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INTEGRITY OF HIGH STRENGTH STEEL STRUCTURES

Experimental results

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SUMMARY

High strength steel with yield strength from 690 up to even 1100 MPa are very promising for high performance steel structures, e.g. bridges, transport, ships, offshore structures, etc. In spite of the base materials with excellent properties, today the design and fabrication of high strength are still facing difficulties. In the structural design the difficulties are in the assessment of the fatigue life in the joints, the buckling strength of the thin members and the deformation capacity of the (welded) connections. Several design as well as fabrication aspects of these steels are foreseen in a national research project called Integrity of High Strength Steel Structures (IHSSS project). The focus of the design part of the project is to develop a theoretical model of the welded joint behaviour with respect to fatigue and static strength. This model must be able to determine the reliability of welded joints in high strength steel. The basis of the modelling will be a number of experiments and a theoretical evaluation. Another focus is the field of application. In this project the field application is crane building (for heavy lifting) and shipbuilding (navy). These circumstances makes that the fatigue part is concentrated on low cycle fatigue and ratcheting, while for the static strength the main concern is the deformation capacity. This report includes the measurements of the experimental program related to the structural design.

CONTENTS

1. INTRODUCTION

1.1 General

The interest for the application of steels with a very high yield and tensile stress, so called very high strength steel (VHSS), has been increased in recent years. In the test programme described in this paper we consider VHSS with a strength which lays a factor two to three higher then the maximum strength of the commonly used structural steels in the design codes. This increasing interest is based on economic benefits using VHSS. These benefits are due to weight reductions, which lead to reduce use of material and savings during fabrication (e.g. welding costs). Another aspect of this growing interest is the fact that using this type of VHSS in specific structures like very heavy lifting cranes, a really new scale of structure becomes possible. To achieve the same level of safety and comfort with the lightweight VHSS structures special attention has to be given to the fabrication and design of VHSS structures. In fabrication the welding and cold deformation of VHSS can lead to weld defects and material deterioration resulting in reduced safety of the structure. In design special attention has to be paid to the design of connections to avoid high stress concentrations and to achieve sufficient deformation capacity. The fatigue design of a VHSS structure needs more attention, as the fatigue strength is not proportional to the yield strength. Special attention has to be paid to the stiffness of a VHSS structure as the reduced dimensions may lead to more deflection and dynamic vibrations. The research project [1] Integrity of High Strength Steel Structures (IHSSS project) concerns the research into the design and fabrication of structures made of VHSS with special emphasis on the structural safety. Due to lack of data, most existing codes for steel structures are restricting their scope to the steel grades up to yield strength of 355 MPa. The prEN 1993-1-1 – General Structural Rules for Steel Structures – [2], deals with steel grades to S420. Additional rules for the extension of EN 1993 to steel grades S500 to S690 are given in prEN 1993-1-12 [4]. The rules for fabrication are given in ENV 1090 – part 1 – Execution for Steel Structures [3]. The sponsors of this project are steel suppliers, designers, fabricators and users of steel structures. The users are interested in better operational performance (lighter, faster, higher loaded) than conventional structures. Fabricators are interested in economic production methods, fulfilling all requirements. The activities are concentrated on two areas of interest, fabrication and structural design. TNO Institute of Industrial Technology carries out the fabrication work package. TNO Building and Construction Research and Delft University of Technology consider the structural design. This report presents the measurements of the experimental programme of the structural design work package.

1.2 General design philosophy

Depending on the application, a VHSS structure is built up as a space frame from (tubular) members (e.g. a crane jib) or as a box structure with plates (e.g. traffic bridges or ships). The design practice is mainly based on codes for conventional steel grades [2, 3]. The research will concentrate on the applicability of these rules using the very high strength structural steels.
Currently using advanced finite element programs often carries out the general design of steel structures. Modelling of the structure and the interpretation of the numerical results is closely related to both the type of structure and the type of elements used and often needs specialist knowledge. The economical and technical advantages of using high strength steels

can only be considered in the right way if at least the design predicts the behaviour of the structure under working conditions. In general, the use of VHSS is more attractive if strength is the governing factor in the design. Two stress states, deformation in the connections and fatigue design, are briefly discussed below.

1.3 Deformation in the connections

In a conventional steel structure the ratio of the tensile strength to the yield strength is relatively high and the weld is generally overmatched. The result is that before failure of the joints the connecting members or plates will yield, resulting in a large deformation capacity and a deformation tolerant structure. For VHSS the situation is more complex due to a higher yield to tensile strength ratio and under matched welds.
The lower ratio of the tensile strength to the yield strength means that the deformation capacity will be lower in connections and structural parts with (bolt) holes or other area reducing effects (e.g. fatigue cracks) and in spite of good toughness properties of the material (base and weld material) a low deformation failure can occur.
At the moment VHSS cannot be welded with an overmatched weld metal. In welded connections with under matched weld metal the deformation will be restricted to the weld metal, also resulting in a low deformation failure.
In the design of a VHSS structure the deformation capacity required at joints has to be determined from an overall analysis. A more detailed joint analysis should ascertain whether the required deformation capacity is available.

1.4 Fatigue design

The design stress in a VHSS structure is higher than in a structure made from conventional steel and the stress due to self weight will be lower. This results in absolute and relative higher stress variations due to the external load. As the fatigue strength is not proportional to the yield stress, fatigue is more often governing the design. For structures with a high number of cycles during the lifetime (e.g. bridges, ships) high cycle fatigue (HCF) is important. For structures with a low number of high stress cycles (e.g. cranes for heavy lifting operations) low cycle fatigue (LCF) has to be considered and for structures with a low number of very heavy loads in a survival condition (e.g. minesweepers) ratcheting may be important. It is expected that the HCF approach for conventional steel can be regarded as a lower approximation for HSS structures. The LCF can be modelled with the cyclic stress-strain relation, an elastic stress concentration factor, Neuber's rule and strain controlled low-cycle-fatigue tests on small-scale specimens. A ratcheting model will probably be based on the notch strain capacity of the material.

2. PARAMETERS INVOLVED IN THE STRUCTURAL DESIGN PART

2.1 Strength of base material

In the project it was decided to go up to material with yield strength of 1100 MPa. So, this will be the upper limit of the material used in this project. At the moment this is also the

upper boundary of available material. For comparison and to make modelling possible, joints of material with lower yield strength have to be tested as well. The main purpose of testing material with lower yield strength is to have joints with overmatching welds. Material with yield strength of 690 MPa can be welded with overmatching welds. Therefore this level was chosen as the minimum value to be used in this project.

2.2 Strength of weld material

The strength of the weld material is an important parameter in the behaviour of a welded joint. Especially the strength relative to the base material is important. In steel with normal strength a weld metal will be chosen with a higher strength than the base material (overmatching welds). When joints with overmatching welds are loaded up to failure large strains will occur in the adjacent parent material and not in the welds. This means that the deformation capacity of the joint is large and especially a redundant structure has the possibility of load redistribution. This enhances the safety of a structure. In very high strength steel the weld metal will be less strong than the base material (under matching welds). When joints with under matching welds are loaded up to failure large strains will occur in the welds metal and not in the adjacent parent material. Due to small dimensions of the weld the deformation capacity of those joint can be limited, even when the weld metal itself has a good deformation capacity. This means that the possibility of load redistribution is also limited, as the joint will fail before the load is redistributed. This reduces the safety of a structure. So, the design of a joint in high strength steel with under matched welds needs special attention with respect to the deformation capacity.

2.3 Global stress concentration factor

The geometry of a welded joint is often responsible for a variation in stiffness in the joint. This will cause an unequal stress/strain distribution, resulting in a stress concentration factor (SCF). The SCF can be the result of a global variation in stiffness or of a more local variation in stiffness (e.g. due to the weld geometry). The latter will be dealt with in the next section. In joints with high global SCF the stress and strain distribution will be more unequal than in joints with low SCF. In joints with overmatched welds the unequal strain distribution can be compensated by the large deformation capacity in the parent material (see section above). However in joints with under matched welds the unequal strain distribution will be localized in the weld metal. Very high SCFs can result in local failure of the weld due to the high strains at the SCF location. This can reduce the deformation capacity and with this the safety of the structure. So, the design of high strength steel joints with under matched welds needs special attention with respect to the SCF.

2.4 Weld type

The incoming members at a joint can be welded together in different ways. In general the following weld types are used:

a) Full penetration weld,
b) Partly penetration weld,

c) Fillet weld.

It is clear that the full penetration weld is the weld with the lowest local SCF as there is a complete connection. The fillet weld has a high local SCF due to the incomplete penetration. The local SCF of the partly penetration weld is depending on the amount of partly penetration.

2.5 Material thickness

The material thickness is a parameter in the high cycle fatigue strength of a welded joint. The thicker the plates the lower the fatigue under the same stress ranges. It is likely that the low cycle fatigue strength has also a thickness effect. Therefore tests at two thicknesses are foreseen.

2.6 Loading mode

A welded connection can be loaded in tension, bending or shear. In heavily loaded joints tension and/or shear will be the most likely loading mode.

3. TEST PROGRAMME

3.1 Joint geometry

The joint geometry to be used in the design part must be practical on one side and serve as a basis for the modelling. Therefore joints with and without an SCF are included in the programme.

The following geometry types are chosen (see Figure 1 to Figure 3):

A: Cross plate connection with fillet welds loaded in shear
B: X-joint with load carrying full penetration welds with low SCF
C: X-joint with load carrying full penetration welds with high SCF

In type A the weld is loaded in shear. There will be unequal stress distribution along the weld and at the end of the plates there is an SCF in the plate. In type B there are load carrying full penetration welds. There is no SCF along the weld. In type C there are also load carrying full penetration welds. Due to the rotated connection of the transverse plate on each side of the connecting plate there is a high SCF along the weld.
The width of the plates is in the order of 5 times the thickness. These geometries are a good starting point for the modelling of the behaviour of joints in high strength steel. The dimensions of the plate material of the test specimens are given in Appendix D.

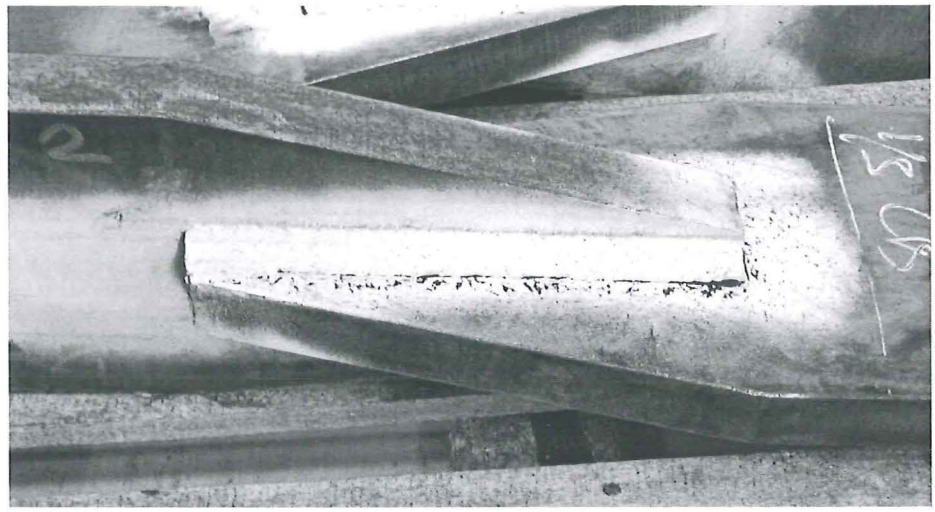


Figure 1. Cross plate connection (Specimen type A)

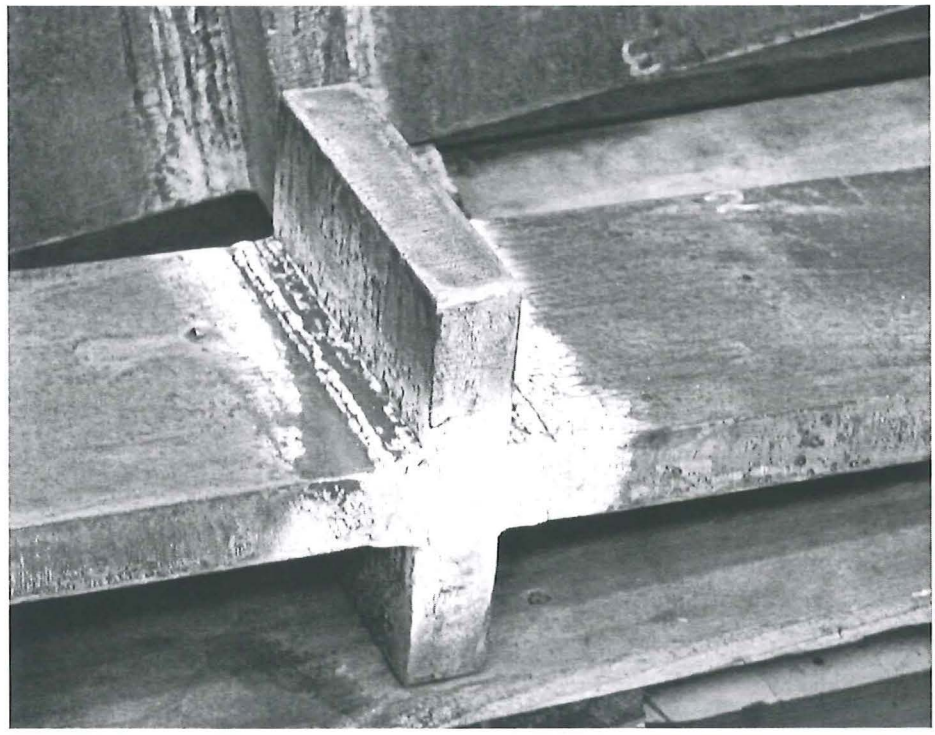


Figure 2 X-joint with load carrying full penetration welds with low SCF (Specimen type B)

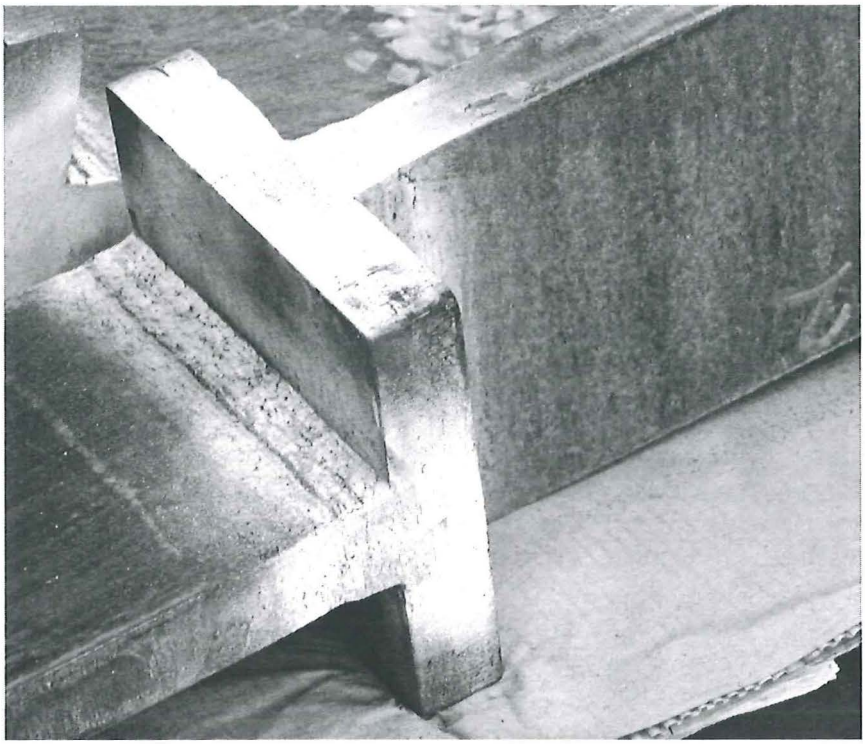


Figure 3. X-joint with load carrying full penetration welds with high SCF (Specimen type C)

3.2 Material properties

Table 1 gives the chemical composition of the different steel grades used for the fabrication of the specimens. Table 2 gives results of the mechanical properties. The data in both tables are taken from the certificates of the material.

Grade	mm	C	Si	Mn	P	S	Cr	Ni	Mo
S690	12	.16	.19	.87	.012	.002	.33	.06	.22
S690	40	.171	.324	1.33	.014	.012	.319	.106	.355
S1100	10	.16	.23	.86	.007	.002	.6	1.89	.586
S1100	40	.147	.18	.28	.007	.0007	1.48	2.62	.434
Grade	mm	V	Ti	Cu	Al	Nb	B	N	CE
S690	12		.004	.03	.085	.026	.002	.0038	.42
S690	40	.002			.065	.03	.0016		
S1100	10	.029	.004	.04	.066	.02	.002	.005	
S1100	40	.004	.002		.041	.001	.0001		

Table 1. Chemical composition of the different steel grades – data from certificates

Grade	Thickness	Reh	Rm	A	Re/Rm	Charpy-V (J)	
	mm	MPa	MPa	%		-20 °C	-40 °C
S690	12	811	842	15	0.96	251	
S690	40	792	835	16.1	0.95		204
S1100	10	1197	1432	11	0.81		29
S1100	40	1106	1325	10.7	0.83		39

Table 2. Mechanical properties of the different steel grades – data from certificates

3.3 Weld dimensions, welding processes and consumables

The dimensions of the welds are as practical as possible. For the type B and C specimens this means that the weld will be carried out as a full penetration weld with the weld base at the intermediate plate as close to the plate thickness as possible. Doing so the plate is fully connected and in an overmatching situation the connection is stronger than the connecting plate. In the under matched situation the possibility that the weld will fail before the plate is present.
For the type A specimens the weld design is more complicated and for the test specimens the design depends on the aim of the tests. An important item is the relative strength of the welded connection to the plate. It was decided that the weld dimension should be such that the weld will fail before the plate in the overmatched situation.

Table 3 gives some data of the welding processes and welding consumables provided by the fabricator of the specimens. As shown the S690 specimens are welded using Flux Cord Arc Welding (FCAW) and the S1100 specimens using Shielded Metal Arc Welding (SMAW). The mechanical properties of the filler metal are theoretical values. In the fabrication part of the research program these values will be verified by measurements.

Plate material Grade	Plate thickness mm	Specimen type	Weld process	OM weld		UM weld	
				Filler metal	MPa	Filler metal	MPa
S690	12	A/B/C	FCAW	OK.15.09	S830	DWA 55 SLR	S550
	40	A/B/C					
S1100	10	A/B/C	SMAW			Tenacito 140	S900
	40	A/B/C					

Table 3. Welding procedure specification data

3.4 Parameters in the test programme

The parameters to be investigated in the test programme are:

a) Specimen type (A, B and C)
b) Test type (static, fatigue and ratcheting)
c) Material thickness (10/12 and 40 mm)
d) Base material strength (690 and 110 MPa)
e) Relative weld strength (overmatched, only for 690 base material) and under matched

A review of the test programme including 48 tests is shown in Table 4. Each test series includes specimens of type A, B and C.

Test Series	Number of tests	Re base MPa	Re weld MPa	Plate mm	Test procedure			Parameter
					Static	Ratcheting	Fatigue	
I	12	690	900	12	X	X	X	Reference
II	9	690	900	40	X	X	X	Thickness
III	12	690	490	12	X	X	X	Under matched
IV	9	1100	900	10	X		X	High strength
V	6	1100	900	40	X		X	Thickness / High strength

Table 4. Test plan

4. TEST PROCEDURE

4.1 Static tests

In the static tests the specimens will be loaded until failure occurs. To get a stable curve to failure the test will be deflection controlled. The main result will be a load deflection (Figure 4). For detailed information strain gauges will be fixed on the specimen at specific locations. As given in Figure 4 it is expected that for an over matched weld the failure load and the deformation capacity will be higher.

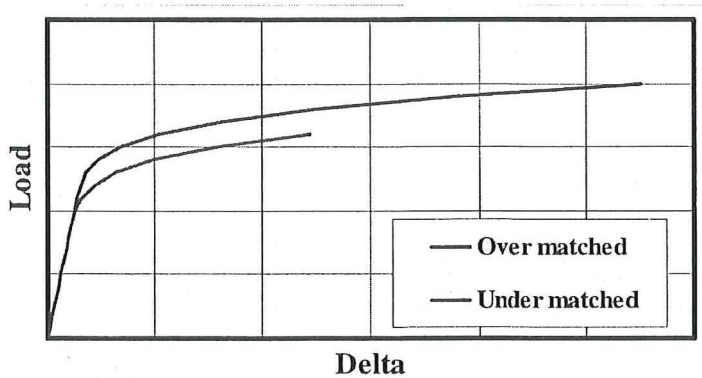


Figure 4. Static test procedure

4.2 Ratcheting tests

The ratcheting tests will be carried in a load-controlled situation. In the ratcheting tests the specimens will be loaded until a certain deformation is reached. Next the specimen will be unloaded and subsequently loaded again to a larger amount of deformation (Figure 5). Based on the static test experience the deformation steps will be chosen in such a way that failure is expected to occur in approximately 10 loading steps. The deflection curve (Figure 5) will be recorded during the test and strain measurements will be taken as well.

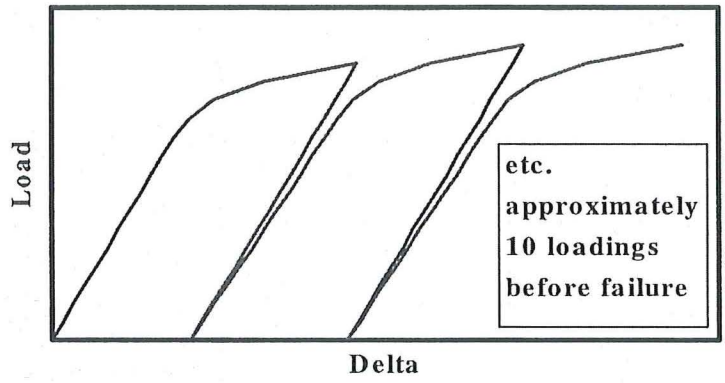


Figure 5. Ratcheting test procedure

4.3 Low cycle fatigue tests

The low cycle fatigue tests will be carried out in a load-controlled situation. The load range will be chosen in such a way that failure is expected between 1000 and 10000 cycles. The load deflection curve (Figure 6) will be recorded during the test and strain measurements will be taken as well.

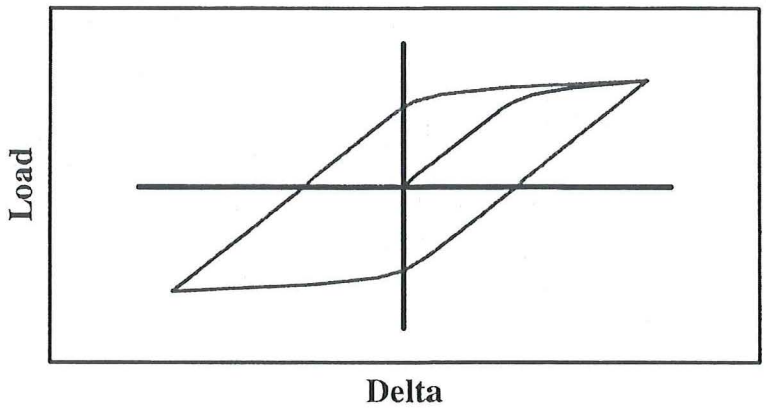


Figure 6. Fatigue test procedure

5. TEST RIG AND MEASUREMENTS

5.1 Test rig

Depending on the expected load level needed to obtain failure of the test specimen, two servo hydraulic test rigs are available. The capacity of these test rigs are 600 kN (Figure 7b) respectively 10.000 kN (Figure 7a).

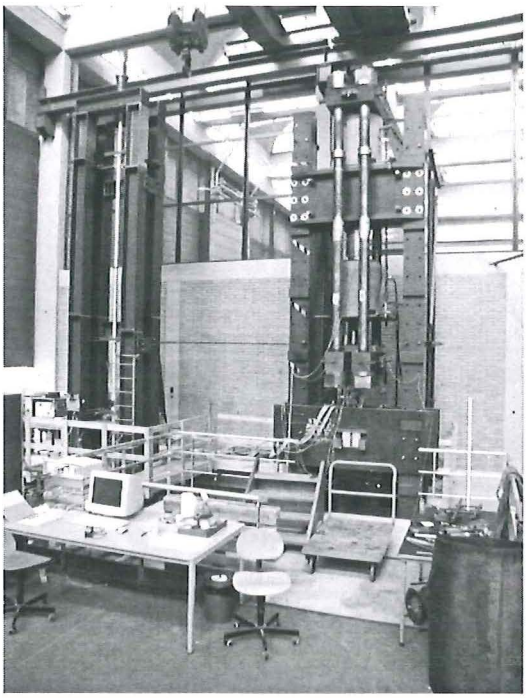


Figure 7a. 10.000 kN Test rig

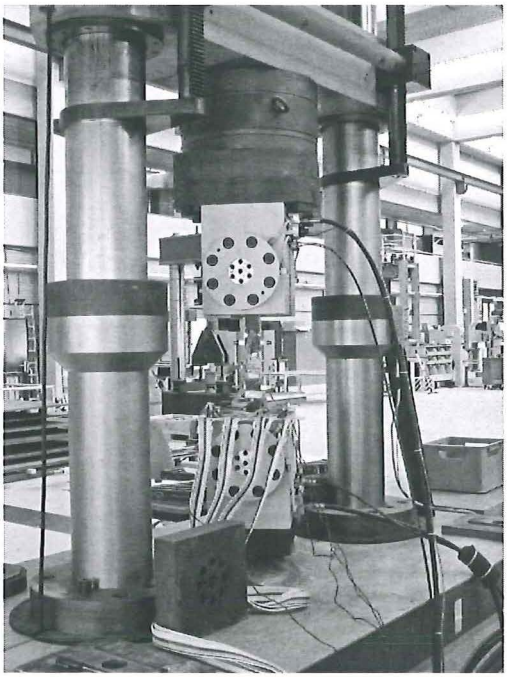


Figure 7b. 600 kN Test rig

5.2 Measurements

All test specimens have been instrumented with displacement transducers measuring locally the deformation of the weld or the deformation of the whole connection. Single strain gauges are used to measure the nominal stress in the connection plates. Strip strain gauges are used to obtain information about the strain development at the hot spot stress location of the welded connection. A typical example of an instrumented specimen is shown in Figure 8.

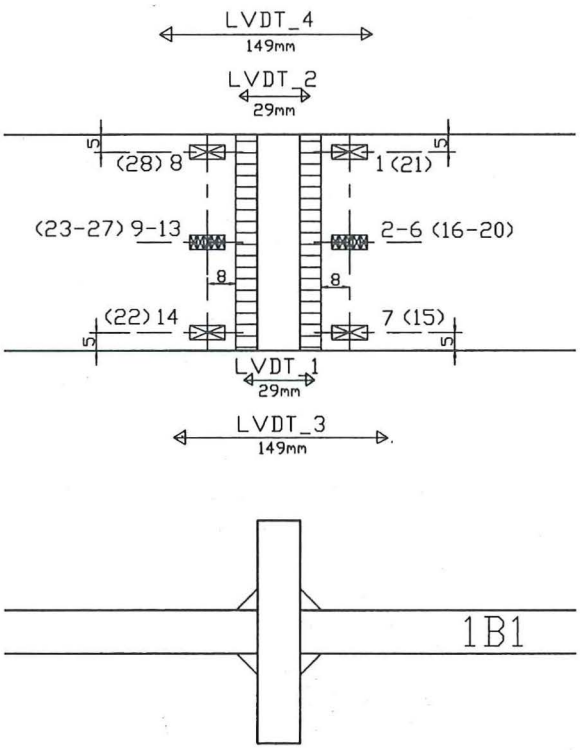


Figure 8: Instrumentation with strain gauges and displacement transducers

6. RESULTS

In the Appendices I-V the data extracted from the test files is presented, after being properly compiled. This data is presented following a standardized layout that was considered to be adequate to the types of tests performed and that will be explained.
Each Appendix refers to a series of tests, containing several tested specimens. Results for A-type test specimens from Series 1 and A-type test specimens from Series 3 were included, even though these test specimens presented wrong fabrication. Series 7 and 8 are substitutes of those specimens, and are also presented. Test specimens of Series 1 and 7 are included in Appendix I. Test specimens of Series 3 and 8 are included in Appendix III.
The data that was considered to be the result of possible measuring errors was excluded. Each time this occurs, a note saying "skipped data" is written underneath the corresponding graph.

The measuring equipment for the tests includes strain gauges and displacement measuring equipment (LVDT's and HP's). As presented before, each face of the specimen is equipped symmetrically with 6 mm long strain gauges on the edges of the specimen (FLA-type) and a 5-element single axis (FXV-type) in the central area (4mm to the weld toe). In the ratcheting tests and the low-cycle fatigue tests, the 5-element single axis strain gauge was not included. The LVDT's and HP's have different lengths (or "ranges"), which means that

they measure the displacement between two different points of the test specimen. The displacement of the piston was also recorded.

For each test specimen, one table summarizes the characteristics of the specimen, the weld metals and the test. Drawings of the test specimen are presented, with the correct lengths and sizes indicated.

For the static tests, graphs were combined in the same way:

- Load-displacement curves of the piston are presented. Some important values as the maximum load (F_{max}), the maximum displacement (S_{max}) and the displacement achieved for the maximum load (S_{Fmax}) are indicated. Whenever convenient the maximum value of strain achieved by a strain gauge is also presented (ε_{max}). This can happen, for instance, when the strain gauge fails before reaching F_{max}.
- Load-displacement curves for the other types of measuring equipment are presented. Curves for symmetrically positioned equipment are together in the same graph. The range of these equipments and S_{Fmax} are shown.
- Load-strain curves are presented. Curves for symmetrically positioned strain gauges are together in the same graph and curves for the 5-in-a-row strain gauges compiled in another graph. A picture or a drawing with the strain gauges location is showed as well as the strain achieved for the maximum load (ε_{Fmax}). The numbering of the strain gauges that appears between parenthese means that the strain gauge is underneath the visible face of the test specimen.

For each group of graphs (LVDT's and HP's or strain gauges) the scale is the same, in order to facilitate any comparisons. Finally, several pictures illustrate the failure after testing.

For the ratcheting and low cycle fatigue tests, graphs are organized in almost the same way. Load-time and displacement time curves are also presented with an indication of the cycles that where performed, as well as the values of the maximum force and corresponding displacement attained in each cycle. There is only one graph for each strain gauge, in order not to confuse the presentation.

7. REFERENCES

1) Research project 'Integrity High Strength Steel Structures', Project Office for Research on Materials and Production technology (PMP), Apeldoorn, The Netherlands (2002).

2) prEN 1993-1-1 – Eurocode 3: Design of steel structures – Part 1-1: General rules and rules for buildings, Final draft, European Committee for Standardization, Brussels (2003).

3) ENV 1090 – 1 – Execution of steel structures – Part 1: General rules and rules for buildings, European Committee for Standardization, Brussels (1996).

4) prEN 1993-1-12 – Eurocode 3: Design of steel structures - Part 1-12: Additional rules for the extension of EN 1993 to steel grades S 500 to S 690, 2nd draft, European Committee for Standardization, Brussels (2003).

Series	No.	Test nr.	Re base	Re weld	T (mm)	Remark	Test	Parameter	Appendix
1	1	1A1	690	900	12	Shear	Static	Reference	I.1A1
1	2	1A2	690	900	12	Shear	Fatigue	Reference	I.1A2
1	3	1A3	690	900	12	Shear	Fatigue	Reference	I.1A3
1	4	1A4	690	900	12	Shear	Ratcheting	Reference	I.1A4
1	5	1B1	690	900	12	Low SCF	Static	Reference	I.1B1
1	6	1B2	690	900	12	Low SCF	Fatigue	Reference	I.1B2
1	7	1B3	690	900	12	Low SCF	Fatigue	Reference	I.1B3
1	8	1B4	690	900	12	Low SCF	Ratcheting	Reference	I.1B4
1	9	1C1	690	900	12	High SCF	Static	Reference	I.1C1
1	10	1C2	690	900	12	High SCF	Fatigue	Reference	I.1C2
1	11	1C3	690	900	12	High SCF	Fatigue	Reference	I.1C3
1	12	1C4	690	900	12	High SCF	Ratcheting	Reference	I.1C4
2	13	2A1	690	900	40	Shear	Static	Thickness	II.2A1
2	14	2A2	690	900	40	Shear	Fatigue	Thickness	II.2A2
2	15	2A3	690	900	40	Shear	Ratcheting	Thickness	II.2A3
2	16	2B1	690	900	40	Low SCF	Static	Thickness	II.2B1
2	17	2B2	690	900	40	Low SCF	Fatigue	Thickness	II.2B2
2	18	2B3	690	900	40	Low SCF	Ratcheting	Thickness	II.2B3
2	16	2B4	690	900	40	Low SCF	Static	Thickness	II.2B4
2	19	2C1	690	900	40	High SCF	Static	Thickness	II.2C1
2	20	2C2	690	900	40	High SCF	Fatigue	Thickness	II.2C2
2	21	2C3	690	900	40	High SCF	Ratcheting	Thickness	II.2C3
3	22	3A1	690	490	12	Shear	Static	Under matched	III.3A1
3	23	3A2	690	490	12	Shear	Fatigue	Under matched	III.3A2
3	24	3A3	690	490	12	Shear	Fatigue	Under matched	III.3A3
3	25	3A4	690	490	12	Shear	Ratcheting	Under matched	III.3A4
3	26	3B1	690	490	12	Low SCF	Static	Under matched	III.3B1
3	27	3B2	690	490	12	Low SCF	Fatigue	Under matched	III.3B2
3	28	3B3	690	490	12	Low SCF	Fatigue	Under matched	III.3B3
3	29	3B4	690	490	12	Low SCF	Ratcheting	Under matched	III.3B4
3	30	3C1	690	490	12	High SCF	Static	Under matched	III.3C1
3	31	3C2	690	490	12	High SCF	Fatigue	Under matched	III.3C2
3	32	3C3	690	490	12	High SCF	Fatigue	Under matched	III.3C3
3	33	3C4	690	490	12	High SCF	Ratcheting	Under matched	III.3C4
4	34	4A1	1100	900	10	Shear	Static	High strength	IV.4A1
4	35	4A2	1100	900	10	Shear	Fatigue	High strength	IV.4A2
4	36	4A3	1100	900	10	Shear	Fatigue	High strength	IV.4A3
4	37	4B1	1100	900	10	Low SCF	Static	High strength	IV.4B1
4	38	4B2	1100	900	10	Low SCF	Fatigue	High strength	IV.4B2
4	39	4B3	1100	900	10	Low SCF	Fatigue	High strength	IV.4B3
4	40	4C1	1100	900	10	High SCF	Static	High strength	IV.4C1
4	41	4C2	1100	900	10	High SCF	Fatigue	High strength	IV.4C2
4	42	4C3	1100	900	10	High SCF	Fatigue	High strength	IV.4C3
5	43	5A1	1100	900	40	Shear	Static	Thickness / HS	V.5A1
5	44	5A2	1100	900	40	Shear	Fatigue	Thickness / HS	V.5A2
5	45	5B1	1100	900	40	Low SCF	Static	Thickness / HS	V.5B1

5	46	5B2	1100	900	40	Low SCF	Fatigue	Thickness / HS	V.5B2
5	47	5C1	1100	900	40	High SCF	Static	Thickness / HS	V.5C1
5	48	5C2	1100	900	40	High SCF	Fatigue	Thickness / HS	V.5C2
7	1	7A1	690	900	12	Shear	Static	Reference	I.7A1
7	2	7A2	690	900	12	Shear	Fatigue	Reference	I.7A2
7	3	7A3	690	900	12	Shear	Fatigue	Reference	I.7A3
7	4	7A4	690	900	12	Shear	Ratcheting	Reference	I.7A4
8	22	8A1	690	490	12	Shear	Static	Under matched	III.8A1
8	23	8A2	690	490	12	Shear	Fatigue	Under matched	III.8A2
8	24	8A3	690	490	12	Shear	Fatigue	Under matched	III.8A3
8	25	8A4	690	490	12	Shear	Ratcheting	Under matched	III.8A4

SPECIMEN 1A1

Table 1A1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1A1 (1)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1A
Test	Type of test	Static strength
	Parameter	Reference
	Remark	Fillet welds loaded in shear
	Failure	Plate

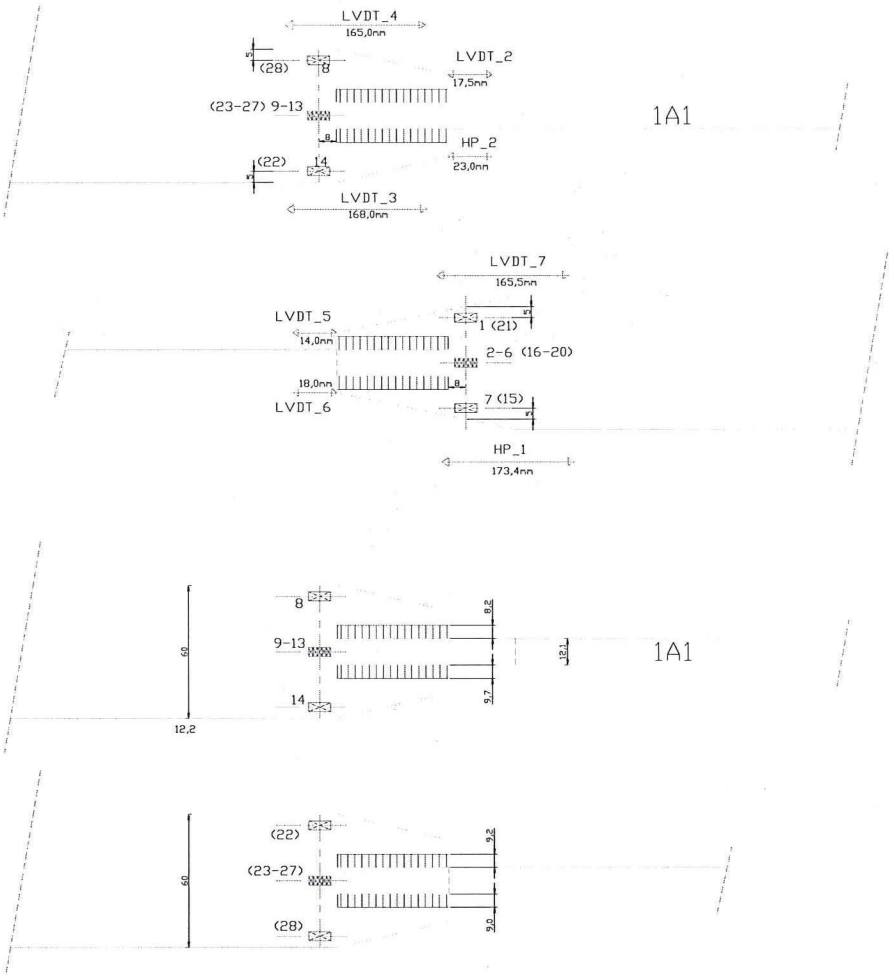
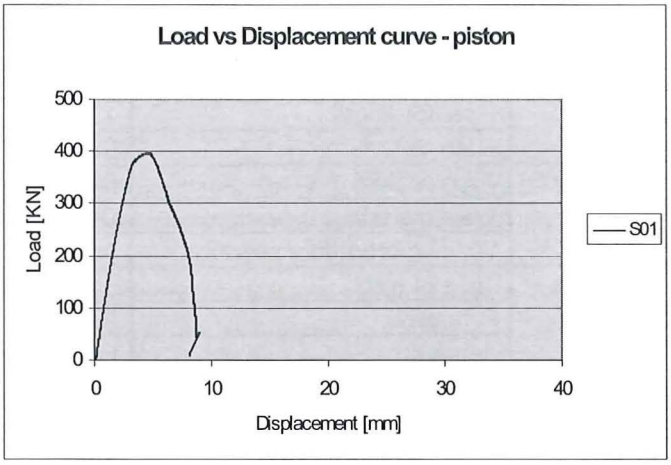
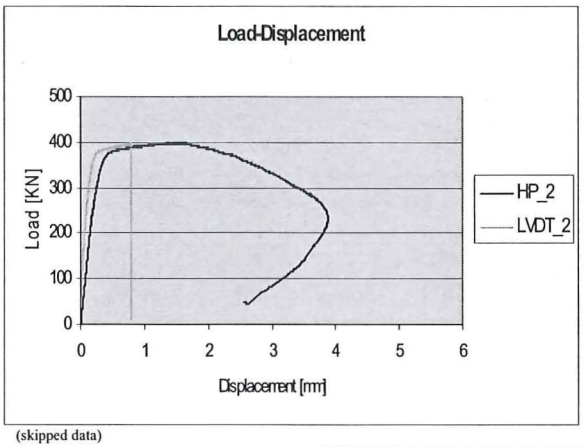


Figure 1.1: Top views of the test specimen with the position of the strain gauges and sizes of the welds and measuring equipment.

