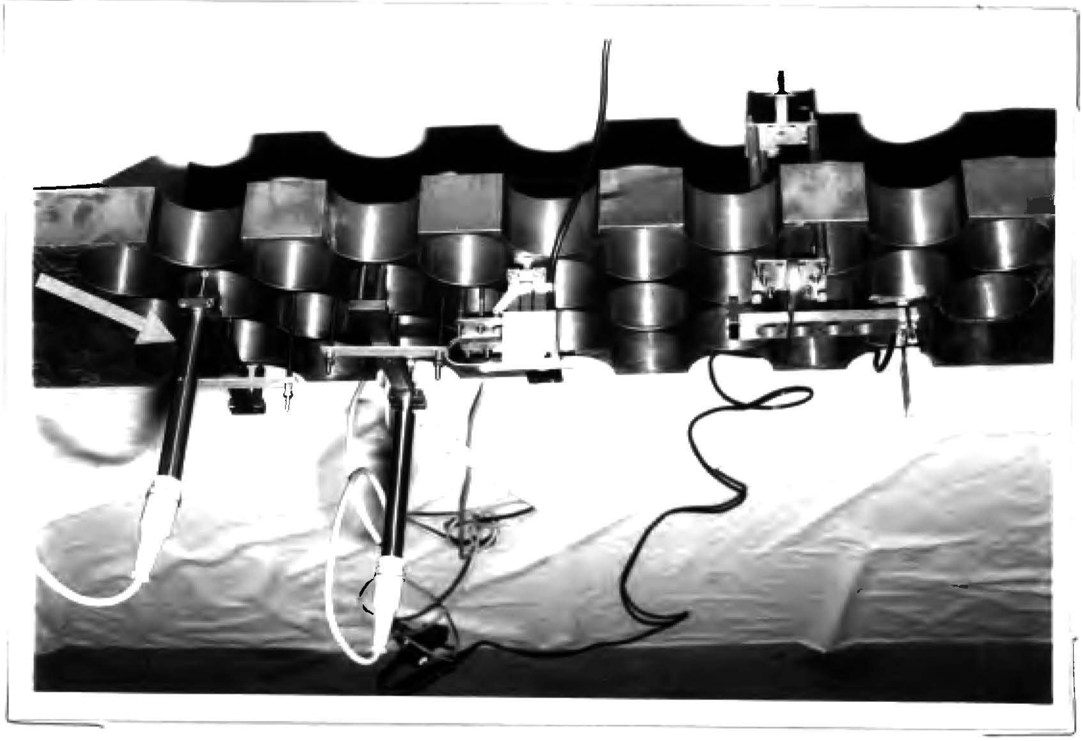


Figure 3.6 Transducers used to measure curvature.

It can be seen that the transducers have been positioned so that they measure the displacement of the plate relative to its centre. This relative displacement can be easily be converted to a curvature as follows:

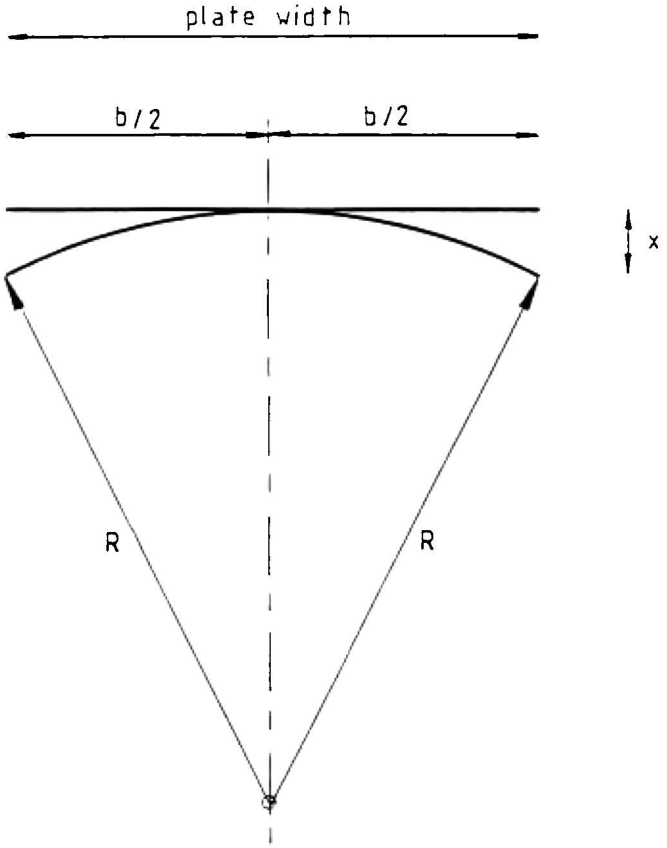


Figure 3.7 Diagrammatic representation of transverse curvature.

From the diagram above:

Let $q = 2 \cdot \cos[\{\pi/2\} - (\arctan\{x/b\})]$ [3.1]

Transverse curvature $= 1/R = q \cdot [(b/2)^2 + (x/2)^2]^{(-0.5)}$ [3.2]

The W 5TK transducers were also calibrated on the steel beam described before in sub-section 3.4. The results were also described in the report[6]. The transducers were found to be highly accurate, with a average error of 0.125%.

3.6 Longitudinal curvature measurement

In the longitudinal direction, three displacements were known, in the middle and at both ends, represented in Figure 3.8 by X0 and X1. These displacements can be used to calculate the longitudinal curvature, as follows:

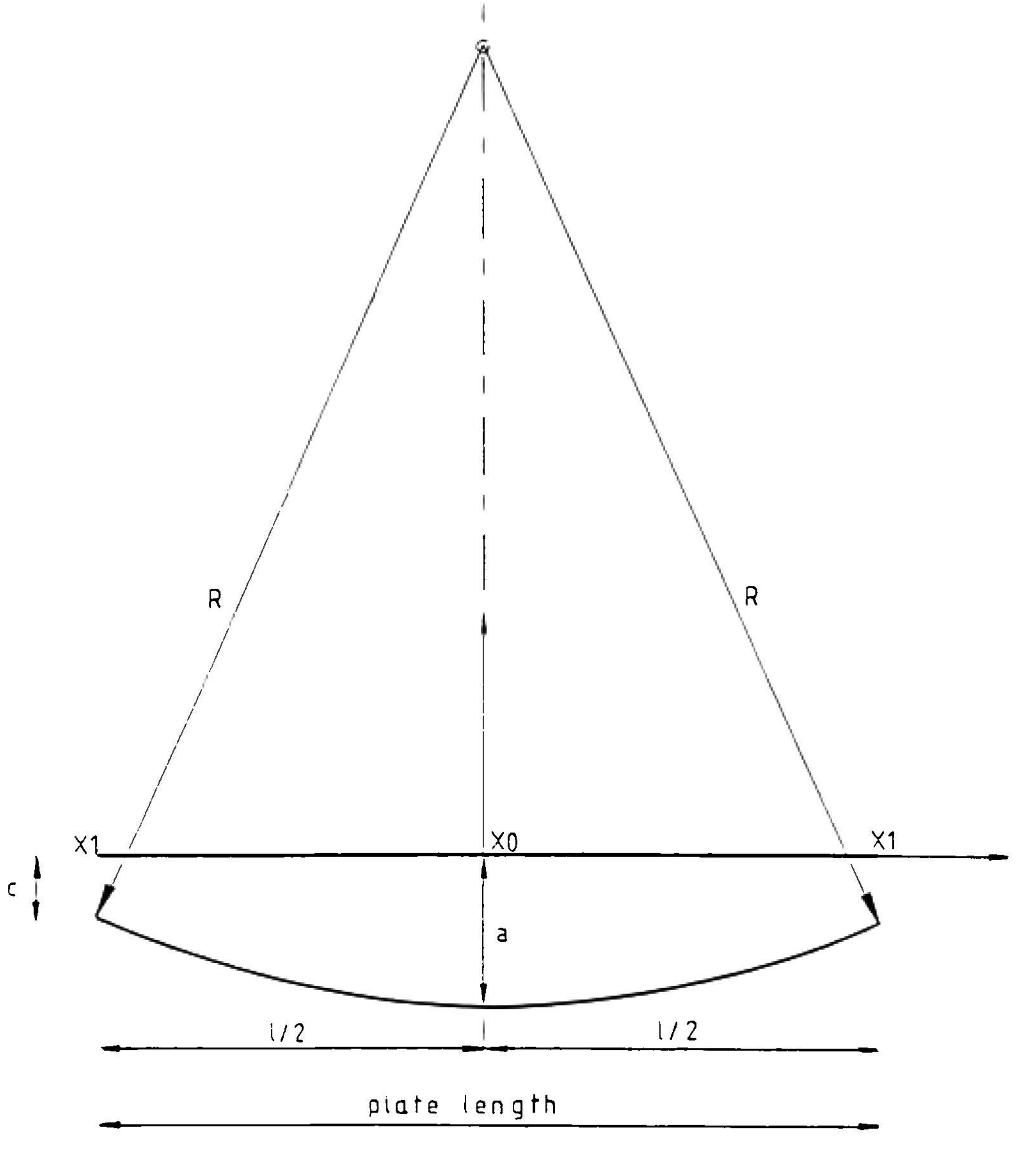


Figure 3.8 Diagrammatic representation of longitudinal curvature.

From the diagram above on the previous page:

Let $$z = [a \cdot a - c \cdot c - (1/2)^2]/[2 \cdot \{c - a\}] \qquad [3.3]$$

Longitudinal curvature $\equiv 1/R = [a \cdot a + 2 \cdot a \cdot z + z \cdot z]^{(-0.5)}$ [3.4]

3.7 Data acquisition

The U1 load cell, the displacement transducers and the strain transducers were connected to HBM KWS 3073 carrier frequency amplifiers. The Instron 50 kN load cell was connected to the Instron control console. The analog signals were converted using a 16 channel 12 bit analog/digital converter. The analog signals of the central displacement transducer and the load cell were plotted directly on a HP X-Y Recorder to obtain a continuous displacement versus load curve during the experiment.

A specific computer program was used to collect the signals and to convert them to data in engineering units, which were saved on disk. The data on the disk was processed further by using various post processing programs. A schematic representation of the data acquisition system is shown in Figure 3.9 overleaf.

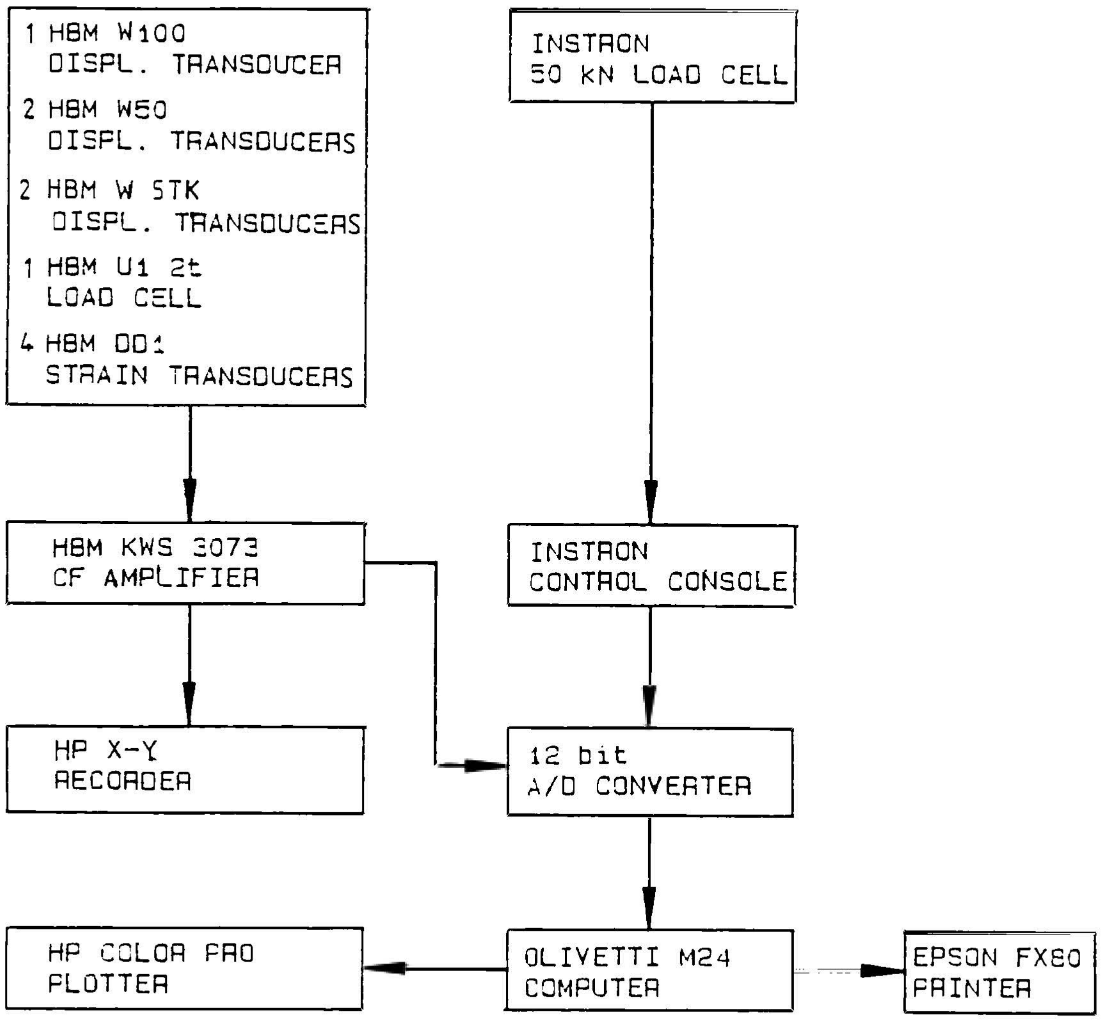


Figure 3.9 Data acquisition system.

4. DESCRIPTION OF THE TESTS

4.1 Perforated plates tested

The first specimen type tested can be seen in Figure 4.1 below.

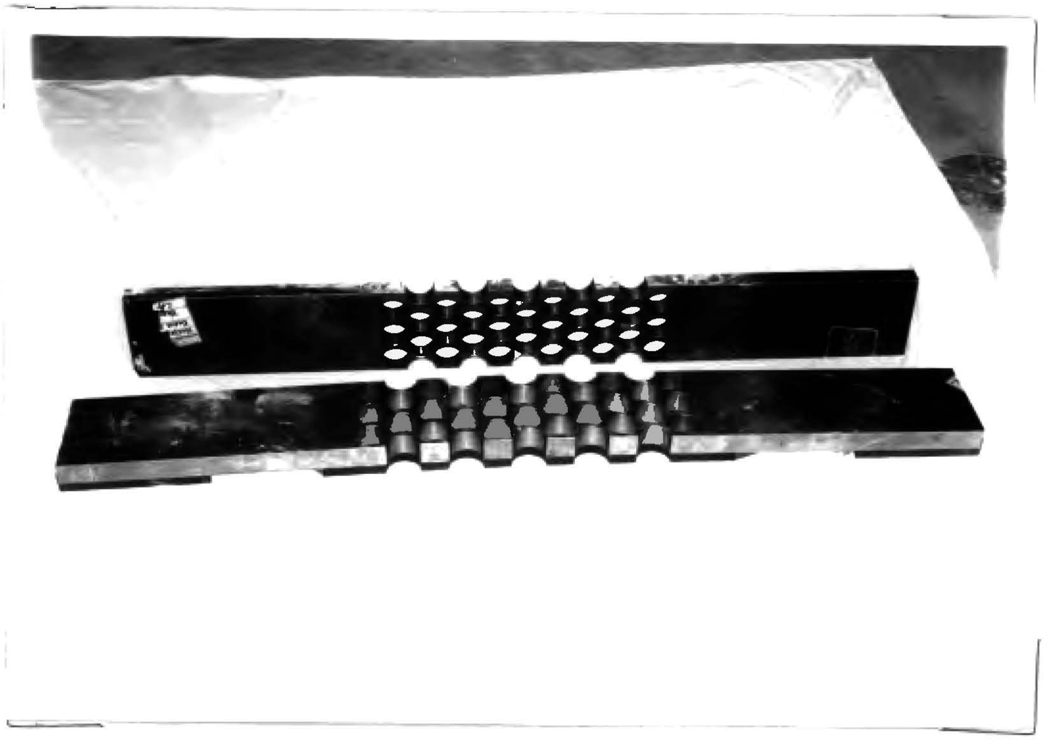


Figure 4.1 View of the perforated plates.

In Figure 4.2 overleaf, the exact dimensions of the plate can be seen. In terms of the equivalent solid plate concept, the perforation pattern is triangular with a ligament efficiency of 0.074 and a plate thickness to pitch ratio of 0.648.

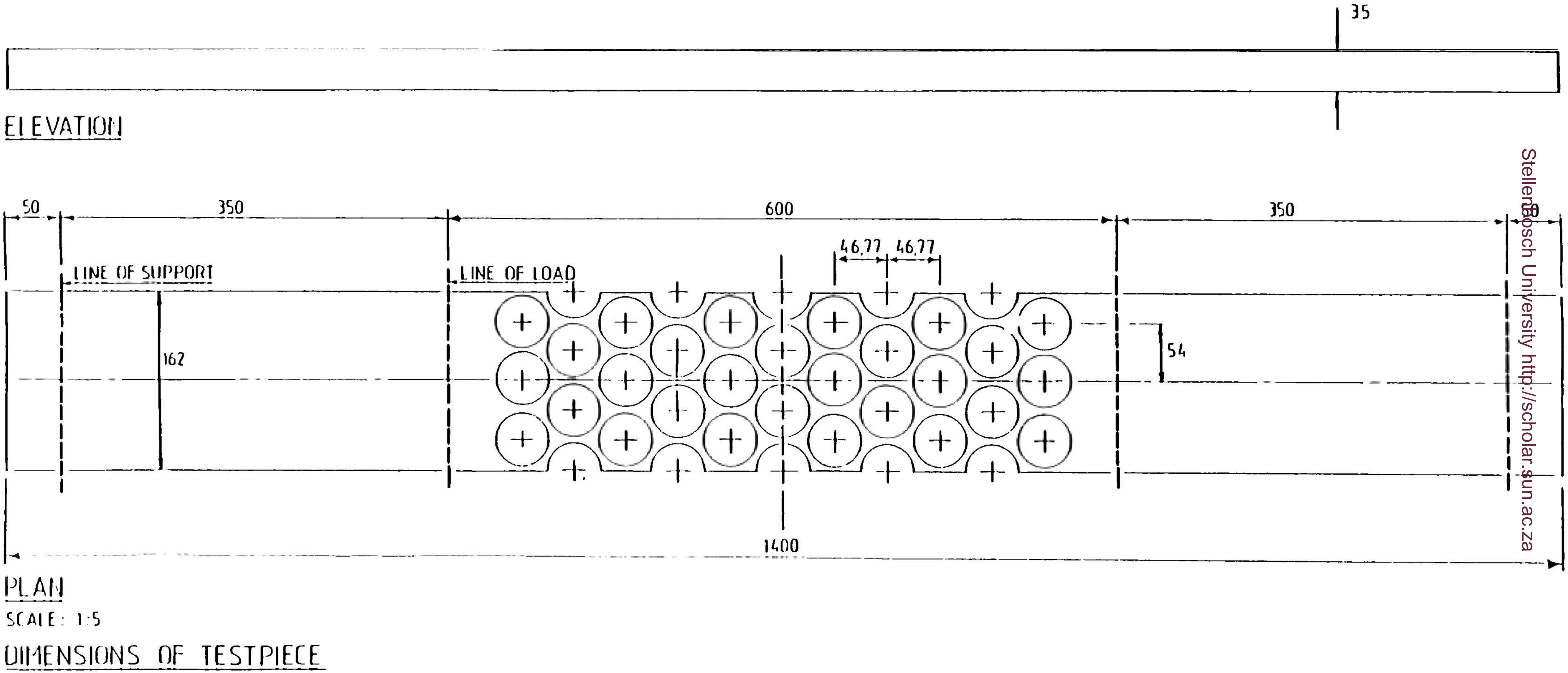


Figure 4.2 Dimensions of testpiece

The second specimen type tested had the same dimensions as those described above. However, these plates had steel pipes situated on the inside of the perforations, as can be seen in Figure 4.3 below.

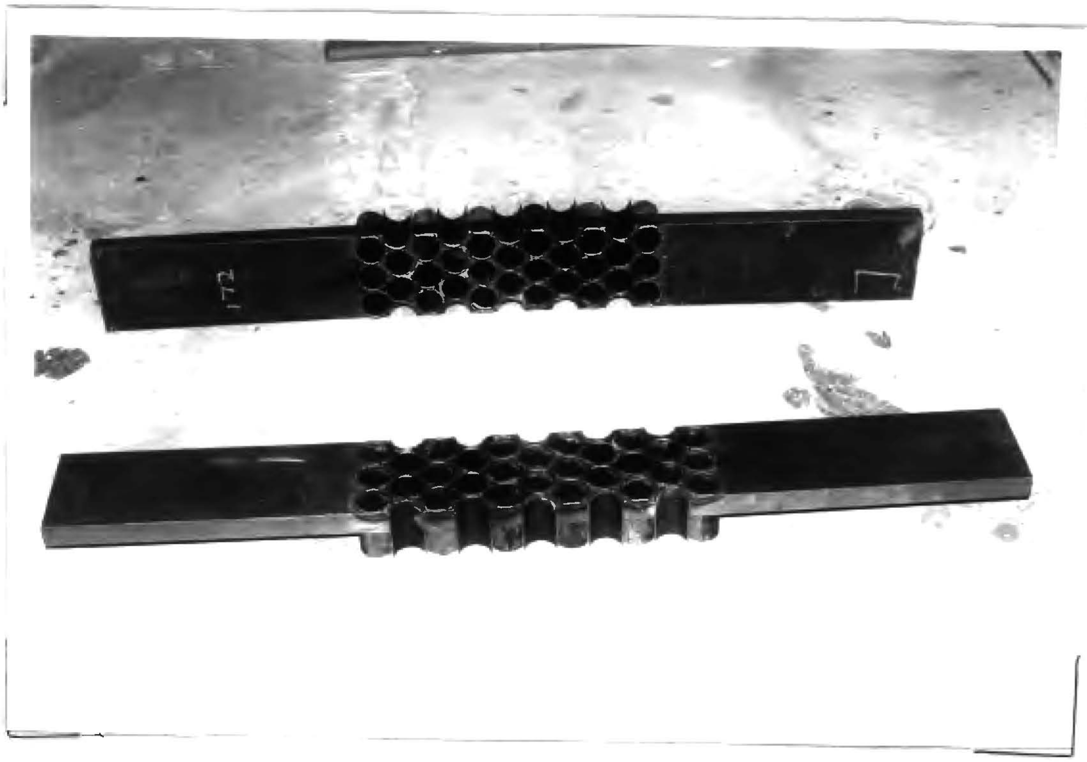


Figure 4.3 View of the perforated plates with pipes.

On all pipes, one end was flush with the surface of the plate and was welded to the plate at this point. The plate dimensions can be seen in Figure 4.4.

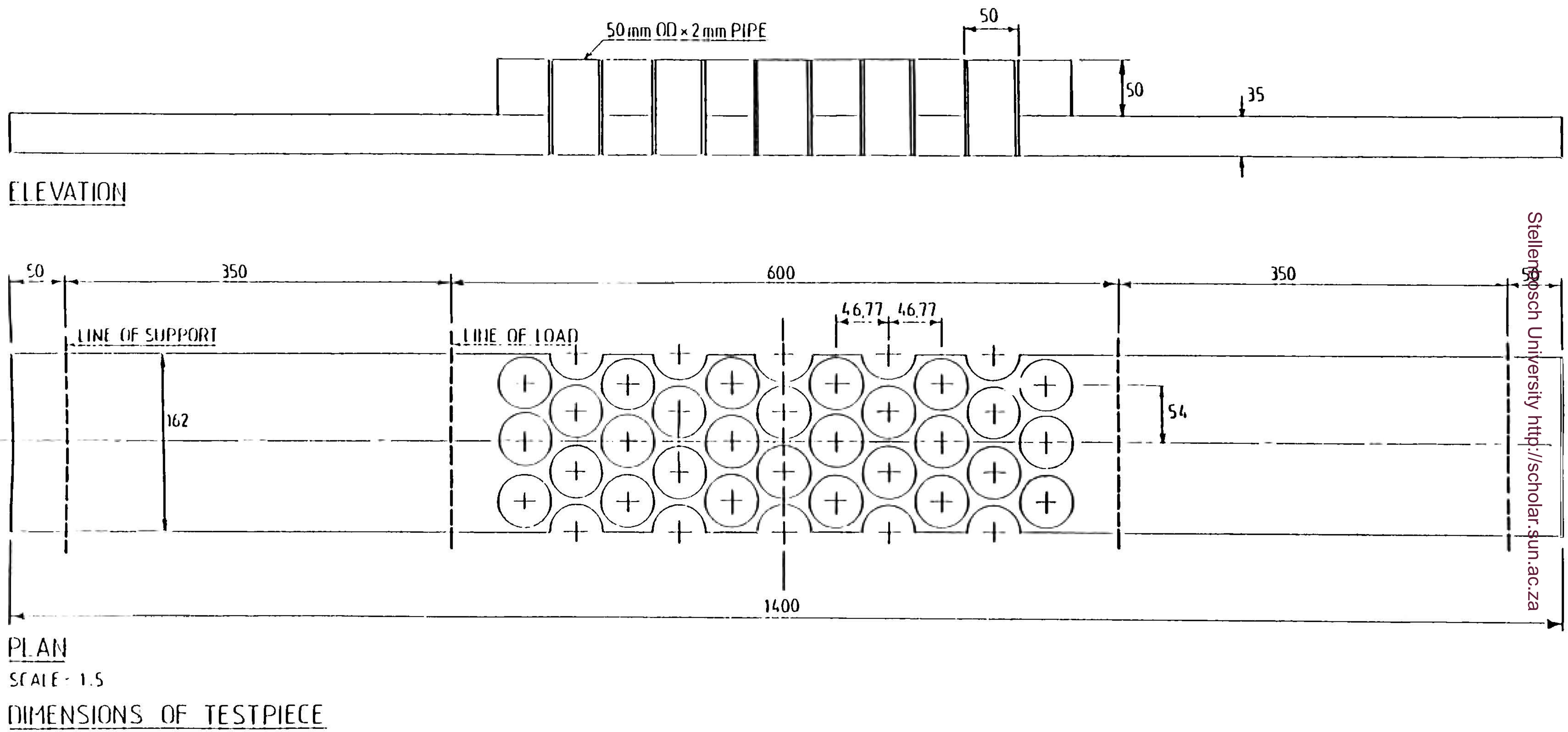


Figure 4.4 Dimensions of testpiece

4.2 Positioning of the instrumentation

The positioning of the instrumentation is numbered in Figure 4.5 overleaf, and is summarised as follows:

Position 1 - HBM W100 LVDT to measure the vertical displacement at the centre point of the plate.

Position 2 - HBM W50 LVDT to measure the end displacement.

Position 3 - HBM W50 LVDT to measure the end displacement.

Position 4 - HBM DD1 transducer to measure the top longitudinal strain.

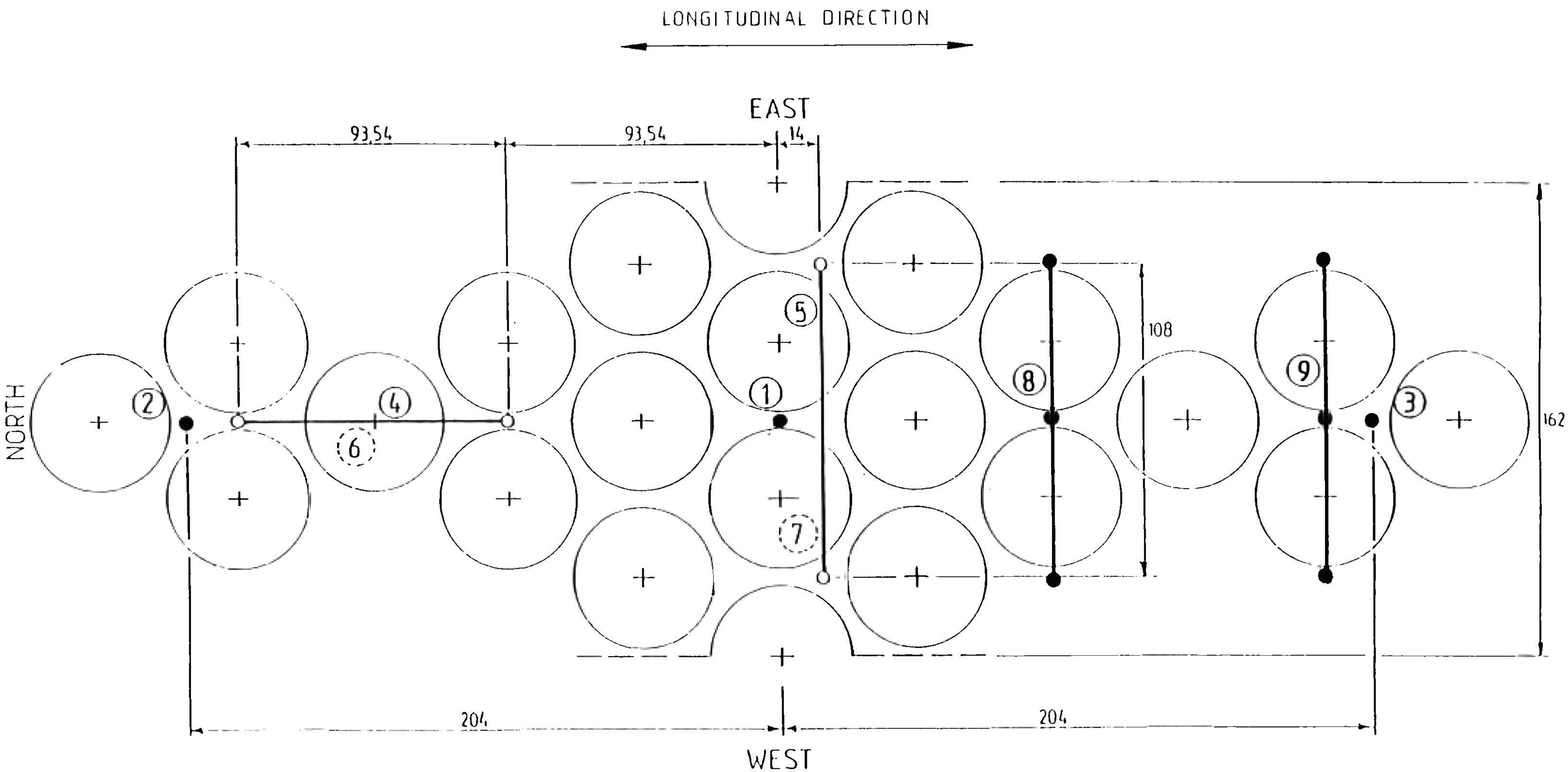
Position 5 - HBM DD1 transducer to measure the top transverse strain.

Position 6 - HBM DD1 transducer situated directly below position 4 on the opposite side of the plate, to measure the bottom longitudinal strain.

Position 7 - HBM DD1 transducer to measure the bottom transverse strain, situated directly below position 5.

Position 8 - HBM W 5TK transducer to measure the transverse curvature. This curvature is referred to as the inner transverse curvature.

Position 9 - HBM W 5TK transducer to measure the transverse curvature. This curvature is referred to as the end transverse curvature.



INSTRUMENTATION POSITIONS

AS SEEN FROM ABOVE

SCALE 1:2

Figure 4.5 Instrumentation positions

4.3 Data files.

The data files are designated in the following manner. Six tests were conducted and each test is indicated by the value before the data file name. For example, 1Plate indicates data from Test 1, 2Plate from Test 2 and so on. The number after the file name indicates the position of the instrumentation, so Plate1 would be the vertical displacement at the centre point of the plate and so forth. In addition to the nine instrument positions, two extra data files were added. The first of these is the transverse curvature in the middle of plate, which was obtained by parabolic extrapolation of the end and inner transverse curvature readings. This is illustrated with the aid of Figure 4.6.

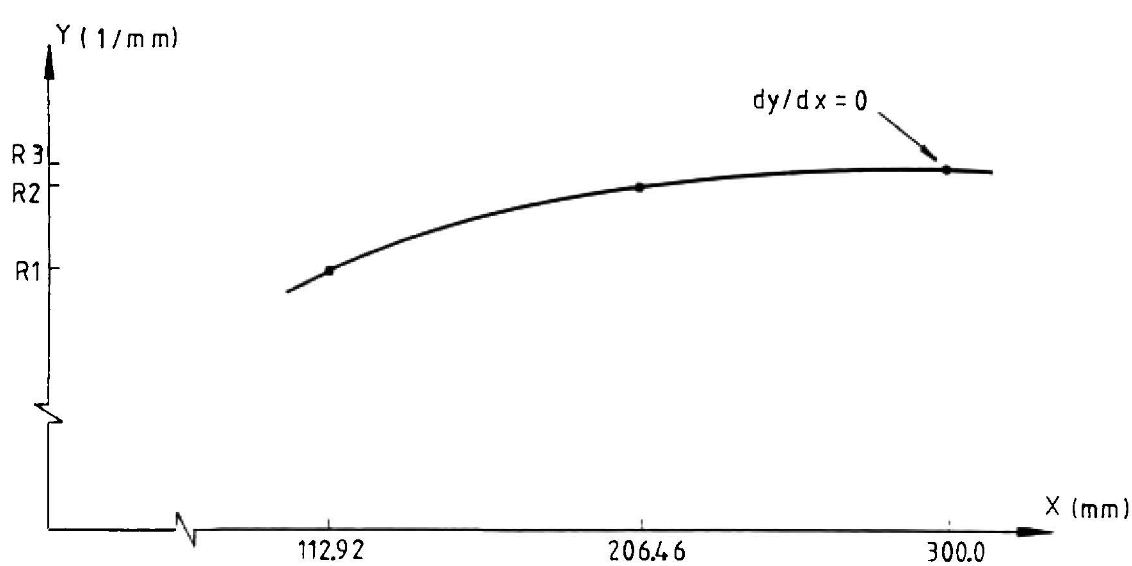


Figure 4.6 Parabolic extrapolation of values

In the figure, R1 and R2 represent the end and inner transverse curvatures, respectively. Because R3 was at the centre point of the plate, it was assumed that the derivative of the parabolic curve would be zero at that point. With R1 and R2 known, R3 was calculated from equation [4.1].

$$R3 = 90000 \cdot a + 300 \cdot b + c \quad (1/mm) \qquad [4.1]$$

where:

$$a = (R1-R2)/26249.1948 \qquad [4.2]$$

$$b = -600 \cdot a \qquad [4.3]$$

$$c = R1 - 12750.9264 \cdot a - 112.92 \cdot b \qquad [4.4]$$

The second data file added is the longitudinal curvature which was calculated from the middle and end vertical displacements as explained in sub-section 3.6.

In summary the data files are as follows (* before the file name refers 1,2,3,4,5 and 6 for each test, respectively):

*Plate1 - Middle displacement.
*Plate2 - End displacement.
*Plate3 - End displacement.
*Plate4 - Top longitudinal strain.
*Plate5 - Top transverse strain.
*Plate6 - Bottom longitudinal strain.
*Plate7 - Bottom transverse strain.
*Plate8 - Inner transverse curvature.
*Plate9 - End transverse curvature.
*Plate10 - Middle transverse curvature.
*Plate11 - Longitudinal curvature.

4.4 Test 1

The first test was conducted on a perforated plate without pipes.

4.5 Test 2

This test was exactly the same as Test 1.

4.6 Test 3

A perforated plate with pipes was tested. The plates were loaded with the pipes below the plate.

4.7 Test 4

The conditions of this test were exactly the same as Test 3. However, the test itself had previously been conducted by Dunaiski *et al*[5]. In order to compare results, the outcome of this test is also given in this text.

4.8 Test 5

In this test the plates were loaded with the pipes above the plate.

4.9 Test 6

Exactly the same as Test 5, but had also been conducted previously by Dunaiski *et al.*

5. INFORMATION OBTAINED FROM THE TESTS

The information obtained from the tests is largely repetitive, therefore only Test 1 will be dealt with in detail.

5.1 Tests 1 and 2

The results of Test 1 are graphically portrayed in Appendix 1. Graph 1.1 shows a displacement versus load curve. The curve is linear for the initial part of the curve up to a load of 3.0 kN. This indicates the region where the perforated plate reacts elastically. Once the load of about 3.0 kN was exceeded, however, the steel plate started yielding. After a load of approximately 5.5 kN was reached, the plate was unloaded in steps. Due to the fact that the steel yielded, the plate exhibited permanent deformation, as seen from the graph.

The two end displacements seen in Graph 1.2. should constantly be the same, however once yielding had taken place, the two values differ only slightly. Obviously the middle displacement must be greater than the end displacements, and this is shown in Graph 1.3.

Graphs 1.4 and 1.5 show the top and bottom longitudinal strains, respectively. As the cross sections of the perforated plates without pipes were symmetrical, and applying Bernoulli's Law that plane sections remain plane, the absolute values of the top and bottom longitudinal strains must therefore be equal. This is shown in Graph 1.6. Unfortunately the values differ somewhat. This was due to the fact that the DD1 strain transducers which had their measurement points extended, gave inaccurate readings.

Fortunately though, it was possible to calculate the effective elastic constants by using only the most accurate readings. For example, it is possible to calculate the Poisson's ratio by using either the top strains or the bottom strains, or both. If necessary, only one of the two sets of readings was considered. This unfortunately meant that the size of the result sample was smaller.

Graphs 1.7 and 1.8 show the top and bottom transverse strains respectively. Once again the absolute values are compared in Graph 1.9, which shows good results.

Graph 1.10 shows the end and inner transverse curvatures. It is suprising to see that the inner transverse curvature is about twice the end transverse curvature. This is explained by the fact that the solid portion of the plate has a stiffening effect on the perforated part of the plate adjacent to the solid section. The transverse curvature in the middle of the plate which was calculated by extrapolation of the end and inner transverse curvatures, is shown in Graph 1.11. Finally, the longitudinal curvature was calculated as explained in sub-section 3.6 and is plotted in Graph 1.12.

The results of Test 2, which were the same as Test 1, are shown in Appendix 2, and are displayed in the same manner. Appendix 3 shows a comparison of the results from Test 1 and 2. Except for the readings of the bottom longitudinal strain, the agreement between the tests is very good and the results can be viewed as representative of this type of perforated plate.

5.2 Tests 3 and 4

The results of Test 3 are given in Appendix 4. As previously explained, this test was conducted on the perforated plates with the pipes below the plates. The plate was loaded to a maximum load of approximately 11.5 kN because the pipes cause the plates to be far stiffer than those plates without pipes. Figure 5.1 shows the plate under maximum load.

Figure 5.1 Perforated plate under maximum applied load.

The results of Test 3 are plotted in Graphs 4.1 to 4.10. Problems were encountered with one LVDT transducer which measured the end displacement, shown in Graph 4.2, and with a DD1 transducer with the extended measurement points as seen in Graphs 4.5 and 4.7.

Appendix 5 gives the results of Test 4 which was conducted by Dunaiski *et al*. (Note that they were unable to measure transverse curvature.) The two tests are compared in Appendix 6. Up until yielding of the steel occurs, the results compare favourably. Only in Graph 6.1 is it seen that the DD1 transducers gave unacceptable results.

5.3 Tests 5 and 6

Test 5 was conducted with the pipes facing upwards. The results are given in Appendix 7. Good results were achieved in this test, with all the instruments giving good readings. The similar test conducted by Dunaiski *et al* is given in Appendix 8. They obtained only a few results from their test. They had discarded the DD1 strain transducers with the extended measurement points, because some of the points had been damaged. Therefore they were unable to measure the strains on the top face of the plate. The results of Test 5 and 6 are compared in Appendix 9. The longitudinal curvature exhibits unusual characteristics during unloading for both tests. It must, however, be remembered that the plates have yielded by that stage and permanent deformation has taken place.

6. ANALYSIS AND INTERPRETATION OF THE RESULTS

Pure bending was applied to the central, perforated section of each test specimen by way of the four point bending procedure described in section 3.1. Referring to Figure 6.1, showing a plate spanning from A to B, the effective elastic constants can be expressed in terms of the coordinate system shown in the figure.

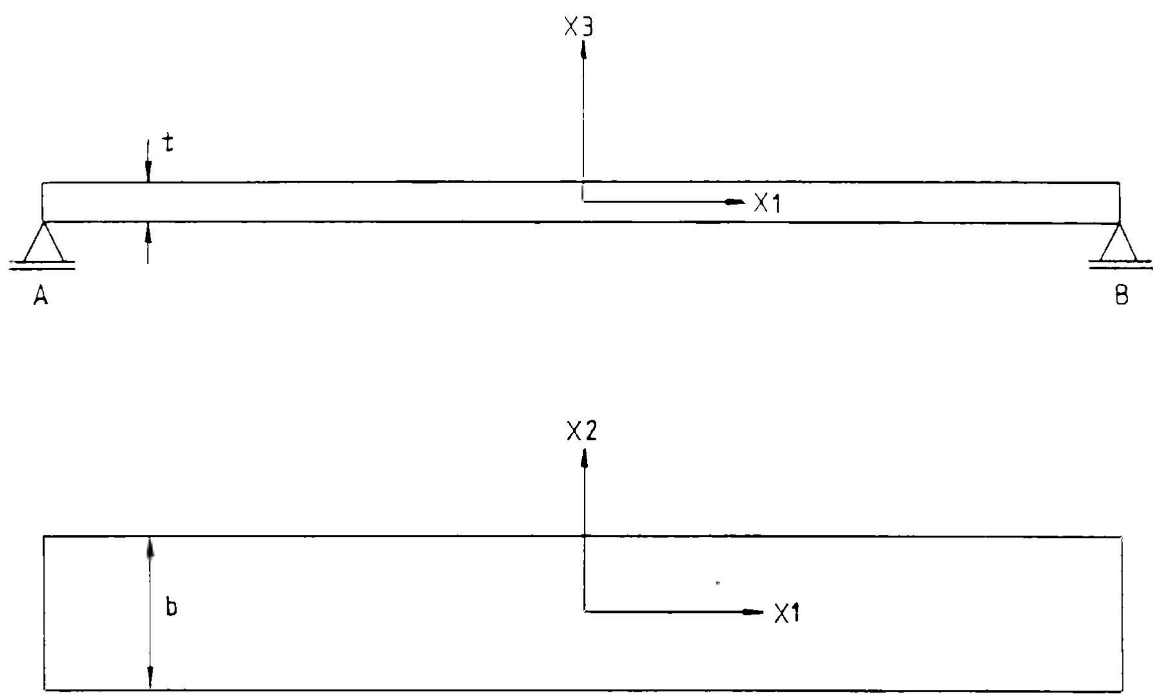


Figure 6.1 Plate coordinate system

6.1 Effective Poisson's ratio

The effective Poisson's ratio is (by definition) given by:

$$\nu^* = -\epsilon^*_{11}/\epsilon^*_{22} \qquad [6.1]$$

and

$$\nu^* = -w^*,_{22}/w^*,_{11} \qquad [6.2]$$

Where: ϵ^* = equivalent strain in the respective direction.
$w^*,$= equivalent curvature in the respective direction.

As mentioned in the description of the experimental setup of the tests, care was taken to adapt the base lengths of the DD1 strain transducers to the geometry of the holes. In this way the strain variations in both the longitudinal (ϵ^*_{11}) and transverse (ϵ^*_{22}) directions were measured from the centre of a ligament to the centre of a ligament. Consequently the measured strains were the same as would be measured in a equivalent solid plate, and equation [6.1] yields the effective Poisson's ratio of the solid plate directly. The longitudinal ($w,_{11}$) and transverse ($w,_{22}$) curvatures in the *centre* of the plate in the respective directions were used. In this way too, the measured curvatures were the same as would be in a equivalent solid plate and equation [6.2] yields the correct Poisson's ratio.

Theoretically, the Poisson's ratio calculated using the measured strain (equation [6.1]) should be the same as the Poisson's ratio calculated from the curvature readings (equation [6.2]). This, however, was not found to be the case, and the following reasons can be cited:

(1) The transducers used to measure the curvature were far more accurate and consistent than the DD1 transducers used to measure the strain (see report written by author[6]).

(2) The strain transducers only measure effects that occur on the surface of the plate, whereas the curvature is a effect that occurs throughout the depth of the plate. Therefore, the strain measurement is a representation of a local effect, while the curvature is a portrayal of integrated effects.

As a result of the reasons given above, far more weight was given to the values calculated from the curvature readings. The Poisson's ratios calculated from the strains were used mainly for comparative purposes to make sure that the curvature readings were not totally inaccurate.

The effective Poisson's ratios for each test are graphically represented in Appendix 10. In calculating the Poisson's ratios, only the readings in the elastic limit of the perforated plate were used. Once yielding of the steel occurred, the readings were ignored. Finally, the effective Poisson's ratio was calculated in the following two ways:

(1) By using statistics and calculating the average Poisson's ratio. Greater weight was given to readings with a smaller coefficient of variation.
(2) By using linear regression and calculating the effective Poisson's ratio for zero load. A greater weight was given to readings with a high correlation coefficient.

A final decision on the value for the Poisson's ratio was made after considering the above factors. In some of the tables, values have not been entered into the columns. The reason for this is that either the relevant readings were not taken, or that they were completely unsatisfactory due to inaccurate instrumentation reading. Graph 4.5 in Appendix 4 would be a good example of a unsatisfactory result.

6.1.1 Perforated plates without pipes

Graphs 10.1 to 10.3 in Appendix 10 show the effective Poisson's ratios for Test 1 and 2. The results of the calculations are given in the following tables.

Table 6.1 Poisson's ratio for Test 1.

	CALCULATED FROM:		
	Top ε	Bottom ε	Curvature
Poisson's ratio (average)	0.822	-	0.838
Coefficient of variation	1.600%	-	2.740%
Poisson's ratio (regression)	0.810	-	0.796
Correlation coefficient	72.500%	-	93.400%

The largest variation in the value for the Poisson's ratio is 5.27%, which can be considered as reasonably accurate.

Table 6.2 Poisson's ratio for Test 2.

	CALCULATED FROM:		
	Top ϵ	Bottom ϵ	Curvature
Poisson's ratio (average)	**0.830**	**0.785**	**0.769**
Coefficient of variation	1.390%	3.688%	0.910%
Poisson's ratio (regression)	**0.810**	**0.734**	**0.775**
Correlation coefficient	93.550%	96.100%	74.500%

As previously stated, the ratios calculated from the strain measurements are mainly for comparative purposes only. The greatest attention is given to the values obtained from the curvature readings. Taking the above calculations into consideration, the following Poisson's ratio for the type of perforated plate loaded in Test 1 and 2 is recommended:

$$\nu^* = 0.79$$

6.1.2 Perforated plates with the pipes below the plate

Graphs 10.4 to 10.6 plot the calculated Poisson's ratios for Tests 3 and 4. The results of these two tests are summarised as follows:

Table 6.3 Poisson's ratio for Test 3.

	CALCULATED FROM:		
	Top ∊	Bottom ∊	Curvature
Poisson's ratio (average)	**0.449**	-	**0.634**
Coefficient of variation	1.810%	-	2.990%
Poisson's ratio (regression)	**0.462**	-	**0.669**
Correlation coefficient	88.860%	-	95.500%

For this test, there is quite a difference between the Poisson's ratio calculated from the strain and curvature, as can be seen from the table and Graph 10.4

In Test 4, no curvature was measured and the bottom strain readings were unsatisfactory. However, the available information is given in the following table.

Table 6.4 Poisson's ratio for Test 4.

	CALCULATED FROM:		
	Top ε	Bottom ε	Curvature
Poisson's ratio (average)	**0.541**	-	-
Coefficient of variation	3.400%	-	-
Poisson's ratio (regression)	**0.511**	-	-
Correlation coefficient	88.430%	-	-

The following Poisson's ratio for the type of plate loaded in Test 3 and 4 is recommended:

$$\nu^* = 0.65$$

6.1.3 Perforated plates with the pipes above the plate

The Poisson's ratios for Test 5 and 6 are plotted in Graphs 10.7 and 10.9 in Appendix 10. The results are as follows:

Table 6.5 Poisson's ratio for Test 5.

	CALCULATED FROM:		
	Top ε	Bottom ε	Curvature
Poisson's ratio (average)	-	0.558	0.648
Coefficient of variation	-	2.320%	1.010%
Poisson's ratio (regression)	-	0.535	0.644
Correlation coefficient	-	94.000%	65.200%

Table 6.6 Poisson's ratio for Test 6.

	CALCULATED FROM:		
	Top ε	Bottom ε	Curvature
Poisson's ratio (average)	-	0.593	-
Coefficient of variation	-	1.970%	-
Poisson's ratio (regression)	-	0.593	-
Correlation coefficient	-	5.430%	-

The following Poisson's ratio for the type of perforated plate loaded in Test 5 and 6 is recommended:

$$\nu^* = 0.64$$

6.2 Effective Young's modulus

According to equation [6.3], the effective Young's modulus of the equivalent solid material is given by:

$$E^* = (M_{11} \cdot x_3)/(\epsilon_{11} \cdot I_{22}) \qquad [6.3]$$

Where:
M_{11} = applied bending moment.
x_3 = depth to the neutral axis.
I_{22} = second moment of inertia.
ϵ_{11} = strain.

For the plates without pipes, the depth to the neutral axis (x_3), is obviously half the plate thickness. However, for the plates with pipes, the inclusion of the x_3 term is necessitated by the fact that the pipes are welded to the plate at only one end - consequently the section is not symmetrical through the thickness. The value for x_3 can be calculated from the top strain (ϵ_t) and bottom strain (ϵ_b). Because the bottom strain reading was unreliable in most of the tests, the depth to the neutral axis was calculated by using the top strain (ϵ_t) and the longitudinal curvature ($w_{,11}$), in the method described overleaf.

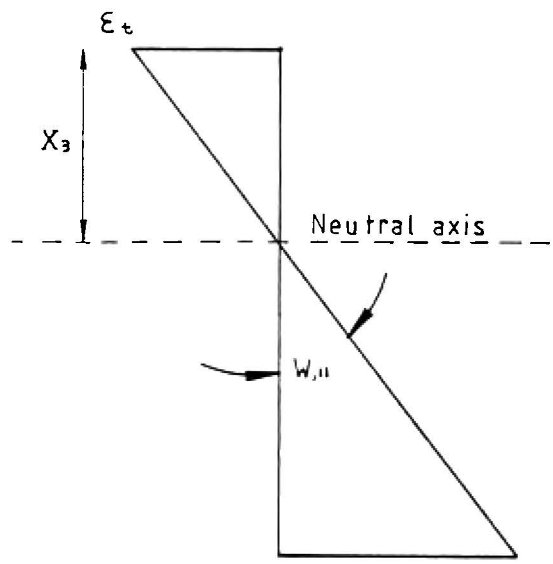


Figure 6.2 Depth to the neutral axis calculation.

$$x_3 = \epsilon_t \cdot \arctan(w_{,11}) \qquad [6.4]$$

The value for I_{22} was calculated in equation [6.5].

$$I_{22} = b \cdot t^3 + b \cdot t \cdot (0.5 \cdot t - x_3)^2 \qquad [6.5]$$

Where: b = plate width

t = plate thickness

Using plate bending theory, the effective Young's modulus was also calculated in the following way:

From $$m_{11} = B \cdot (w_{,11} + \nu^* \cdot w_{,22}) \qquad [6.6]$$

with, $$B = E^* \cdot t^3 / [12 \cdot (1 - \nu^{*2})] \qquad [6.7]$$

follows: $$E^* = 12(1 - \nu^{*2}) \cdot m_{11} / [t^3 (w_{,11} + \nu^* \cdot w_{,22})] \qquad [6.8]$$

where: m_{11} = bending moment per unit width.

Therefore, in the same way as the Poisson's ratio was calculated, the effective Young's modulus can be calculated in two ways, using the measured strains (equation [6.3]) and curvature (equation [6.8]). For the same reasons as were given in calculating the Poisson's ratios, greater weight was given to the values calculated using the curvature readings. Missing values in the tables are once again as a result of readings which were either completely inaccurate or not taken at all. The effective Young's modulus for each test is plotted in Appendix 11.

6.2.1 Perforated plates without pipes

Graphs 11.1 to 11.3 show the effective Young's modulus for Test 1 and 2. It can be seen that the values calculated from the two methods described, agree very well. The results of the calculations are given in the following tables:

Table 6.7 Young's modulus (in GPa) for Test 1.

	CALCULATED FROM:	
	Strain	Curvature
Young's modulus (average)	**6.81**	**6.87**
Coefficient of variation	8.37%	4.90%
Young's modulus (regression)	**7.79**	**7.50**
Correlation coefficient	89.90%	94.70%

Table 6.8 Young's modulus (in GPa) for Test 2.

	CALCULATED FROM:	
	Strain	Curvature
Young's modulus (average)	7.02	6.28
Coefficient of variation	3.41%	4.30%
Young's modulus (regression)	7.37	6.77
Correlation coefficient	80.53%	94.50%

Taking the above calculations into consideration, the following Young's modulus for perforated plates without pipes is recommended:

$$E^* = 7.0 \text{ GPa}$$

6.2.2 Perforated plates with pipes below the plate

Graph 11.4 shows the effective Young's modulus as determined from Test 3. The values exhibit a tendency to decrease linearly with increasing load. Graph 11.5 portrays the results of Test 4 conducted Dunaiski *et al.* The results of the calculations are given in the following tables:

Table 6.9 Young's modulus (in GPa) for Test 3.

	CALCULATED FROM:	
	Strain	Curvature
Young's modulus (average)	**10.12**	**11.00**
Coefficient of variation	7.25%	7.23%
Young's modulus (regression)	**11.63**	**12.56**
Correlation coefficient	99.69%	99.80%

Table 6.10 Young's modulus (in GPa) for Test 4.

	CALCULATED FROM:	
	Strain	Curvature
Young's modulus (average)	**12.83**	-
Coefficient of variation	2.72%	-
Young's modulus (regression)	**13.44**	-
Correlation coefficient	94.34%	-

Taking the above calculations into consideration, the following Young's modulus for perforated plates with pipes protruding below the plate is recommended:

$$E^* = 11.5 \text{ GPa}$$

6.2.3 Perforated plates with pipes above the plate

The results of Test 5 and 6 are plotted in Graphs 11.7 to 11.9 in the appendix. The results are summarised as follows:

Table 6.11 Young's modulus (in GPa) for Test 5.

	CALCULATED FROM:	
	Strain	Curvature
Young's modulus (average)	**9.61**	**11.99**
Coefficient of variation	2.84%	4.64%
Young's modulus (regression)	**9.33**	**12.19**
Correlation coefficient	50.92%	75.17%

Table 6.12 Young's modulus (in GPa) for Test 6.

	CALCULATED FROM:	
	Strain	Curvature
Young's modulus (average)	12.97	-
Coefficient of variation	1.47%	-
Young's modulus (regression)	12.89	-
Correlation coefficient	72.20%	-

The following Young's modulus for perforated plates with pipes protruding above the plate is recommended:

$$E^* = 12.0 \text{ GPa}$$

6.3 Summary of the results

The effective Young's moduli and Poisson's ratios for perforated plates with ligament efficiencies (h/p) of 0.074, and plate thickness to pitch (t/p) ratios of 0.648, are summarised in the following table.

Table 6.13 Effective elastic constants.

Position of pipes	Young's modulus (GPa)	Poisson's ratio
None	7.0	0.79
Above	11.5	0.65
Below	12.0	0.64

7. CONCLUSIONS

The perforated steel plates tested, had a ligament efficiency (h/p) of 0.074 and a plate thickness to pitch ratio (t/p) of 0.648 for all the plates. Figure 7.1 is a reproduction of the graph drawn up by O'Donnell. The arrow indicates the characteristics of the plates tested in this investigation.

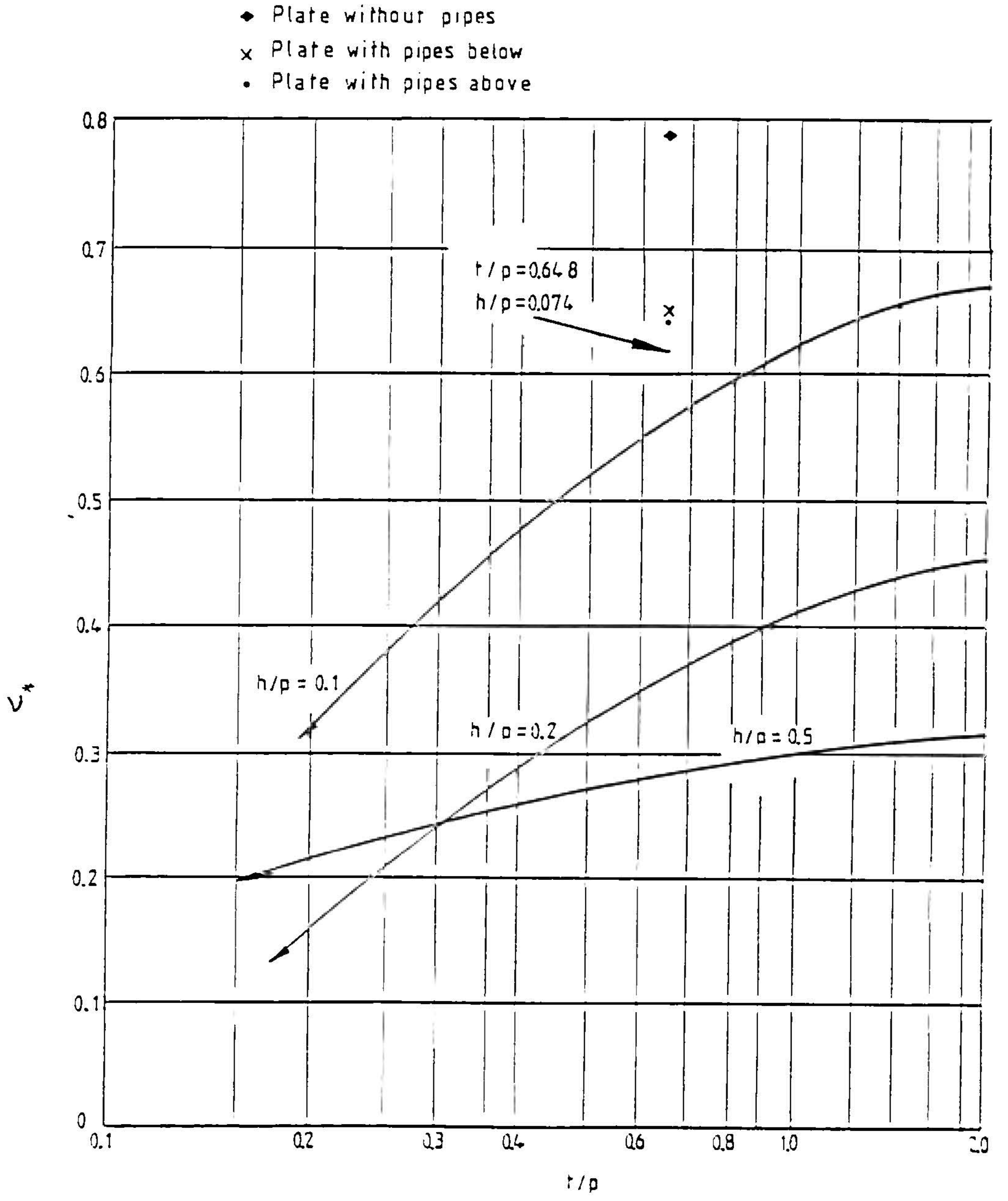


Figure 7.1 Effective Poisson's ratios

As indicated in the graph, O'Donnell only tested specimens with ligament efficiencies of 0.1, 0.2 and 0.5 in his tests. Therefore the ligament efficiency of 0.074 falls outside O'Donnell's test range. The ligament efficiency of 0.074 was therefore extrapolated and is indicated by the arrow in the figure.

The three Poisson's ratios of 0.79, 0.65 and 0.64 as determined from Tests 1 to 6 are plotted in the graph. Because these results fall outside those done by O'Donnell, it would be difficult to predict by how far these Poisson's ratios differ from those of O'Donnell. The perforated plates tested by O'Donnell were without any pipes, therefore the Poisson's ratio of 0.79 should be closest to the extrapolated point, however, it is the furthest. As explained before, it is impossible to comment on this.

The steel used in the plates was tested in a uniaxial tension test to determine it's Young's modulus. The results can be seen in Appendix 12. The Young's modulus was found to be 210 GPa, very typical of steel. In Tests 1 to 6, effective Young's moduli of 7.0 GPa, 11.5 GPa and 12.0 GPa were determined. Therefore:

- Perforated plates without pipes, $E^*/E = 0.0333$
- Perforated plates with pipes above, $E^*/E = 0.0547$
- Perforated plates with pipes below, $E^*/E = 0.0571$

These three point are plotted in Figure 7.2, which was also produced by O'Donnell.

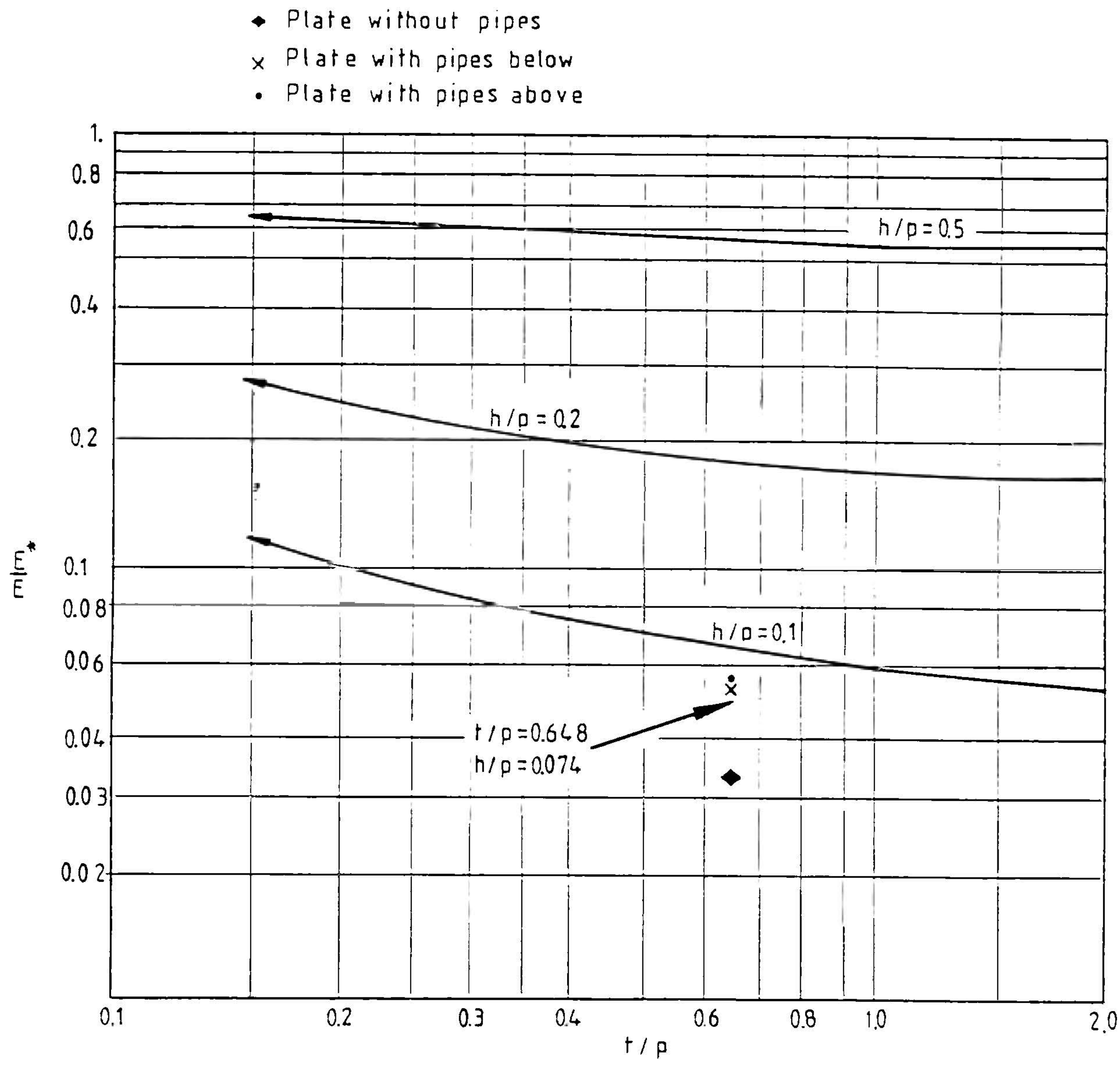


Figure 7.2 Effective Young's moduli

It is enlightening to examine the effective elastic constants determined from the tests, as summarised in the following table. The table shows the ratio of the normal elastic constants of steel to the effective elastic constants The normal elastic constants are taken as 0.3 for Poisson's ratio (ν), and for Young's modulus (E), 210 GPa.

Table 7.1 Effective - normal elastic constants ratio

Position of pipes	ν/ν^*	E/E^*
None	0.379	30.00
Above	0.461	18.26
Below	0.468	17.50

As can be seen from the table, the perforations in the steel plate results in large changes in the elastic constants.

The stiffness of a steel plate is given by the following equation:

$$B = E \cdot t^3 / [12 \cdot (1 - \nu^2)] \qquad [7.1]$$

Taking a plate of normal steel and unit thickness, the stiffness would be given as:

$$B = 210/[12 \cdot (1 - 0.3 \cdot 0.3)]$$
$$= 19.23 \text{ Nm}$$

The stiffness of the perforated plates tested in this investigation are summarised in the following table:

Table 7.2 Perforated plate stiffness.

Position of pipes	B* (Nm)	B/B*
None	1.551	12.398
Above	1.659	11.591
Below	1.693	11.358

Therefore, the perforated steel plates with a ligament efficiency (h/p) of 0.074 and a plate thickness to pitch (t/p) ratio causes an approximate 91% reduction in stiffness.

Where perforated plates are used in reactors, it is not known beforehand in which direction the plate will bend, ie. if the pipes will be effective above or below the plate. For this reason it is necessary to recommend only one set of elastic constants for the perforated plates with pipes. The following recommendations are made:

Table 7.3 Recommended effective elastic constants

Plate description	ν^*	E* (GPa)
No pipes	0.79	7.0
Pipes present	0.645	11.75

Dunaiski *et al* recommended a effective Poisson's ratio of 0.531 and Young's modulus of 12.64 GPa for the perforated plates with pipes.