SPECIMEN 1A1

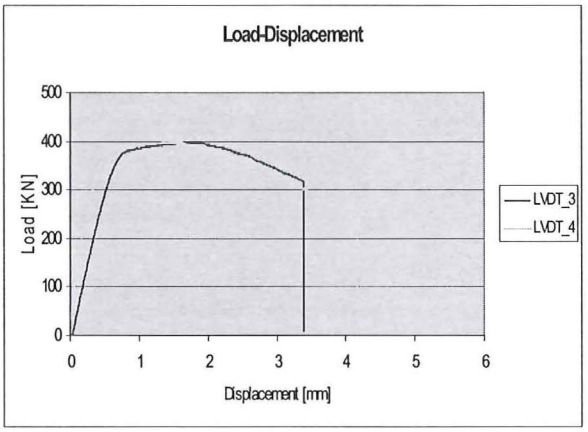


F_{max} [KN]	399
S_{Fmax} [mm]	4.81
S_{max} [mm]	9.01

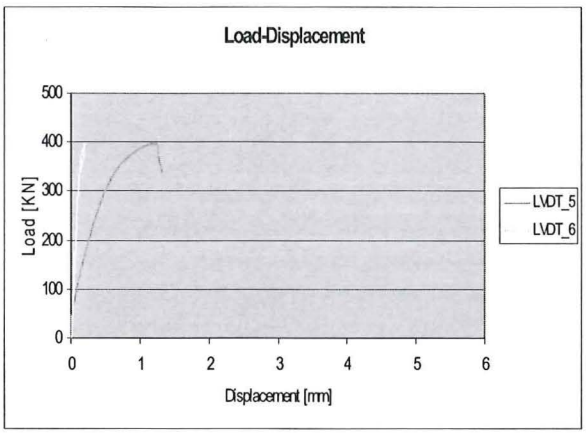


(skipped data)

	Range [mm]	S_{Fmax} [mm]
HP_2	23.0	1.64
LVDT_2	17.5	0.79

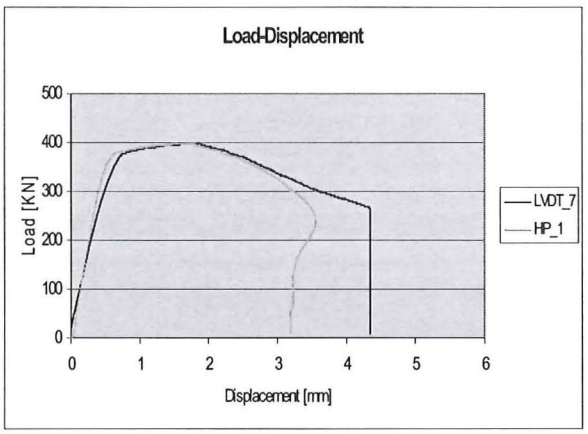


	Range [mm]	S_{Fmax} [mm]
LVDT_3	168.0	1.89
LVDT_4	165.0	1.61



(skipped data)

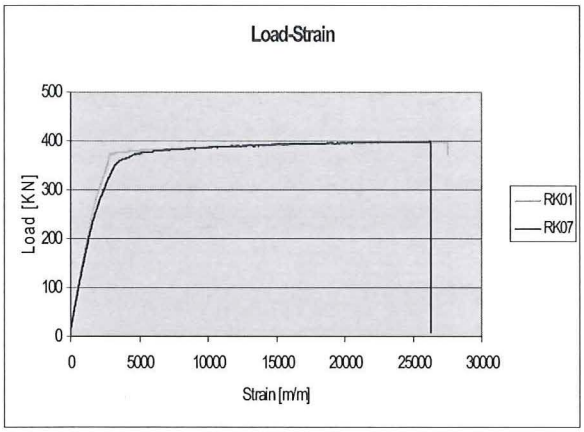
	Range [mm]	S_{Fmax} [mm]
LVDT_5	14.0	1.23
LVDT_6	18.0	0.21



(skipped data)

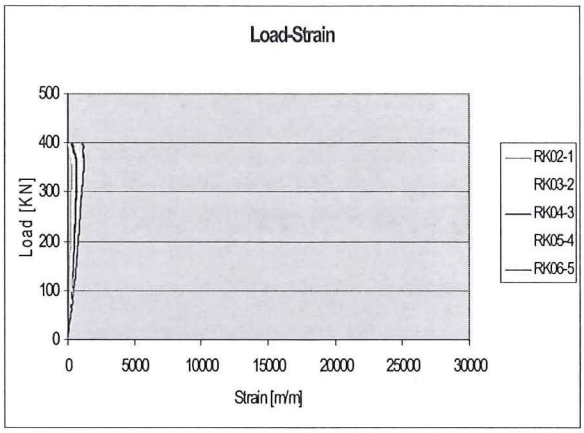
	Range [mm]	S_{Fmax} [mm]
LVDT_7	165.5	1.86
HP_1	173.4	1.75

SPECIMEN 1A1



(skipped data)

	ε_{Fmax} [m/m]
RK01	27502.60
RK07	26213.00



(skipped data)

	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK02-1	165.05	302.596
RK03-2	9.17 (Failure before F_{max})	504.328
RK04-3	275.09	669.381
RK05-4	706.06	1109.52
RK06-5	1109.52	1210.39

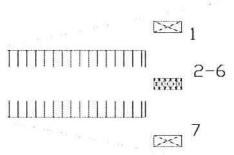
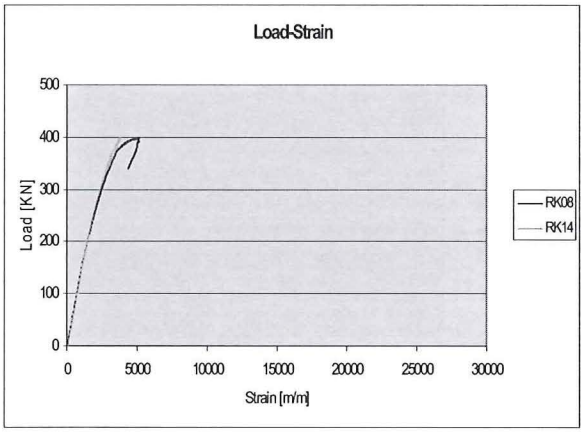
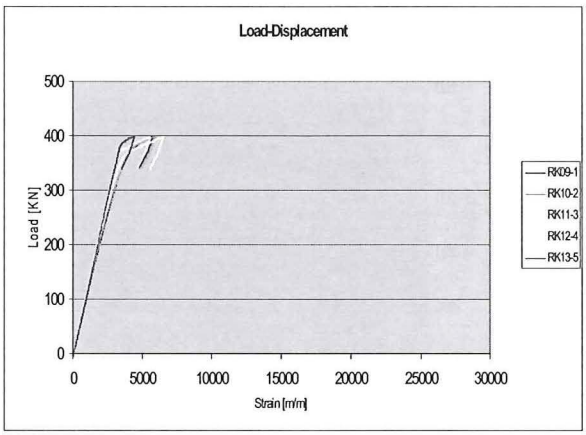


Figure 1.2: Test specimen face with the position of the strain gauges 1 to 7.



(skipped data)

	ε_{Fmax} [m/m]
RK08	5111.77
RK14	3784.76



(skipped data)

	ε_{Fmax} [m/m]
RK09-1	5795.19
RK10-2	5969.41
RK11-3	6537.93
RK12-4	5593.46
RK13-5	4465.60

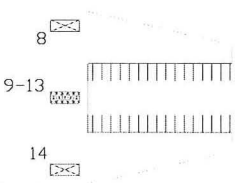
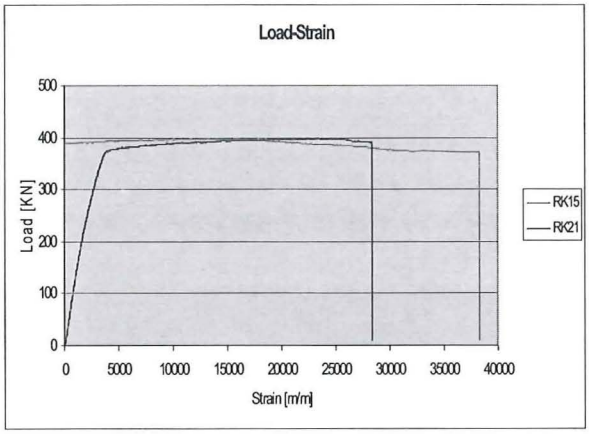


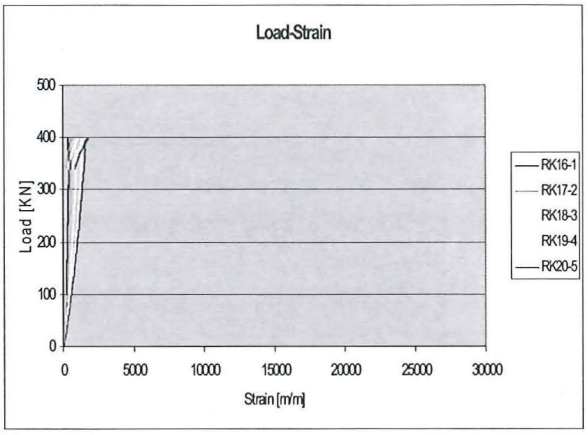
Figure 1.3: Test specimen face with the position of the strain gauges 8 to 14.

SPECIMEN 1A1



(skipped data – Note that a scale up to 40000 m/m is used to RK15)

	ε_{Fmax} [m/m]
RK15	16223.10
RK21	24923.40



(skipped data)

	ε_{Fmax} [m/m]
RK16-1	384.42
RK17-2	641.87
RK18-3	1072.84
RK19-4	1512.98
RK20-5	1778.90

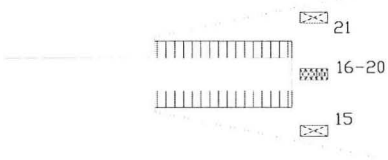
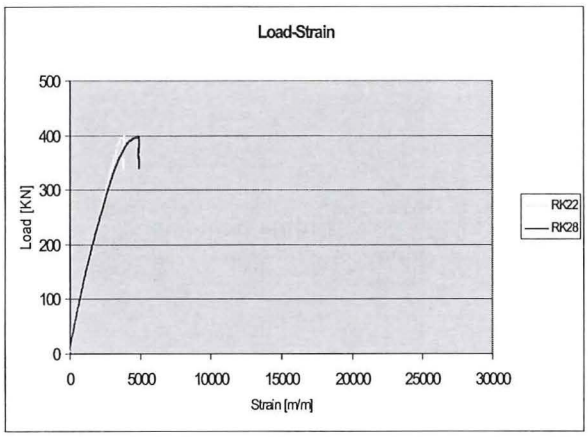


Figure 1.4: Test specimen face with the position of the strain gauges 15 to 21.



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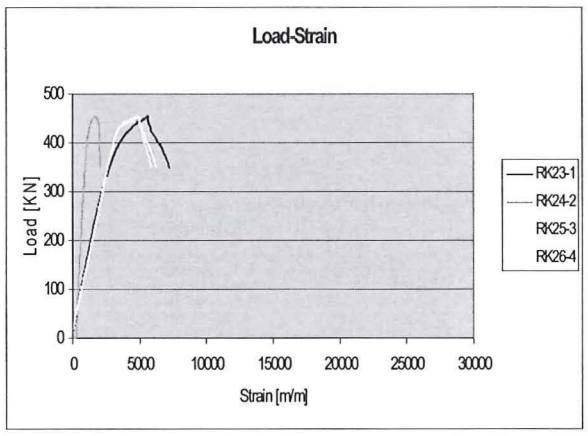
	ε_{Fmax} [m/m]
RK22	3850.18
RK28	4850.10



(skipped data)

	ε_{Fmax} [m/m]
RK23-1	6272.01
RK24-2	6061.11
RK25-3	6758.00
RK26-4	5666.81
RK27-5	5153.32

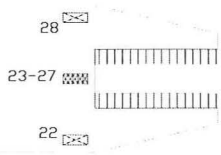


Figure 1.5: Test specimen face with the position of the strain gauges 22 to 28.

SPECIMEN 1A1

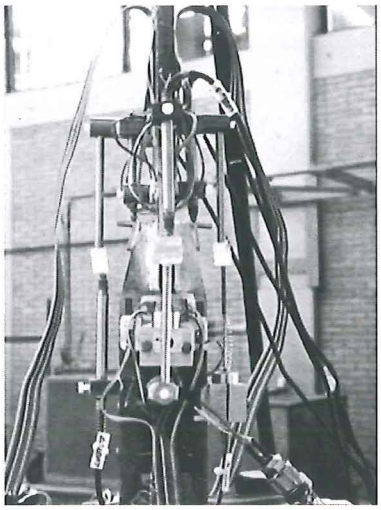
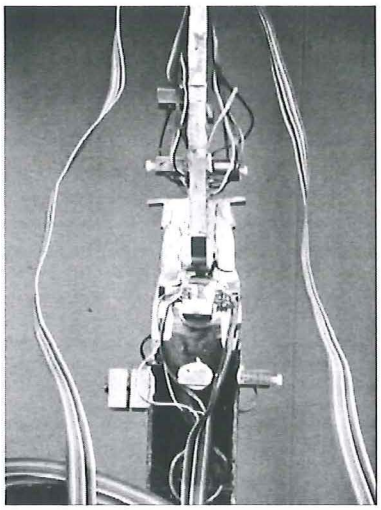
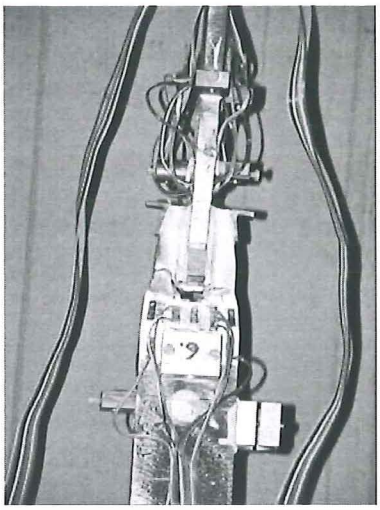
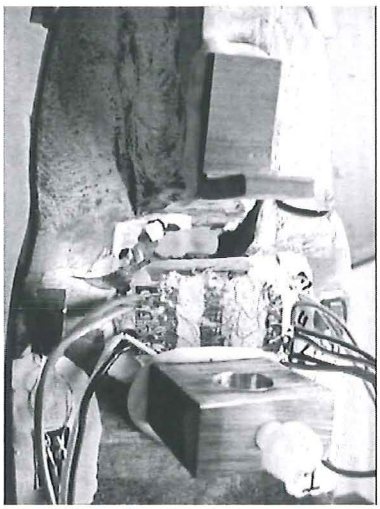


Figure 1.6: Test specimen during the test.





Figures 1.7 and 1.8: Test specimen after failure. Views of both sides.



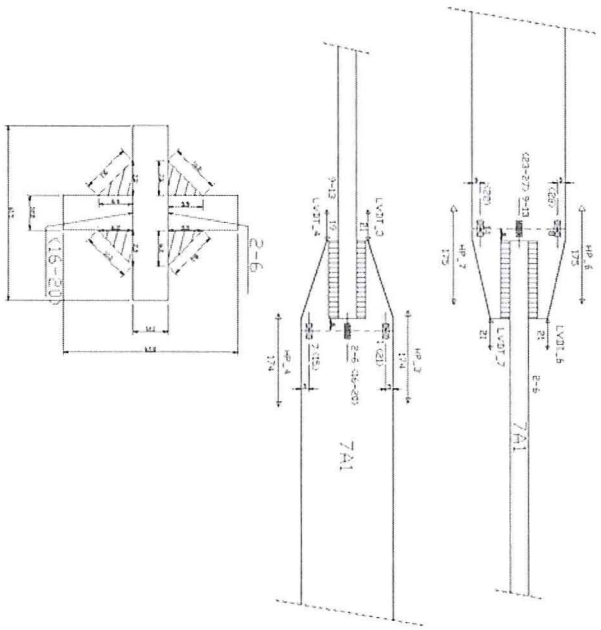
Figures 1.9, 1.10 and 1.11: Detailed views of the crack and weld toe, in both sides of the test specimen.

SPECIMEN 7A1

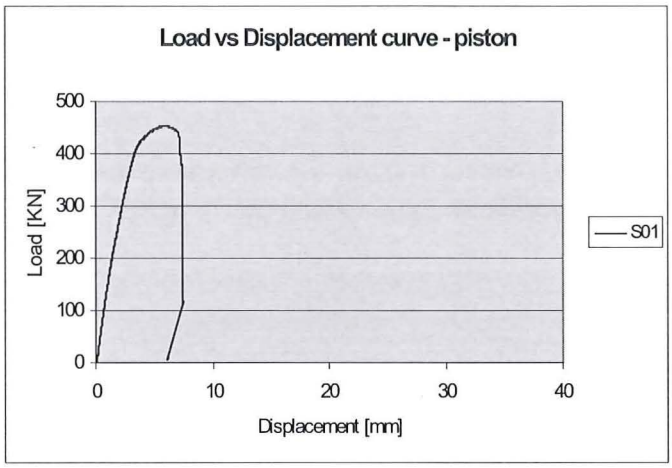
Table 7A1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	7A1 (1)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1A
Test	Type of test	Static strength
	Parameter	Reference
	Remark	Fillet welds loaded in shear
	Failure	Weld

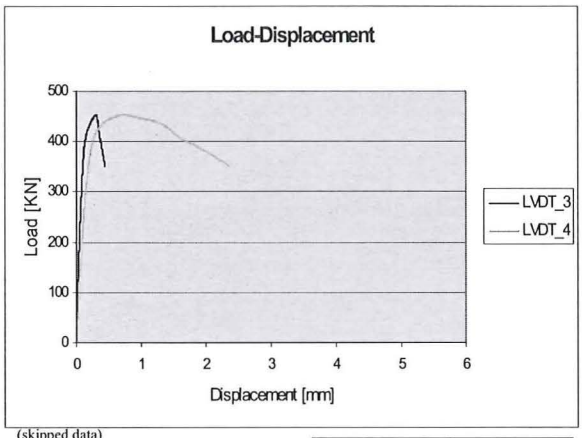
SPECIMEN 7A1



SPECIMEN 7A1

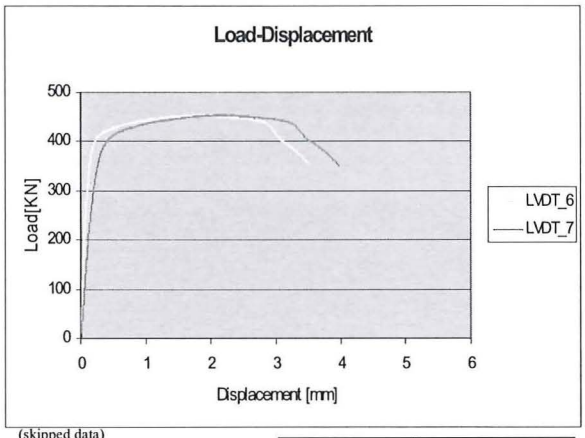


Fmax [KN]	454
S_{Fmax} [mm]	5.77
S_{max} [mm]	7.47



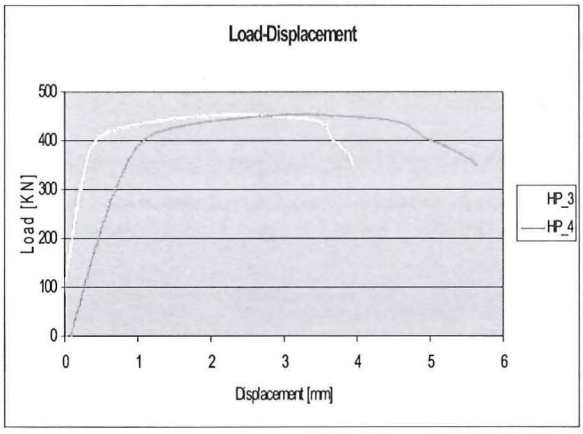
(skipped data)

	Range [mm]	S_{Fmax} [mm]
LVDT_3	21.0	0.31
LVDT_4	19.0	0.78



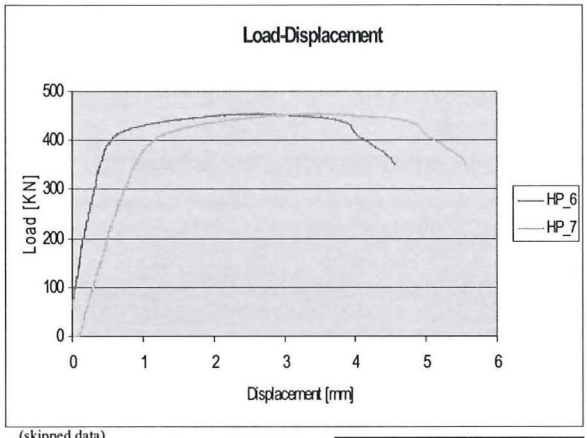
(skipped data)

	Range [mm]	S_{Fmax} [mm]
LVDT_6	21.0	1.95
LVDT_7	21.0	2.29



(skipped data)

	Range [mm]	S_{Fmax} [mm]
HP_3	174.0	2.23
HP_4	174.0	3.14

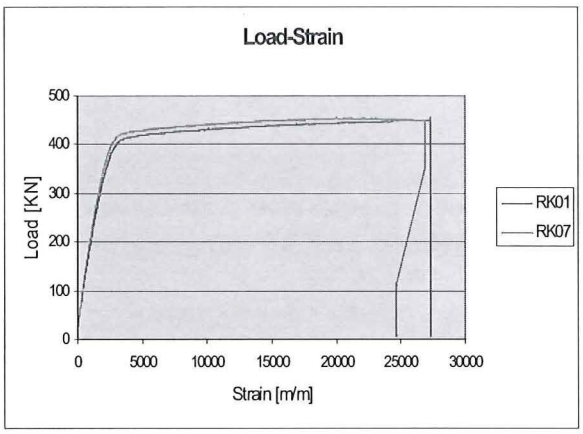


(skipped data)

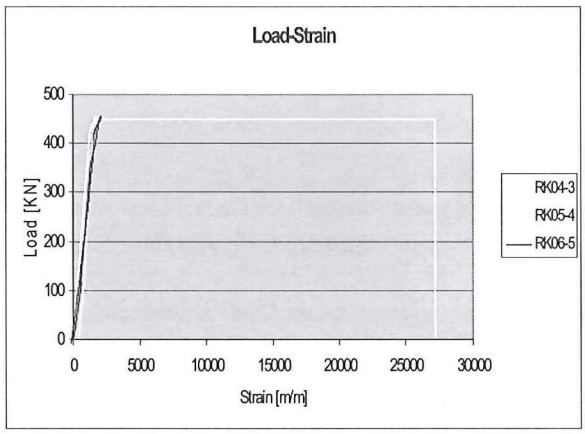
	Range [mm]	S_{Fmax} [mm]
HP_6	175.0	2.45
HP_7	175.0	3.29

SPECIMEN 7A1

SPECIMEN 7A1



	ε_{Fmax} [m/m]
RK01	27334.50
RK07	19938.50



(skipped data)

	ε_{Fmax} [m/m]
RK02-1	Measuring Error
RK03-2	
RK04-3	1692.71
RK05-4	2018.23
RK06-5	2101.93

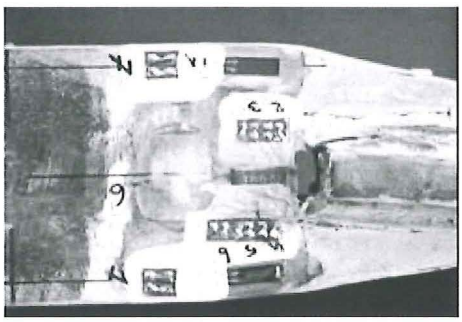
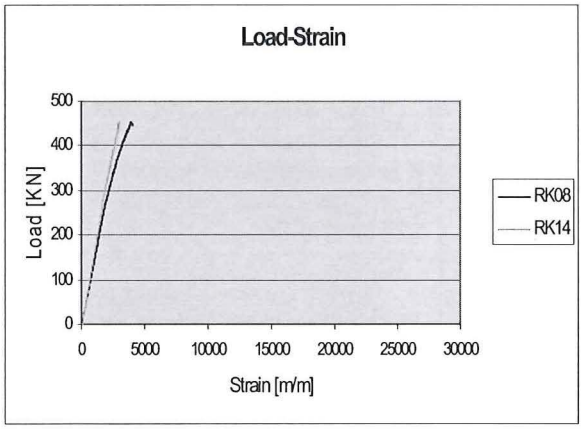
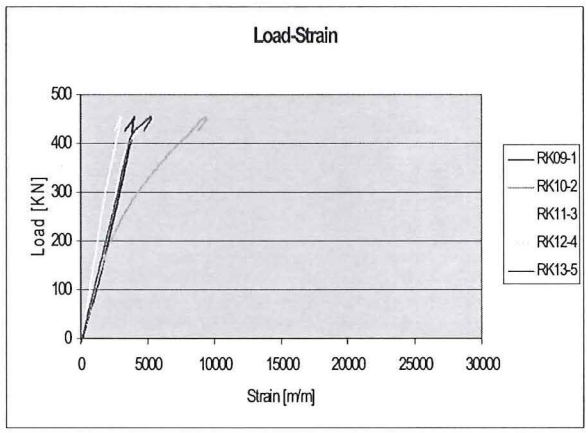


Figure 50.3: Test specimen face with the position of the strain gauges 1 to 7.



(skipped data)

	ε_{Fmax} [m/m]
RK08	3998.82
RK14	3017.62



(skipped data)

	ε_{Fmax} [m/m]
RK09-1	4036.46
RK10-2	9365.70
RK11-3	5338.54
RK12-4	5636.16
RK13-5	5264.14

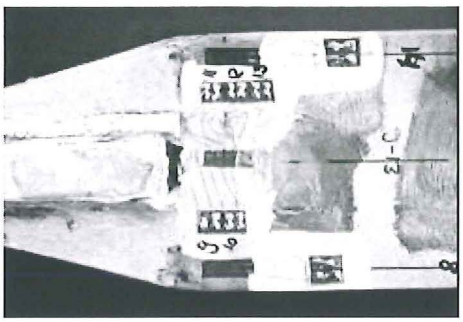
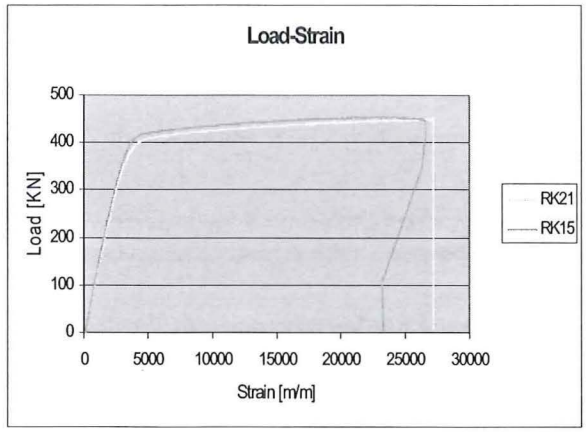
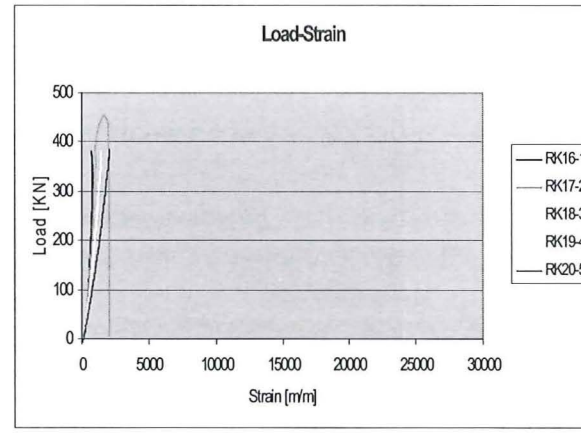


Figure 50.4: Test specimen face with the position of the strain gauges 8 to 14.

SPECIMEN 7A1



	ε_{Fmax} [m/m]
RK21	27204.90
RK15	21873.20



(skipped data)

	ε_{Fmax} [m/m]
RK16-1	111.607
RK17-2	734.747
RK18-3	1302.08
RK19-4	1729.91
RK20-5	1934.52

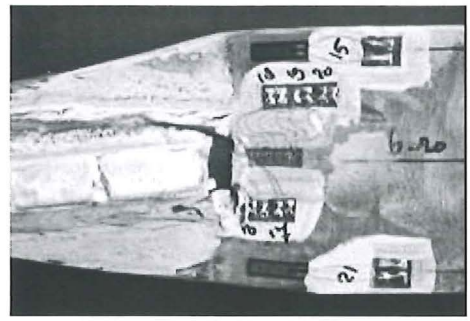
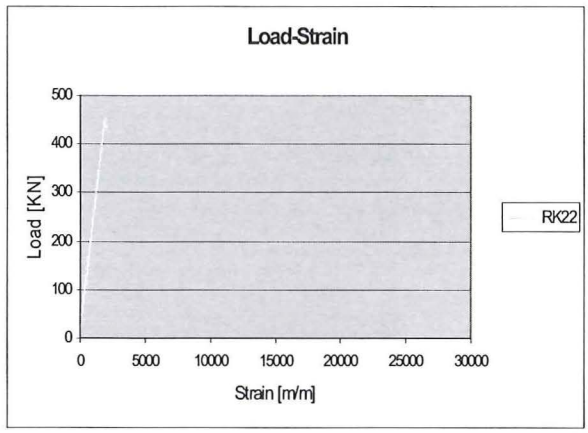
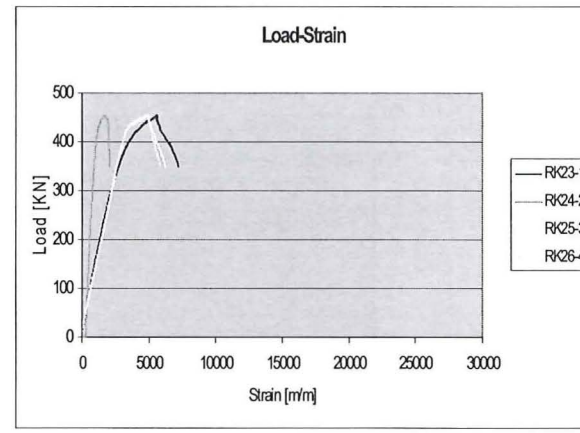


Figure 50.5: Test specimen face with the position of the strain gauges 15 to 21.



(skipped data)

	ε_{Fmax} [m/m]
RK22	1906.84
RK21	Measuring Error



(skipped data)

	ε_{Fmax} [m/m]
RK23-1	5580.36
RK24-2	4603.79
RK25-3	4817.71
RK26-4	4827.01

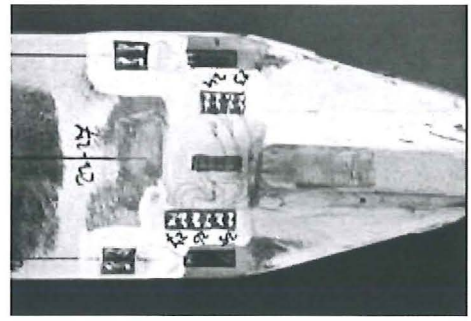


Figure 50.6: Test specimen face with the position of the strain gauges 22 to 28.

SPECIMEN 7A1

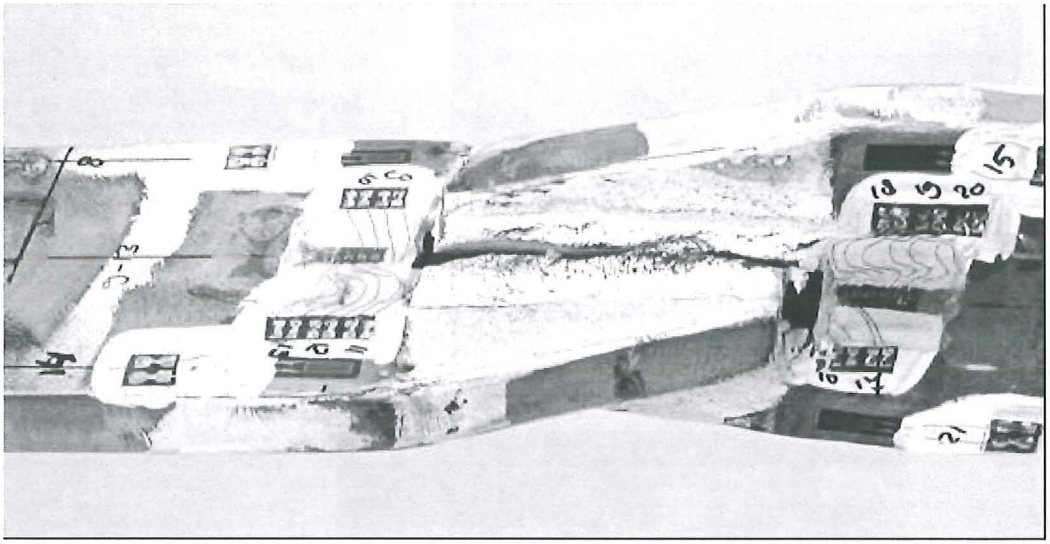
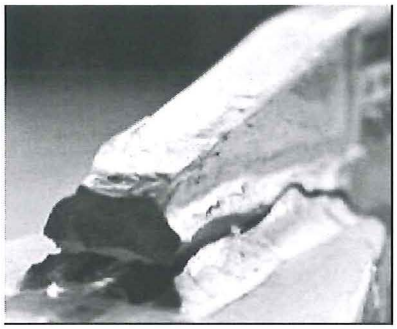


Figure 50.7: Test specimen after failure.



Figures 50.8 and 50.9: Detailed perspectives of the crack.

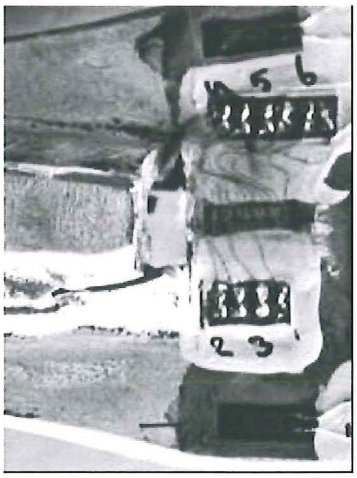
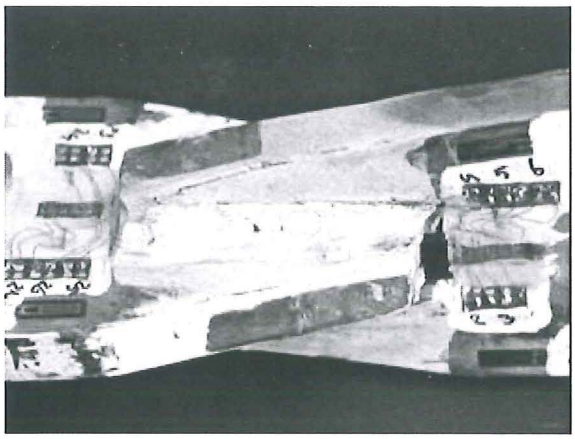


Figure 50.10: Upper view of the region of the weld toe.

SPECIMEN 7A1



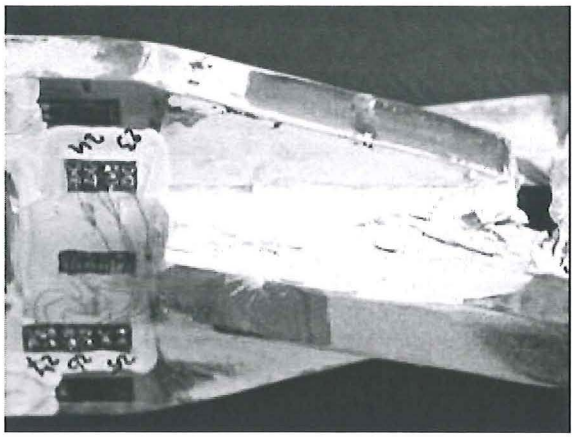


Figure 50.11, 50.12 and 50.13: Three different sides of the connection (the fourth one was presented in G5).