8. RECOMMENDATIONS

The following recommendations are made:

1) The perforated plates only need to be loaded up to their elastic limit, as any reading taken after that does not contribute to the determination of the elastic constants. In the investigation, the plates were loaded in steps of either 0.25 kN or 0.5 kN, depending on the plate type. I recommend that these load steps be made far smaller, in the order of 0.1 kN. In this way, the instrumentation undergoes small changes at a time and a large number of readings are taken in the elastic limit.

2) The transverse curvature should be measured in the centre of the plate to avoid extrapolation of values.

3) The ideal would be to conduct a large number of tests with different combinations of ligament efficiencies and thickness to pitch ratios. In this way it would be possible to add additional curves to O'Donnell's graphs, instead of a single point.

4) The results presented in this investigation can be used to develop a procedure using the finite element methods which determines the effective elastic constants of perforated plates directly, and therefore negates the necessity of having to perform experiments.

9. REFERENCES

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3. **Slot, T. and Branca, T.R.** "On the determination of effective elastic-plastic properties for the equivalent solid plate analysis of tube sheets." Trans. ASME, Jr. Pressure Vessel Technol., Vol. 96, Aug. 1974, pp. 220-226.

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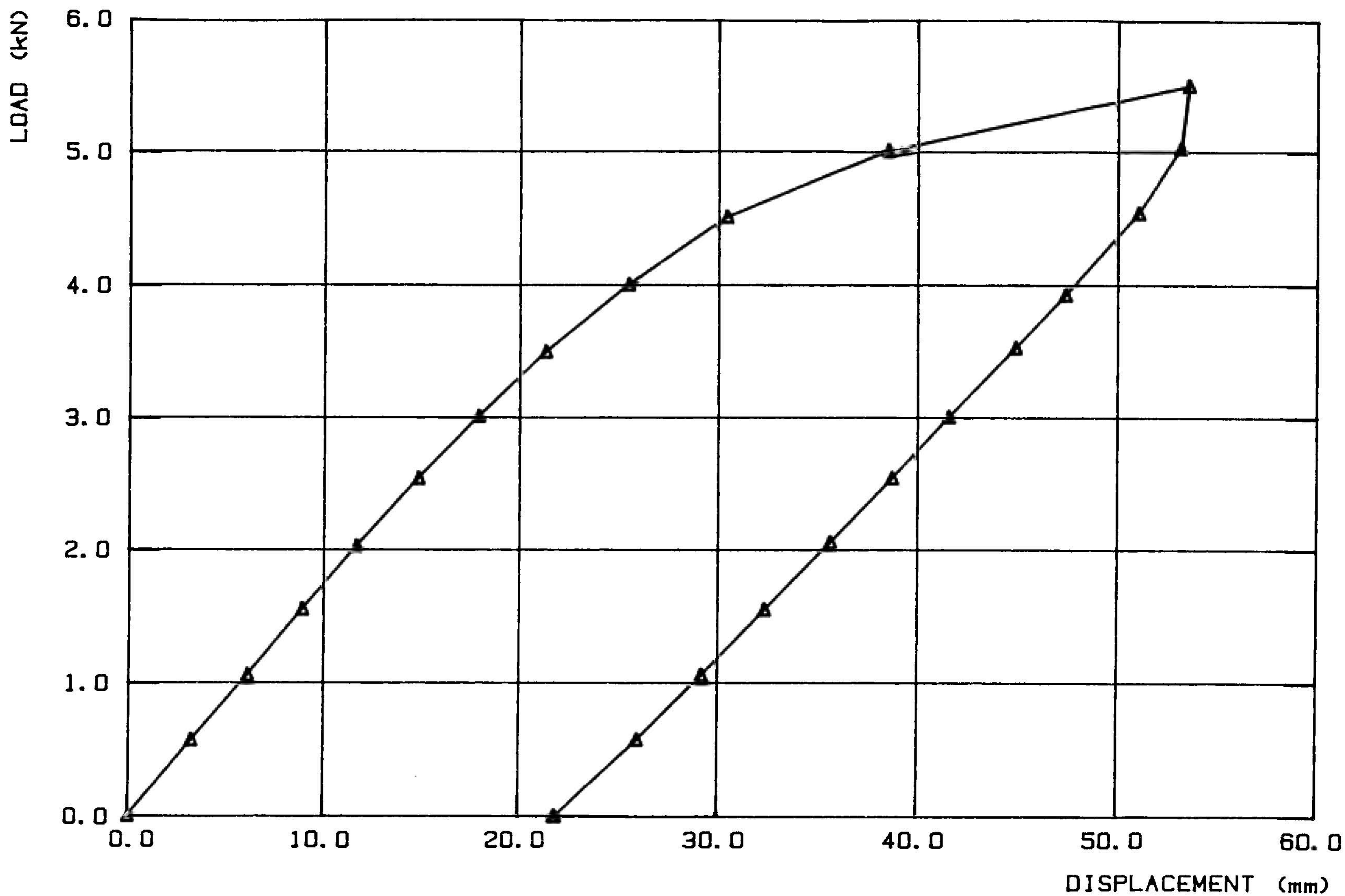


DISPLACEMENT VERSUS LOAD

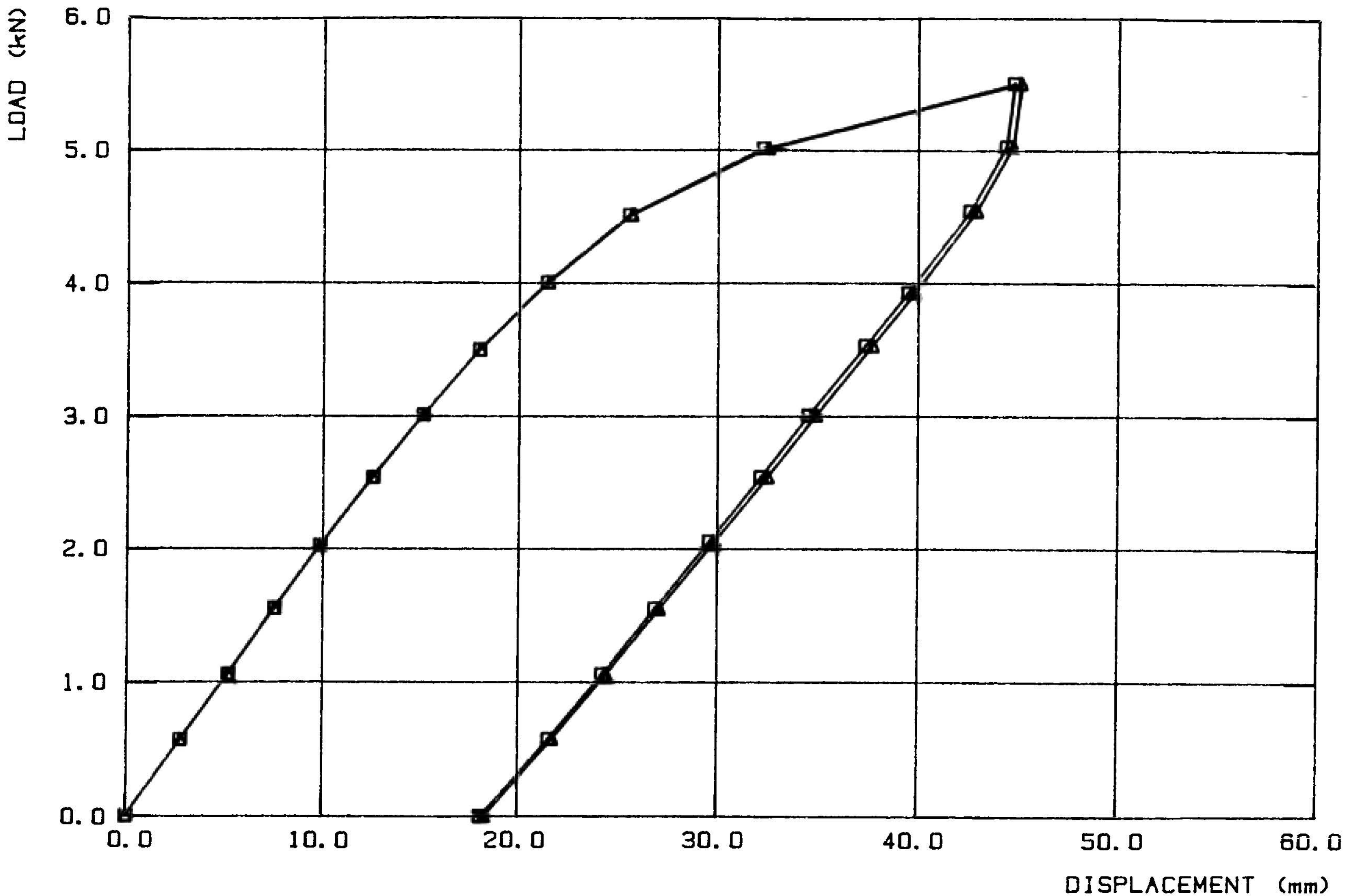
TEST 1: MIDDLE DISPLACEMENT. LVDT POSITION 1.

GRAPH 1.1

MIDDLE DISPLACEMENT. LVDT POSITION 1.

FILE :B:1PLATE1.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	1.916016E-03	0
1	.5767208	3.251953
2	1.067221	6.103516
3	1.557721	8.876953
4	2.030977	11.62109
5	2.546385	14.77539
6	3.015809	17.86133
7	3.502477	21.28906
8	4.008305	25.43945
9	4.514133	30.3711
10	5.01613	38.52539
11	5.510462	53.55469
12	5.031458	53.125
13	4.542874	51.02539
14	3.929749	47.36328
15	3.531217	44.87305
16	3.010061	41.54297
17	2.546385	38.7207
18	2.059717	35.64453
19	1.553889	32.34375
20	1.063389	29.15039
21	.5786368	25.92774
22	-1.916016E-03	21.83594
23	0	21.79688



DISPLACEMENT VERSUS LOAD

TEST 1: END DISPLACEMENTS. LVDT POSITIONS 2 AND 3.

GRAPH 1.2

END DISPLACEMENT. LVDT POSITION 2.

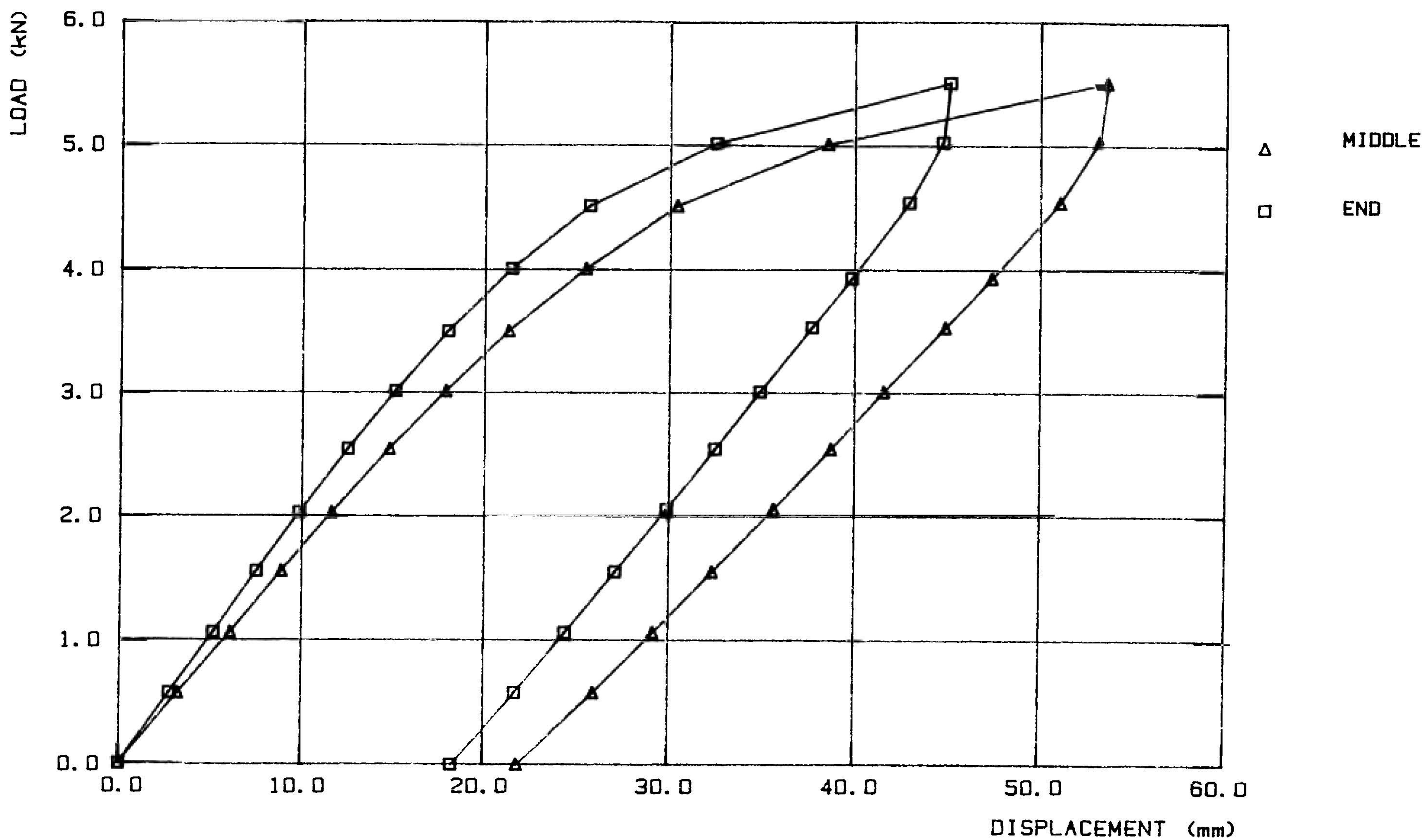
FILE :B:1PLATE2.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	1.916016E-03	0
1	.5767208	2.758789
2	1.067221	5.15625
3	1.557721	7.495117
4	2.030977	9.829102
5	2.546385	12.49512
6	3.015809	15.08789
7	3.502477	17.96875
8	4.008305	21.45508
9	4.514133	25.63477
10	5.01613	32.49512
11	5.510462	45.10254
12	5.031458	44.70703
13	4.542874	42.89551
14	3.929749	39.81934
15	3.531217	37.69531
16	3.010061	34.8877
17	2.546385	32.47559
18	2.059717	29.8584
19	1.553889	27.0752
20	1.063389	24.38965
21	.5786368	21.67969
22	-1.916016E-03	18.26172
23	0	18.23731

END DISPLACEMENT. LVDT POSITION 3.

FILE :B:1PLATE3.DAT

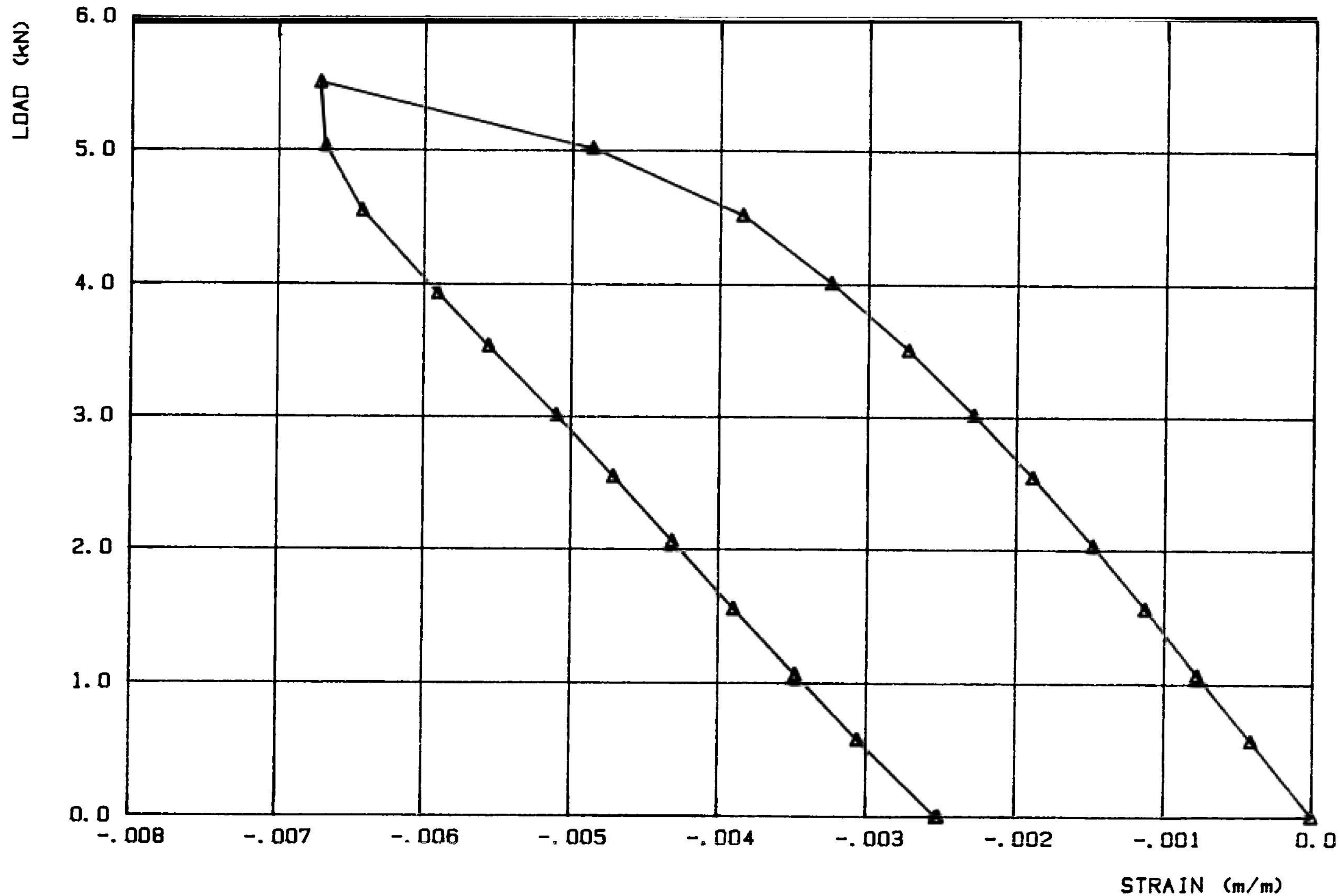
LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	1.916016E-03	0
1	.5767208	2.768555
2	1.067221	5.19043
3	1.557721	7.519532
4	2.030977	9.838868
5	2.546385	12.53418
6	3.015809	15.09277
7	3.502477	17.94434
8	4.008305	21.38672
9	4.514133	25.5127
10	5.01613	32.25098
11	5.510462	44.77539
12	5.031458	44.36524
13	4.542874	42.57813
14	3.929749	39.47754
15	3.531217	37.35352
16	3.010061	34.52149
17	2.546385	32.15332
18	2.059717	29.58985
19	1.553889	26.85059
20	1.063389	24.19434
21	.5786368	21.50391
22	-1.916016E-03	18.06641
23	0	18.04688



DISPLACEMENT VERSUS LOAD

TEST 1: DISPLACEMENTS. LVDT POSITIONS 1, 2 AND 3.

GRAPH 1.3



STRAIN VERSUS LOAD

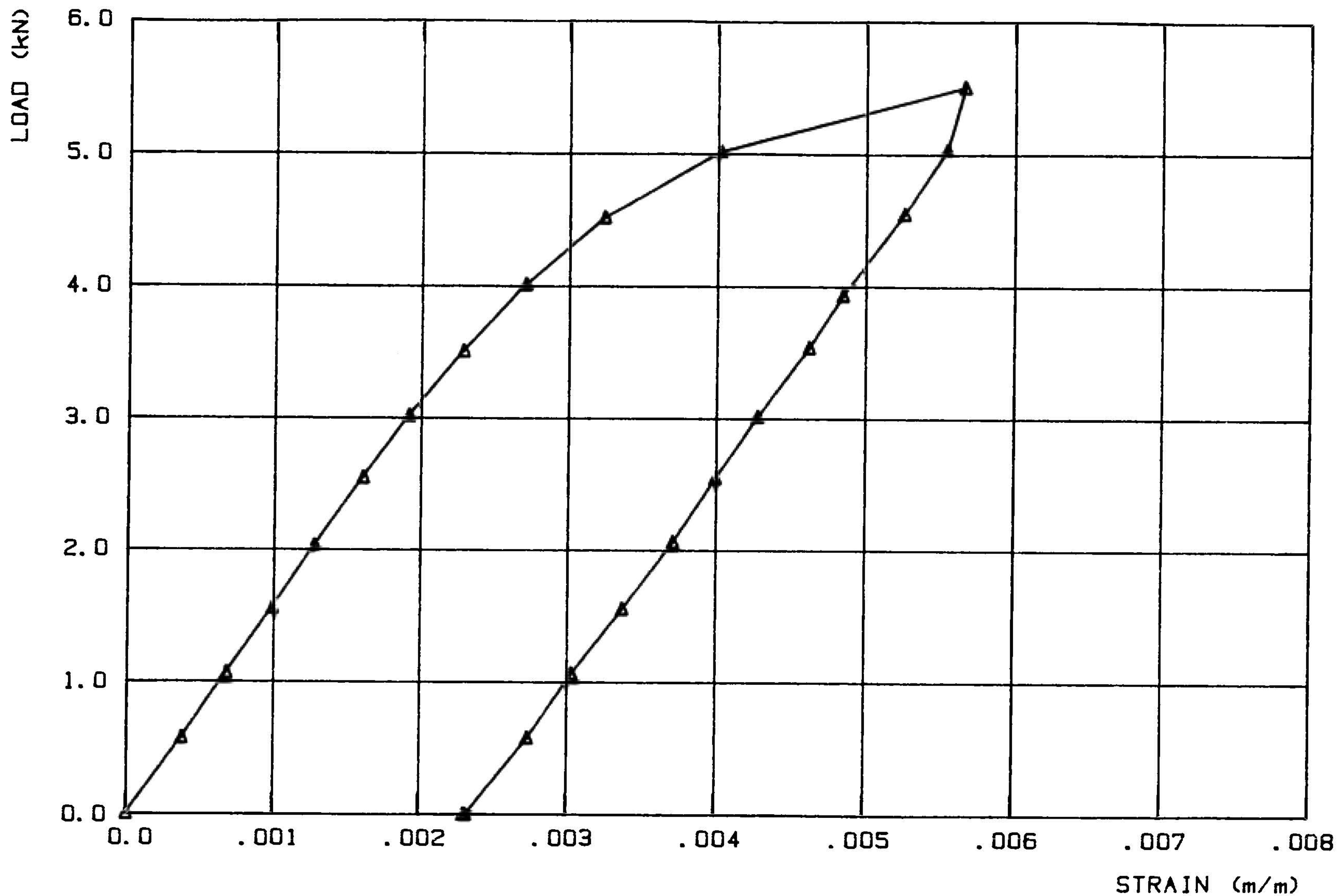
TEST 1: TOP LONGITUDINAL STRAIN. DD1 POSITION 4

GRAPH 1.4

TOP LONGITUDINAL STRAIN. DD1 POSITION 4.

FILE :B:1PLATE4.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	1.916016E-03	-4.208261E-06
1	.5767208	-4.145138E-04
2	1.067221	-7.827368E-04
3	1.557721	-1.134127E-03
4	2.030977	-1.487621E-03
5	2.546385	-1.893718E-03
6	3.015809	-2.291398E-03
7	3.502477	-2.733266E-03
8	4.008305	-3.252986E-03
9	4.514133	-3.85056E-03
10	5.01613	-4.864751E-03
11	5.510462	-6.716386E-03
12	5.031458	-6.680615E-03
13	4.542874	-6.42812E-03
14	3.929749	-5.912608E-03
15	3.531217	-5.563323E-03
16	3.010061	-5.100413E-03
17	2.546385	-4.713253E-03
18	2.059717	-4.315573E-03
19	1.553889	-3.898955E-03
20	1.063389	-3.482337E-03
21	.5786368	-3.063615E-03
22	-1.916016E-03	-2.531269E-03
23	0	-2.516541E-03



STRAIN VERSUS LOAD

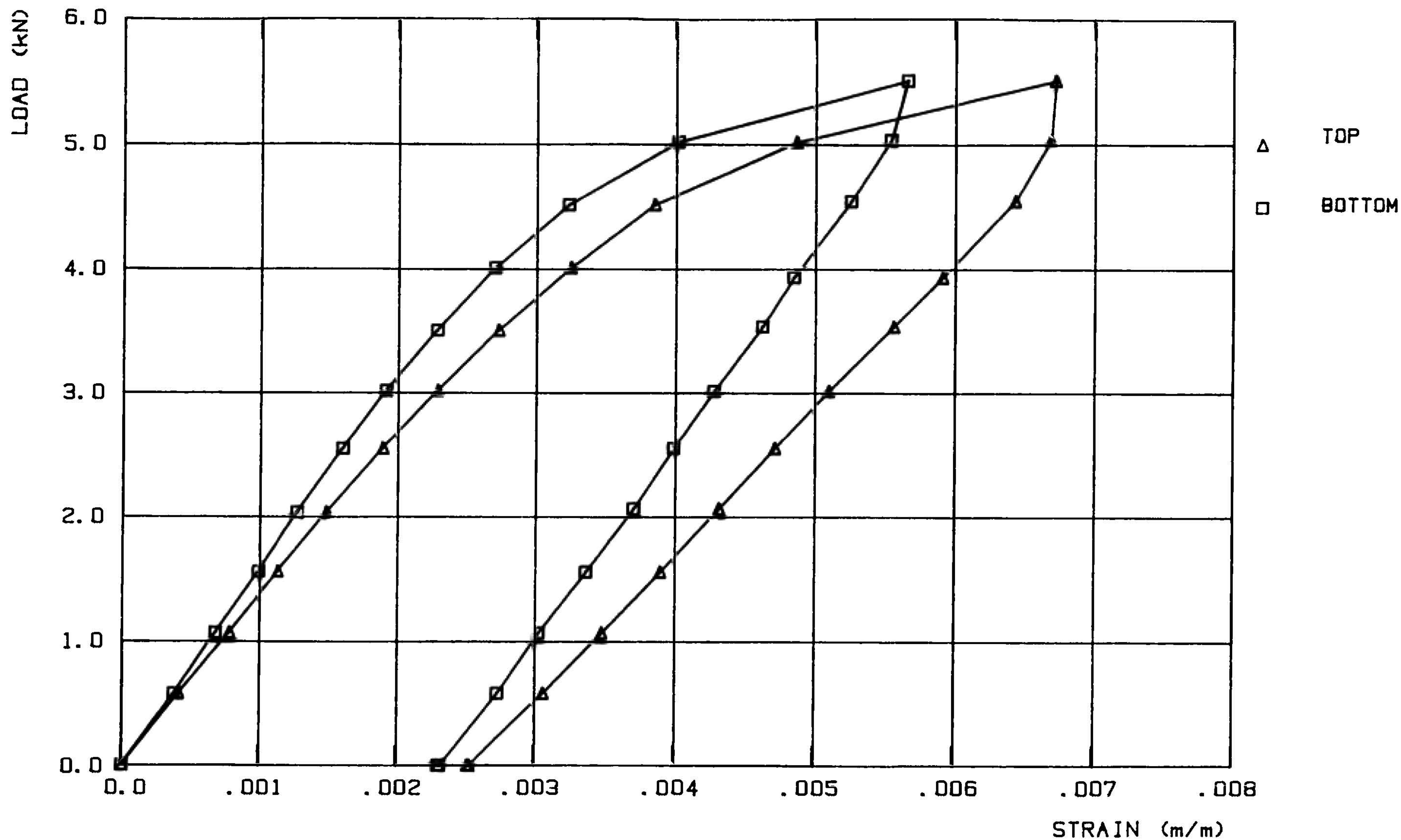
TEST 1: BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 6

GRAPH 1.5

BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 6.

FILE :B:1PLATE6.DAT

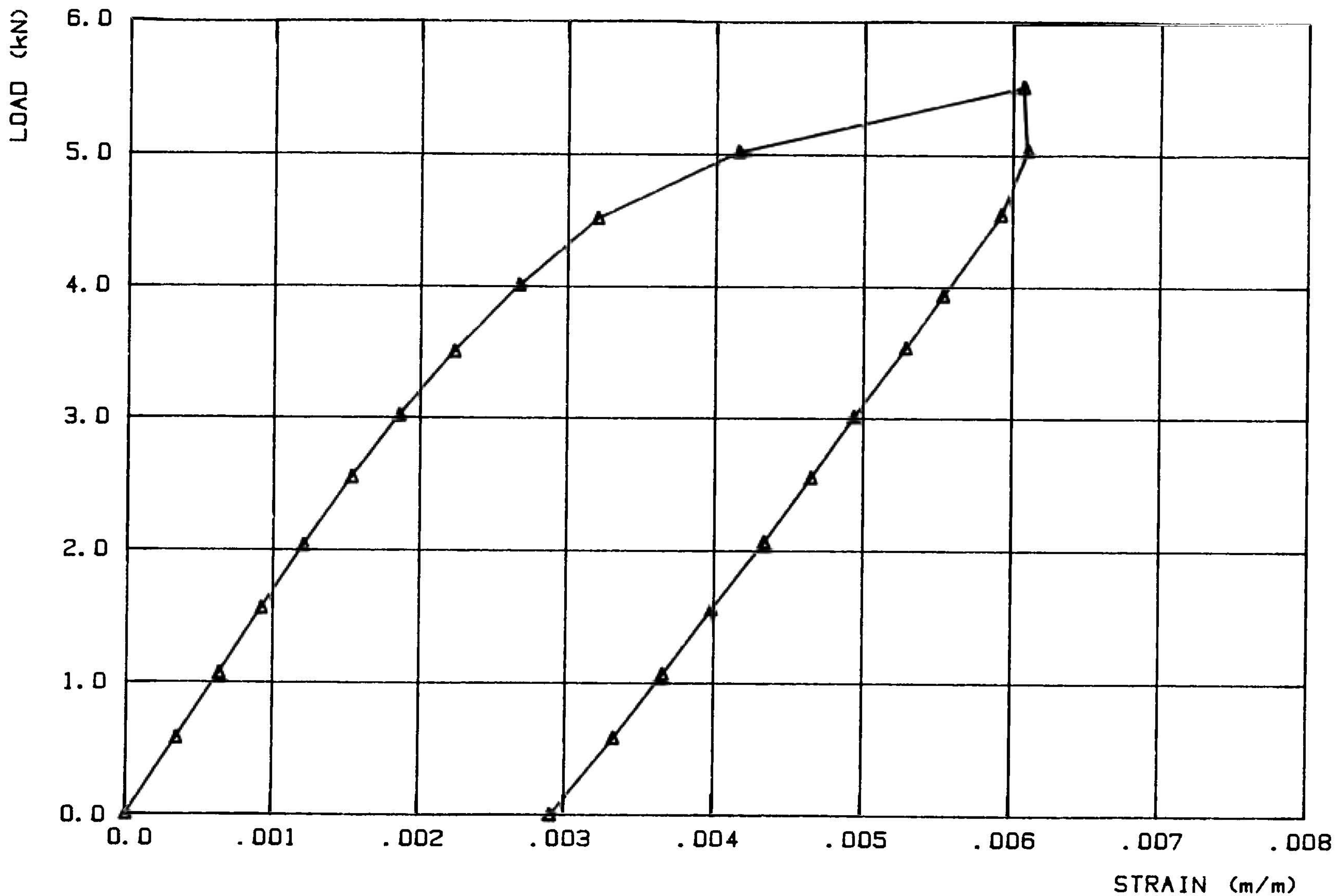
LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	1.916016E-03	0
1	.5767208	3.78563E-04
2	1.067221	6.778917E-04
3	1.557721	9.904262E-04
4	2.030977	1.272148E-03
5	2.546385	1.60229E-03
6	3.015809	1.914824E-03
7	3.502477	2.284583E-03
8	4.008305	2.707165E-03
9	4.514133	3.235393E-03
10	5.01613	4.01893E-03
11	5.510462	5.660837E-03
12	5.031458	5.541986E-03
13	4.542874	5.255862E-03
14	3.929749	4.846486E-03
15	3.531217	4.62199E-03
16	3.010061	4.278642E-03
17	2.546385	3.992519E-03
18	2.059717	3.706395E-03
19	1.553889	3.36745E-03
20	1.063389	3.028504E-03
21	.5786368	2.733577E-03
22	-1.916016E-03	2.315397E-03
23	0	2.302191E-03



STRAIN VERSUS LOAD

TEST 1: TOP AND BOTTOM LONGITUDINAL STRAIN. (ABSOLUTE VALUES)

GRAPH 1.6



STRAIN VERSUS LOAD

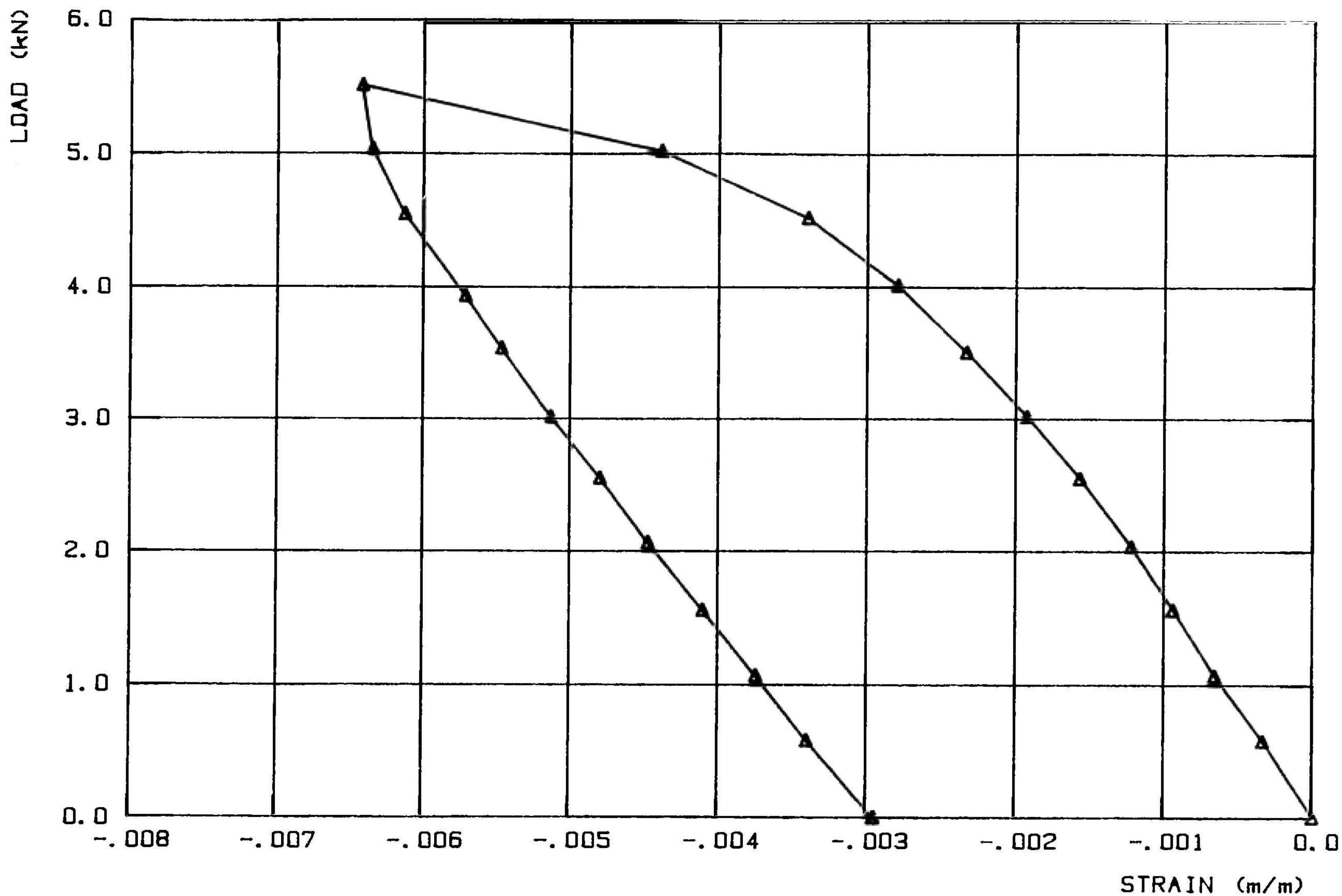
TEST 1: TOP TRANSVERSE STRAIN. DD1 POSITION 5.

GRAPH 1.7

TOP TRANSVERSE STRAIN. DD1 POSITION 5.

FILE :B:1PLATE5.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	1.916016E-03	3.527093E-06
1	.5767208	3.456548E-04
2	1.067221	6.366397E-04
3	1.557721	9.240975E-04
4	2.030977	1.209792E-03
5	2.546385	1.536048E-03
6	3.015809	1.858776E-03
7	3.502477	2.230884E-03
8	4.008305	2.675298E-03
9	4.514133	3.206125E-03
10	5.01613	4.153148E-03
11	5.510462	6.071885E-03
12	5.031458	6.101866E-03
13	4.542874	5.923748E-03
14	3.929749	5.537532E-03
15	3.531217	5.287108E-03
16	3.010061	4.937927E-03
17	2.546385	4.650468E-03
18	2.059717	4.334794E-03
19	1.553889	3.985612E-03
20	1.063389	3.659356E-03
21	.5786368	3.329573E-03
22	-1.916016E-03	2.906322E-03
23	0	2.904558E-03



STRAIN VERSUS LOAD

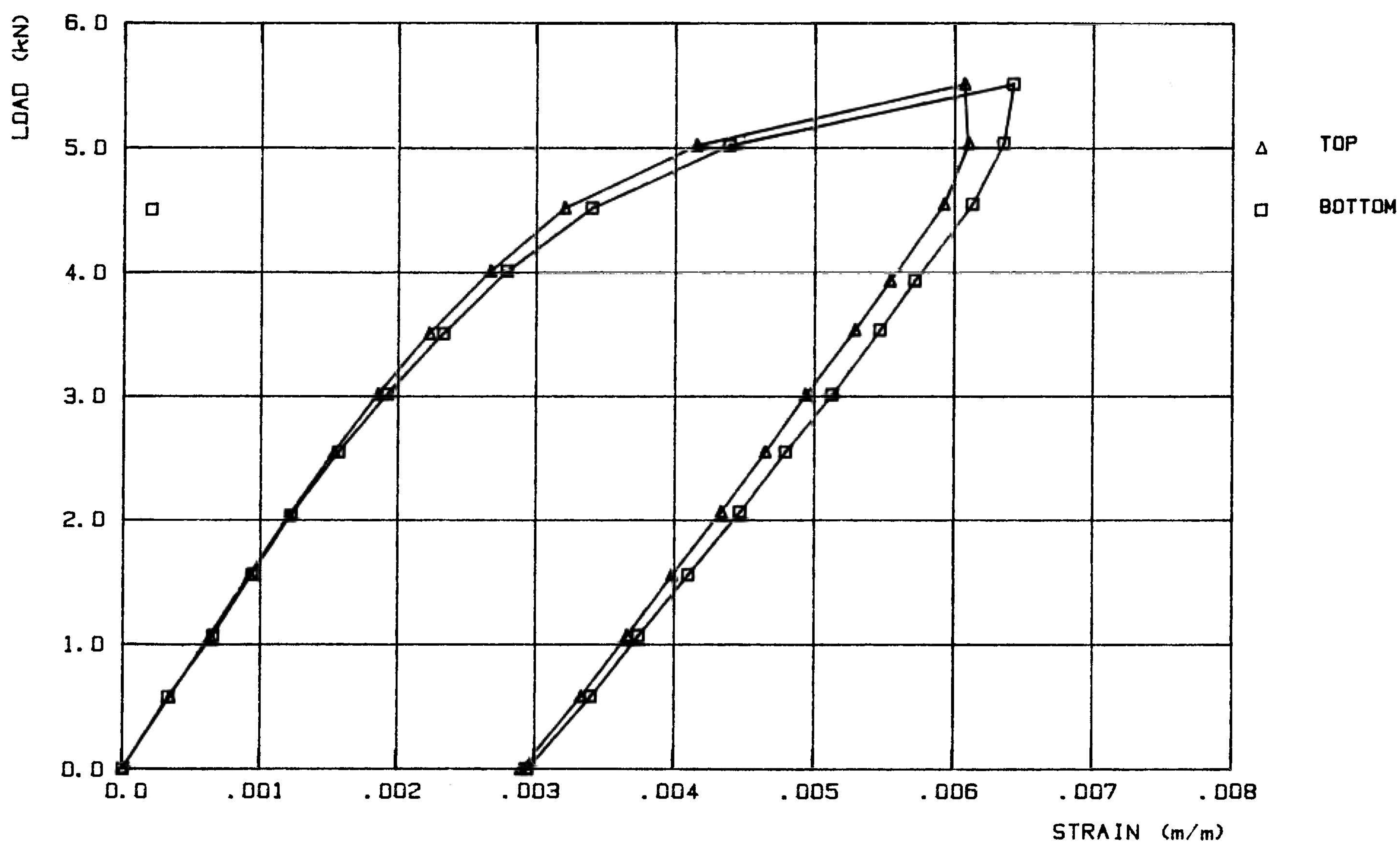
TEST 1: BOTTOM TRANSVERSE STRAIN. DD1 POSITION 7.

GRAPH 1.8

BOTTOM TRANSVERSE STRAIN. DD1 POSITION 7.

FILE :B:1PLATE7.DAT

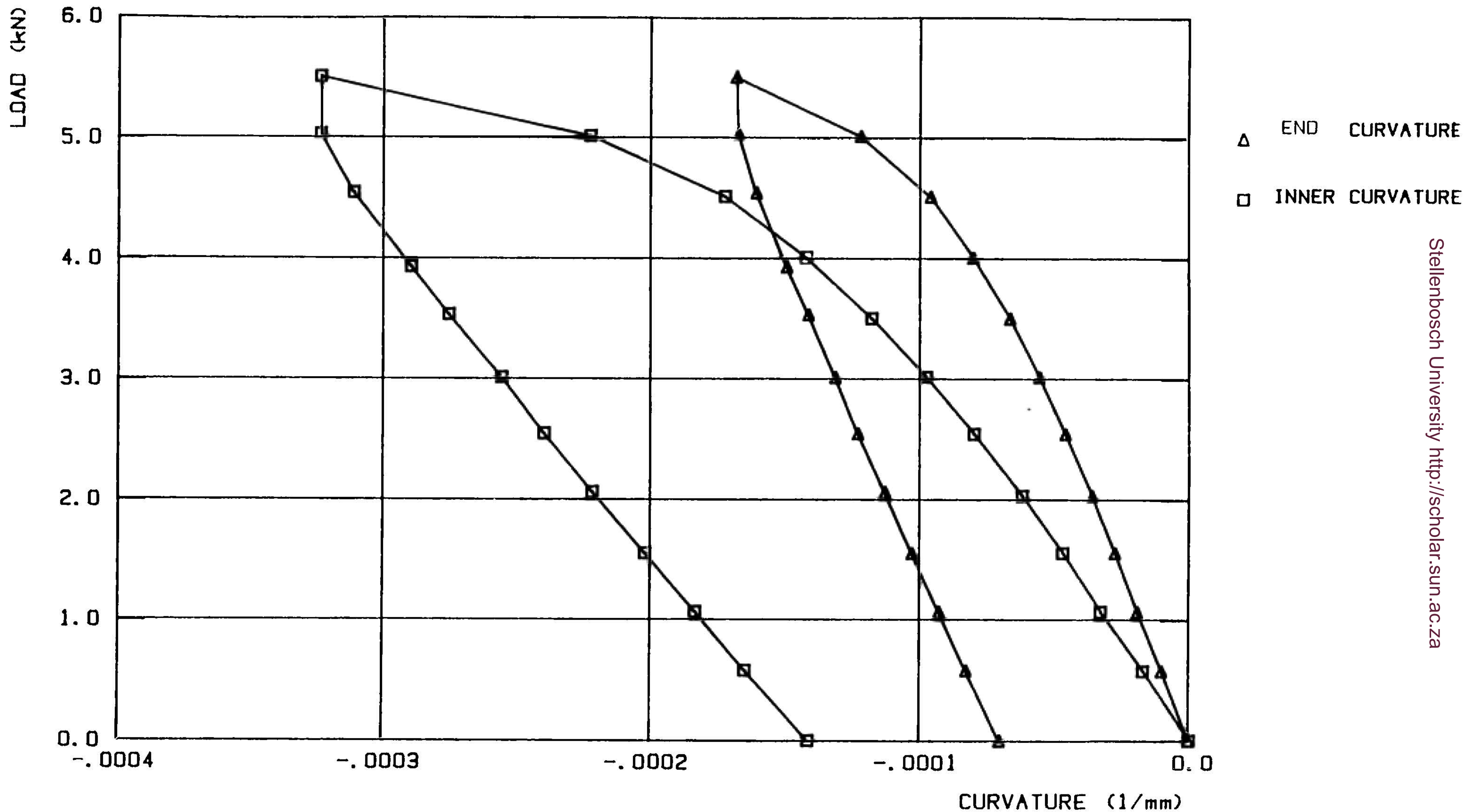
LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	1.916016E-03	3.725552E-06
1	.5767208	-3.315745E-04
2	1.067221	-6.55698E-04
3	1.557721	-9.388402E-04
4	2.030977	-1.221983E-03
5	2.546385	-1.568459E-03
6	3.015809	-1.926113E-03
7	3.502477	-2.332199E-03
8	4.008305	-2.794168E-03
9	4.514133	-3.401433E-03
10	5.01613	-4.388706E-03
11	5.510462	-6.42286E-03
12	5.031458	-6.352075E-03
13	4.542874	-6.128541E-03
14	3.929749	-5.715004E-03
15	3.531217	-5.465392E-03
16	3.010061	-5.126366E-03
17	2.546385	-4.794792E-03
18	2.059717	-4.470668E-03
19	1.553889	-4.101838E-03
20	1.063389	-3.744184E-03
21	.5786368	-3.401433E-03
22	-1.916016E-03	-2.950641E-03
23	0	-2.946915E-03



STRAIN VERSUS LOAD

TEST 1: TOP AND BOTTOM TRANSVERSE STRAIN. (ABSOLUTE VALUES)

GRAPH 1.9



CURVATURE VERSUS LOAD

TEST 1: TRANSVERSE CURVATURE. POSITIONS 8 AND 9.

GRAPH 1.10

INNER TRANSVERSE CURVATURE. POSITION 8.

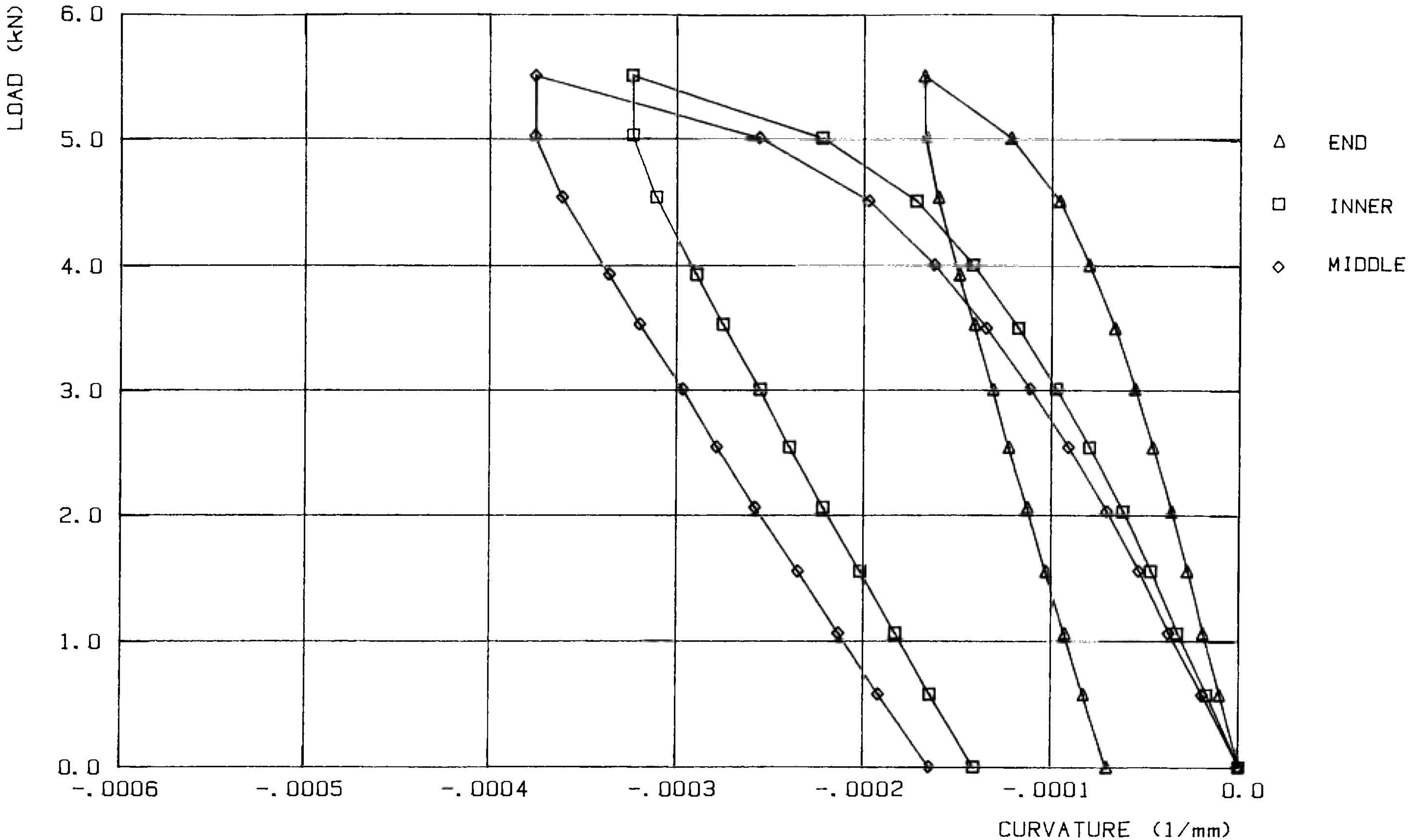
FILE :B:1PLATE8.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	1.916016E-03	1.675217E-07
1	.5767208	-1.703948E-05
2	1.067221	-3.274845E-05
3	1.557721	-4.695007E-05
4	2.030977	-6.199023E-05
5	2.546385	-7.987093E-05
6	3.015809	-9.775214E-05
7	3.502477	-1.179763E-04
8	4.008305	-1.422151E-04
9	4.514133	-1.723039E-04
10	5.01613	-2.224662E-04
11	5.510462	-3.236471E-04
12	5.031458	-3.236471E-04
13	4.542874	-3.11103E-04
14	3.929749	-2.893601E-04
15	3.531217	-2.751448E-04
16	3.010061	-2.552389E-04
17	2.546385	-2.395206E-04
18	2.059717	-2.21628E-04
19	1.553889	-2.018968E-04
20	1.063389	-1.831721E-04
21	.5786368	-1.647837E-04
22	-1.916016E-03	-1.41377E-04
23	0	-1.41377E-04

END TRANSVERSE CURVATURE. POSITION 9.

FILE :B:1PLATE9.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	1.916016E-03	0
1	.5767208	-1.004481E-05
2	1.067221	-1.908746E-05
3	1.557721	-2.7459E-05
4	2.030977	-3.599841E-05
5	2.546385	-4.604794E-05
6	3.015809	-5.575759E-05
7	3.502477	-6.664185E-05
8	4.008305	-8.037416E-05
9	4.514133	-9.628356E-05
10	5.01613	-1.222388E-04
11	5.510462	-1.682949E-04
12	5.031458	-1.674559E-04
13	4.542874	-1.607571E-04
14	3.929749	-1.495367E-04
15	3.531217	-1.415001E-04
16	3.010061	-1.314499E-04
17	2.546385	-1.230777E-04
18	2.059717	-1.130321E-04
19	1.553889	-1.02982E-04
20	1.063389	-9.293211E-05
21	.5786368	-8.288663E-05
22	-1.916016E-03	-7.03288E-05
23	0	-7.03288E-05



CURVATURE VERSUS LOAD

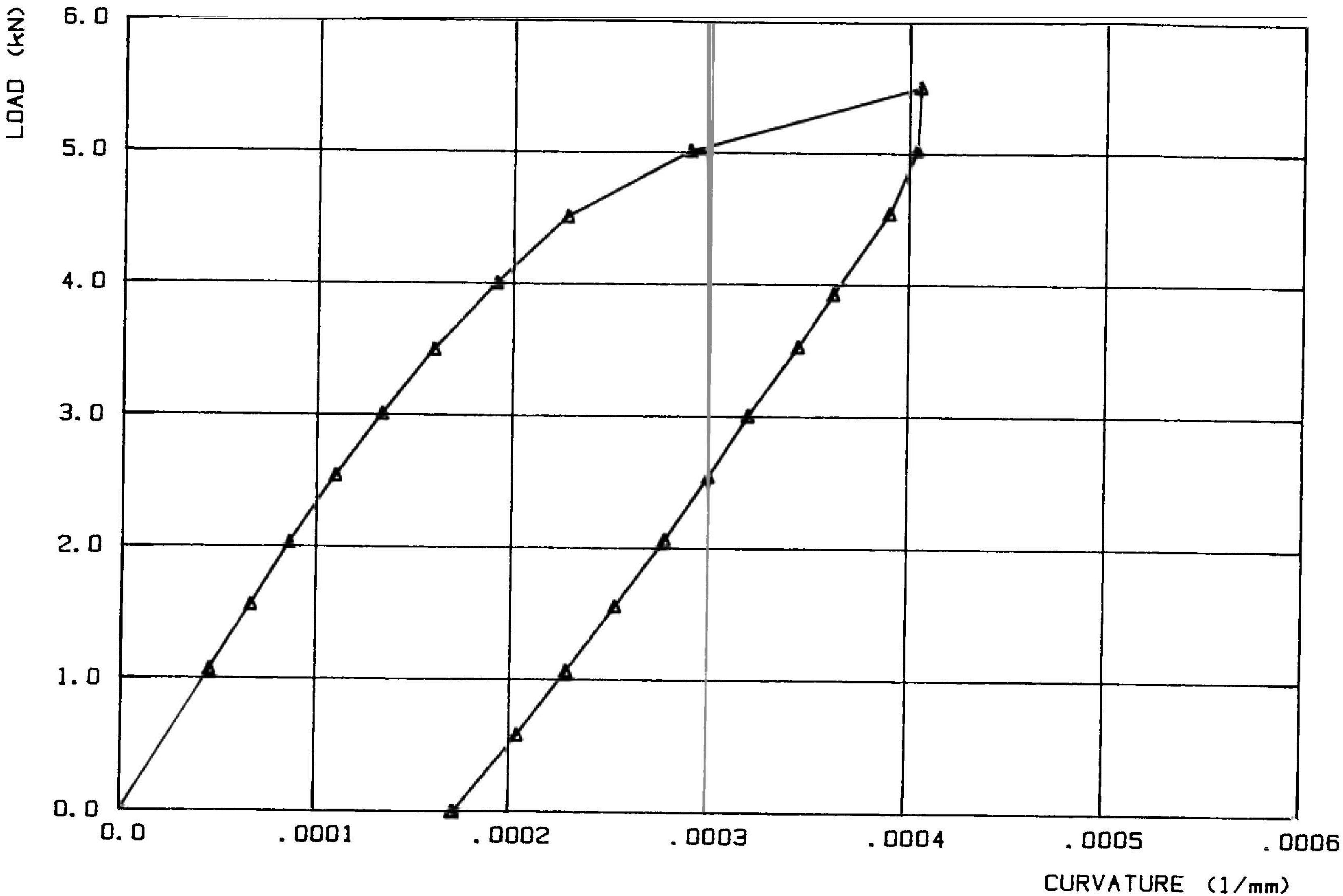
TEST 1: (MIDDLE CURVATURE CALCULATED BY EXTRAPOLATION)

GRAPH 1.11

MIDDLE TRANSVERSE CURVATURE.

FILE :B:1PLATE10.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	1.916016E-03	2.233623E-07
1	.5767208	-1.937104E-05
2	1.067221	-3.730212E-05
3	1.557721	-5.344709E-05
4	2.030977	-7.065418E-05
5	2.546385	-9.114528E-05
6	3.015809	-1.117503E-04
7	3.502477	-1.350878E-04
8	4.008305	-1.628287E-04
9	4.514133	-1.97644E-04
10	5.01613	-2.558754E-04
11	5.510462	-3.754311E-04
12	5.031458	-3.757108E-04
13	4.542874	-3.612183E-04
14	3.929749	-3.359679E-04
15	3.531217	-3.19693E-04
16	3.010061	-2.965019E-04
17	2.546385	-2.78335E-04
18	2.059717	-2.578267E-04
19	1.553889	-2.348684E-04
20	1.063389	-2.132521E-04
21	.5786368	-1.920828E-04
22	-1.916016E-03	-1.650597E-04
23	0	-1.650597E-04



CURVATURE VERSUS LOAD

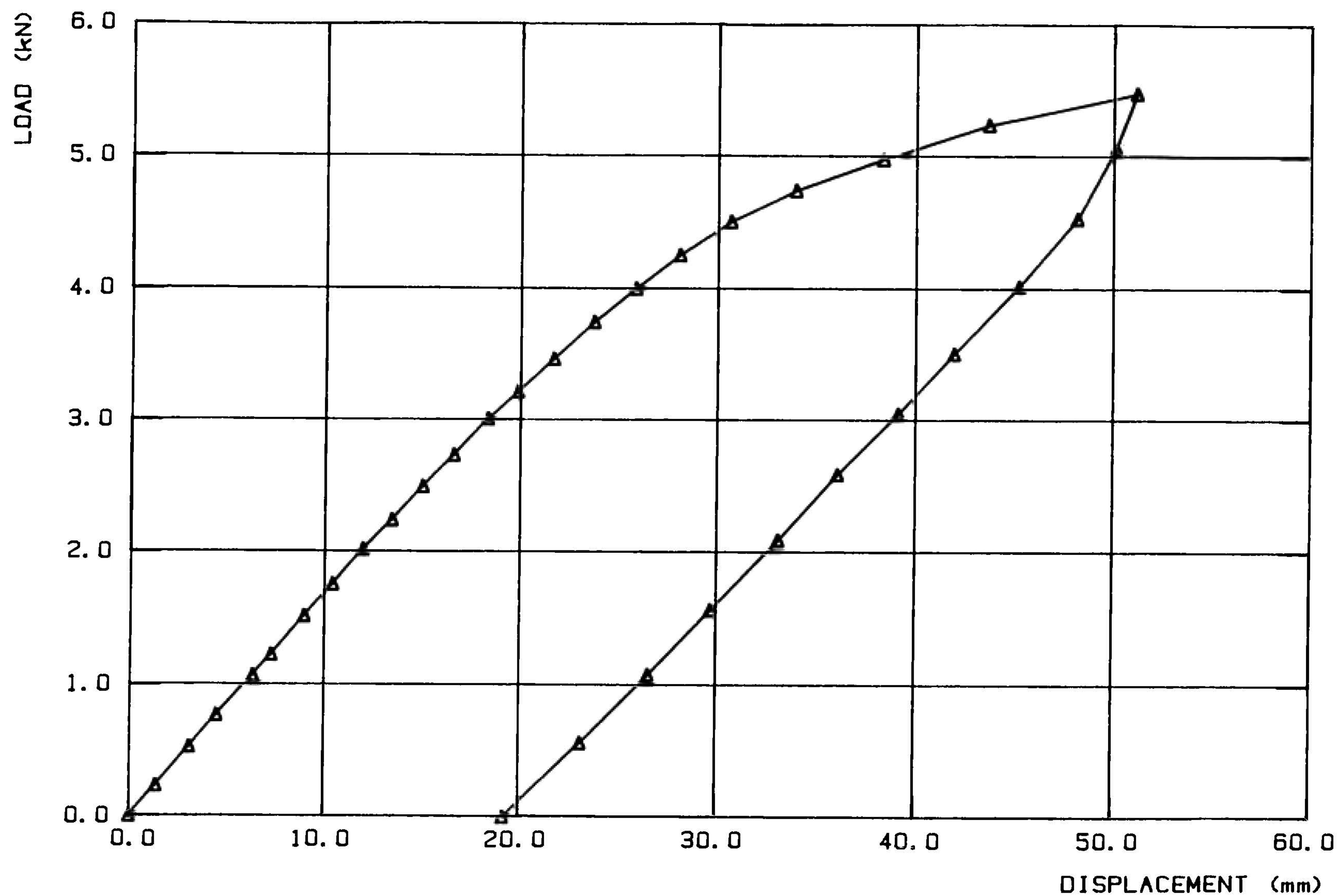
TEST 1: LONGITUDINAL CURVATURE.

GRAPH 1.12

LONGITUDINAL CURVATURE.

FILE :B:1PLATE11.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	1.916016E-03	7.666467E-20
1	.5767208	2.370055E-05
2	1.067221	4.552314E-05
3	1.557721	6.640589E-05
4	2.030977	8.611351E-05
5	2.546385	1.095725E-04
6	3.015809	1.332626E-04
7	3.502477	1.595267E-04
8	4.008305	1.914096E-04
9	4.514133	2.274982E-04
10	5.01613	2.895524E-04
11	5.510462	4.055014E-04
12	5.031458	4.03867E-04
13	4.542874	3.900899E-04
14	3.929749	3.62055E-04
15	3.531217	3.445247E-04
16	3.010061	3.195021E-04
17	2.546385	2.998495E-04
18	2.059717	2.778491E-04
19	1.553889	2.530296E-04
20	1.063389	2.286693E-04
21	.5786368	2.040663E-04
22	-1.916016E-03	1.717188E-04
23	0	1.710155E-04



DISPLACEMENT VERSUS LOAD

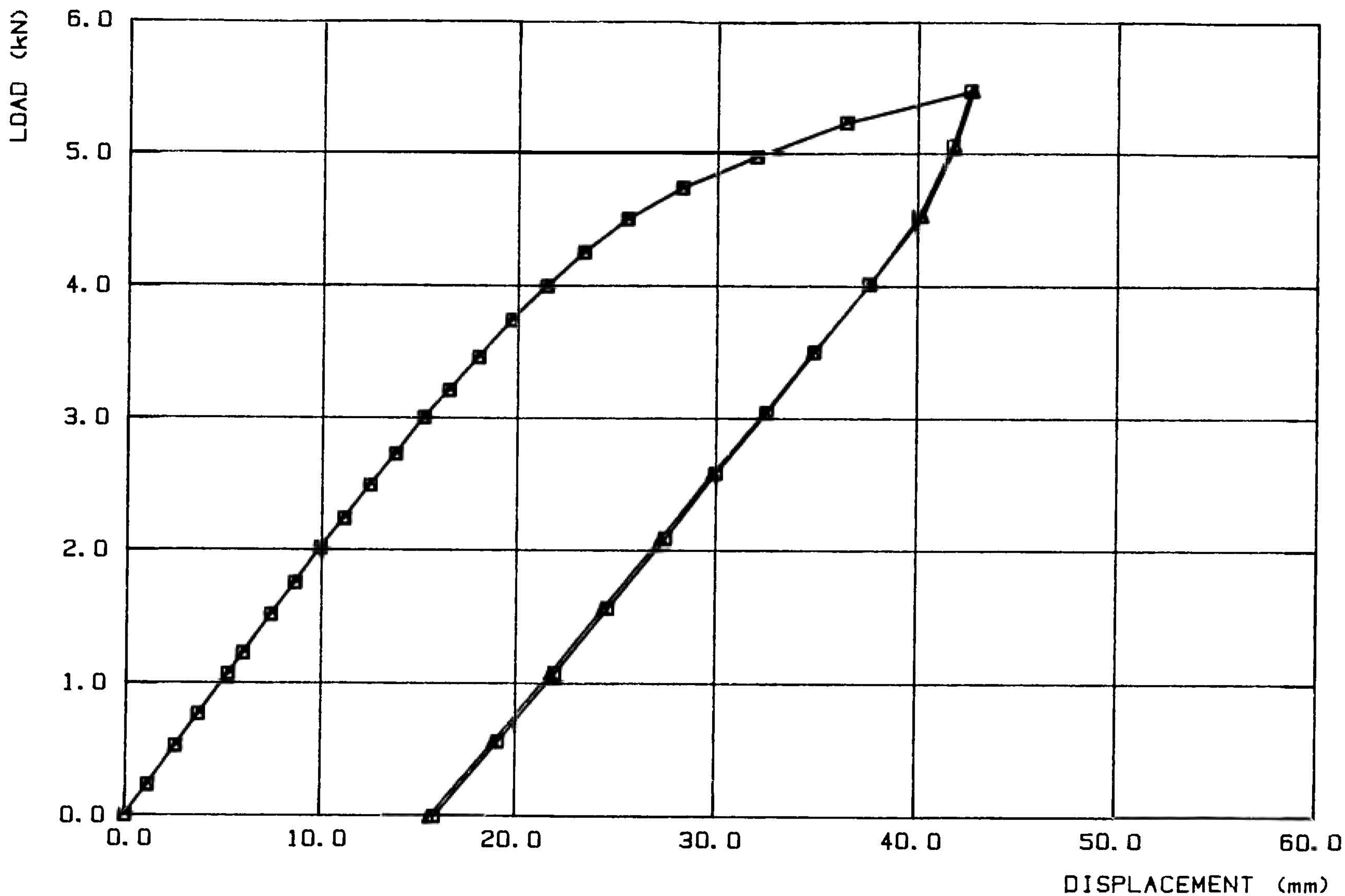
TEST 2: MIDDLE DISPLACEMENT. LVDT POSITION 1.

GRAPH 2.1

MIDDLE DISPLACEMENT. LVDT POSITION 1.

FILE :B:2PLATE1.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	-3.832032E-03	0
1	.2280059	1.367188
2	.5230724	3.076172
3	.7644905	4.453125
4	1.067221	6.298828
5	1.222418	7.226563
6	1.513653	8.935547
7	1.753155	10.39063
8	2.017565	11.94336
9	2.239823	13.42774
10	2.492737	14.99024
11	2.732239	16.57227
12	3.008145	18.31055
13	3.215075	19.84375
14	3.464157	21.64063
15	3.745811	23.69141
16	4.002557	25.80078
17	4.255471	28.02735
18	4.508385	30.61524
19	4.744056	33.88672
20	4.979726	38.28125
21	5.238388	43.62305
22	5.47789	51.12305
23	5.062114	50.04883
24	4.531378	48.11524
25	4.017885	45.16602
26	3.506309	41.89453
27	3.048381	39.07227
28	2.586622	36.03516
29	2.090373	33.05664
30	1.561553	29.66797
31	1.072969	26.52343
32	.5556446	23.0957
33	-7.664064E-03	19.18945



DISPLACEMENT VERSUS LOAD

TEST 2: END DISPLACEMENTS. LVDT POSITIONS 2 AND 3.

GRAPH 2.2

END DISPLACEMENT. LVDT POSITION 2.

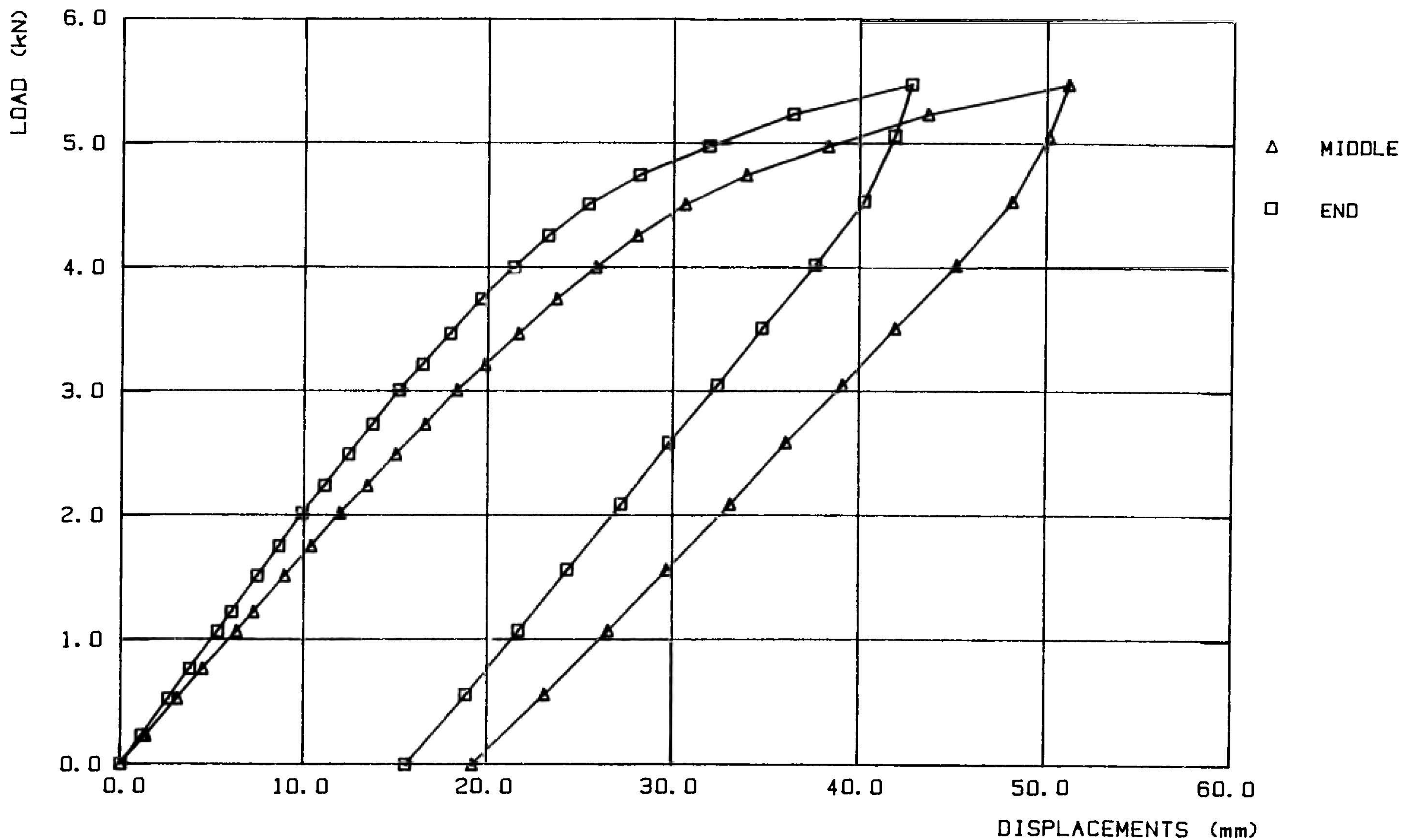
FILE :B:2PLATE2.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	-3.832032E-03	0
1	.2280059	1.152344
2	.5230724	2.587891
3	.7644905	3.75
4	1.067221	5.258789
5	1.222418	6.030274
6	1.513653	7.421875
7	1.753155	8.627931
8	2.017565	9.887696
9	2.239823	11.1084
10	2.492737	12.42188
11	2.732239	13.7207
12	3.008145	15.16113
13	3.215075	16.43555
14	3.464157	17.94434
15	3.745811	19.62891
16	4.002557	21.38672
17	4.255471	23.24219
18	4.508385	25.40527
19	4.744056	28.1543
20	4.979726	31.89942
21	5.238388	36.40137
22	5.47789	42.73926
23	5.062114	41.8457
24	4.531378	40.20996
25	4.017885	37.59766
26	3.506309	34.76563
27	3.048381	32.37305
28	2.586622	29.77539
29	2.090373	27.20215
30	1.561553	24.31641
31	1.072969	21.69434
32	.5556446	18.82324
33	-7.664064E-03	15.55176

END DISPLACEMENT. LVDT POSITION 3.

FILE :B:2PLATE3.DAT

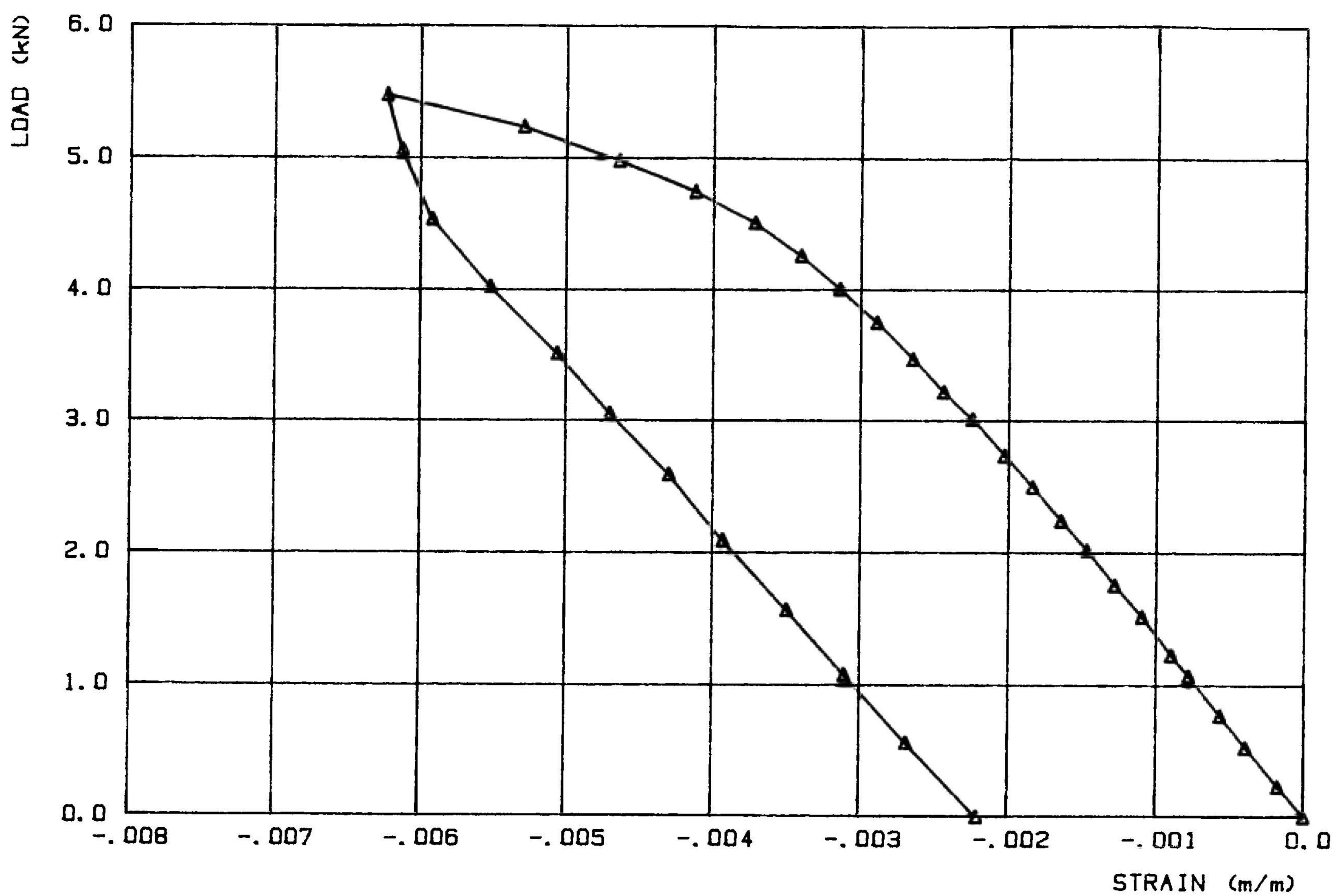
LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	-3.832032E-03	4.88472E-03
1	.2280059	1.162108
2	.5230724	2.573242
3	.7644905	3.720703
4	1.067221	5.229492
5	1.222418	5.991211
6	1.513653	7.402344
7	1.753155	8.62793
8	2.017565	9.912109
9	2.239823	11.12305
10	2.492737	12.43652
11	2.732239	13.74024
12	3.008145	15.1709
13	3.215075	16.4502
14	3.464157	17.9541
15	3.745811	19.66309
16	4.002557	21.4209
17	4.255471	23.2959
18	4.508385	25.46875
19	4.744056	28.22754
20	4.979726	31.94336
21	5.238388	36.41113
22	5.47789	42.61231
23	5.062114	41.70899
24	4.531378	40.04883
25	4.017885	37.58301
26	3.506309	34.84863
27	3.048381	32.48535
28	2.586622	29.94141
29	2.090373	27.42676
30	1.561553	24.56543
31	1.072969	21.9336
32	.5556446	19.05762
33	-7.664064E-03	15.80566



DISPLACEMENT VERSUS LOAD

TEST 2: DISPLACEMENTS. LVDT POSITIONS 1, 2 AND 3.

GRAPH 2.3



STRAIN VERSUS LOAD

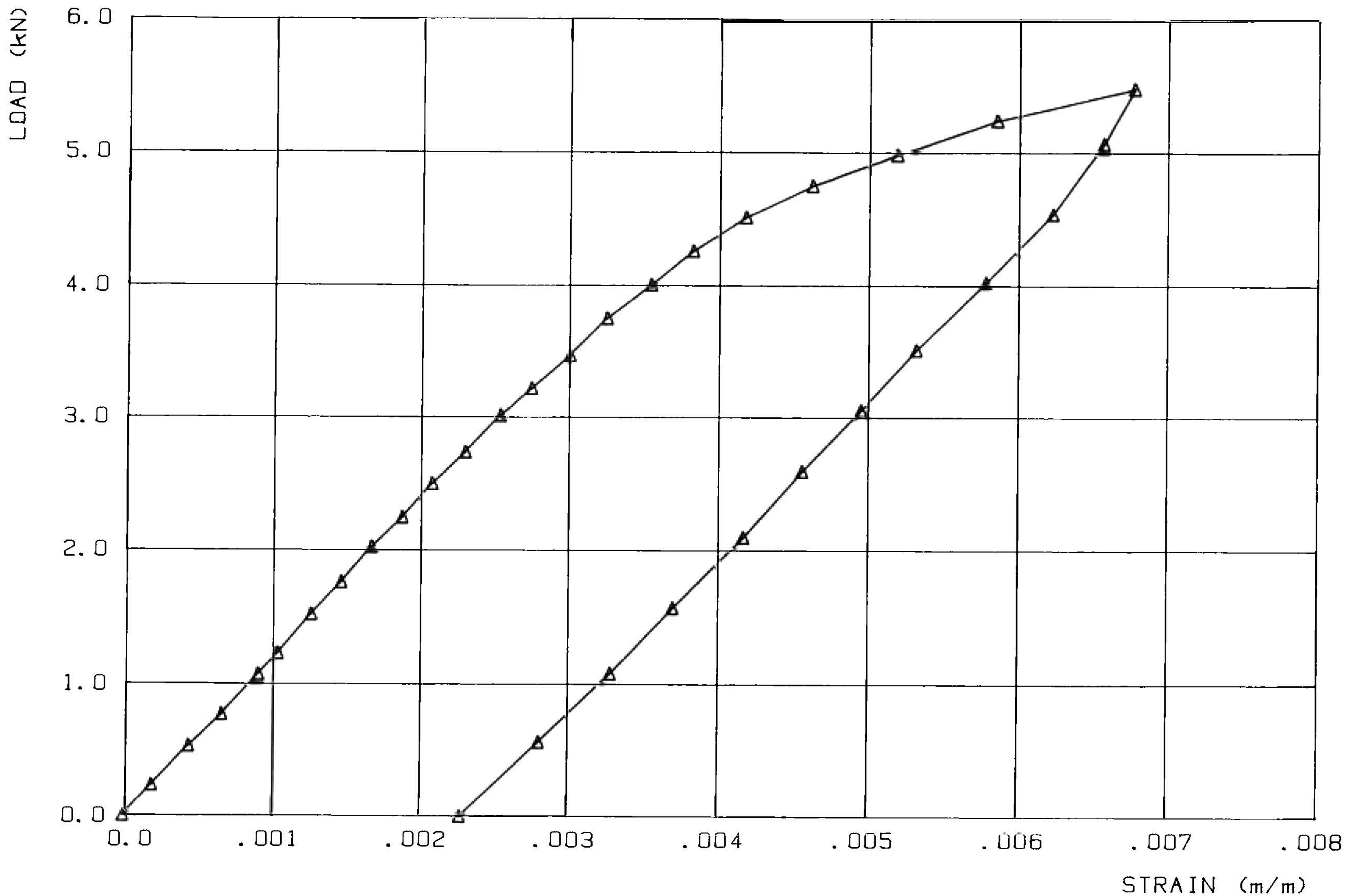
TEST 2: TOP LONGITUDINAL STRAIN. DD1 POSITION 4.

GRAPH 2.4

TOP LONGITUDINAL STRAIN. DD1 POSITION 4.

FILE :B:2PLATE4.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-3.832032E-03	0
1	.2280059	-1.76747E-04
2	.5230724	-3.934725E-04
3	.7644905	-5.660112E-04
4	1.067221	-7.827367E-04
5	1.222418	-9.00568E-04
6	1.513653	-1.098356E-03
7	1.753155	-1.285624E-03
8	2.017565	-1.474996E-03
9	2.239823	-1.649639E-03
10	2.492737	-1.841115E-03
11	2.732239	-2.032591E-03
12	3.008145	-2.249316E-03
13	3.215075	-.002445
14	3.464157	-2.651205E-03
15	3.745811	-2.895284E-03
16	4.002557	-3.145676E-03
17	4.255471	-3.410796E-03
18	4.508385	-3.722208E-03
19	4.744056	-4.126201E-03
20	4.979726	-4.641713E-03
21	5.238388	-5.293993E-03
22	5.47789	-6.236644E-03
23	5.062114	-6.131438E-03
24	4.531378	-5.923128E-03
25	4.017885	-5.52124E-03
26	3.506309	-5.058331E-03
27	3.048381	-4.698525E-03
28	2.586622	-4.296636E-03
29	2.090373	-3.930517E-03
30	1.561553	-3.497066E-03
31	1.072969	-3.105697E-03
32	.5556446	-2.686975E-03
33	-7.664064E-03	-2.209338E-03



STRAIN VERSUS LOAD

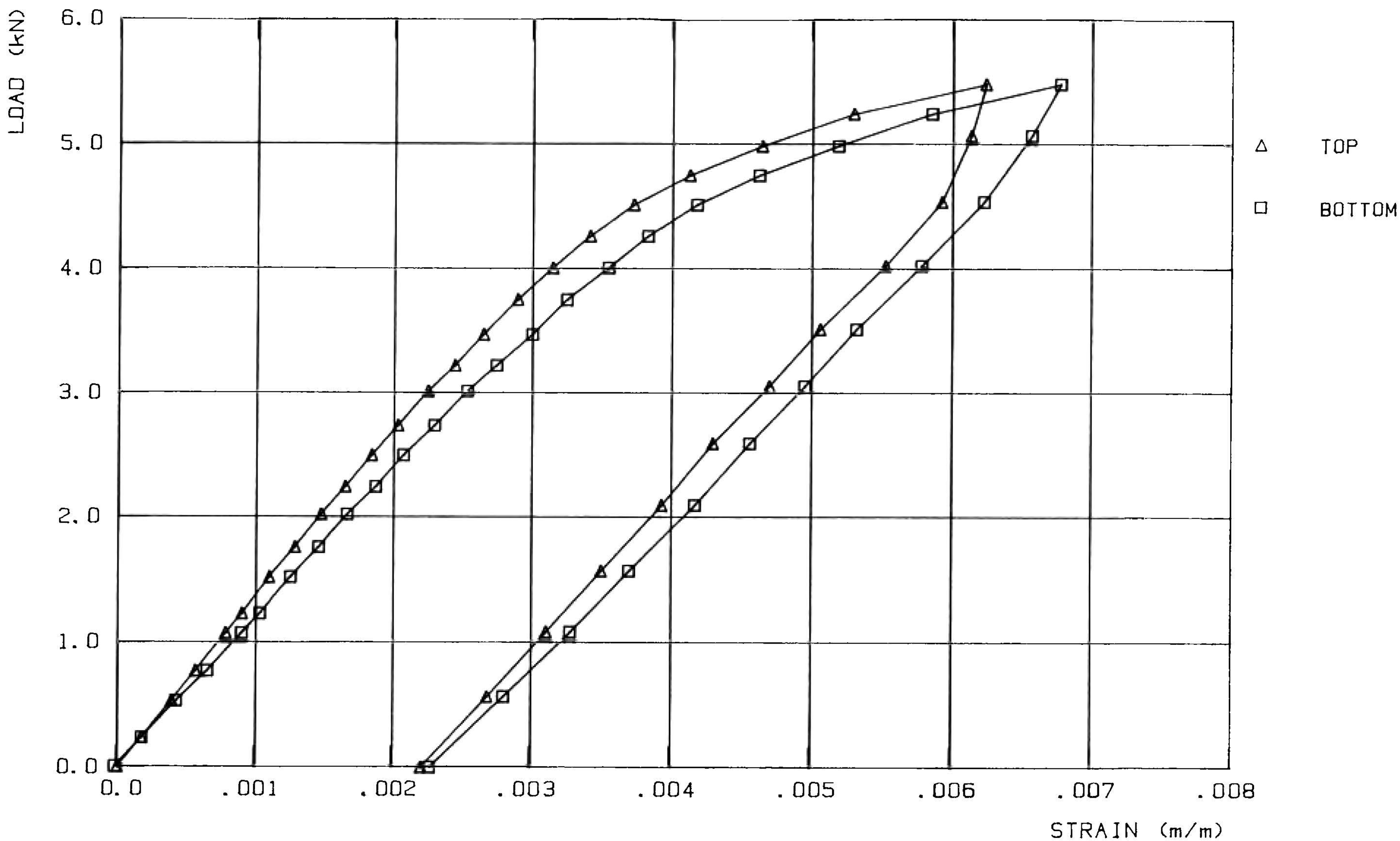
TEST 2: BOTTOM LONDITUDINAL STRAIN. DD1 POSITION 6

GRAPH 2.5

BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 6.

FILE :B:2PLATE6.DAT

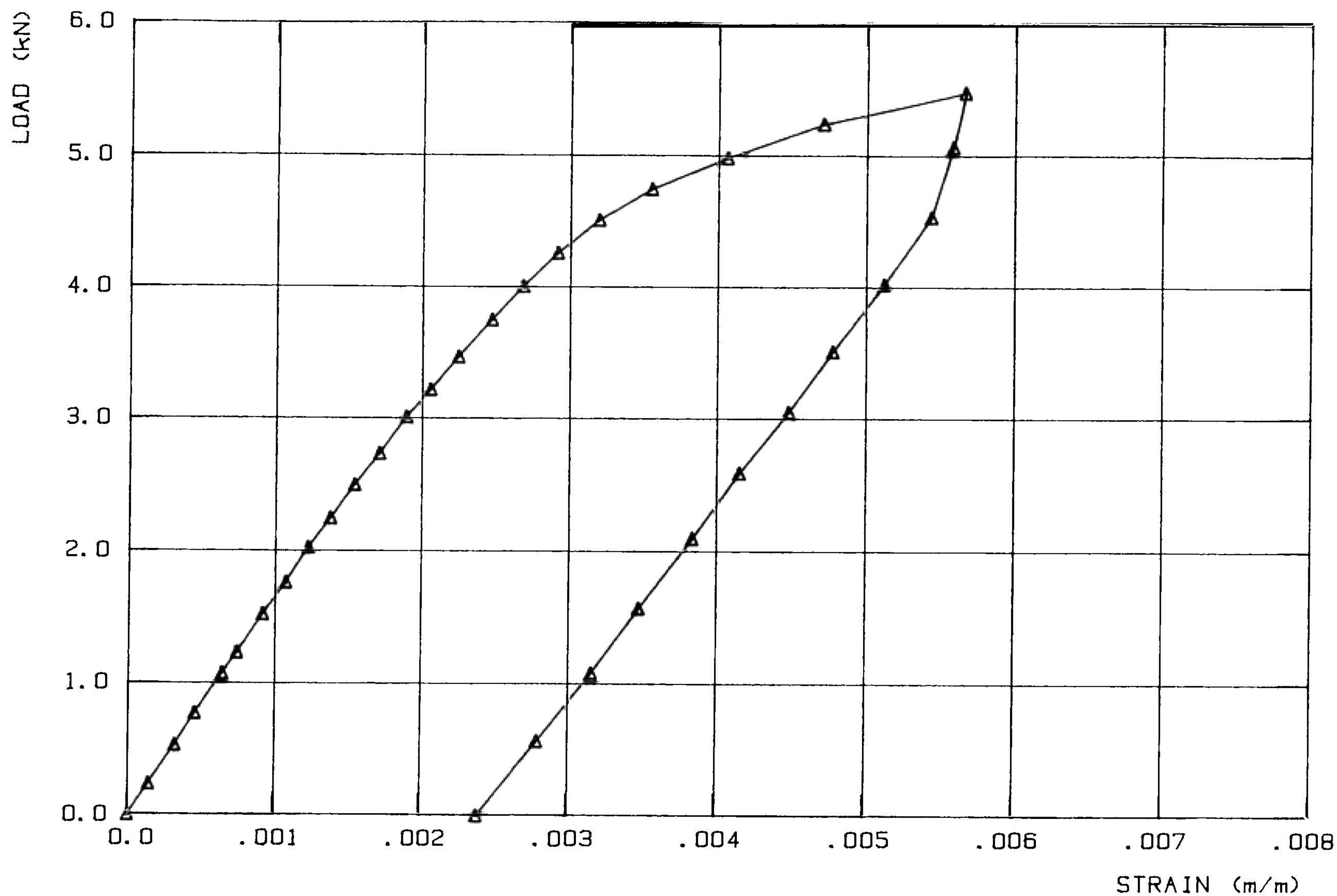
LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-3.832032E-03	-1.760758E-05
1	.2280059	1.760758E-04
2	.5230724	4.269838E-04
3	.7644905	6.514805E-04
4	1.067221	8.979866E-04
5	1.222418	1.030043E-03
6	1.513653	1.25454E-03
7	1.753155	1.457027E-03
8	2.017565	1.663916E-03
9	2.239823	1.870805E-03
10	2.492737	2.073292E-03
11	2.732239	2.297789E-03
12	3.008145	2.535492E-03
13	3.215075	2.746782E-03
14	3.464157	3.002092E-03
15	3.745811	3.248598E-03
16	4.002557	3.543526E-03
17	4.255471	3.825246E-03
18	4.508385	4.177398E-03
19	4.744056	4.62199E-03
20	4.979726	5.185432E-03
21	5.238388	5.850118E-03
22	5.47789	6.770115E-03
23	5.062114	6.563225E-03
24	4.531378	6.224279E-03
25	4.017885	5.779688E-03
26	3.506309	5.317489E-03
27	3.048381	4.952132E-03
28	2.586622	4.560363E-03
29	2.090373	4.168594E-03
30	1.561553	3.697592E-03
31	1.072969	3.279412E-03
32	.5556446	2.804007E-03
33	-7.664064E-03	2.271378E-03



STRAIN VERSUS LOAD

TEST 2: TOP AND BOTTOM LONGITUDINAL STRAIN. (ABSOLUTE VALUES)

GRAPH 2.6



STRAIN VERSUS LOAD

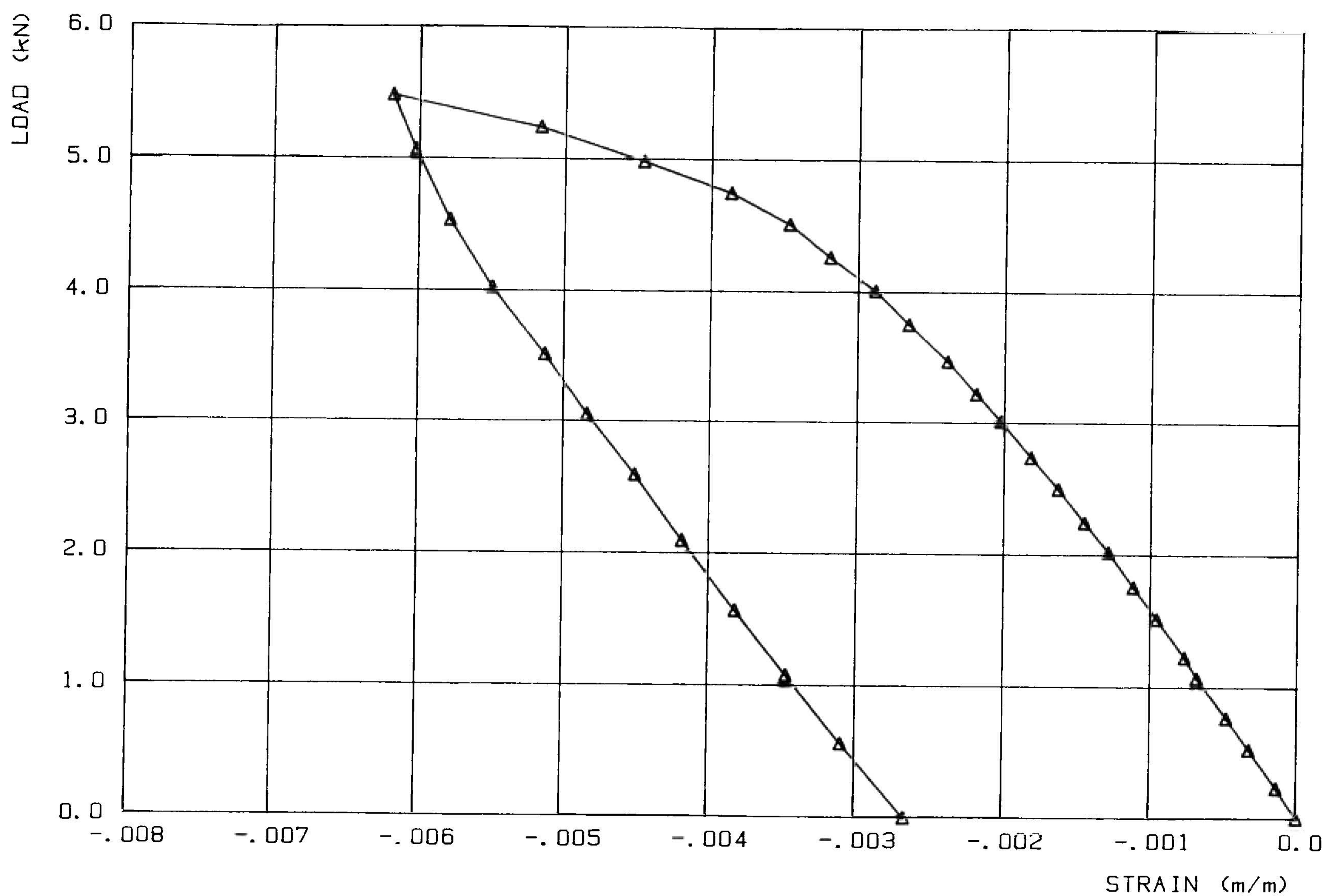
TEST 2: TOP TRANSVERSE STRAIN. DD1 POSITION 5.

GRAPH 2.7

TOP TRANSVERSE STRAIN. DD1 POSITION 5.

FILE :B:2PLATE5.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-3.832032E-03	1.763546E-06
1	.2280059	1.428472E-04
2	.5230724	3.209652E-04
3	.7644905	4.567582E-04
4	1.067221	6.401669E-04
5	1.222418	7.40689E-04
6	1.513653	9.135163E-04
7	1.753155	1.072235E-03
8	2.017565	1.225664E-03
9	2.239823	1.377329E-03
10	2.492737	1.541338E-03
11	2.732239	1.710639E-03
12	3.008145	1.894047E-03
13	3.215075	2.05982E-03
14	3.464157	2.24852E-03
15	3.745811	2.476017E-03
16	4.002557	2.69117E-03
17	4.255471	2.922194E-03
18	4.508385	3.200834E-03
19	4.744056	3.555307E-03
20	4.979726	4.063208E-03
21	5.238388	4.712193E-03
22	5.47789	5.662743E-03
23	5.062114	5.58162E-03
24	4.531378	5.43701E-03
25	4.017885	5.121335E-03
26	3.506309	4.779207E-03
27	3.048381	4.484695E-03
28	2.586622	4.154912E-03
29	2.090373	3.839238E-03
30	1.561553	3.479474E-03
31	1.072969	3.160273E-03
32	.5556446	2.796982E-03
33	-7.664064E-03	2.389603E-03



STRAIN VERSUS LOAD

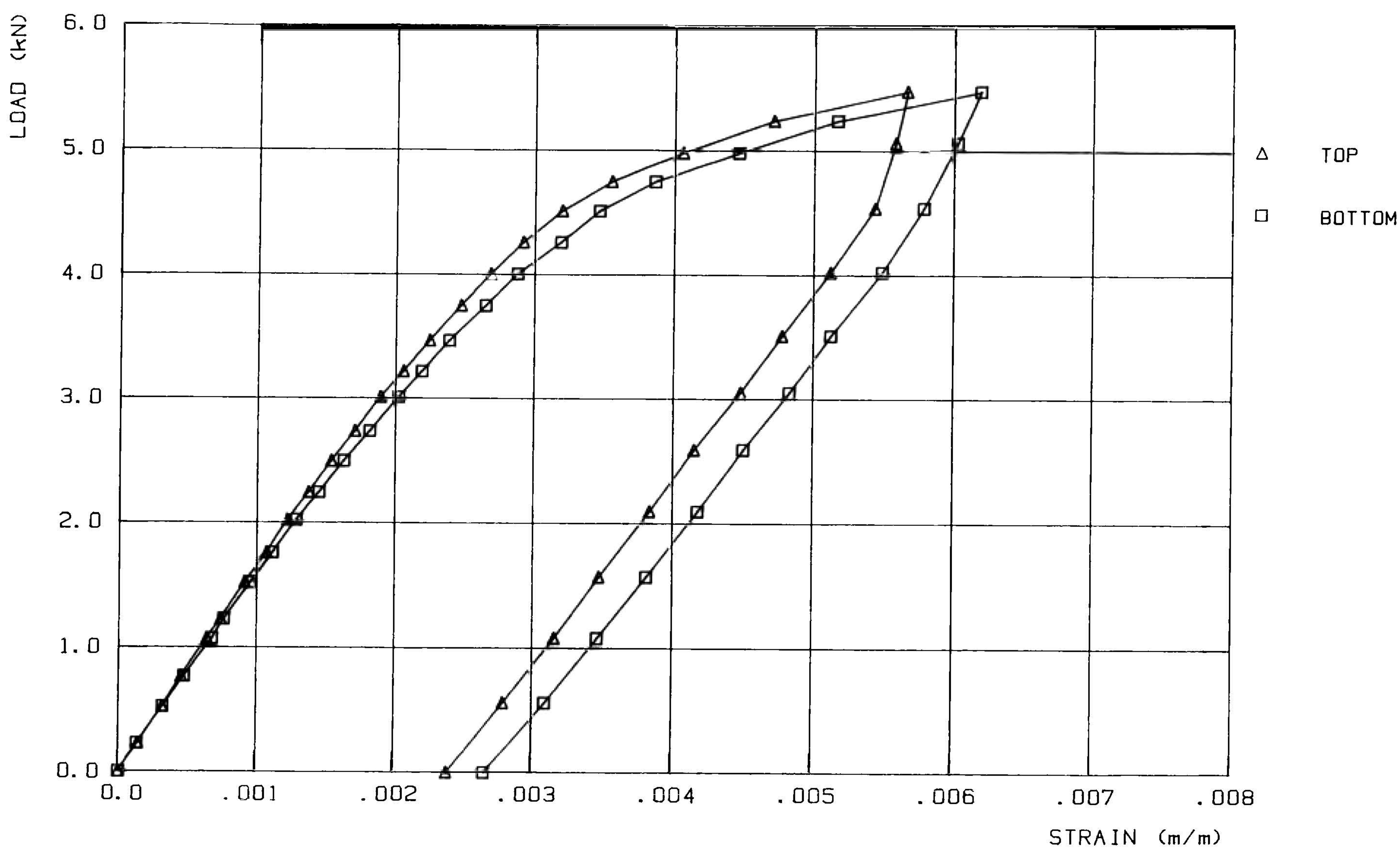
TEST 2: BOTTOM TRANSVERSE STRAIN. DD1 POSITION 7.

GRAPH 2.8

BOTTOM TRANSVERSE STRAIN. DD1 POSITION 7.

FILE :B:2PLATE7.DAT

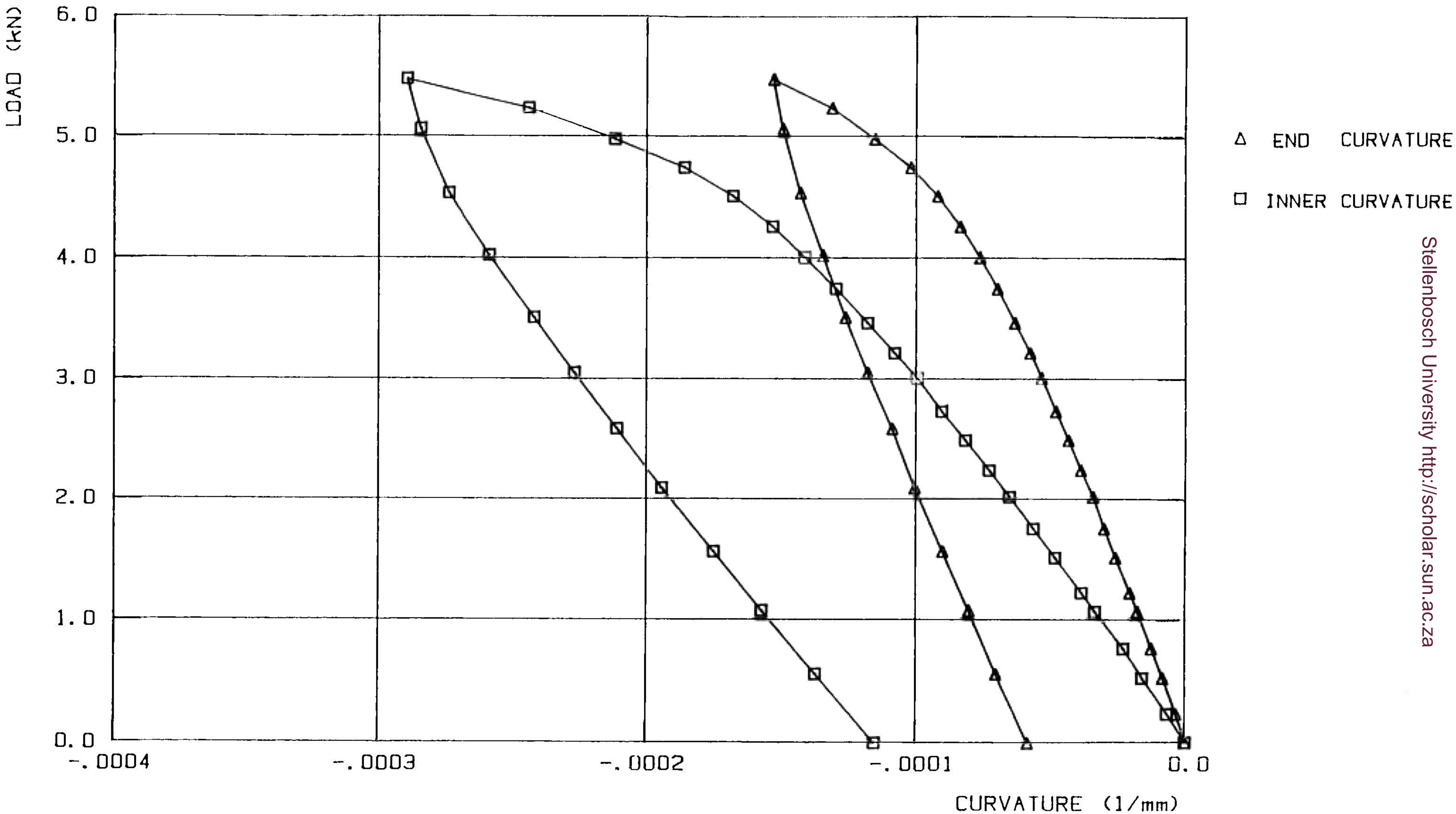
LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-3.832032E-03	3.725557E-06
1	.2280059	-1.378456E-04
2	.5230724	-3.241234E-04
3	.7644905	-4.768712E-04
4	1.067221	-6.780513E-04
5	1.222418	-7.637391E-04
6	1.513653	-9.574681E-04
7	1.753155	-1.117667E-03
8	2.017565	-1.289042E-03
9	2.239823	-1.452967E-03
10	2.492737	-1.631794E-03
11	2.732239	-1.818072E-03
12	3.008145	-2.026703E-03
13	3.215075	-2.194353E-03
14	3.464157	-2.391807E-03
15	3.745811	-2.656322E-03
16	4.002557	-2.883581E-03
17	4.255471	-3.192802E-03
18	4.508385	-3.468493E-03
19	4.744056	-3.867128E-03
20	4.979726	-4.463217E-03
21	5.238388	-5.167347E-03
22	5.47789	-6.18815E-03
23	5.062114	-6.024225E-03
24	4.531378	-5.78579E-03
25	4.017885	-5.49147E-03
26	3.506309	-5.126366E-03
27	3.048381	-4.835773E-03
28	2.586622	-4.507924E-03
29	2.090373	-.0041838
30	1.561553	-3.818696E-03
31	1.072969	-3.468493E-03
32	.5556446	-3.095938E-03
33	-7.664064E-03	-2.663773E-03



STRAIN VERSUS LOAD

TEST 2: TOP AND BOTTOM TRANSVERSE STRAIN. (ABSOLUTE VALUES)

GRAPH 2.9



CURVATURE VERSUS LOAD

TEST 2: TRANSVERSE CURVATURE. POSITIONS 8 AND 9.

GRAPH 2.10

INNER TRANSVERSE CURVATURE. POSITION 8.

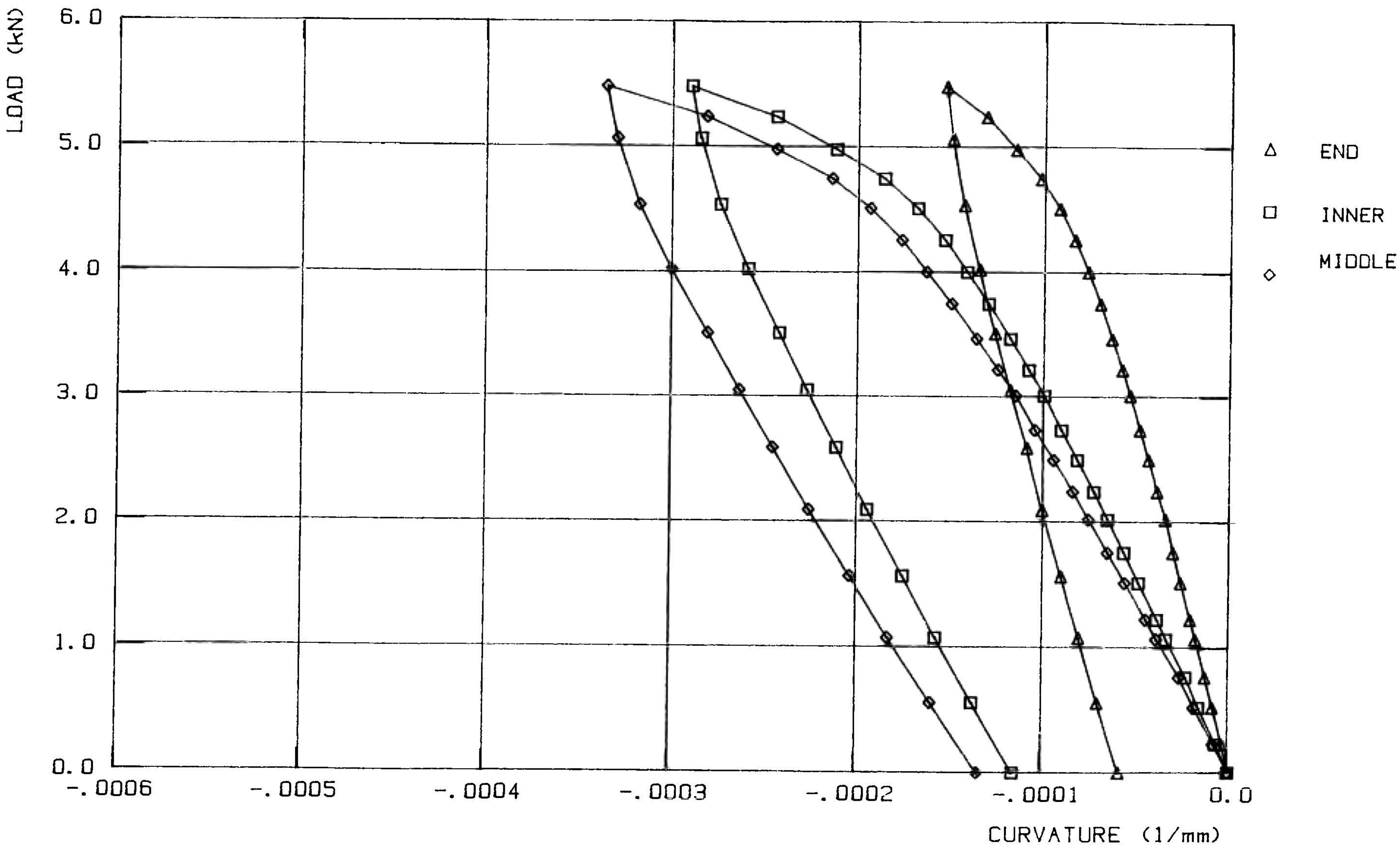
FILE :B:2PLATE8.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	-3.832032E-03	0
1	.2280059	-6.698943E-06
2	.5230724	-1.591054E-05
3	.7644905	-2.29451E-05
4	1.067221	-3.349472E-05
5	1.222418	-3.852003E-05
6	1.513653	-4.840284E-05
7	1.753155	-5.64398E-05
8	2.017565	-6.531577E-05
9	2.239823	-7.285371E-05
10	2.492737	-8.172967E-05
11	2.732239	-9.043779E-05
12	3.008145	-9.964932E-05
13	3.215075	-1.080218E-04
14	3.464157	-1.180723E-04
15	3.745811	-1.297964E-04
16	4.002557	-1.415204E-04
17	4.255471	-1.534078E-04
18	4.508385	-1.681477E-04
19	4.744056	-1.860669E-04
20	4.979726	-2.118546E-04
21	5.238388	-2.440093E-04
22	5.47789	-2.897233E-04
23	5.062114	-2.845307E-04
24	4.531378	-2.738143E-04
25	4.017885	-2.587441E-04
26	3.506309	-2.420002E-04
27	3.048381	-2.269253E-04
28	2.586622	-2.110201E-04
29	2.090373	-1.942713E-04
30	1.561553	-1.750142E-04
31	1.072969	-1.572628E-04
32	.5556446	-1.373298E-04
33	-7.664064E-03	-1.153919E-04

END TRANSVERSE CURVATURE. POSITION 9.

FILE :B:2PLATE9.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	-3.832032E-03	0
1	.2280059	-3.345078E-06
2	.5230724	-8.36287E-06
3	.7644905	-1.254649E-05
4	1.067221	-1.773622E-05
5	1.222418	-2.057827E-05
6	1.513653	-2.593116E-05
7	1.753155	-3.011467E-05
8	2.017565	-3.429811E-05
9	2.239823	-3.881689E-05
10	2.492737	-4.349888E-05
11	2.732239	-4.818524E-05
12	3.008145	-5.35379E-05
13	3.215075	-5.78888E-05
14	3.464157	-6.357675E-05
15	3.745811	-6.993092E-05
16	4.002557	-7.645705E-05
17	4.255471	-8.364936E-05
18	4.508385	-9.201525E-05
19	4.744056	-1.020488E-04
20	4.979726	-1.15431E-04
21	5.238388	-1.313188E-04
22	5.47789	-1.530604E-04
23	5.062114	-1.495488E-04
24	4.531378	-1.43028E-04
25	4.017885	-1.34663E-04
26	3.506309	-1.263024E-04
27	3.048381	-1.179415E-04
28	2.586622	-1.087422E-04
29	2.090373	-1.003766E-04
30	1.561553	-9.000767E-05
31	1.072969	-8.030475E-05
32	.5556446	-7.026625E-05
33	-7.664064E-03	-5.85551E-05



CURVATURE VERSUS LOAD

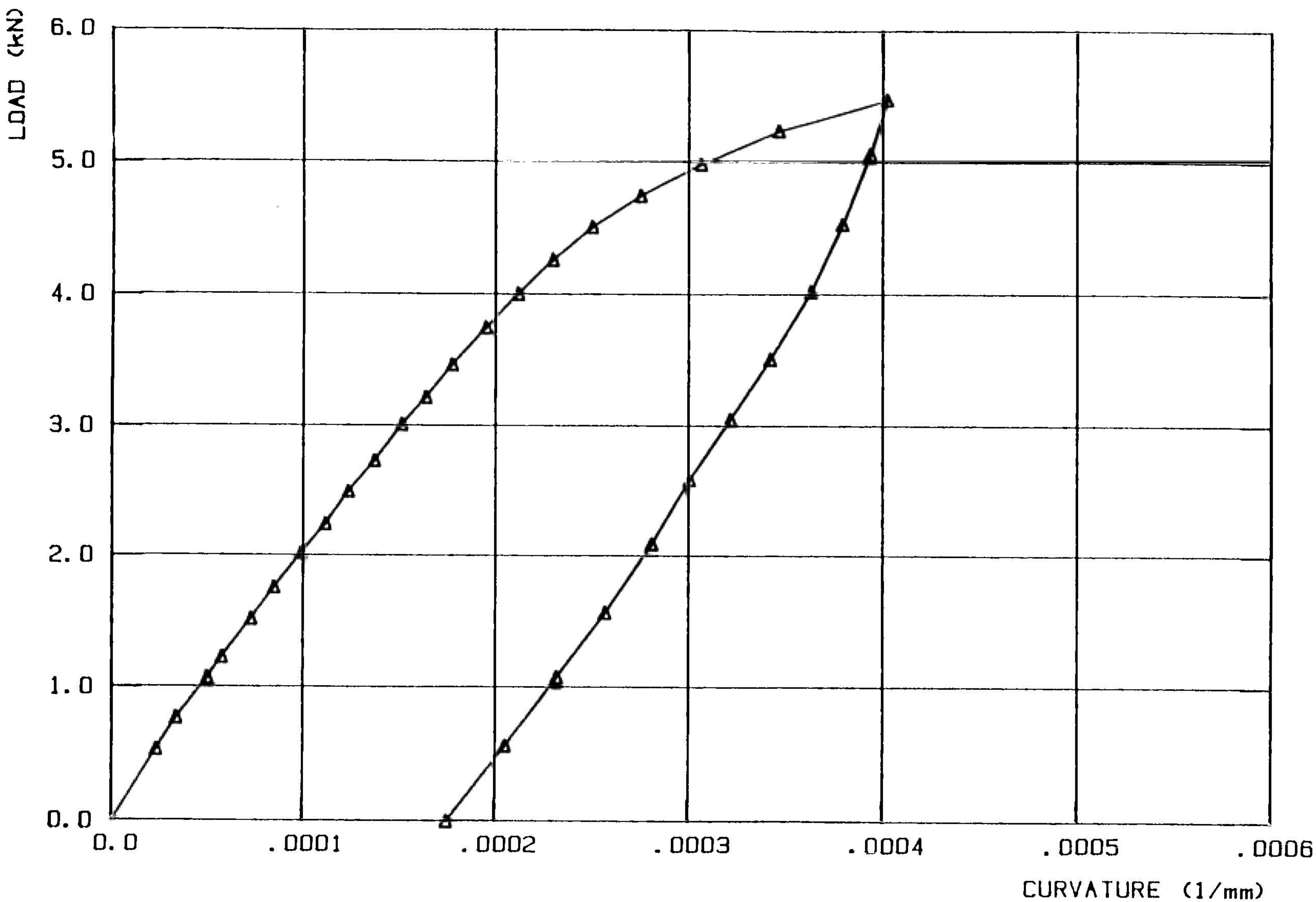
TEST 2: TRANSVERSE CURVATURE. (MIDDLE CURVATURE CALCULATED BY EXTRAPOLATION)

GRAPH 2.11

MIDDLE TRANSVERSE CURVATURE.

FILE :B:2PLATE10.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	-3.832032E-03	0
1	.2280059	-7.816899E-06
2	.5230724	-1.842643E-05
3	.7644905	-2.641131E-05
4	1.067221	-3.874757E-05
5	1.222418	-4.450062E-05
6	1.513653	-5.58934E-05
7	1.753155	-6.521485E-05
8	2.017565	-7.5655E-05
9	2.239823	-8.41993E-05
10	2.492737	-9.447326E-05
11	2.732239	-1.04522E-04
12	3.008145	-1.150198E-04
13	3.215075	-1.247328E-04
14	3.464157	-1.362375E-04
15	3.745811	-1.497516E-04
16	4.002557	-1.632082E-04
17	4.255471	-1.766606E-04
18	4.508385	-1.935252E-04
19	4.744056	-2.140729E-04
20	4.979726	-2.439958E-04
21	5.238388	-2.815729E-04
22	5.47789	-3.352776E-04
23	5.062114	-3.295247E-04
24	4.531378	-3.174098E-04
25	4.017885	-3.001045E-04
26	3.506309	-2.805661E-04
27	3.048381	-2.632532E-04
28	2.586622	-2.451128E-04
29	2.090373	-2.255695E-04
30	1.561553	-2.033497E-04
31	1.072969	-1.829155E-04
32	.5556446	-1.596843E-04
33	-7.664064E-03	-1.343375E-04



CURVATURE VERSUS LOAD

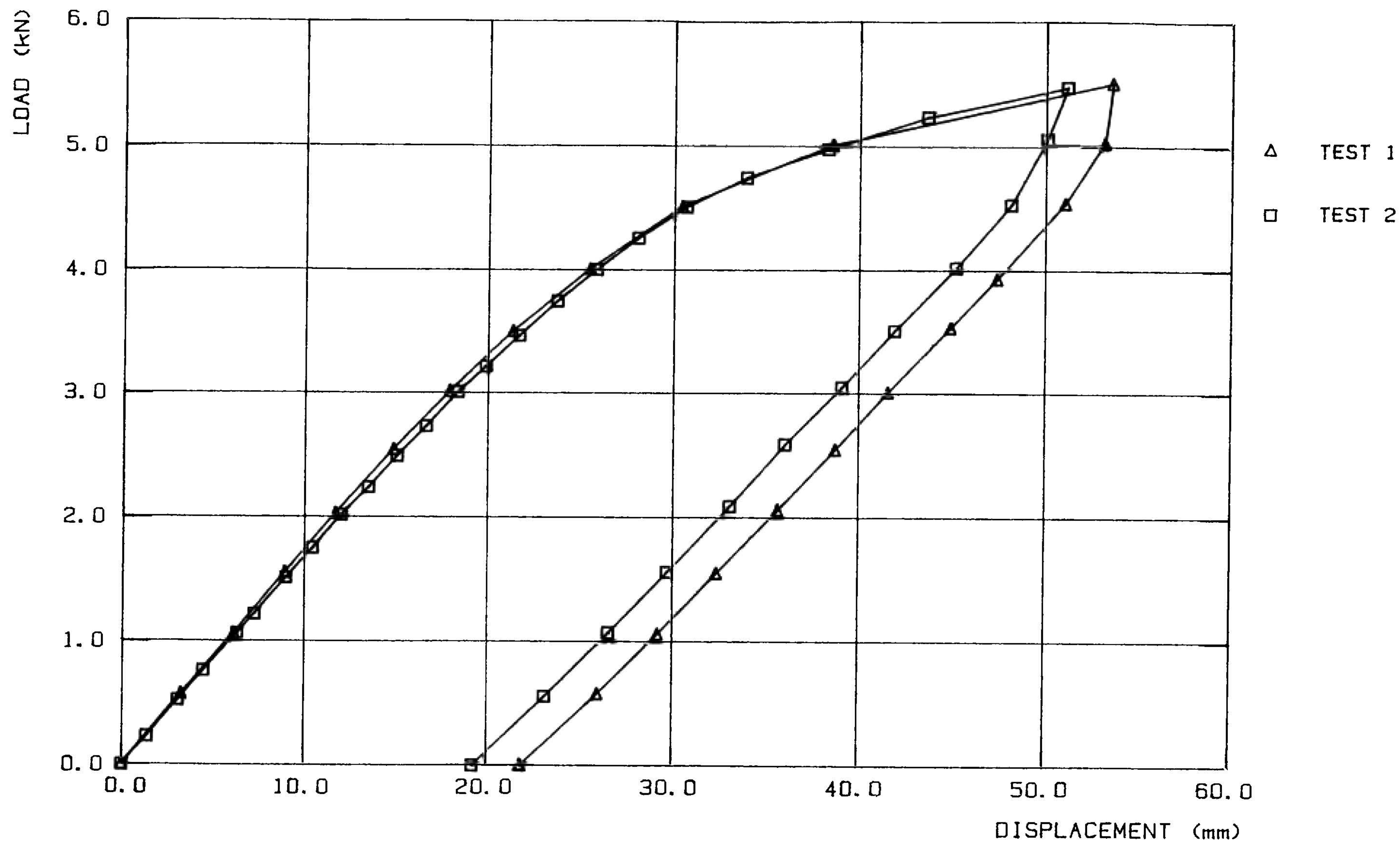
TEST 2: LONGITUDINAL CURVATURE.

GRAPH 2.12

LONGITUDINAL CURVATURE.

FILE :B:2PLATE11.DAT

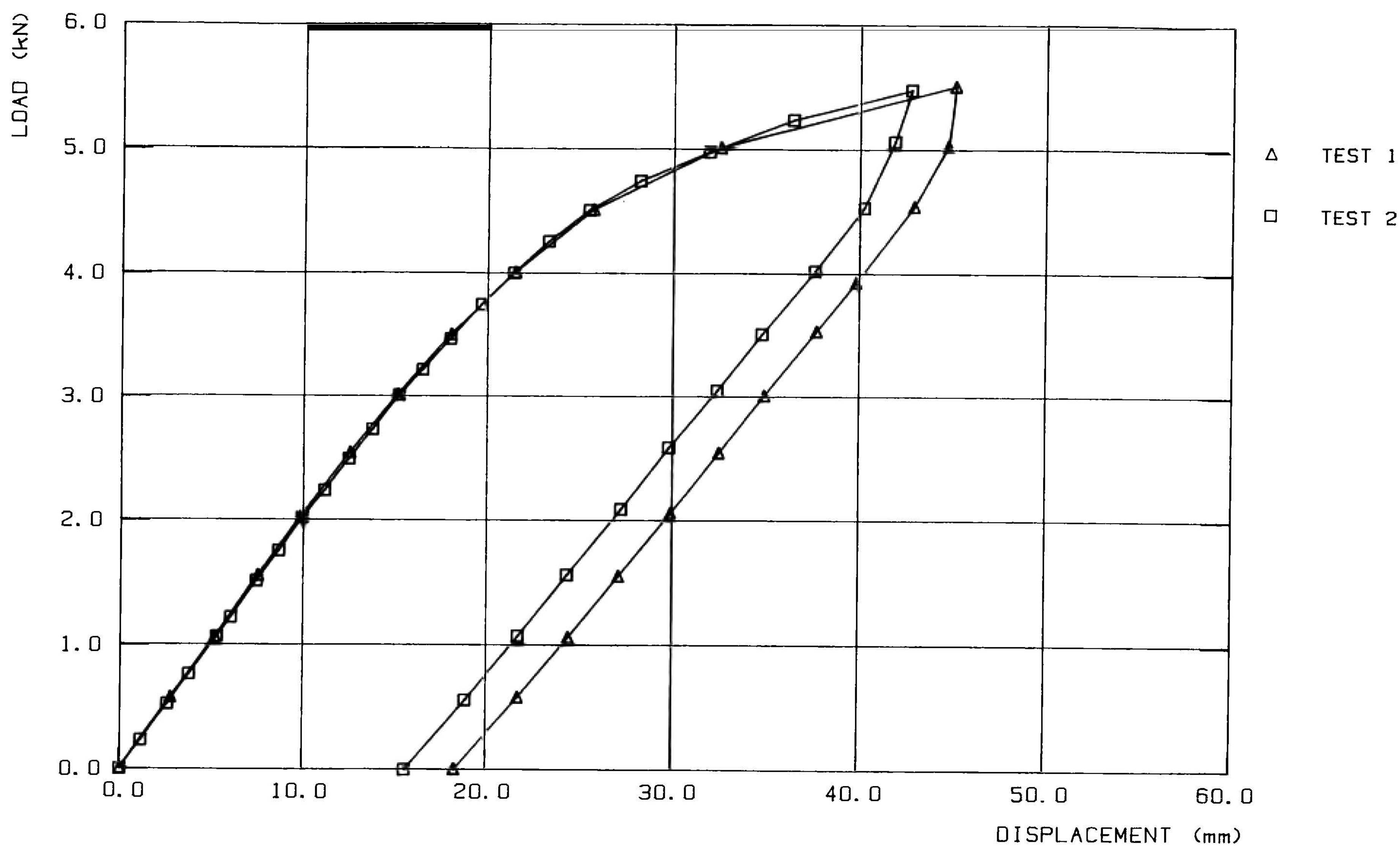
LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	-3.832032E-03	7.666467E-20
1	.2280059	1.032505E-05
2	.5230724	2.34659E-05
3	.7644905	3.379073E-05
4	1.067221	4.998138E-05
5	1.222418	5.748981E-05
6	1.513653	7.274076E-05
7	1.753155	8.47063E-05
8	2.017565	9.8782E-05
9	2.239823	1.114495E-04
10	2.492737	1.234118E-04
11	2.732239	1.370153E-04
12	3.008145	1.513201E-04
13	3.215075	1.637471E-04
14	3.464157	1.775797E-04
15	3.745811	1.9516E-04
16	4.002557	2.120336E-04
17	4.255471	2.29841E-04
18	4.508385	2.502201E-04
19	4.744056	2.752738E-04
20	4.979726	3.064009E-04
21	5.238388	3.466284E-04
22	5.47789	4.022327E-04
23	5.062114	3.935933E-04
24	4.531378	3.793456E-04
25	4.017885	3.632237E-04
26	3.506309	3.421862E-04
27	3.048381	3.216071E-04
28	2.586622	3.005517E-04
29	2.090373	2.811262E-04
30	1.561553	2.570108E-04
31	1.072969	2.319485E-04
32	.5556446	2.052378E-04
33	-7.664064E-03	1.747662E-04



DISPLACEMENT VERSUS LOAD

TEST 1 AND 2: MIDDLE DISPLACEMENT.

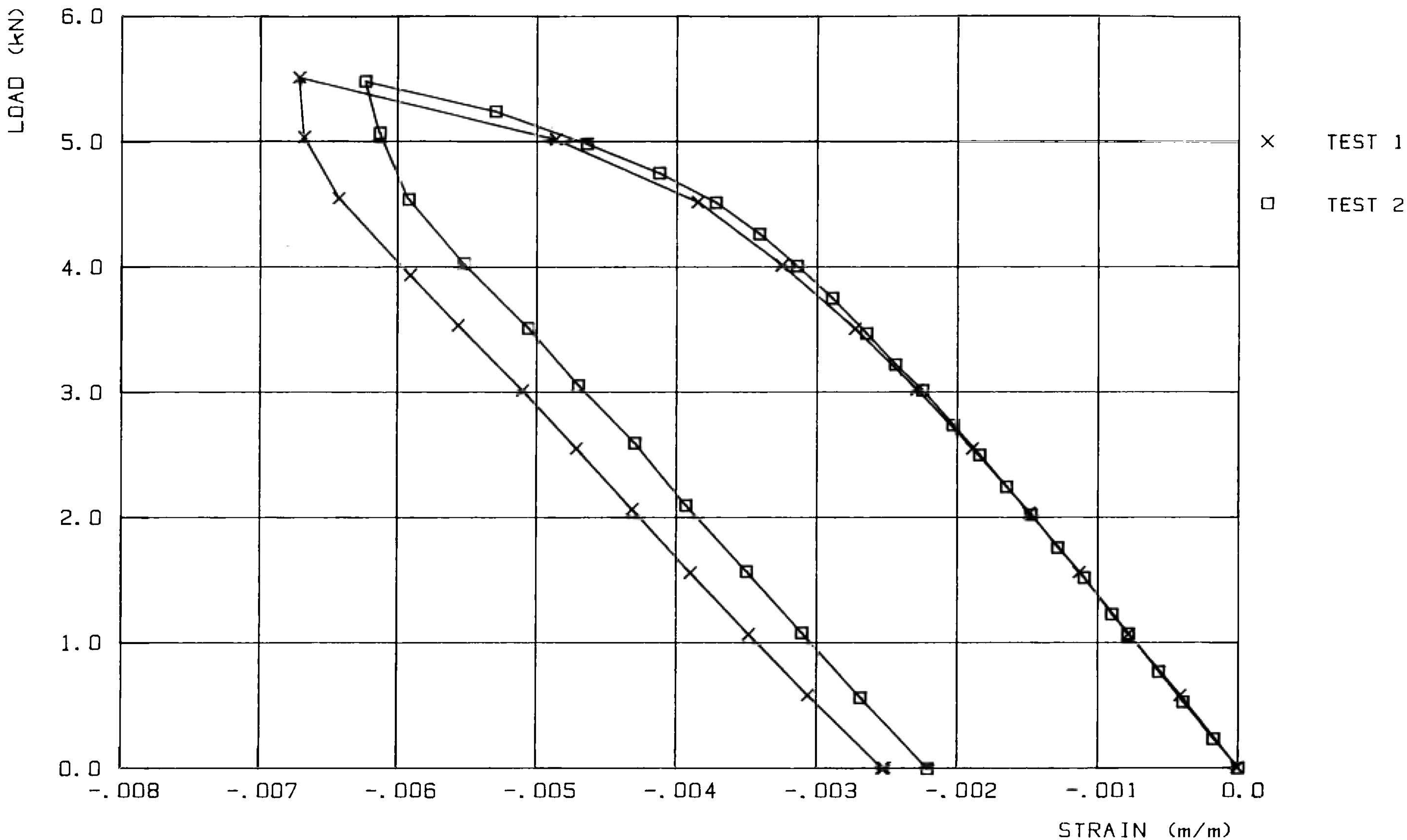
GRAPH 3.1



DISPLACEMENT VERSUS LOAD

TEST 1 AND 2. END DISPLACEMENT.

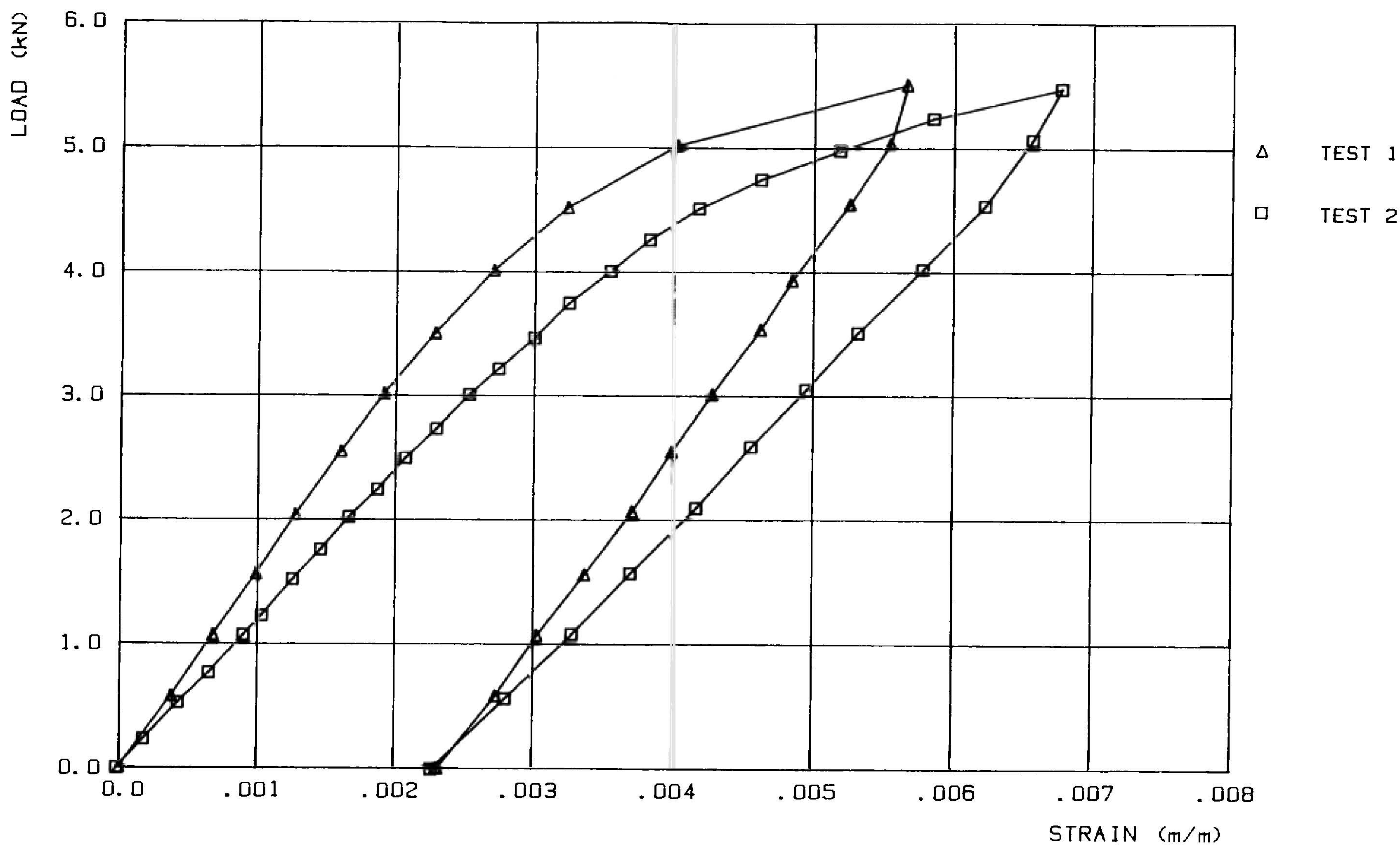
GRAPH 3.2



STRAIN VERSUS LOAD

TEST 1 AND 2: TOP LONGITUDINAL STRAIN.