SPECIMEN 7A2

Table 7A2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	7A2 (2)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1A
Test	Type of test	Fatigue
	Parameter	Reference
	Remark	Fillet welds loaded in shear
	Failure	Weld

SPECIMEN 7A2

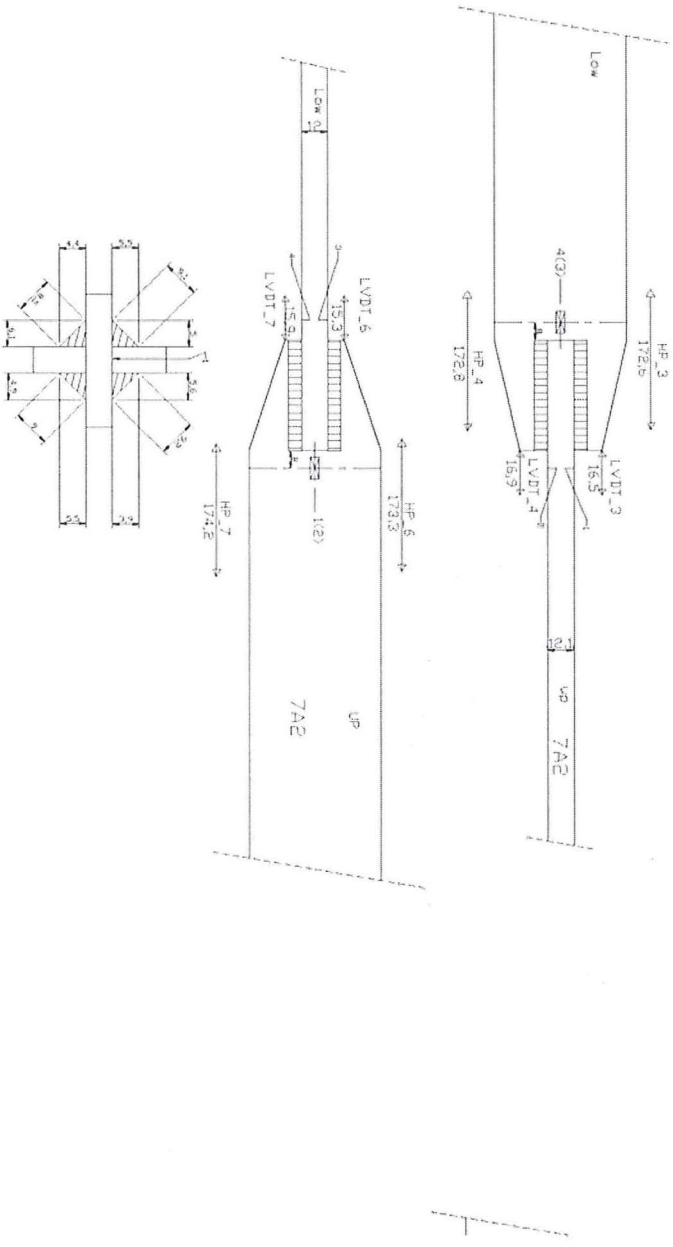


Figure 7A2-1: Dimensions of the test specimen

Figure 7A2-2: Dimensions of the welds

Figure 7A2-3: Position of strain gauges and LVDT's

SPECIMEN 7A2

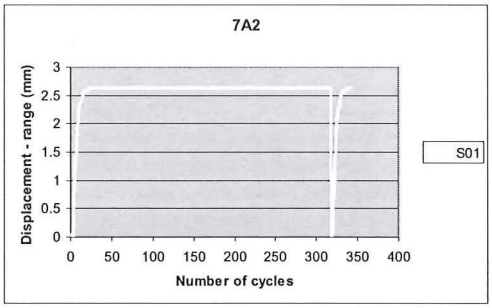


Figure 7A2-4: Test displacement controlled (range)

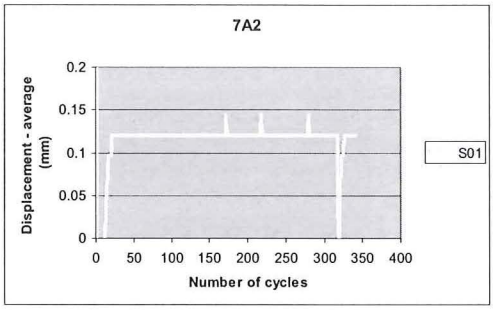


Figure 7A2-5: Test displacement controlled (average)

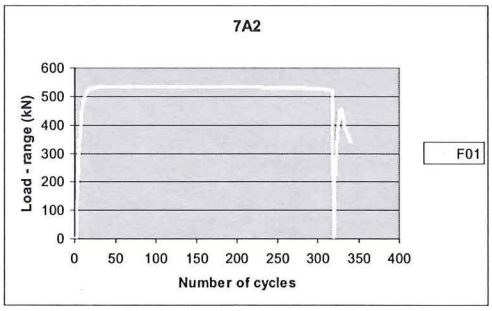


Figure 7A2-6: Test load (range)

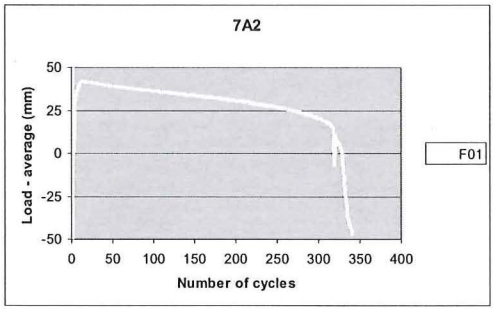


Figure 7A2-7: Test load (average)

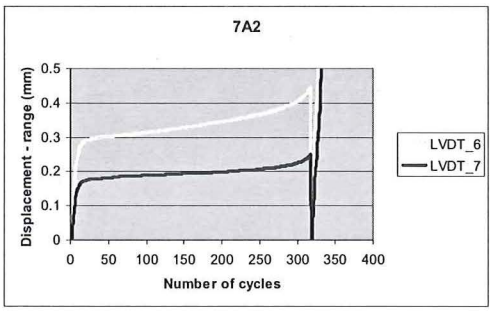


Figure 7A2-8: Deformation whole connection (range)

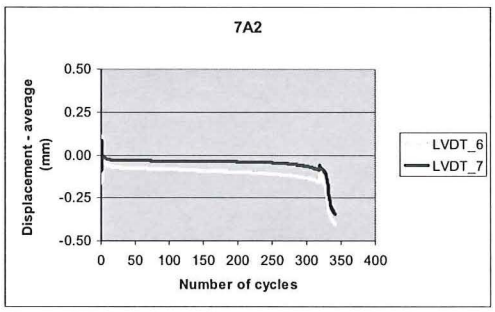


Figure 7A2-9: Deformation whole connection (average)

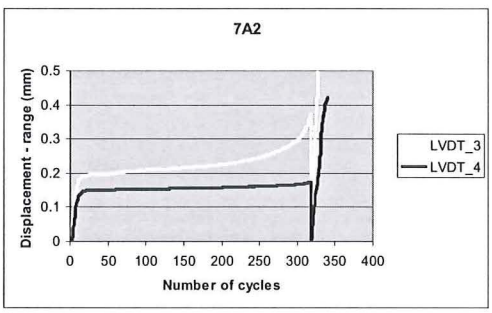


Figure 7A2-10: Local deformation (range)

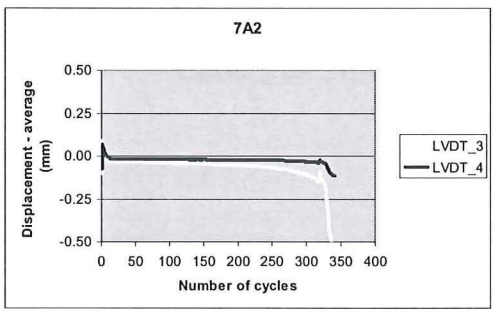


Figure 7A2-11: Local deformation (average)

SPECIMEN 7A2

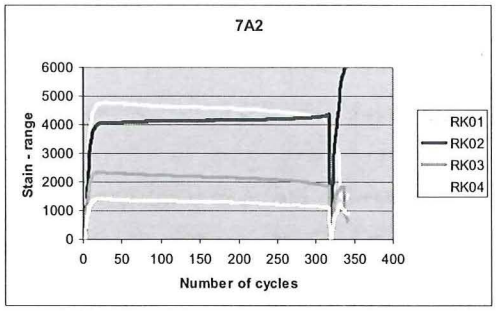


Figure 7A2-12: Measured strains (range)

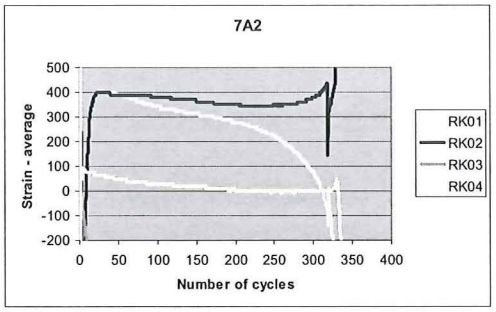


Figure 7A2-13: Measured strains (average)

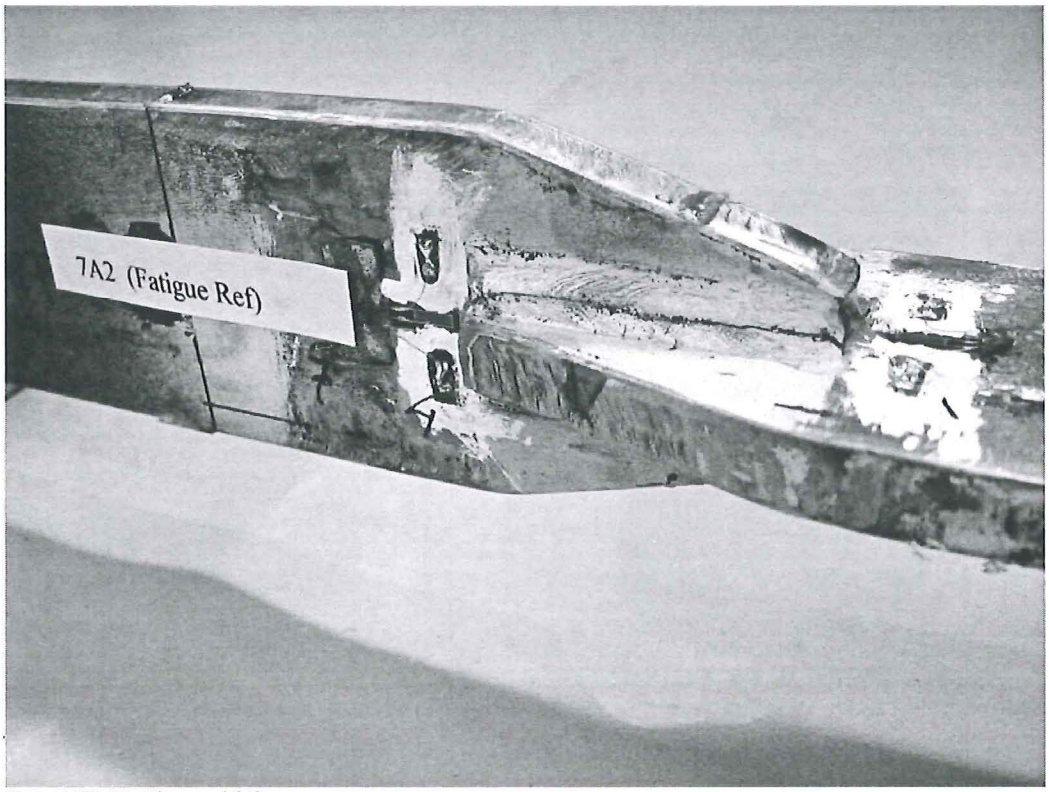


Figure 7A2-14: Observed failure

SPECIMEN 7A3

Table 7A3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	7A3 (3)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1A
Test	Type of test	Fatigue
	Parameter	Reference
	Remark	Fillet welds loaded in shear
	Failure	Weld

SPECIMEN 7A3

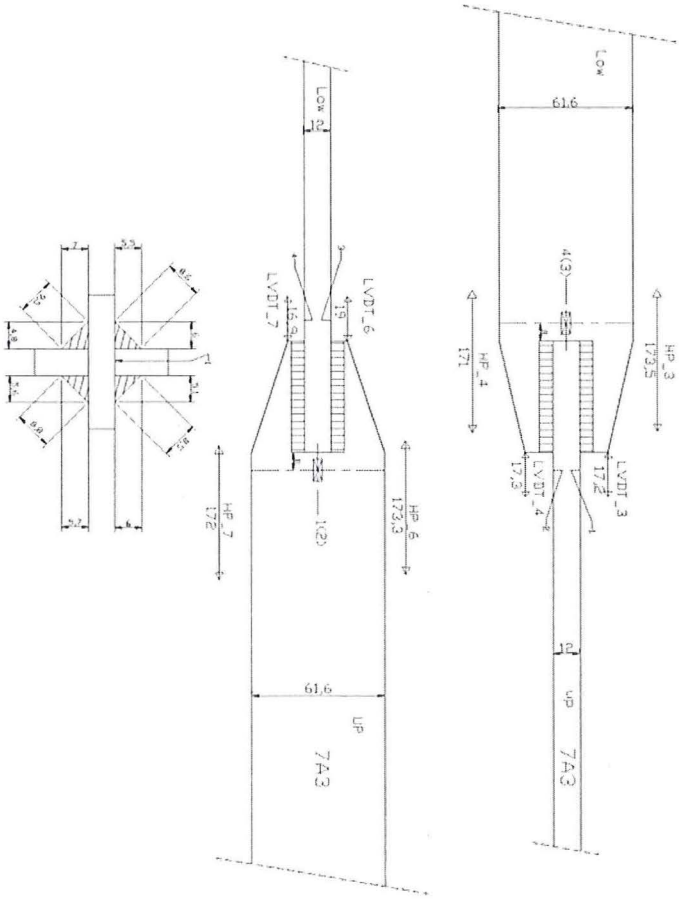


Figure 7A3-1: Dimensions of the test specimen

Figure 7A3-2: Dimensions of the welds

Figure 7A3-3: Position of strain gauges and LVDT's

SPECIMEN 7A3

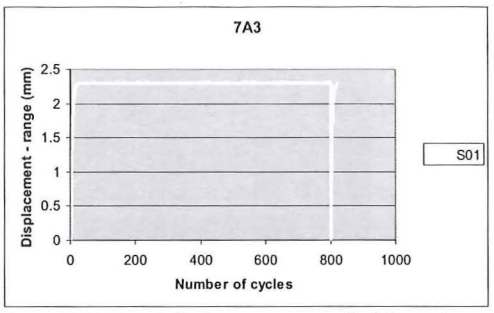


Figure 7A3-4: Test displacement controlled (range)

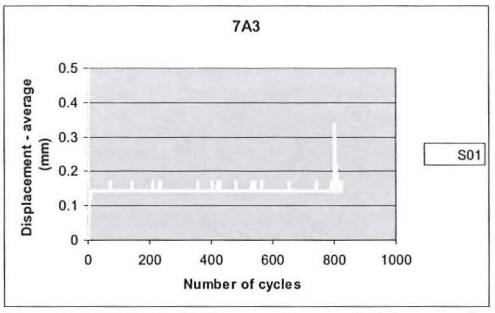


Figure 7A3-5: Test displacement controlled (average)

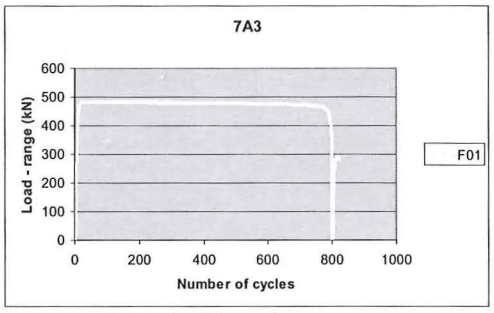


Figure 7A3-6: Test load (range)

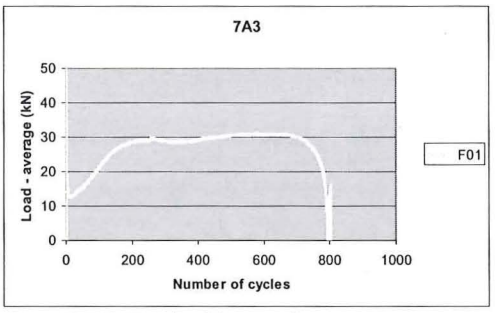


Figure 7A3-7: Test load (average)

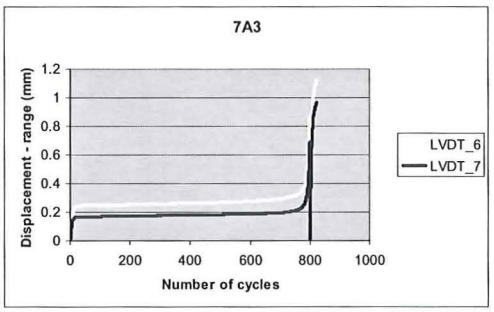


Figure 7A3-8: Deformation whole connection (range)

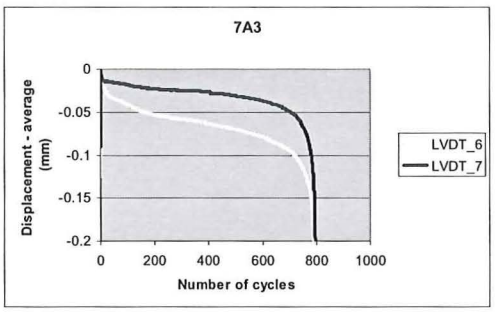


Figure 7A3-9: Deformation whole connection (average)

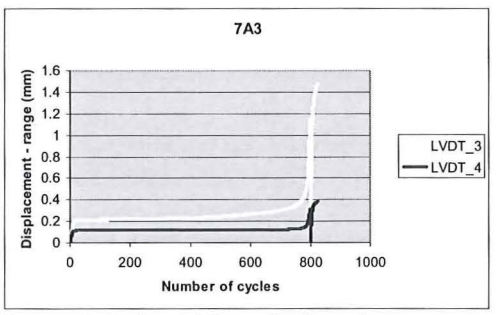


Figure 7A3-10: Local deformation (range)

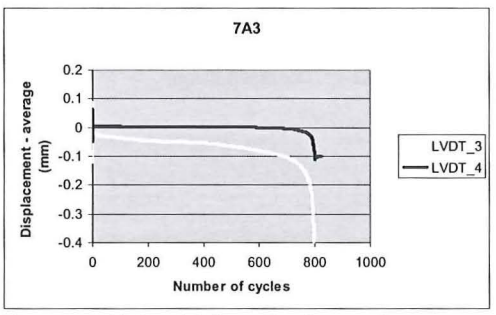


Figure 7A3-11: Local deformation (average)

SPECIMEN 7A3

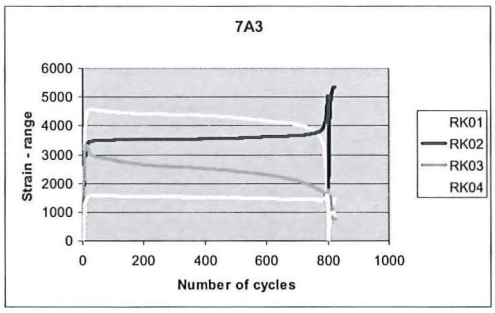


Figure 7A3-12: Measured strains (range)

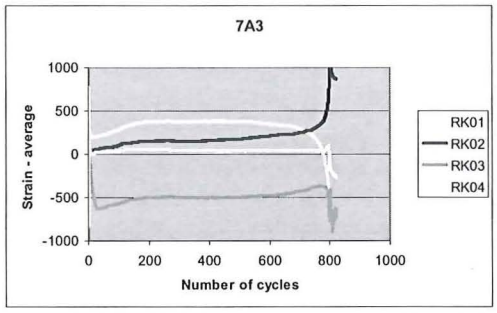


Figure 7A3-13: Measured strains (average)

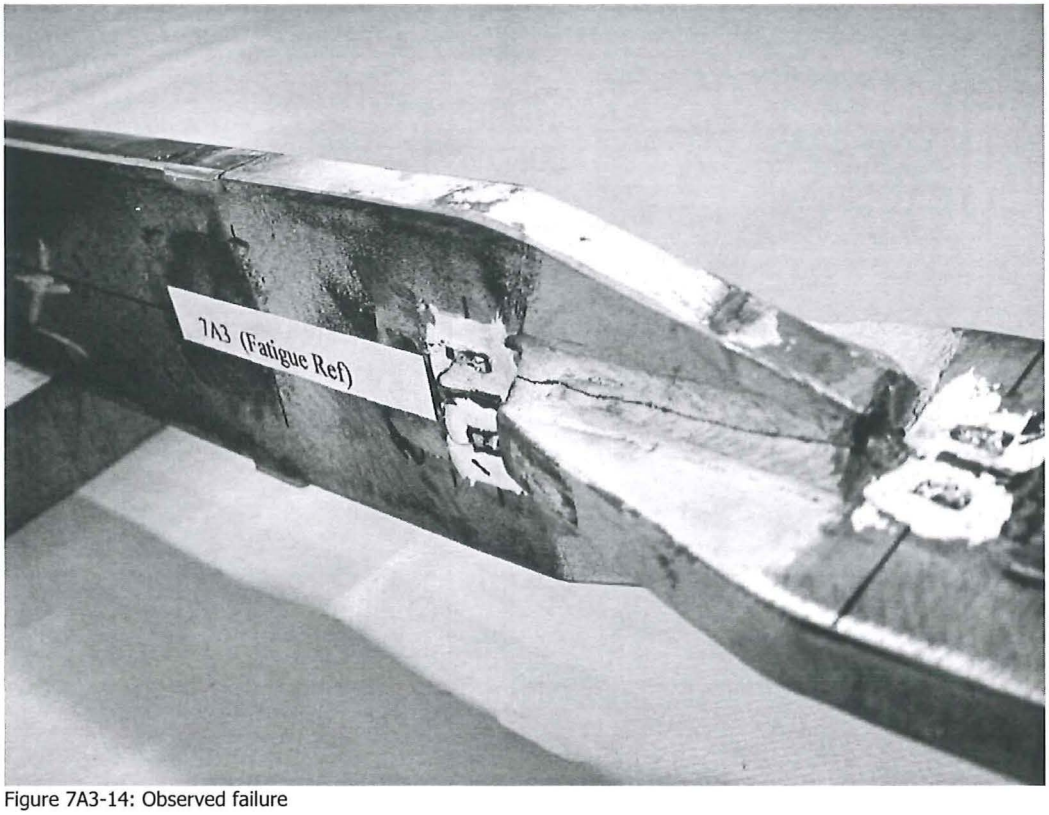


Figure 7A3-14: Observed failure

SPECIMEN 1A4

Table 1A4-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1A4 (4)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1A
Test	Type of test	Ratcheting
	Parameter	Reference
	Remark	Fillet welds loaded in shear
	Failure	Plate

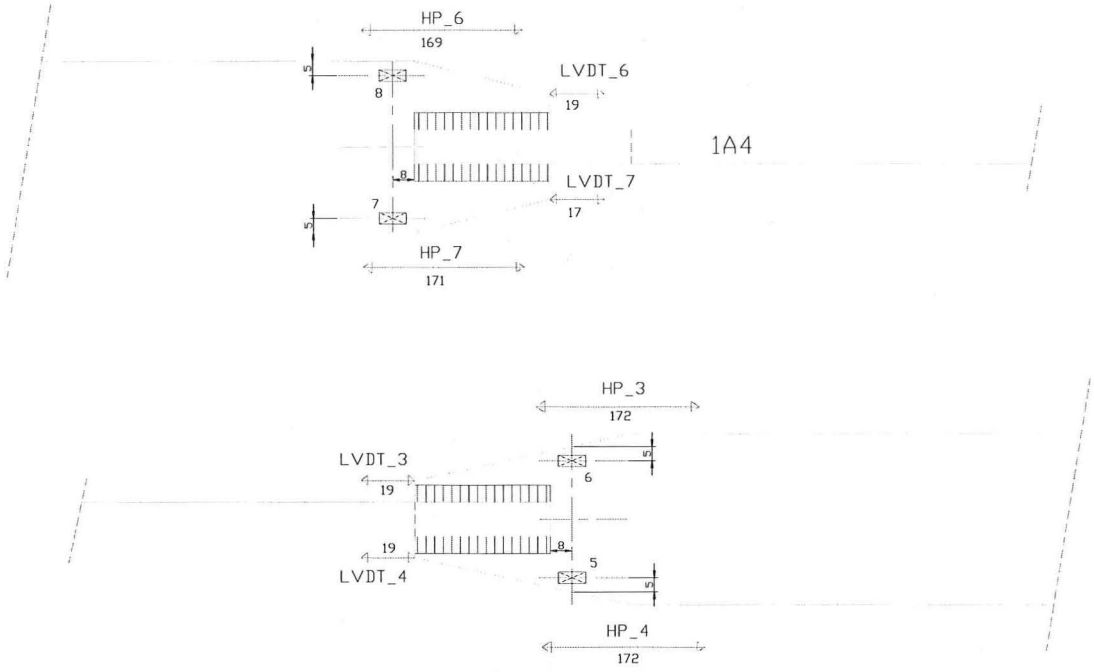


Figure 4.1: Top views of the test specimen with the position of the strain gauges and sizes of the measuring equipment.

SPECIMEN 1A4

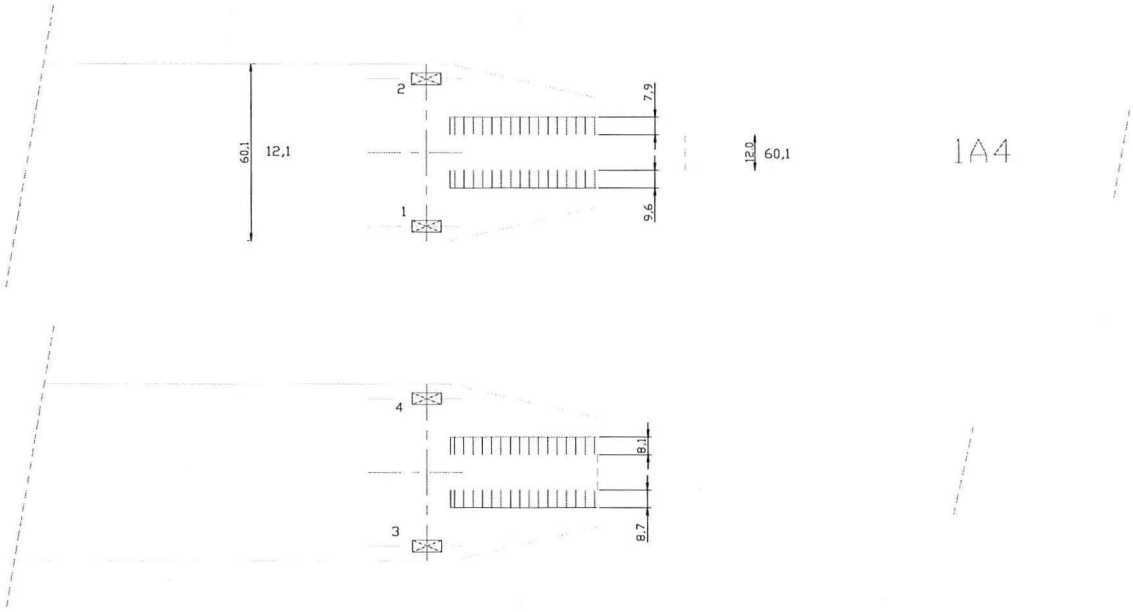
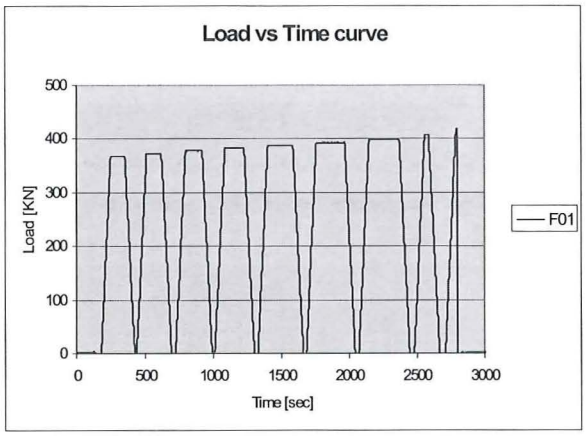
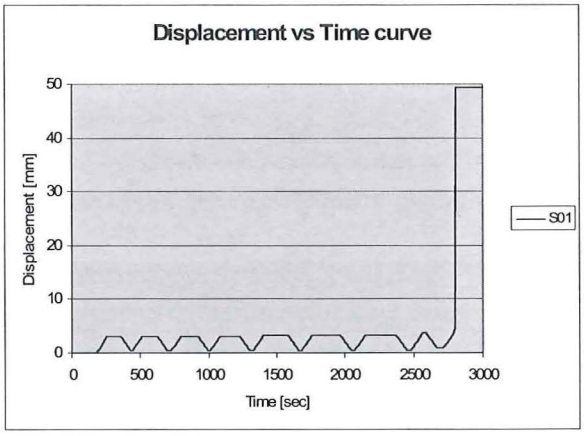


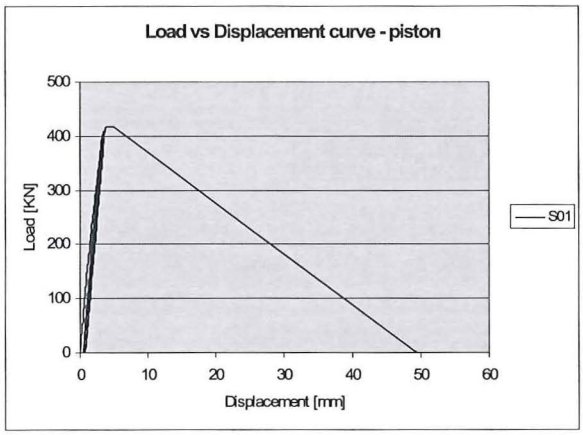
Figure 4.2: Top views, with the sizes of the welds.

SPECIMEN 1A4



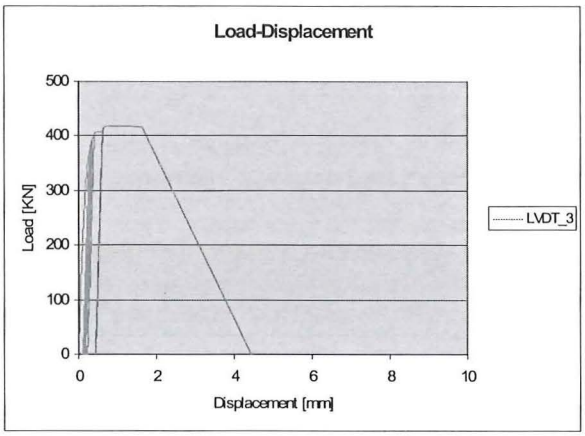


Cycle	Time [sec]	Peak Force [KN]	Displacement [mm]
1	345	368	3.09
2	616	373	3.11
3	916	378	3.14
4	1186	383	3.16
5	1548	388	3.21
6	1897	393	3.26
7	2214	398	3.32
8	2577	408	3.66
9	2800	418	4.69

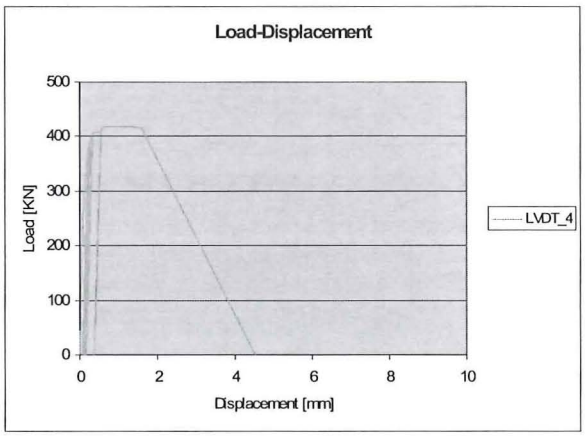


F_{max} [KN]	418
S_{Fmax} [mm]	4.69
S_{max} [mm]	49.41

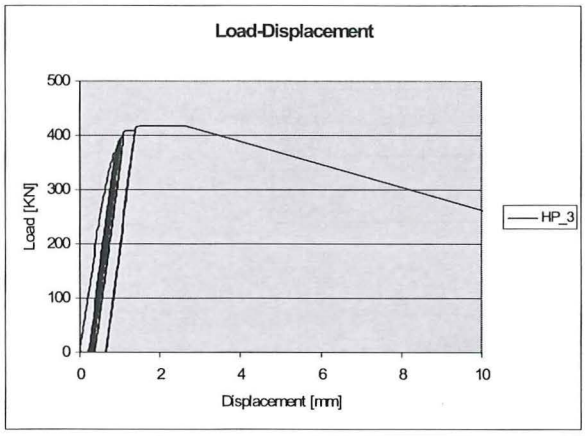
SPECIMEN 1A4



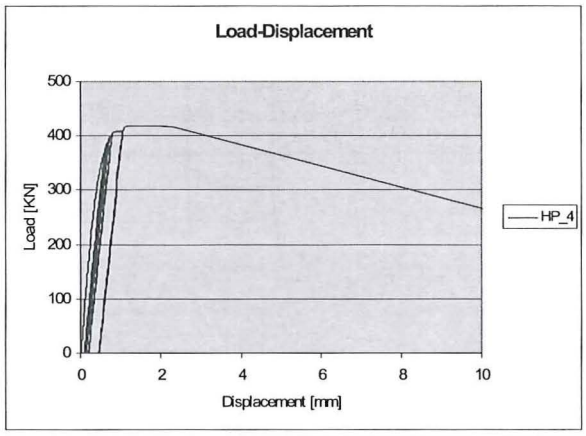
	Range [mm]	S_{Fmax} [mm]
LVDT_3	19.0	1.35



	Range [mm]	S_{Fmax} [mm]
LVDT_4	19.0	1.29

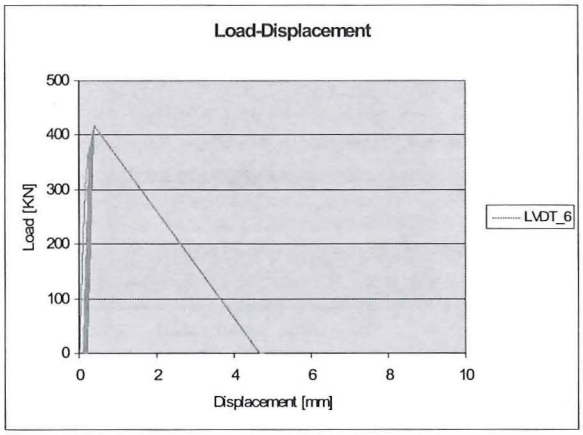


	Range [mm]	S_{Fmax} [mm]
HP_3	172.0	2.28

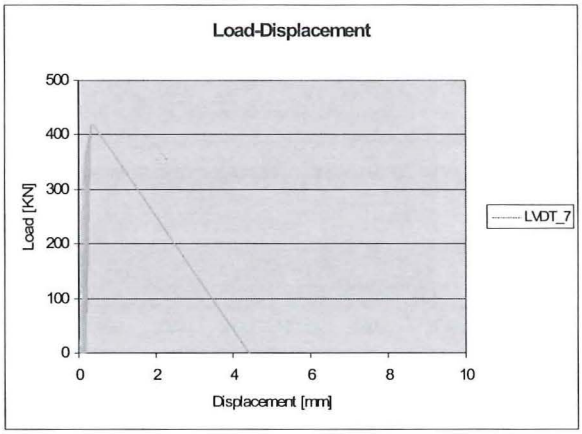


	Range [mm]	S_{Fmax} [mm]
HP_4	172.0	1.99

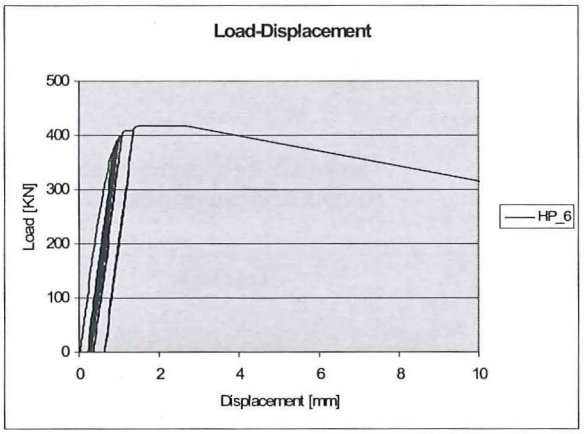
SPECIMEN 1A4



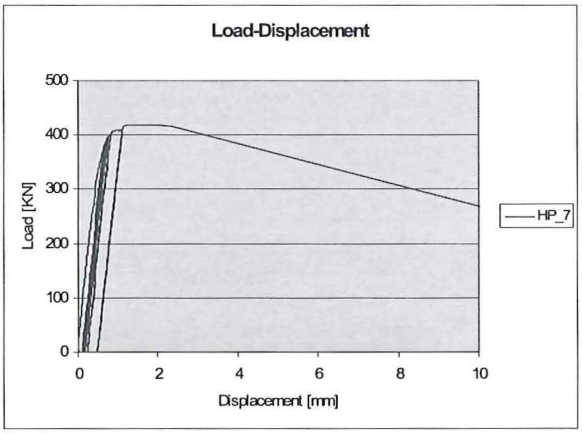
	Range [mm]	S_{Fmax} [mm]
LVDT_6	19.0	0.42



	Range [mm]	S_{Fmax} [mm]
LVDT_7	17.0	0.40

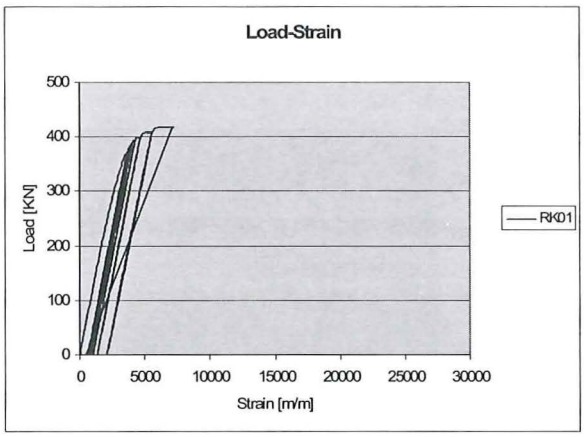


	Range [mm]	S_{Fmax} [mm]
HP_6	169.0	2.30

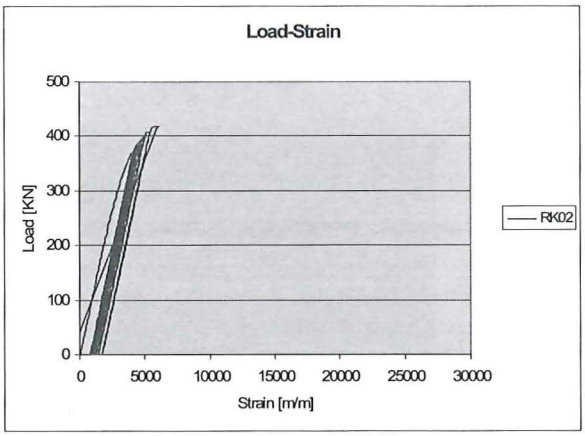


	Range [mm]	S_{Fmax} [mm]
HP_7	171.0	2.03

SPECIMEN 1A4



	ε_{Fmax} [m/m]
RK01	7257.11



	ε_{Fmax} [m/m]
RK02	6090.79

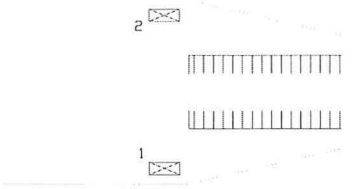
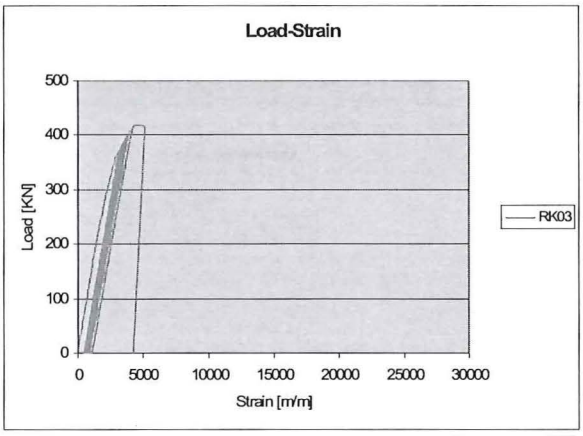
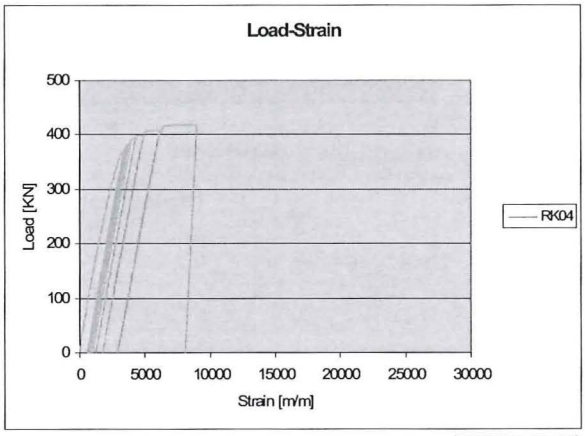


Figure 4.3: Test specimen face with the position of the strain gauges 1 and 2.



	ε_{Fmax} [m/m]
RK03	4961.49



	ε_{Fmax} [m/m]
RK04	8691.87

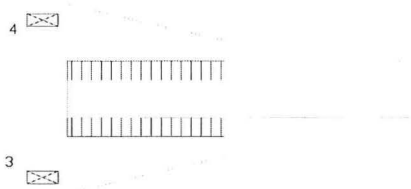
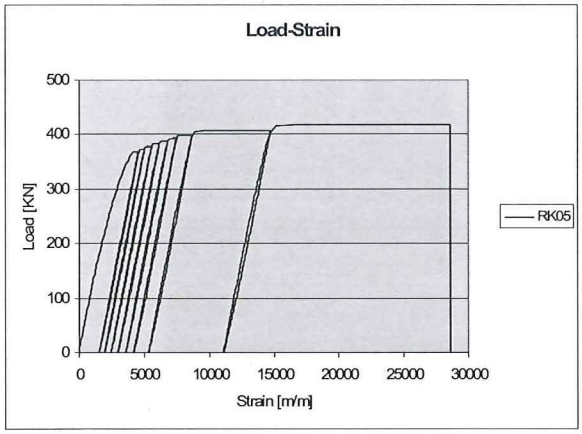
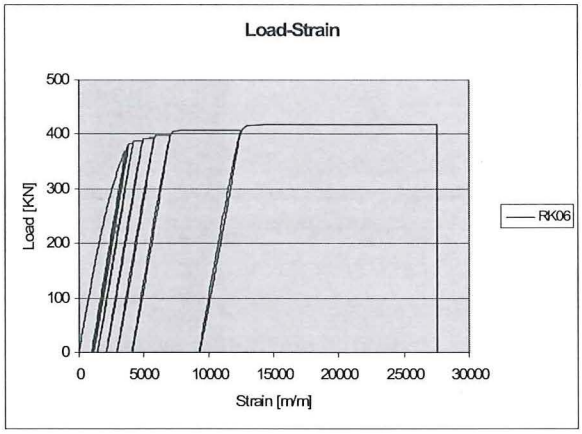


Figure 4.4: Test specimen face with the position of the strain gauges 3 and 4.

SPECIMEN 1A4



	ε_{Fmax} [m/m]
RK05	28648.9



	ε_{Fmax} [m/m]
RK06	27547.4

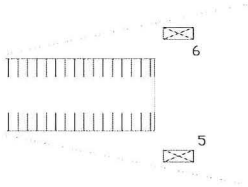
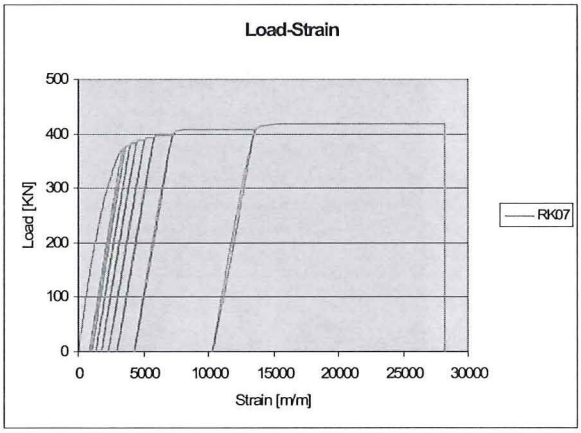
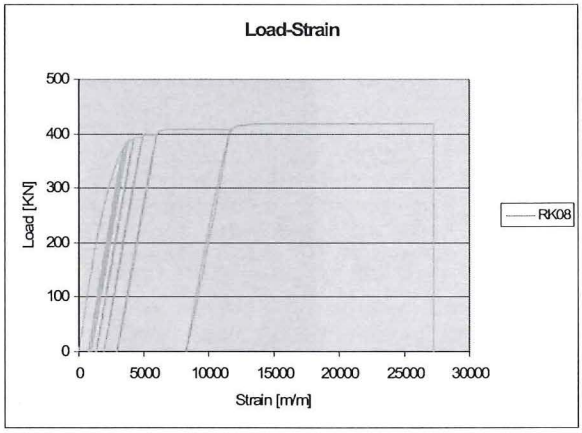


Figure 4.5: Test specimen face with the position of the strain gauges 5 and 6.



	ε_{Fmax} [m/m]
RK07	28213.9



	ε_{Fmax} [m/m]
RK08	27251.2

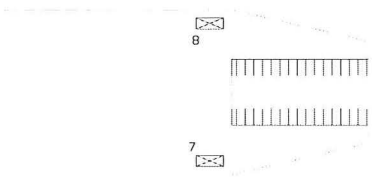
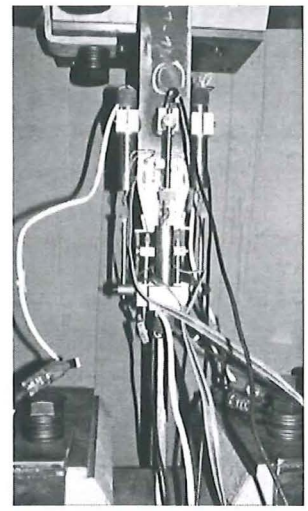
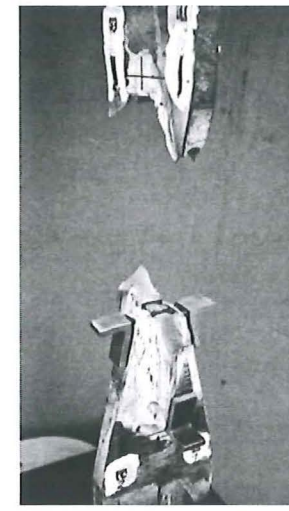


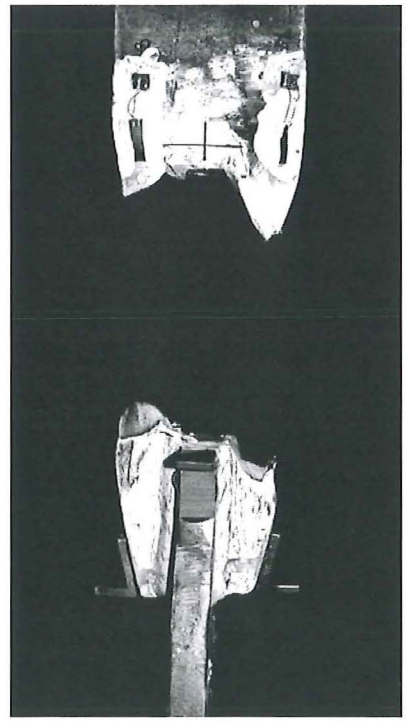
Figure 4.6: Test specimen face with the position of the strain gauges 7 and 8.

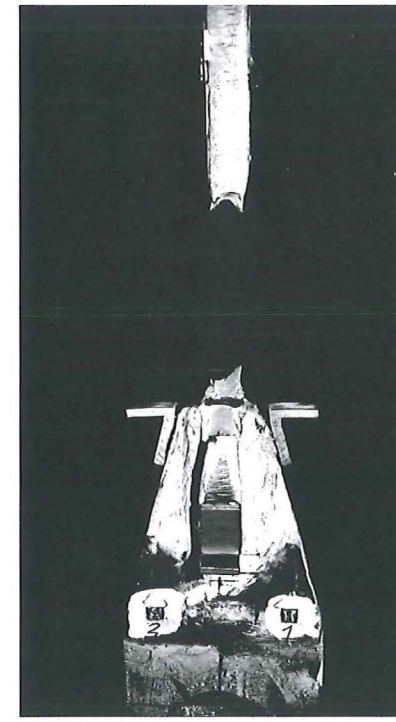
SPECIMEN 1A4





Figures 4.7 and 4.8: Test specimen during the test and after failure.





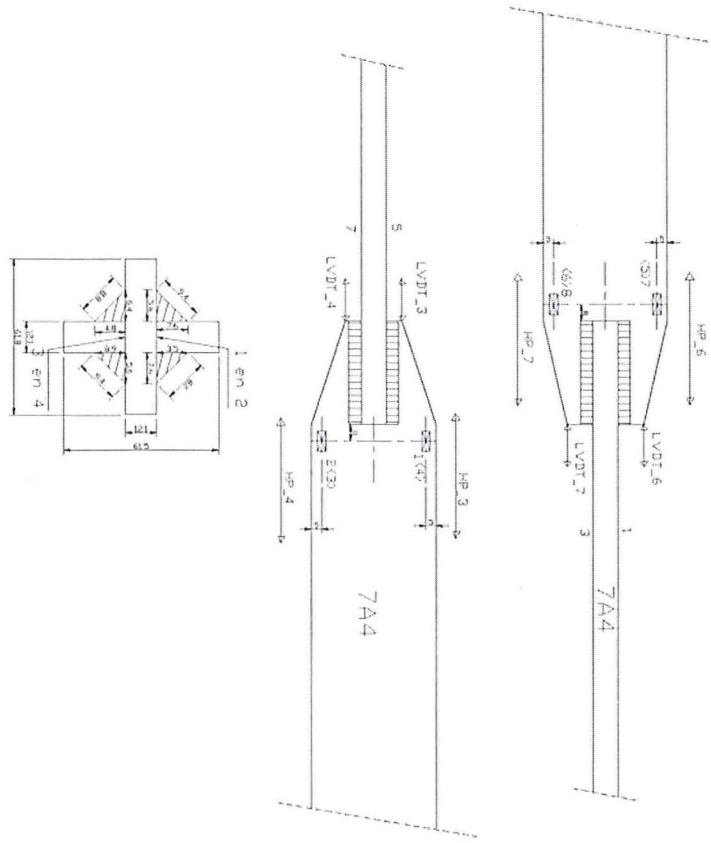
Figures 4.9 and 4.10: Different side views of the test specimen after failure.

SPECIMEN 7A4

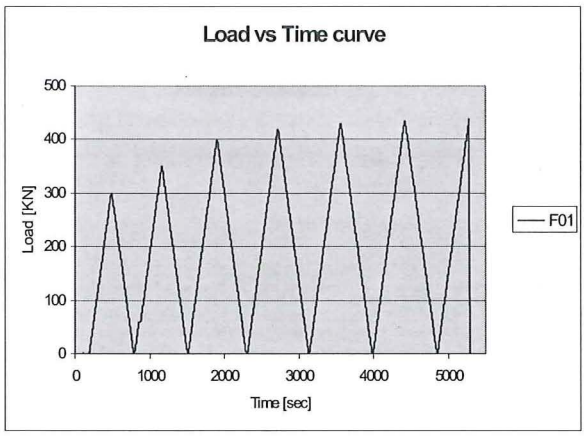
Table 7A4-1: Characteristics of the test specimen, weld material and test

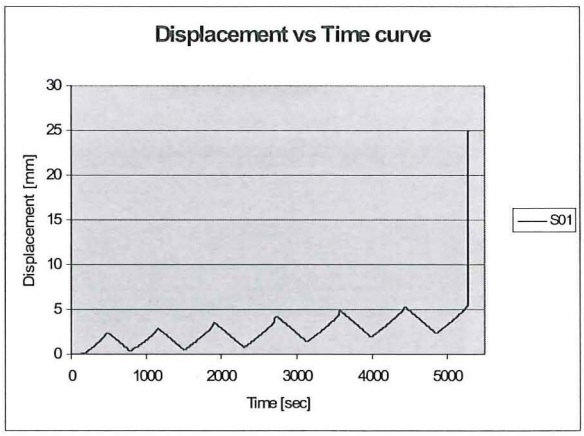
Specimen	Test Nr.	7A4 (4
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1A
Test	Type of test	Ratcheting
	Parameter	Reference
	Remark	Fillet welds loaded in shear
	Failure	Weld

SPECIMEN 7A4

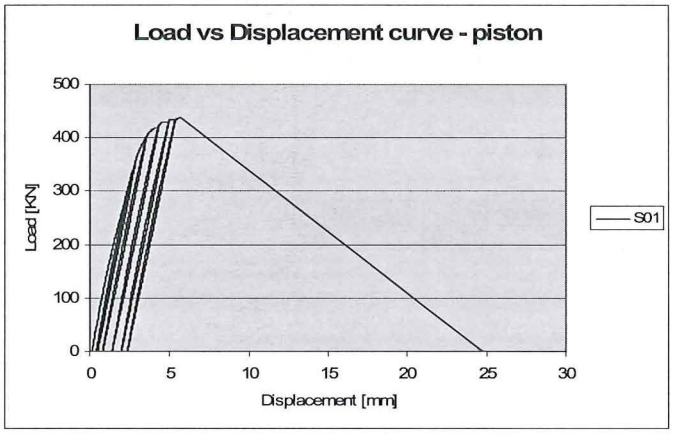


SPECIMEN 7A4



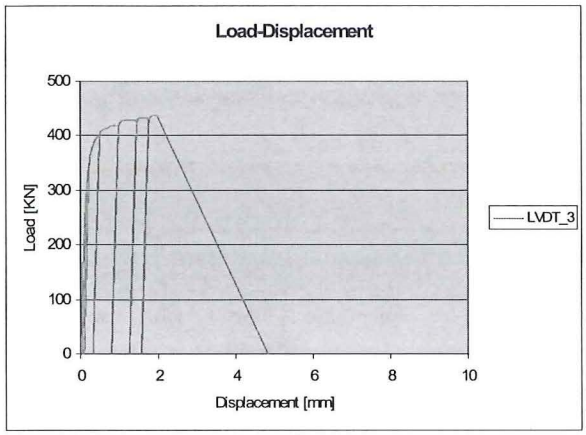


Cycle	Time [sec]	Peak Force [KN]	Displacement [mm]
1	489	300	2.39
2	1165	349	2.82
3	1906	399	3.53
4	2725	419	4.26
5	3558	429	4.57
6	4423	434	5.26
7	5278	438	5.64

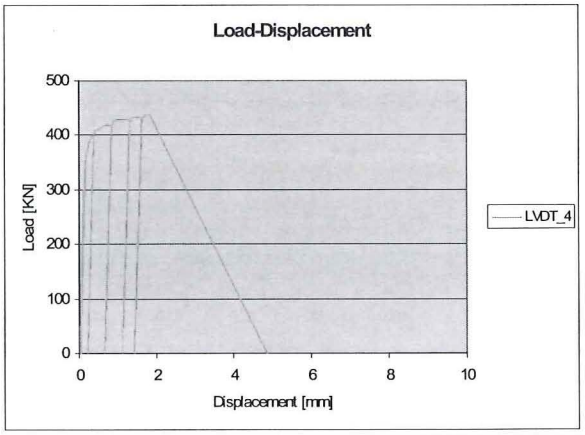


F_{max} [KN]	438
S_{Fmax} [mm]	5.64
S_{max} [mm]	24.96

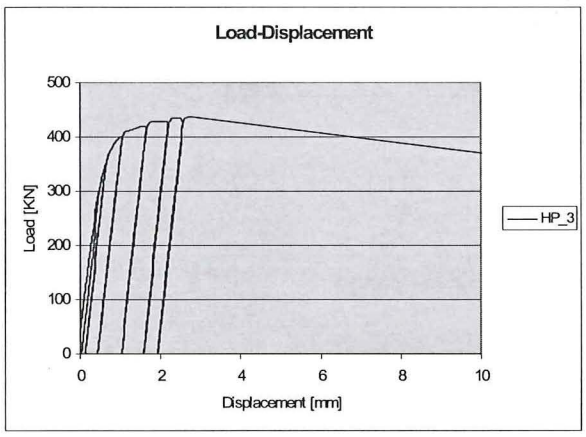
SPECIMEN 7A4



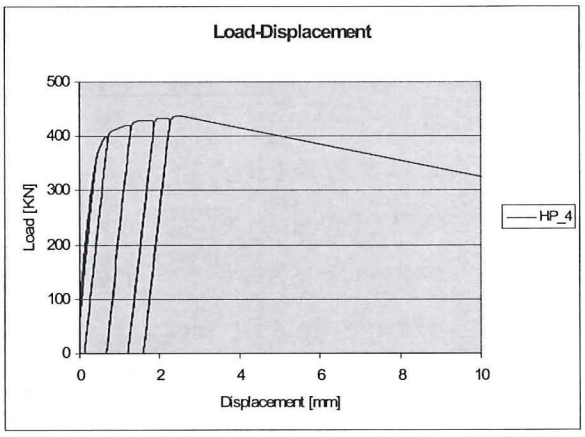
	Range [mm]	S_{Fmax} [mm]
LVDT_3	~ 19.0	1.96



	Range [mm]	SFmax [mm]
LVDT_4	~ 19.0	1.83

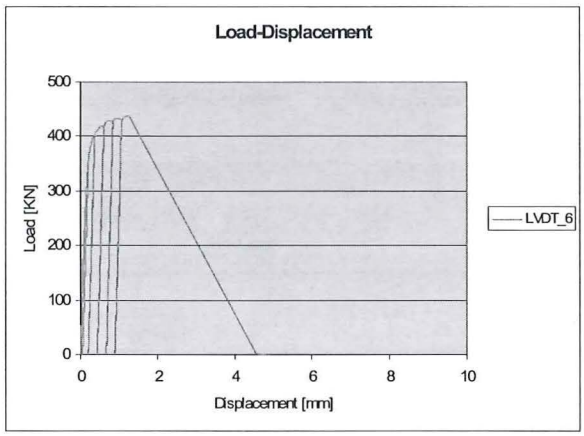


	Range [mm]	S_{Fmax} [mm]
HP_3	~ 172.0	2.80

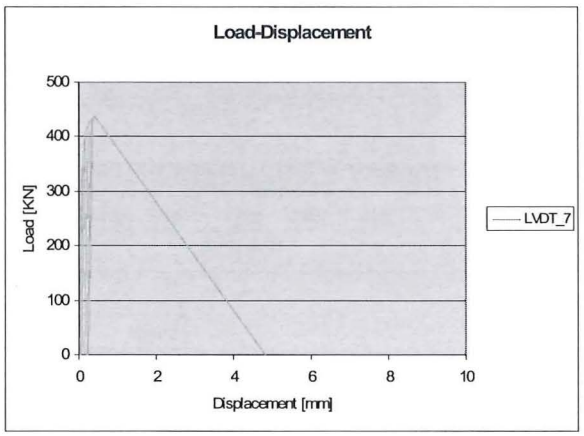


	Range [mm]	S_{Fmax} [mm]
HP_4	~ 172.0	2.54

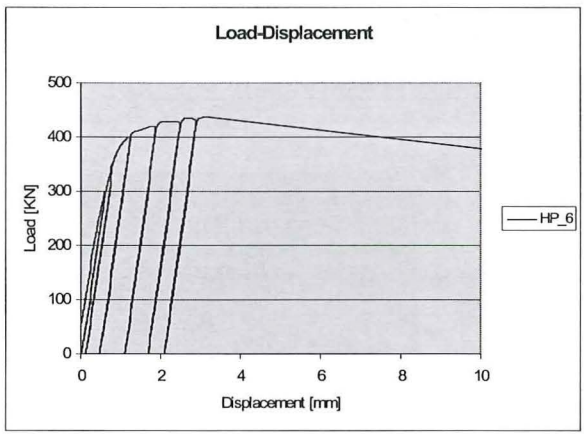
SPECIMEN 7A4



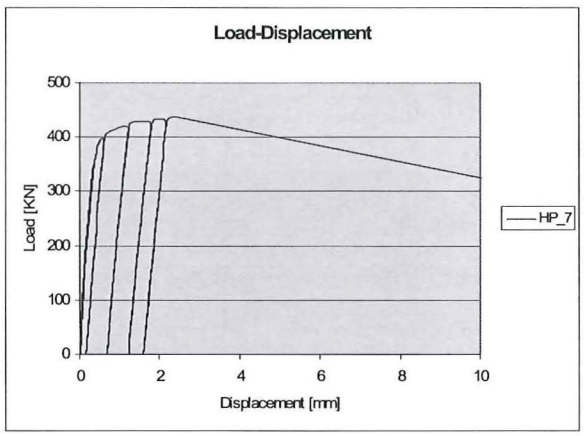
	Range [mm]	S_{Fmax} [mm]
LVDT_6	~ 19.0	1.27



	Range [mm]	S_{Fmax} [mm]
LVDT_7	~ 17.0	0.40

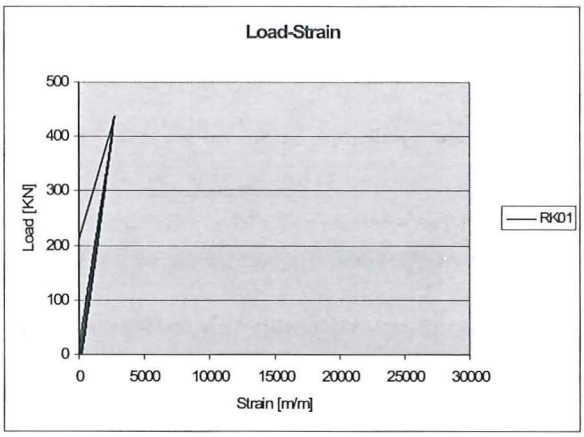


	Range [mm]	S_{Fmax} [mm]
HP_6	~ 179.0	3.18

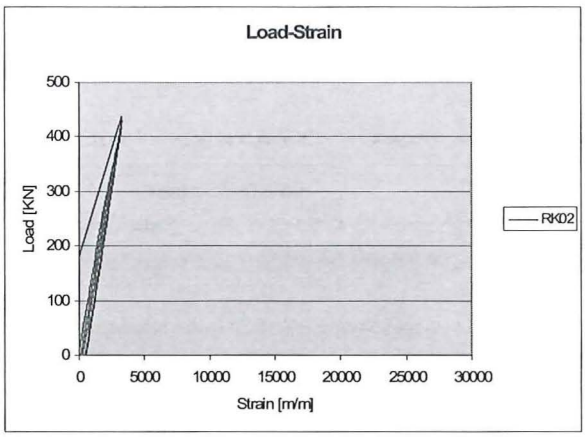


	Range [mm]	S_{Fmax} [mm]
HP_7	~ 171.0	2.42

SPECIMEN 7A4



	ε_{Fmax} [m/m]
RK01	2767.70



	ε_{Fmax} [m/m]
RK02	3221.27

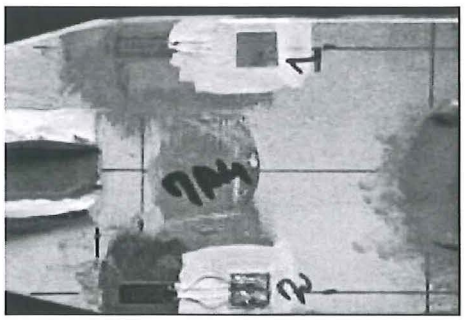
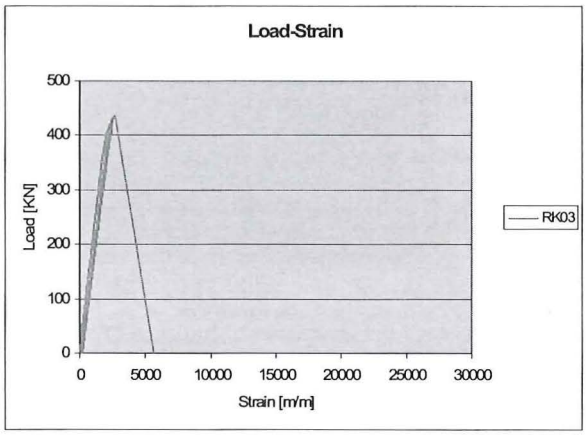
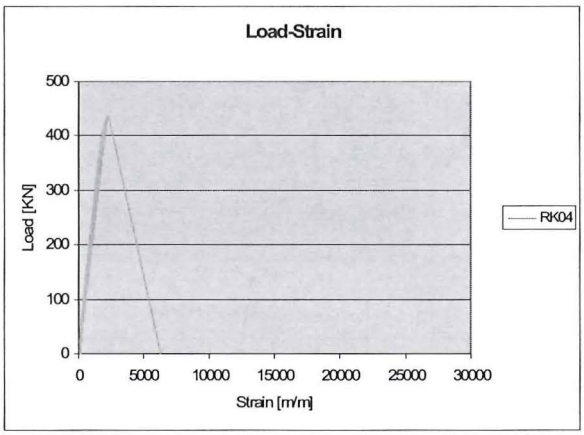


Figure 53.3: Test specimen face with the position of the strain gauges 1 and 2.



	ε_{Fmax} [m/m]
RK03	2693.65



	ε_{Fmax} [m/m]
RK04	2314.13

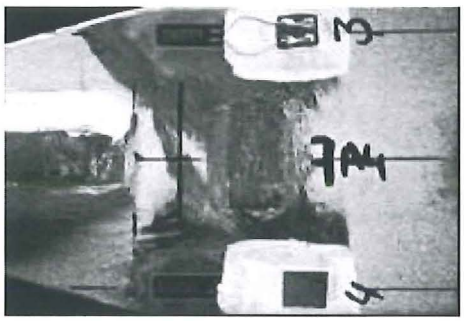
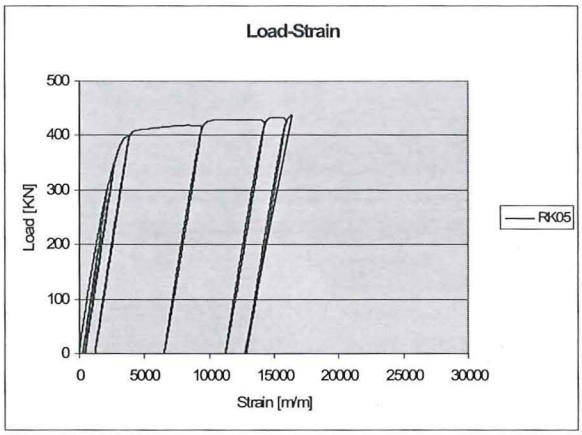
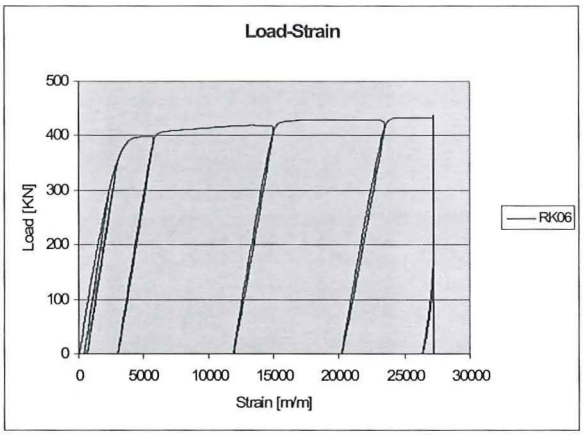


Figure 53.4: Test specimen face with the position of the strain gauges 3 and 4.

SPECIMEN 7A4



	ε_{Fmax} [m/m]
RK05	16411.80



	ε_{Fmax} [m/m]
RK06	27241.90

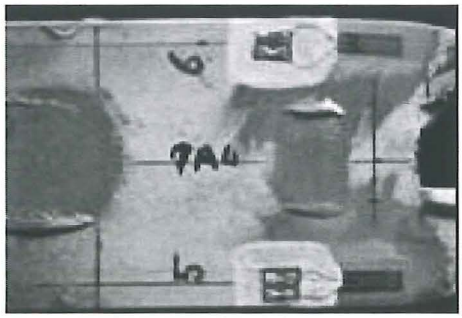
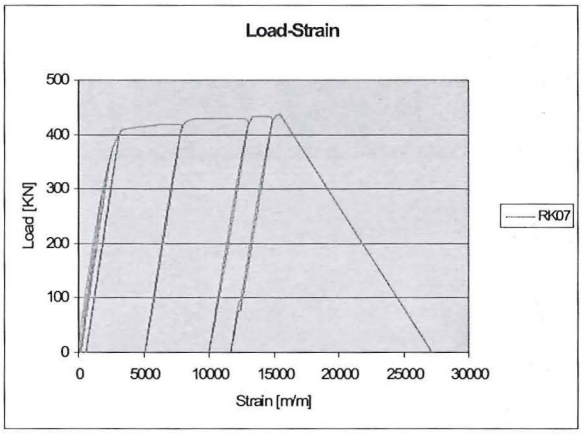
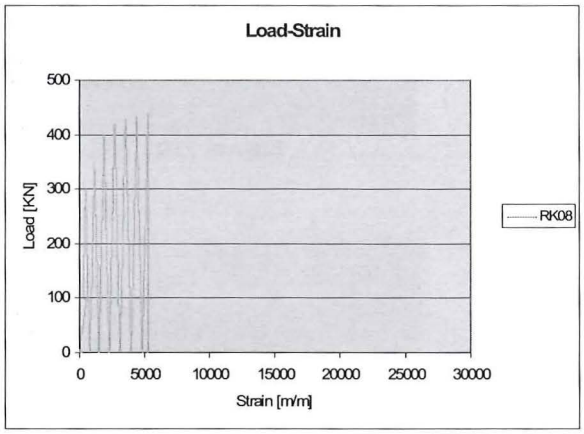


Figure 53.5: Test specimen face with the position of the strain gauges 5 and 6.



	ε_{Fmax} [m/m]
RK07	15430.60



	ε_{Fmax} [m/m]
RK08	27241.90 (Measuring Error)

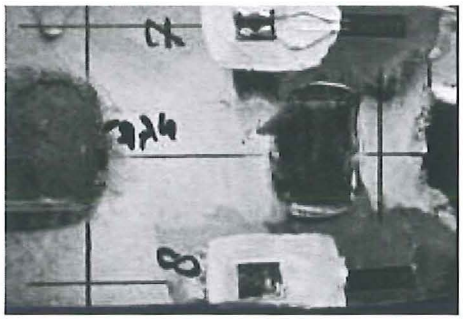
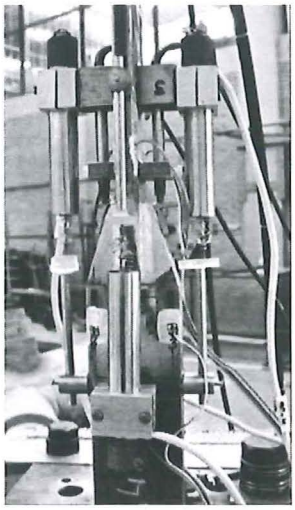
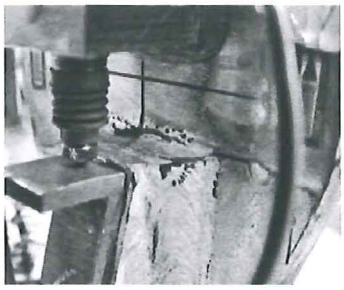


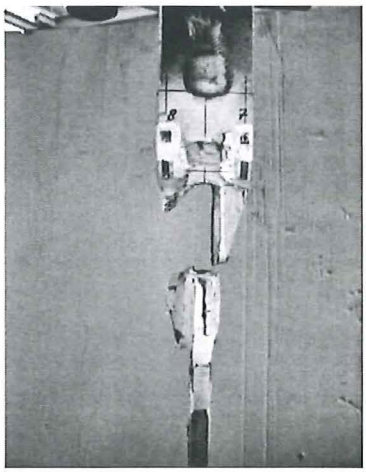
Figure 53.6: Test specimen face with the position of the strain gauges 7 and 8.

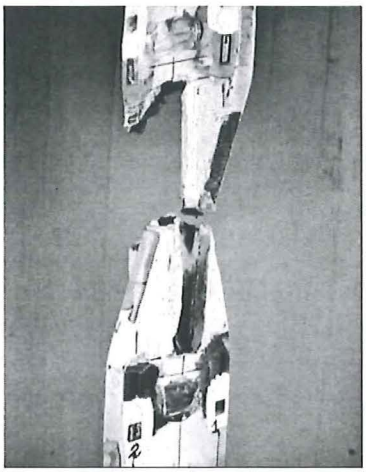
SPECIMEN 7A4

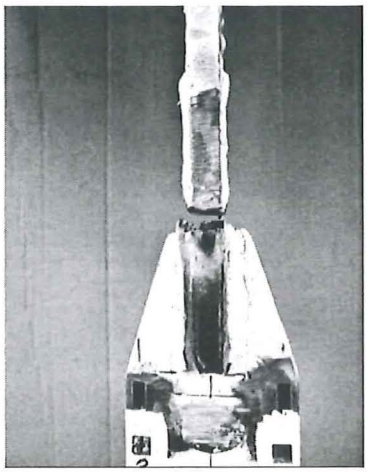




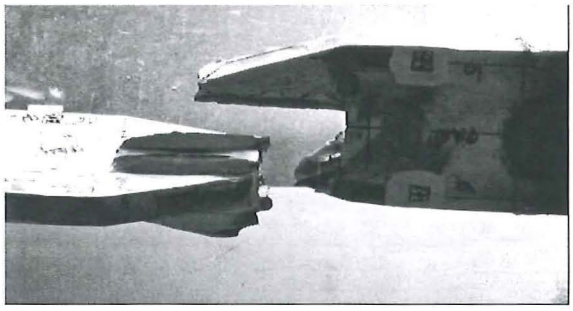
Figures 53.7, 53.8 and 53.9: Test specimen during the test. Crack initiation in the weld toe.

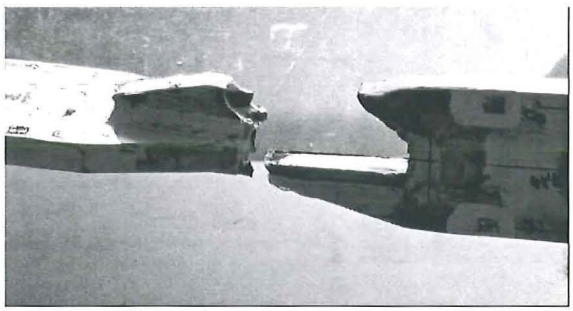






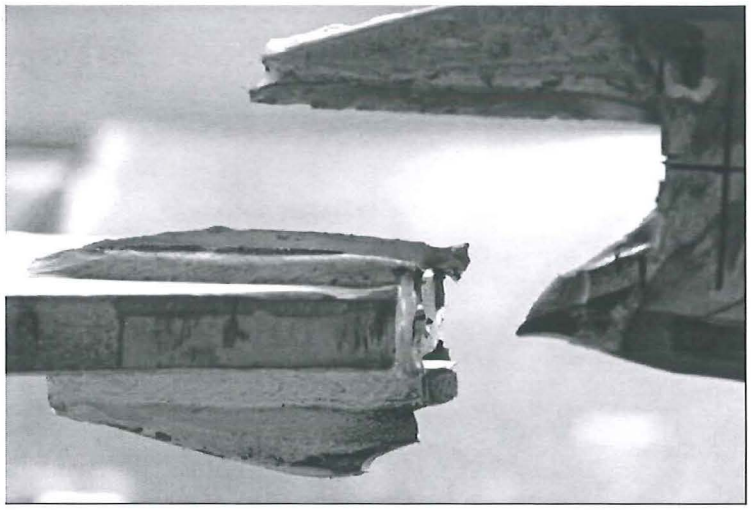
Figures 53.10, 53.11 and 53.12: Different side views of the test specimen after failure.

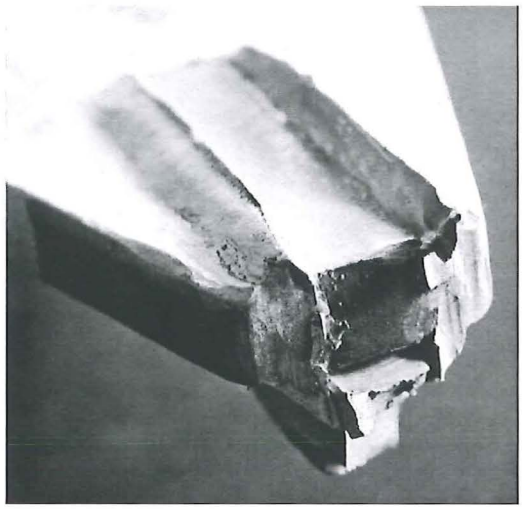


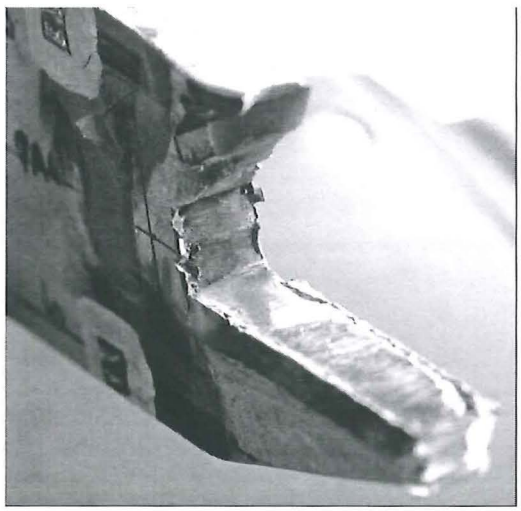


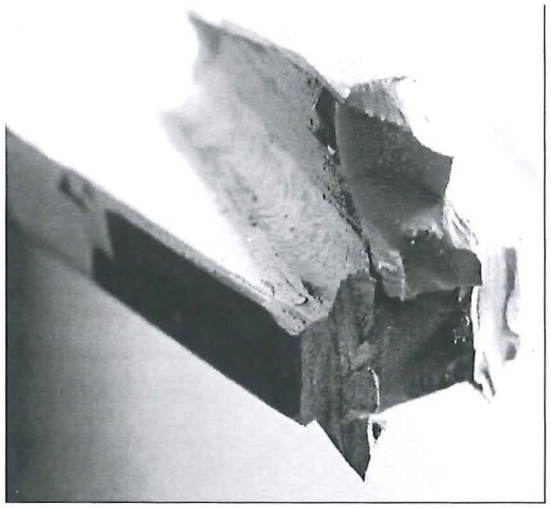
Figures 53.13, 53.14: Test specimen after failure.