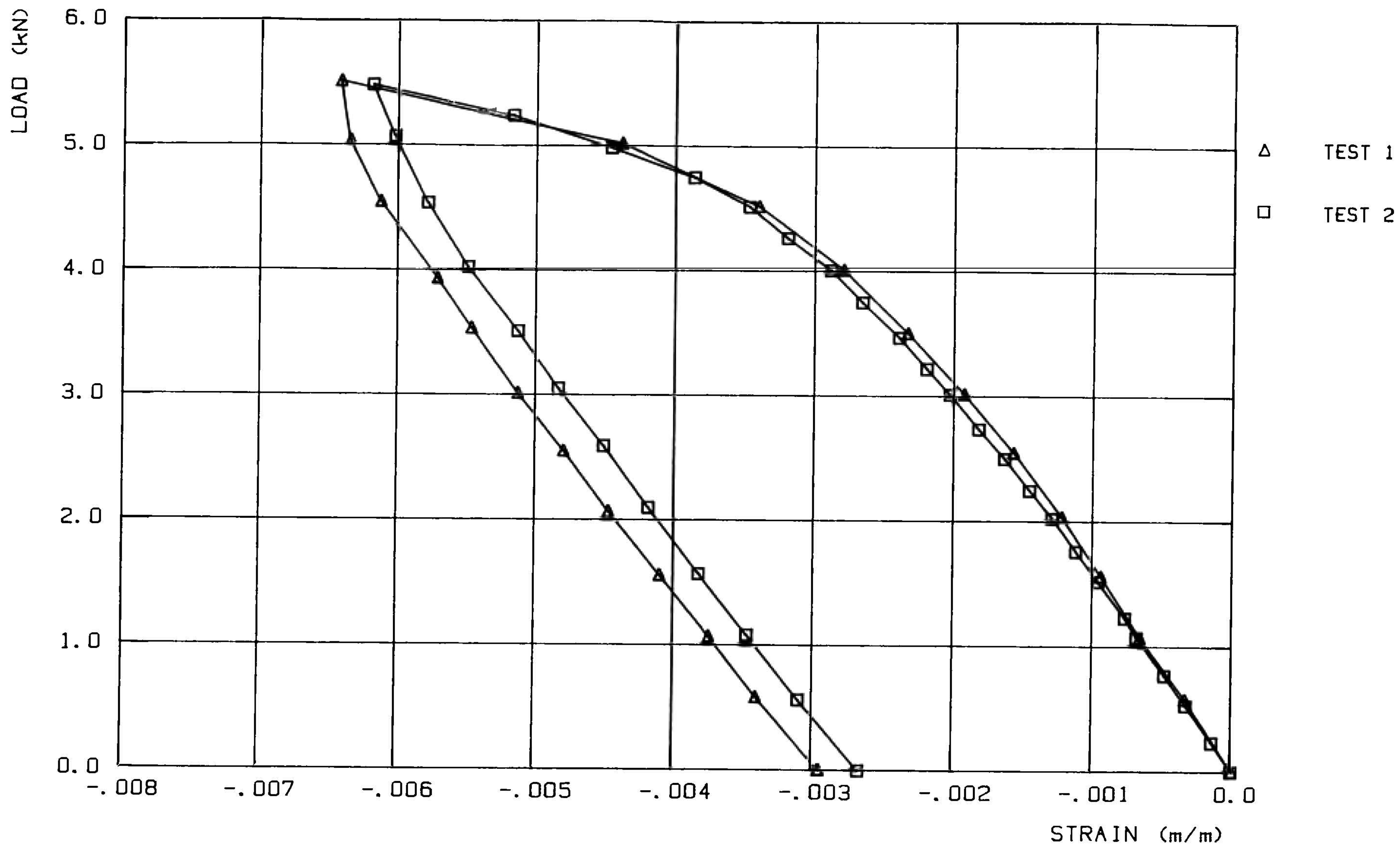
GRAPH 3.3



STRAIN VERSUS LOAD

TEST 1 AND 2: BOTTOM LONGITUDINAL STRAIN.

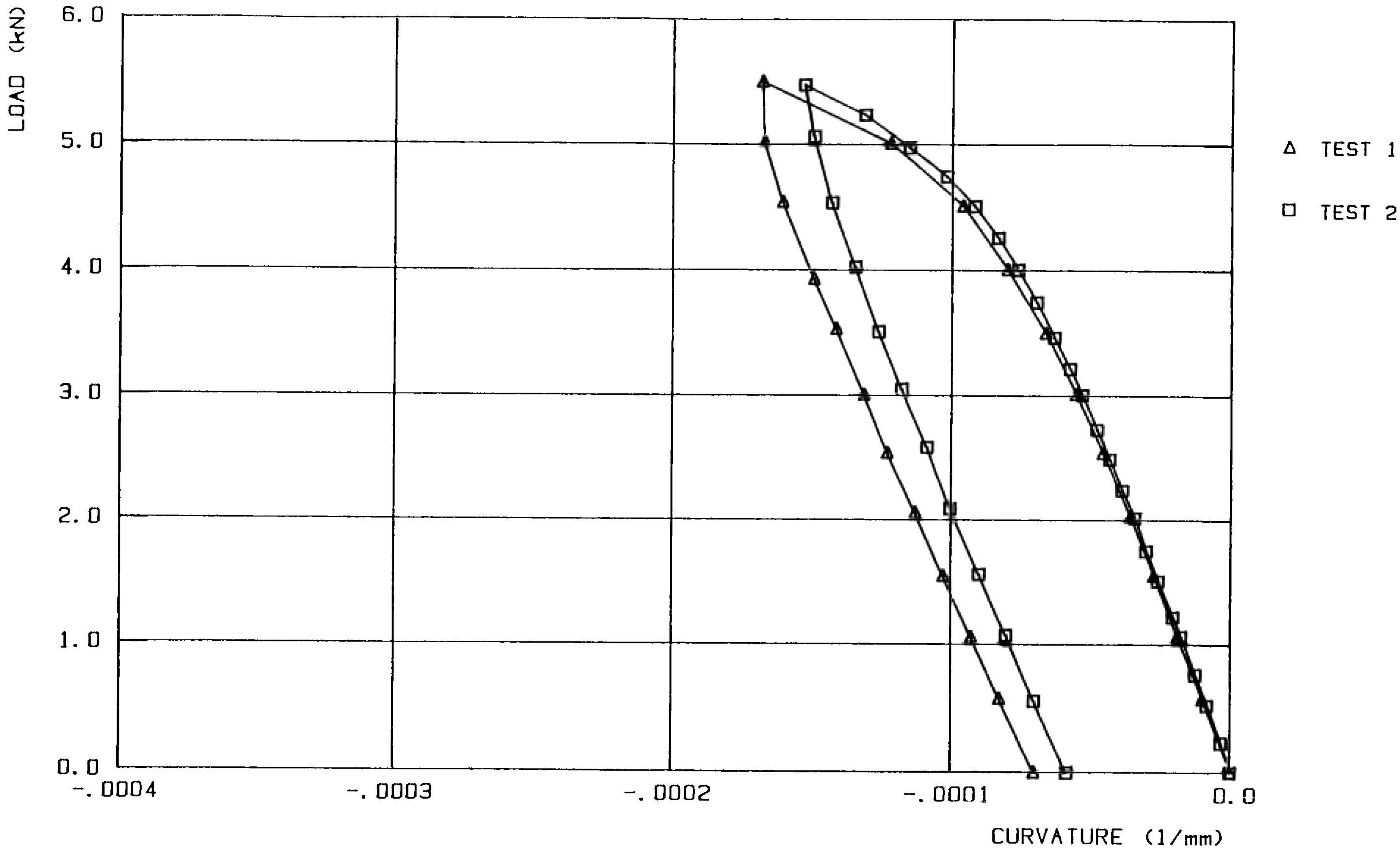
GRAPH 3.4



STRAIN VERSUS LOAD

TEST 1 AND 2: BOTTOM TRANSVERSE STRAIN

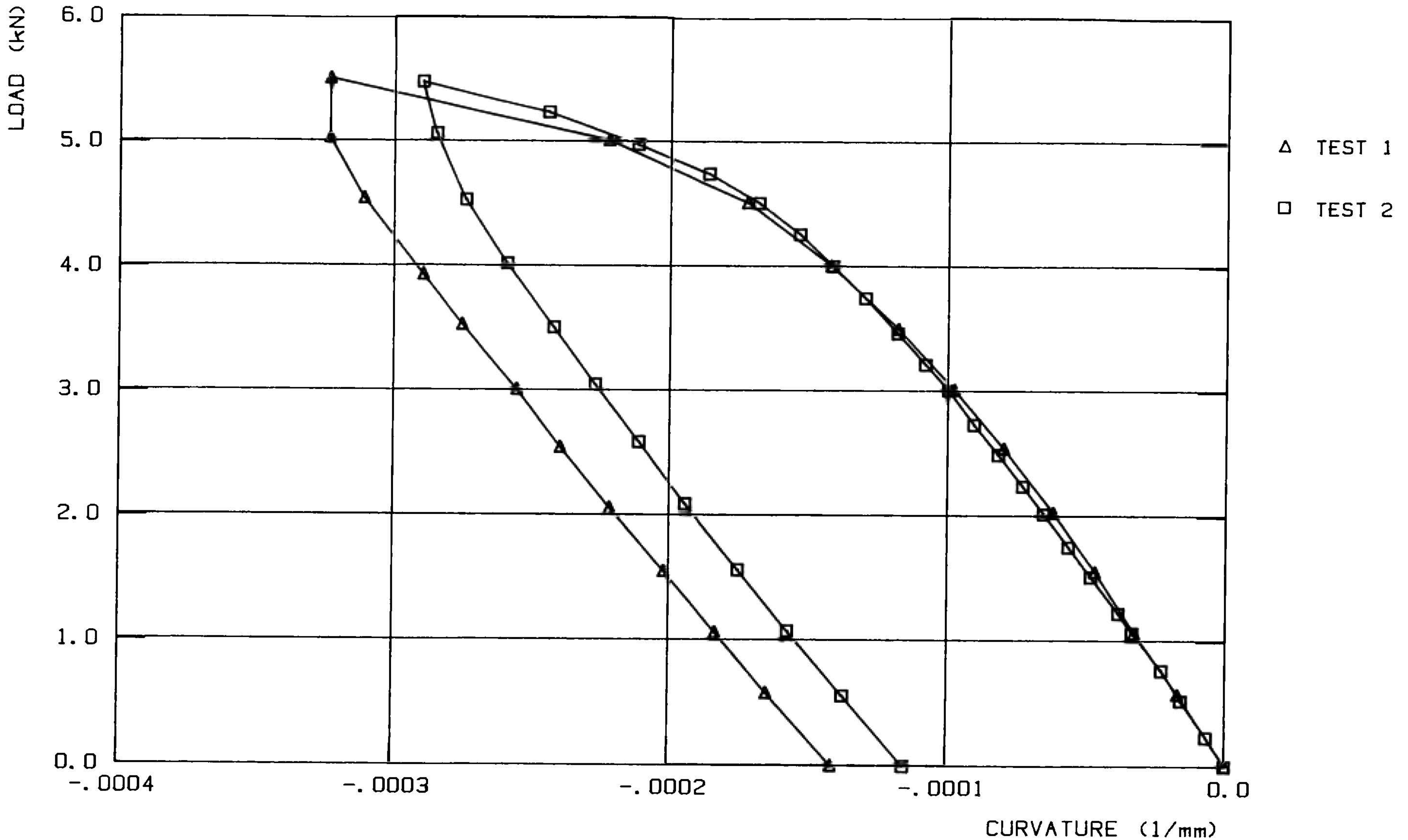
GRAPH 3.6



CURVATURE VERSUS LOAD

TEST 1 AND 2: END TRANSVERSE CURVATURE.

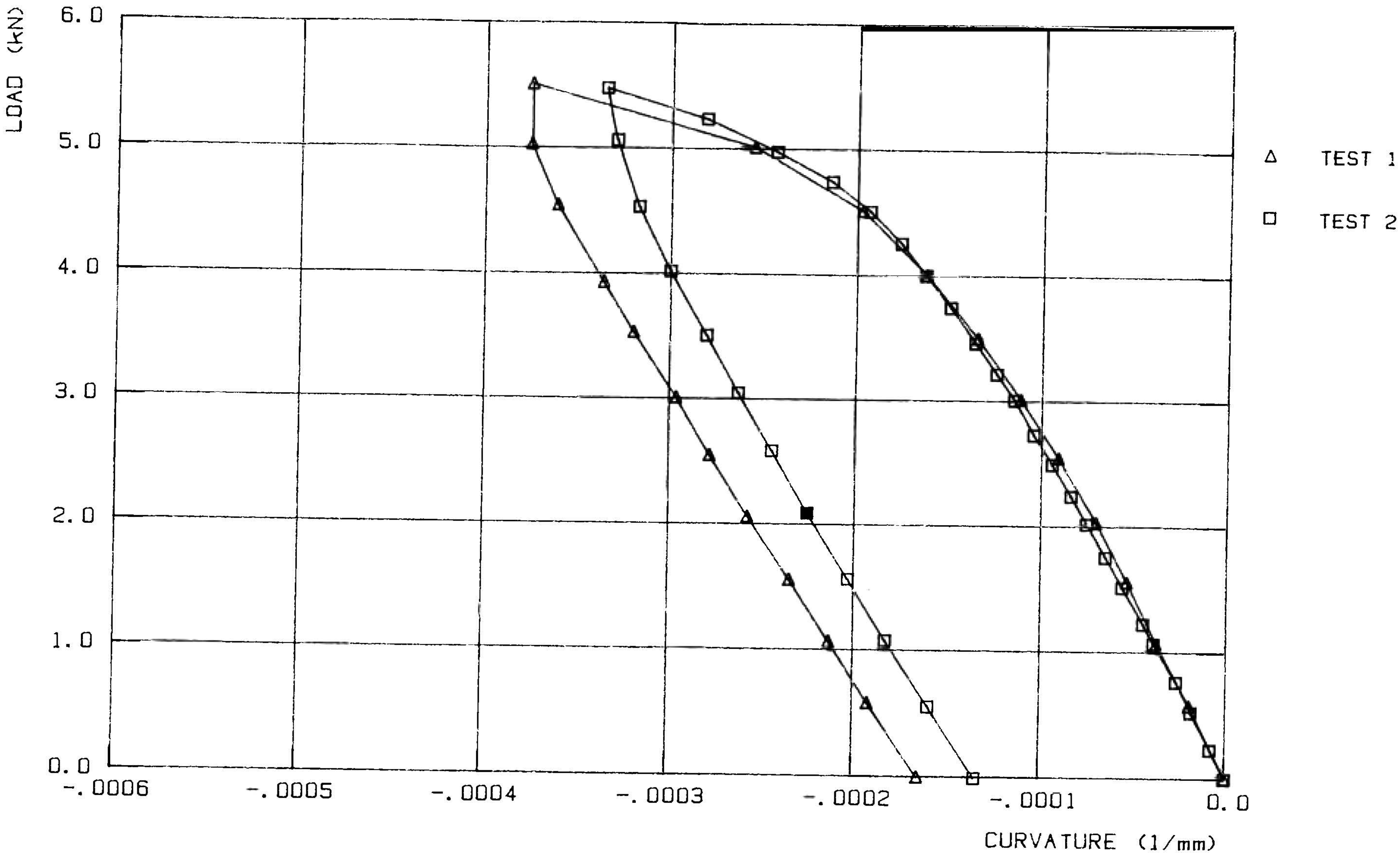
GRAPH 3.7



CURVATURE VERSUS LOAD

TEST 1 AND 2: INNER TRANSVERSE CURVATURE.

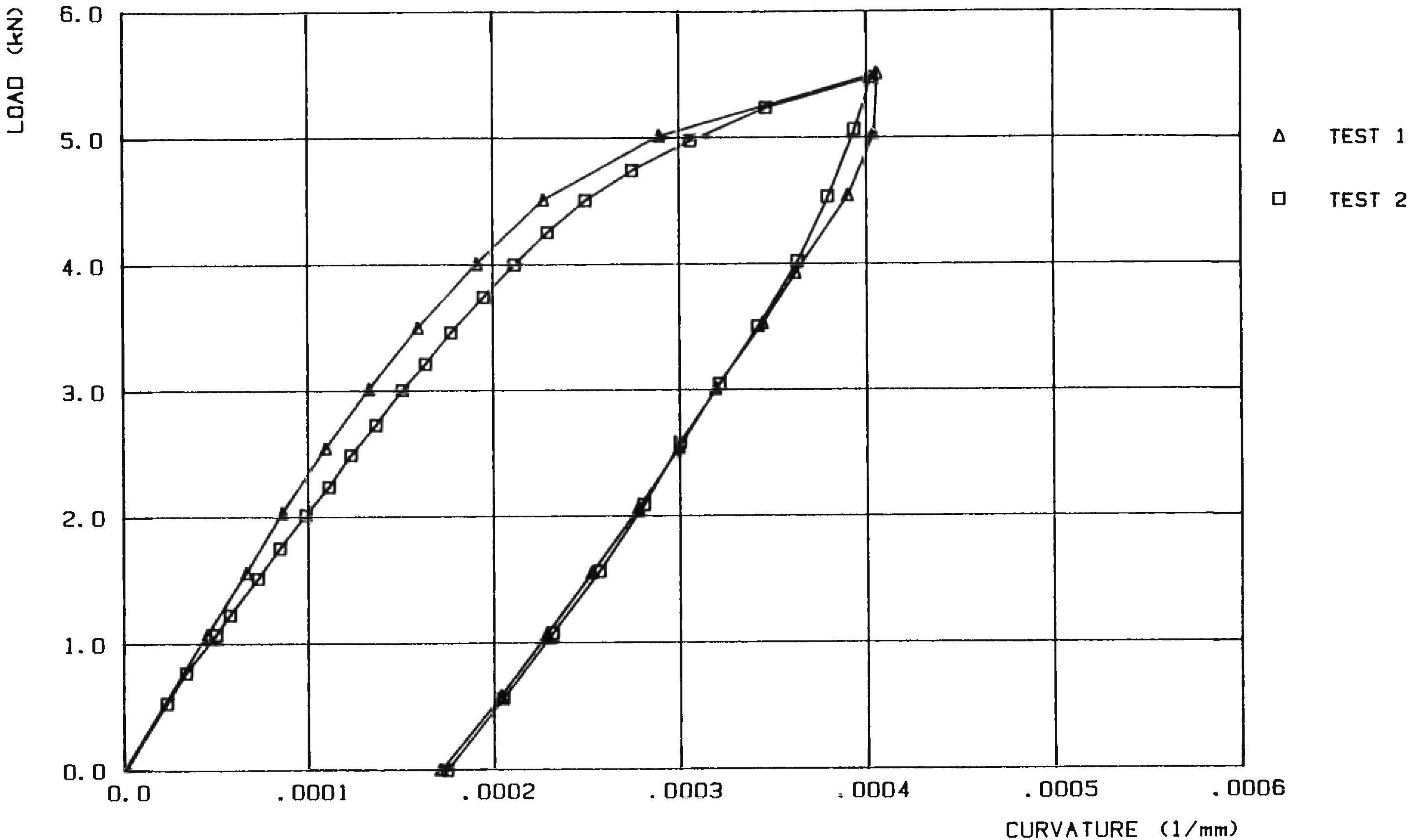
GRAPH 3.8



CURVATURE VERSUS LOAD

TEST 1 AND 2: MIDDLE TRANSVERSE CURVATURE.

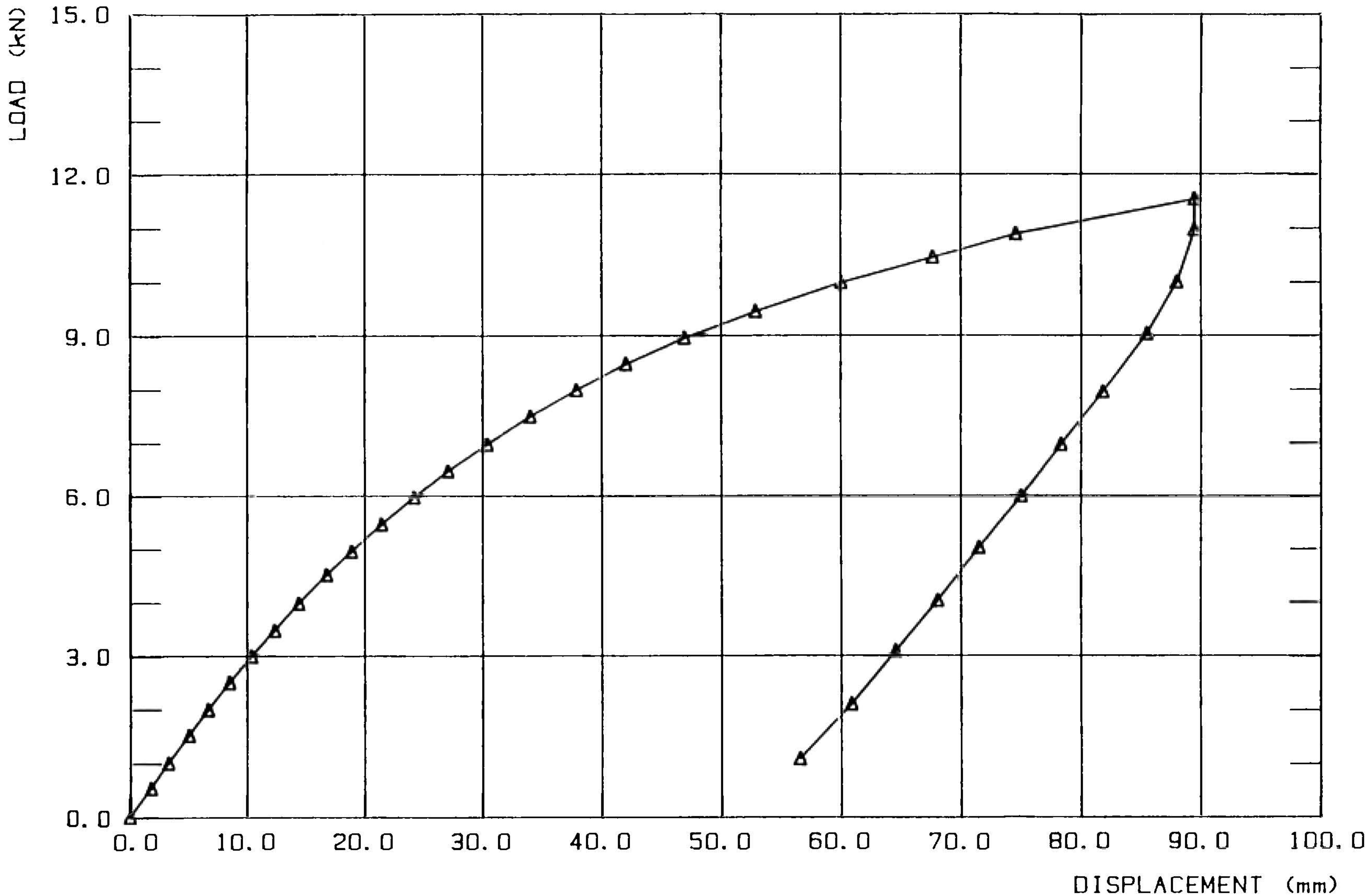
GRAPH 3.9



CURVATURE VERSUS LOAD

TEST 1 AND 2: LONGITUDINAL CURVATURE.

GRAPH 3.10



DISPLACEMENT VERSUS LOAD

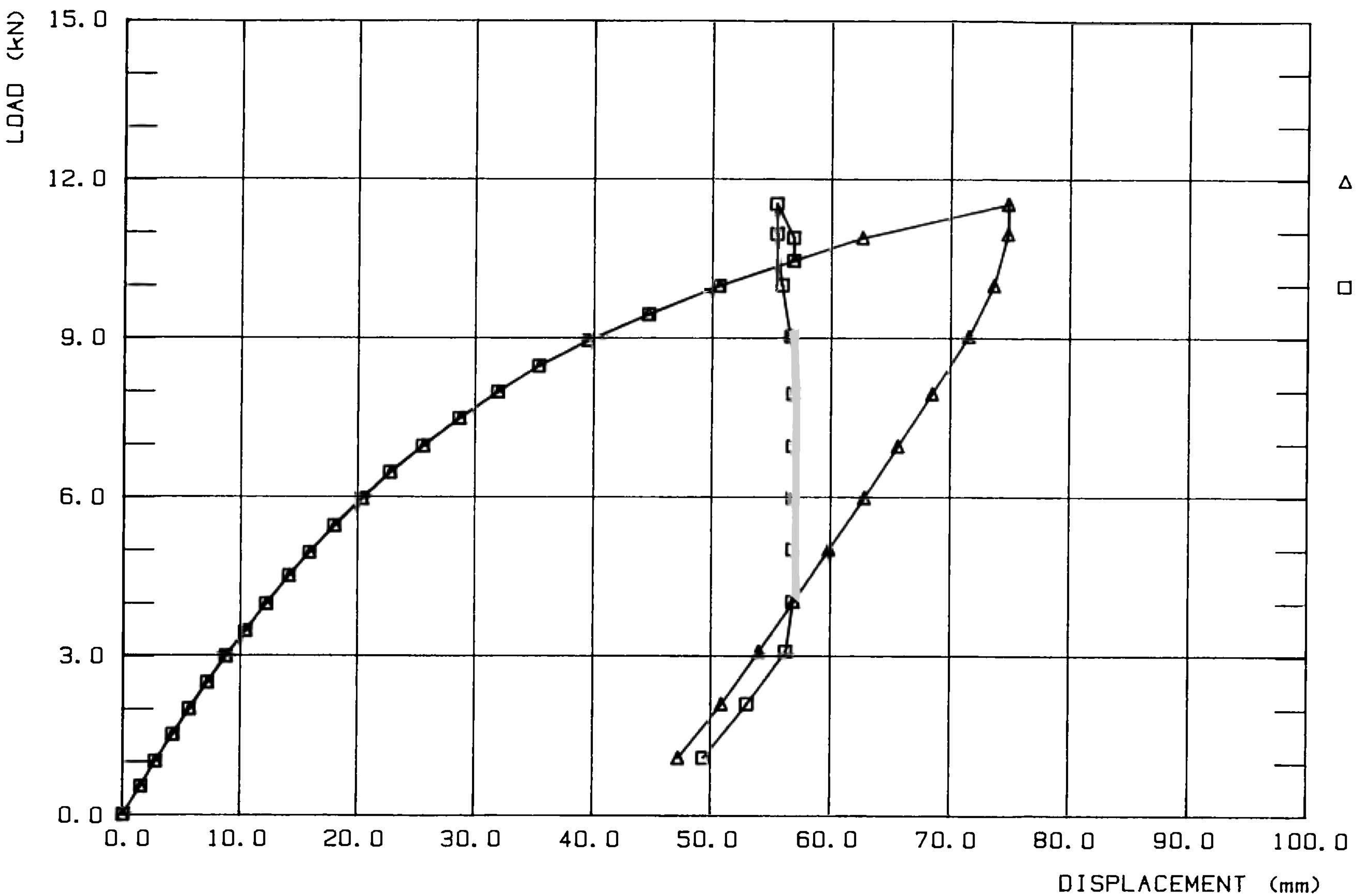
TEST 3: MIDDLE DISPLACEMENT. LVDT POSITION 1.

GRAPH 4.1

MIDDLE DISPLACEMENT. LVDT POSITION 1.

FILE :B:3PLATE1.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	7.664064E-03	-9.765625E-03
1	.5364845	1.787109
2	1.005908	3.251953
3	1.511737	5.009766
4	1.990741	6.621094
5	2.492737	8.427734
6	2.988985	10.2832
7	3.469905	12.22656
8	3.981481	14.28711
9	4.51605	16.65039
10	4.952901	18.76953
11	5.462562	21.31836
12	5.974138	24.0918
13	6.476134	26.96289
14	6.976214	30.30274
15	7.501202	33.96485
16	7.997451	37.83203
17	8.484119	41.97266
18	8.966954	46.86524
19	9.459371	52.85157
20	9.99777	60
21	10.46719	67.60743
22	10.90213	74.54103
23	11.54783	89.43359
24	10.97686	89.41406
25	10.00352	87.93946
26	9.039761	85.42969
27	7.95913	81.76758
28	6.96855	78.30078
29	5.989466	74.98047
30	5.014214	71.46485
31	4.021717	67.99805
32	3.079038	64.49219
33	2.088457	60.82032
34	1.078717	56.52344



DISPLACEMENT VERSUS LOAD

TEST 3: END DISPLACEMENT. POSITIONS 2 AND 3.

GRAPH 4.2

END DISPLACEMENT. LVDT POSITION 2.

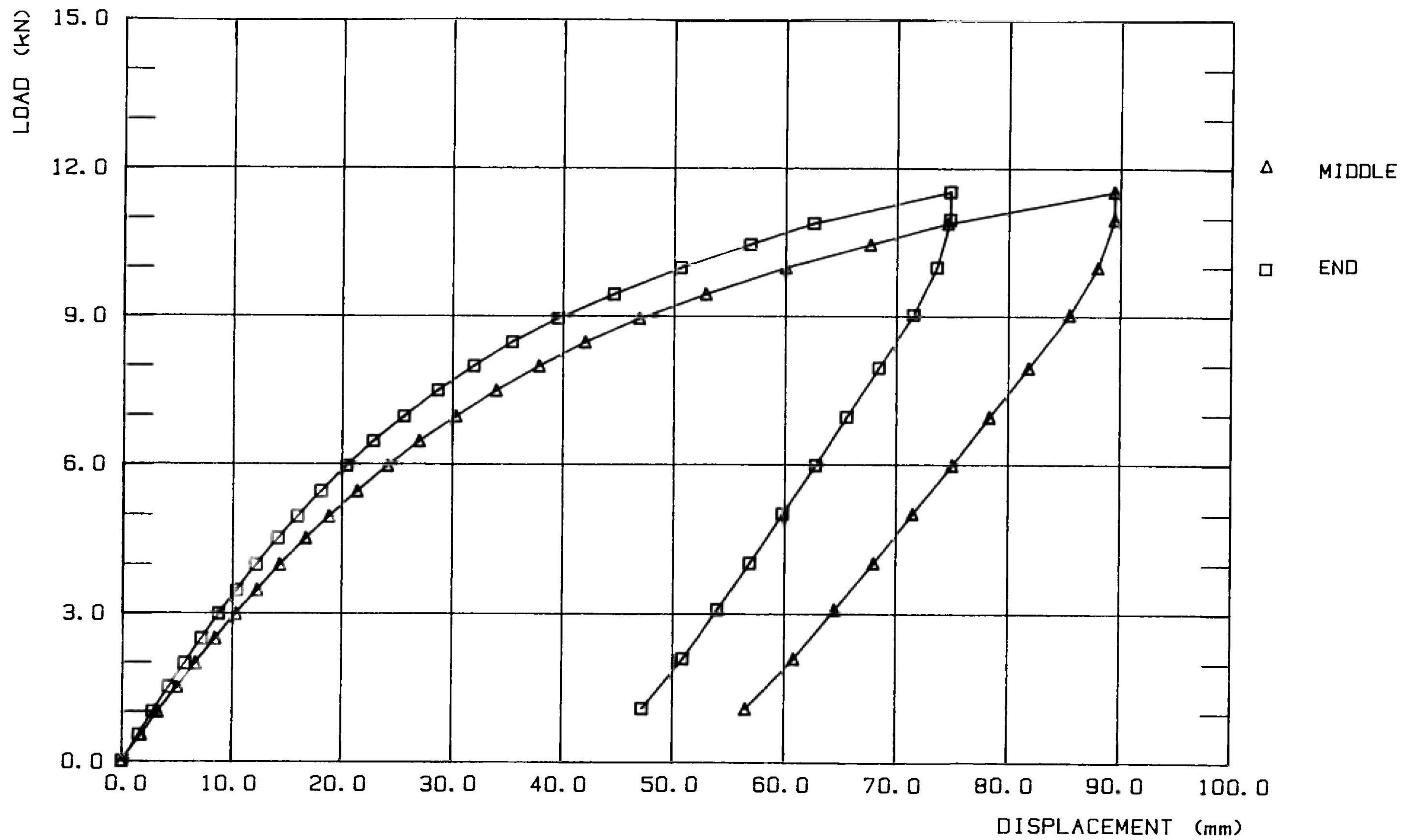
FILE :B:3PLATE2.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	7.664064E-03	1.464844E-02
1	.5364845	1.538086
2	1.005908	2.788084
3	1.511737	4.248047
4	1.990741	5.659182
5	2.492737	7.177735
6	2.988985	8.740234
7	3.469905	10.37598
8	3.981481	12.13379
9	4.51605	14.11133
10	4.952901	15.89356
11	5.462562	18.03711
12	5.974138	20.38086
13	6.476134	22.78809
14	6.976214	25.58594
15	7.501202	28.66211
16	7.997451	31.9336
17	8.484119	35.38574
18	8.966954	39.52149
19	9.459371	44.55567
20	9.99777	50.56153
21	10.46719	56.82617
22	10.90213	62.5293
23	11.54783	74.76075
24	10.97686	74.73633
25	10.00352	73.55957
26	9.039761	71.4795
27	7.95913	68.40821
28	6.96855	65.53711
29	5.989466	62.73926
30	5.014214	59.79004
31	4.021717	56.86035
32	3.079038	53.95508
33	2.088457	50.85449
34	1.078717	47.22168

END DISPLACEMENT. LVDT POSITION 3.

FILE :B:3PLATE3.DAT

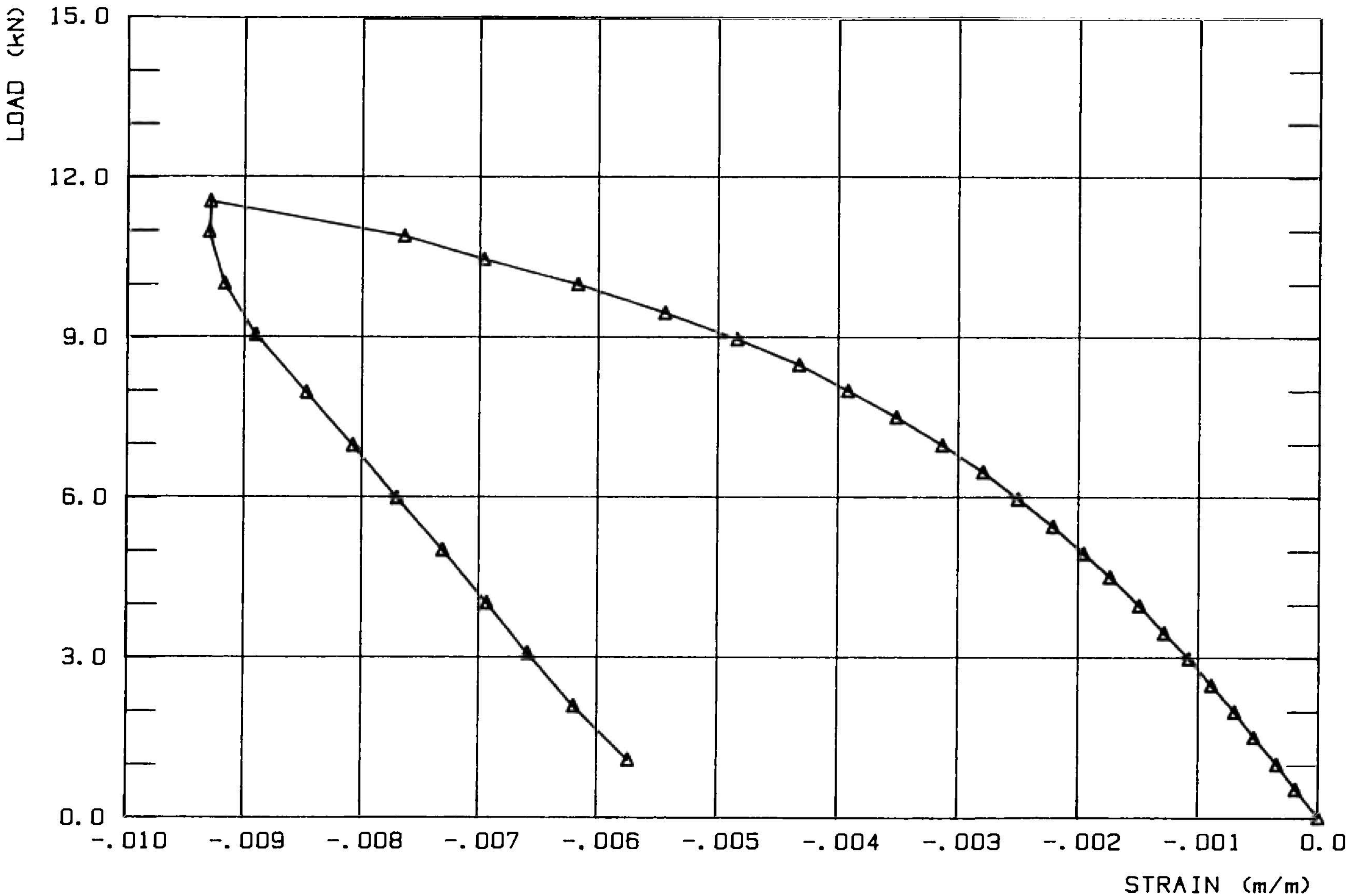
LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	7.664064E-03	0
1	.5364845	1.508789
2	1.005908	2.734375
3	1.511737	4.199219
4	1.990741	5.590821
5	2.492737	7.114258
6	2.988985	8.691406
7	3.469905	10.33691
8	3.981481	12.10938
9	4.51605	14.0625
10	4.952901	15.83984
11	5.462562	17.94922
12	5.974138	20.28809
13	6.476134	22.70508
14	6.976214	25.50781
15	7.501202	28.58887
16	7.997451	31.87012
17	8.484119	35.35645
18	8.966954	39.55078
19	9.459371	44.62403
20	9.99777	50.53711
21	10.46719	56.78711
22	10.90213	56.78711
23	11.54783	55.34668
24	10.97686	55.3711
25	10.00352	55.83496
26	9.039761	56.61621
27	7.95913	56.78711
28	6.96855	56.78711
29	5.989466	56.78711
30	5.014214	56.78711
31	4.021717	56.78711
32	3.079038	56.19629
33	2.088457	52.97852
34	1.078717	49.35059



DISPLACEMENT VERSUS LOAD

TEST 3: DISPLACEMENTS. LVDT POSITIONS 1 AND 2.

GRAPH 4.3



STRAIN VERSUS LOAD

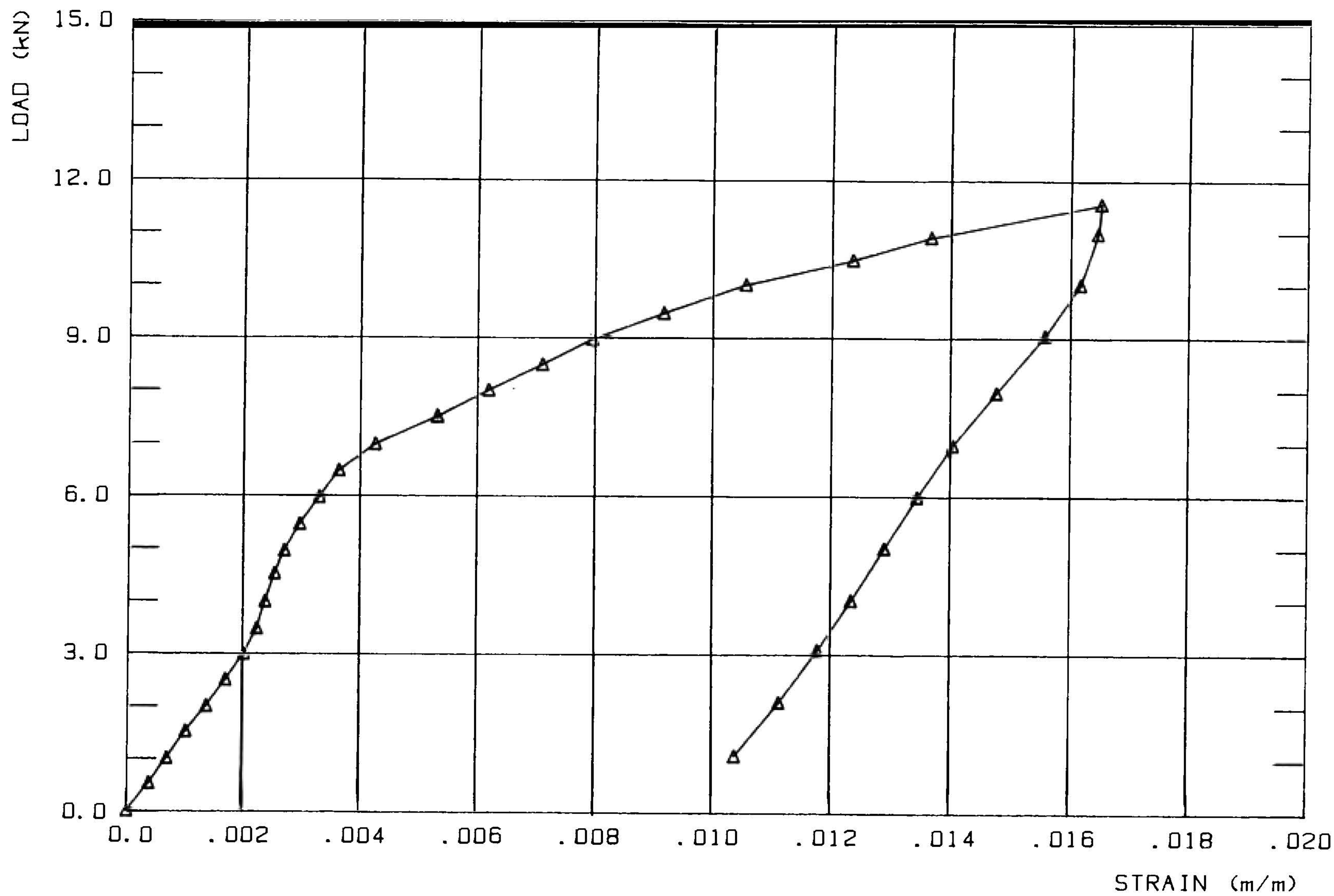
TEST 3: TOP LONGITUDINAL STRAIN. DD1 POSITION 4.

GRAPH 4.4

TOP LONGITUDINAL STRAIN: DD1 POSITION 4.

FILE :B:3PLATE4.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	7.664064E-03	6.312393E-06
1	.5364845	-1.872677E-04
2	1.005908	-3.429733E-04
3	1.511737	-5.344493E-04
4	1.990741	-6.964673E-04
5	2.492737	-8.900473E-04
6	2.988985	-1.081523E-03
7	3.469905	-1.287728E-03
8	3.981481	-1.493933E-03
9	4.51605	-1.738012E-03
10	4.952901	-1.958946E-03
11	5.462562	-2.21565E-03
12	5.974138	-2.50602E-03
13	6.476134	-2.798494E-03
14	6.976214	-3.135155E-03
15	7.501202	-3.516003E-03
16	7.997451	-3.919996E-03
17	8.484119	-4.328198E-03
18	8.966954	-4.845813E-03
19	9.459371	-5.449699E-03
20	9.99777	-6.175624E-03
21	10.46719	-6.970986E-03
22	10.90213	-7.648516E-03
23	11.54783	-9.296051E-03
24	10.97686	-9.306571E-03
25	10.00352	-9.174011E-03
26	9.039761	-8.90889E-03
27	7.95913	-8.475439E-03
28	6.96855	-8.079863E-03
29	5.989466	-7.703224E-03
30	5.014214	-7.311855E-03
31	4.021717	-6.935216E-03
32	3.079038	-6.58593E-03
33	2.088457	-6.19877E-03
34	1.078717	-5.742173E-03



STRAIN VERSUS LOAD

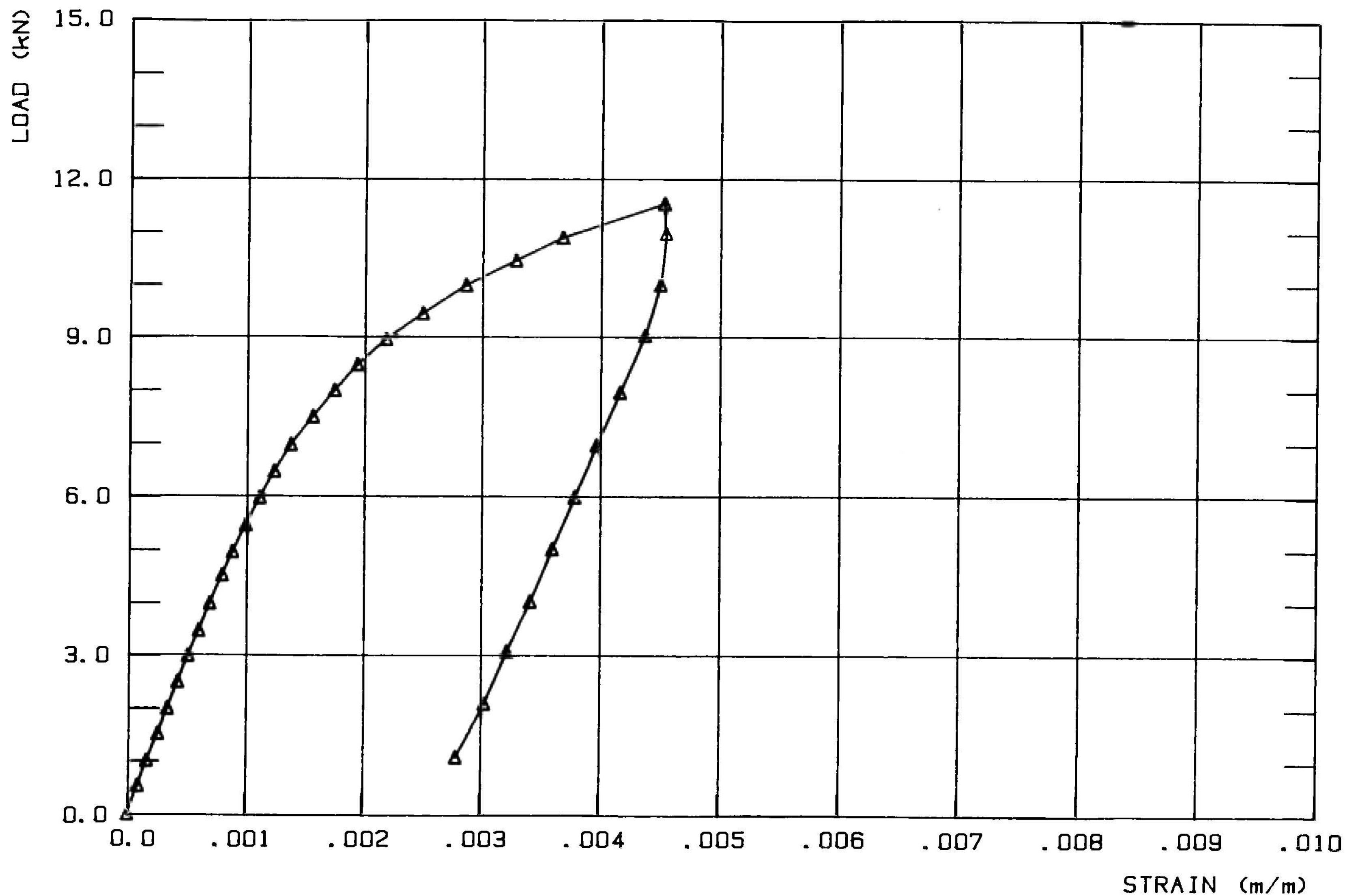
TEST 3: BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 6

GRAPH 4.5

BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 6.

FILE :B:3PLATE6.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	7.664064E-03	8.803789E-06
1	.5364845	3.829649E-04
2	1.005908	6.866956E-04
3	1.511737	1.003632E-03
4	1.990741	1.355784E-03
5	2.492737	1.685926E-03
6	2.988985	1.994058E-03
7	3.469905	2.214153E-03
8	3.981481	2.355014E-03
9	4.51605	2.517884E-03
10	4.952901	2.680754E-03
11	5.462562	2.940466E-03
12	5.974138	3.27501E-03
13	6.476134	3.609554E-03
14	6.976214	4.230221E-03
15	7.501202	5.286676E-03
16	7.997451	6.162653E-03
17	8.484119	7.082649E-03
18	8.966954	7.932215E-03
19	9.459371	9.138332E-03
20	9.99777	1.052053E-02
21	10.46719	1.232531E-02
22	10.90213	1.364147E-02
23	11.54783	.0164895
24	10.97686	1.643227E-02
25	10.00352	1.614175E-02
26	9.039761	1.555189E-02
27	7.95913	1.474635E-02
28	6.96855	1.401563E-02
29	5.989466	1.342138E-02
30	5.014214	1.287114E-02
31	4.021717	.0123165
32	3.079038	1.175306E-02
33	2.088457	1.111038E-02
34	1.078717	1.037086E-02



STRAIN VERSUS LOAD

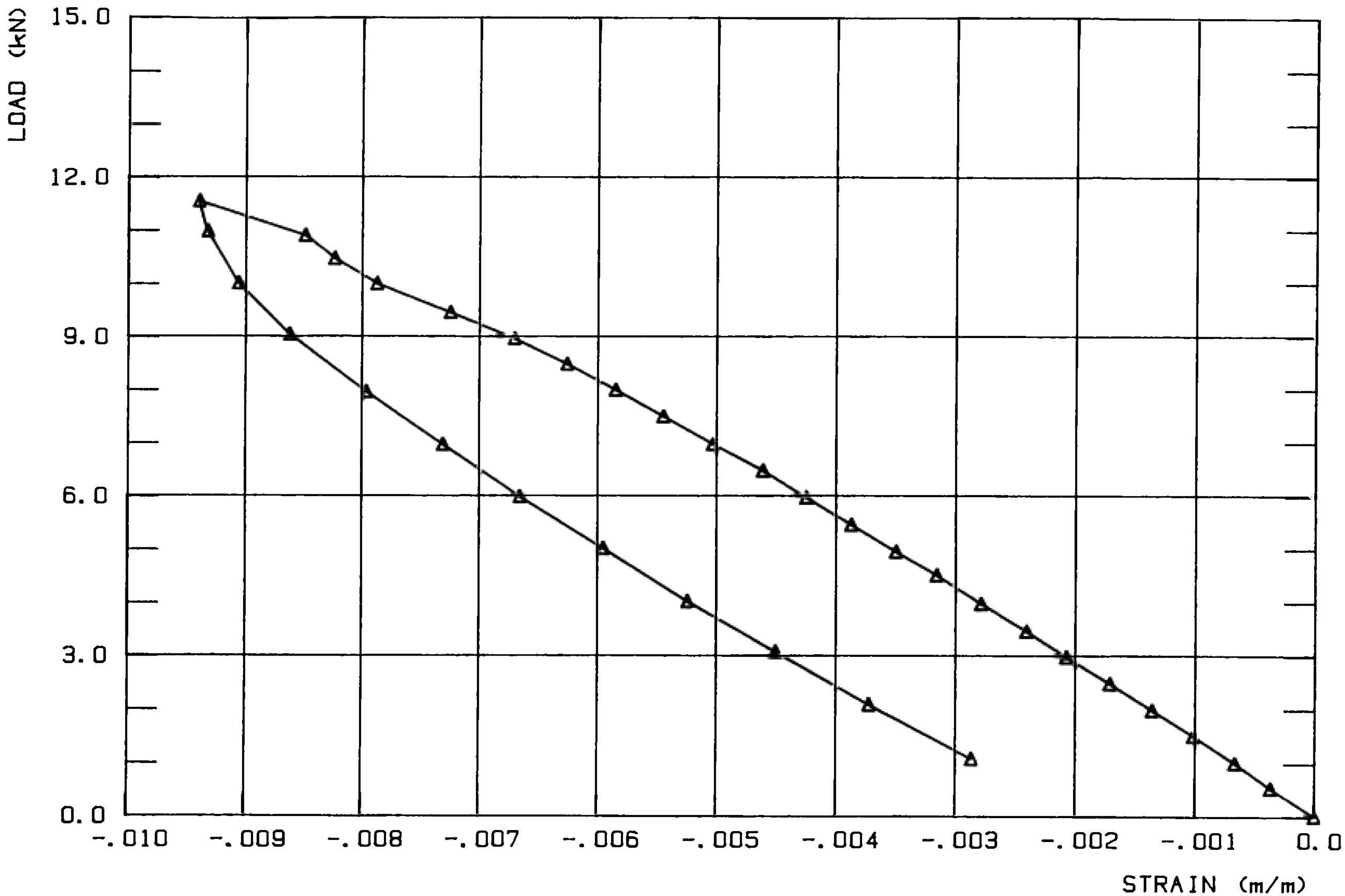
TEST 3: TOP TRANSVERSE STRAIN. DD1 POSITION 5.

GRAPH 4.6

TOP TRANSVERSE STRAIN, DD1 POSITION 5.

FILE :B:3PLATE5.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	7.664064E-03	-5.290635E-06
1	.5364845	8.288662E-05
2	1.005908	1.55192E-04
3	1.511737	2.486599E-04
4	1.990741	3.280194E-04
5	2.492737	4.144331E-04
6	2.988985	5.008469E-04
7	3.469905	5.907876E-04
8	3.981481	6.842555E-04
9	4.51605	7.883046E-04
10	4.952901	8.764818E-04
11	5.462562	9.893488E-04
12	5.974138	1.107506E-03
13	6.476134	1.230954E-03
14	6.976214	1.372038E-03
15	7.501202	1.55721E-03
16	7.997451	1.742382E-03
17	8.484119	1.936372E-03
18	8.966954	2.177978E-03
19	9.459371	2.491889E-03
20	9.99777	2.858706E-03
21	10.46719	3.283721E-03
22	10.90213	3.676992E-03
23	11.54783	4.528784E-03
24	10.97686	4.541128E-03
25	10.00352	4.49704E-03
26	9.039761	4.370065E-03
27	7.95913	4.161966E-03
28	6.96855	3.967976E-03
29	5.989466	3.784567E-03
30	5.014214	3.597632E-03
31	4.021717	3.414223E-03
32	3.079038	3.213179E-03
33	2.088457	3.022716E-03
34	1.078717	2.784638E-03



STRAIN VERSUS LOAD

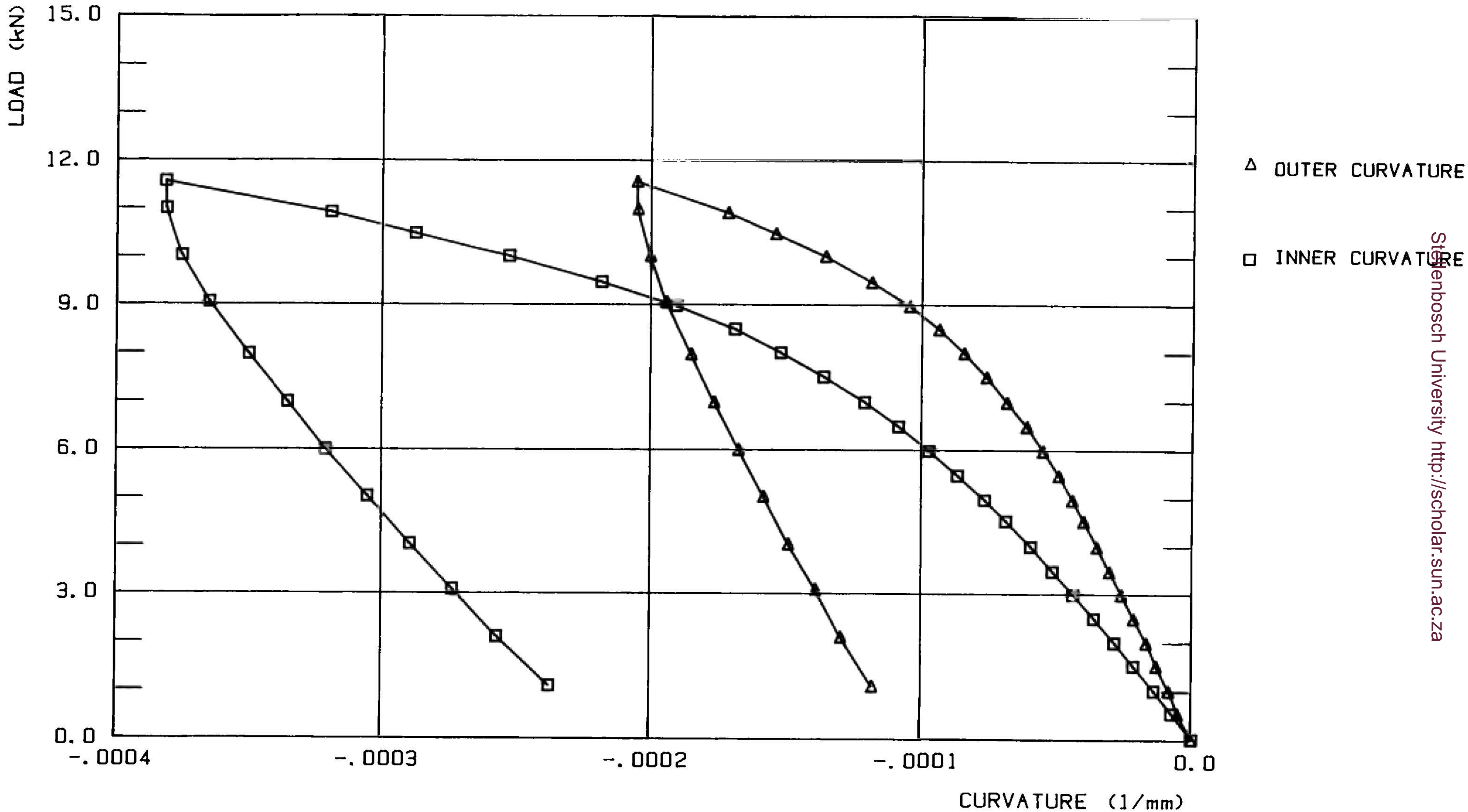
TEST 3: BOTTOM TRANSVERSE STRAIN. DD1 POSITION 7.

GRAPH 4.7

BOTTOM TRANSVERSE STRAIN. DD1 POSITION 7.

FILE :B:3PLATE7.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	7.664064E-03	3.725556E-06
1	.5364845	-3.651045E-04
2	1.005908	-6.668746E-04
3	1.511737	-1.013351E-03
4	1.990741	-1.359828E-03
5	2.492737	-1.713756E-03
6	2.988985	-2.075135E-03
7	3.469905	-2.406709E-03
8	3.981481	-2.786716E-03
9	4.51605	-3.159272E-03
10	4.952901	-3.502023E-03
11	5.462562	-3.874579E-03
12	5.974138	-4.25086E-03
13	6.476134	-4.612239E-03
14	6.976214	-5.033227E-03
15	7.501202	-5.450489E-03
16	7.997451	-5.852849E-03
17	8.484119	-6.262661E-03
18	8.966954	-6.706001E-03
19	9.459371	-7.253659E-03
20	9.99777	-7.879553E-03
21	10.46719	-8.240932E-03
22	10.90213	-8.494269E-03
23	11.54783	-9.395854E-03
24	10.97686	-9.321343E-03
25	10.00352	-9.060554E-03
26	9.039761	-8.624664E-03
27	7.95913	-7.968966E-03
28	6.96855	-7.313268E-03
29	5.989466	-6.65757E-03
30	5.014214	-5.957165E-03
31	4.021717	-5.245583E-03
32	3.079038	-4.504198E-03
33	2.088457	-3.725557E-03
34	1.078717	-2.864953E-03



CURVATURE VERSUS LOAD

TEST 3: TRANSVERSE CURVATURE. POSITIONS 8 AND 9.

GRAPH 4.8

INNER TRANSVERSE CURVATURE. POSITION 8.

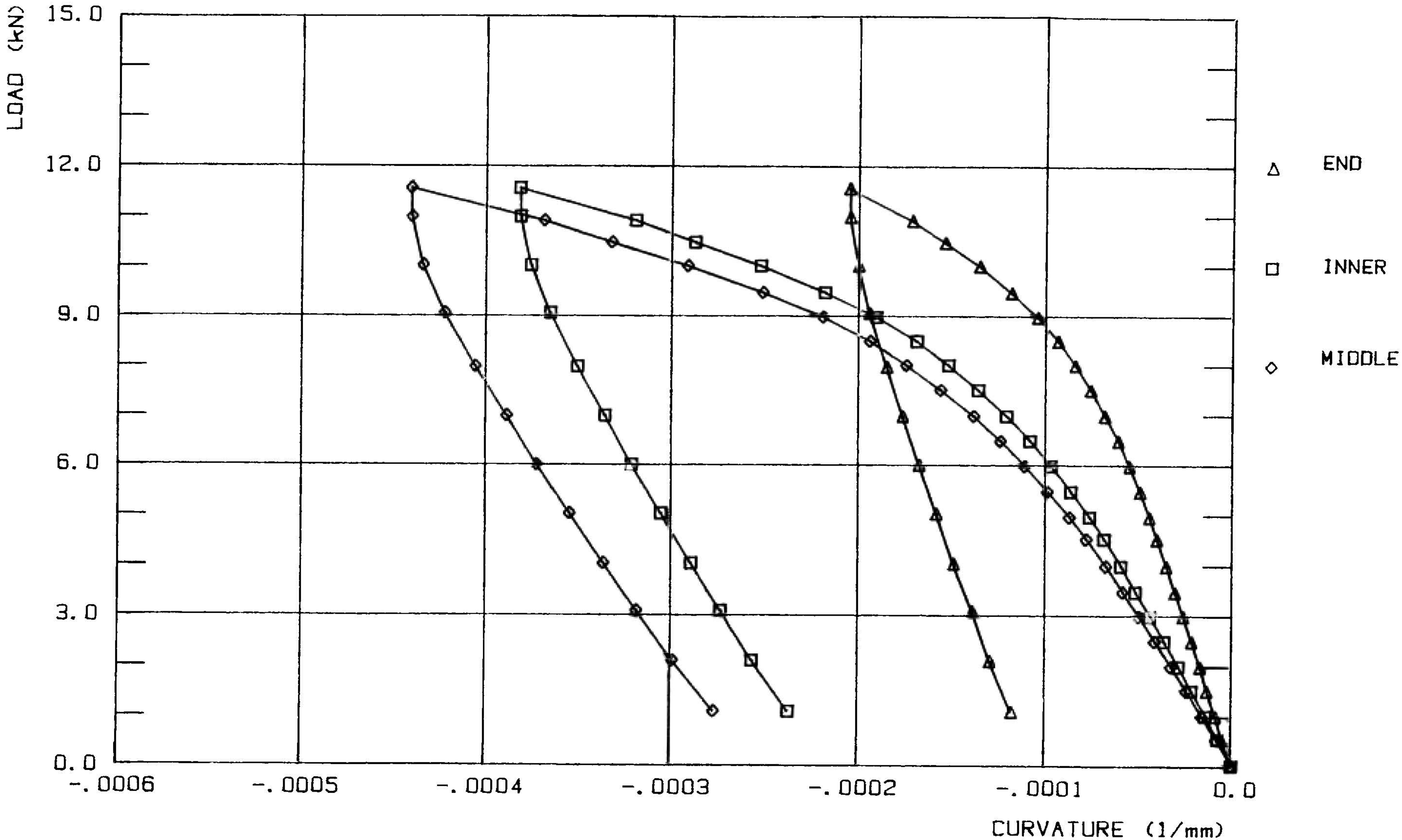
FILE :B:3PLATE8.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	7.664064E-03	1.677836E-07
1	.5364845	-7.19601E-06
2	1.005908	-1.389315E-05
3	1.511737	-2.142482E-05
4	1.990741	-2.845764E-05
5	2.492737	-3.615717E-05
6	2.988985	-4.386122E-05
7	3.469905	-5.15609E-05
8	3.981481	-5.960063E-05
9	4.51605	-6.880598E-05
10	4.952901	-7.667806E-05
11	5.462562	-8.67224E-05
12	5.974138	-9.727024E-05
13	6.476134	-1.084893E-04
14	6.976214	-1.210463E-04
15	7.501202	-1.361158E-04
16	7.997451	-1.520244E-04
17	8.484119	-1.689355E-04
18	8.966954	-1.905405E-04
19	9.459371	-2.181688E-04
20	9.99777	-2.525005E-04
21	10.46719	-2.876675E-04
22	10.90213	-3.1932E-04
23	11.54783	-3.817869E-04
24	10.97686	-3.814513E-04
25	10.00352	-3.755914E-04
26	9.039761	-3.652096E-04
27	7.95913	-3.503016E-04
28	6.96855	-3.353981E-04
29	5.989466	-3.211614E-04
30	5.014214	-3.05419E-04
31	4.021717	-2.893411E-04
32	3.079038	-2.734311E-04
33	2.088457	-2.566866E-04
34	1.078717	-2.372576E-04

END TRANSVERSE CURVATURE. POSITION 9.