SPECIMEN 7A4









Figures 53.15 to 53.18: Several detailed prespectives of the failed weld.

SPECIMEN 1B1

Table 1B1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1B1 (5)
	Type of specimen	X-joint with low SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1B
Test	Type of test	Static strength
	Parameter	Reference
	Remark	Low SCF
	Failure	Plate

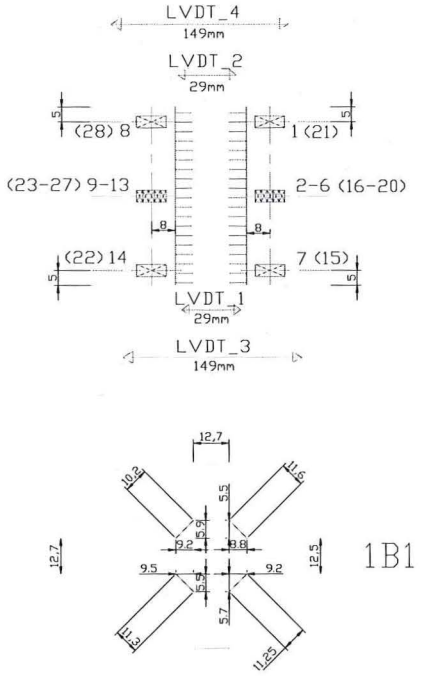
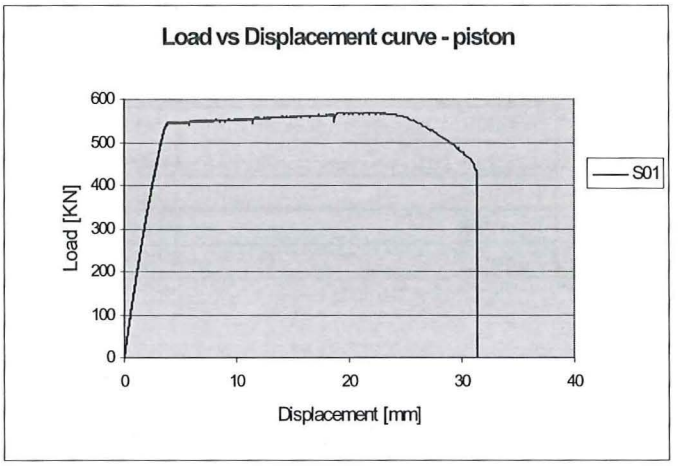
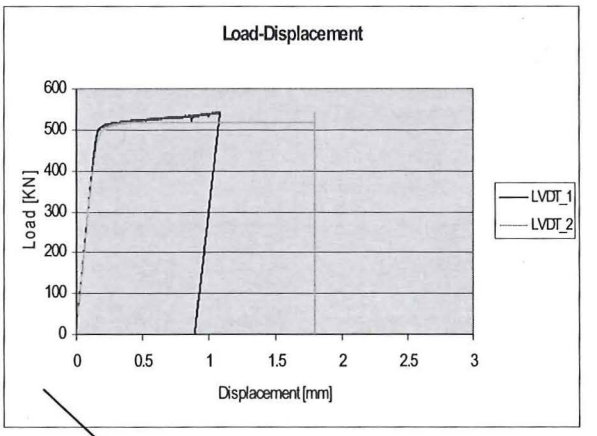


Figure 5.1: Top and side views of the test specimen with the position of the strain gauges and sizes of the welds and measuring equipment.

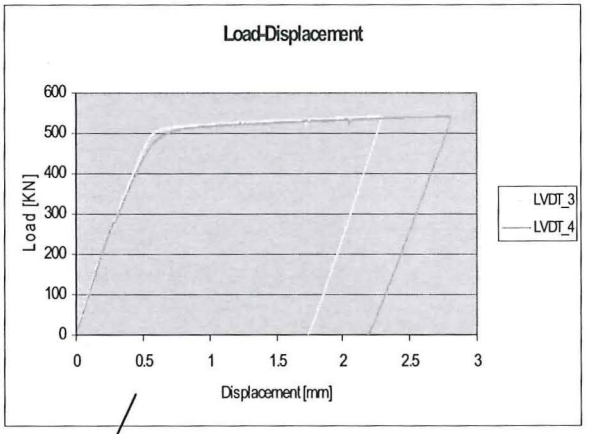
SPECIMEN 1B1



F_{max} [KN]	568
S_{Fmax} [mm]	19.37
S_{max} [mm]	32.12



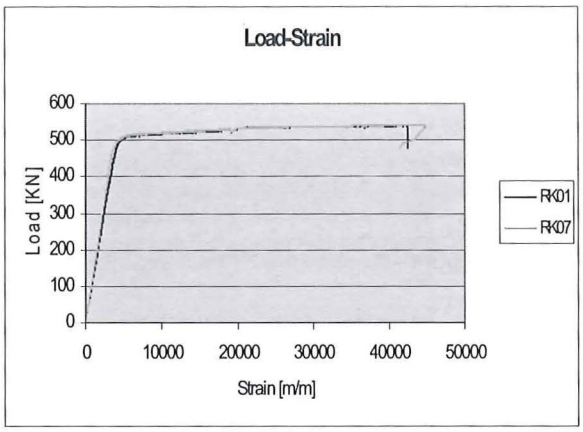
	Range [mm]	S_{Fmax} [mm]
LVDT_1	29.0	1.08
LVDT_2	29.0	1.79



	Range [mm]	S_{Fmax} [mm]
LVDT_3	149.0	2.29
LVDT_4	149.0	2.80

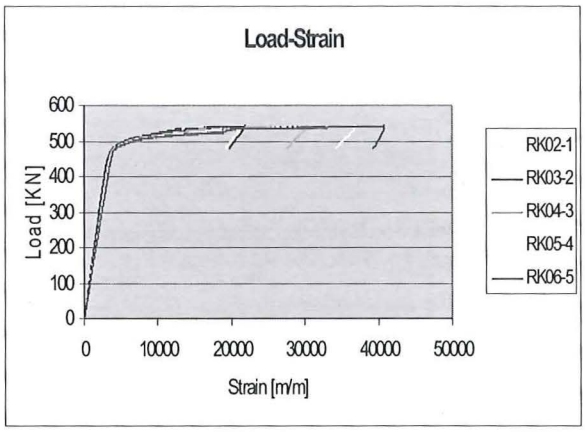
Questionable data

SPECIMEN 1B1



(skipped data)

	ε_{Fmax} [m/m]
RK01	42472.03
RK07	44776.95



(skipped data)

	ε_{Fmax} [m/m]
RK02-1	21522.55
RK03-2	21904.65
RK04-3	30209.36
RK05-4	36869.43
RK06-5	40879.49

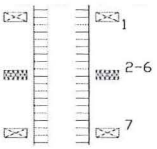
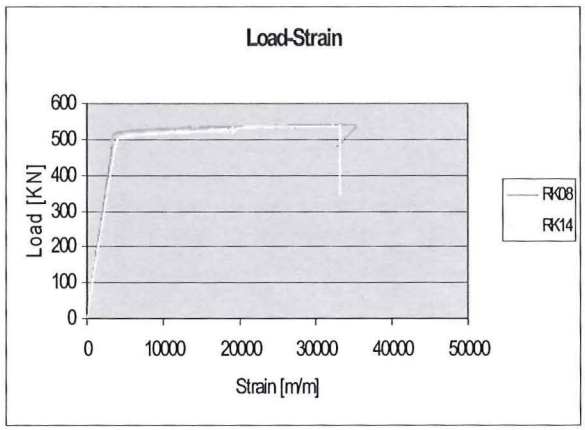
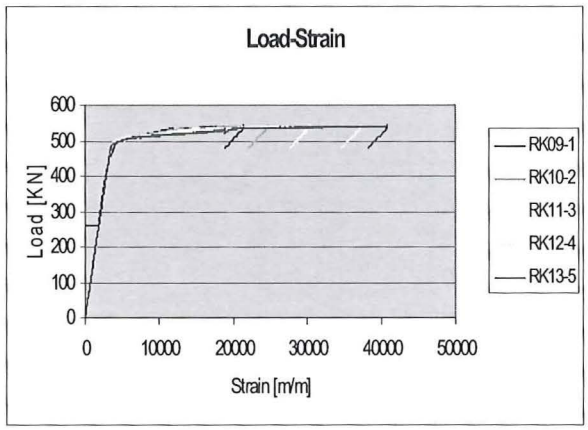


Figure 5.2: Drawing of the test specimen face with the position of the strain gauges 1 to 7.



(skipped data)

	ε_{Fmax} [m/m]
RK08	35269.93
RK14	33108.14



(skipped data)

	ε_{Fmax} [m/m]
RK09-1	21455.47
RK10-2	24641.83
RK11-3	30225.93
RK12-4	37286.56
RK13-5	40772.39

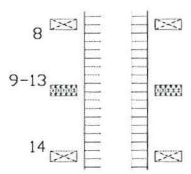
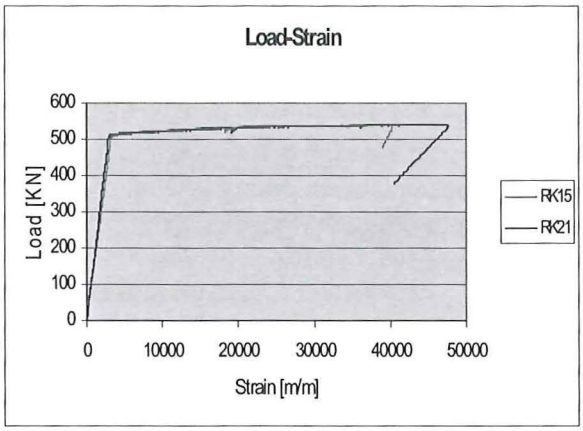


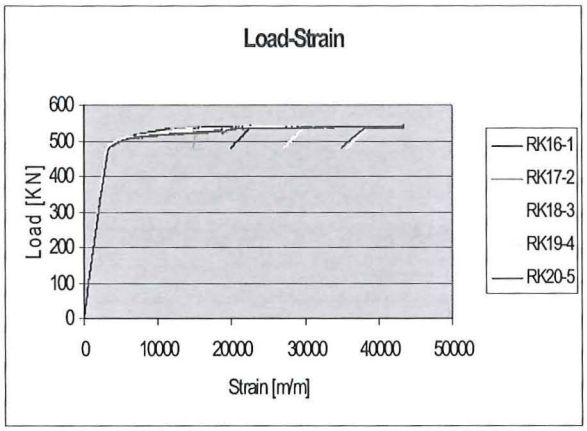
Figure 5.3: Drawing of the test specimen face with the position of the strain gauges 8 to 14.

SPECIMEN 1B1



(skipped data)

	ε_{Fmax} [m/m]
RK15	40173.03
RK21	47550.93



(skipped data)

	ε_{Fmax} [m/m]
RK16-1	22545.17
RK17-2	15305.62
RK18-3	29698.83
RK19-4	38351.85
RK20-5	43364.76

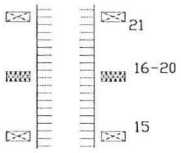
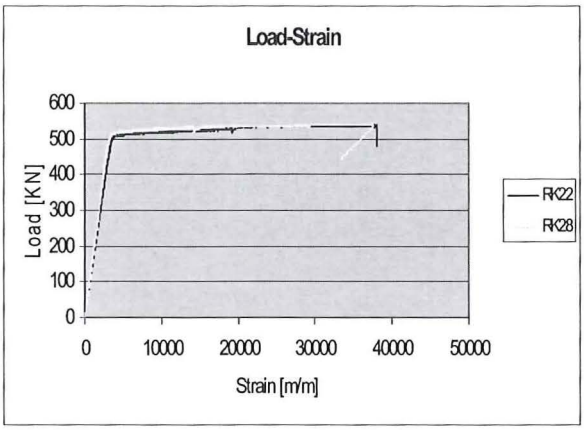
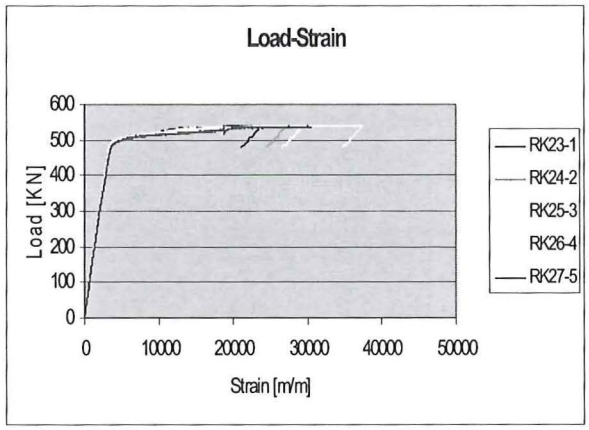


Figure 5.4: Drawing of the test specimen face with the position of the strain gauges 15 to 21.



(skipped data)

	ε_{Fmax} [m/m]
RK22	38096.82
RK28	37584.38



(skipped data)

	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK23-1	23727.93	
RK24-2	27056.74	
RK25-3	29213.06	
RK26-4	37326.42	
RK27-5	Failure before F_{max}	30549.75

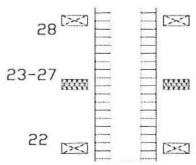


Figure 5.5: Drawing of the test specimen face with the position of the strain gauges 22 to 28.

SPECIMEN 1B1

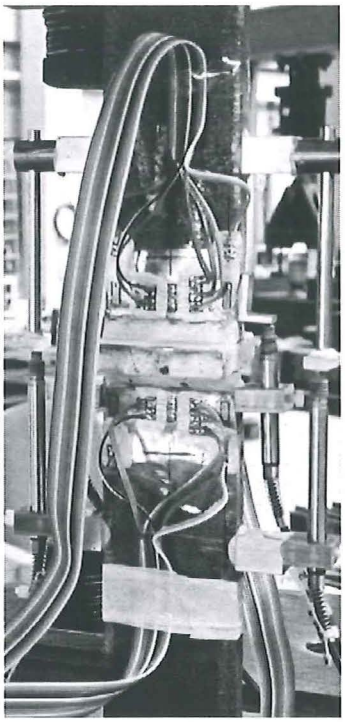


Figure 5.6: Test specimen during the test.

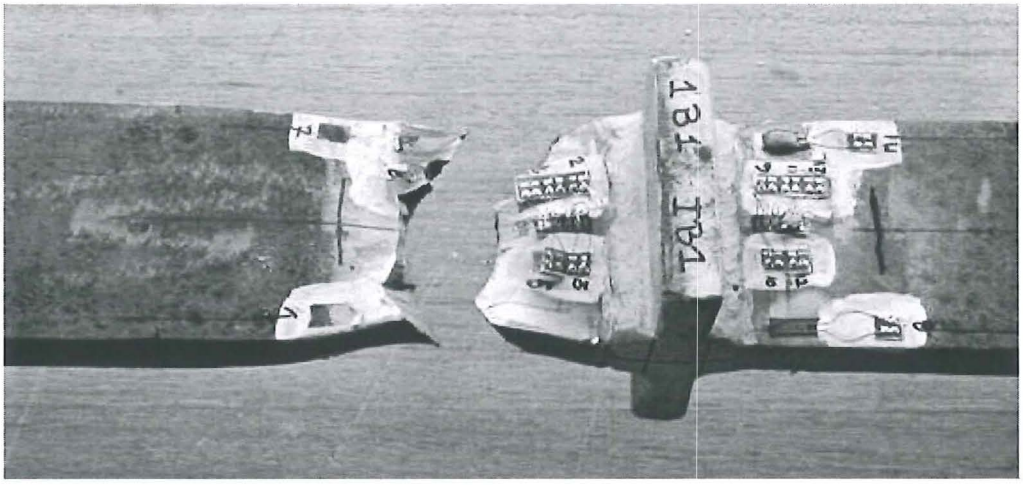
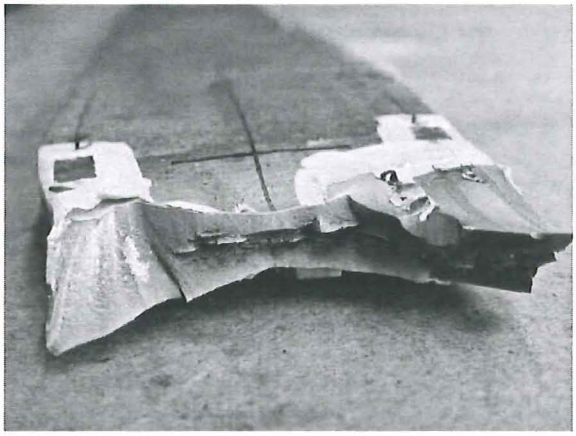
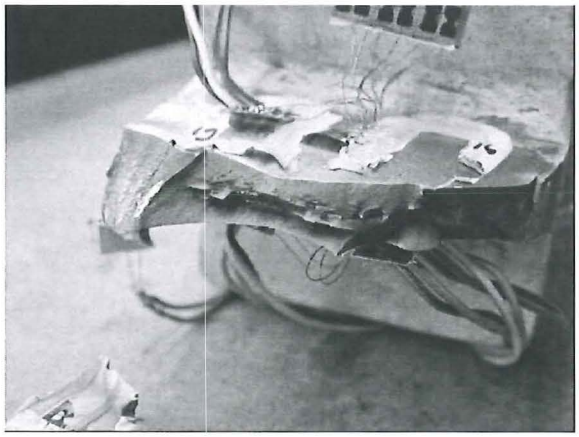


Figure 5.7: Test specimen after failure.

SPECIMEN 1B1





Figures 5.8, 5.9 and 5.10: Perspectives of both parts of the failed plate.

SPECIMEN 1B2

Table 1B2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1B2 (6)
	Type of specimen	X-joint with low SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1B
Test	Type of test	Fatigue
	Parameter	Reference
	Remark	Low SCF
	Failure	Weld

SPECIMEN 1B2

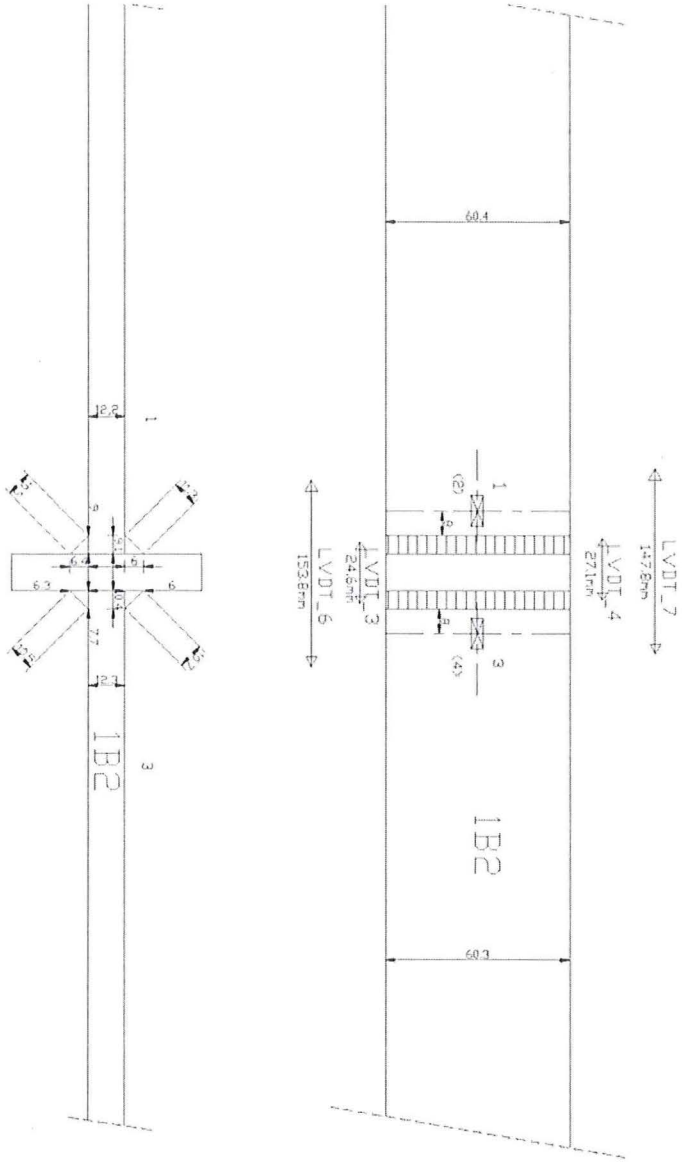


Figure 1B2-1: Dimensions of the test specimen

Figure 1B2-2: Dimensions of the welds

Figure 1B2-3: Position of strain gauges and LVDT's

SPECIMEN 1B2

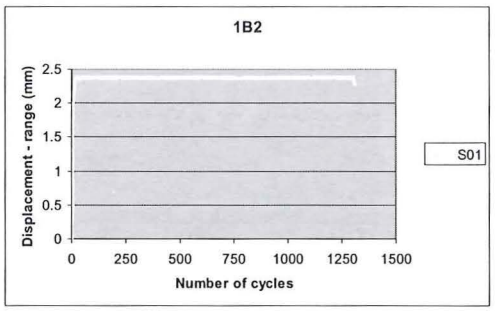


Figure 1B2-4: Test displacement controlled (range)

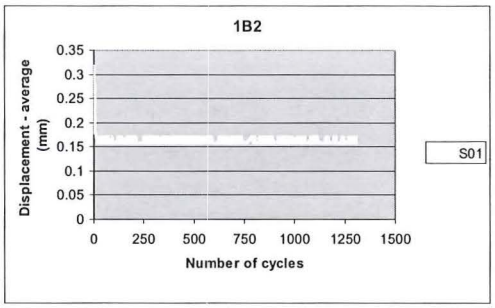


Figure 1B2-5: Test displacement controlled (average)

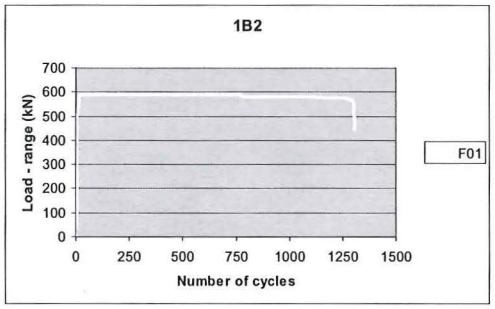


Figure 1B2-6: Test load (range)

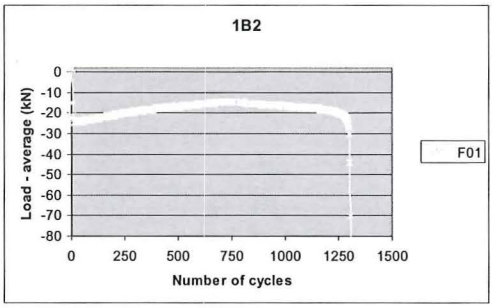


Figure 1B2-7: Test load (average)

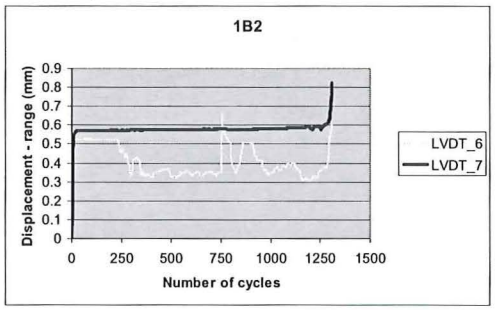


Figure 1B2-8: Deformation whole connection (range)

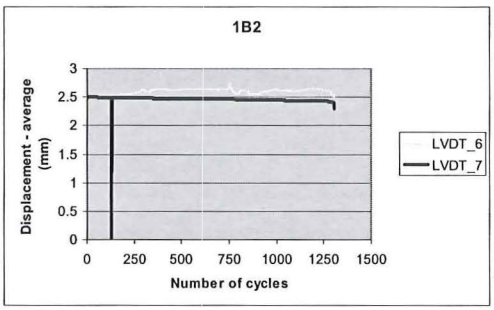


Figure 1B2-9: Deformation whole connection (average)

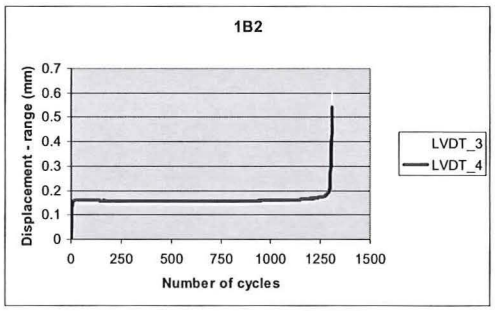


Figure 1B2-10: Local deformation (range)

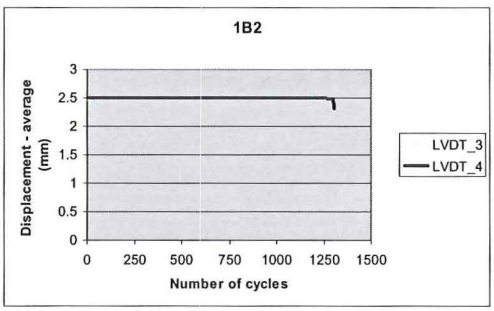


Figure 1B2-11: Local deformation (average)

SPECIMEN 1B2

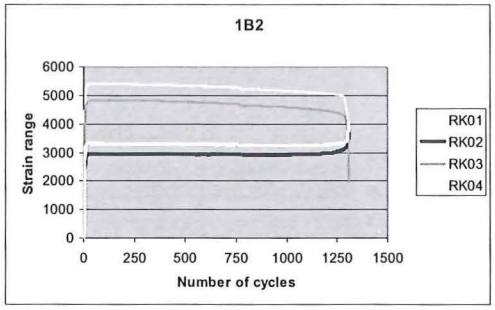


Figure 1B2-12: Measured strains (range)

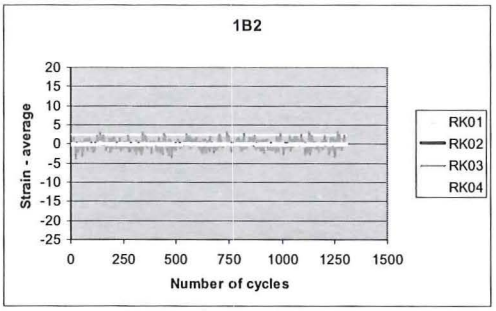


Figure 1B2-13: Measured strains (average)

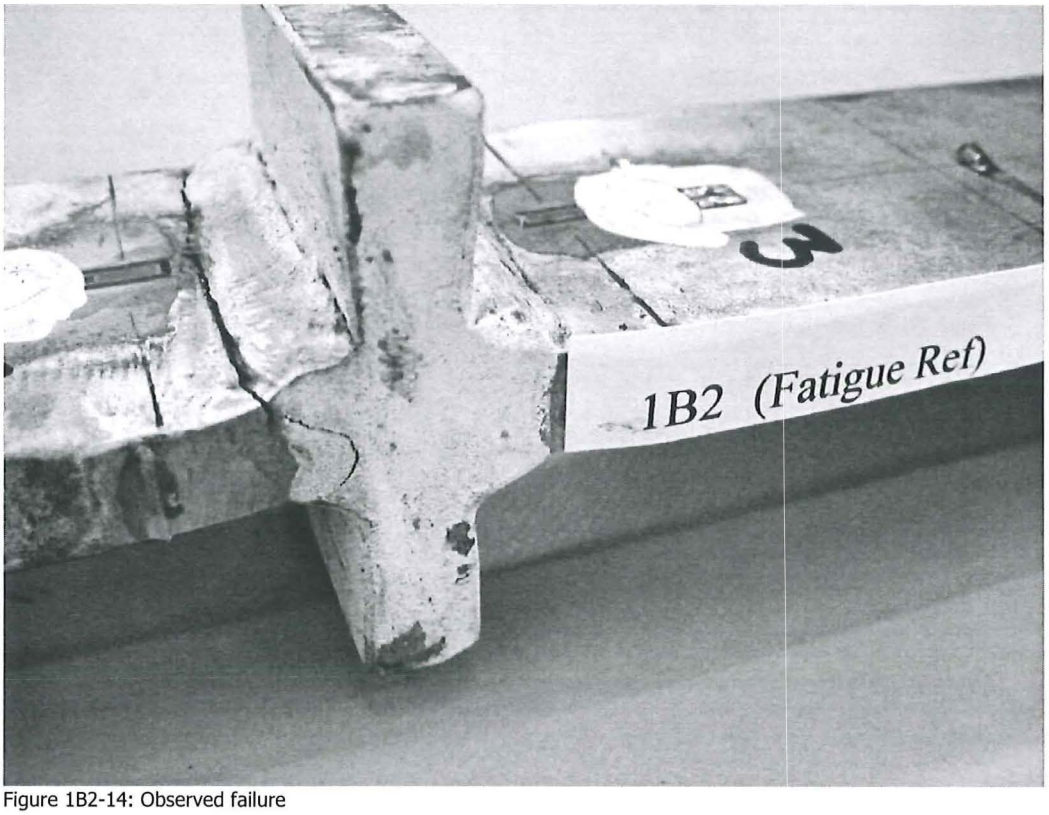


Figure 1B2-14: Observed failure

SPECIMEN 1B3

Table 1B3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1B3 (7)
	Type of specimen	X-joint with low SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1B
Test	Type of test	Fatigue
	Parameter	Reference
	Remark	Low SCF
	Failure	Weld

SPECIMEN 1B3

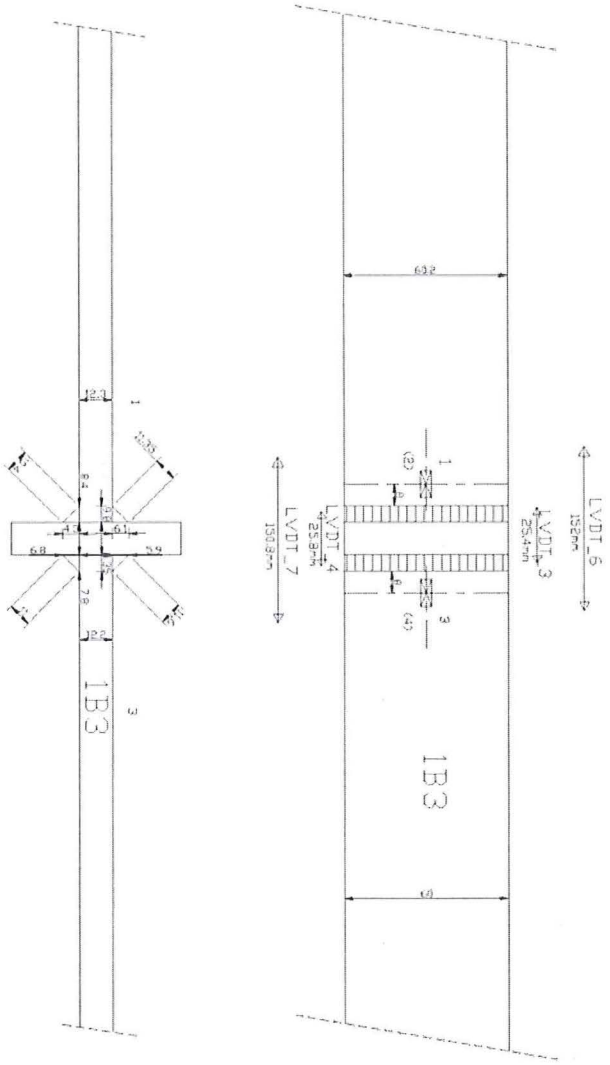


Figure 1B3-1: Dimensions of the test specimen

Figure 1B3-2: Dimensions of the welds

Figure 1B3-3: Position of strain gauges and LVDT's

SPECIMEN 1B3

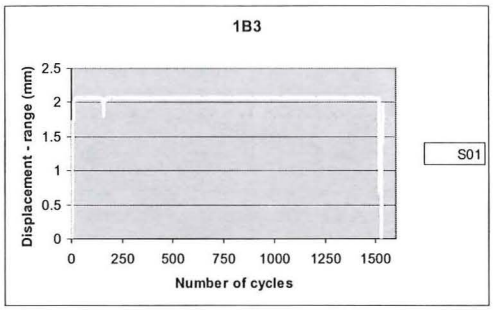


Figure 1B3-4: Test displacement controlled (range)

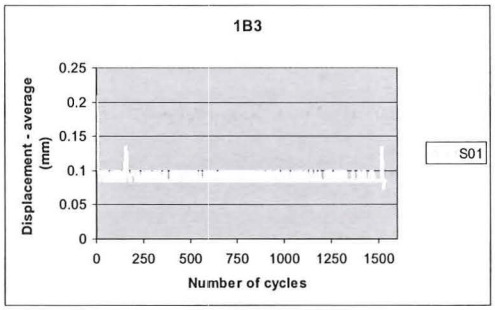


Figure 1B3-5: Test displacement controlled (average)

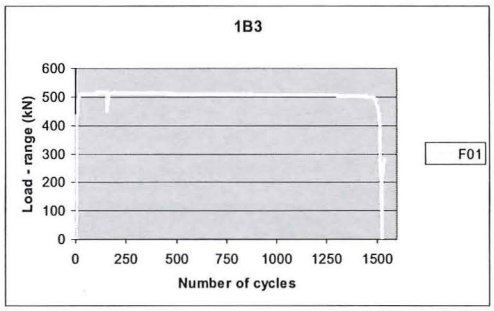


Figure 1B3-6: Test load (range)

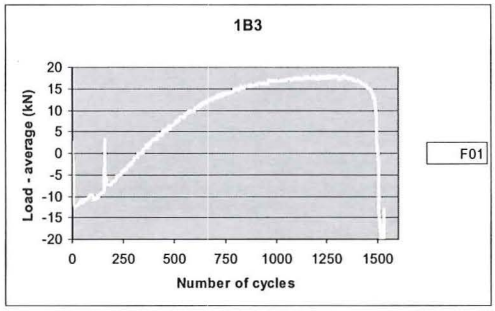


Figure 1B3-7: Test load (average)

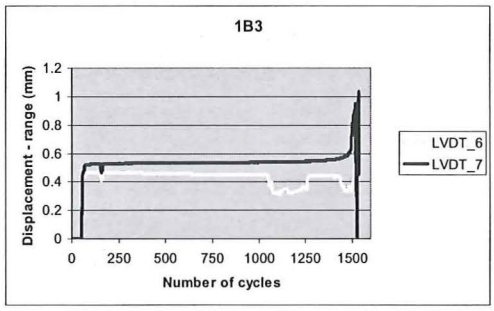


Figure 1B3-8: Deformation whole connection (range)

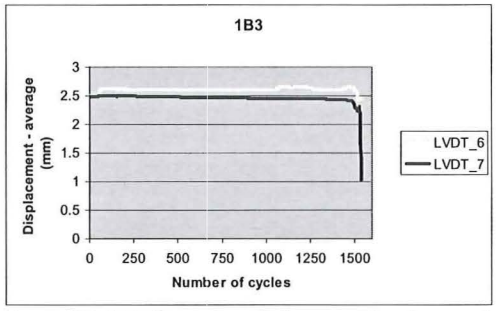


Figure 1B3-9: Deformation whole connection (average)

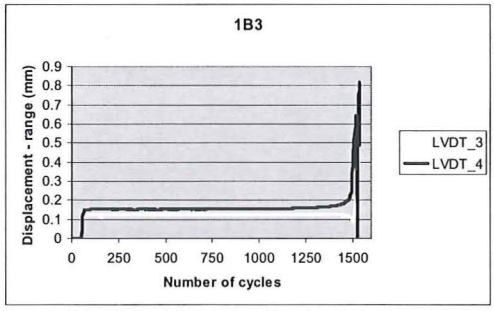


Figure 1B3-10: Local deformation (range)

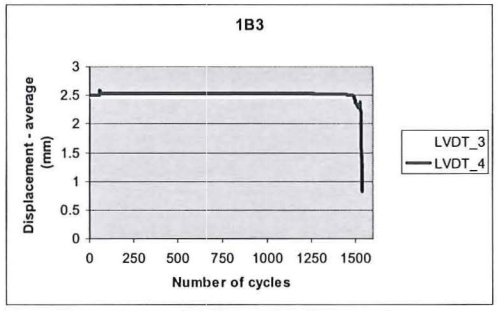


Figure 1B3-11: Local deformation (average)

SPECIMEN 1B3

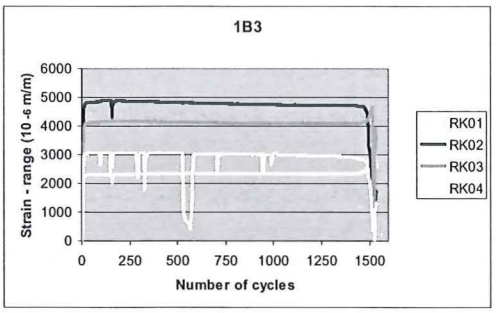


Figure 1B3-12: Measured strains (range)

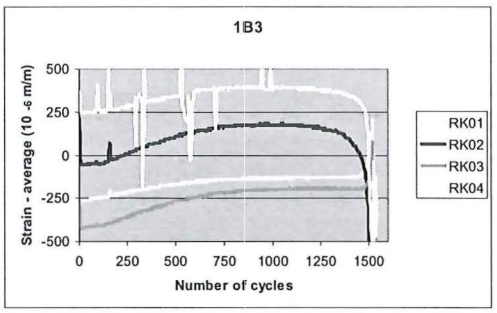


Figure 1B3-13: Measured strains (average)

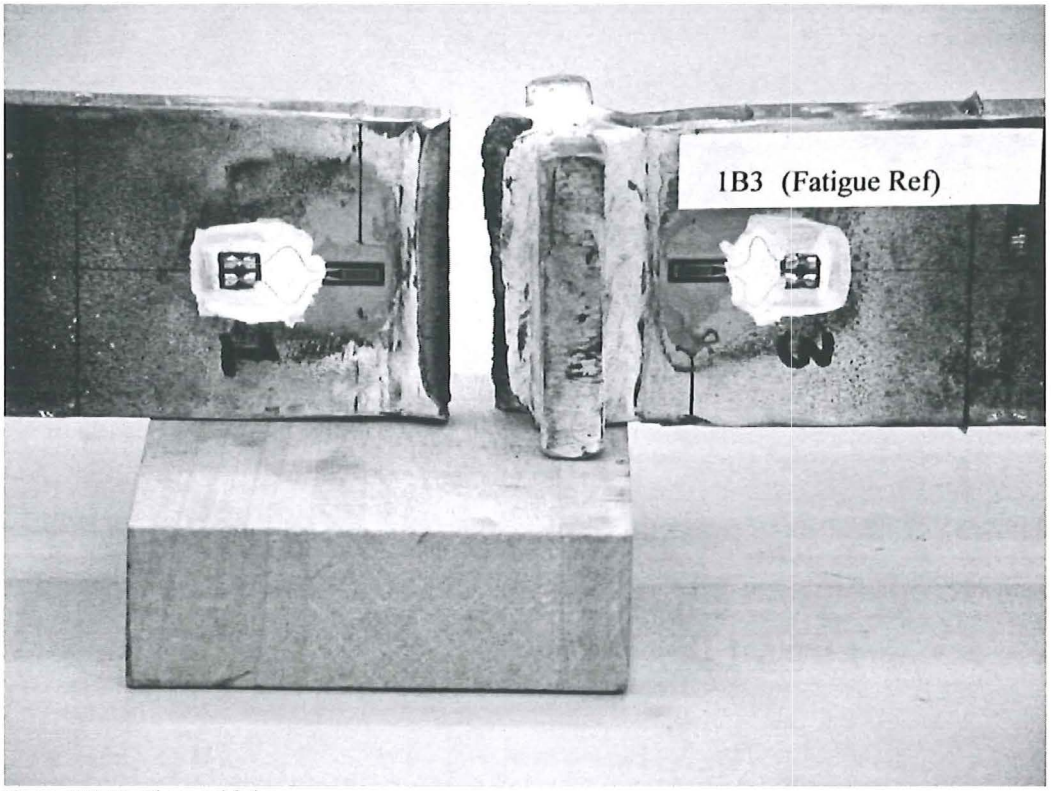


Figure 1B3-14: Observed failure

SPECIMEN 1B4

Table 1B4-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1B4 (8)
	Type of specimen	X-joint with low SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1B
Test	Type of test	Ratcheting
	Parameter	Reference
	Remark	Low SCF
	Failure	Plate

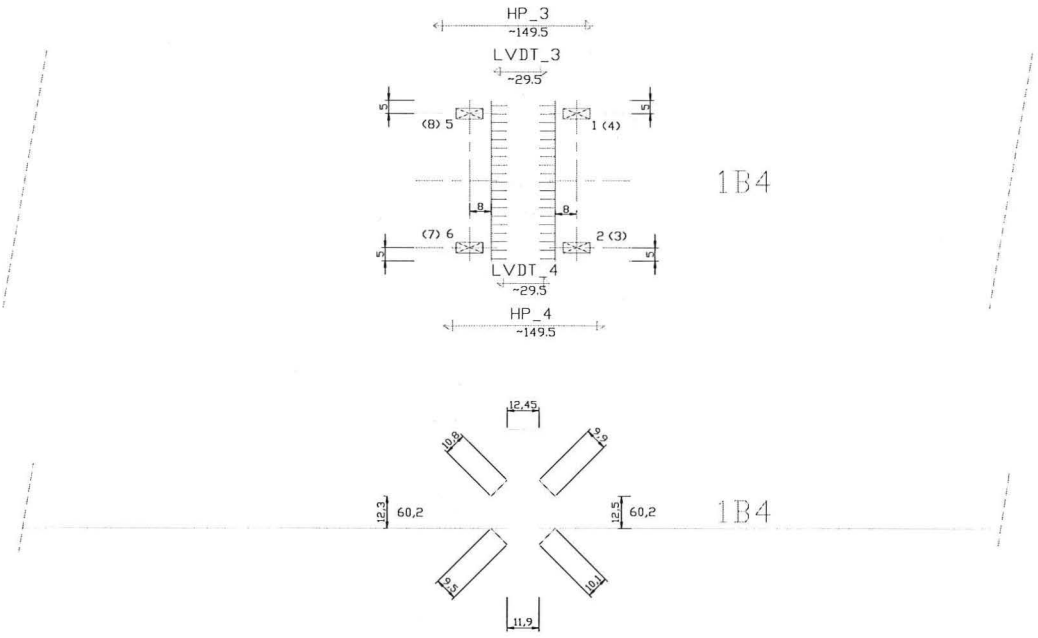
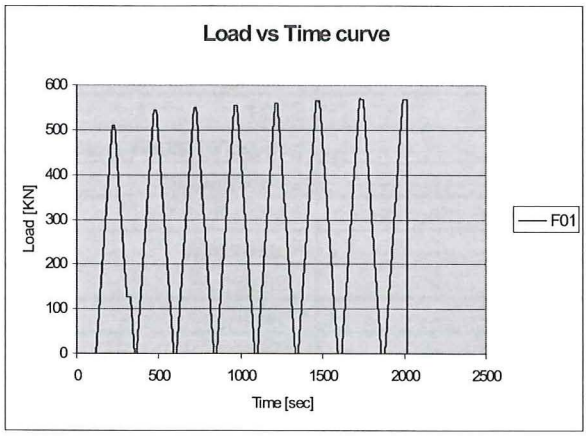
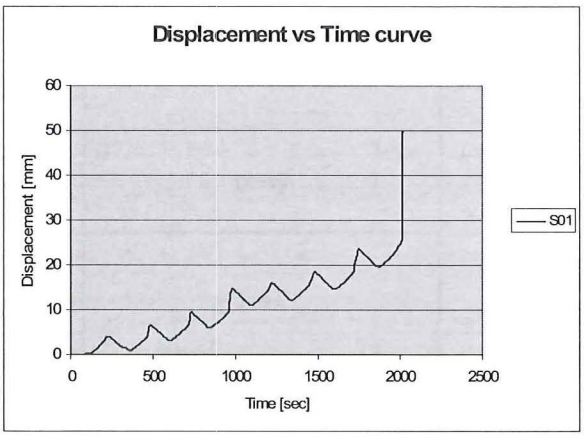


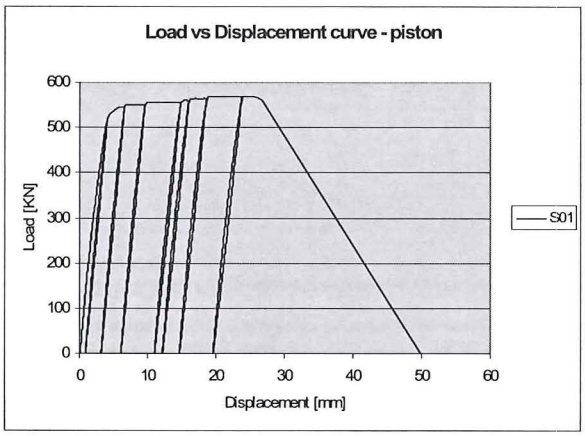
Figure 8.1 Top and side views of the test specimen with the position of the strain gauges and sizes of the welds. The sizes of the measuring equipment were not measured. The dimensions presented are the ones used for 3B4.

SPECIMEN 1B4



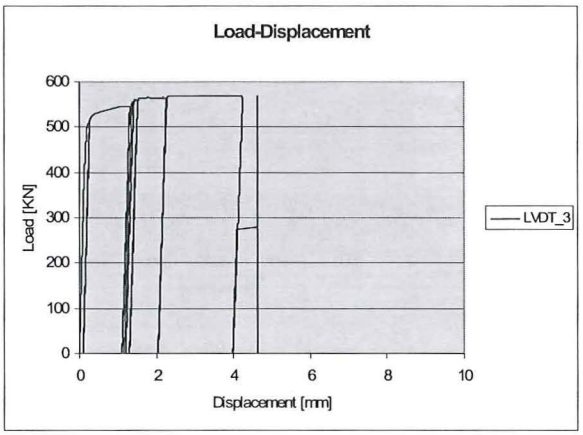


Cycle	Time [sec]	Peak Force [KN]	Displacement [mm]
1	230	509	4.00
2	486	545	6.54
3	728	550	9.22
4	973	555	14.47
5	1221	560	15.98
6	1479	565	18.44
7	1726	570	20.14
8	2011	570	25.37

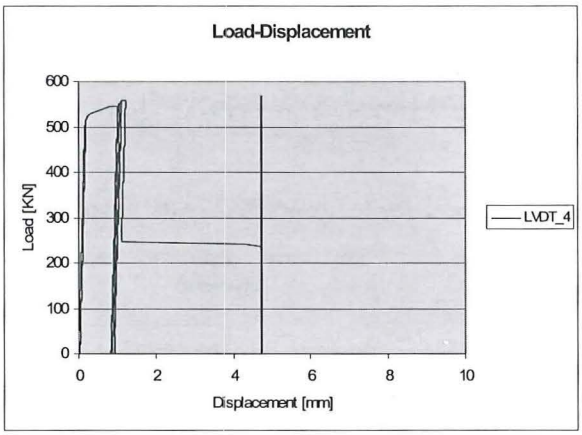


F_{max} [KN]	570
S_{Fmax} [mm]	20.14
S_{max} [mm]	49.78

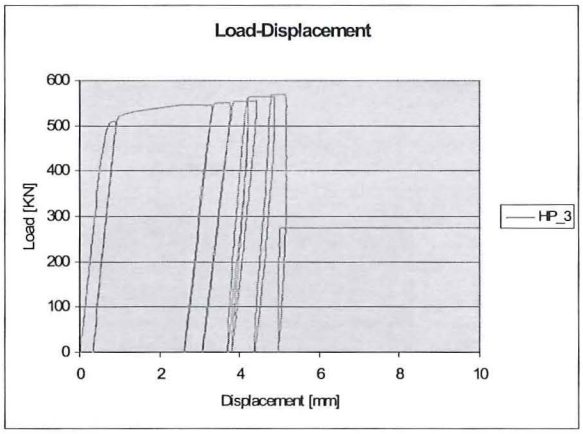
SPECIMEN 1B4



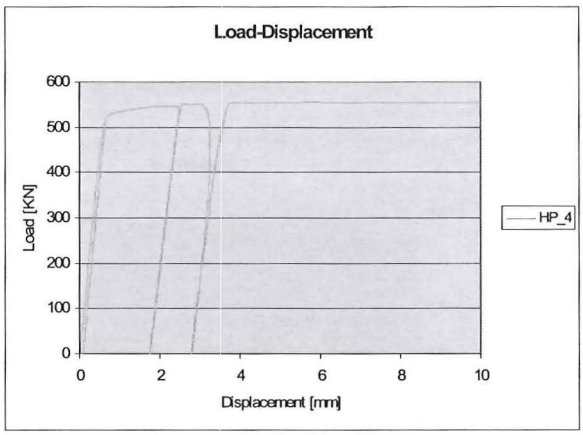
	Range [mm]	S_{Fmax} [mm]
LVDT_3	~ 29.5	2.34



	Range [mm]	S_{Fmax} [mm]
LVDT_4	~ 29.5	4.73

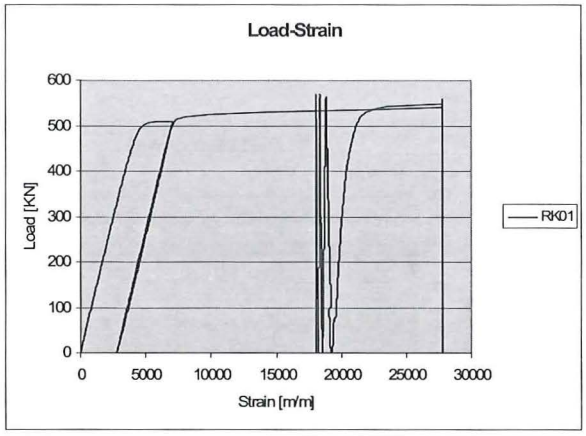


	Range [mm]	S_{Fmax} [mm]
HP_3	~ 149.5	4.82

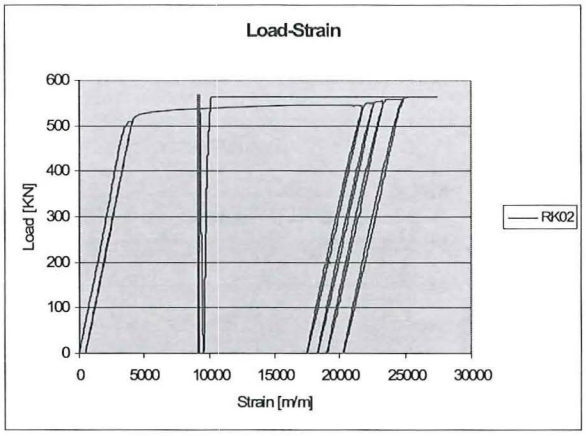


	Range [mm]	S_{Fmax} [mm]
HP_4	~ 149.5	Measuring Error ~ 6.09

SPECIMEN 1B4



	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK01	18355.70	27825.10



	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK02	9321.31	27399.30

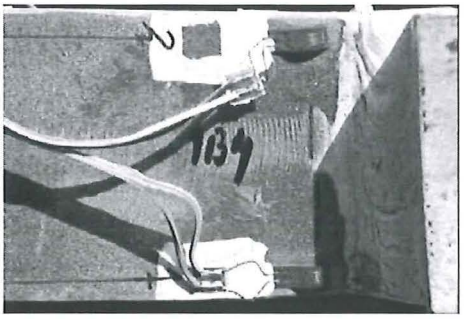
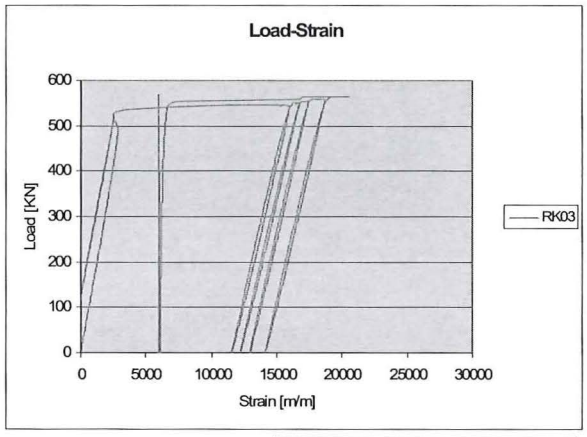
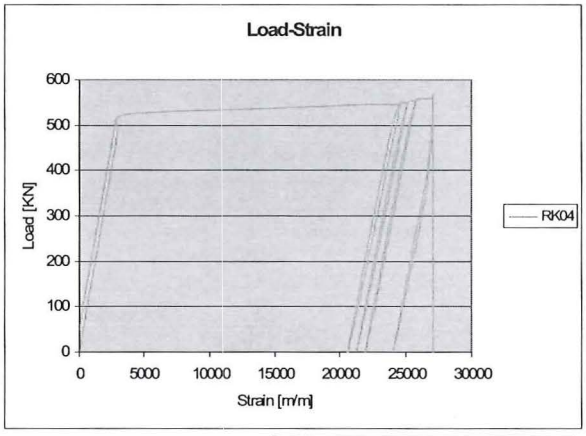


Figure 8.2 Test specimen face with the position of the strain gauges 1 and 2.



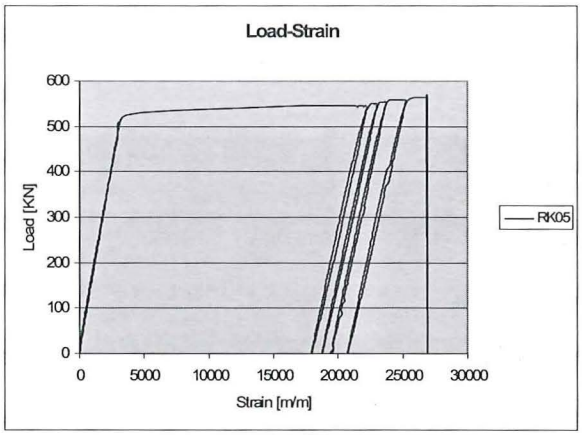
	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK03	5979.71	20549.50



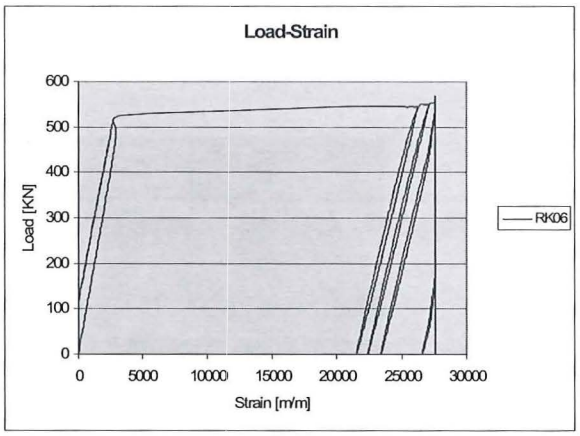
	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK04	27056.80	27056.80

Figure 8.3: Test specimen face with the position of the strain gauges 3 and 4.

SPECIMEN 1B4



	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK05	26918.00	26918.00



	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK06	27593.70	27593.70

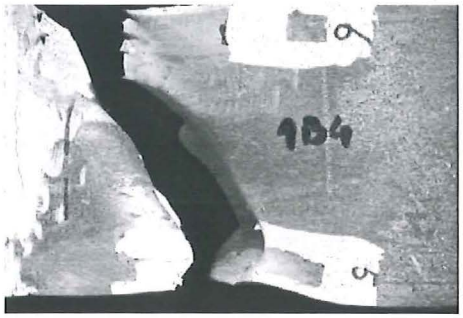
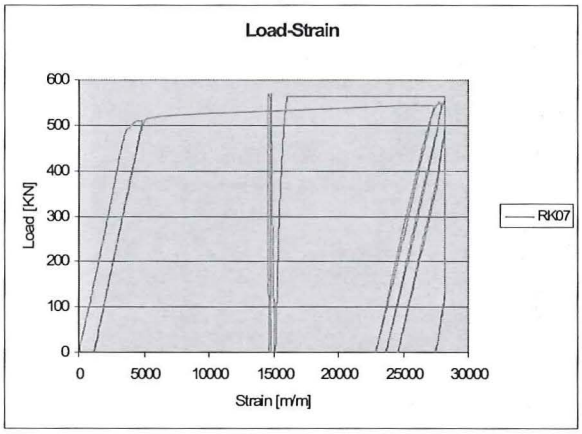
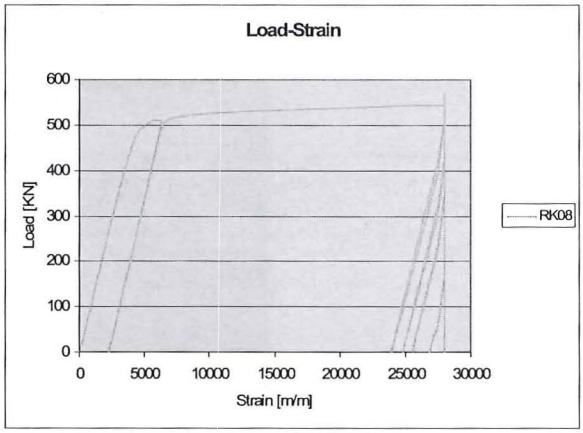


Figure 8.4: Test specimen face with the position of the strain gauges 5 and 6.



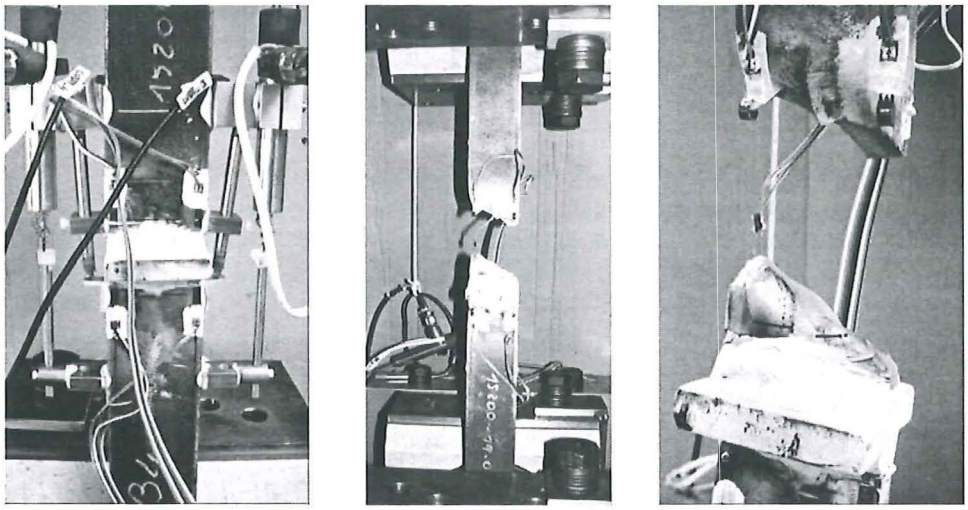
	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK07	14791.90	28176.80



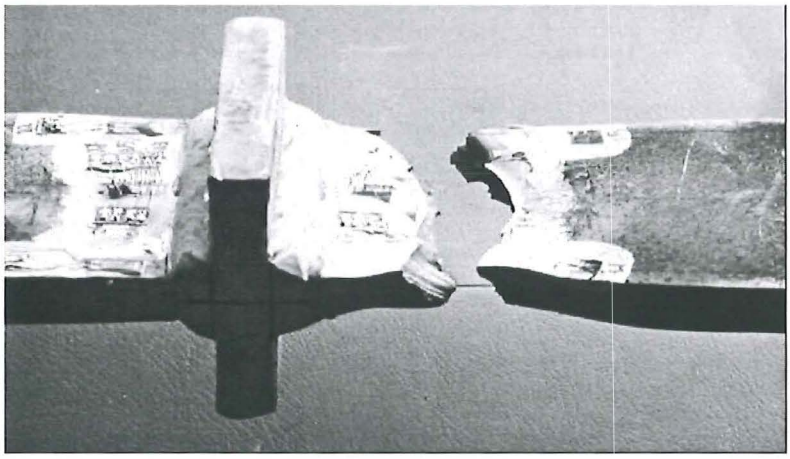
	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK08	27945.40	27945.40

Figure 8.5: Test specimen face with the position of the strain gauges 7 and 8.

SPECIMEN 1B4



Figures 8.6, 8.7 and 8.8: Test specimen during the test and after failure of the plate.



Figures 8.9: Test specimen after failure.

SPECIMEN 1B4

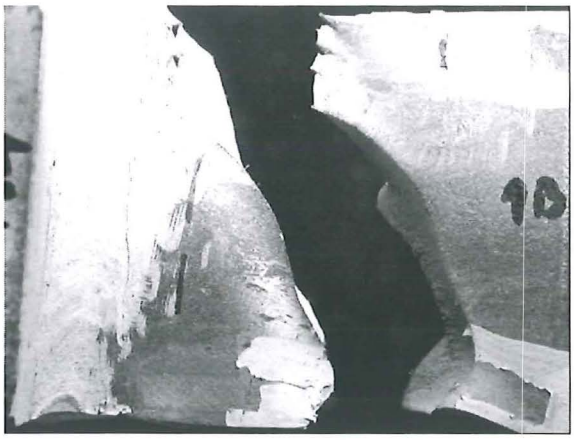
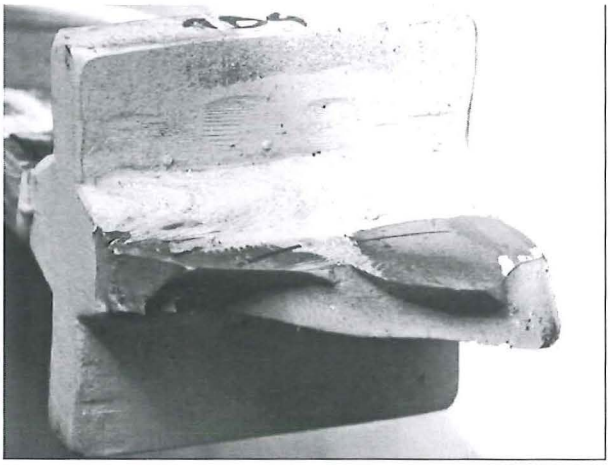
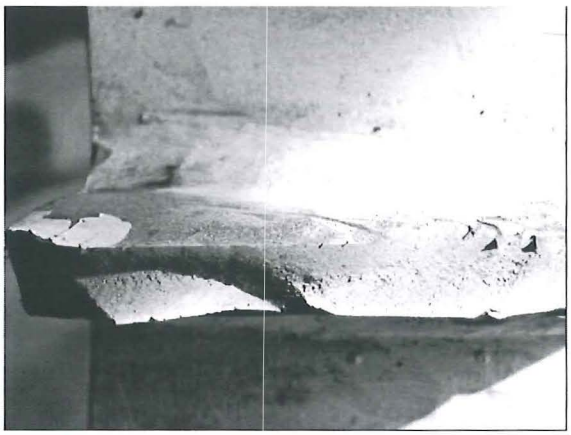


Figure 8.10: Top view of the test specimen in the failure area.



Figures 8.11 and 8.12: Detailed perspectives of the failed plate.



SPECIMEN 1C1

Table 1C1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1C1 (9)
	Type of specimen	X-joint with high SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1C
Test	Type of test	Static strength
	Parameter	Reference
	Remark	High SCF
	Failure	Plate

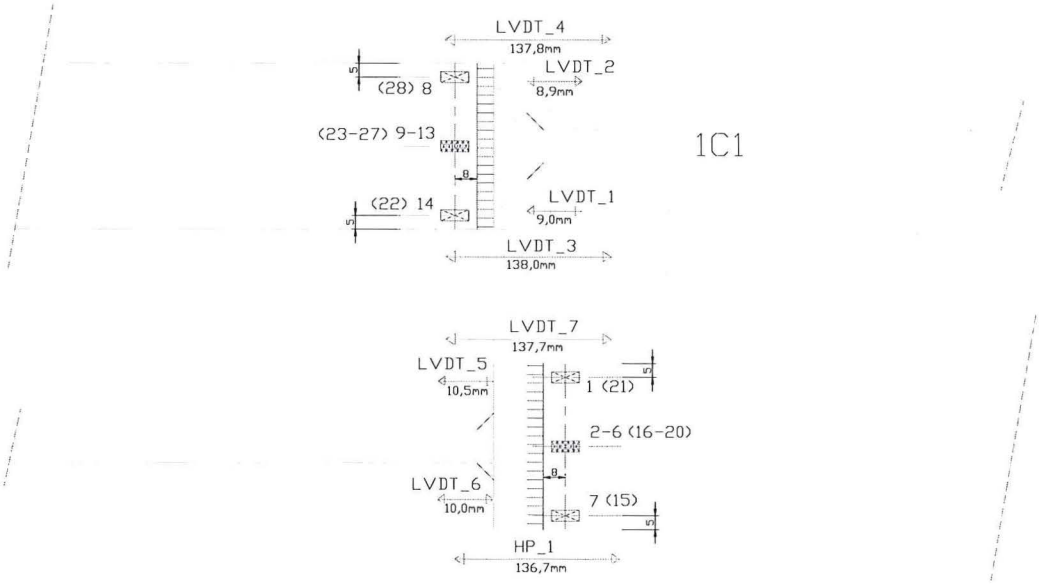


Figure 9.1: Top views of the test specimen with the position of the strain gauges and sizes of the measuring equipment.

SPECIMEN 1C1

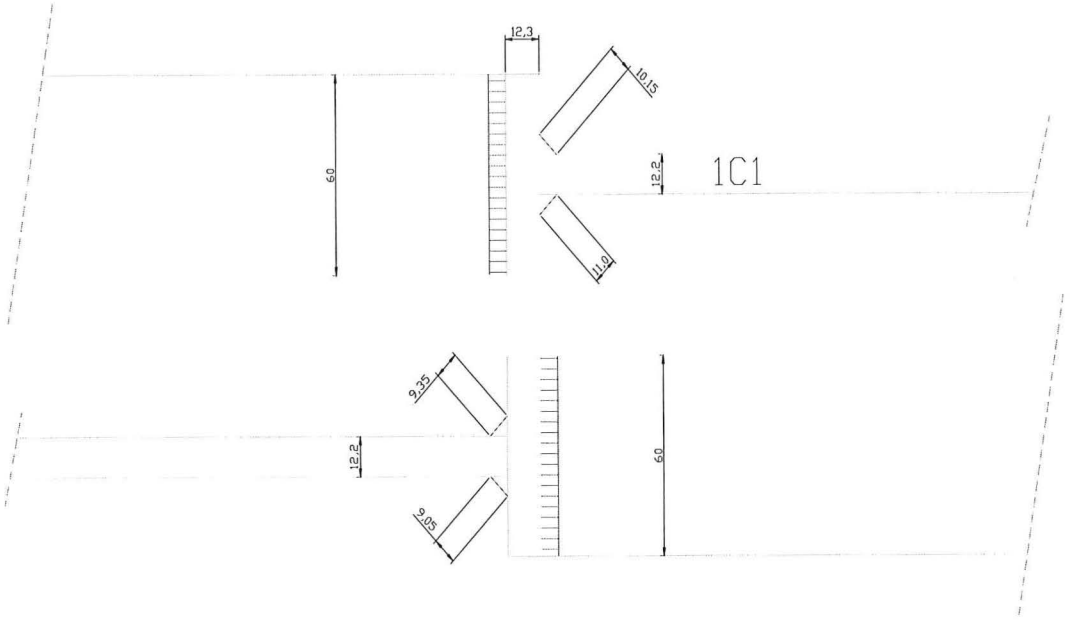
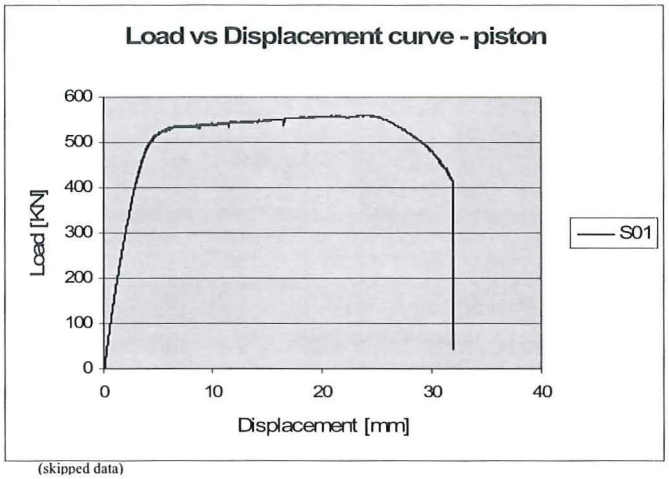


Figure 9.2: Side views, with the sizes of the welds.

SPECIMEN 1C1



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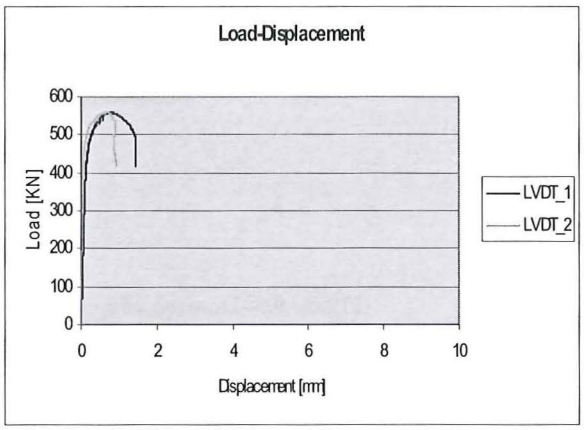
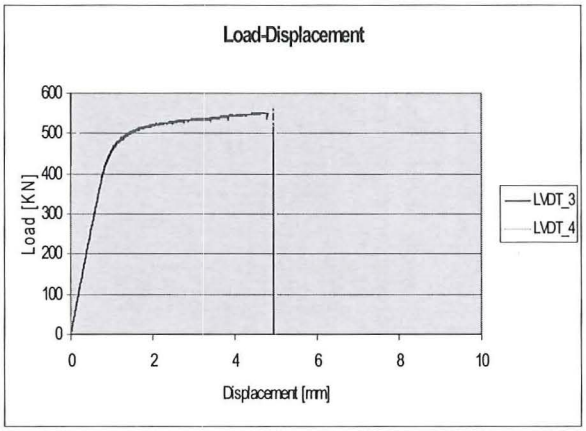
F_{max} [KN]	560
S_{Fmax} [mm]	23.86
S_{max} [mm]	35.30

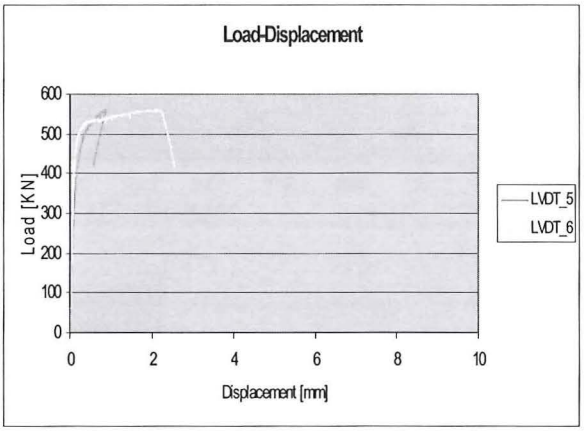


(skipped data)

	Range [mm]	S_{Fmax} [mm]
LVDT_1	9.0	0.78
LVDT_2	8.9	0.67

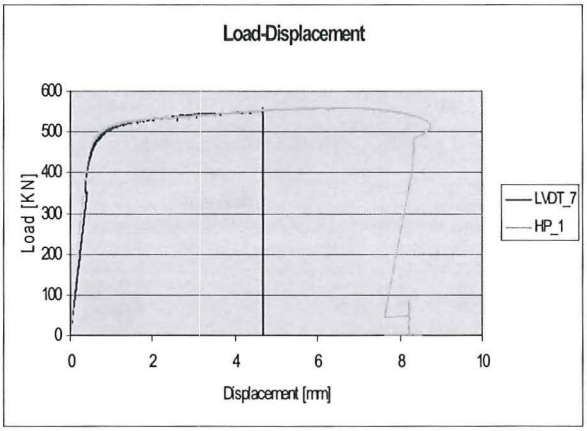


	Range [mm]	S_{Fmax} [mm]
LVDT_3	138.0	4.95
LVDT_4	137.8	4.10



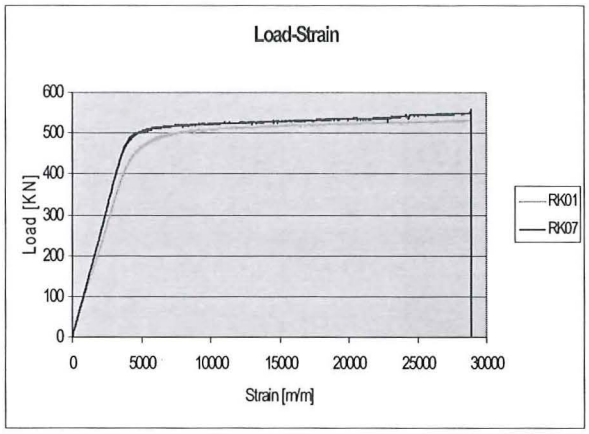
(skipped data)

	Range [mm]	S_{Fmax} [mm]
LVDT_5	10.5	0.87
LVDT_6	10.0	2.11



	Range [mm]	S_{Fmax} [mm]
LVDT_7	137.7	4.67
HP_1	136.7	6.62

SPECIMEN 1C1



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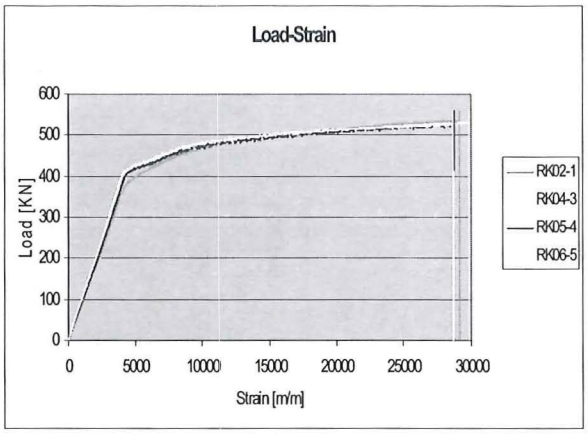
	ε_{Fmax} [m/m]
RK01	28876.30
RK07	28895.00



(skipped data)

	ε_{Fmax} [m/m]
RK02-1	29159.30
RK03-2	Measuring Error
RK04-3	29883.70
RK05-4	28728.40
RK06-5	28636.70

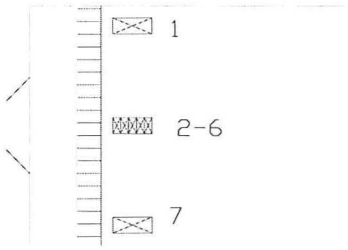
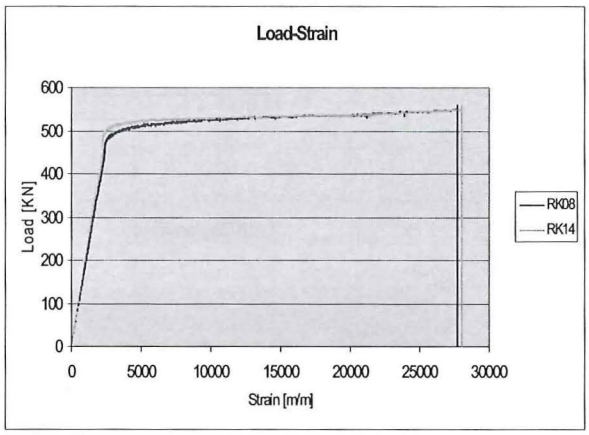
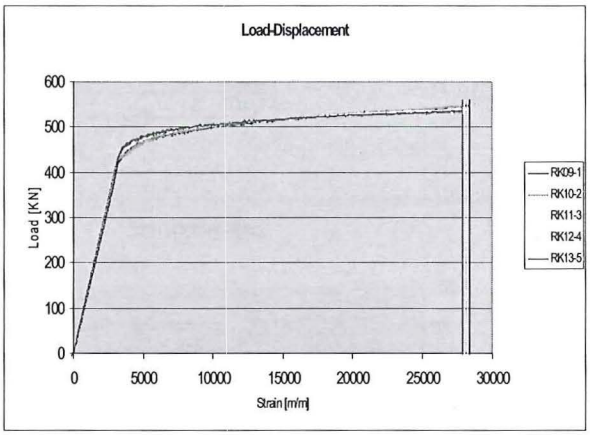


Figure 9.3: Drawing of the test specimen face with the position of the strain gauges 1 to 7.