FILE :B:3PLATE9.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	7.664064E-03	0
1	.5364845	-5.020469E-06
2	1.005908	-8.371848E-06
3	1.511737	-1.306114E-05
4	1.990741	-1.674373E-05
5	2.492737	-2.143307E-05
6	2.988985	-2.595464E-05
7	3.469905	-3.047619E-05
8	3.981481	-3.516558E-05
9	4.51605	-4.019054E-05
10	4.952901	-4.437659E-05
11	5.462562	-4.939715E-05
12	5.974138	-5.526115E-05
13	6.476134	-6.128856E-05
14	6.976214	-6.865834E-05
15	7.501202	-7.619155E-05
16	7.997451	-8.456818E-05
17	8.484119	-9.377946E-05
18	8.966954	-1.046643E-04
19	9.459371	-1.18733E-04
20	9.99777	-1.356456E-04
21	10.46719	-1.540685E-04
22	10.90213	-1.716525E-04
23	11.54783	-2.053148E-04
24	10.97686	-2.049792E-04
25	10.00352	-2.002939E-04
26	9.039761	-1.942618E-04
27	7.95913	-1.850503E-04
28	6.96855	-1.765099E-04
29	5.989466	-1.674662E-04
30	5.014214	-1.582547E-04
31	4.021717	-1.490433E-04
32	3.079038	-1.389928E-04
33	2.088457	-1.29618E-04
34	1.078717	-1.180618E-04



CURVATURE VERSUS LOAD

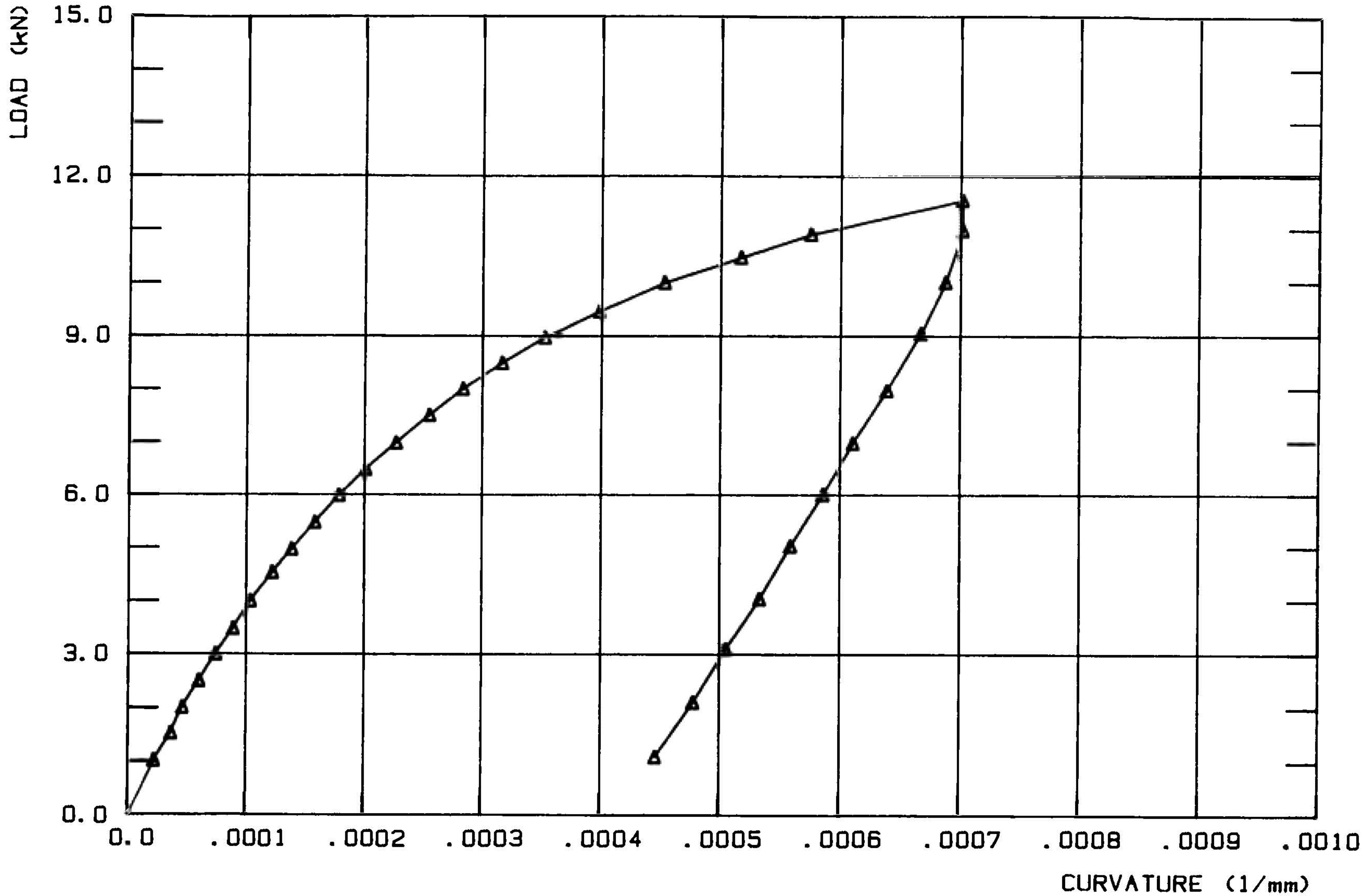
TEST 3: TRANSVERSE CURVATURE. (MIDDLE CURVATURE CALCULATED BY EXTRAPOLATION)

GRAPH 4.9

MIDDLE TRANSVERSE CURVATURE.

FILE :B:3PLATE10.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	7.664064E-03	2.237115E-07
1	.5364845	-7.921191E-06
2	1.005908	-1.573358E-05
3	1.511737	-2.421271E-05
4	1.990741	-3.236228E-05
5	2.492737	-4.10652E-05
6	2.988985	-4.983008E-05
7	3.469905	-5.858913E-05
8	3.981481	-6.774565E-05
9	4.51605	-7.834446E-05
10	4.952901	-8.744522E-05
11	5.462562	-9.916414E-05
12	5.974138	-1.112733E-04
13	6.476134	-1.242229E-04
14	6.976214	-1.38509E-04
15	7.501202	-1.560906E-04
16	7.997451	-1.745098E-04
17	8.484119	-1.939875E-04
18	8.966954	-2.191659E-04
19	9.459371	-2.51314E-04
20	9.99777	-2.914521E-04
21	10.46719	-3.322005E-04
22	10.90213	-3.685425E-04
23	11.54783	-4.40611E-04
24	10.97686	-4.402754E-04
25	10.00352	-4.340239E-04
26	9.039761	-4.221922E-04
27	7.95913	-4.053854E-04
28	6.96855	-3.883608E-04
29	5.989466	-3.723932E-04
30	5.014214	-3.544738E-04
31	4.021717	-3.36107E-04
32	3.079038	-3.182439E-04
33	2.088457	-2.990427E-04
34	1.078717	-2.769895E-04



CURVATURE VERSUS LOAD

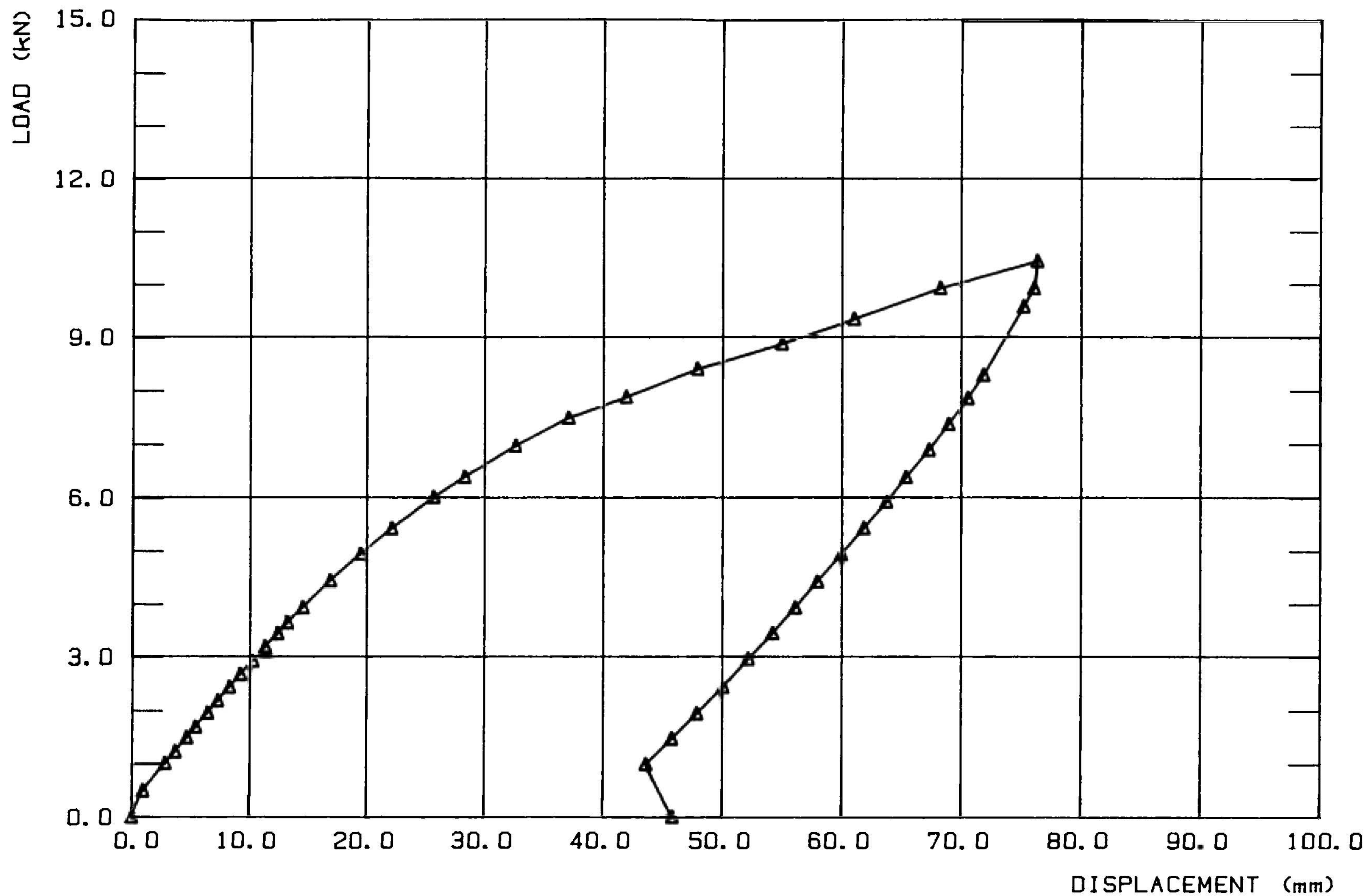
TEST 3: LONGITUDINAL CURVATURE.

GRAPH 4.10

LONGITUDINAL CURVATURE.

FILE :B:3PLATE11.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	7.664064E-03	1.173302E-06
1	.5364845	1.196764E-05
2	1.005908	2.229271E-05
3	1.511737	3.660656E-05
4	1.990741	4.622697E-05
5	2.492737	6.007079E-05
6	2.988985	7.41483E-05
7	3.469905	8.892871E-05
8	3.981481	1.034737E-04
9	4.51605	1.220044E-04
10	4.952901	1.381872E-04
11	5.462562	1.576511E-04
12	5.974138	1.782831E-04
13	6.476134	2.005505E-04
14	6.976214	2.265612E-04
15	7.501202	2.546696E-04
16	7.997451	2.832327E-04
17	8.484119	3.162276E-04
18	8.966954	3.524726E-04
19	9.459371	3.980298E-04
20	9.99777	4.526293E-04
21	10.46719	5.166877E-04
22	10.90213	5.752706E-04
23	11.54783	7.015246E-04
24	10.97686	7.017571E-04
25	10.00352	6.876583E-04
26	9.039761	6.673037E-04
27	7.95913	6.39289E-04
28	6.96855	6.110104E-04
29	5.989466	5.861825E-04
30	5.014214	5.592418E-04
31	4.021717	5.336694E-04
32	3.079038	5.0505E-04
33	2.088457	4.77802E-04
34	1.078717	4.461009E-04



DISPLACEMENT VERSUS LOAD

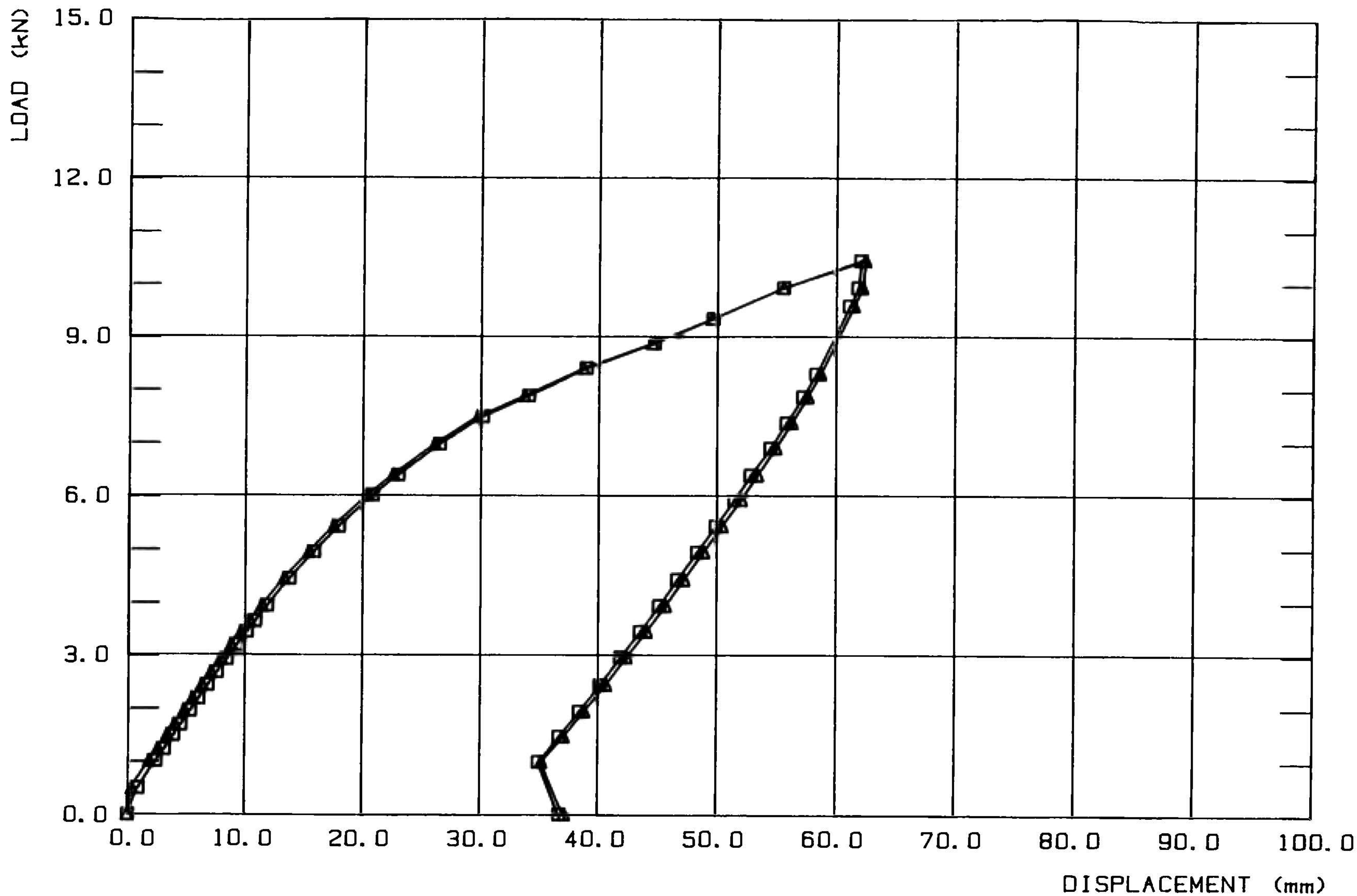
TEST 4: MIDDLE DISPLACEMENT. LVDT POSITION 1.

GRAPH 5.1

MIDDLE DISPLACEMENT. LVDT POSITION 1.

FILE :B:4PLATE1.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	-3.832042E-03	0
1	.4981641	.9375
2	1.007824	2.832031
3	1.228166	3.691407
4	1.492576	4.667969
5	1.691842	5.419922
6	1.956252	6.396485
7	2.186174	7.275391
8	2.441004	8.251953
9	2.682422	9.179689
10	2.933421	10.24414
11	3.201663	11.2793
12	3.448829	12.34375
13	3.651927	13.18359
14	3.941245	14.46289
15	4.448989	16.80664
16	4.947153	19.38477
17	5.429989	22.02149
18	6.022038	25.58594
19	6.397577	28.22266
20	6.976214	32.56836
21	7.499286	37.05078
22	7.888238	41.88477
23	8.409393	47.86133
24	8.882649	54.9414
25	9.346325	60.97657
26	9.93071	68.2129
27	10.44037	76.29883
28	9.926878	76.0254
29	9.581995	75.15625
30	8.290601	71.82618
31	7.859498	70.50781
32	7.372829	68.8965
33	6.89191	67.25586
34	6.386081	65.33203
35	5.93007	63.70117
36	5.431906	61.80664
37	4.943321	59.91211
38	4.425997	57.91992
39	3.937413	56.05469
40	3.452661	54.16015
41	2.965993	52.12891
42	2.444836	50.01953
43	1.94284	47.8418
44	1.469584	45.75196
45	.9944122	43.59375
46	5.748034E-03	45.84961



DISPLACEMENT VERSUS LOAD

TEST 4: END DISPLACEMENT. LVDT POSITIONS 2 AND 3.

GRAPH 5.2

END DISPLACEMENT: LVDT POSITION 2.

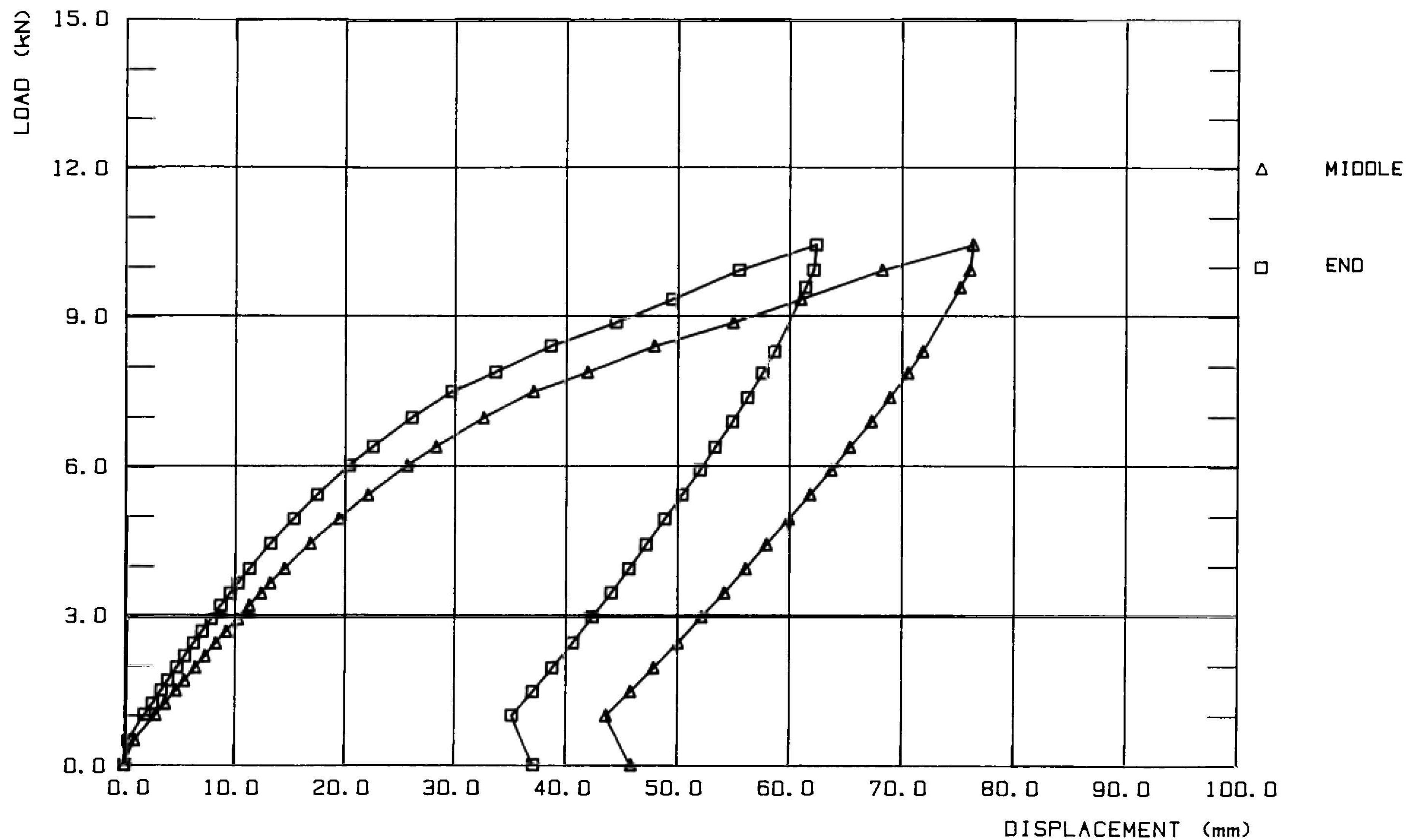
FILE :B:4PLATE2.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	-3.832042E-03	-9.767532E-03
1	.4981641	.3271485
2	1.007824	1.84082
3	1.228166	2.548828
4	1.492576	3.330078
5	1.691842	3.94043
6	1.956252	4.746094
7	2.186174	5.454102
8	2.441004	6.259766
9	2.682422	7.016602
10	2.933421	7.861328
11	3.201663	8.720703
12	3.448829	9.575196
13	3.651927	10.28809
14	3.941245	11.32812
15	4.448989	13.21777
16	4.947153	15.31738
17	5.429989	17.43652
18	6.022038	20.33203
19	6.397577	22.49512
20	6.976214	26.03516
21	7.499286	29.69727
22	7.888238	33.66211
23	8.409393	38.6084
24	8.882649	44.47266
25	9.346325	49.51172
26	9.93071	55.47852
27	10.44037	62.36328
28	9.926878	62.11914
29	9.581995	61.40625
30	8.290601	58.62793
31	7.859498	57.55371
32	7.372829	56.23535
33	6.89191	54.89258
34	6.386081	53.33008
35	5.93007	51.98731
36	5.431906	50.37598
37	4.943321	48.83789
38	4.425997	47.17774
39	3.937413	45.63965
40	3.452661	44.05274
41	2.965993	42.3584
42	2.444836	40.61035
43	1.94284	38.78418
44	1.469584	37.0459
45	.9944122	35.19043
46	5.748034E-03	37.12402

END DISPLACEMENT: LVDT POSITION 3.

FILE :B:4PLATE3.DAT

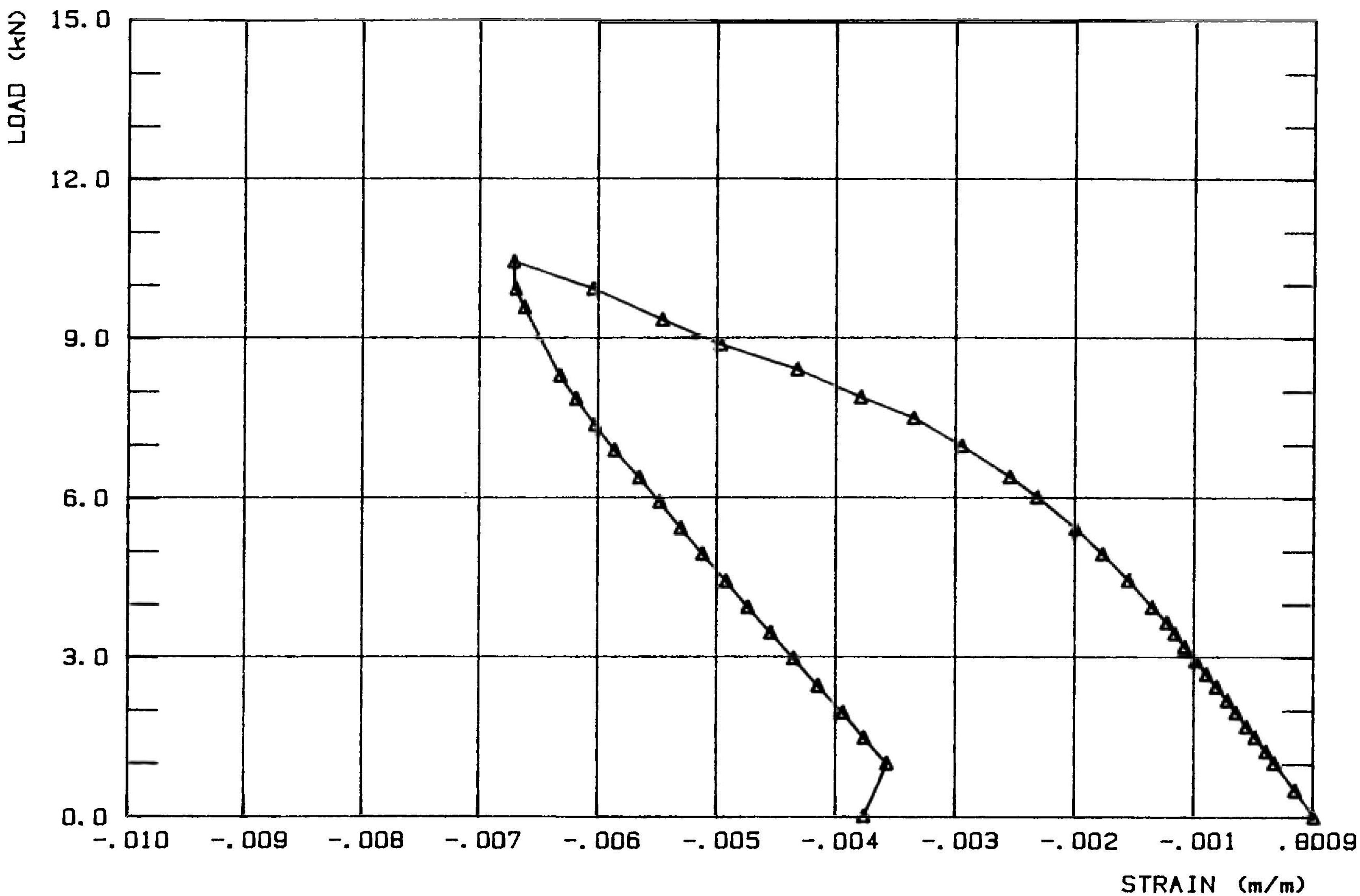
LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	-3.832042E-03	0
1	.4981641	.8789062
2	1.007824	2.392578
3	1.228166	3.100586
4	1.492576	3.886719
5	1.691842	4.497071
6	1.956252	5.297852
7	2.186174	6.000977
8	2.441004	6.78711
9	2.682422	7.543946
10	2.933421	8.38379
11	3.201663	9.228516
12	3.448829	10.08301
13	3.651927	10.78125
14	3.941245	11.81152
15	4.448989	13.69629
16	4.947153	15.77637
17	5.429989	17.89551
18	6.022038	20.7959
19	6.397577	22.94922
20	6.976214	26.47949
21	7.499286	30.12695
22	7.888238	34.0625
23	8.409393	38.91602
24	8.882649	44.68262
25	9.346325	49.60938
26	9.93071	55.5127
27	10.44037	62.01172
28	9.926878	61.76758
29	9.581995	61.05957
30	8.290601	58.27637
31	7.859498	57.17774
32	7.372829	55.81055
33	6.89191	54.44336
34	6.386081	52.80762
35	5.93007	51.43555
36	5.431906	49.87793
37	4.943321	48.31055
38	4.425997	46.65528
39	3.937413	45.12207
40	3.452661	43.54492
41	2.965993	41.87012
42	2.444836	40.15625
43	1.94284	38.39356
44	1.469584	36.69434
45	.9944122	34.96094
46	5.748034E-03	36.72363



DISPLACEMENT VERSUS LOAD

TEST 4: DISPLACEMENTS. LVDT POSITIONS 1, 2 AND 3.

GRAPH 5.3



STRAIN VERSUS LOAD

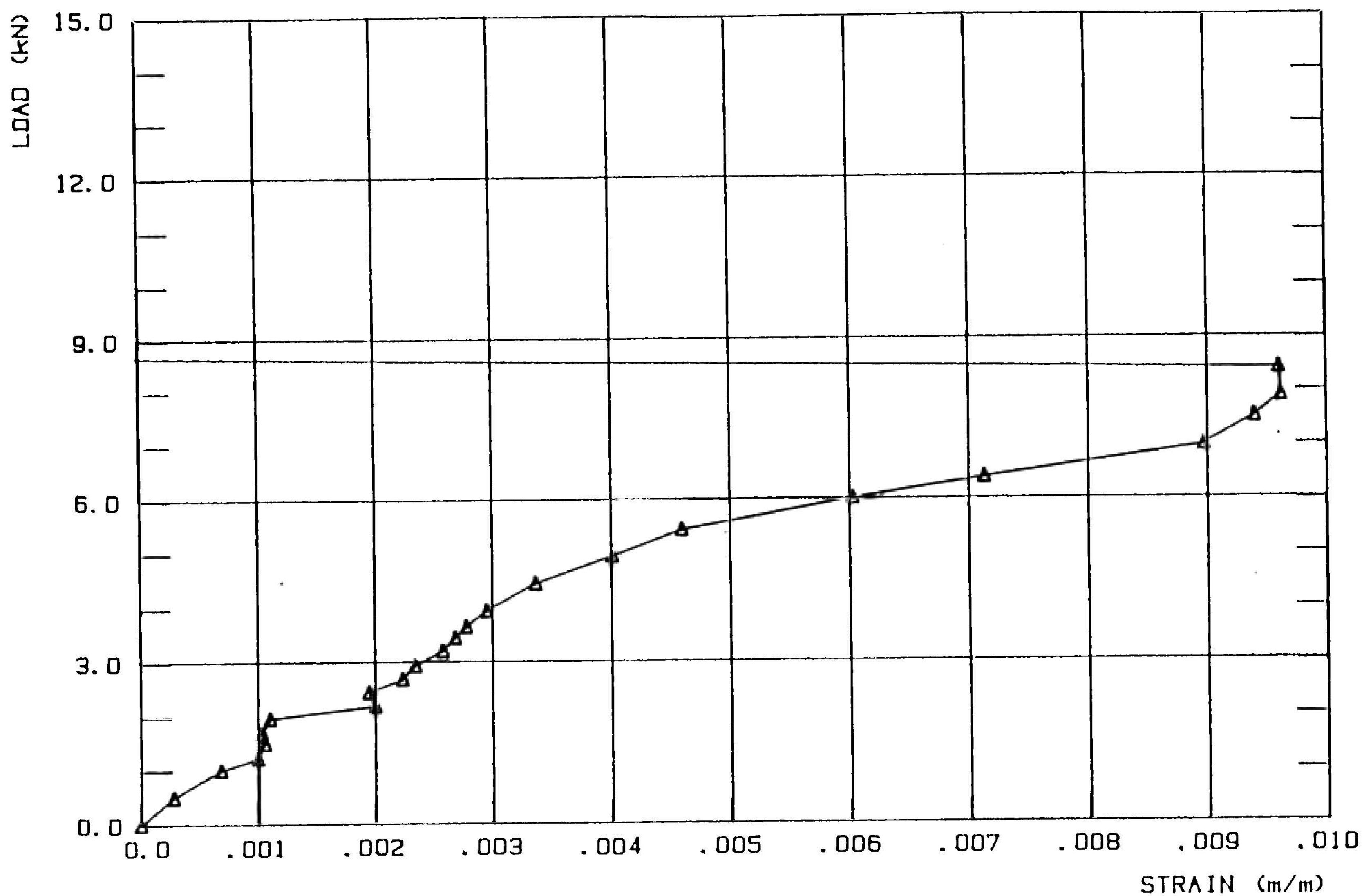
TEST 4: TOP LONGITUDINAL STRAIN. DD1 POSITION 4.

GRAPH 5.4

TOP LONGITUDINAL STRAIN. DD1 POSITION 4.

FILE :B:4PLATE4.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-3.832042E-03	8.508225E-06
1	.4981641	-1.51021E-04
2	1.007824	-3.254396E-04
3	1.228166	-3.956325E-04
4	1.492576	-4.870959E-04
5	1.691842	-5.594159E-04
6	1.956252	-6.466251E-04
7	2.186174	-7.189451E-04
8	2.441004	-8.104085E-04
9	2.682422	-8.976177E-04
10	2.933421	-9.869541E-04
11	3.201663	-1.082672E-03
12	3.448829	-1.163499E-03
13	3.651927	-1.231565E-03
14	3.941245	-1.354935E-03
15	4.448989	-1.552751E-03
16	4.947153	-1.771838E-03
17	5.429989	-1.995178E-03
18	6.022038	-2.318491E-03
19	6.397577	-2.548214E-03
20	6.976214	-2.950227E-03
21	7.499286	-3.352241E-03
22	7.888238	-3.794668E-03
23	8.409393	-4.326432E-03
24	8.882649	-4.973057E-03
25	9.346325	-5.46228E-03
26	9.93071	-6.042967E-03
27	10.44037	-6.710863E-03
28	9.926878	-6.693846E-03
29	9.581995	-6.619399E-03
30	8.290601	-6.319485E-03
31	7.859498	-6.183353E-03
32	7.372829	-6.023824E-03
33	6.89191	-5.860041E-03
34	6.386081	-5.651588E-03
35	5.93007	-5.481425E-03
36	5.431906	-5.302752E-03
37	4.943321	-5.119825E-03
38	4.425997	-4.919881E-03
39	3.937413	-4.736955E-03
40	3.452661	-4.545519E-03
41	2.965993	-4.351957E-03
42	2.444836	-4.149887E-03
43	1.94284	-3.939309E-03
44	1.469584	-3.762762E-03
45	.9944122	-3.573455E-03
46	5.748034E-03	-3.76489E-03



STRAIN VERSUS LOAD

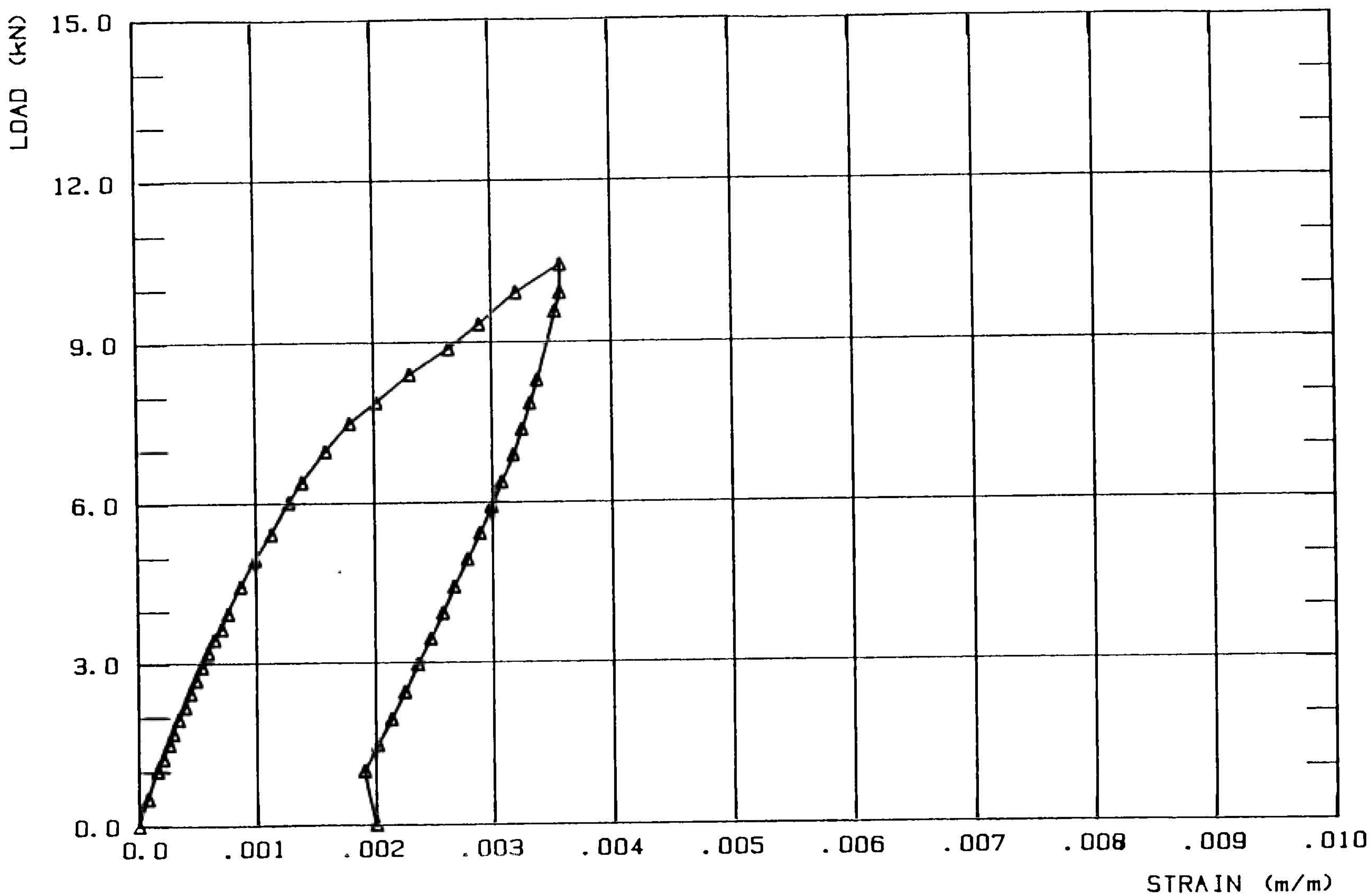
TEST 4: BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 6

GRAPH 5.5

BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 6.

FILE :B:4PLATE6.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-3.832042E-03	0
1	.4981641	2.768385E-04
2	1.007824	6.803656E-04
3	1.228166	9.994339E-04
4	1.492576	1.060432E-03
5	1.691842	1.032279E-03
6	1.956252	1.102662E-03
7	2.186174	2.00356E-03
8	2.441004	1.947254E-03
9	2.682422	2.233477E-03
10	2.933421	2.341397E-03
11	3.201663	2.576006E-03
12	3.448829	2.683927E-03
13	3.651927	2.777769E-03
14	3.941245	2.95138E-03
15	4.448989	3.364292E-03
16	4.947153	4.011812E-03
17	5.429989	4.598335E-03
18	6.022038	6.029448E-03
19	6.397577	7.13211E-03
20	6.976214	8.971441E-03
21	7.499286	9.398432E-03
22	7.888238	9.618962E-03
23	8.409393	9.604887E-03
24	8.882649	-7.972011E-03
25	9.346325	-8.028316E-03
26	9.93071	-7.657633E-03
27	10.44037	-6.587818E-03
28	9.926878	-6.630047E-03
29	9.581995	-6.72389E-03
30	8.290601	-7.563791E-03
31	7.859498	-7.882858E-03
32	7.372829	-8.286385E-03
33	6.89191	-8.76968E-03
34	6.386081	-9.351509E-03
35	5.93007	-9.769112E-03
36	5.431906	-1.004126E-02
37	4.943321	-1.047763E-02
38	4.425997	-1.090931E-02
39	3.937413	-1.132692E-02
40	3.452661	-1.167414E-02
41	2.965993	-1.206828E-02
42	2.444836	-1.288472E-02
43	1.94284	-1.372931E-02
44	1.469584	-1.456921E-02
45	.9944122	-1.532934E-02
46	5.748034E-03	-.0153575



STRAIN VERSUS LOAD

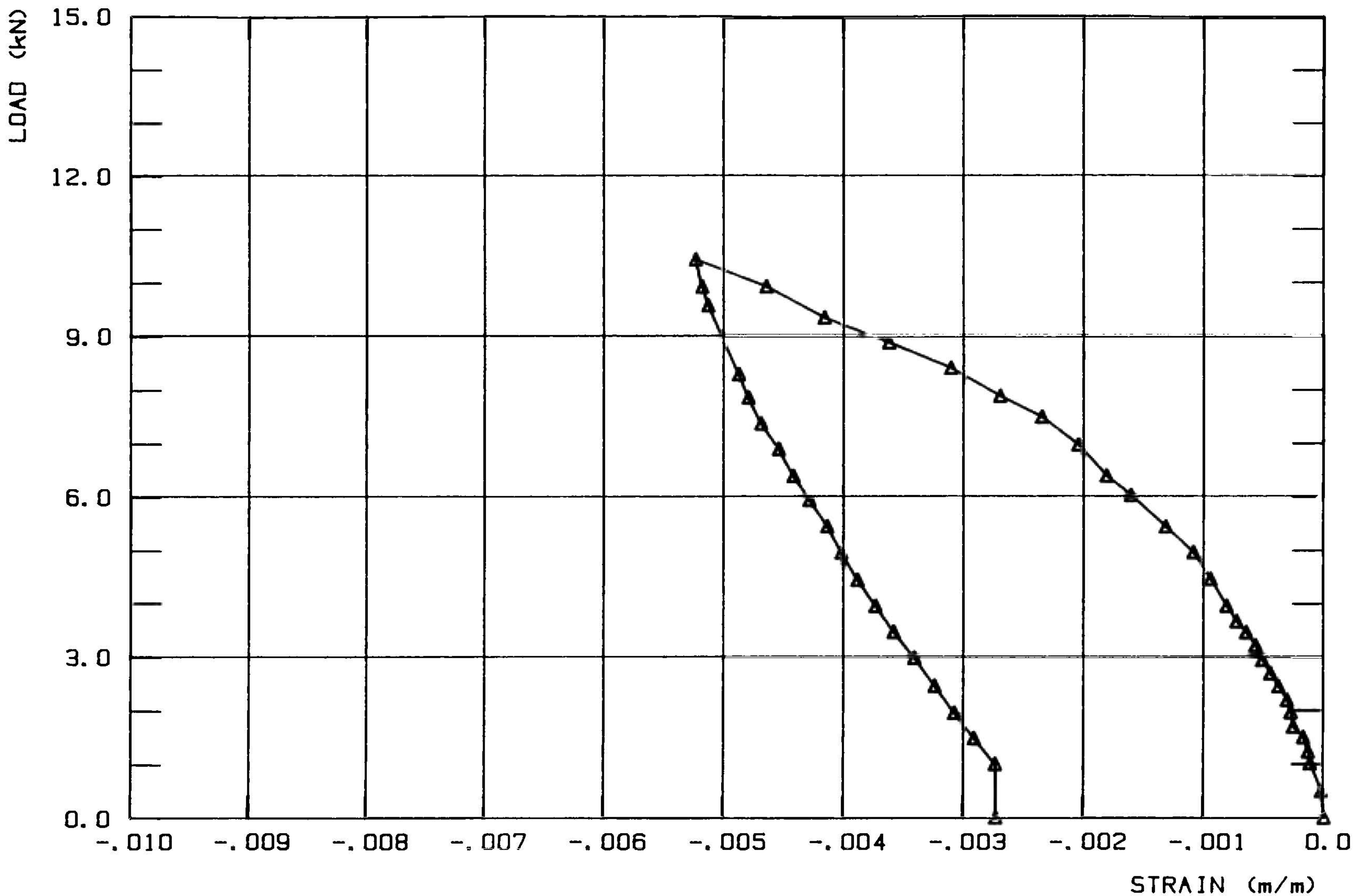
TEST 4: TOP TRANSVERSE STRAIN. DD1 POSITION 5.

GRAPH 5.6

TOP TRANSVERSE STRAIN. DD1 POSITION 5.

FILE :B:4PLATE5.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-3.832042E-03	5.62391E-06
1	.4981641	8.248408E-05
2	1.007824	1.612189E-04
3	1.228166	2.080849E-04
4	1.492576	.0002587
5	1.691842	2.924436E-04
6	1.956252	3.393095E-04
7	2.186174	3.936741E-04
8	2.441004	4.386654E-04
9	2.682422	4.855314E-04
10	2.933421	5.34272E-04
11	3.201663	5.886365E-04
12	3.448829	6.43001E-04
13	3.651927	7.029894E-04
14	3.941245	7.592286E-04
15	4.448989	8.679576E-04
16	4.947153	9.898091E-04
17	5.429989	1.126658E-03
18	6.022038	1.276629E-03
19	6.397577	1.389107E-03
20	6.976214	1.587819E-03
21	7.499286	1.792155E-03
22	7.888238	2.017112E-03
23	8.409393	2.302057E-03
24	8.882649	2.633867E-03
25	9.346325	2.894441E-03
26	9.93071	3.205632E-03
27	10.44037	3.58056E-03
28	9.926878	3.578685E-03
29	9.581995	3.533693E-03
30	8.290601	3.381848E-03
31	7.859498	3.319985E-03
32	7.372829	3.248748E-03
33	6.89191	3.175638E-03
34	6.386081	3.076281E-03
35	5.93007	2.988174E-03
36	5.431906	2.888818E-03
37	4.943321	2.781964E-03
38	4.425997	2.66761E-03
39	3.937413	2.57013E-03
40	3.452661	2.467024E-03
41	2.965993	2.35642E-03
42	2.444836	2.245817E-03
43	1.94284	2.131464E-03
44	1.469584	2.013361E-03
45	.9944122	1.902758E-03
46	5.748034E-03	2.002113E-03



STRAIN VERSUS LOAD

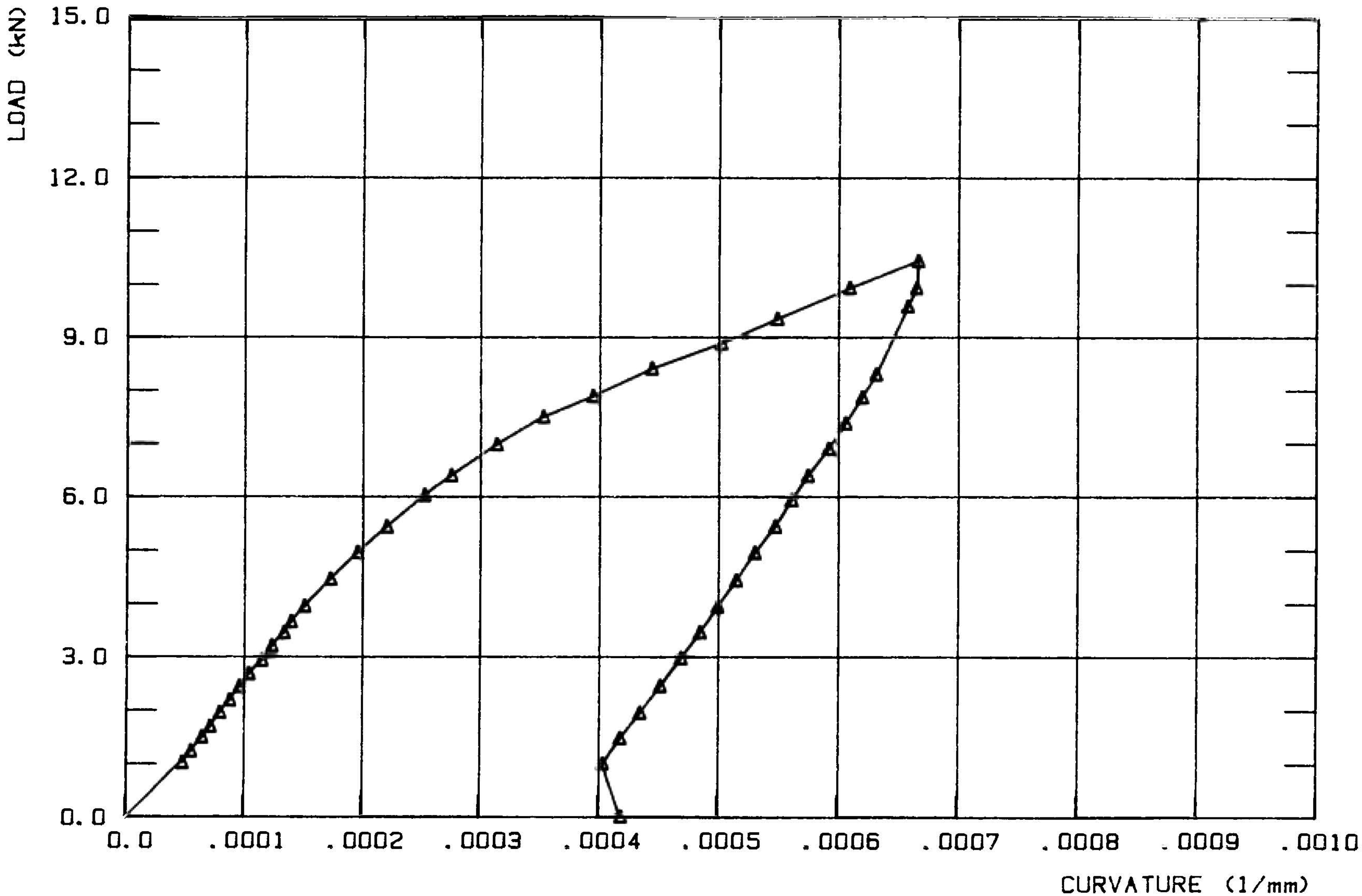
TEST 4: BOTTOM TRANSVERSE STRAIN. DD1 POSITION 7.

GRAPH 5.7

BOTTOM TRANSVERSE STRAIN. DDI POSITION 7.

FILE :B:4PLATE7.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-3.832042E-03	8.409288E-06
1	.4981641	-1.681858E-05
2	1.007824	-1.093208E-04
3	1.228166	-1.261393E-04
4	1.492576	-1.681858E-04
5	1.691842	-2.522787E-04
6	1.956252	-2.733018E-04
7	2.186174	-3.027344E-04
8	2.441004	-3.742133E-04
9	2.682422	-4.414876E-04
10	2.933421	-5.087619E-04
11	3.201663	-5.634225E-04
12	3.448829	-6.433105E-04
13	3.651927	-7.231988E-04
14	3.941245	-8.072917E-04
15	4.448989	-9.418403E-04
16	4.947153	-1.084798E-03
17	5.429989	-1.316054E-03
18	6.022038	-1.606174E-03
19	6.397577	-1.807997E-03
20	6.976214	-2.043457E-03
21	7.499286	-2.346192E-03
22	7.888238	-2.695177E-03
23	8.409393	-3.103027E-03
24	8.882649	-.0036202
25	9.346325	-4.158394E-03
26	9.93071	-4.641927E-03
27	10.44037	-5.230579E-03
28	9.926878	-5.175918E-03
29	9.581995	-5.12546E-03
30	8.290601	-4.868978E-03
31	7.859498	-4.789089E-03
32	7.372829	-4.683974E-03
33	6.89191	-4.536812E-03
34	6.386081	-4.414876E-03
35	5.93007	-4.280327E-03
36	5.431906	-4.133165E-03
37	4.943321	-4.015434E-03
38	4.425997	-3.880886E-03
39	3.937413	-3.72952E-03
40	3.452661	-3.578154E-03
41	2.965993	-3.405761E-03
42	2.444836	-3.237575E-03
43	1.94284	-3.073596E-03
44	1.469584	-2.909615E-03
45	.9944122	-2.733018E-03
46	5.748034E-03	-2.728814E-03



CURVATURE VERSUS LOAD

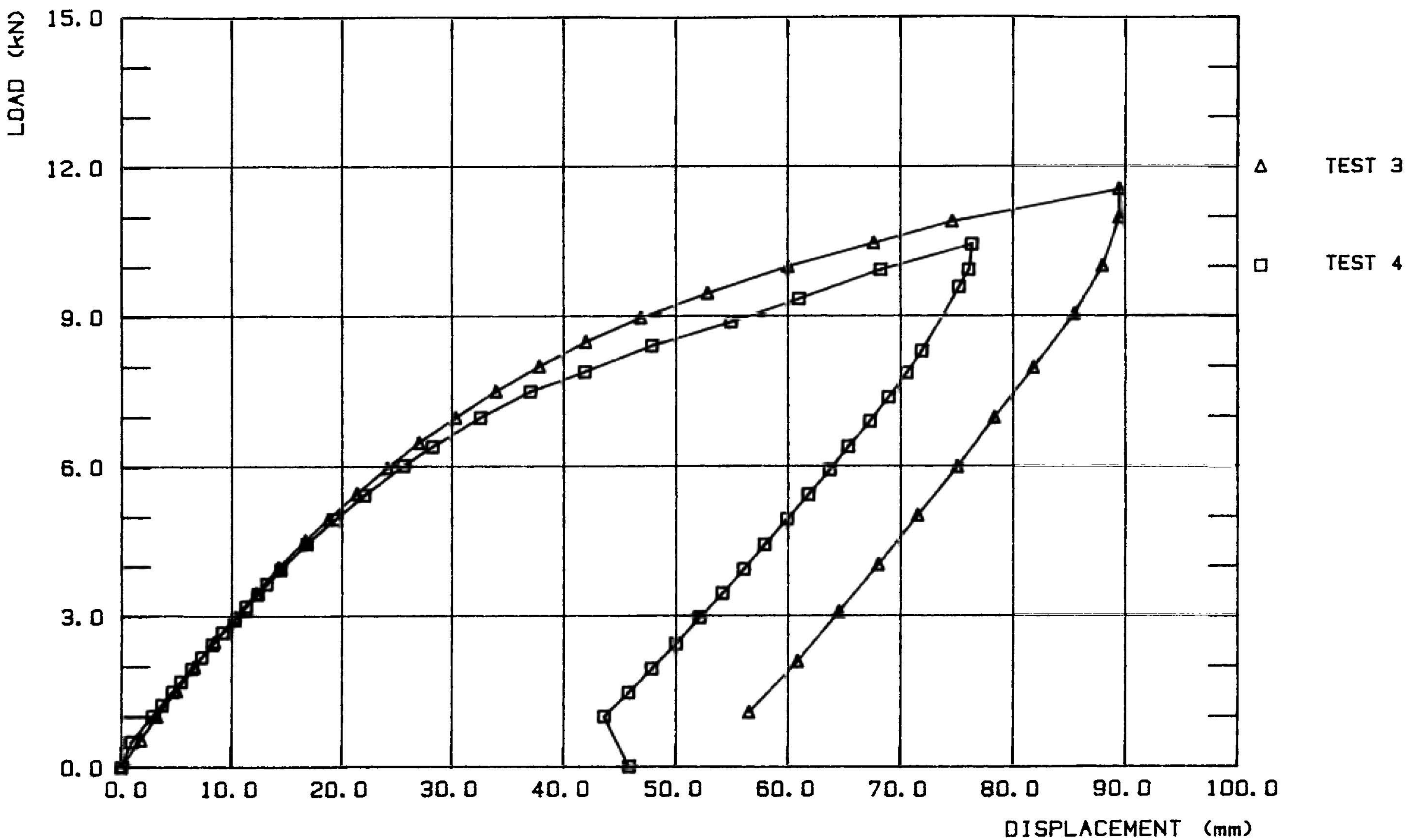
TEST 4: LONGITUDINAL CURVATURE.

GRAPH 5.8

LONGITUDINAL CURVATURE:

FILE :B:4PLATE11.DAT

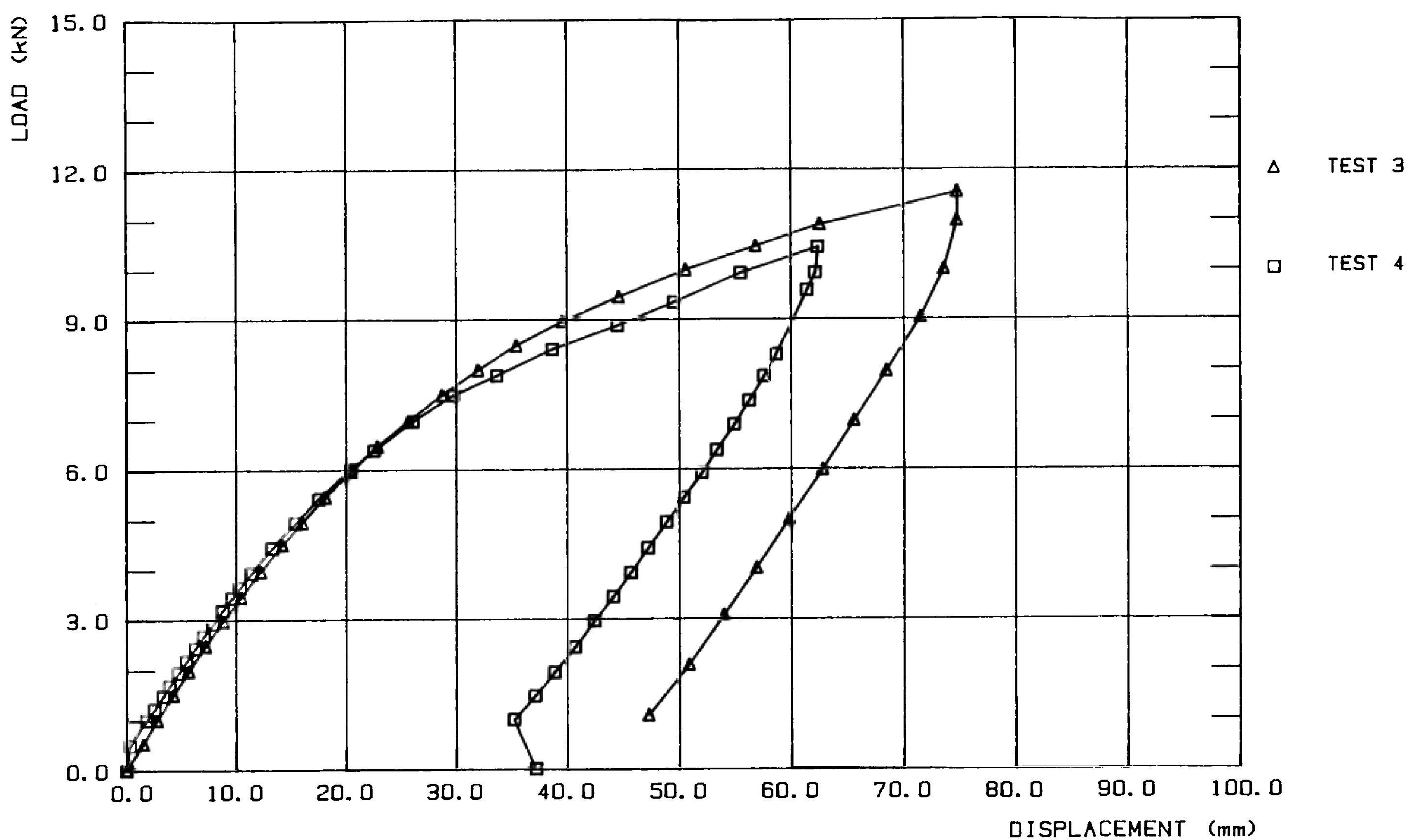
LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	-3.832042E-03	4.694126E-07
1	.4981641	2.933229E-05
2	1.007824	4.763495E-05
3	1.228166	5.490891E-05
4	1.492576	6.429426E-05
5	1.691842	7.10984E-05
6	1.956252	7.931005E-05
7	2.186174	8.752137E-05
8	2.441004	9.573225E-05
9	2.682422	1.039429E-04
10	2.933421	1.144986E-04
11	3.201663	1.229428E-04
12	3.448829	1.330278E-04
13	3.651927	1.391252E-04
14	3.941245	1.506167E-04
15	4.448989	1.724222E-04
16	4.947153	1.953949E-04
17	5.429989	2.202355E-04
18	6.022038	2.523274E-04
19	6.397577	2.750401E-04
20	6.976214	3.136536E-04
21	7.499286	3.529398E-04
22	7.888238	3.945272E-04
23	8.409393	4.437685E-04
24	8.882649	5.017901E-04
25	9.346325	5.492482E-04
26	9.93071	6.096189E-04
27	10.44037	6.666102E-04
28	9.926878	6.652219E-04
29	9.581995	6.578152E-04
30	8.290601	6.316434E-04
31	7.859498	6.200538E-04
32	7.372829	6.061403E-04
33	6.89191	5.919858E-04
34	6.386081	5.748054E-04
35	5.93007	5.610999E-04
36	5.431906	5.476206E-04
37	4.943321	5.306459E-04
38	4.425997	5.148255E-04
39	3.937413	4.992296E-04
40	3.452661	4.845572E-04
41	2.965993	4.68481E-04
42	2.444836	4.512306E-04
43	1.94284	4.344387E-04
44	1.469584	4.176392E-04
45	.9944122	4.031665E-04
46	5.748034E-03	4.185725E-04



DISPLACEMENT VERSUS LOAD

TEST 3 AND 4: MIDDLE DISPLACEMENT.

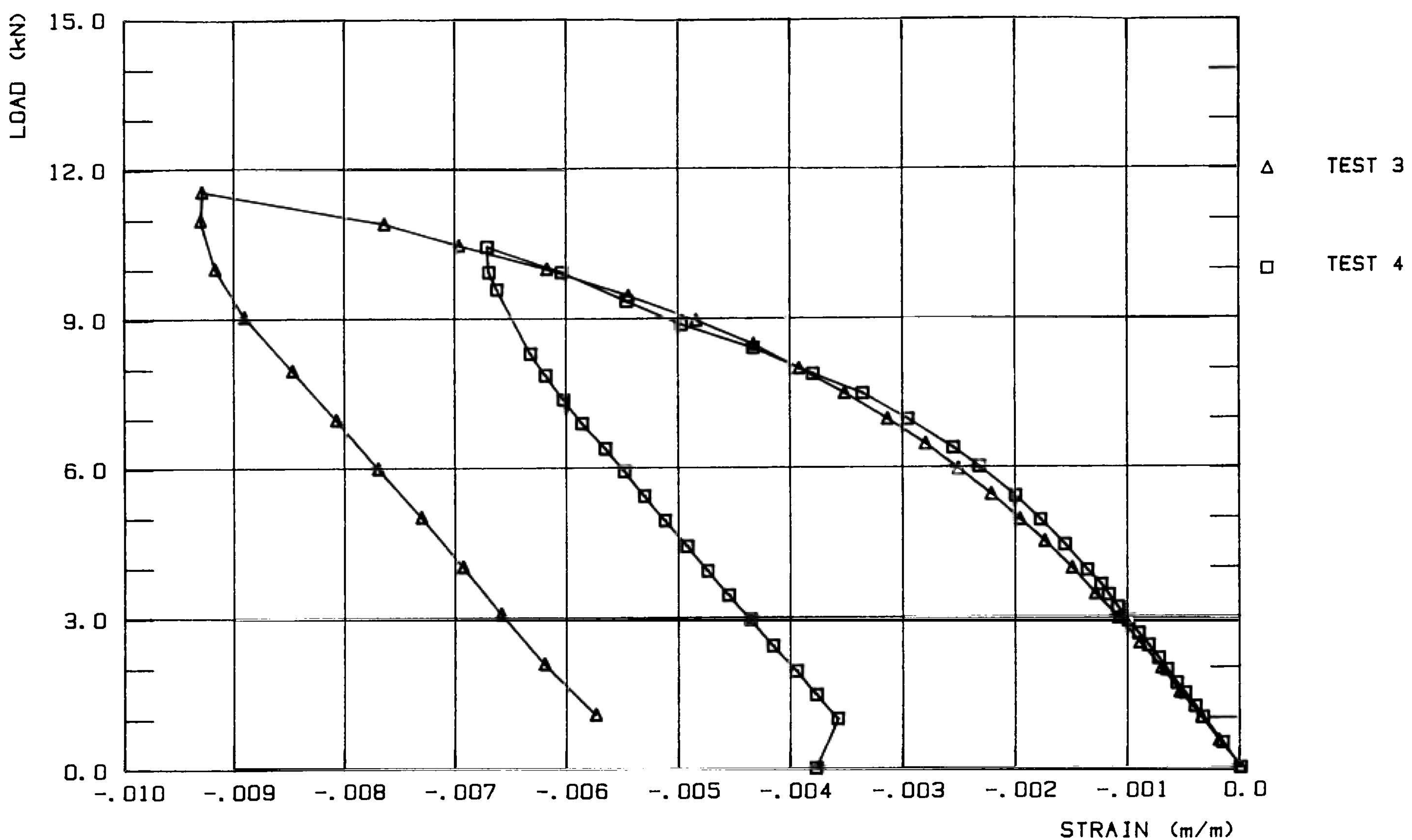
GRAPH 6.1



DISPLACEMENT VERSUS LOAD

TEST 3 AND 4: END DISPLACEMENT.

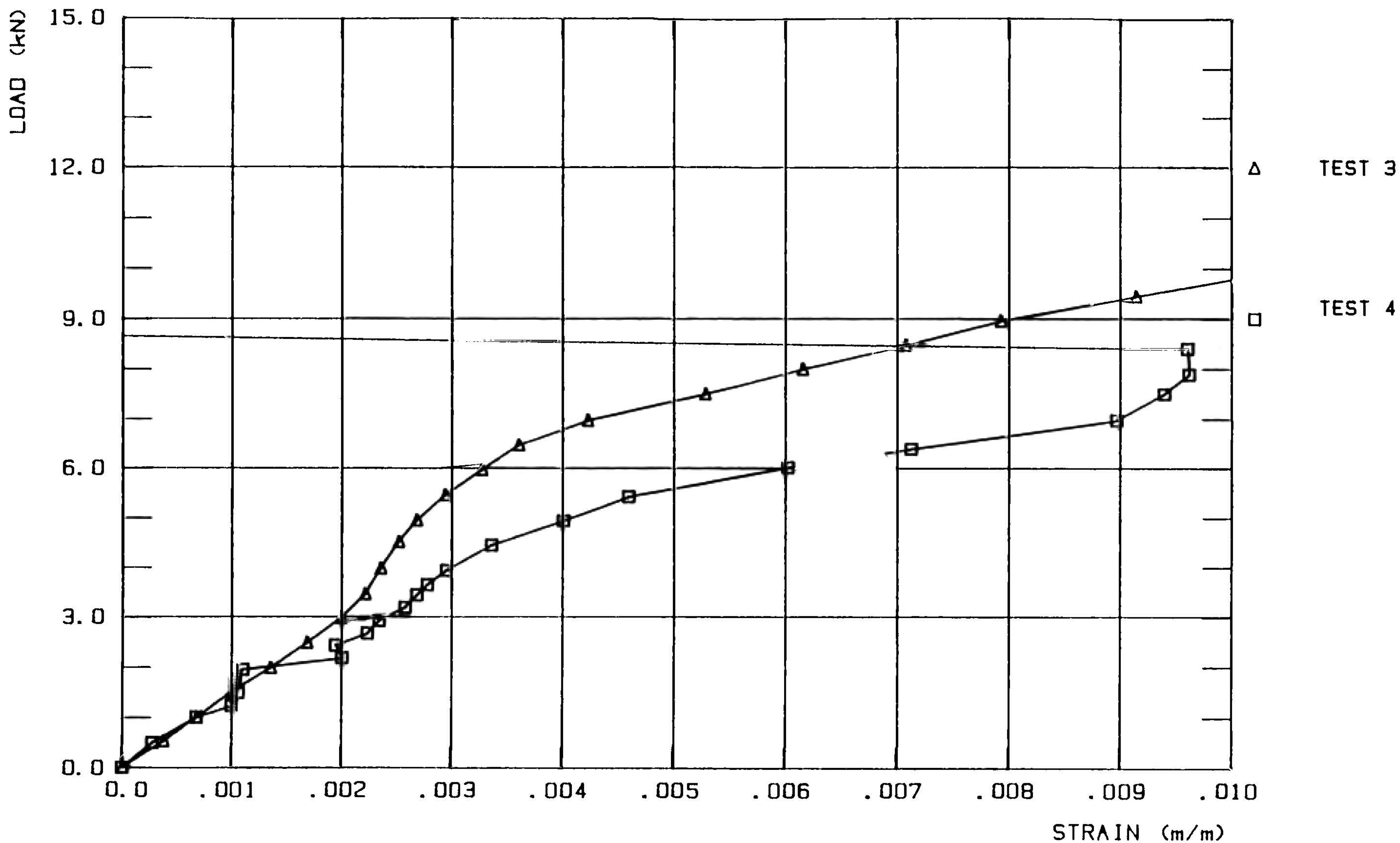
GRAPH 6.2



STRAIN VERSUS LOAD

TEST 3 AND 4: TOP LONGITUDINAL STRAIN.