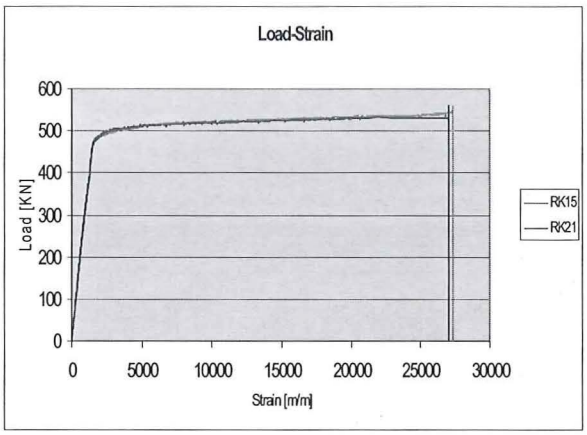
	ε_{Fmax} [m/m]
RK08	27726.90
RK14	28054.00



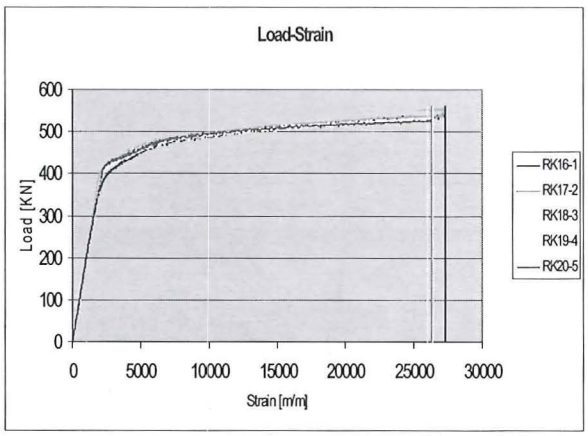
	ε_{Fmax} [m/m]
RK09-1	28370.70
RK10-2	27930.60
RK11-3	28013.10
RK12-4	28233.20
RK13-5	27866.40

Figure 9.4: Test specimen face with the position of the strain gauges 8 to 14.

SPECIMEN 1C1



	ε_{Fmax} [m/m]
RK15	27343.80
RK21	27063.40



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	ε_{Fmax} [m/m]
RK16-1	27248.00
RK17-2	27160.40
RK18-3	26371.80
RK19-4	25968.30
RK20-5	26280.10

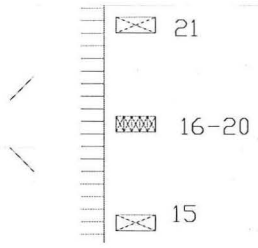
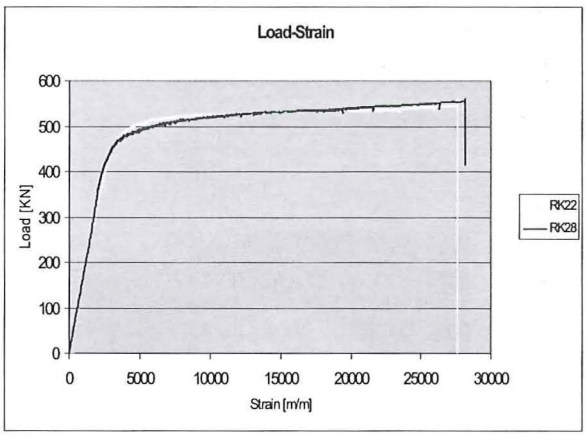


Figure 9.5: Drawing of the test specimen face with the position of the strain gauges 15 to 21.



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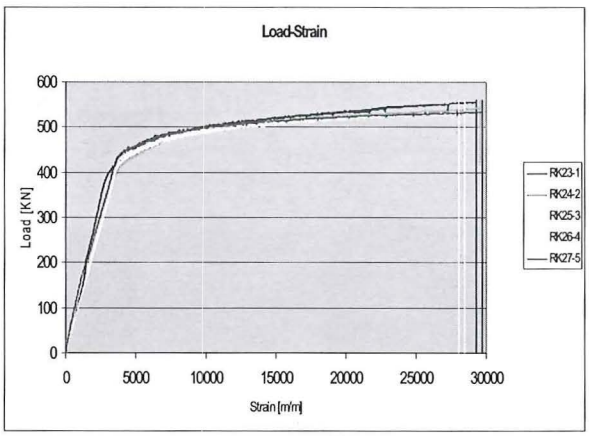
	ε_{Fmax} [m/m]
RK22	27642.80
RK28	28138.10



	ε_{Fmax} [m/m]
RK23-1	29287.70
RK24-2	29516.90
RK25-3	28040.60
RK26-4	28462.40
RK27-5	29663.70

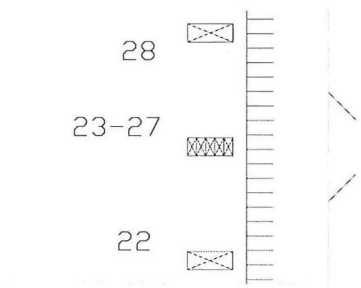
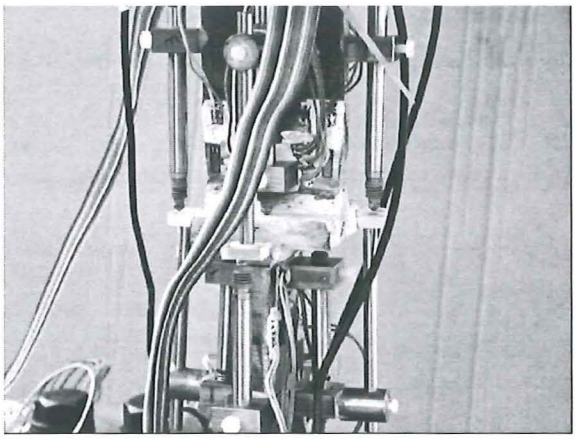
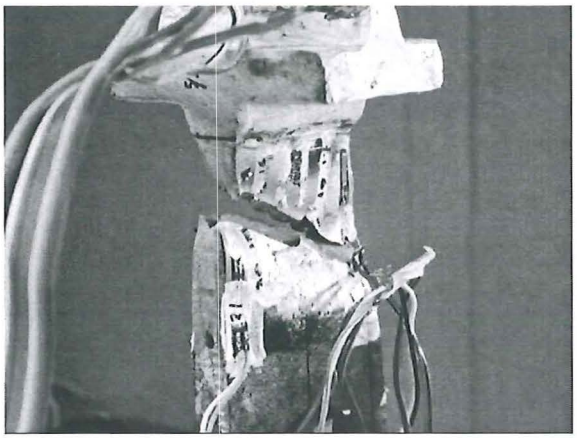


Figure 9.6: Test specimen face with the position of the strain gauges 22 to 28.

SPECIMEN 1C1





Figures 9.7 and 9.8: Test specimen during the test and after failure.

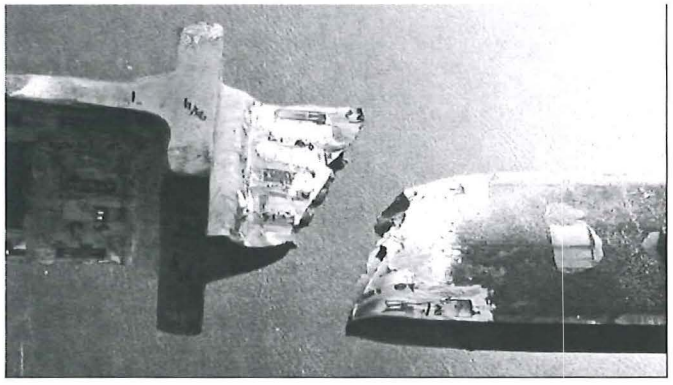
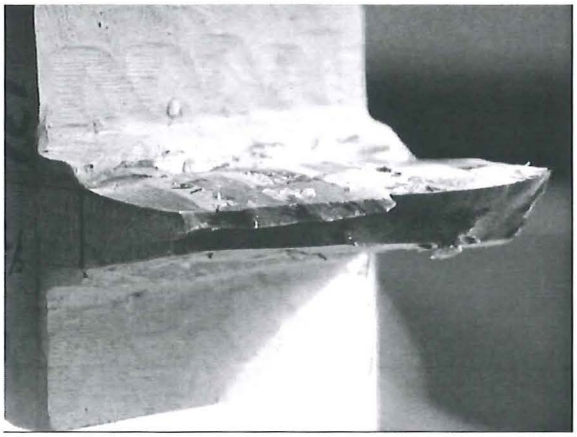


Figure 9.9: Failure of the test specimen in one of the plates.



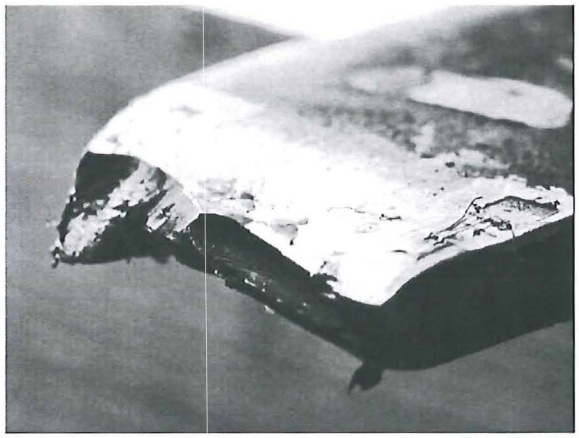


Figure 9.10 and 9.11: Detailed views of both parts of the failed plate.

SPECIMEN 1C2

Table 1C2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1C2 (10)
	Type of specimen	X-joint with high SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1C
Test	Type of test	Fatigue
	Parameter	Reference
	Remark	High SCF
	Failure	Weld

SPECIMEN 1C2

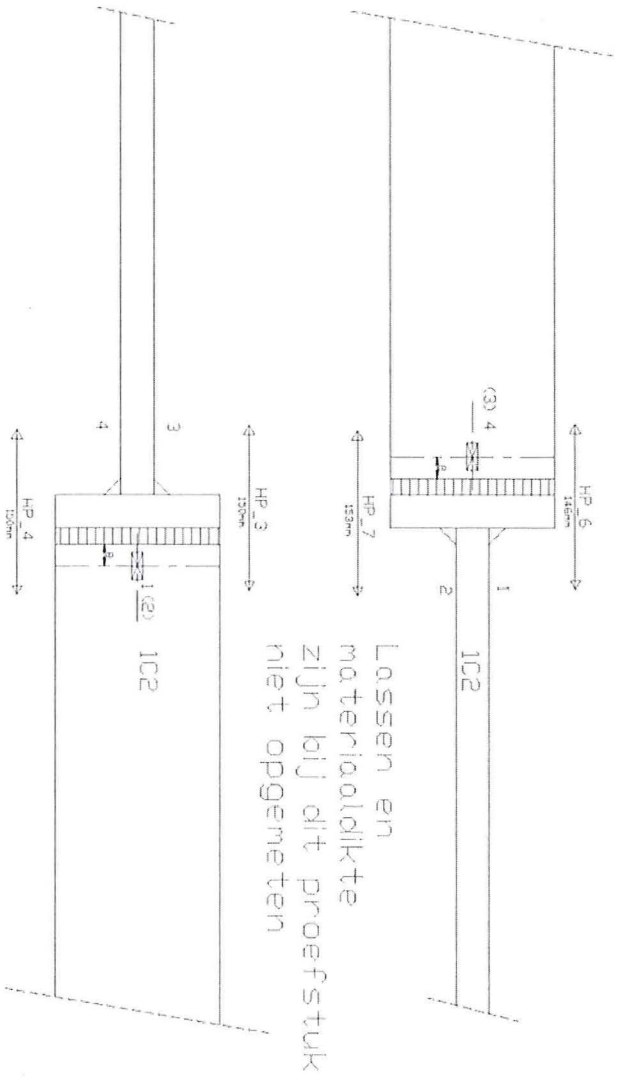


Figure 1C2-1: Dimensions of the test specimen

Figure 1C2-2: Dimensions of the welds

Figure 1C2-3: Position of strain gauges and LVDT's

SPECIMEN 1C2

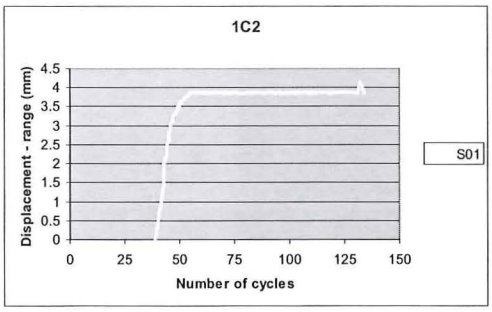


Figure 1C2-4: Test displacement controlled (range)

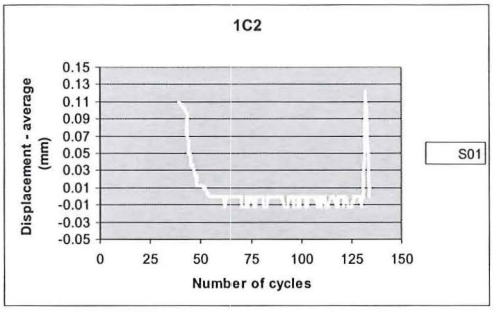


Figure 1C2-5: Test displacement controlled (average)

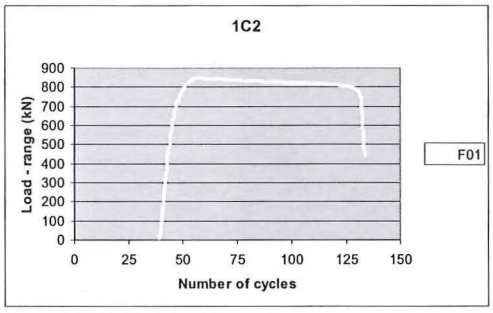


Figure 1C2-6: Test load (range)

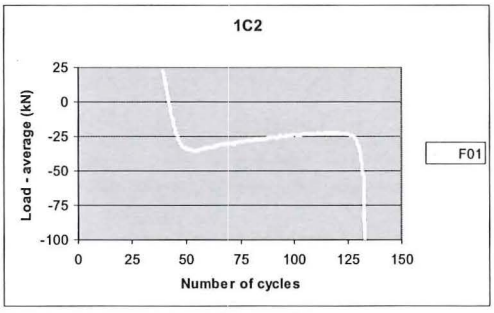


Figure 1C2-7: Test load (average)

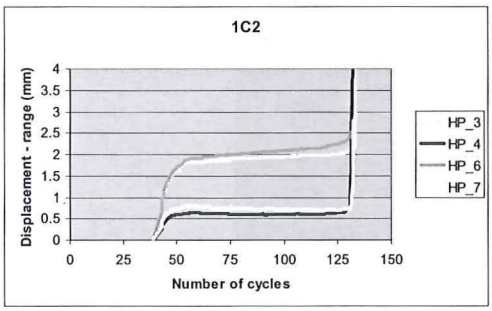


Figure 1C2-8: Deformation whole connection (range)

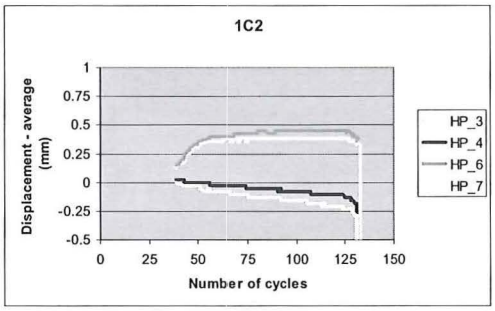


Figure 1C2-9: Deformation whole connection (average)

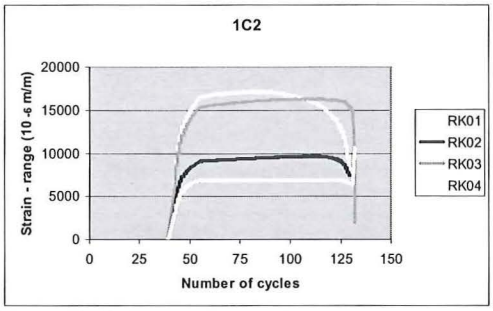


Figure 1C2-9: Measured strains (range)

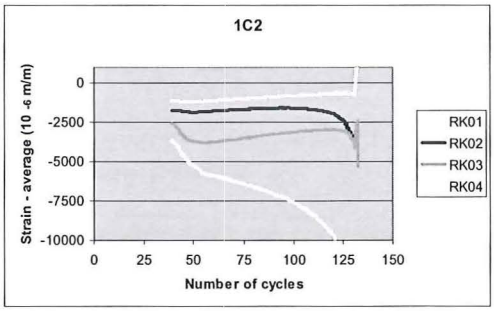


Figure 1C2-10: Measured strains (average)

SPECIMEN 1C2

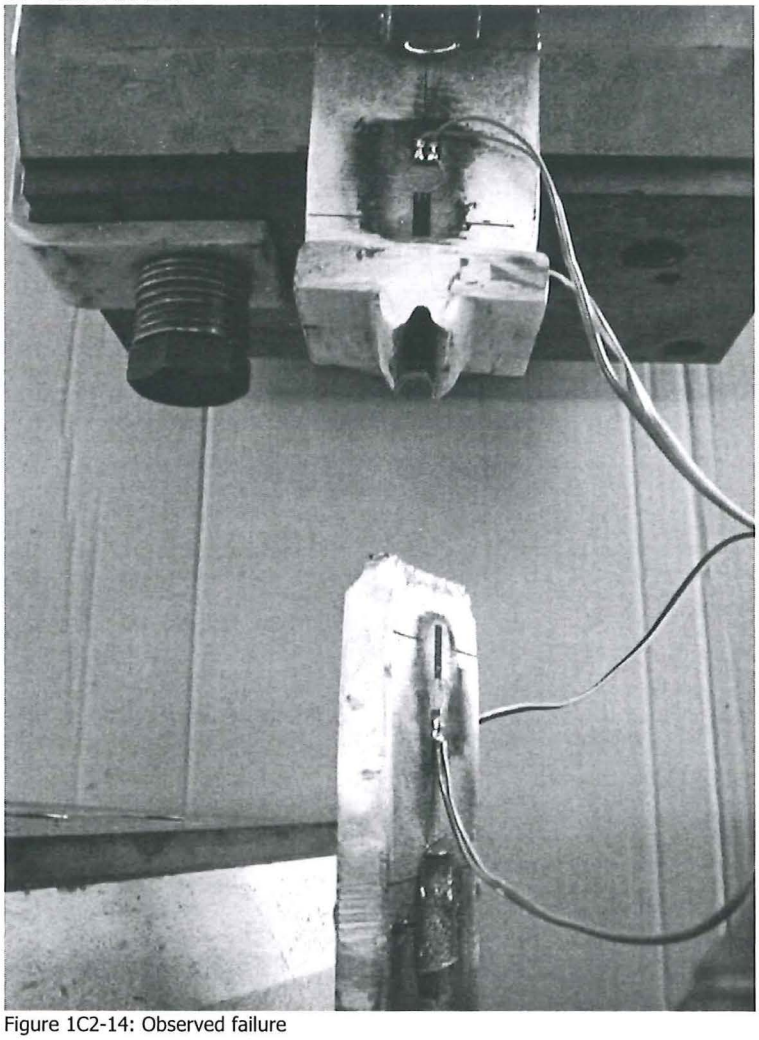


Figure 1C2-14: Observed failure

SPECIMEN 1C3

Table 1C3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1C3 (11.1)
	Type of specimen	X-joint with high SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1C
Test	Type of test	Fatigue
	Parameter	Reference
	Remark	High SCF
	Failure	**Test overloaded**

SPECIMEN 1C4

Table 1C4-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1C4 (12)
	Type of specimen	X-joint with high SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1C
Test	Type of test	Ratcheting
	Parameter	Reference
	Remark	High SCF
	Failure	Plate

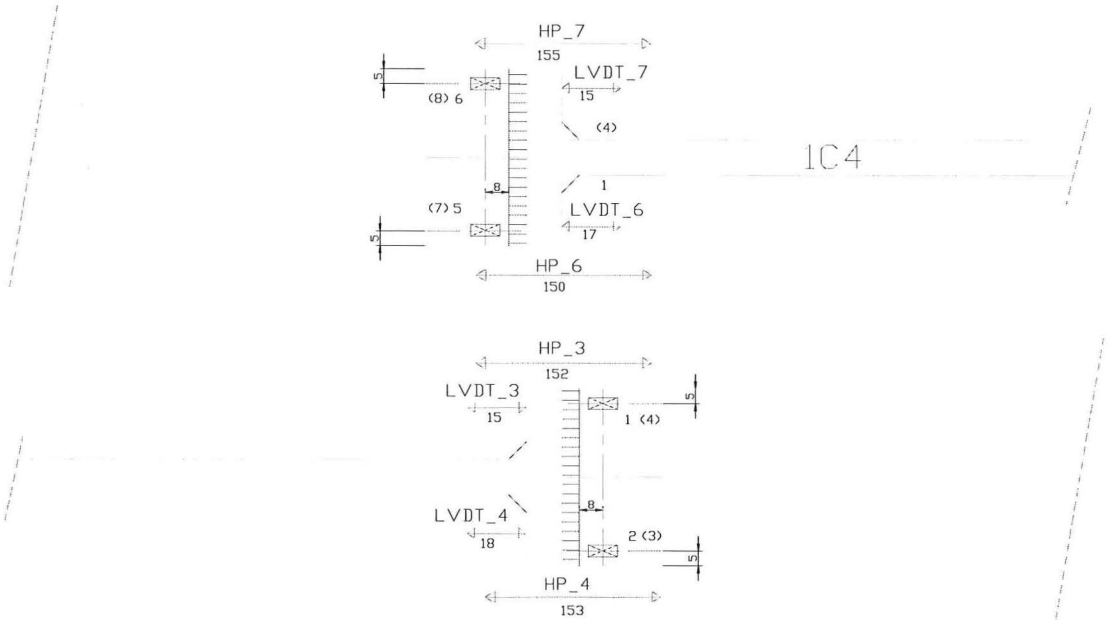


Figure 12.1: Top views of the test specimen with the position of the strain gauges and sizes of the measuring equipment.

SPECIMEN 1C4

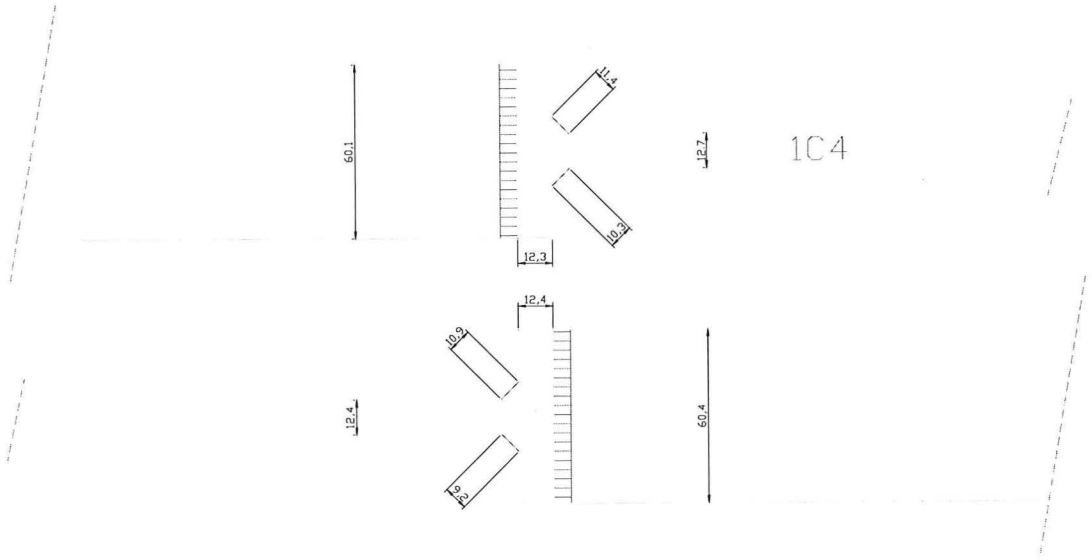
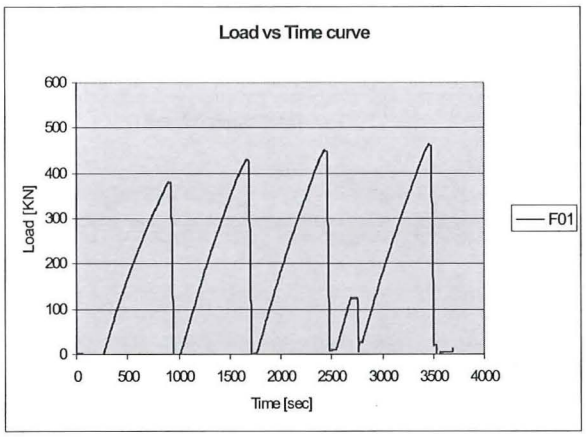
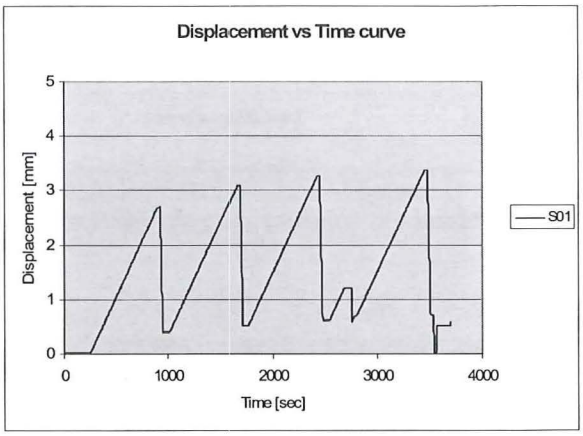


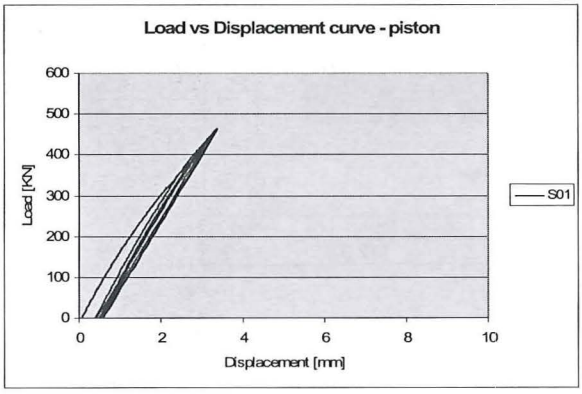
Figure 12.2: Side views, with the sizes of the welds.

SPECIMEN 1C4



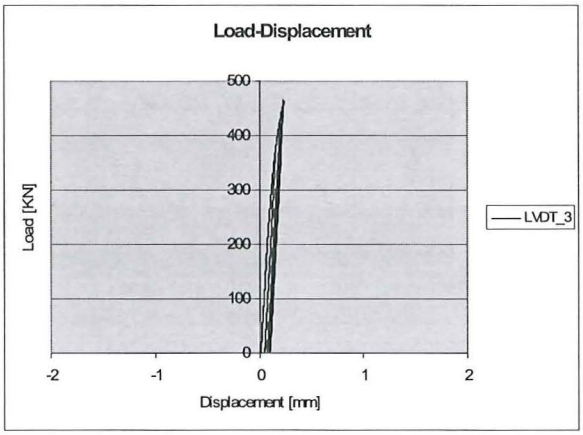


Cycle	Time [sec]	Peak Force [KN]	Displacement [mm]
1	926	380	2.70
2	1666	430	3.09
3	2437	451	3.27
4	2759	124	1.21
5	3454	464	3.38

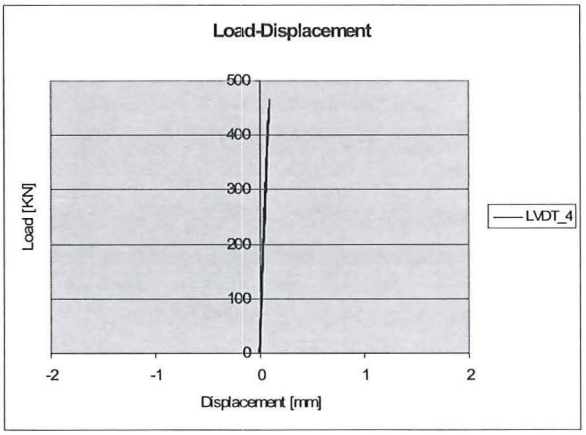


F_{max} [KN]	464
S_{Fmax} [mm]	3.38
S_{max} [mm]	3.38

SPECIMEN 1C4

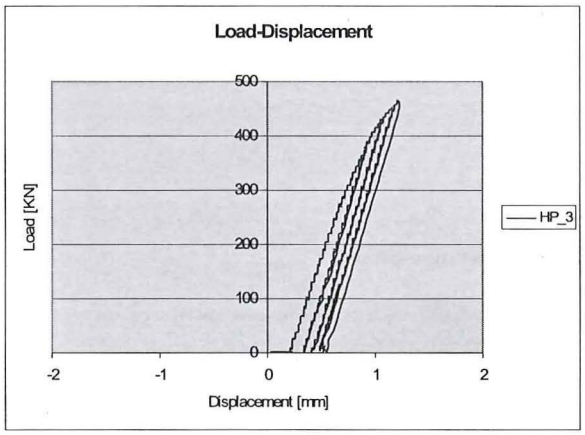


	Range [mm]	S_{Fmax} [mm]
LVDT_3	15.0	0.23

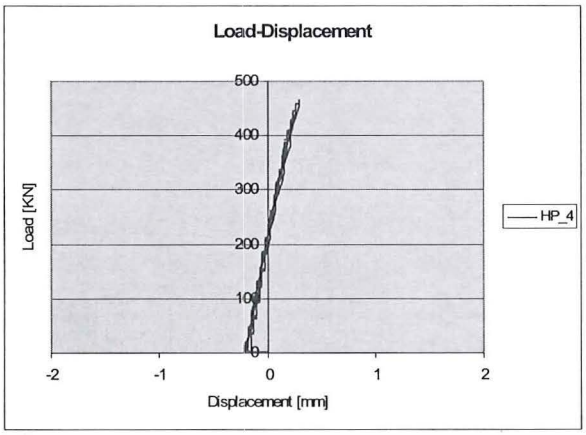


	Range [mm]	S_{Fmax} [mm]
LVDT_4	18.0	0.09

Measuring Error

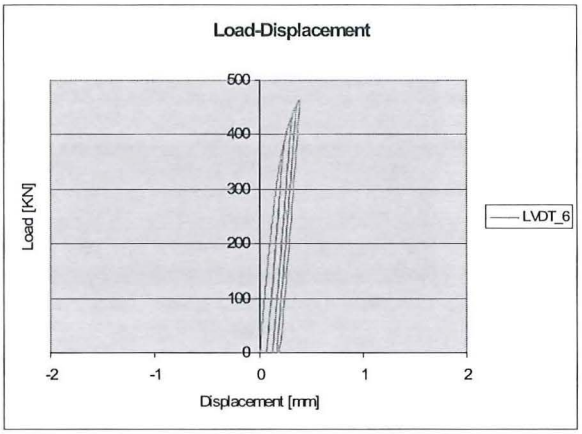


	Range [mm]	S_{Fmax} [mm]
HP_3	152.0	1.21

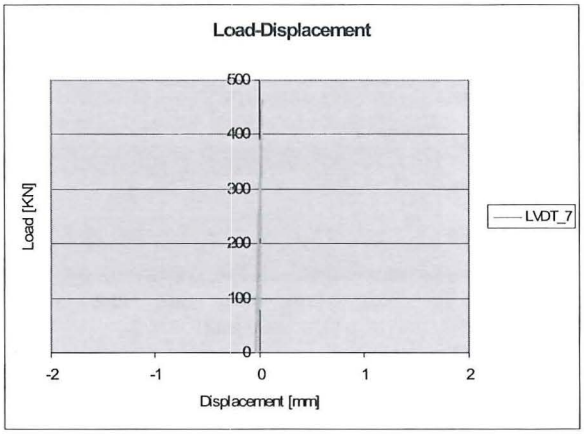


	Range [mm]	S_{Fmax} [mm]
HP_4	153.0	0.29

SPECIMEN 1C4

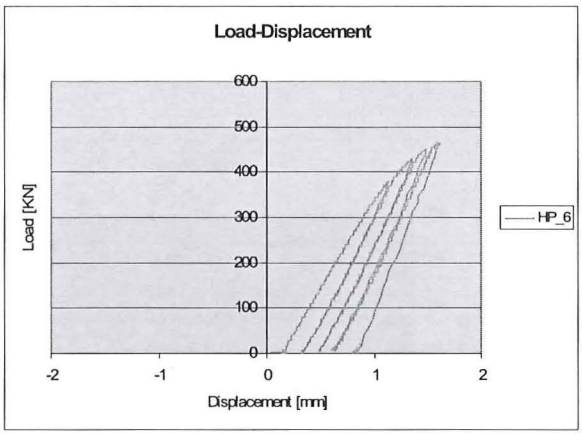


	Range [mm]	S_{Fmax} [mm]
LVDT_6	17.0	0.38

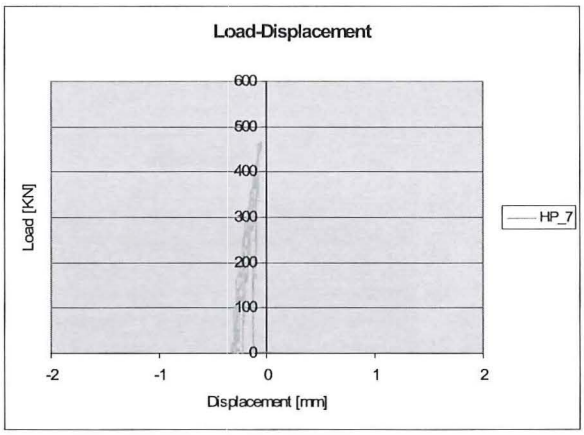


	Range [mm]	SFmax [mm]
LVDT_7	15.0	0.03

Measuring Error

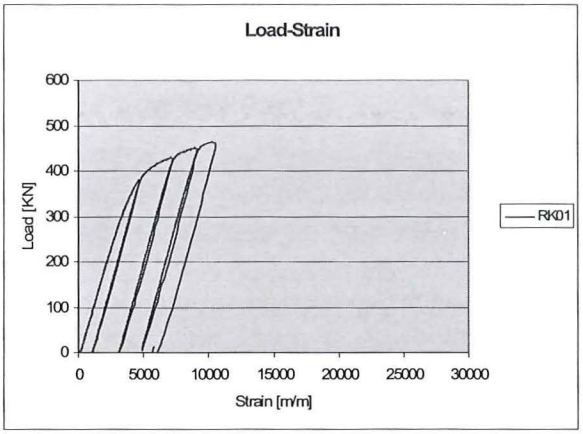


	Range [mm]	S_{Fmax} [mm]
HP_6	150.0	1.59

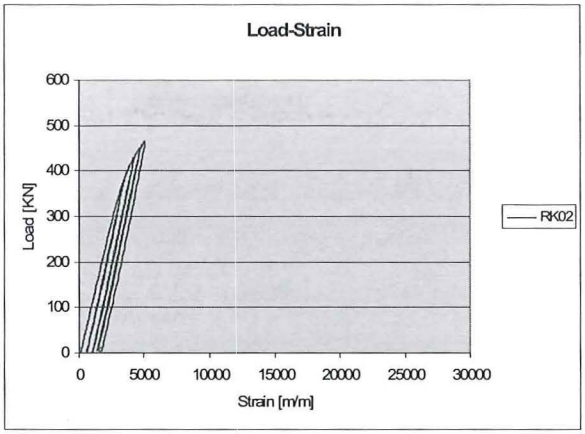


	Range [mm]	S_{Fmax} [mm]
HP_7	155.0	-0.05

SPECIMEN 1C4



	ε_{Fmax} [m/m]
RK01	10237.70



	ε_{Fmax} [m/m]
RK02	5026.29

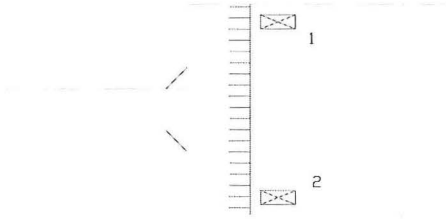
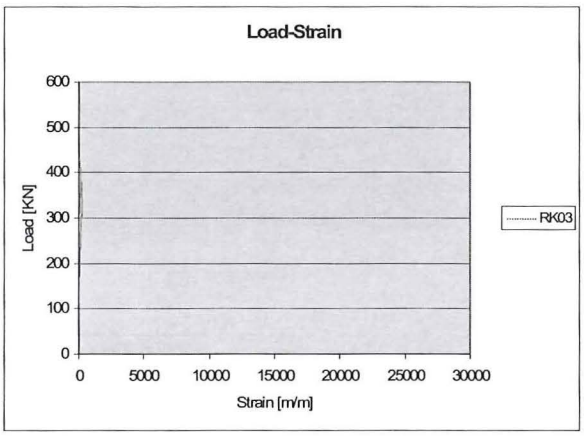
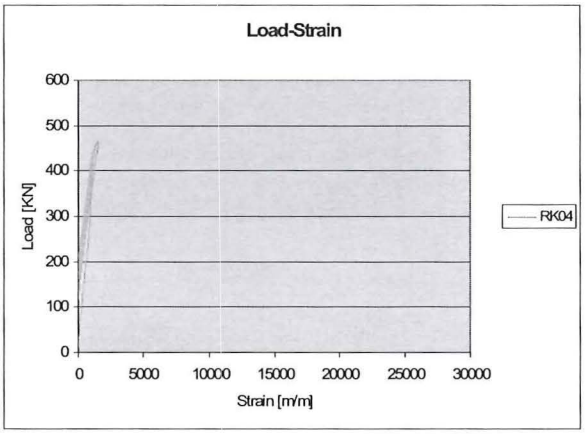


Figure 12.3: Test specimen face with the position of the strain gauges 1 and 2.



	ε_{Fmax} [m/m]
RK03	Measuring Error



	ε_{Fmax} [m/m]
RK04	1508.81

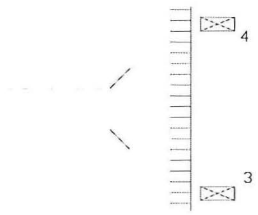
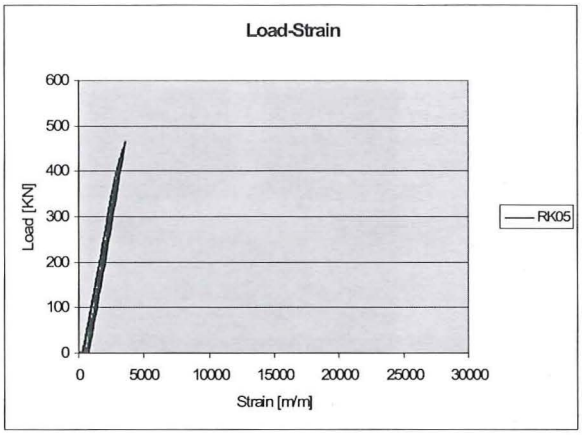
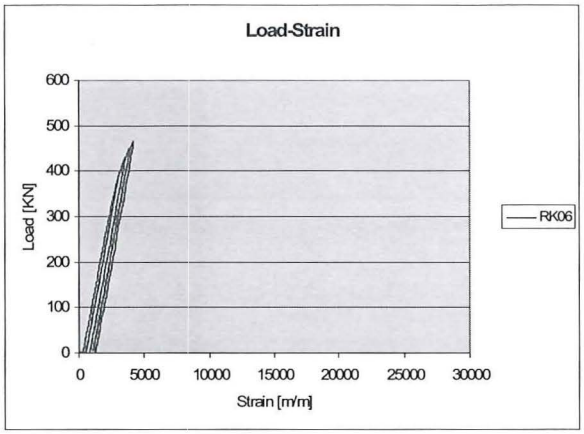


Figure 12.4: Test specimen face with the position of the strain gauges 3 and 4.