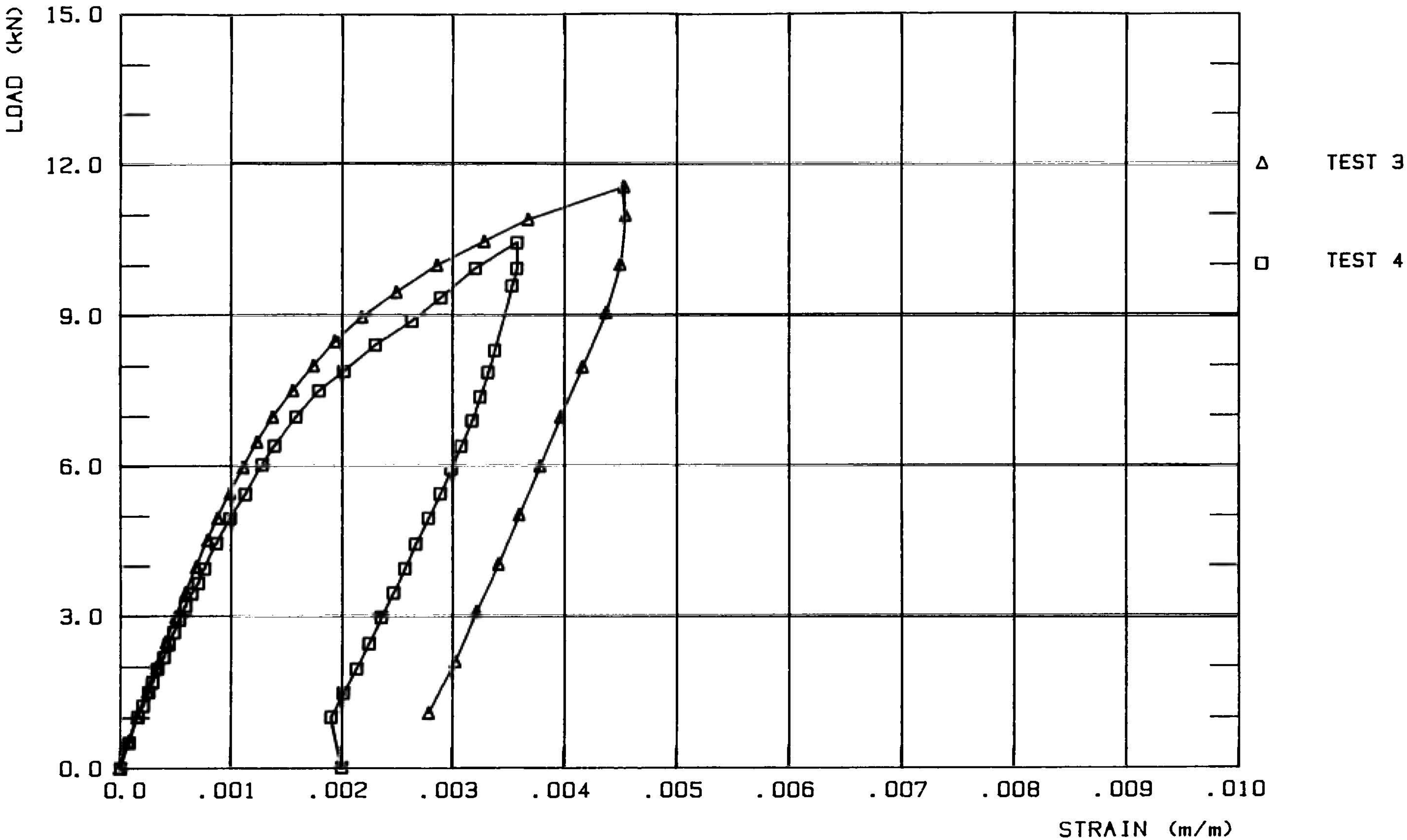
GRAPH 6.3



STRAIN VERSUS LOAD

TEST 3 AND 4: BOTTOM LONGITUDINAL STRAIN.

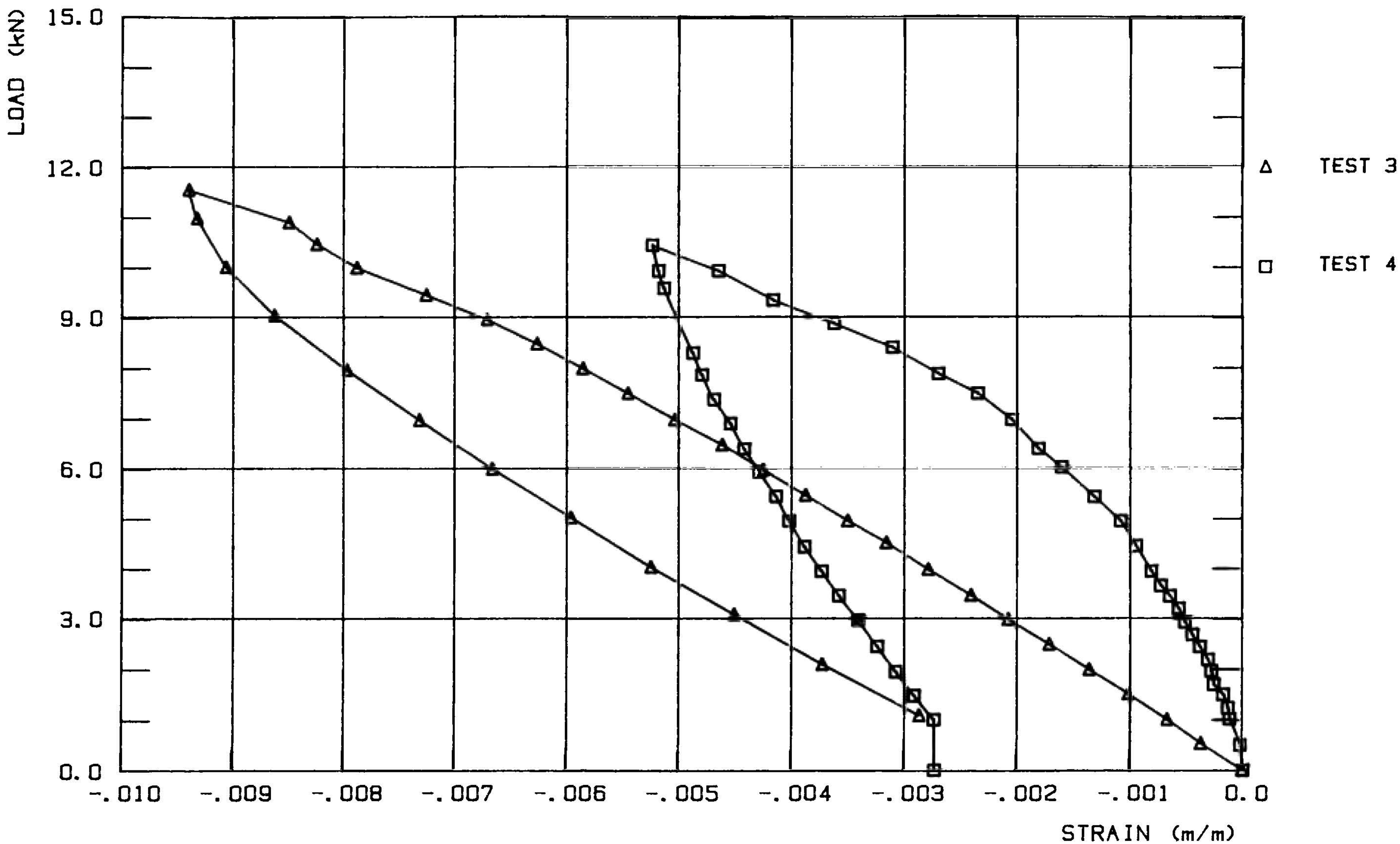
GRAPH 6.4



STRAIN VERSUS LOAD

TEST 3 AND 4: TOP TRANSVERSE LOAD.

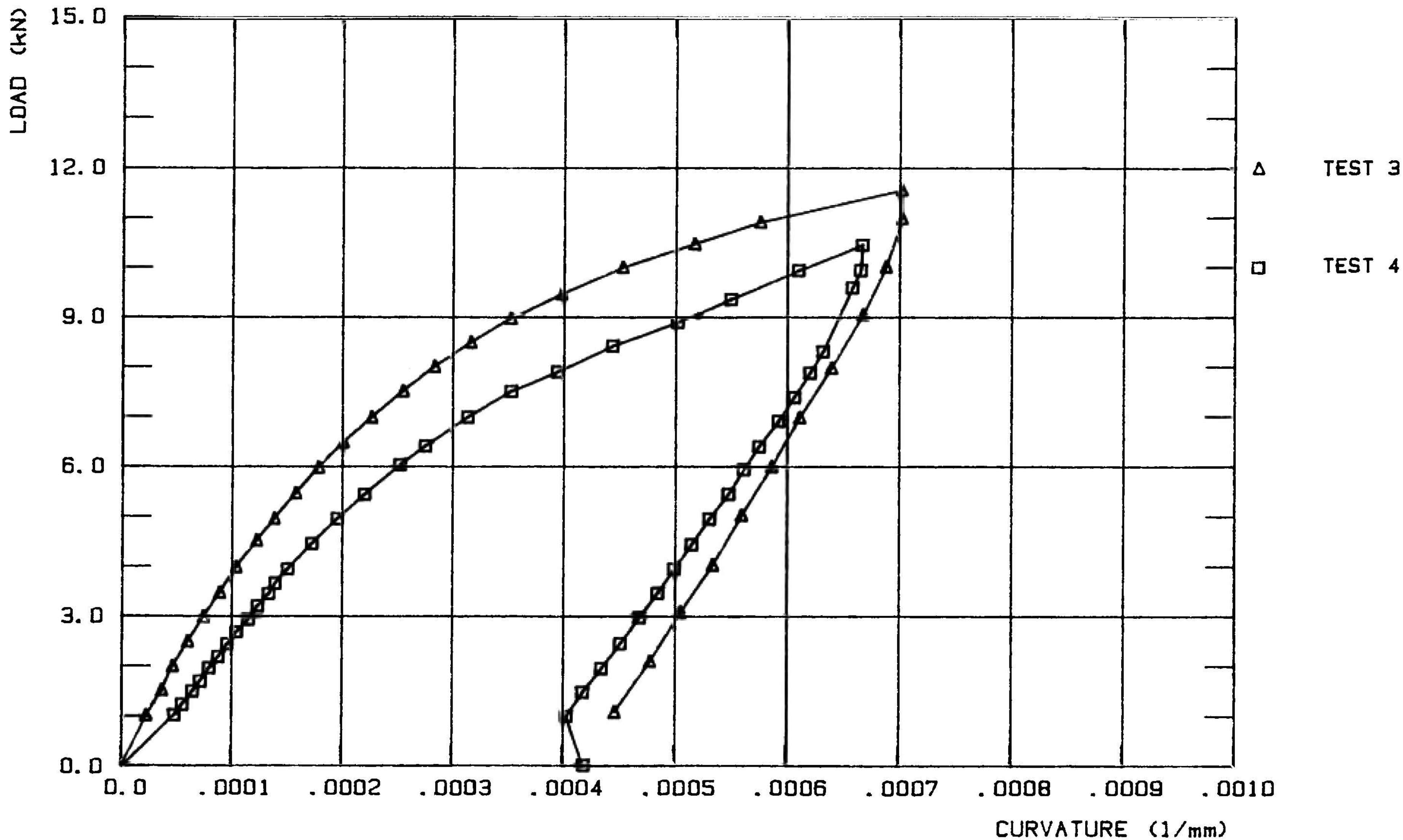
GRAPH 6.5



STRAIN VERSUS LOAD

TEST 3 AND 4: BOTTOM TRANSVERSE STRAIN.

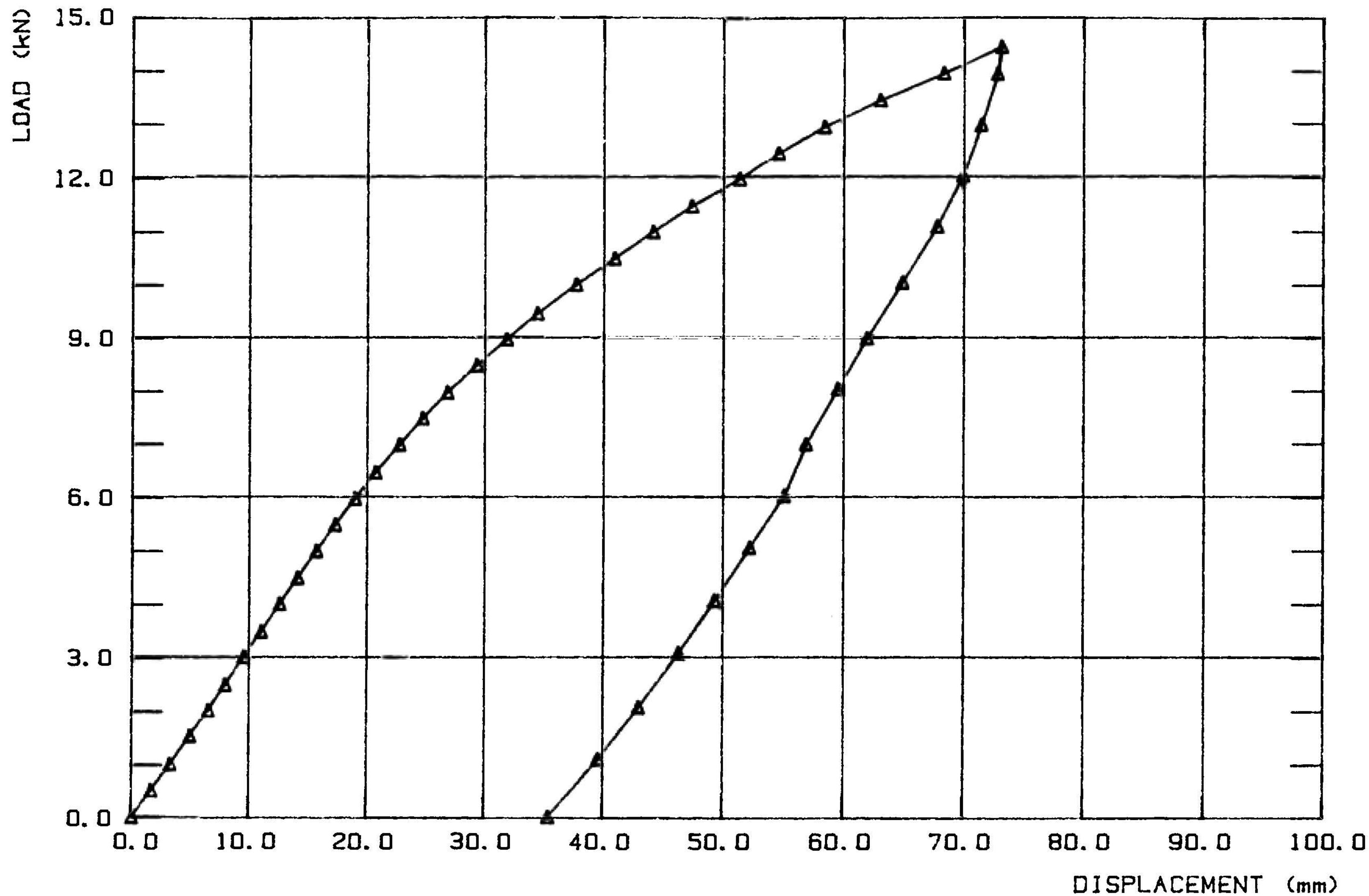
GRAPH 6.6



CURVATURE VERSUS LOAD

TEST 3 AND 4: LONGITUDINAL CURVATURE.

GRAPH 6.7



DISPLACEMENT VERSUS LOAD

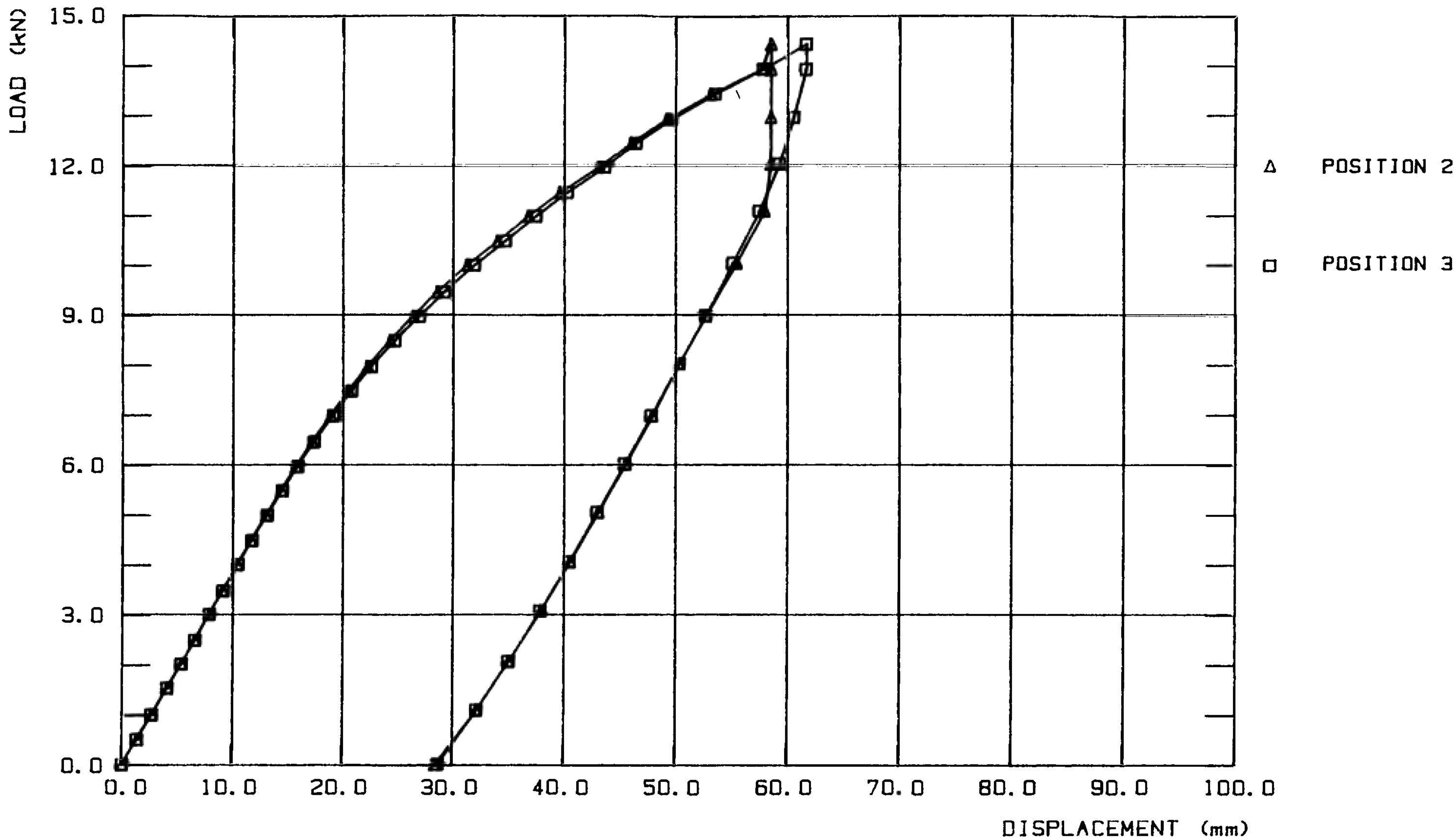
TEST 5: MIDDLE DISPLACEMENT. LVDT POSITION 1.

GRAPH 7.1

MIDDLE DISPLACEMENT. LVDT POSITION 1.

FILE :B:5PLATE1.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	1.916016E-03	4.882813E-02
1	.5058282	1.660156
2	1.002076	3.271485
3	1.534729	4.931641
4	2.017565	6.494141
5	2.494653	7.910157
6	3.015809	9.472656
7	3.483317	10.9375
8	4.004473	12.50977
9	4.48731	14.01367
10	4.991222	15.625
11	5.485554	17.23633
12	5.96839	18.89649
13	6.460806	20.6543
14	6.980047	22.70508
15	7.476294	24.6582
16	7.962962	26.75781
17	8.47837	29.24805
18	8.966954	31.78711
19	9.453622	34.375
20	9.999686	37.59766
21	10.48827	40.82031
22	10.98644	44.04297
23	11.46161	47.31446
24	11.96744	51.3086
25	12.44836	54.58985
26	12.93886	58.39844
27	13.4466	63.03711
28	13.95051	68.29103
29	14.44484	73.10547
30	13.93902	72.78321
31	12.97526	71.42578
32	12.03066	69.91211
33	11.08224	67.74415
34	10.03034	64.84375
35	8.97845	61.91407
36	8.020442	59.51172
37	6.980047	56.88477
38	6.018206	55.07813
39	5.048702	52.19727
40	4.060038	49.26758
41	3.08287	46.26953
42	2.071213	42.91992
43	1.097877	39.50195
44	.0114961	35.35156



DISPLACEMENT VERSUS LOAD

TEST 5: END DISPLACEMENT. LVDT POSITIONS 2 AND 3.

GRAPH 7.2

END DISPLACEMENT. LVDT POSITION 2.

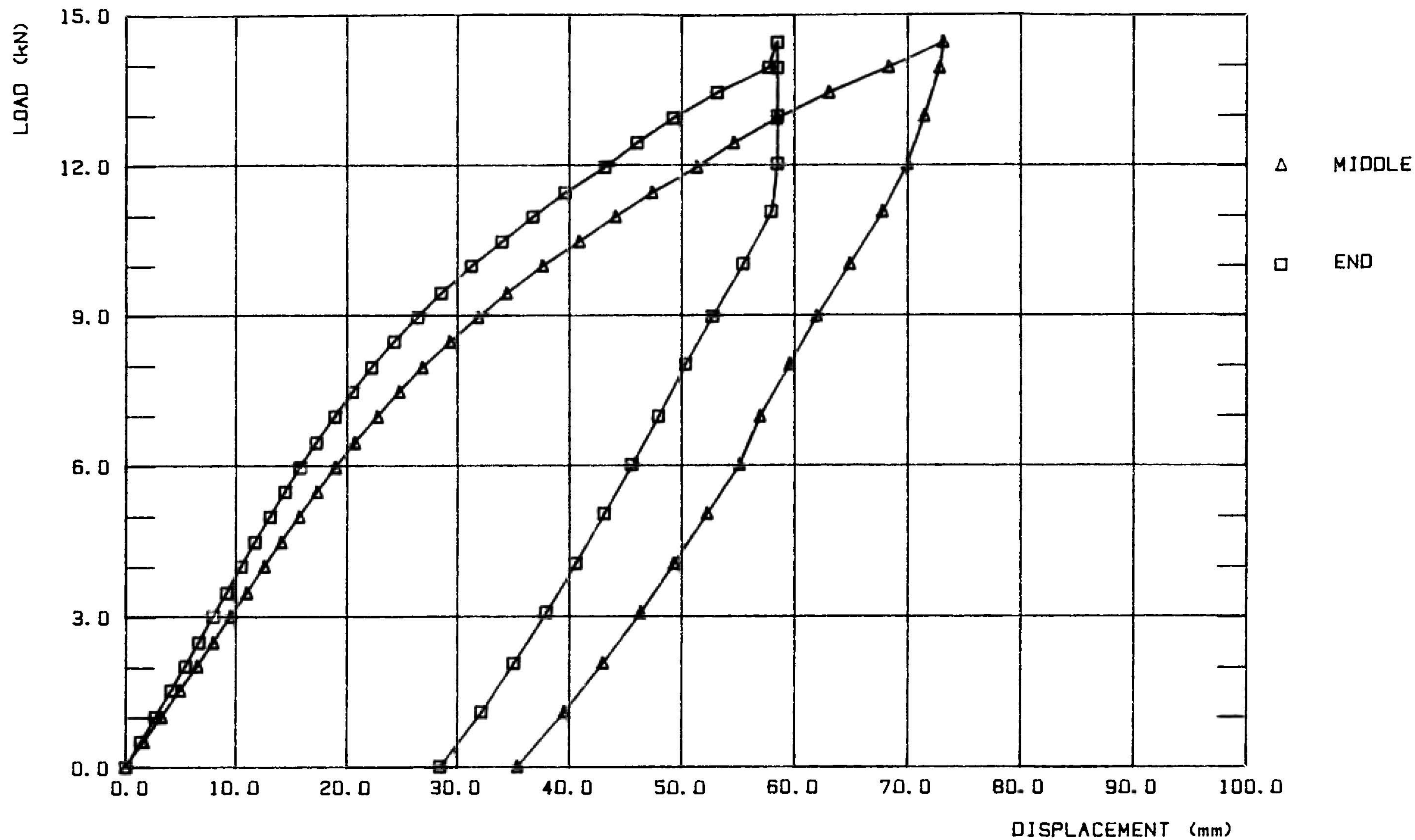
FILE :B:5PLATE2.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	1.916016E-03	2.441406E-02
1	.5058282	1.416016
2	1.002076	2.734375
3	1.534729	4.125977
4	2.017565	5.395508
5	2.494653	6.611328
6	3.015809	7.905274
7	3.483317	9.130859
8	4.004473	10.42969
9	4.48731	11.66992
10	4.991222	13.01758
11	5.485554	14.35547
12	5.96839	15.70313
13	6.460806	17.17285
14	6.980047	18.84766
15	7.476294	20.45899
16	7.962962	22.18262
17	8.47837	24.21875
18	8.966954	26.32324
19	9.453622	28.48145
20	9.999686	31.20117
21	10.48827	33.98438
22	10.98644	36.74317
23	11.46161	39.59961
24	11.96744	43.11524
25	12.44836	45.99121
26	12.93886	49.19922
27	13.4466	53.11035
28	13.95051	57.71485
29	14.44484	58.47168
30	13.93902	58.47168
31	12.97526	58.47168
32	12.03066	58.47168
33	11.08224	57.91016
34	10.03034	55.41504
35	8.97845	52.67578
36	8.020442	50.26856
37	6.980047	47.87598
38	6.018206	45.50782
39	5.048702	43.04199
40	4.060038	40.50293
41	3.08287	37.90527
42	2.071213	35.01953
43	1.097877	32.10449
44	.0114961	28.39356

END DISPLACEMENT. LVDT POSITION 3.

FILE :B:5PLATE3.DAT

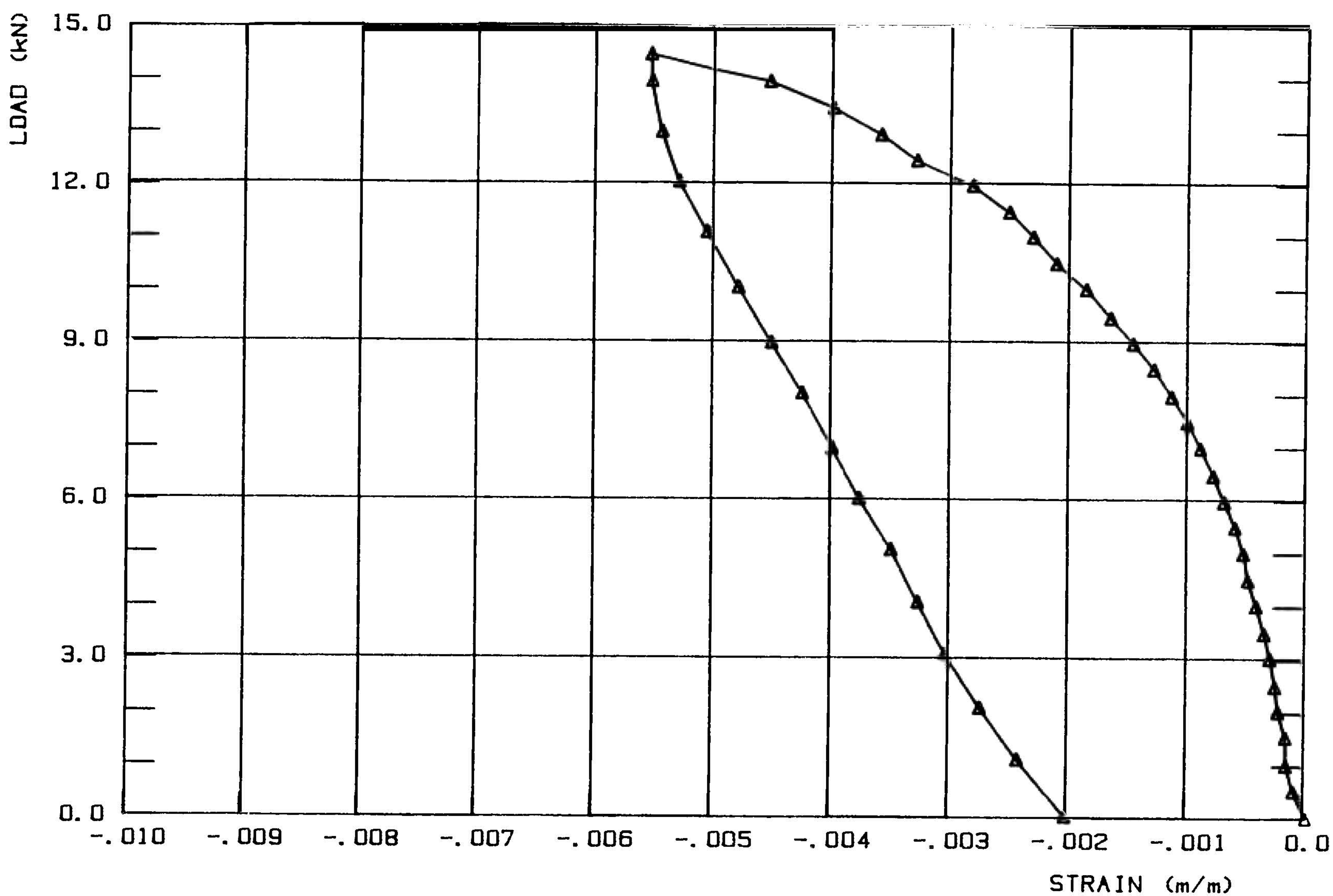
LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	1.916016E-03	9.765625E-03
1	.5058282	1.333008
2	1.002076	2.675781
3	1.534729	4.086914
4	2.017565	5.361328
5	2.494653	6.582032
6	3.015809	7.895508
7	3.483317	9.140625
8	4.004473	10.46387
9	4.48731	11.72852
10	4.991222	13.0957
11	5.485554	14.46289
12	5.96839	15.85449
13	6.460806	17.35352
14	6.980047	19.07715
15	7.476294	20.73731
16	7.962962	22.51953
17	8.47837	24.66309
18	8.966954	26.86524
19	9.453622	29.11133
20	9.999686	31.87012
21	10.48827	34.68262
22	10.98644	37.43652
23	11.46161	40.25391
24	11.96744	43.6377
25	12.44836	46.44532
26	12.93886	49.64356
27	13.4466	53.48145
28	13.95051	57.79297
29	14.44484	61.63086
30	13.93902	61.60645
31	12.97526	60.51758
32	12.03066	59.2627
33	11.08224	57.48047
34	10.03034	55.08789
35	8.97845	52.64649
36	8.020442	50.30274
37	6.980047	47.77832
38	6.018206	45.41992
39	5.048702	42.9541
40	4.060038	40.43945
41	3.08287	37.85156
42	2.071213	35.01953
43	1.097877	32.11426
44	.0114961	28.62793



DISPLACEMENT VERSUS LOAD

TEST 5: DISPLACEMENTS. LVDT POSITIONS 1, 2 AND 3.

GRAPH 7.3



STRAIN VERSUS LOAD

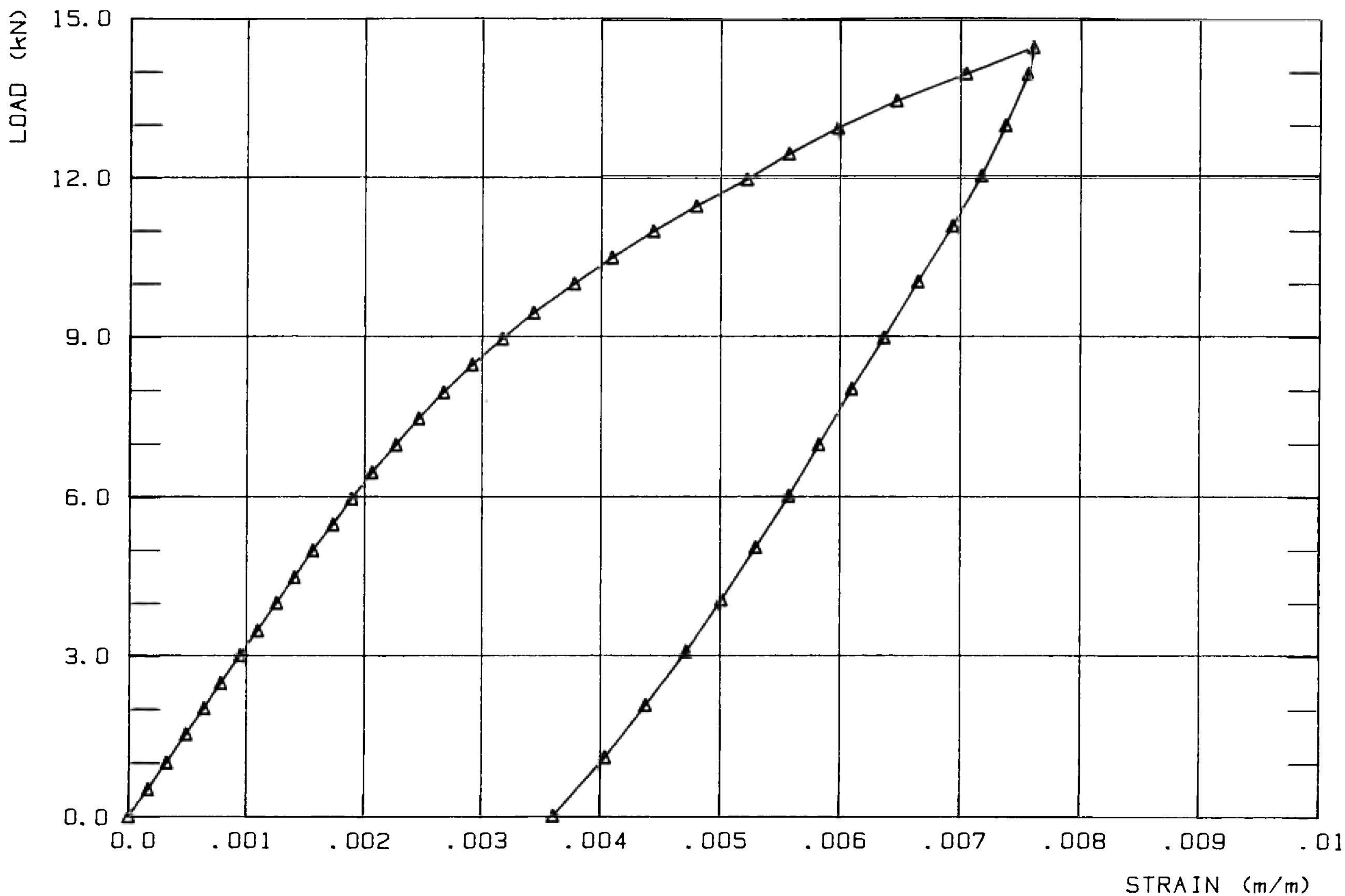
TEST 5: TOP LONGITUDINAL STRAIN. DD1 POSITION 6.

GRAPH 7.4

TOP LONGITUDINAL STRAIN. DD1 POSITION 6.

FILE :B:5PLATE6.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	1.916016E-03	1.760758E-05
1	.5058282	-8.3636E-05
2	1.002076	-1.496644E-04
3	1.534729	-1.540663E-04
4	2.017565	-2.200947E-04
5	2.494653	-2.465061E-04
6	3.015809	-2.905251E-04
7	3.483317	-3.389459E-04
8	4.004473	-4.093762E-04
9	4.48731	-4.798065E-04
10	4.991222	-5.194236E-04
11	5.485554	-5.898539E-04
12	5.96839	-6.822938E-04
13	6.460806	-7.747335E-04
14	6.980047	-8.847808E-04
15	7.476294	-9.992301E-04
16	7.962962	-1.131287E-03
17	8.47837	-1.280951E-03
18	8.966954	-1.457027E-03
19	9.453622	-1.646309E-03
20	9.999686	-1.853198E-03
21	10.48827	-2.104106E-03
22	10.98644	-2.302191E-03
23	11.46161	-2.504678E-03
24	11.96744	-2.812811E-03
25	12.44836	-3.283814E-03
26	12.93886	-3.583142E-03
27	13.4466	-3.988117E-03
28	13.95051	-4.525148E-03
29	14.44484	-5.533182E-03
30	13.93902	-5.524378E-03
31	12.97526	-5.43634E-03
32	12.03066	-5.286676E-03
33	11.08224	-5.048973E-03
34	10.03034	-4.780458E-03
35	8.97845	-4.498737E-03
36	8.020442	-4.239025E-03
37	6.980047	-3.983715E-03
38	6.018206	-3.754816E-03
39	5.048702	-3.486301E-03
40	4.060038	-3.261804E-03
41	3.08287	-3.028504E-03
42	2.071213	-2.733577E-03
43	1.097877	-2.41664E-03
44	.0114961	-2.011666E-03



STRAIN VERSUS LOAD

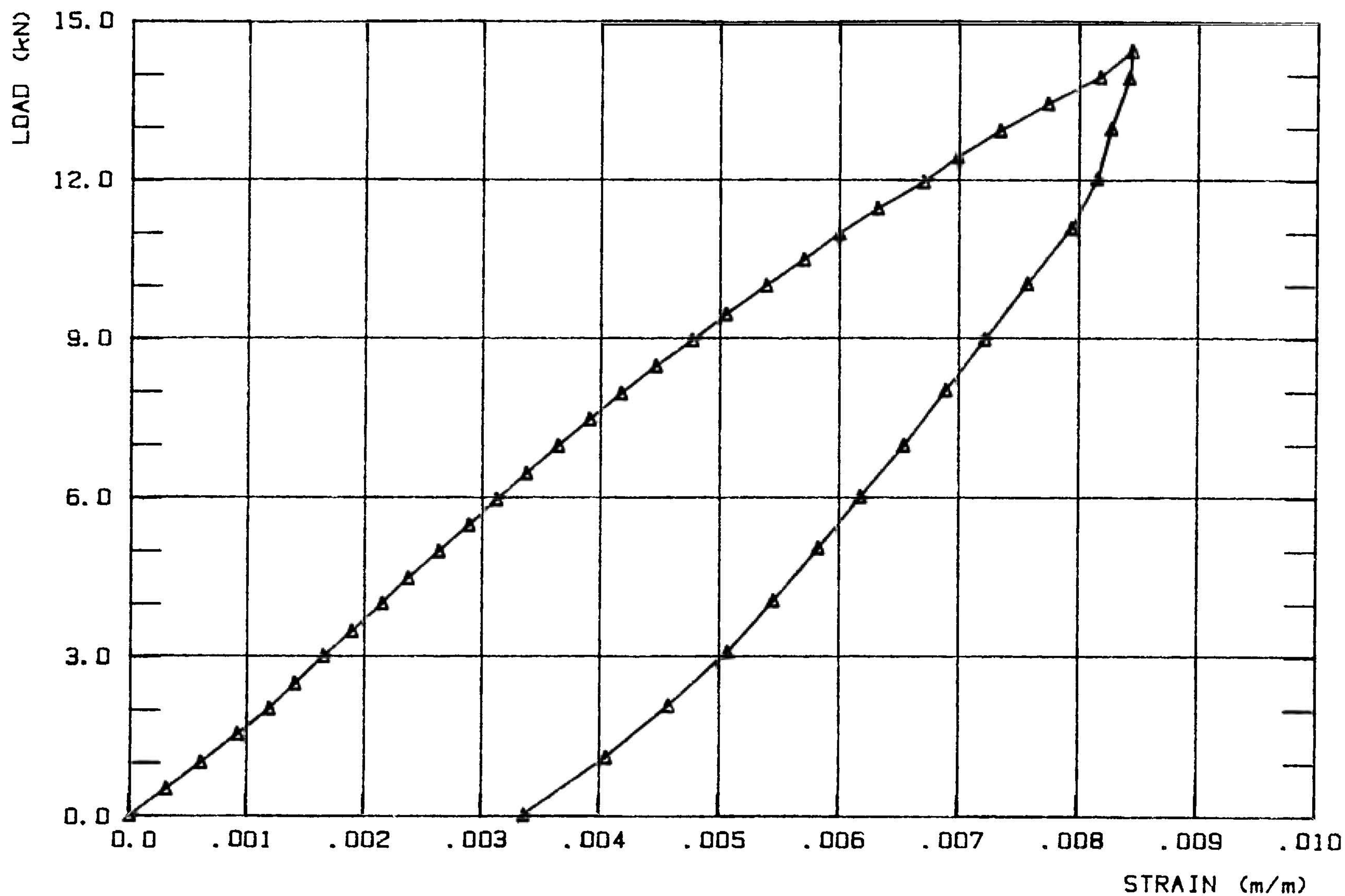
TEST 5: BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 4

GRAPH 7.5

BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 4.

FILE :B:5PLATE4.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	1.916016E-03	4.208262E-06
1	.5058282	1.683305E-04
2	1.002076	3.240362E-04
3	1.534729	4.881584E-04
4	2.017565	6.396558E-04
5	2.494653	7.827367E-04
6	3.015809	9.468589E-04
7	3.483317	1.094148E-03
8	4.004473	1.256166E-03
9	4.48731	1.407664E-03
10	4.991222	1.561265E-03
11	5.485554	.0017317
12	5.96839	1.88951E-03
13	6.460806	2.064152E-03
14	6.980047	2.266149E-03
15	7.476294	2.461833E-03
16	7.962962	2.672246E-03
17	8.47837	2.914222E-03
18	8.966954	3.173029E-03
19	9.453622	3.43815E-03
20	9.999686	3.779019E-03
21	10.48827	4.096743E-03
22	10.98644	4.439716E-03
23	11.46161	4.799523E-03
24	11.96744	5.222453E-03
25	12.44836	5.575947E-03
26	12.93886	5.986253E-03
27	13.4466	6.47441E-03
28	13.95051	7.050943E-03
29	14.44484	7.608538E-03
30	13.93902	7.562246E-03
31	12.97526	7.377083E-03
32	12.03066	7.177191E-03
33	11.08224	6.939424E-03
34	10.03034	6.653262E-03
35	8.97845	6.369204E-03
36	8.020442	6.10198E-03
37	6.980047	5.826338E-03
38	6.018206	5.575947E-03
39	5.048702	5.298202E-03
40	4.060038	5.01204E-03
41	3.08287	4.717462E-03
42	2.071213	4.378696E-03
43	1.097877	4.042035E-03
44	.0114961	3.608585E-03



STRAIN VERSUS LOAD

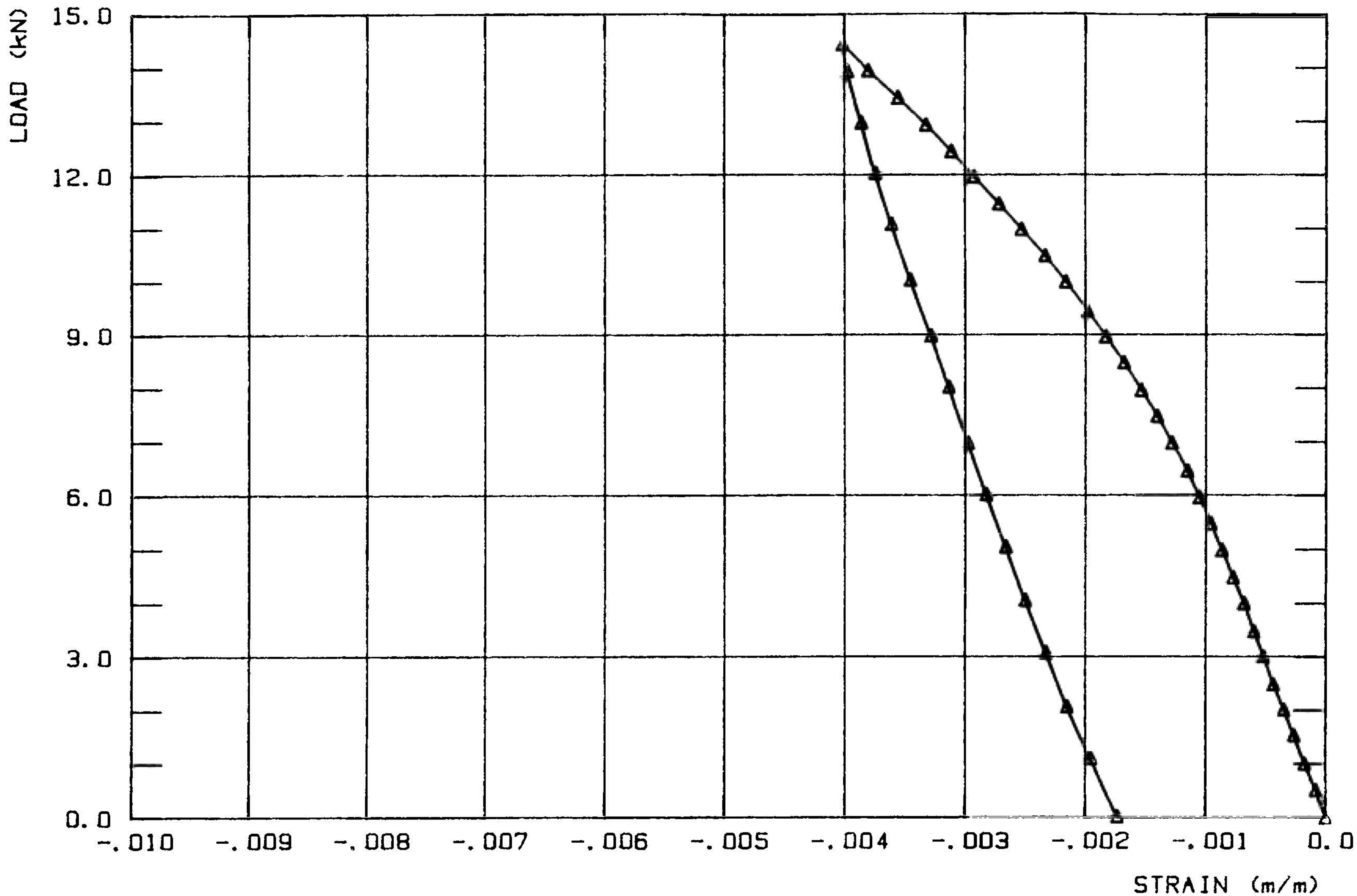
TEST 5: TOP TRANSVERSE STRAIN. DD1 POSITION 7.

GRAPH 7.6

TOP TRANSVERSE STRAIN. DD1 POSITION 7.

FILE :B:5PLATE7.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	1.916016E-03	3.725557E-06
1	.5058282	3.129468E-04
2	1.002076	6.072658E-04
3	1.534729	9.16487E-04
4	2.017565	1.188453E-03
5	2.494653	1.40826E-03
6	3.015809	1.650422E-03
7	3.483317	1.892583E-03
8	4.004473	2.149646E-03
9	4.48731	2.369454E-03
10	4.991222	2.630243E-03
11	5.485554	2.883581E-03
12	5.96839	3.118291E-03
13	6.460806	3.375354E-03
14	6.980047	3.643595E-03
15	7.476294	3.908109E-03
16	7.962962	4.172624E-03
17	8.47837	4.463217E-03
18	8.966954	4.768713E-03
19	9.453622	5.051855E-03
20	9.999686	5.39088E-03
21	10.48827	5.707553E-03
22	10.98644	6.001872E-03
23	11.46161	6.325995E-03
24	11.96744	6.709728E-03
25	12.44836	6.99287E-03
26	12.93886	7.346798E-03
27	13.4466	7.745432E-03
28	13.95051	8.177596E-03
29	14.44484	8.442111E-03
30	13.93902	8.419758E-03
31	12.97526	8.270735E-03
32	12.03066	8.155243E-03
33	11.08224	7.939161E-03
34	10.03034	7.574057E-03
35	8.97845	7.220129E-03
36	8.020442	6.896006E-03
37	6.980047	6.545803E-03
38	6.018206	6.180698E-03
39	5.048702	5.830496E-03
40	4.060038	5.454215E-03
41	3.08287	5.066757E-03
42	2.071213	4.574984E-03
43	1.097877	4.053406E-03
44	.0114961	3.360452E-03



STRAIN VERSUS LOAD

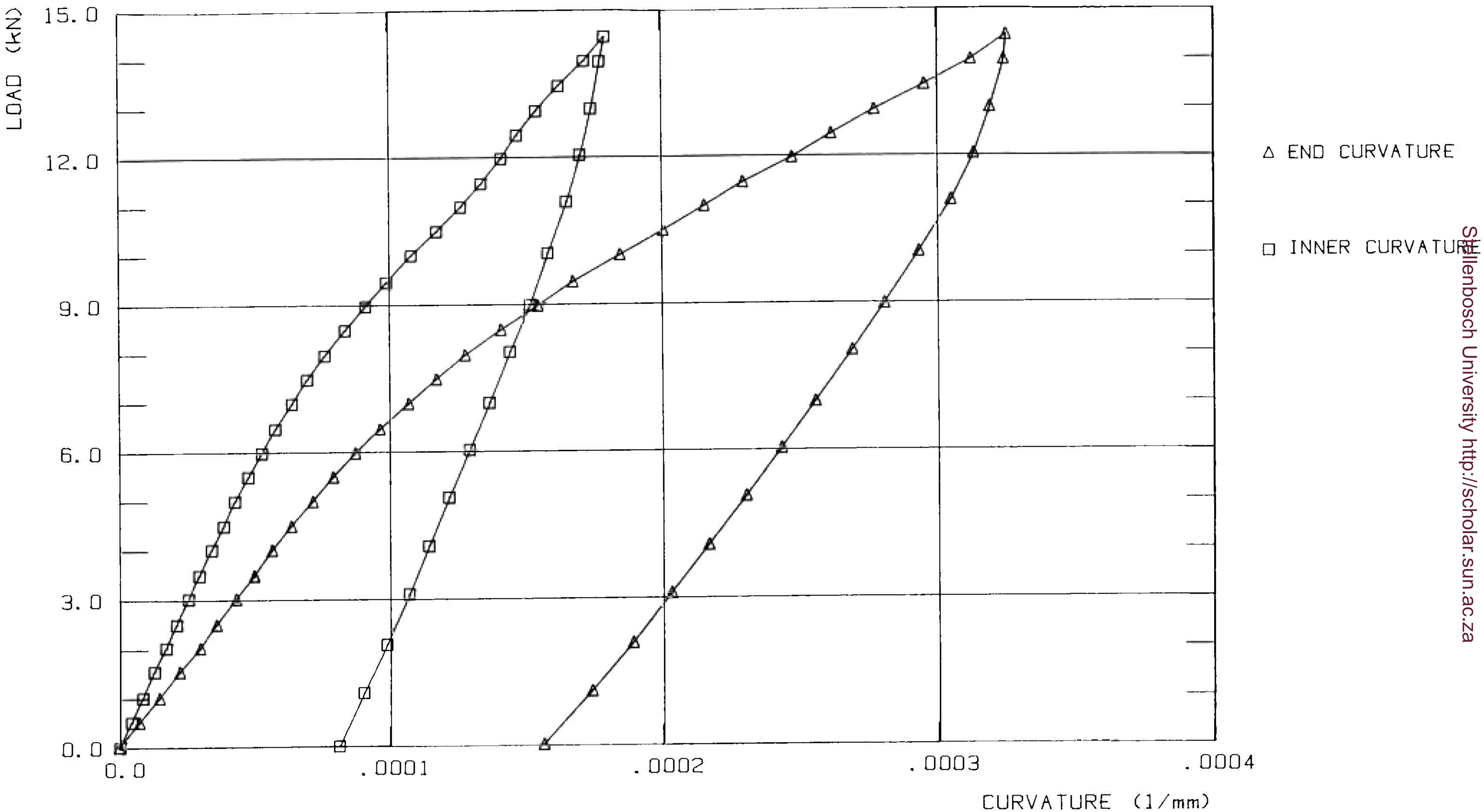
TEST 5: BOTTOM TRANSVERSE STRAIN. DD1 POSITION 5.

GRAPH 7.7

BOTTOM TRANSVERSE STRAIN. DD1 POSITION 5.

FILE :B:5PLATE5.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	1.916016E-03	-3.52709E-06
1	.5058282	-8.288662E-05
2	1.002076	-1.745909E-04
3	1.534729	-2.645317E-04
4	2.017565	-3.491819E-04
5	2.494653	-4.355956E-04
6	3.015809	-5.184822E-04
7	3.483317	-5.978418E-04
8	4.004473	-6.82492E-04
9	4.48731	-7.759598E-04
10	4.991222	-8.676641E-04
11	5.485554	-9.628956E-04
12	5.96839	-1.061654E-03
13	6.460806	-1.160413E-03
14	6.980047	-1.289151E-03
15	7.476294	-1.410836E-03
16	7.962962	-1.541338E-03
17	8.47837	-1.685949E-03
18	8.966954	-1.83585E-03
19	9.453622	-1.989279E-03
20	9.999686	-2.169161E-03
21	10.48827	-2.341988E-03
22	10.98644	-2.537741E-03
23	11.46161	-2.724677E-03
24	11.96744	-2.932775E-03
25	12.44836	-3.117948E-03
26	12.93886	-3.329573E-03
27	13.4466	-3.560597E-03
28	13.95051	-3.809257E-03
29	14.44484	-4.020882E-03
30	13.93902	-3.980321E-03
31	12.97526	-3.863927E-03
32	12.03066	-3.747533E-03
33	11.08224	-3.615267E-03
34	10.03034	-3.458312E-03
35	8.97845	-3.287248E-03
36	8.020442	-3.13911E-03
37	6.980047	-2.980391E-03
38	6.018206	-2.828726E-03
39	5.048702	-2.66648E-03
40	4.060038	-2.504234E-03
41	3.08287	-2.329643E-03
42	2.071213	-2.156816E-03
43	1.097877	-1.959299E-03
44	.0114961	-1.738855E-03



CURVATURE VERSUS LOAD

TEST 5: TRANSVERSE CURVATURE. POSITIONS 8 AND 9.

GRAPH 7.8

INNER TRANSVERSE CURVATURE. POSITION 8.

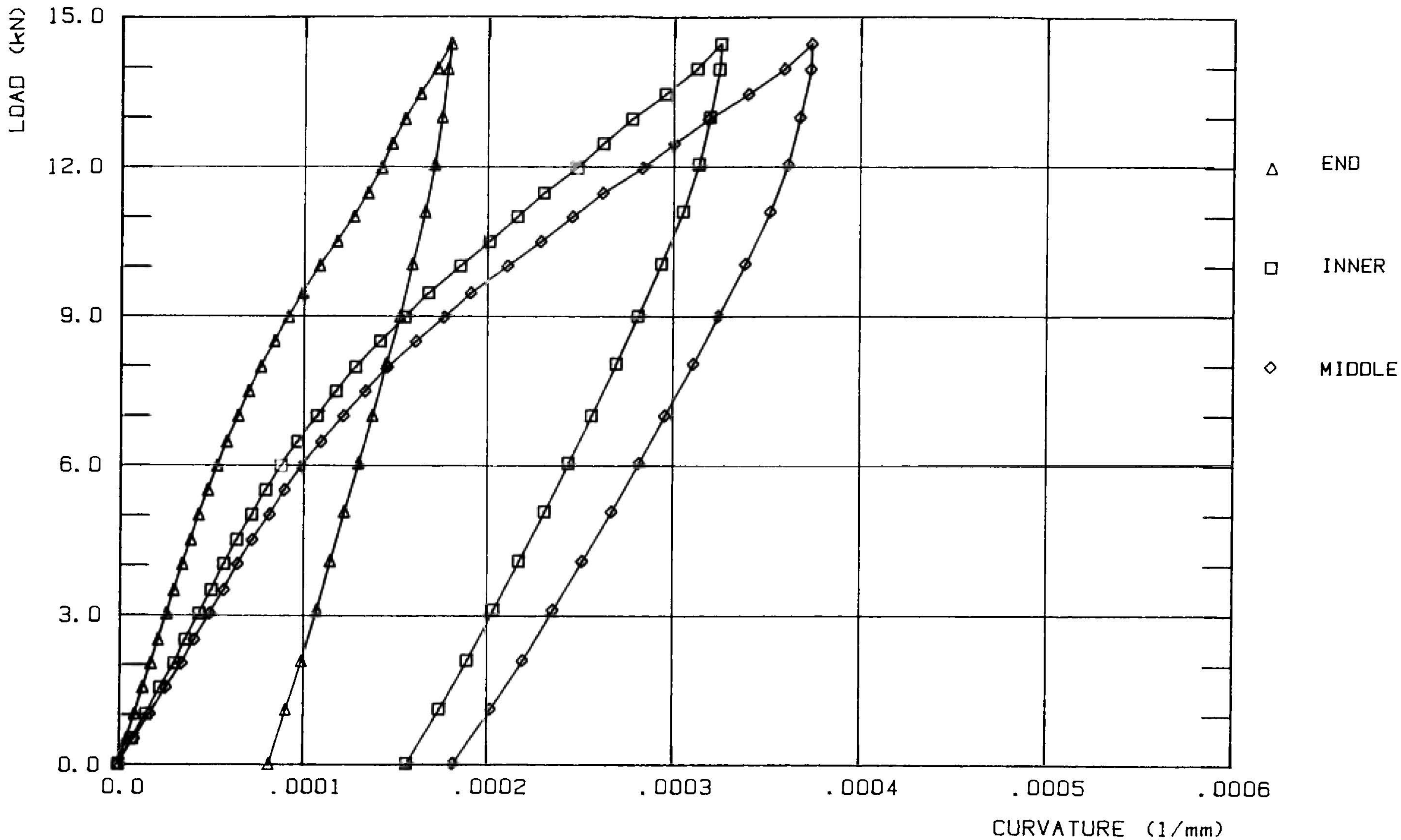
FILE :B:5PLATE8.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	1.916016E-03	-3.301539E-07
1	.5058282	7.172814E-06
2	1.002076	1.467625E-05
3	1.534729	2.21798E-05
4	2.017565	2.9688E-05
5	2.494653	3.569038E-05
6	3.015809	4.302699E-05
7	3.483317	4.969933E-05
8	4.004473	5.637133E-05
9	4.48731	6.337871E-05
10	4.991222	7.138588E-05
11	5.485554	7.889536E-05
12	5.96839	8.72378E-05
13	6.460806	9.641296E-05
14	6.980047	1.070906E-04
15	7.476294	1.174382E-04
16	7.962962	1.281166E-04
17	8.47837	1.414698E-04
18	8.966954	1.54819E-04
19	9.453622	1.676711E-04
20	9.999686	1.84864E-04
21	10.48827	2.007226E-04
22	10.98644	2.157494E-04
23	11.46161	2.299396E-04
24	11.96744	2.478105E-04
25	12.44836	2.620024E-04
26	12.93886	2.775345E-04
27	13.4466	2.955716E-04
28	13.95051	3.124413E-04
29	14.44484	3.251372E-04
30	13.93902	3.24304E-04
31	12.97526	3.192916E-04
32	12.03066	3.134463E-04
33	11.08224	3.050929E-04
34	10.03034	2.934028E-04
35	8.97845	2.808756E-04
36	8.020442	2.691822E-04
37	6.980047	2.55823E-04
38	6.018206	2.434651E-04
39	5.048702	2.306095E-04
40	4.060038	2.169173E-04
41	3.08287	2.032298E-04
42	2.071213	1.890367E-04
43	1.097877	1.740159E-04
44	.0114961	1.564886E-04

END TRANSVERSE CURVATURE. POSITION 9.

FILE :B:5PLATE9.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	1.916016E-03	0
1	.5058282	4.331465E-06
2	1.002076	8.500647E-06
3	1.534729	1.283235E-05
4	2.017565	1.716893E-05
5	2.494653	2.100342E-05
6	3.015809	2.550276E-05
7	3.483317	2.950477E-05
8	4.004473	3.400876E-05
9	4.48731	3.850833E-05
10	4.991222	4.267798E-05
11	5.485554	4.767964E-05
12	5.96839	5.268143E-05
13	6.460806	5.768356E-05
14	6.980047	6.385695E-05
15	7.476294	6.952405E-05
16	7.962962	7.602795E-05
17	8.47837	8.35315E-05
18	8.966954	9.120721E-05
19	9.453622	9.904616E-05
20	9.999686	1.082197E-04
21	10.48827	1.177284E-04
22	10.98644	1.267353E-04
23	11.46161	1.344078E-04
24	11.96744	1.417503E-04
25	12.44836	1.474237E-04
26	12.93886	1.544317E-04
27	13.4466	1.627747E-04
28	13.95051	1.719504E-04
29	14.44484	1.794614E-04
30	13.93902	1.776244E-04
31	12.97526	1.744527E-04
32	12.03066	1.704483E-04
33	11.08224	1.654442E-04
34	10.03034	1.586031E-04
35	8.97845	1.519297E-04
36	8.020442	1.445871E-04
37	6.980047	1.370771E-04
38	6.018206	1.295718E-04
39	5.048702	1.218993E-04
40	4.060038	1.143899E-04
41	3.08287	1.070527E-04
42	2.071213	9.871158E-05
43	1.097877	9.020325E-05
44	.0114961	8.103042E-05



CURVATURE VERSUS LOAD

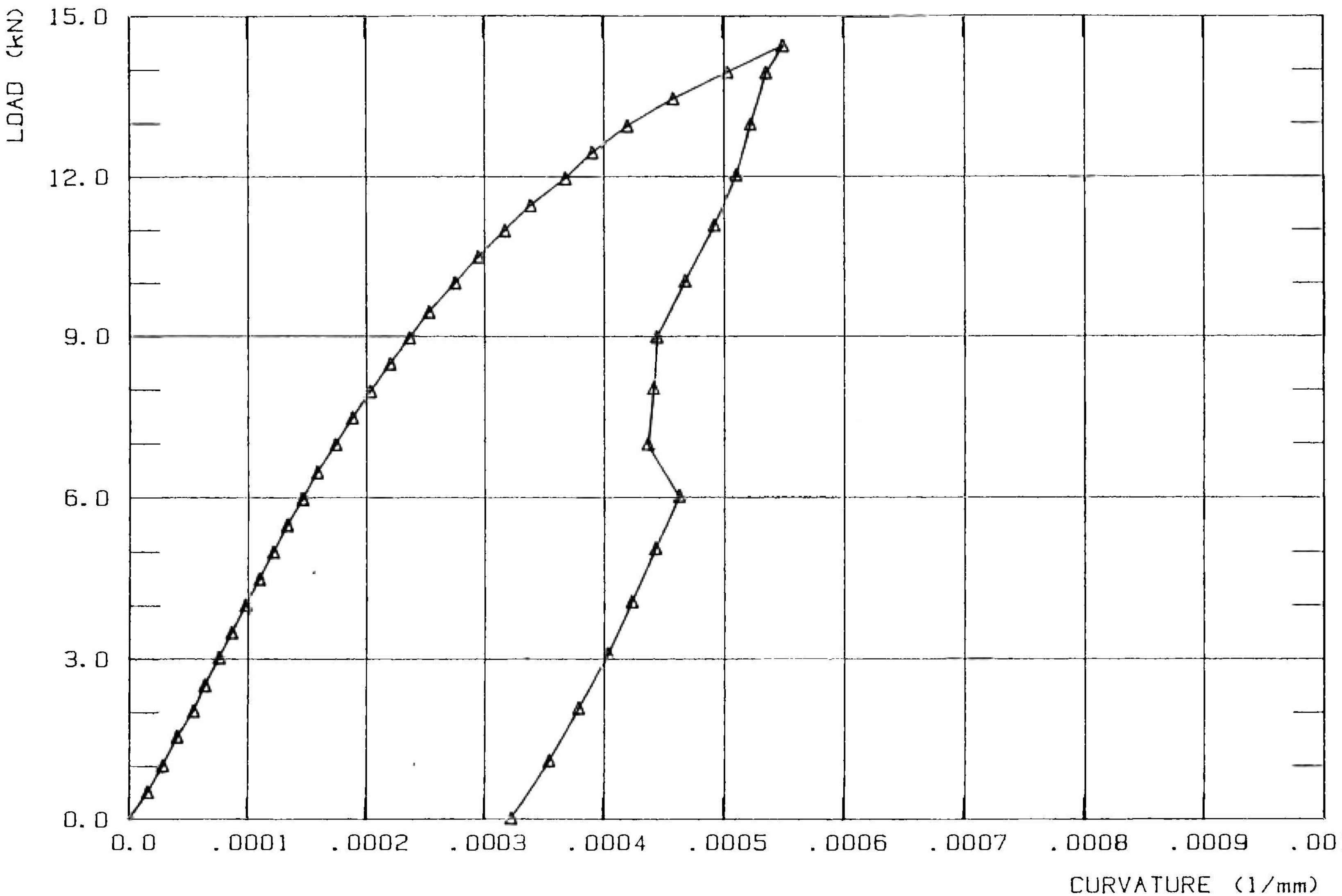
TEST 5: TRANSVERSE CURVATURE. (MIDDLE CURVATURE CALCULATED BY EXTRAPOLATION)

GRAPH 7.9

MIDDLE TRANSVERSE CURVATURE.

FILE :B:5PLATE10.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	1.916016E-03	-4.402051E-07
1	.5058282	8.11993E-06
2	1.002076	1.673478E-05
3	1.534729	2.529562E-05
4	2.017565	3.386103E-05
5	2.494653	4.058603E-05
6	3.015809	4.88684E-05
7	3.483317	5.643084E-05
8	4.004473	6.382553E-05
9	4.48731	7.166885E-05
10	4.991222	8.095517E-05
11	5.485554	8.930061E-05
12	5.96839	9.875658E-05
13	6.460806	1.093228E-04
14	6.980047	1.215018E-04
15	7.476294	1.334096E-04
16	7.962962	1.454795E-04
17	8.47837	1.607826E-04
18	8.966954	1.760229E-04
19	9.453622	1.905461E-04
20	9.999686	2.104121E-04
21	10.48827	2.283873E-04
22	10.98644	2.454208E-04
23	11.46161	2.617836E-04
24	11.96744	2.831639E-04
25	12.44836	3.001953E-04
26	12.93886	3.185688E-04
27	13.4466	3.398373E-04
28	13.95051	3.592716E-04
29	14.44484	3.736958E-04
30	13.93902	3.731973E-04
31	12.97526	3.675713E-04
32	12.03066	3.611122E-04
33	11.08224	3.516424E-04
34	10.03034	3.383361E-04
35	8.97845	3.238576E-04
36	8.020442	3.107139E-04
37	6.980047	2.95405E-04
38	6.018206	2.814295E-04
39	5.048702	2.668463E-04
40	4.060038	2.510931E-04
41	3.08287	2.352889E-04
42	2.071213	2.191451E-04
43	1.097877	2.019535E-04
44	.0114961	1.816413E-04



CURVATURE VERSUS LOAD

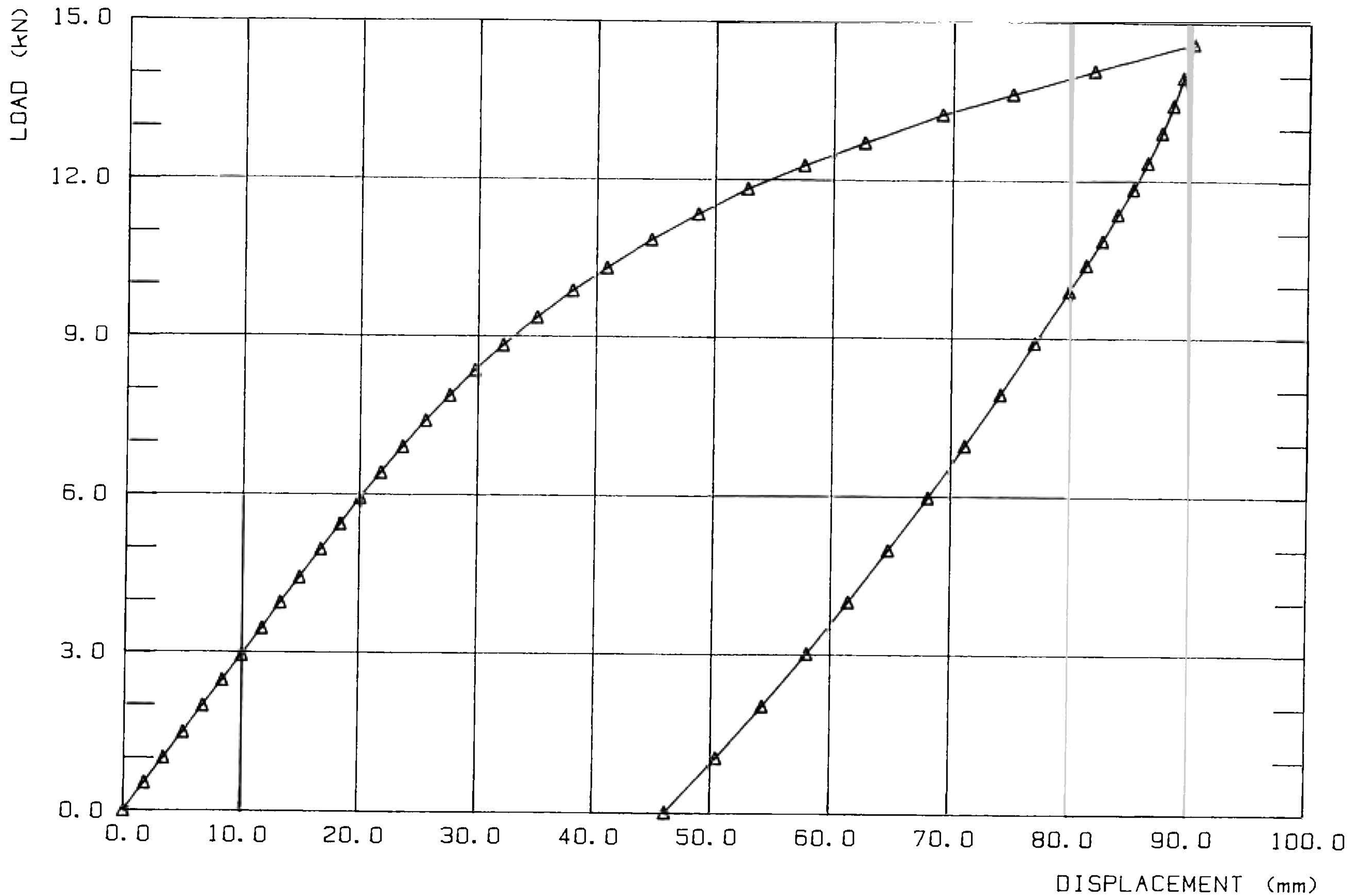
TEST 5: LONGITUDINAL CURVATURE

GRAPH 7.10

LONGITUDINAL CURVATURE.

FILE :B:5PLATE11.DAT

LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	1.916016E-03	1.173302E-06
1	.5058282	1.173297E-05
2	1.002076	2.581252E-05
3	1.534729	3.871835E-05
4	2.017565	5.279706E-05
5	2.494653	6.241719E-05
6	3.015809	7.532155E-05
7	3.483317	8.681756E-05
8	4.004473	9.995501E-05
9	4.48731	1.126221E-04
10	4.991222	1.252881E-04
11	5.485554	1.38422E-04
12	5.96839	1.534304E-04
13	6.460806	1.672645E-04
14	6.980047	1.853154E-04
15	7.476294	2.01722E-04
16	7.962962	2.197661E-04
17	8.47837	2.415535E-04
18	8.966954	2.623969E-04
19	9.453622	2.829989E-04
20	9.999686	3.071035E-04
21	10.48827	3.281557E-04
22	10.98644	3.503684E-04
23	11.46161	3.702345E-04
24	11.96744	3.931261E-04
25	12.44836	4.125043E-04
26	12.93886	4.412033E-04
27	13.4466	4.759378E-04
28	13.95051	5.069123E-04
29	14.44484	6.996768E-04
30	13.93902	6.844217E-04
31	12.97526	6.200538E-04
32	12.03066	5.480856E-04
33	11.08224	4.715105E-04
34	10.03034	4.521633E-04
35	8.97845	4.430691E-04
36	8.020442	4.433018E-04
37	6.980047	4.321056E-04
38	6.018206	4.589242E-04
39	5.048702	4.391043E-04
40	4.060038	4.204394E-04
41	3.08287	4.012989E-04
42	2.071213	3.791122E-04
43	1.097877	3.550437E-04
44	.0114961	3.340023E-04



DISPLACEMENT VERSUS LOAD

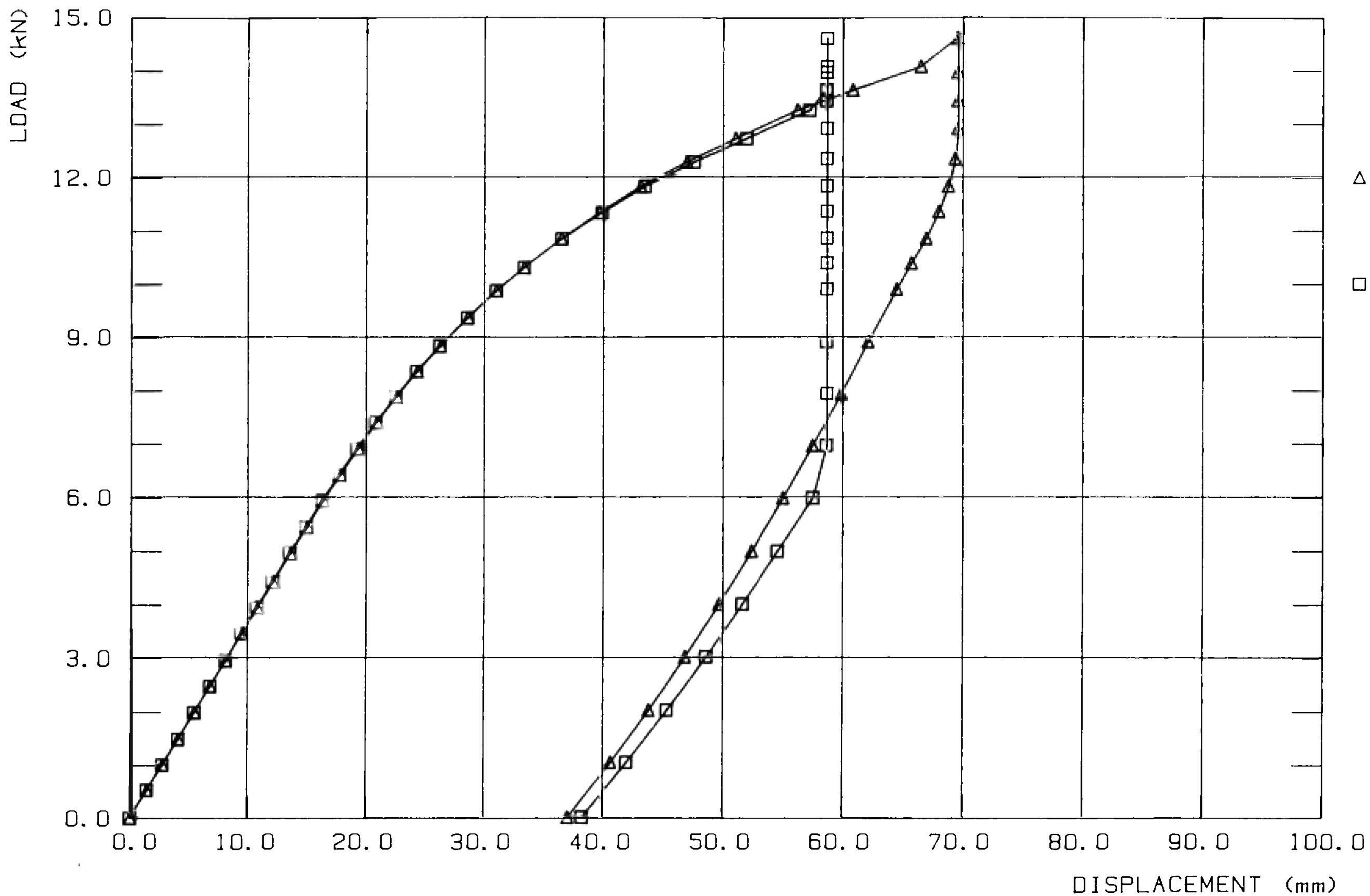
TEST 6: MIDDLE DISPLACEMENT. LVDT POSITION 1.

GRAPH 8.1

MIDDLE DISPLACEMENT. LVDT POSITION 1.

FILE :B:6PLATE1.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	-9.580076E-03	0
1	.5115763	1.757813
2	.9867482	3.369141
3	1.473416	5.029297
4	1.977329	6.689453
5	2.467829	8.339844
6	2.946833	9.960939
7	3.458409	11.66992
8	3.946993	13.23242
9	4.424081	14.84375
10	4.960565	16.65039
11	5.439569	18.31055
12	5.937733	19.98047
13	6.418654	21.74805
14	6.907238	23.58399
15	7.403486	25.53711
16	7.878658	27.58789
17	8.361493	29.73633
18	8.832833	32.12891
19	9.367402	35
20	9.878978	37.98828
21	10.31391	40.86914
22	10.85615	44.62891
23	11.34665	48.57422
24	11.8314	52.73438
25	12.28166	57.51953
26	12.72043	62.57813
27	13.255	69.10156
28	13.6382	75
29	14.07889	81.84571
30	14.60579	90.13672
31	13.96584	89.30664
32	13.43127	88.47656
33	12.91203	87.54883
34	12.34872	86.37696
35	11.83906	85.19531
36	11.36389	83.89649
37	10.85998	82.61719
38	10.39055	81.25
39	9.900054	79.834
40	8.91139	76.95313
41	7.938054	74.1211
42	6.966634	71.14258
43	5.981802	68.06641
44	4.985474	64.75586
45	4.000641	61.43555
46	3.011977	57.99805
47	2.013733	54.25782
48	1.030817	50.41016
49	3.832042E-03	46.14258



DISPLACEMENT VERSUS LOAD

TEST 6: END DISPLACEMENT. LVDT POSITIONS 2 AND 3.

GRAPH 8.2

END DISPLACEMENT. LVDT POSITION 2.

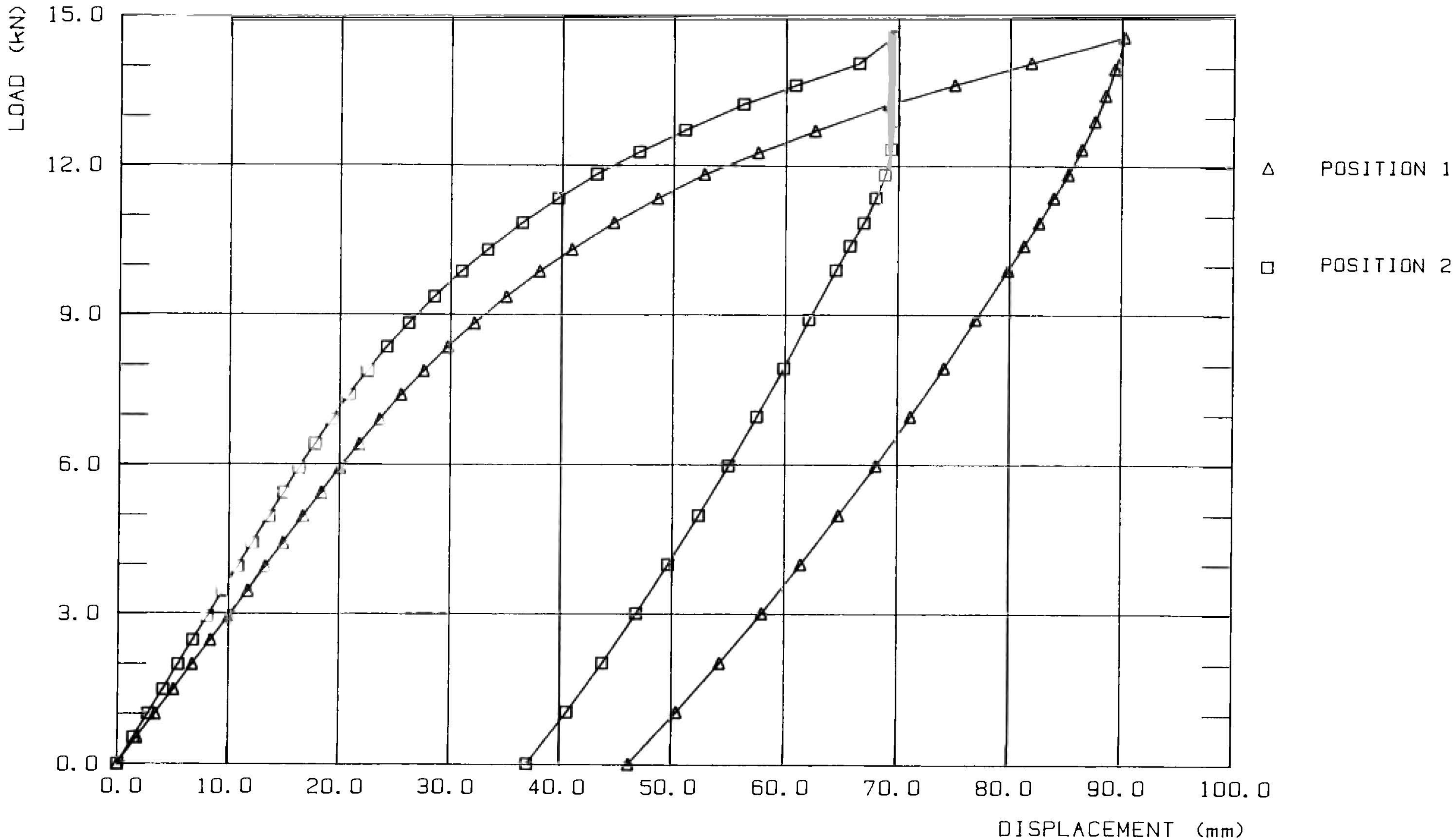
FILE :B:6PLATE2.DAT

LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	-9.580076E-03	0
1	.5115763	1.44043
2	.9867482	2.753906
3	1.473416	4.091796
4	1.977329	5.43457
5	2.467829	6.762696
6	2.946833	8.090821
7	3.458409	9.472656
8	3.946993	10.7666
9	4.424081	12.08496
10	4.960565	13.54981
11	5.439569	14.89258
12	5.937733	16.28906
13	6.418654	17.72461
14	6.907238	19.23828
15	7.403486	20.80078
16	7.878658	22.48535
17	8.361493	24.24805
18	8.832833	26.21094
19	9.367402	28.53027
20	9.878978	30.98145
21	10.31391	33.33008
22	10.85615	36.43555
23	11.34665	39.65332
24	11.8314	43.07129
25	12.28166	46.92383
26	12.72043	51.00098
27	13.255	56.22071
28	13.6382	60.83985
29	14.07889	66.48926
30	14.60579	69.55566
31	13.96584	69.55566
32	13.43127	69.55566
33	12.91203	69.55566
34	12.34872	69.33594
35	11.83906	68.79883
36	11.36389	67.99316
37	10.85998	66.94336
38	10.39055	65.72266
39	9.900054	64.48731
40	8.91139	62.11426
41	7.938054	59.8877
42	6.966634	57.49512
43	5.981802	55.00977
44	4.985474	52.34375
45	4.000641	49.63379
46	3.011977	46.80176
47	2.013733	43.76953
48	1.030817	40.60059
49	3.832042E-03	37.06055

END DISPLACEMENT. LVDT POSITION 3.

FILE :B:6PLATE3.DAT

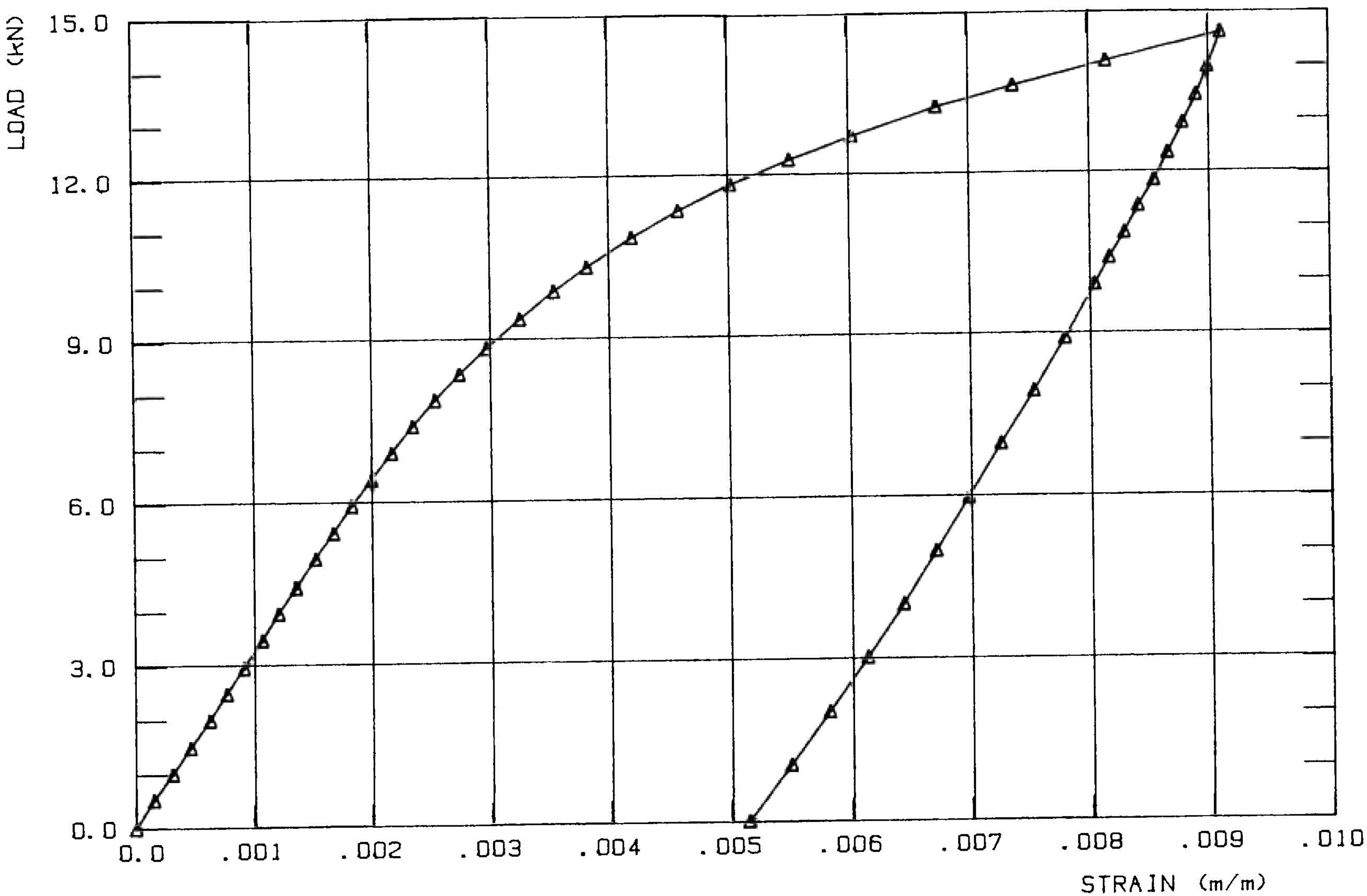
LOADSTEP	LOAD (kN)	DISPLACEMENT (mm)
0	-9.580076E-03	4.882813E-03
1	.5115763	1.425781
2	.9867482	2.744141
3	1.473416	4.086914
4	1.977329	5.429688
5	2.467829	6.767578
6	2.946833	8.066406
7	3.458409	9.433594
8	3.946993	10.73242
9	4.424081	12.0459
10	4.960565	13.48145
11	5.439569	14.8291
12	5.937733	16.21582
13	6.418654	17.64649
14	6.907238	19.15039
15	7.403486	20.73731
16	7.878658	22.42188
17	8.361493	24.18457
18	8.832833	26.15723
19	9.367402	28.50098
20	9.878978	30.9668
21	10.31391	33.33496
22	10.85615	36.48926
23	11.34665	39.84863
24	11.8314	43.44239
25	12.28166	47.54395
26	12.72043	51.91407
27	13.255	57.26074
28	13.6382	58.65235
29	14.07889	58.65235
30	14.60579	58.65235
31	13.96584	58.65235
32	13.43127	58.65235
33	12.91203	58.65235
34	12.34872	58.65235
35	11.83906	58.65235
36	11.36389	58.65235
37	10.85998	58.65235
38	10.39055	58.65235
39	9.900054	58.65235
40	8.91139	58.65235
41	7.938054	58.65235
42	6.966634	58.65235
43	5.981802	57.50977
44	4.985474	54.55078
45	4.000641	51.59668
46	3.011977	48.56934
47	2.013733	45.29785
48	1.030817	41.9336
49	3.832042E-03	38.26172



DISPLACEMENT VERSUS LOAD

TEST 6: DISPLACEMENTS. LVDT POSITIONS 1 AND 2.

GRAPH 8.3



STRAIN VERSUS LOAD

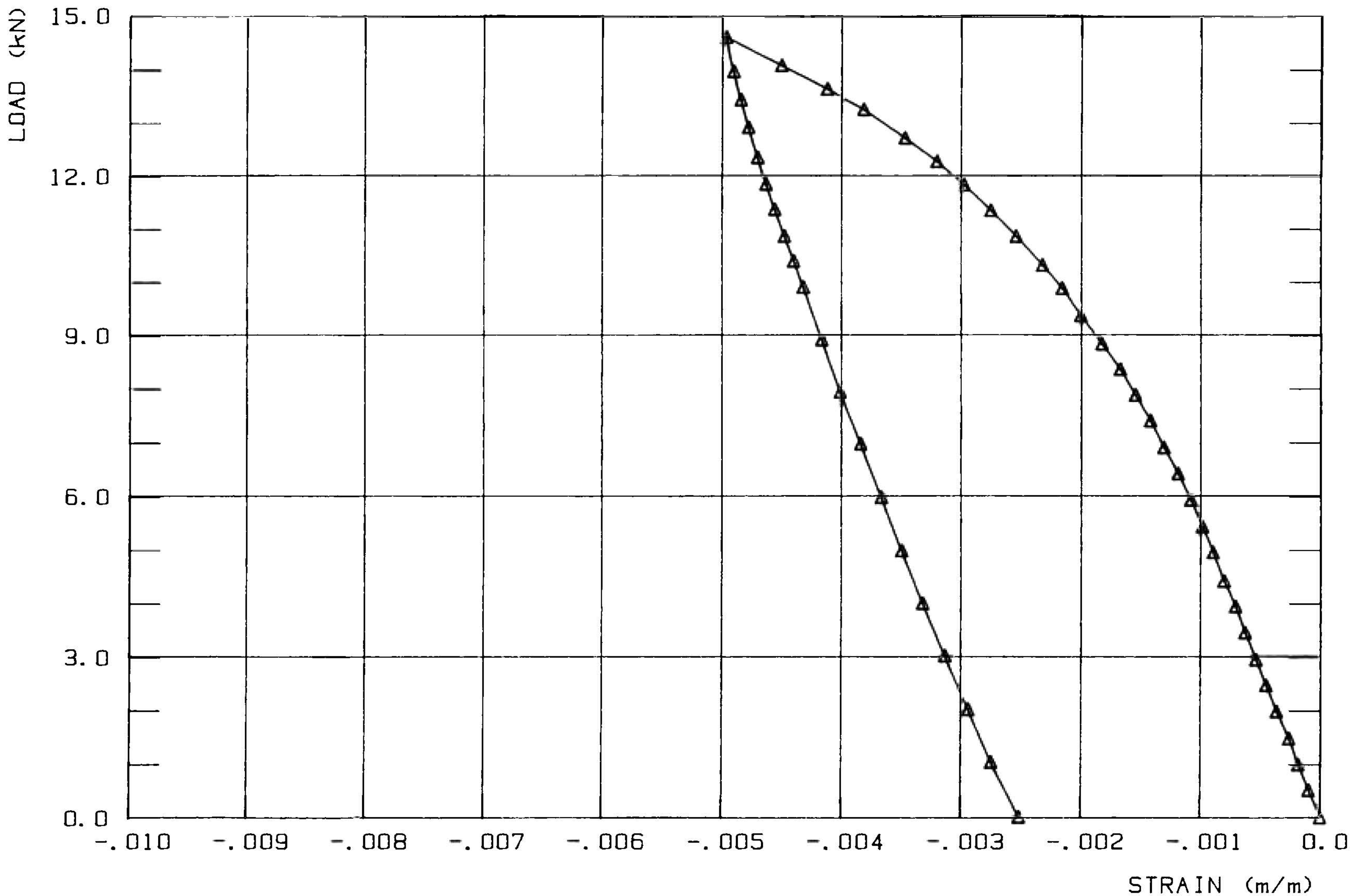
TEST 6: BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 4

GRAPH 8.4

BOTTOM LONGITUDINAL STRAIN. DD1 POSITION 4.

FILE :B:6PLATE4.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-9.580076E-03	0
1	.5115763	1.53148E-04
2	.9867482	3.105503E-04
3	1.473416	4.594442E-04
4	1.977329	6.232275E-04
5	2.467829	7.636132E-04
6	2.946833	9.1038E-04
7	3.458409	1.065655E-03
8	3.946993	1.203914E-03
9	4.424081	1.352808E-03
10	4.960565	1.516591E-03
11	5.439569	1.669739E-03
12	5.937733	1.825014E-03
13	6.418654	1.995178E-03
14	6.907238	2.165343E-03
15	7.403486	2.344016E-03
16	7.878658	2.533324E-03
17	8.361493	2.741776E-03
18	8.832833	2.969371E-03
19	9.367402	3.250142E-03
20	9.878978	3.539421E-03
21	10.31391	3.81594E-03
22	10.85615	4.194556E-03
23	11.34665	4.583807E-03
24	11.8314	5.019853E-03
25	12.28166	5.515457E-03
26	12.72043	6.032331E-03
27	13.255	6.73426E-03
28	13.6382	7.376632E-03
29	14.07889	8.146626E-03
30	14.60579	9.095292E-03
31	13.96584	8.988939E-03
32	13.43127	8.893222E-03
33	12.91203	8.780488E-03
34	12.34872	8.657119E-03
35	11.83906	8.540131E-03
36	11.36389	8.41038E-03
37	10.85998	8.293393E-03
38	10.39055	8.165768E-03
39	9.900054	8.042399E-03
40	8.91139	7.791408E-03
41	7.938054	7.52978E-03
42	6.966634	7.253262E-03
43	5.981802	6.980998E-03
44	4.985474	6.704482E-03
45	4.000641	6.432218E-03
46	3.011977	6.130176E-03
47	2.013733	5.811117E-03
48	1.030817	5.49206E-03
49	3.832042E-03	5.138968E-03



STRAIN VERSUS LOAD

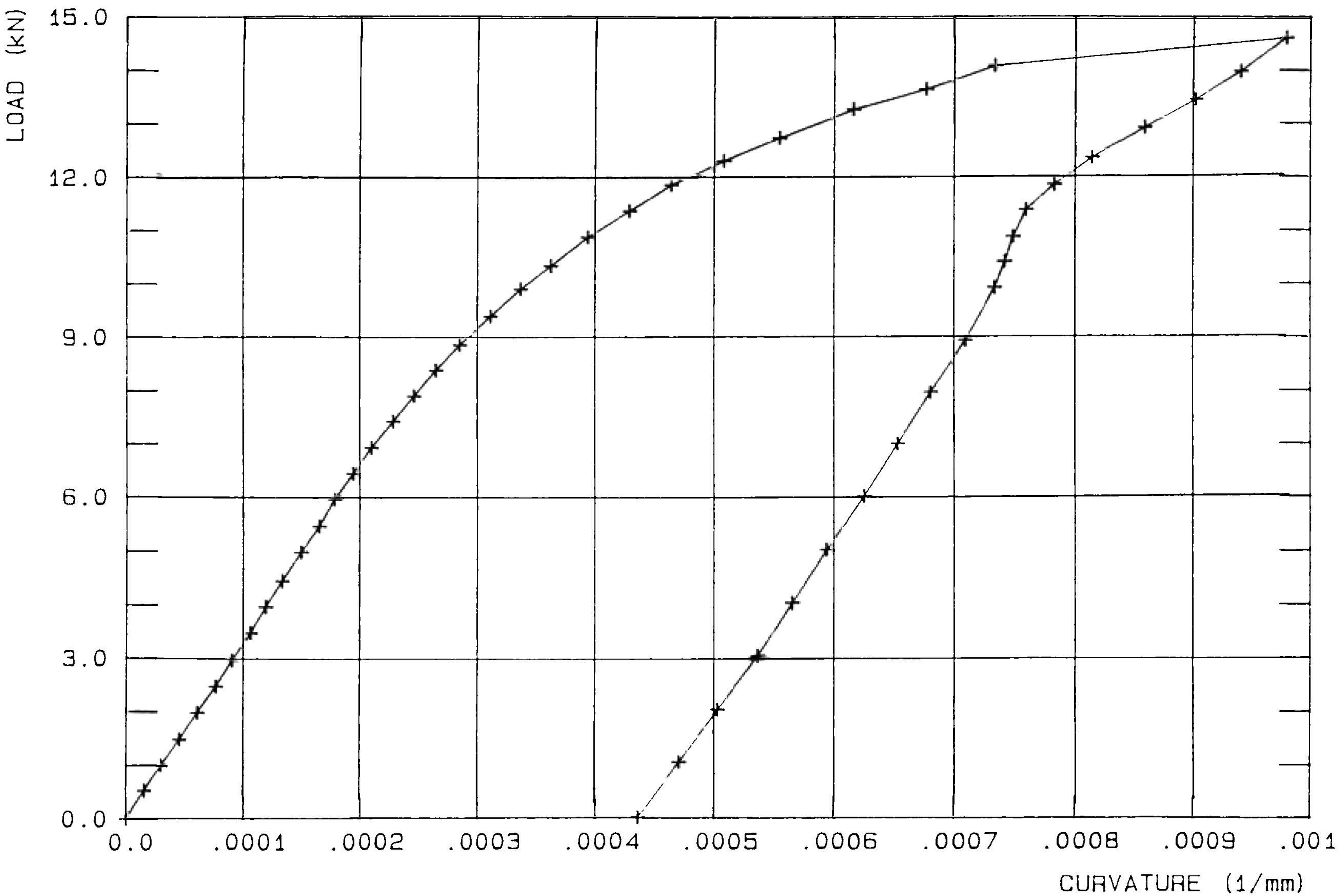
TEST 6: BOTTOM TRANSVERSE STRAIN. DD1 POSITION 5.

GRAPH 8.5

BOTTOM TRANSVERSE STRAIN. DD1 POSITION 5.

FILE :B:6PLATE5.DAT

LOADSTEP	LOAD (kN)	STRAIN (m/m)
0	-9.580076E-03	1.874638E-06
1	.5115763	-9.560656E-05
2	.9867482	-1.837146E-04
3	1.473416	-2.605748E-04
4	1.977329	-3.655545E-04
5	2.467829	-4.536625E-04
6	2.946833	-5.380212E-04
7	3.458409	-6.280039E-04
8	3.946993	-7.086133E-04
9	4.424081	-8.042198E-04
10	4.960565	-8.998264E-04
11	5.439569	-9.916836E-04
12	5.937733	-1.087291E-03
13	6.418654	-1.194145E-03
14	6.907238	-1.314122E-03
15	7.403486	-.0014266
16	7.878658	-1.552201E-03
17	8.361493	-1.679676E-03
18	8.832833	-1.833396E-03
19	9.367402	-2.009612E-03
20	9.878978	-2.165208E-03
21	10.31391	-2.330176E-03
22	10.85615	-2.547634E-03
23	11.34665	-2.757593E-03
24	11.8314	-2.980675E-03
25	12.28166	-3.207506E-03
26	12.72043	-3.473705E-03
27	13.255	-3.818639E-03
28	13.6382	-4.124204E-03
29	14.07889	-4.508505E-03
30	14.60579	-4.969667E-03
31	13.96584	-4.90593E-03
32	13.43127	-4.84594E-03
33	12.91203	-4.782203E-03
34	12.34872	-4.705343E-03
35	11.83906	-4.635981E-03
36	11.36389	-4.562869E-03
37	10.85998	-4.480386E-03
38	10.39055	-4.403526E-03
39	9.900054	-4.322917E-03
40	8.91139	-4.167321E-03
41	7.938054	-4.013601E-03
42	6.966634	-3.841134E-03
43	5.981802	-3.668667E-03
44	4.985474	-3.498075E-03
45	4.000641	-3.32186E-03
46	3.011977	-3.13627E-03
47	2.013733	-2.943182E-03
48	1.030817	-2.751969E-03
49	3.832042E-03	-2.519514E-03



CURVATURE VERSUS LOAD

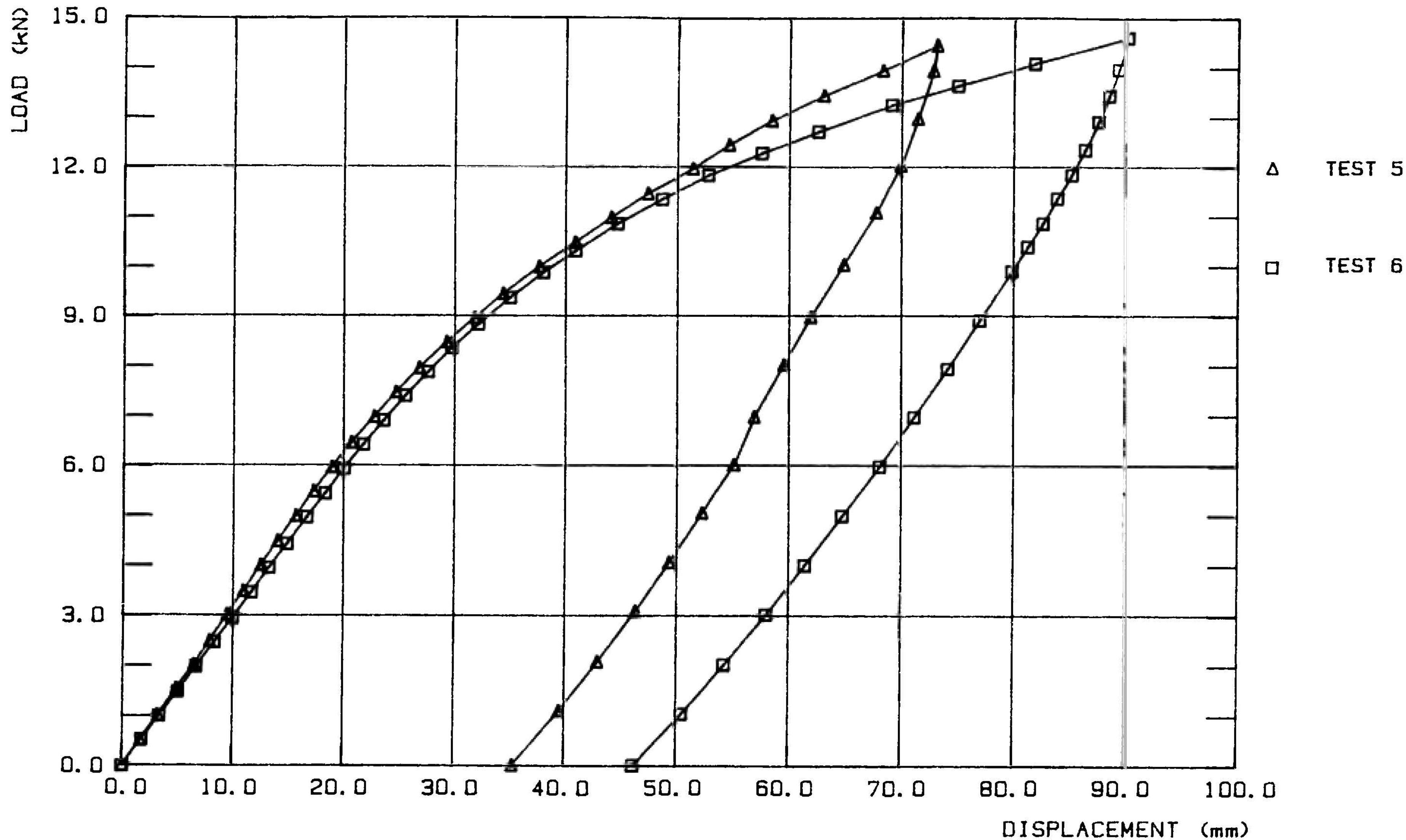
TEST 6: LONGITUDINAL CURVATURE

GRAPH 8.6

LONGITUDINAL CURVATURE.

FILE :B:6PLATE11.DAT

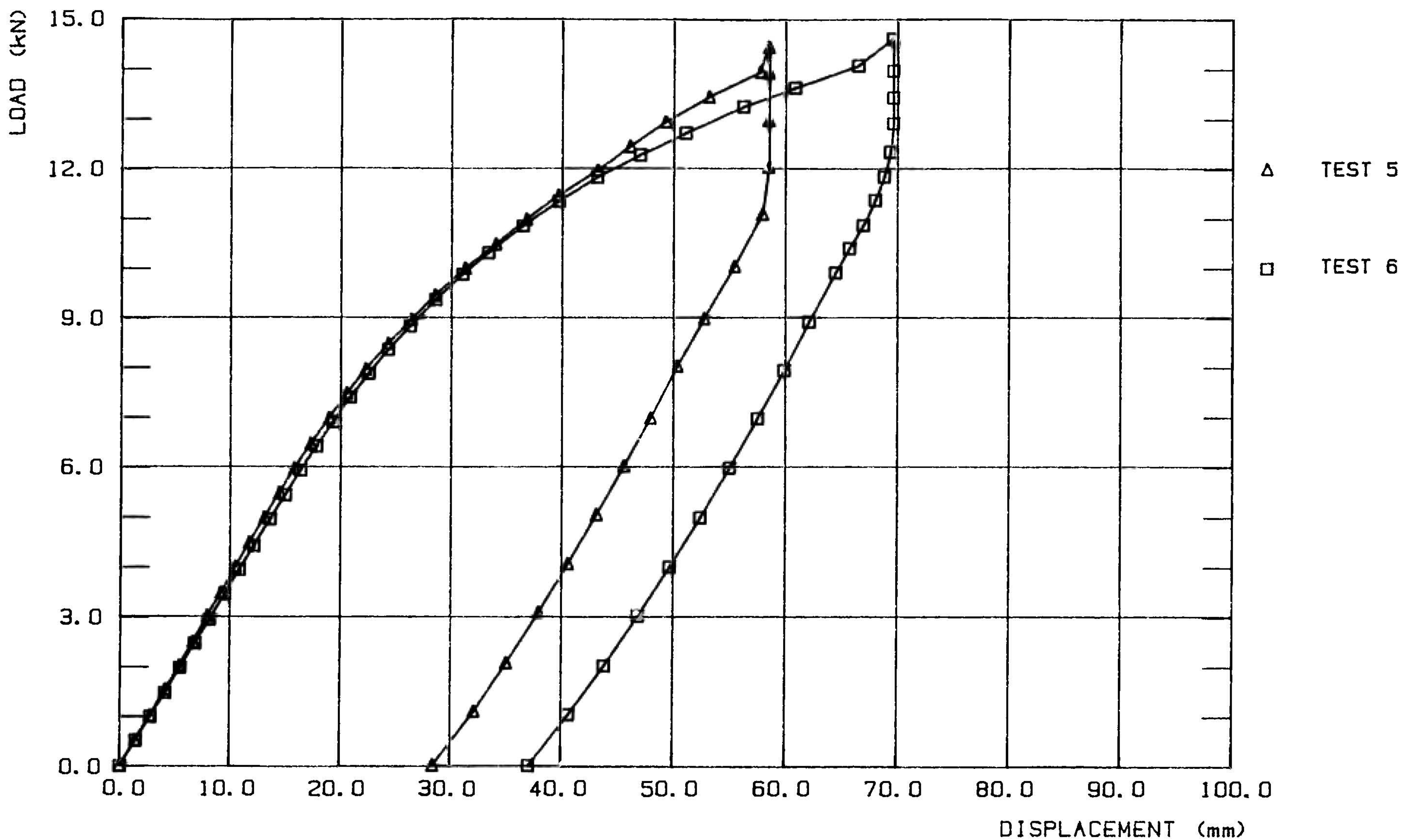
LOADSTEP	LOAD (kN)	CURVATURE (1/mm)
0	-9.580076E-03	7.666467E-20
1	.5115763	1.52529E-05
2	.9867482	2.956696E-05
3	1.473416	4.505391E-05
4	1.977329	6.030545E-05
5	2.467829	7.579082E-05
6	2.946833	8.986742E-05
7	3.458409	1.055849E-04
8	3.946993	1.184862E-04
9	4.424081	1.32559E-04
10	4.960565	1.489748E-04
11	5.439569	1.642163E-04
12	5.937733	1.773453E-04
13	6.418654	1.932853E-04
14	6.907238	2.087532E-04
15	7.403486	2.274982E-04
16	7.878658	2.450668E-04
17	8.361493	2.635676E-04
18	8.832833	2.841694E-04
19	9.367402	3.106129E-04
20	9.878978	3.363409E-04
21	10.31391	3.618215E-04
22	10.85615	3.931259E-04
23	11.34665	4.279061E-04
24	11.8314	4.633534E-04
25	12.28166	5.07843E-04
26	12.72043	5.545937E-04
27	13.255	6.165754E-04
28	13.6382	6.772515E-04
29	14.07889	7.338489E-04
30	14.60579	9.791281E-04
31	13.96584	9.403865E-04
32	13.43127	9.015535E-04
33	12.91203	8.580485E-04
34	12.34872	8.132899E-04
35	11.83906	7.829318E-04
36	11.36389	7.596728E-04
37	10.85998	7.488397E-04
38	10.39055	7.419218E-04
39	9.900054	7.333872E-04
40	8.91139	7.093795E-04
41	7.938054	6.807214E-04
42	6.966634	6.529534E-04
43	5.981802	6.249216E-04
44	4.985474	5.943066E-04
45	4.000641	5.652826E-04
46	3.011977	5.364605E-04
47	2.013733	5.02722E-04
48	1.030817	4.70345E-04
49	3.832042E-03	4.356047E-04



DISPLACEMENT VERSUS LOAD

TEST 5 AND 6: MIDDLE DISPLACEMENT.

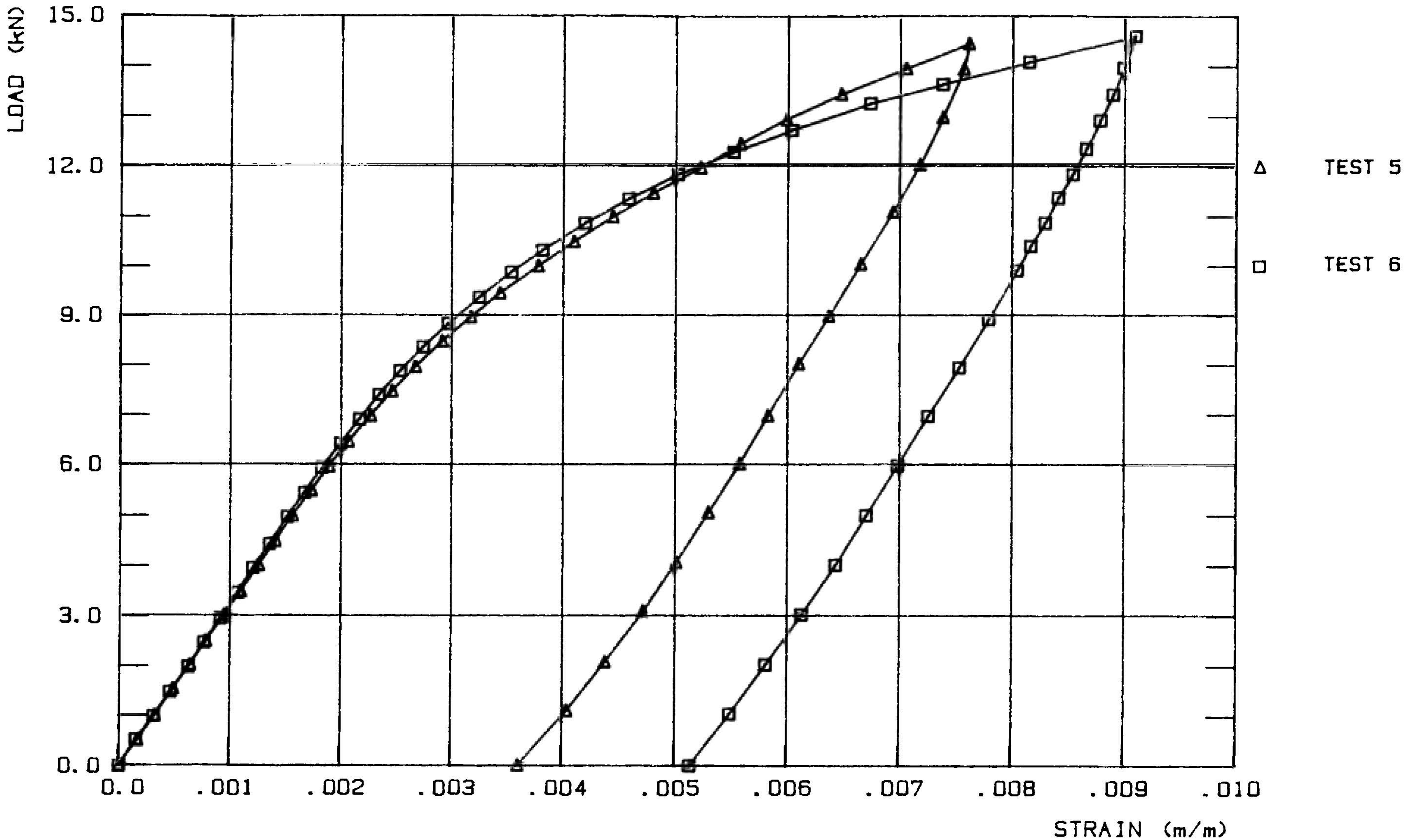
GRAPH 9.1



DISPLACEMENT VERSUS LOAD

TEST 5 AND 6: END DISPLACEMENT.

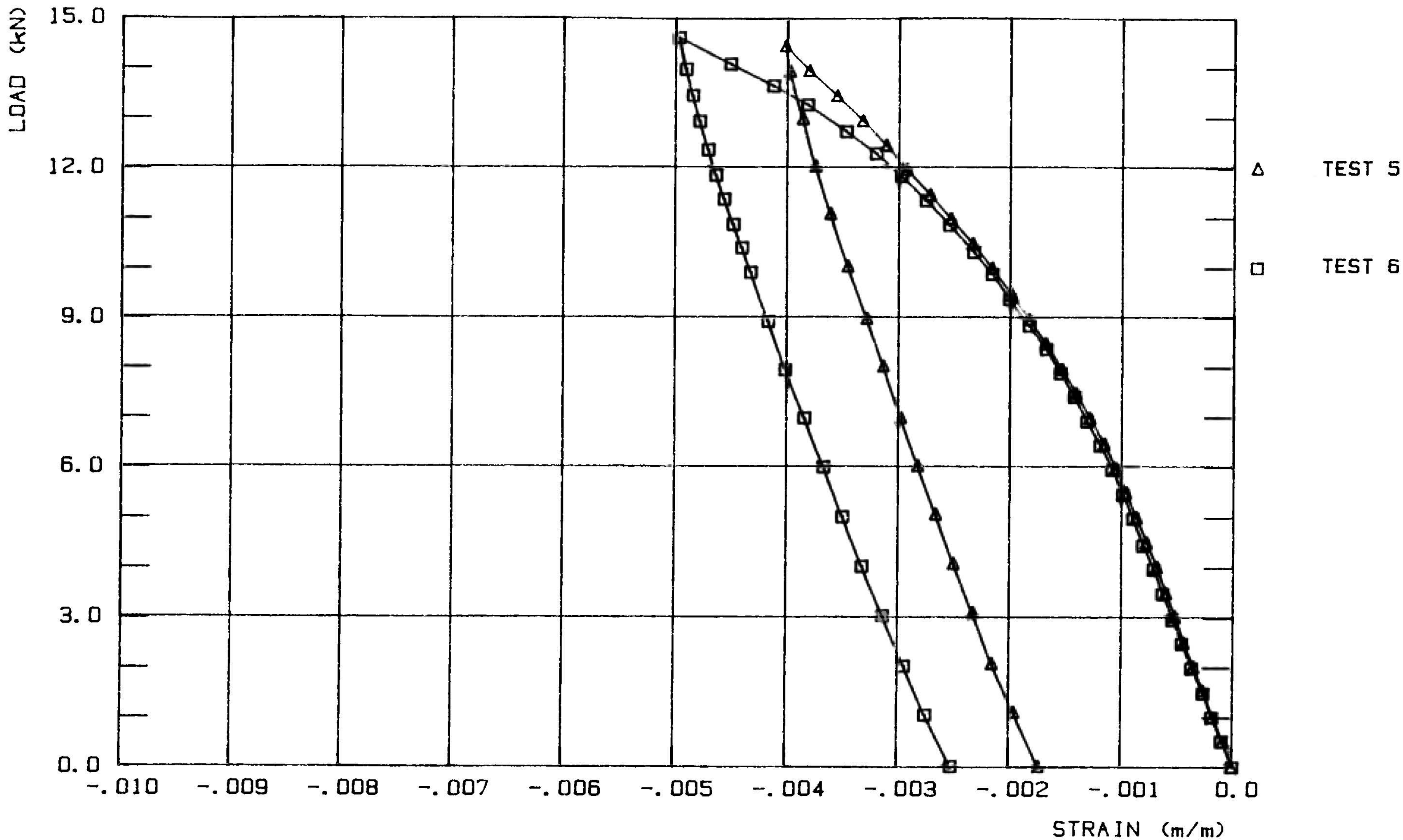
GRAPH 9.2



STRAIN VERSUS LOAD

TEST 5 AND 6: BOTTOM LONGITUDINAL STRAIN.

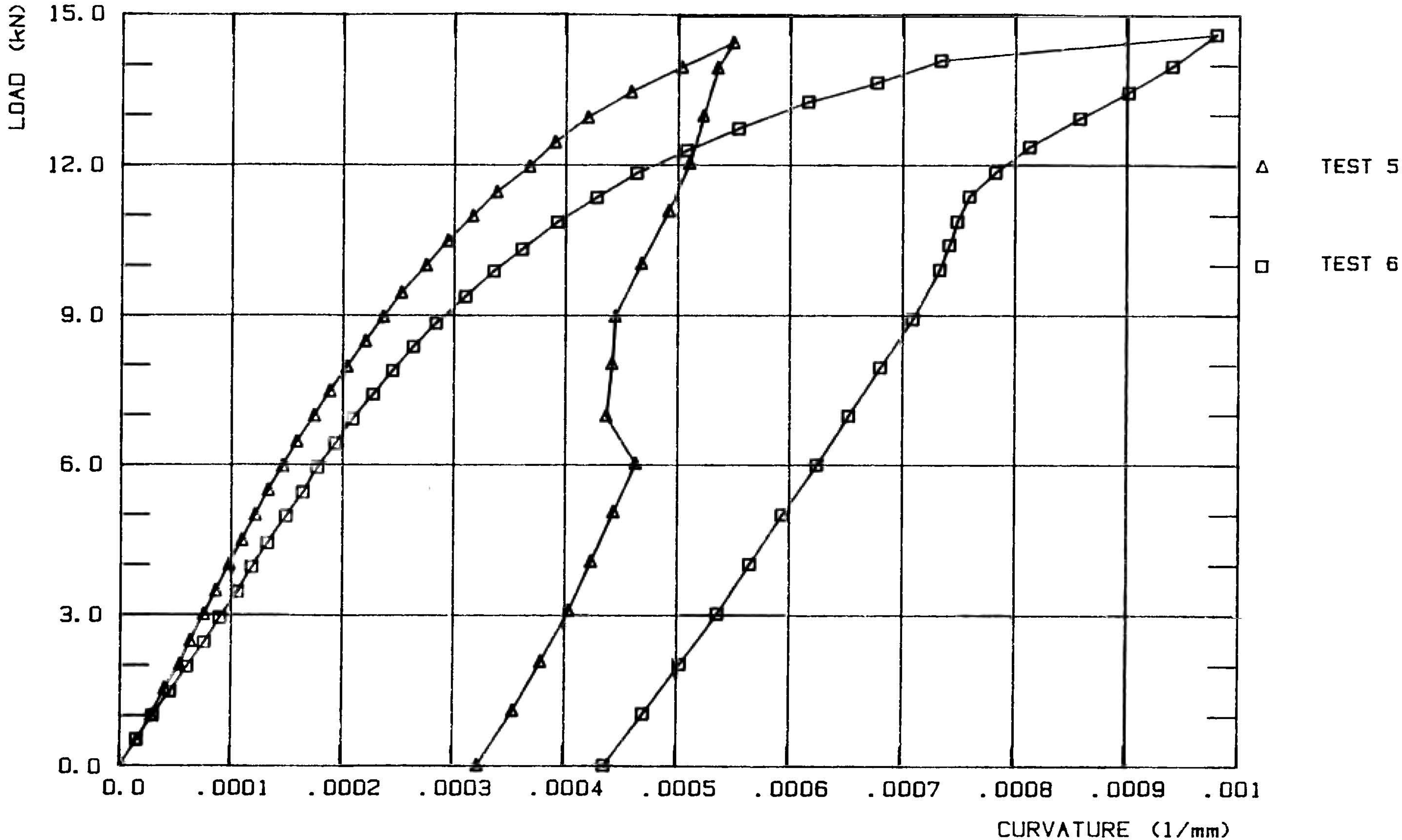
GRAPH 9.3



STRAIN VERSUS LOAD

TEST 5 AND 6: BOTTOM TRANSVERSE STRAIN.

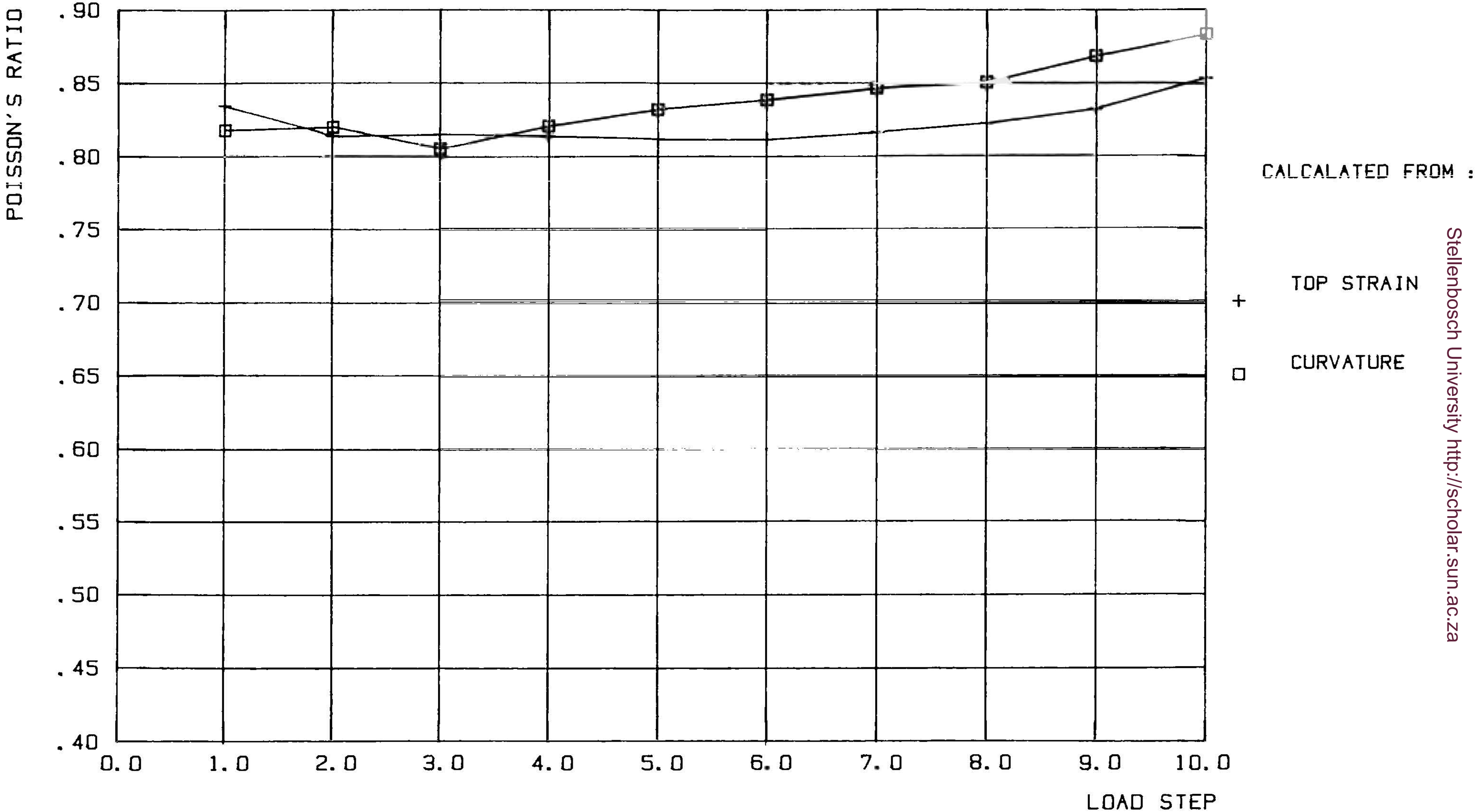
GRAPH 9.4



CURVATURE VERSUS LOAD

TEST 5 AND 6: LONGITUDINAL CURVATURE.

GRAPH 9.5



POISSON'S RATIO VERSUS LOAD STEP

TEST 1:

GRAPH 10.1

TEST 1: POISSON'S RATIO CALCULATED FROM TOP STRAIN.

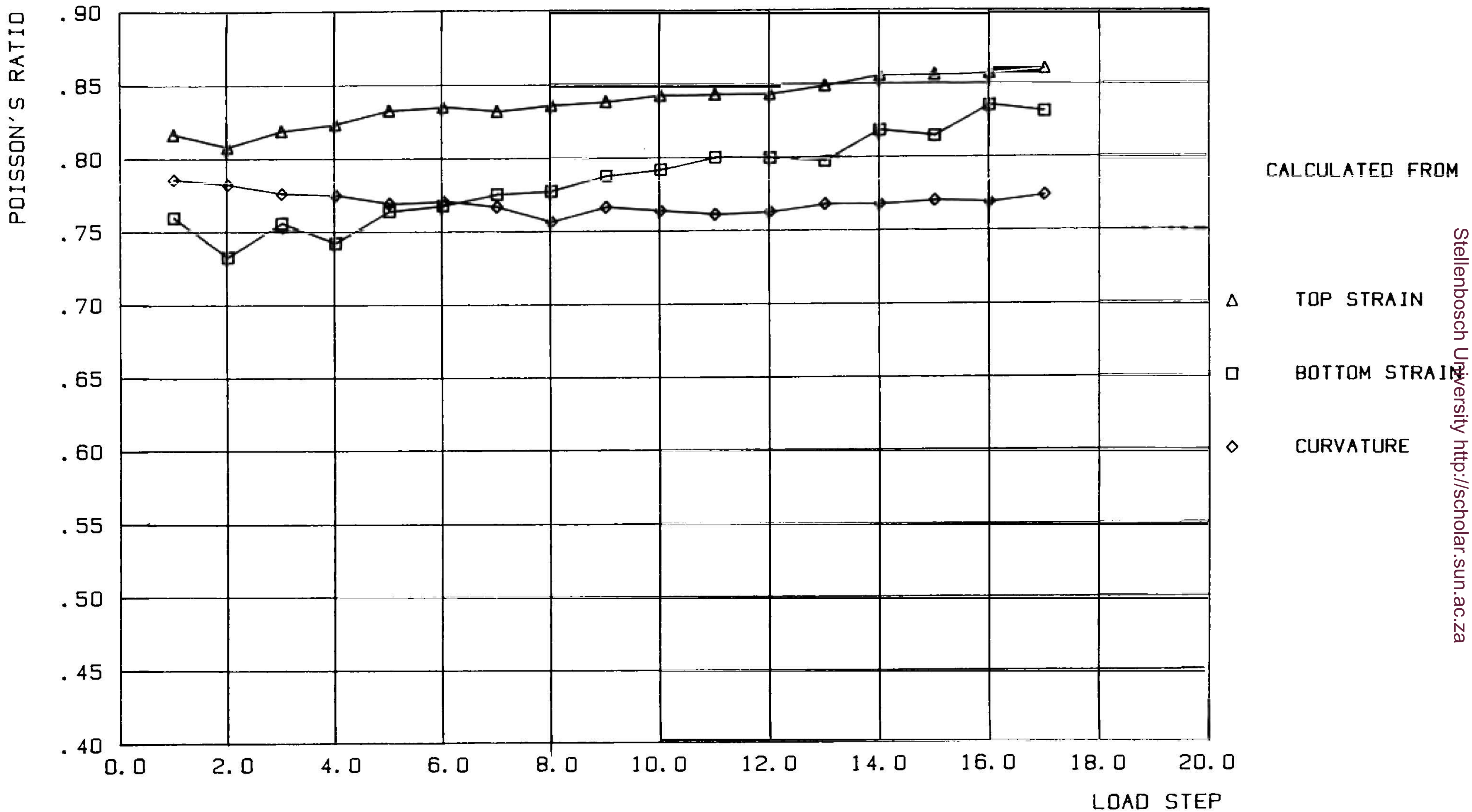
FILE :B:1POISN1.DAT

LOADSTEP	POISSON'S RATIO
1	.83388
2	.813351
3	.8148095
4	.8132394
5	.8111281
6	.8111974
7	.8161972
8	.822413
9	.8326386
10	.8537226

TEST 1: POISSON'S RATIO CALCULATED FROM CURVATURE.

FILE :B:1POISN3.DAT

LOADSTEP	POISSON'S RATIO
1	.8173245
2	.8194101
3	.8048546
4	.8204773
5	.8318261
6	.8385721
7	.8468038
8	.8506819
9	.8687718
10	.8836929



POISSON'S RATIO VERSUS LOAD STEP

TEST 2:

GRAPH 10.2

TEST 2: POISSON'S RATIO CALCULATED FROM TOP STRAIN.

FILE :B:2POISN1.DAT

LOADSTEP	POISSON'S RATIO
1	.8157246
2	.8069773
3	.8178573
4	.8224687
5	.8317125
6	.8340192
7	.830961
8	.8349275
9	.8371765
10	.8416051
11	.8420546
12	.8424622
13	.8481124
14	.8551897
15	.855514
16	.8567484
17	.8599288

POISSON'S RATIO CALCULATED FROM BOTTOM STRAIN.

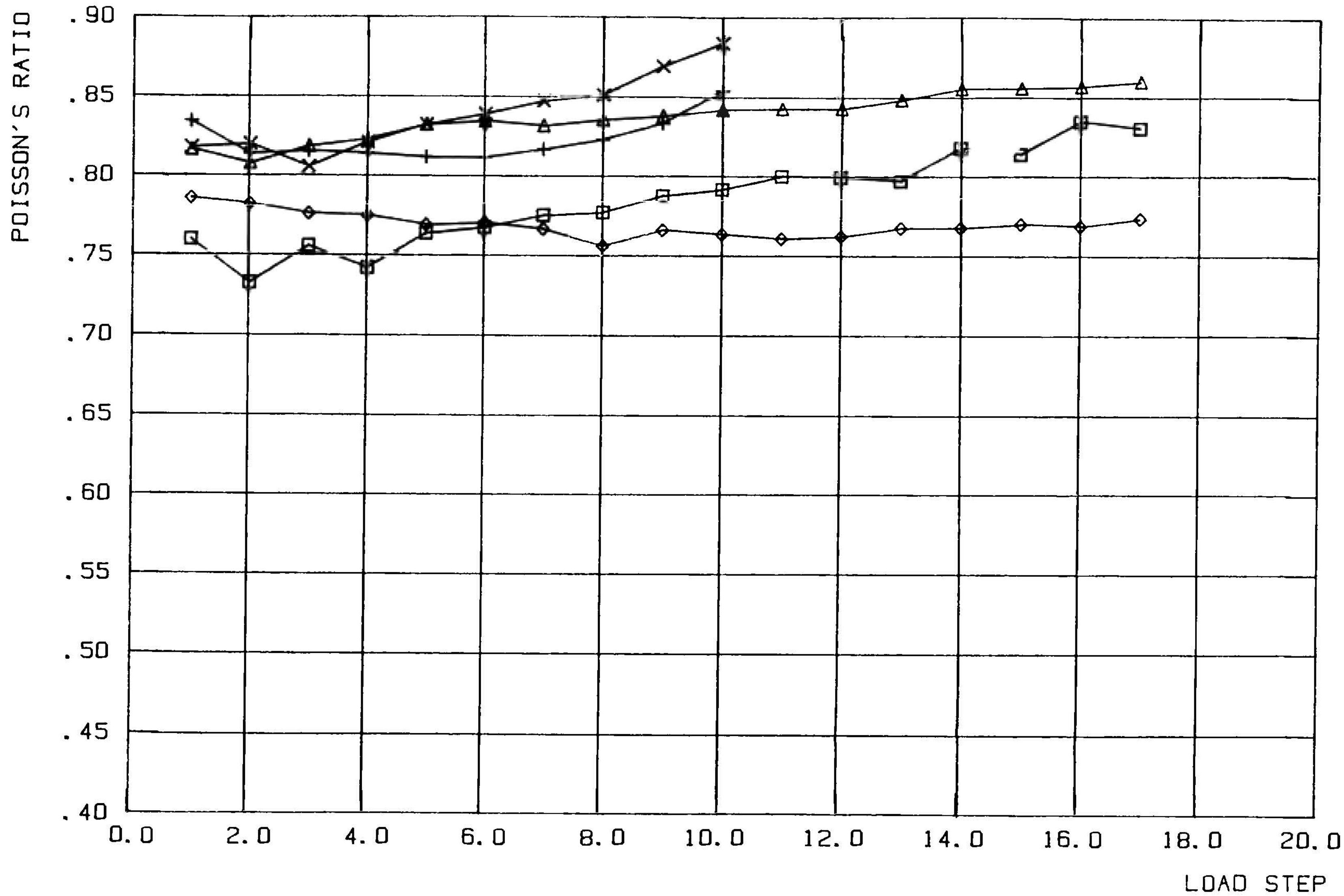
FILE :B:2POISN2.DAT

LOADSTEP	POISSON'S RATIO
1	.7591
2	.7319808
3	.7550796
4	.7414633
5	.7632025
6	.7670873
7	.7747038
8	.7766533
9	.7870547
10	.7912267
11	.7993332
12	.7988815
13	.7967135
14	.8176826
15	.8137604
16	.8346658
17	.8303

TEST 2: POISSON'S RATIO CALCULATED FROM CURVATURE.

FILE :B:2POISN3.DAT

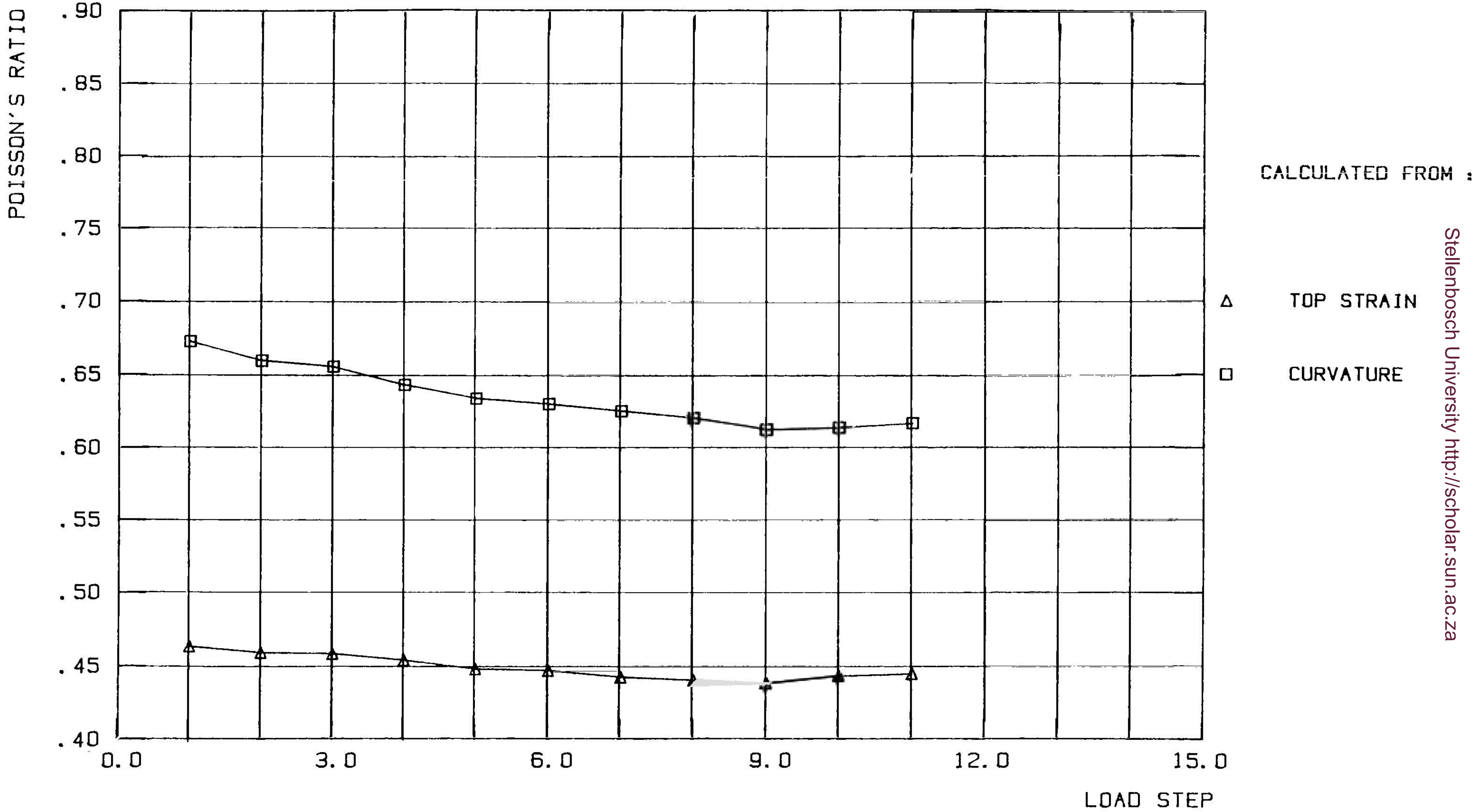
LOADSTEP	POISSON'S RATIO
1	.785243
2	.7816141
3	.7752401
4	.774061
5	.768392
6	.7698938
7	.7658783
8	.755493
9	.7655125
10	.7628491
11	.7601092
12	.7617406
13	.7671908
14	.7673275
15	.769728
16	.768621
17	.77342



POISSON'S RATIO VERSUS LOAD STEP

TEST 1 AND 2:

GRAPH 10.3



POISSON'S RATIO VERSUS LOAD STEP

TEST 3:

GRAPH 10.4

TEST 3: POISSON'S RATIO CALCULATED FROM TOP STRAIN.

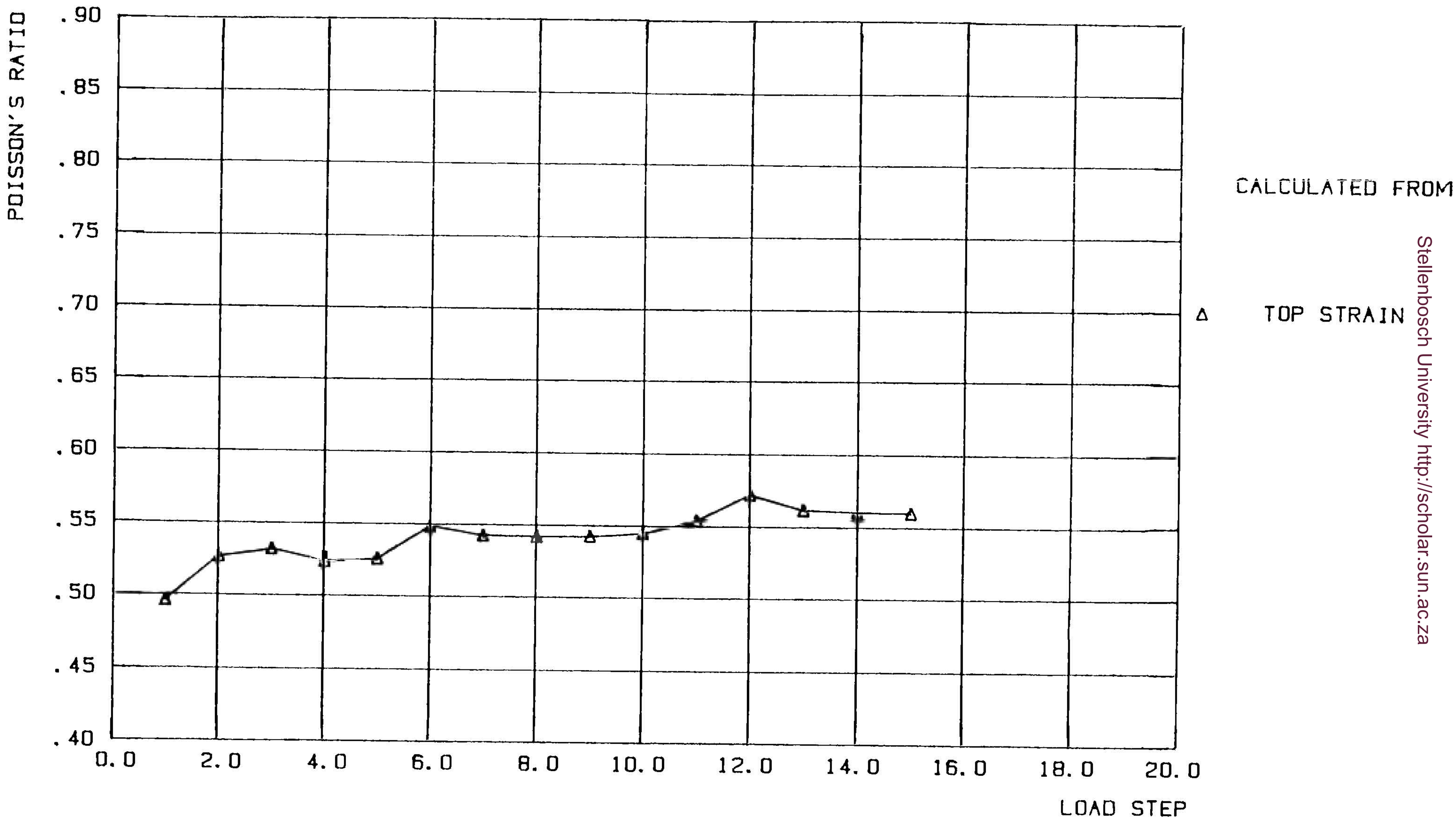
FILE :B:3POISN1.DAT

LOADSTEP	POISSON'S RATIO
1	.4630941
2	.458783
3	.4580229
4	.4535669
5	.4474252
6	.4465276
7	.4419382
8	.439863
9	.4376301
10	.4428921
11	.4444857

TEST 3: POISSON'S RATIO CALCULATED FROM CURVATURE.

FILE :B:3POISN3.DAT

LOADSTEP	POISSON'S RATIO
1	.6720326
2	.6588326
3	.6547137
4	.6421446
5	.6328026
6	.6290101
7	.6241383
8	.6194096
9	.6113536
10	.6129141
11	.6161358



POISSON'S RATIO VERSUS LOAD STEP

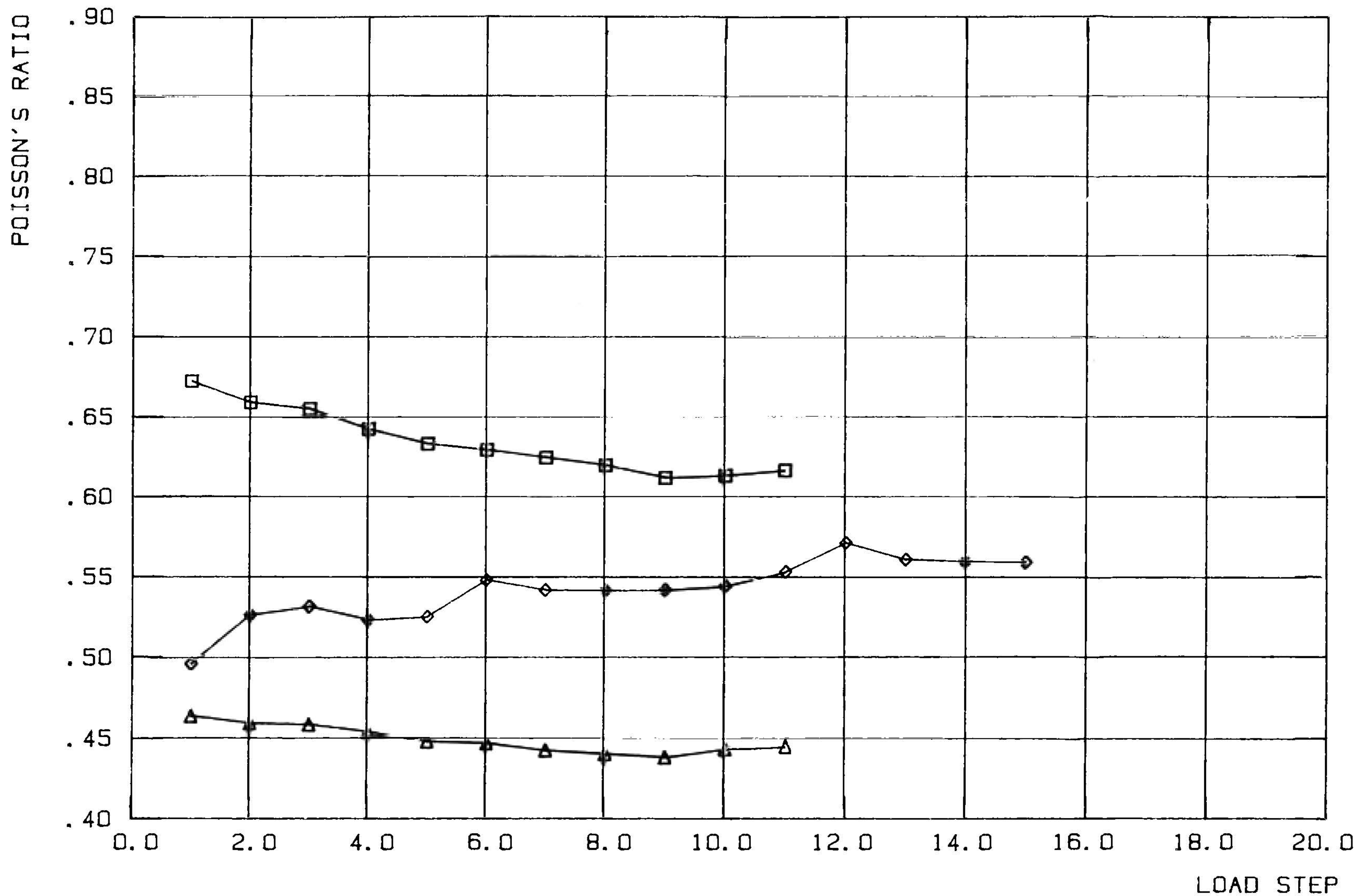
TEST 4:

GRAPH 10.5

TEST 4: POISSON'S RATIO CALCULATED FROM TOP STRAIN.

FILE :B:4POISN1.DAT

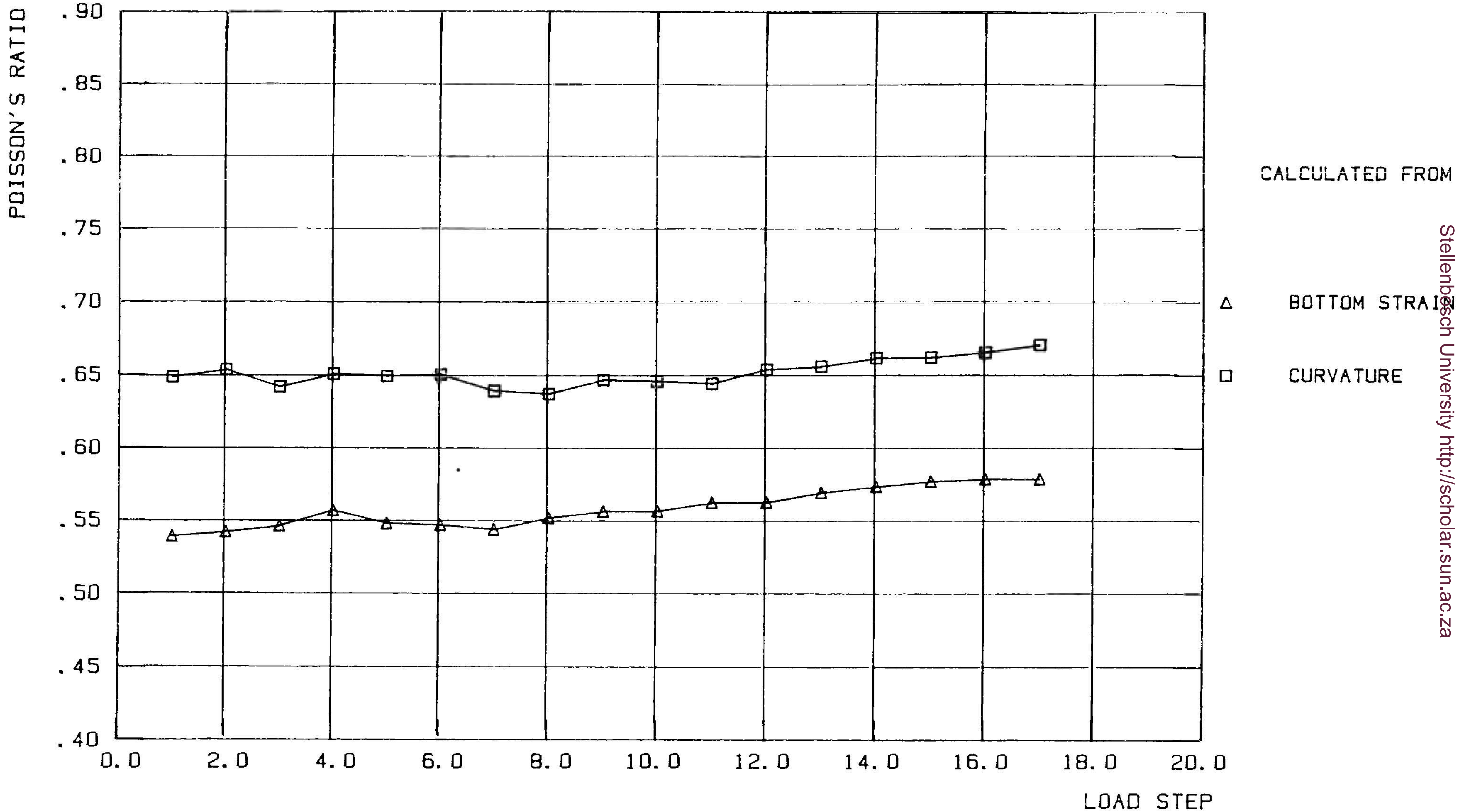
LOADSTEP	POISSON'S RATIO
1	.4953881
2	.525955
3	.5311069
4	.522766
5	.5247391
6	.5475718
7	.5412892
8	.5409111
9	.5413342
10	.5436886
11	.5526443
12	.5708098
13	.5603432
14	.5589805
15	.5586341



POISSON'S RATIO VERSUS LOAD STEP

TEST 3 AND 4:

GRAPH 10.6



POISSON'S RATIO VERSUS LOAD STEP

TEST 5:

GRAPH 10.7

TEST 5: POISSON'S RATIO CALCULATED FROM BOTTOM STRAIN.

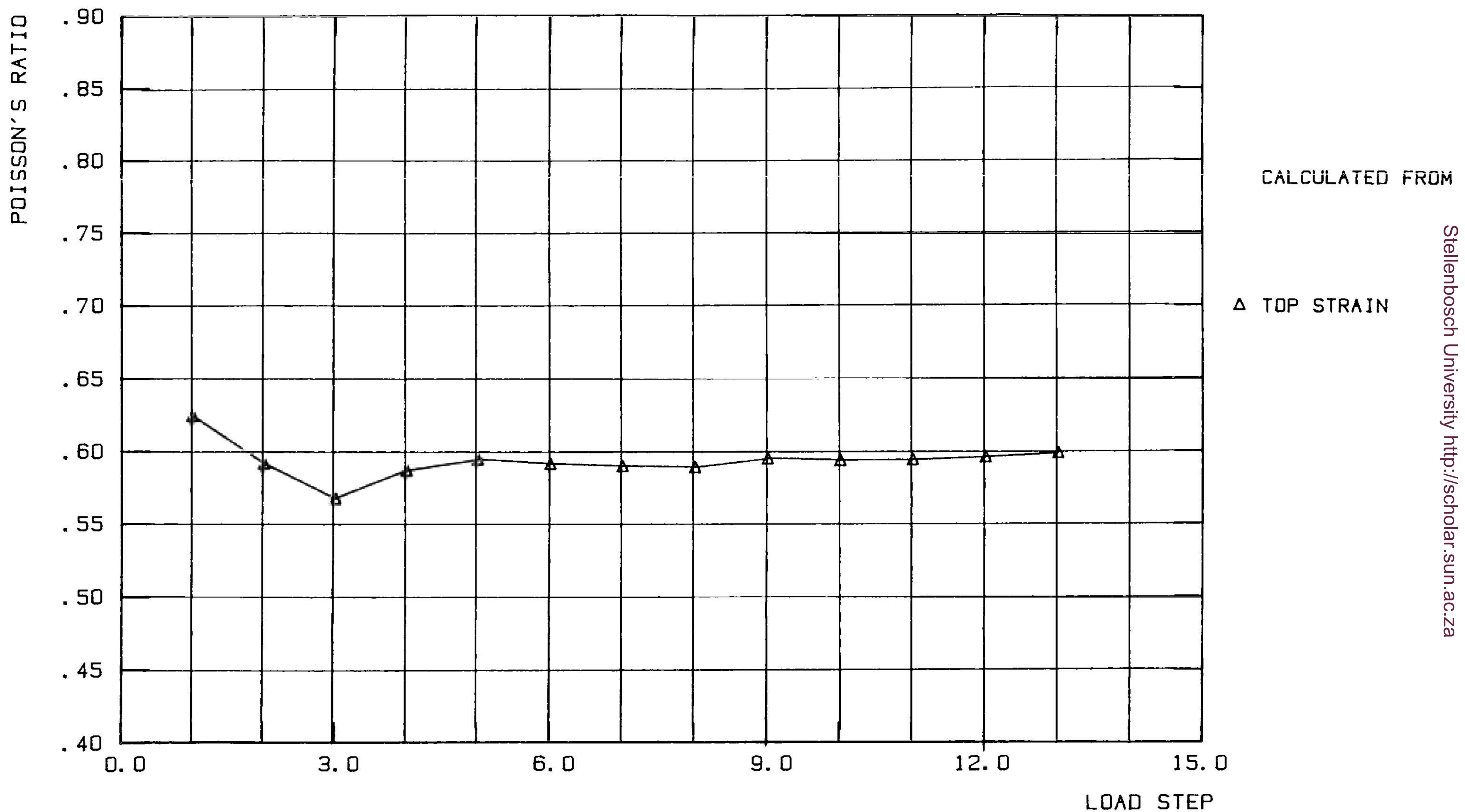
FILE :B:5POISN1.DAT

LOADSTEP	POISSON'S RATIO
1	.5388006
2	.5418973
3	.5458903
4	.5565035
5	.5475813
6	.5463995
7	.5433135
8	.5512394
9	.5557443
10	.5560406
11	.5618675
12	.5621743
13	.568873
14	.5730836
15	.576795
16	.5785246
17	.5785796

TEST 5: POISSON'S RATIO CALCULATED FROM CURVATURE.

FILE :B:5POISN3.DAT

LOADSTEP	POISSON'S RATIO
1	.6483203
2	.6533238
3	.6413431
4	.6502381
5	.6487971
6	.6499935
7	.6385426
8	.6363658
9	.6461521
10	.6451331
11	.6436571
12	.6535925
13	.6556487
14	.6613538
15	.6619743
16	.665619
17	.670827



POISSON'S RATIO VERSUS LOAD STEP

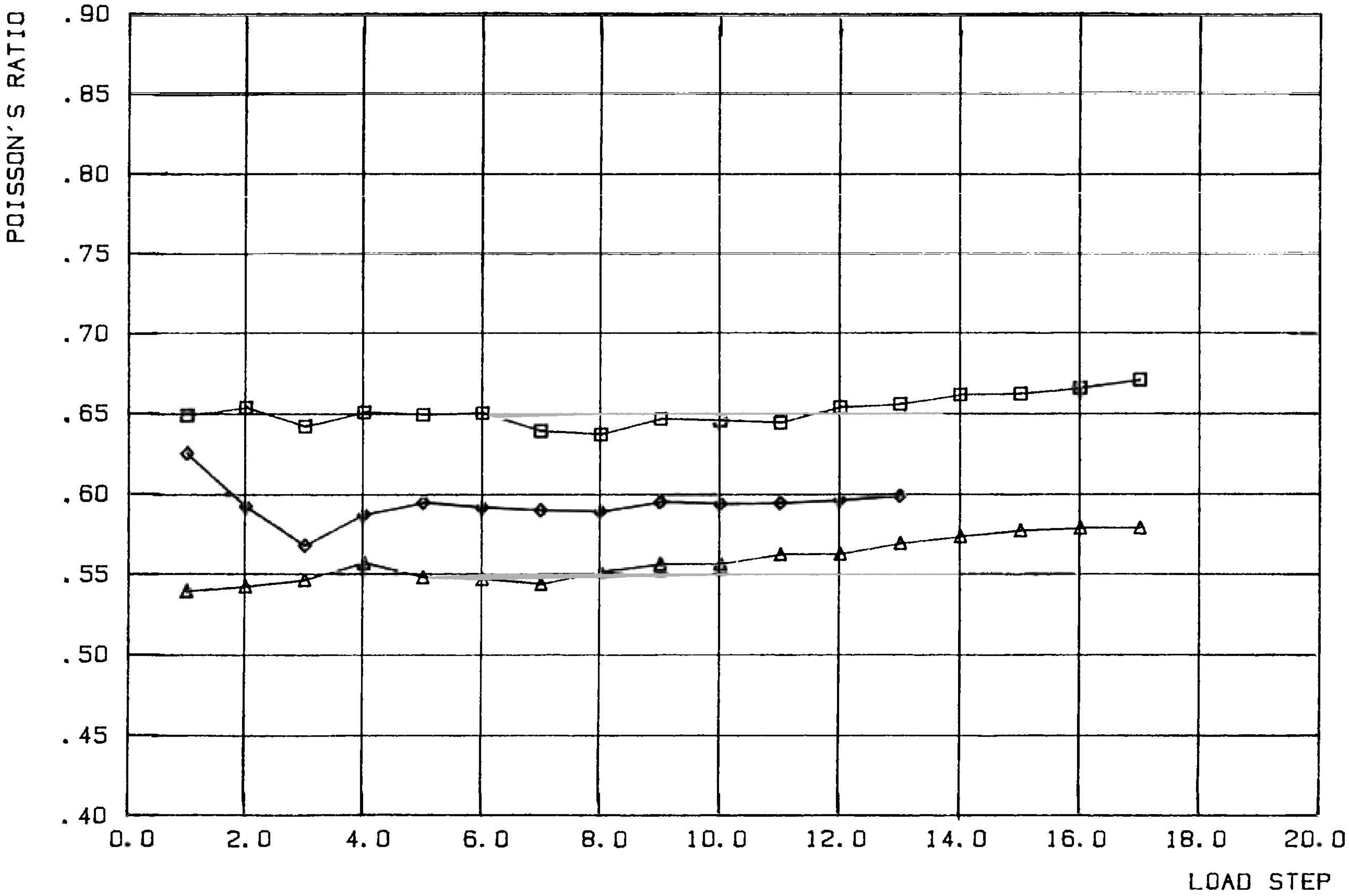
TEST 6:

GRAPH 10.8

:TEST 6: POISSON'S RATIO CALCULATED FROM BOTTOM STRAIN.

FILE :B:6POISN1.DAT

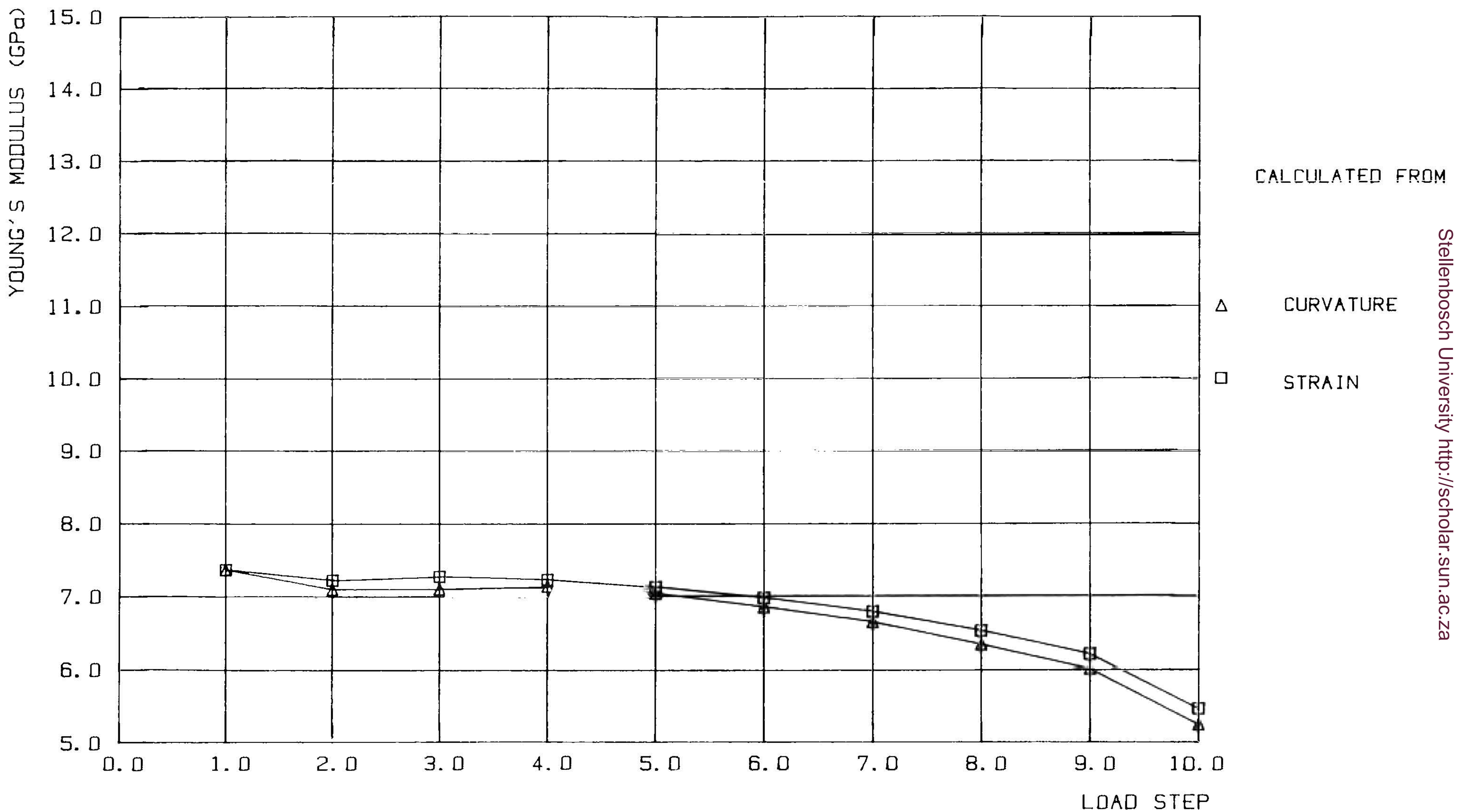
LOADSTEP	POISSON'S RATIO
1	.6242756
2	.5915776
3	.5671522
4	.5865506
5	.5940999
6	.5909853
7	.5893126
8	.5885913
9	.5944819
10	.5933218
11	.5939153
12	.5957714
13	.5985155



POISSON'S RATIO VERSUS LOAD STEP

TEST 5 AND 6:

GRAPH 10.9



YOUNG'S MODULUS VERSUS LOAD STEP

TEST 1:

GRAPH 11.1

TEST 1: YOUNG'S MODULUS CALCULATED FROM CURVATURE.

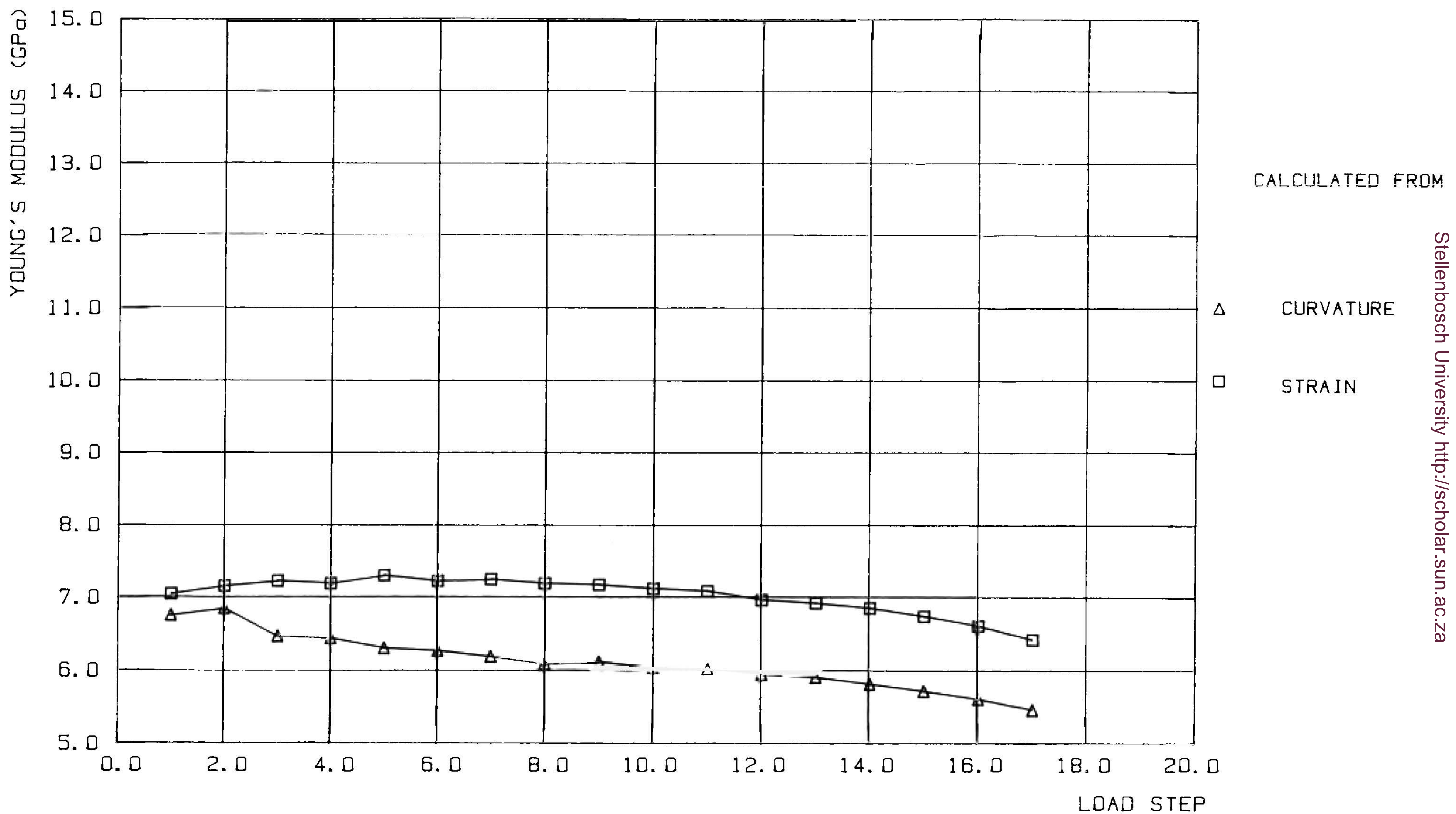
FILE :B:1ELAS1.DAT

LOADSTEP	YOUNG'S MODULUS (GPa)
1	7.357111
2	7.087979
3	7.092238
4	7.130727
5	7.026234
6	6.8422
7	6.638075
8	6.331362
9	5.999243
10	5.237712

TEST 1: YOUNG'S MODULUS CALCULATED FROM STRAIN.

FILE :B:1ELAS2.DAT

LOADSTEP	YOUNG'S MODULUS (GPa)
1	7.361474
2	7.214011
3	7.267185
4	7.223554
5	7.114542
6	6.963724
7	6.78003
8	6.519538
9	6.202813
10	5.455649



YOUNG'S MODULUS VERSUS LOAD STEP

TEST 2:

GRAPH 11.2

TEST 2: YOUNG'S MODULUS CALCULATED FROM CURVATURE.

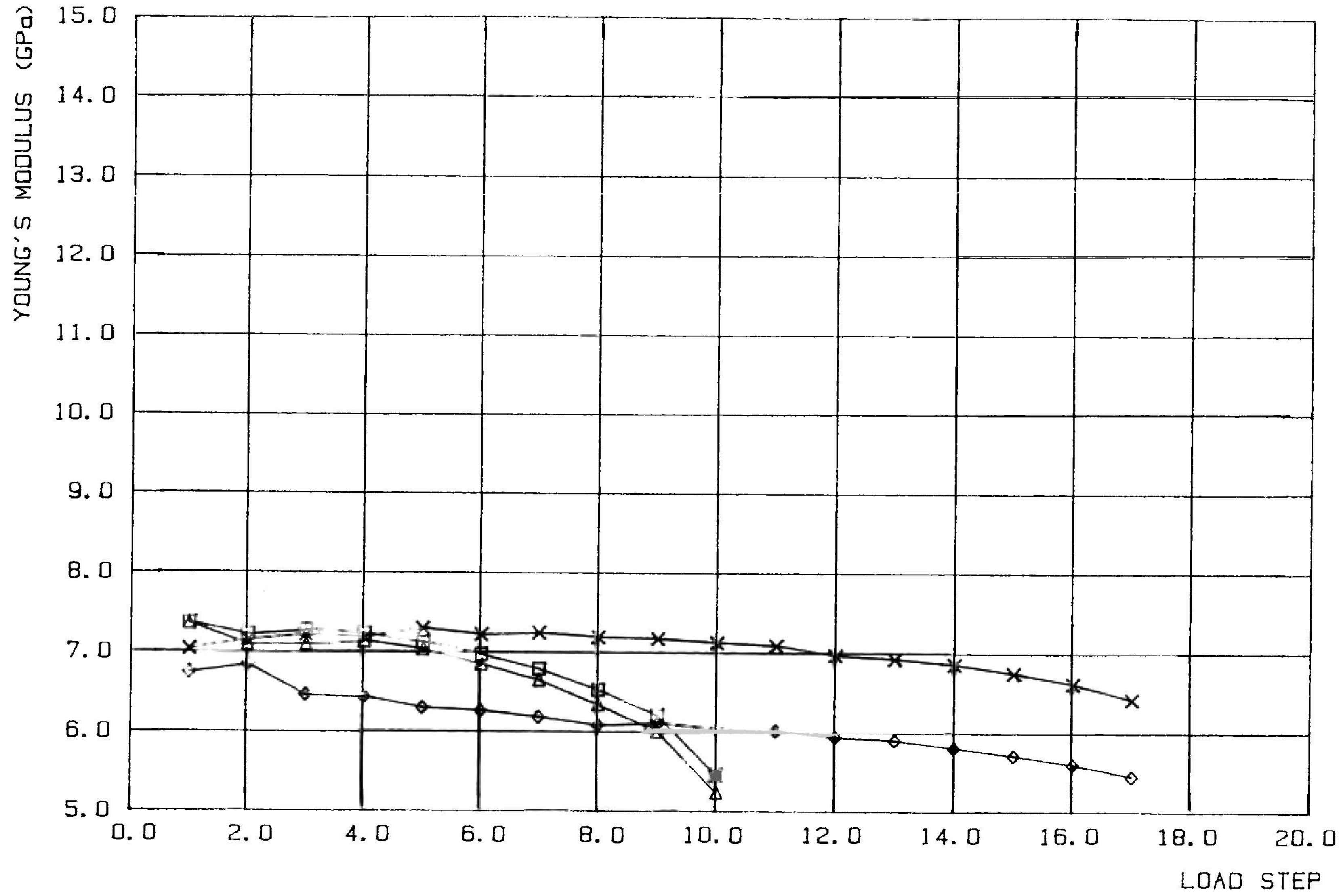
FILE :B:2ELAS1.DAT

LOADSTEP	YOUNG'S MODULUS (GPa)
1	6.739454
2	6.840293
3	6.455742
4	6.428786
5	6.29142
6	6.257556
7	6.175183
8	6.07625
9	6.106888
10	6.029062
11	6.010387
12	5.936325
13	5.897995
14	5.803035
15	5.707331
16	5.597838
17	5.447522

TEST 2: YOUNG'S MODULUS CALCULATED FROM STRAIN.

FILE :B:2ELAS2.DAT

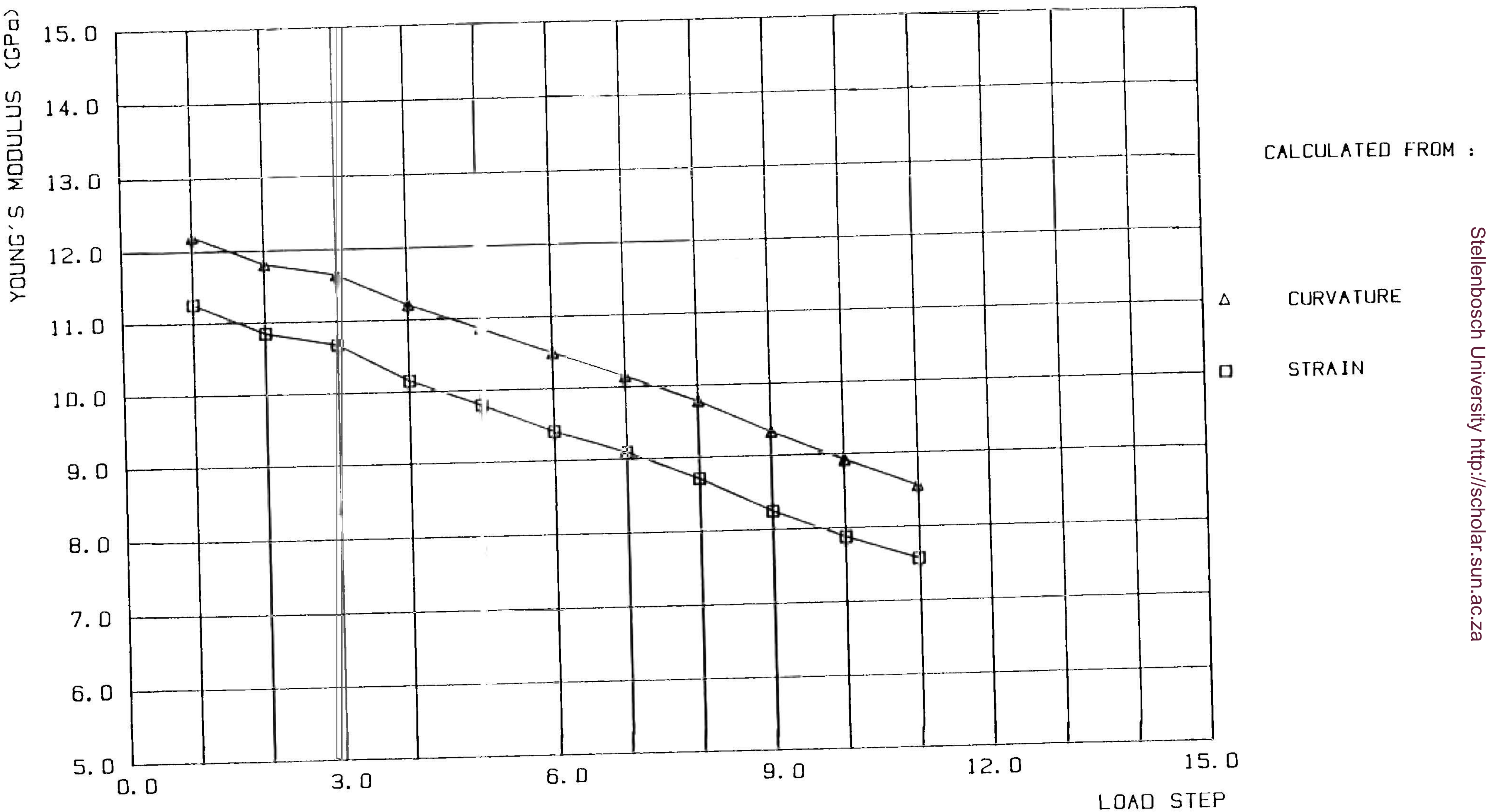
LOADSTEP	YOUNG'S MODULUS (GPa)
1	7.033729
2	7.146366
3	7.214012
4	7.181934
5	7.291577
6	7.215137
7	7.237273
8	7.183945
9	7.16364
10	7.112248
11	7.075979
12	6.957456
13	6.913412
14	6.845307
15	6.732273
16	6.60131
17	6.408532



YOUNG'S MODULUS VERSUS LOAD STEP

TEST 1 AND 2:

GRAPH 11.3



YOUNG'S MODULUS VERSUS LOAD STEP

TEST 3:

GRAPH 11.4

TEST 3: YOUNG'S MODULUS CALCULATED FROM CURVATURE.

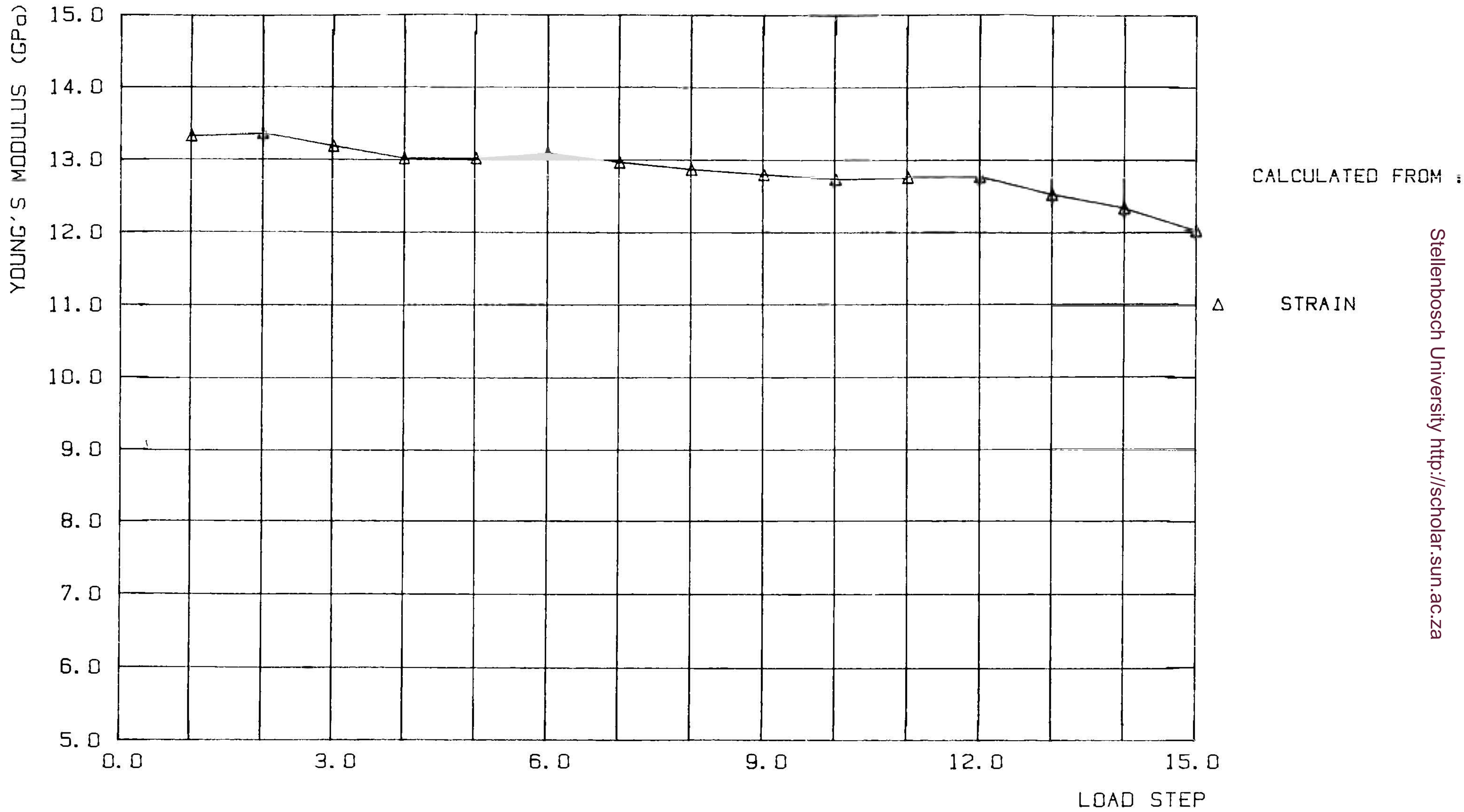
FILE :B:3ELAS1.DAT

LOADSTEP	YOUNG'S MODULUS (GPa)
1	12.18773
2	11.79711
3	11.63362
4	11.19137
5	10.83657
6	10.4761
7	10.1313
8	9.763202
9	9.309672
10	8.905412
11	8.537062

TEST 3: YOUNG'S MODULUS CALCULATED FROM STRAIN.

FILE :B:3ELAS2.DAT

LOADSTEP	YOUNG'S MODULUS (GPa)
1	11.25176
2	10.82984
3	10.6549
4	10.13935
5	9.778246
6	9.384521
7	9.076899
8	8.692538
9	8.228708
10	7.855438
11	7.546852



YOUNG'S MODULUS VERSUS LOAD STEP

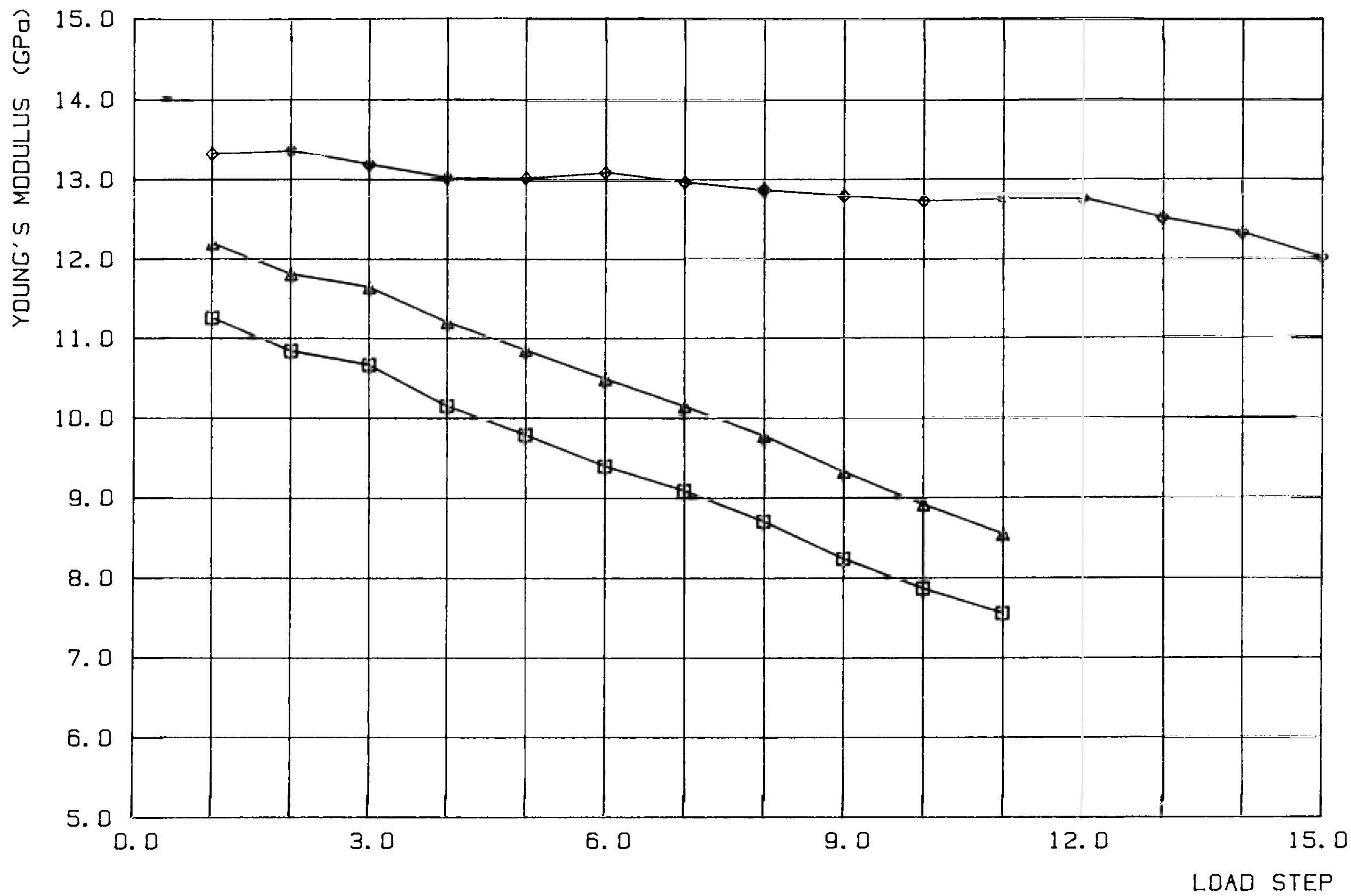
TEST 4:

GRAPH 11.5

TEST 4: YOUNG'S MODULUS CALCULATED FROM STRAIN.

FILE :B:4ELAS2.DAT

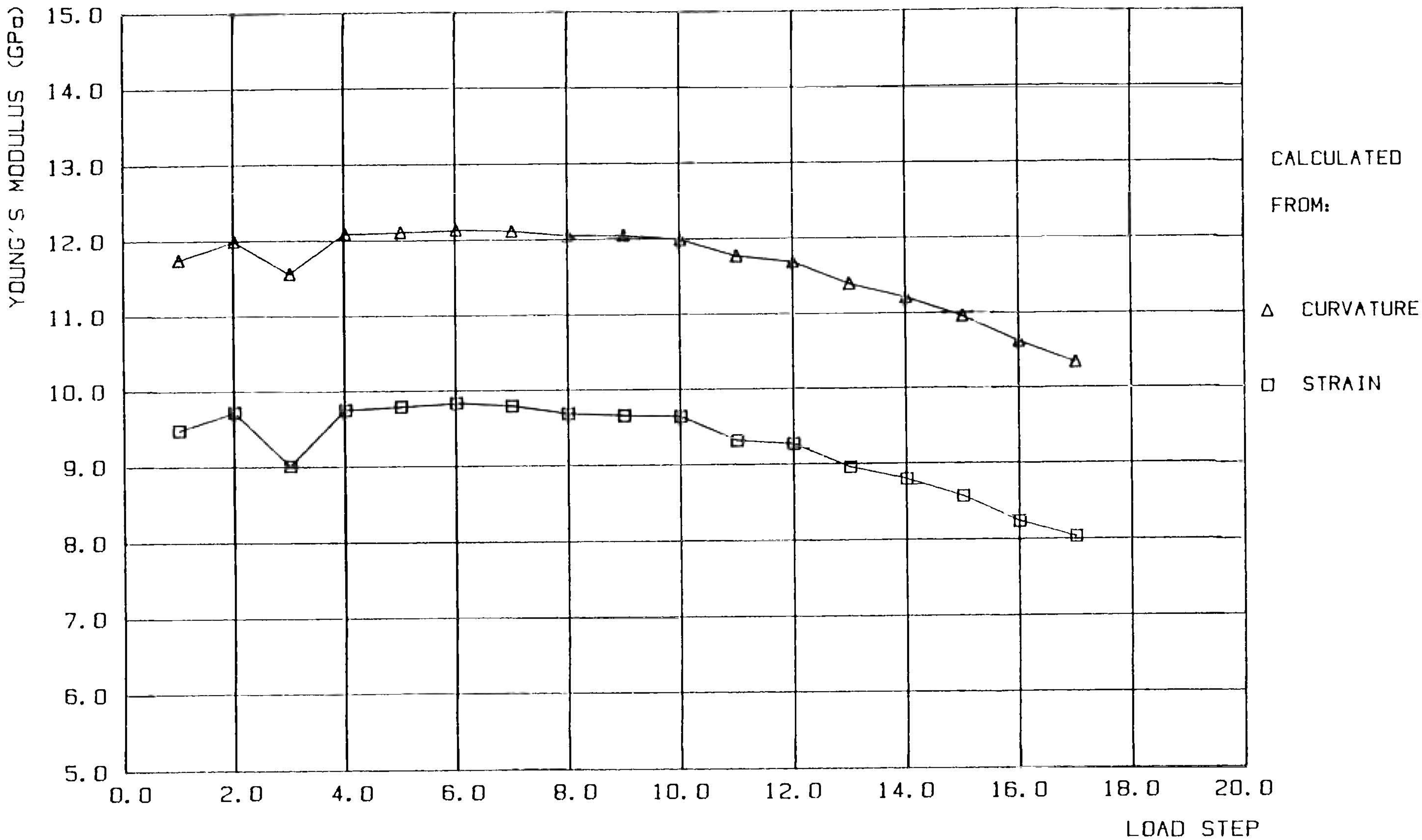
LOADSTEP	YOUNG'S MODULUS (GPa)
1	13.31627
2	13.34854
3	13.17621
4	13.00449
5	13.00891
6	13.07547
7	12.95189
8	12.85003
9	12.78044
10	12.7159
11	12.74601
12	12.75068
13	12.50787
14	12.32049
15	12.00604



YOUNG'S MODULUS VERSUS LOAD STEP

TEST 3 AND 4:

GRAPH 11.6



YOUNG'S MODULUS VERSUS LOAD STEP

TEST 5:

GRAPH 11.7

TEST 5: YOUNG'S MODULUS CALCULATED FROM CURVATURE.

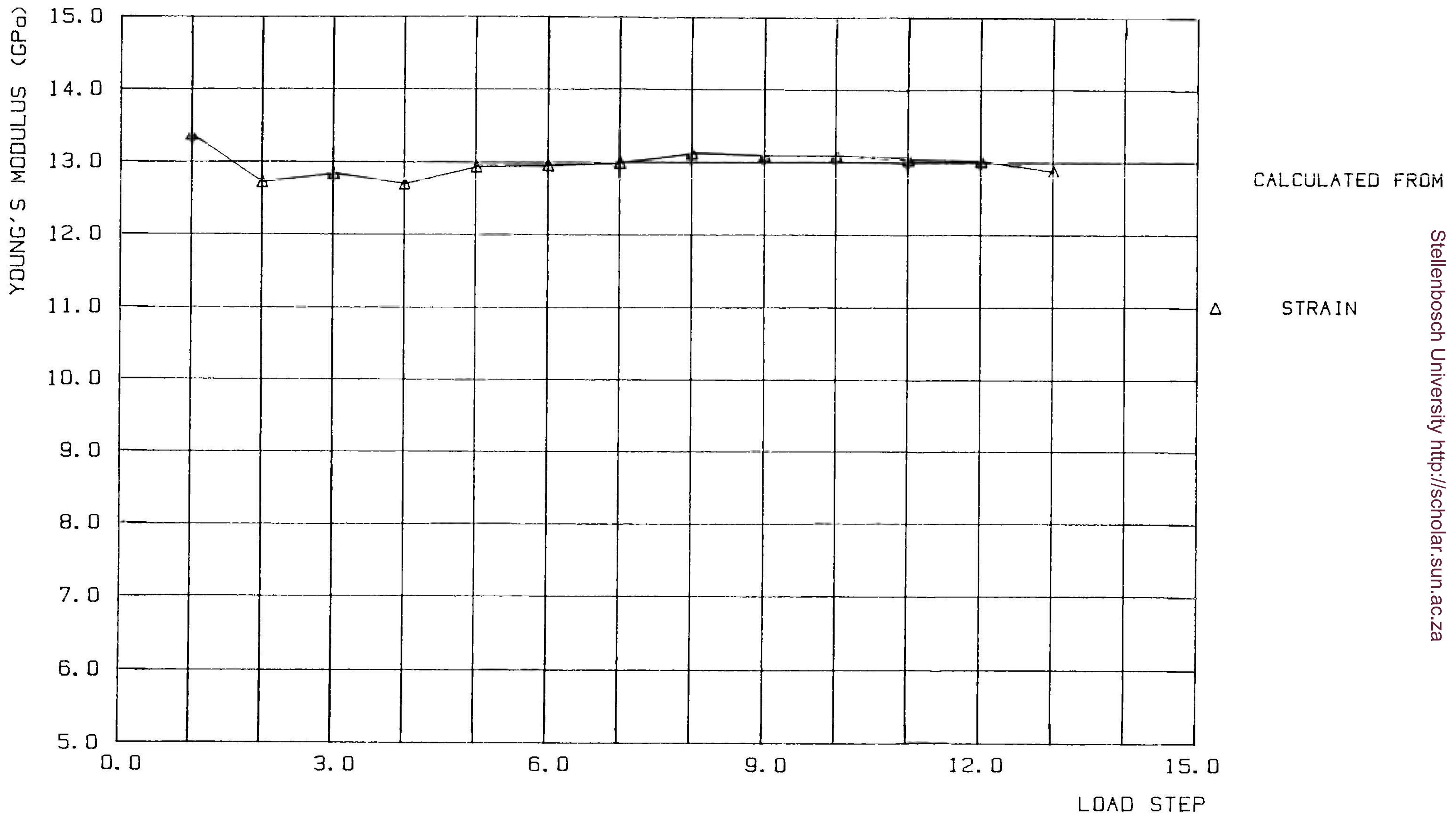
FILE :B:5ELAS1.DAT

LOADSTEP	YOUNG'S MODULUS (GPa)
1	11.73736
2	11.98436
3	11.55362
4	12.08387
5	12.10556
6	12.13069
7	12.1127
8	12.04655
9	12.04473
10	11.98162
11	11.76105
12	11.67839
13	11.38799
14	11.20555
15	10.95504
16	10.61205
17	10.33205

TEST 5: YOUNG'S MODULUS CALCULATED FROM STRAIN.

FILE :B:5ELAS2.DAT

LOADSTEP	YOUNG'S MODULUS (GPa)
1	9.467981
2	9.70835
3	8.997965
4	9.73755
5	9.778296
6	9.823001
7	9.781336
8	9.675976
9	9.645864
10	9.632375
11	9.309442
12	9.263001
13	8.951378
14	8.790441
15	8.562718
16	8.230111
17	8.031471



YOUNG'S MODULUS VERSUS LOAD STEP

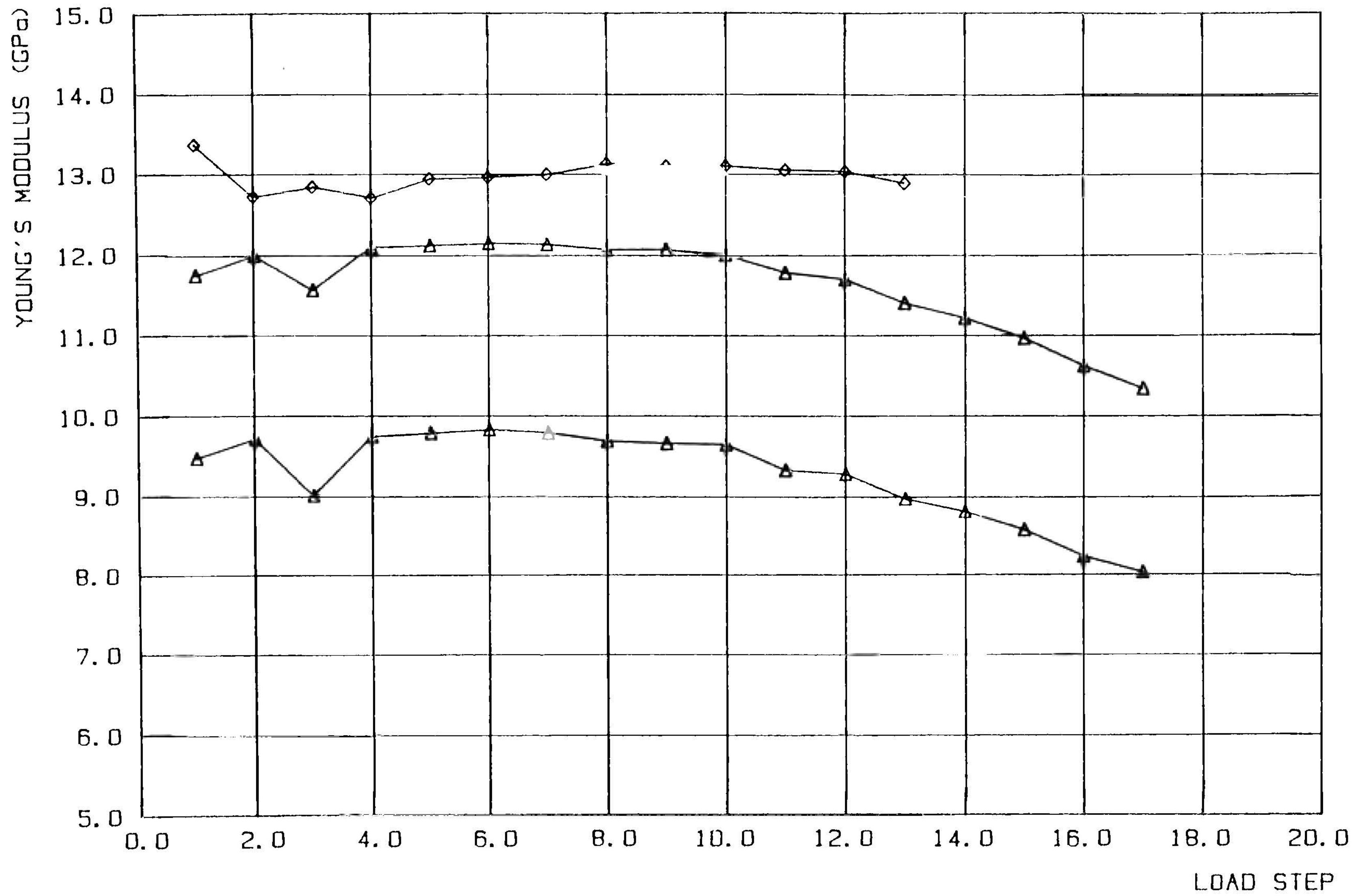
TEST 6:

GRAPH 11.8

TEST 6: YOUNG'S MODULUS CALCULATED FROM STRAIN.

FILE :B:6ELAS2.DAT

LOADSTEP	YOUNG'S MODULUS (GPa)
1	13.36162
2	12.70967
3	12.82781
4	12.6909
5	12.92712
6	12.94771
7	12.98135
8	13.11387
9	13.08118
10	13.08346
11	13.03094
12	13.01411
13	12.86833



YOUNG'S MODULUS VERSUS LOAD STEP

TEST 5 AND 6:

GRAPH 11.9