SPECIMEN 1C4



	ε_{Fmax} [m/m]
RK05	3573.02



	ε_{Fmax} [m/m]
RK06	4165.43

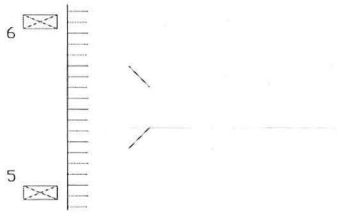
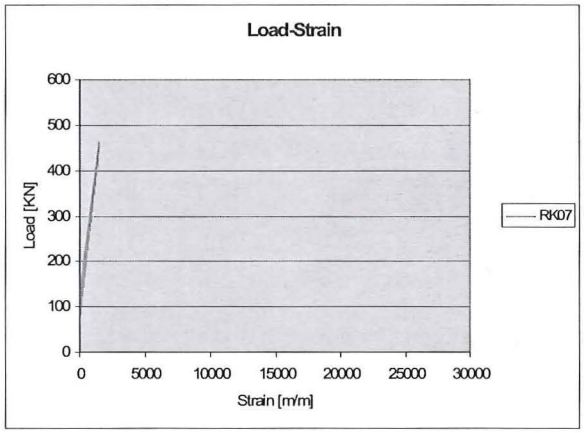
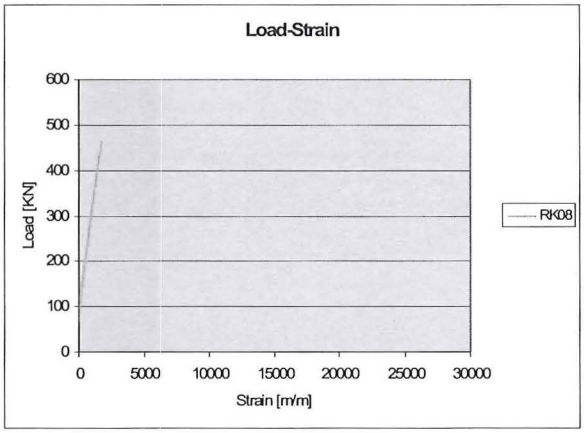


Figure 12.5: Test specimen face with the position of the strain gauges 5 and 6.



	ε_{Fmax} [m/m]
RK07	1481.04



	ε_{Fmax} [m/m]
RK08	1749.48

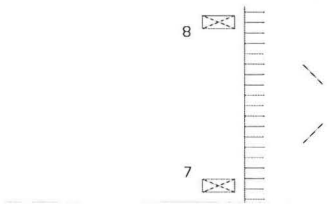


Figure 12.6: Test specimen face with the position of the strain gauges 7 and 8.

SPECIMEN 1C4

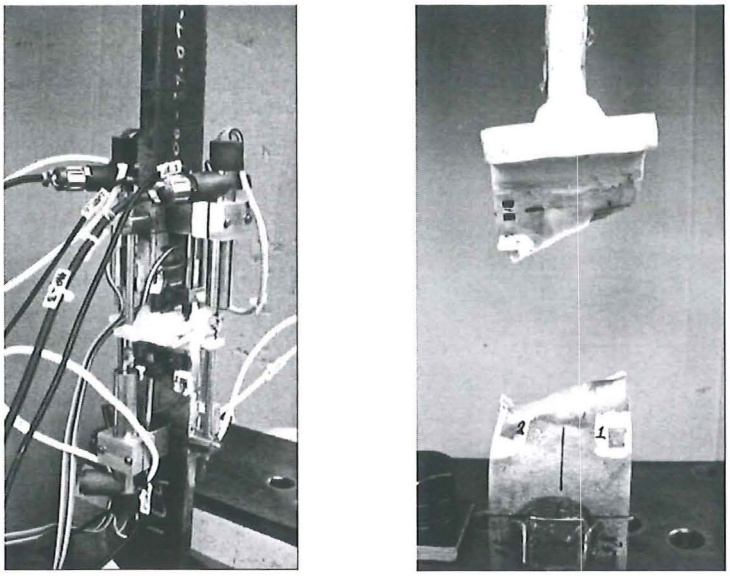


Figure 12.7: Test specimen during the test and after failure.

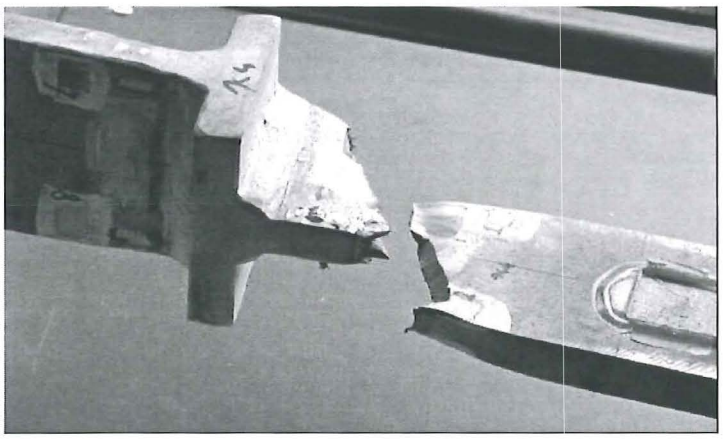
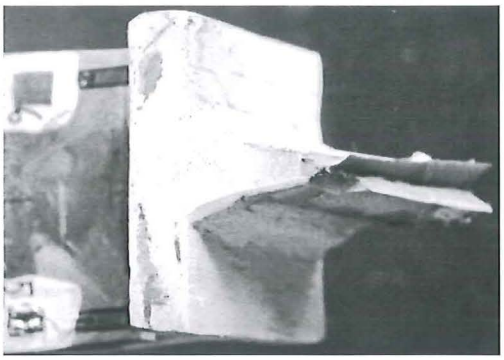
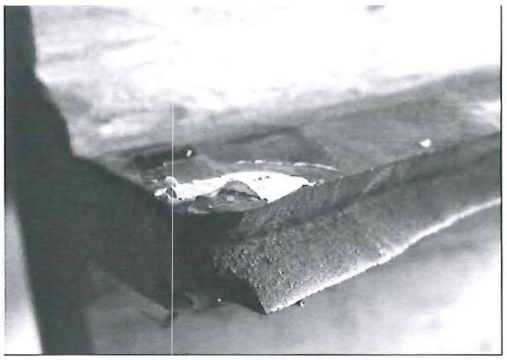
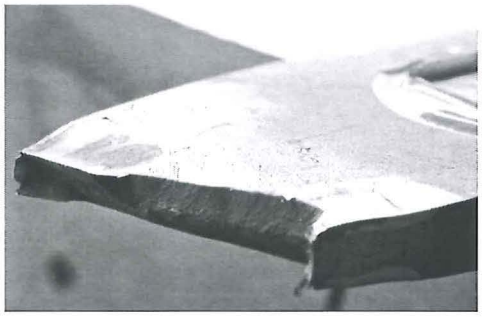


Figure 12.8: View of the failed test specimen (failure in the plate).

SPECIMEN 1C4







Figures 12.9 to 12.12: Detailed views of both parts of the failed plate.

SPECIMEN 1C5

Table 1C5-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	1C5 (11.2)
	Type of specimen	X-joint with high SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-1C
Test	Type of test	Fatigue
	Parameter	Reference
	Remark	High SCF
	Failure	**Test overloaded**

SPECIMEN 2A1

Table 2A1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2A1 (13)
	Type of specimen	Cross plate connection
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2A
Test	Type of test	Static strength
	Parameter	Thickness effect
	Remark	Fillet welds loaded in shear
	Failure	Plate

SPECIMEN 2A1

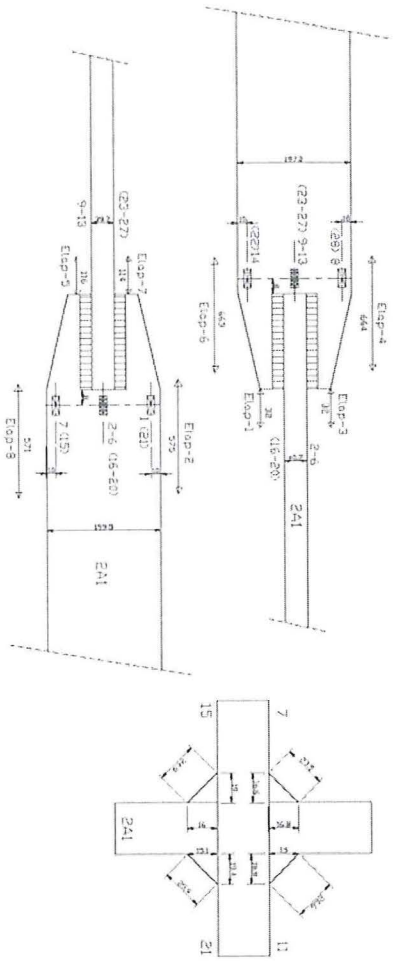


Figure 2A1-1: Dimensions of the test specimen

Figure 2A1-2: Dimensions of the welds

Figure 2A1-2: Position of strain gauges and LVDT's

SPECIMEN 2A1

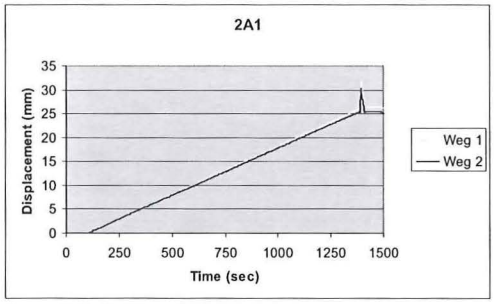


Figure 2A1-3: Test displacement controlled

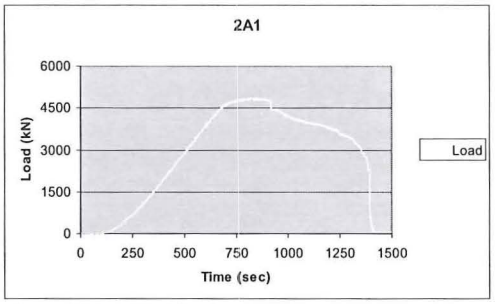


Figure 2A1-4: Test load

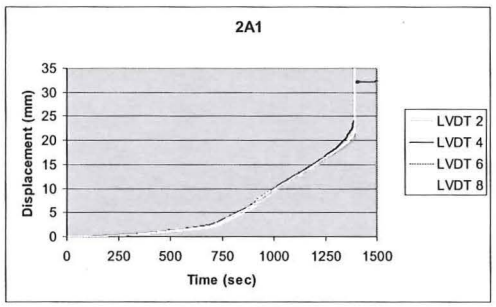


Figure 2A1-5: Deformation of the whole connection

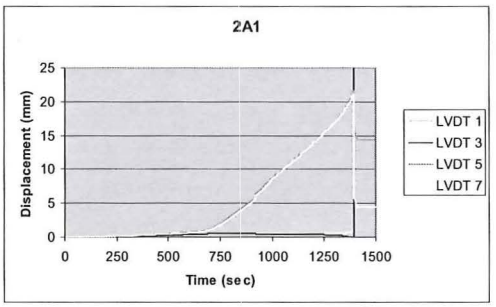


Figure 2A1-6: Local displacements

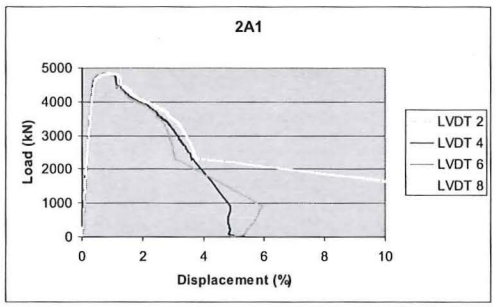


Figure 2A1-7: Relative deformation of the connection

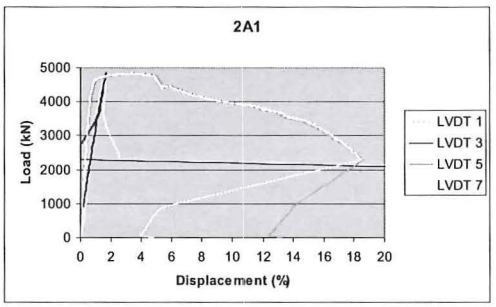


Figure 2A1-8: Relative displacements, locally

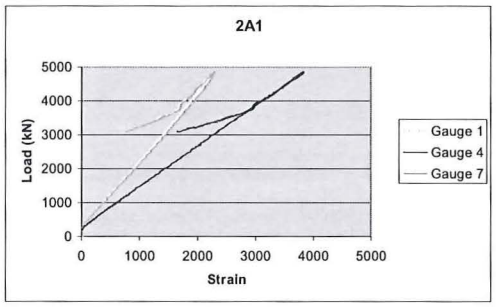


Figure 2A1-9: Measured strains plate 1 side 1

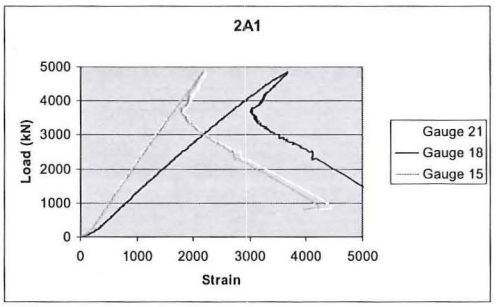


Figure 2A1-10: Measured strains plate 1 side 2

SPECIMEN 2A1

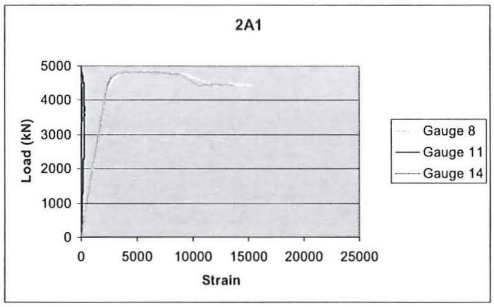


Figure 2A1-11: Measured strains plate 2 side 1

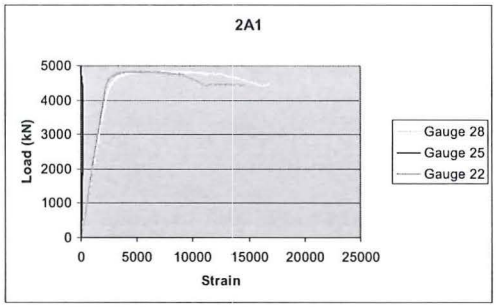


Figure 2A1-12: Measured strains plate 2 side 2

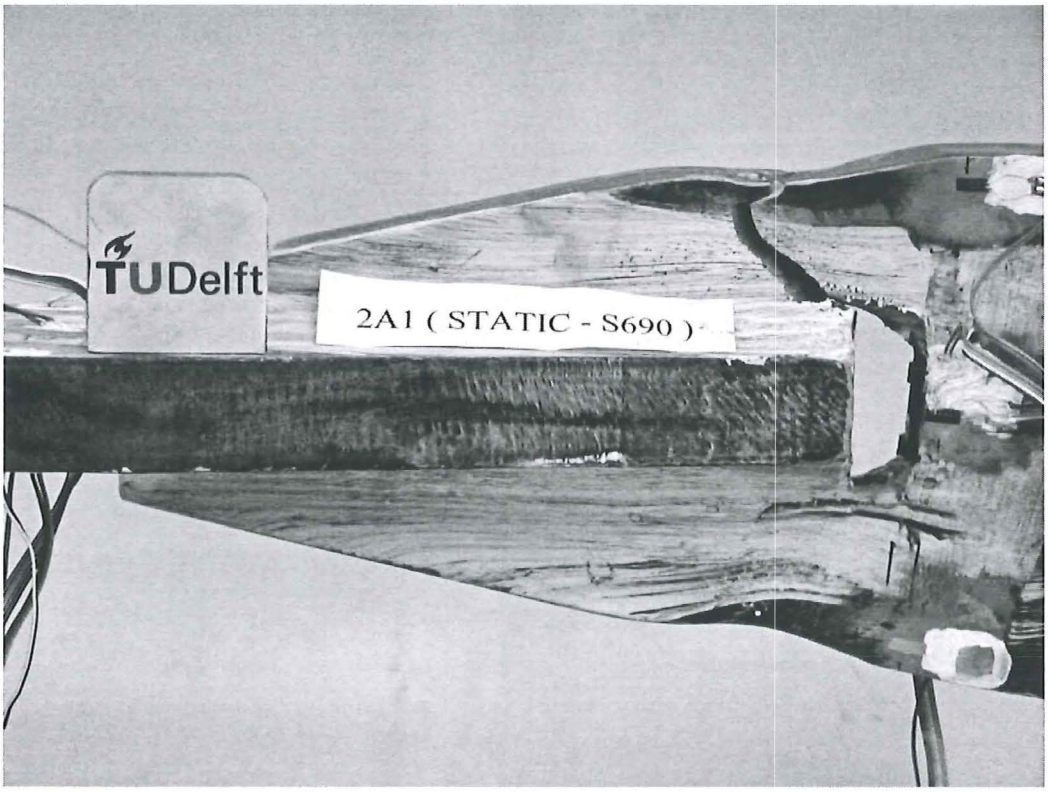


Figure 2A1-13: Observed failure in plate 2

SPECIMEN 2A1

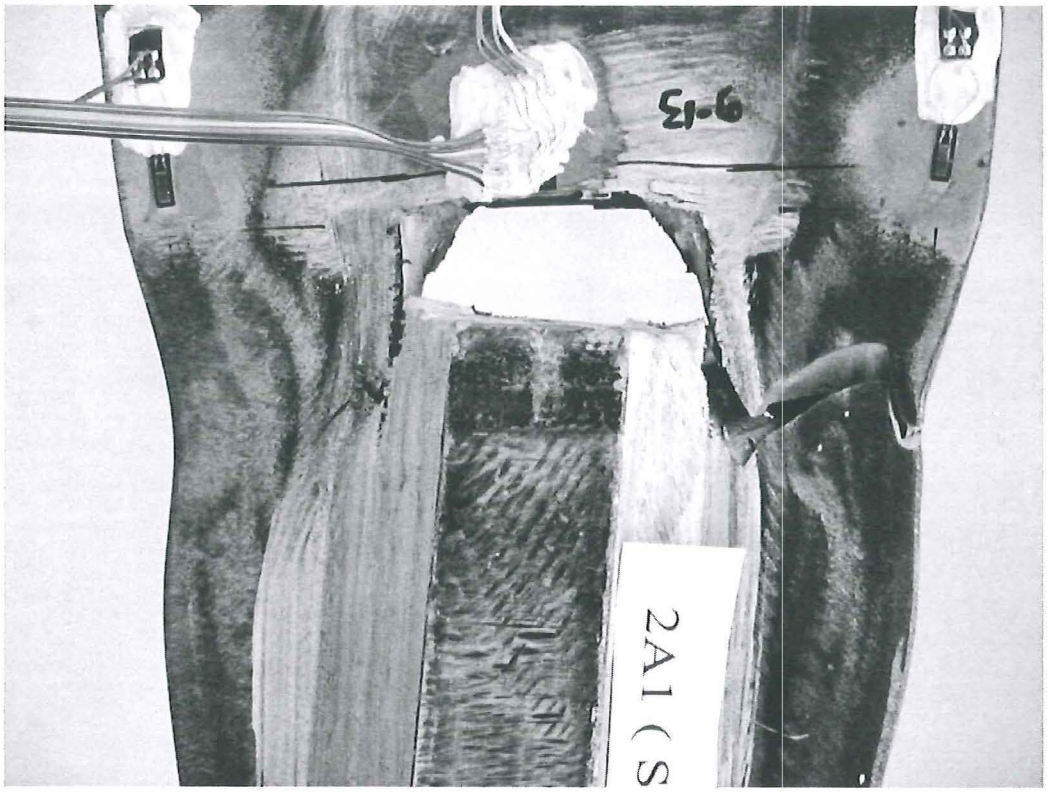


Figure 2A1-14: Observed failure in plate 2

SPECIMEN 2A2

Table 2A2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2A2 (14)
	Type of specimen	Cross plate connection
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2A
Test	Type of test	Fatigue
	Parameter	Thickness effect
	Remark	Fillet welds loaded in shear
	Failure	Plate

SPECIMEN 2A2

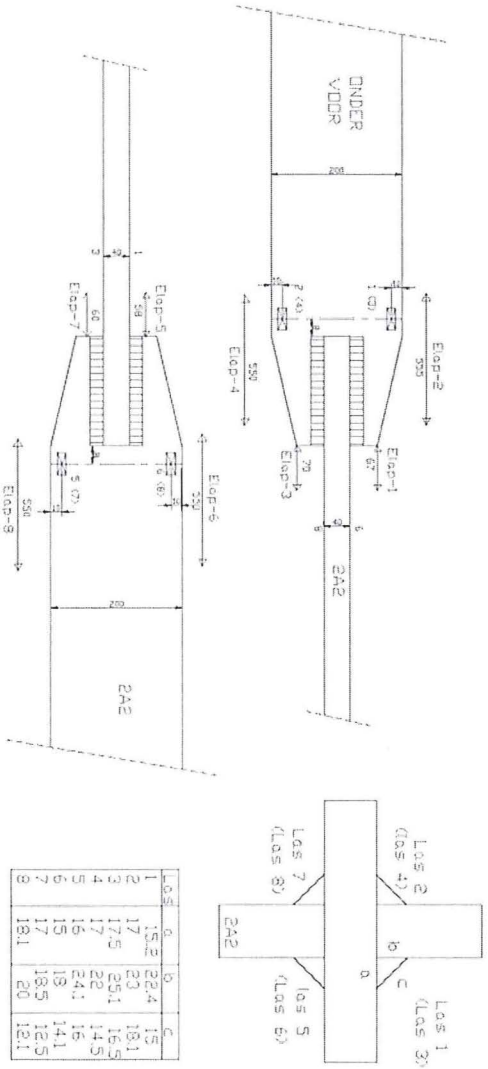


Figure 2A2-1: Dimensions of the test specimen

Figure 2A2-2: Dimensions of the welds

Figure 2A2-3: Position of strain gauges and LVDT's

SPECIMEN 2A2

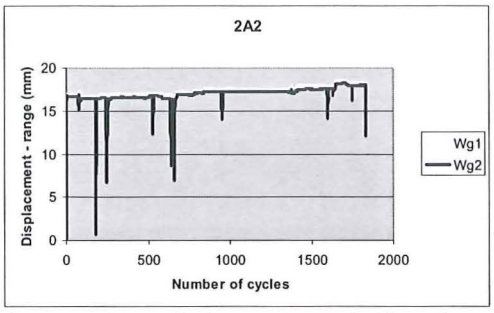


Figure 2A2-4: Test displacement controlled (range)

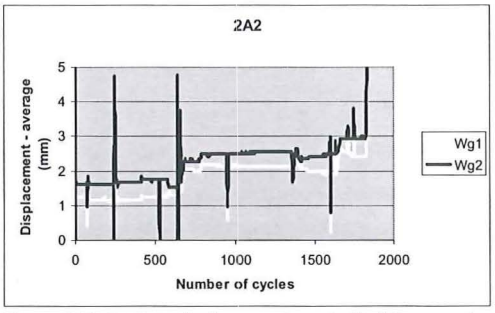


Figure 2A2-5: Test displacement controlled (average)

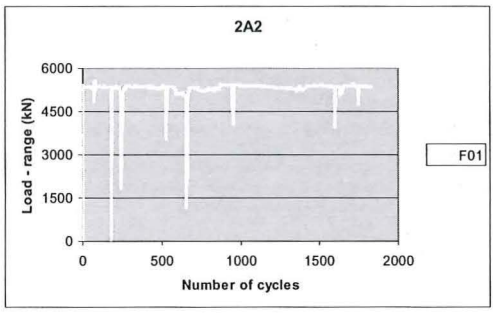


Figure 2A2-6: Test load (range)

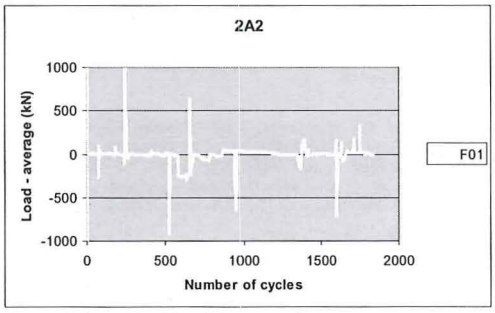


Figure 2A2-7: Test load (average)

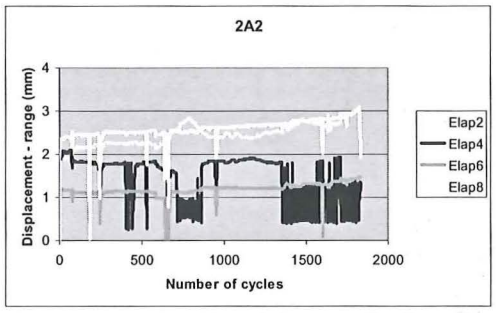


Figure 2A2-8: Deformation whole connection (range)

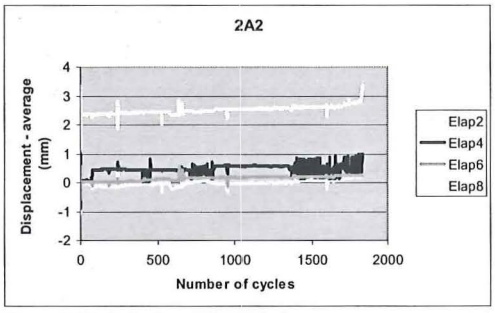


Figure 2A2-9: Deformation whole connection (average)

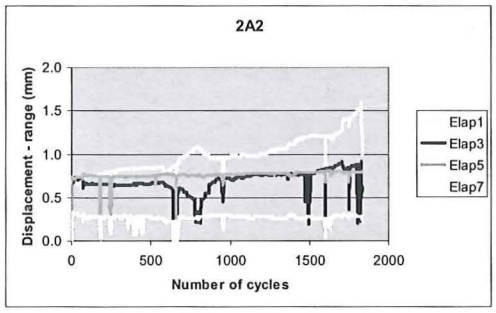


Figure 2A2-10: Local deformation (range)

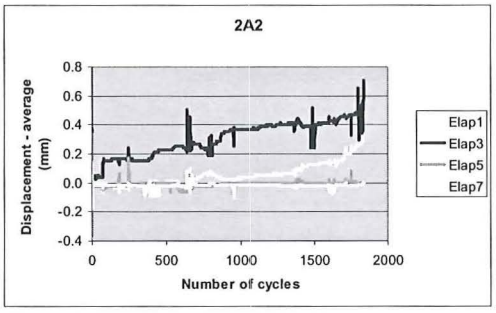


Figure 2A2-11: Local deformation (average)

SPECIMEN 2A2

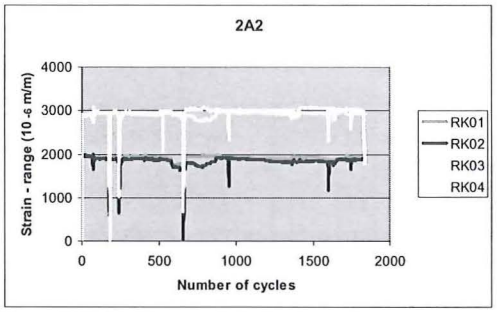


Figure 2A2-12: Measured strains (range)

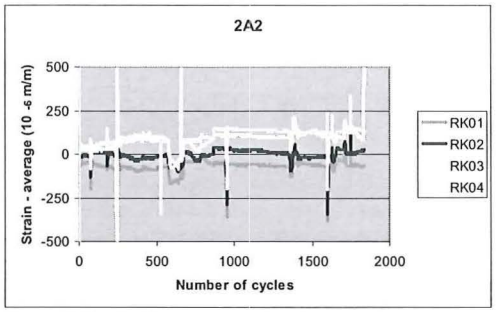


Figure 2A2-13: Measured strains (average)

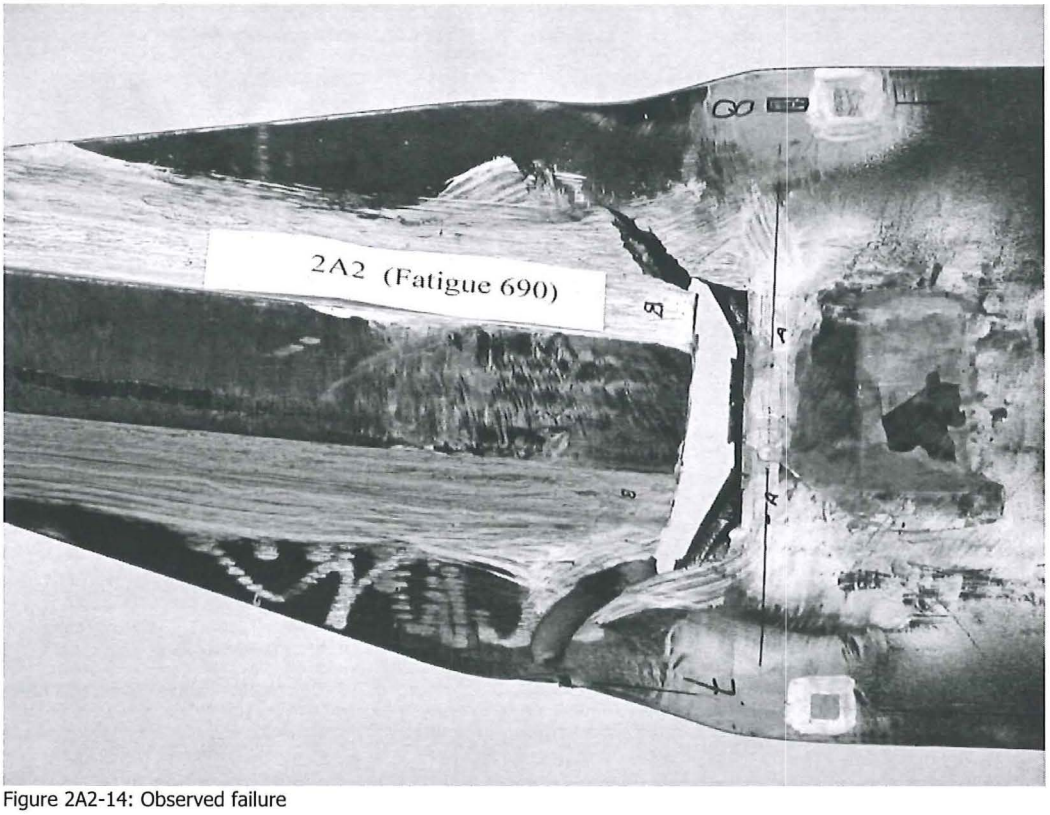


Figure 2A2-14: Observed failure

SPECIMEN 2A3

Table 2A3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2A3 (15)
	Type of specimen	Cross plate connection
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2A
Test	Type of test	Ratcheting
	Parameter	Thickness effect
	Remark	Fillet welds loaded in shear
	Failure	Plate

SPECIMEN 2A3

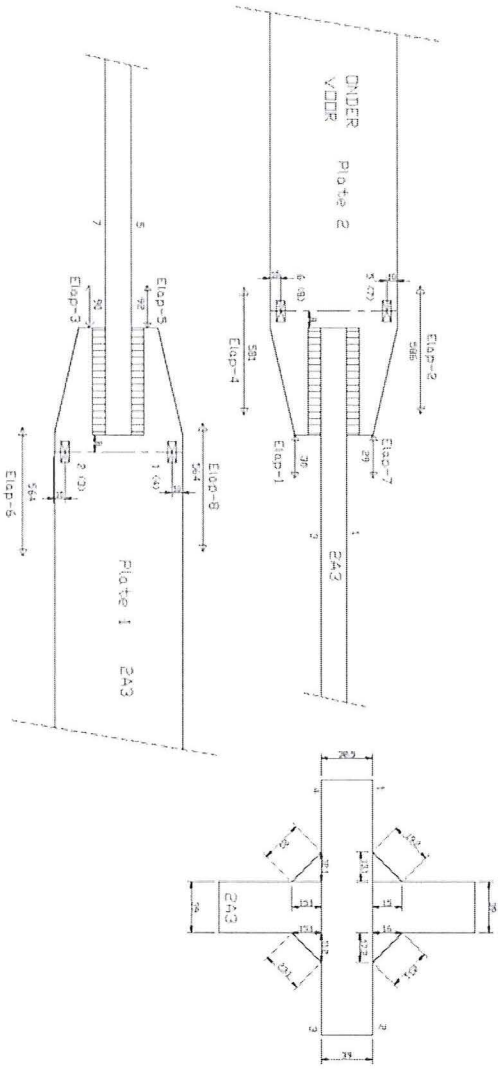


Figure 2A3-1: Dimensions of the test specimen

Figure 2A3-2: Dimensions of the welds

Figure 2A3-3: Position of strain gauges and LVDT's

SPECIMEN 2A3

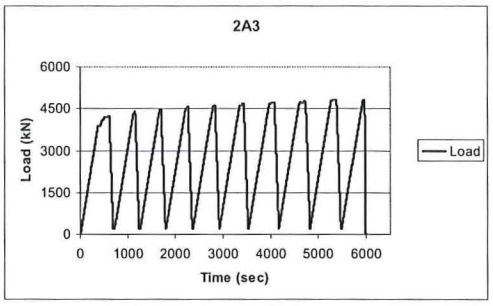


Figure 2A3-4: Test load controlled

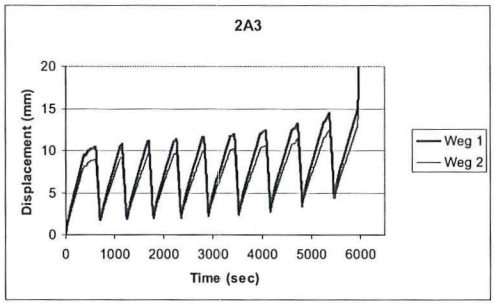
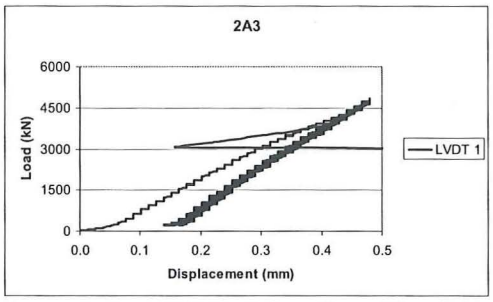


Figure 2A3-5: Total displacements



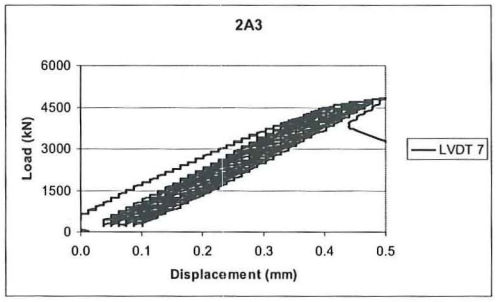
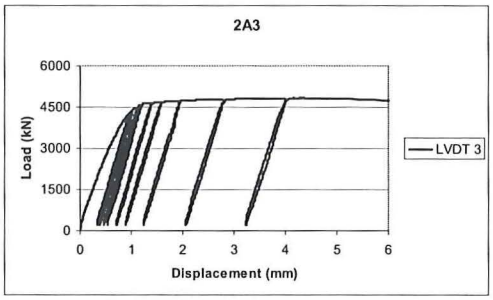


Figure 2A3-6a and 2A3-6b: Deformations of the whole connection (no final failure observed)



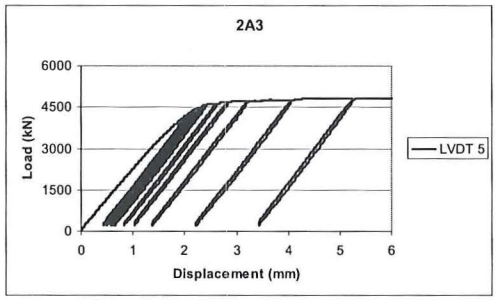


Figure 2A3-7a and 2A3-7b: Local displacements at the failed part of the connection

SPECIMEN 2A3

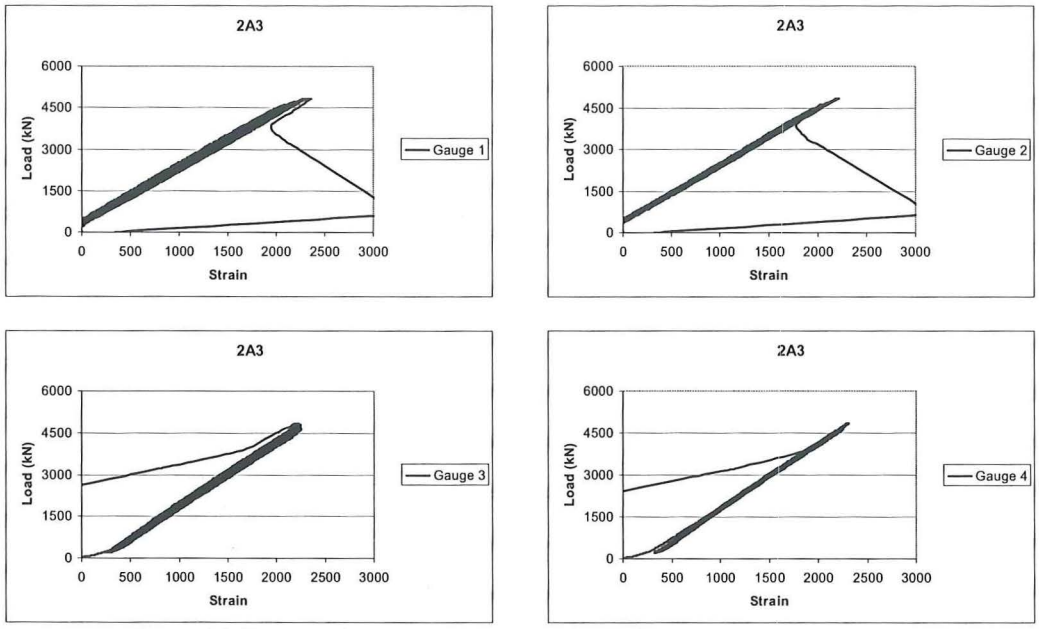


Figure 2A3-7a, b, c and d: Measured strains plate 1 (no failure observed)

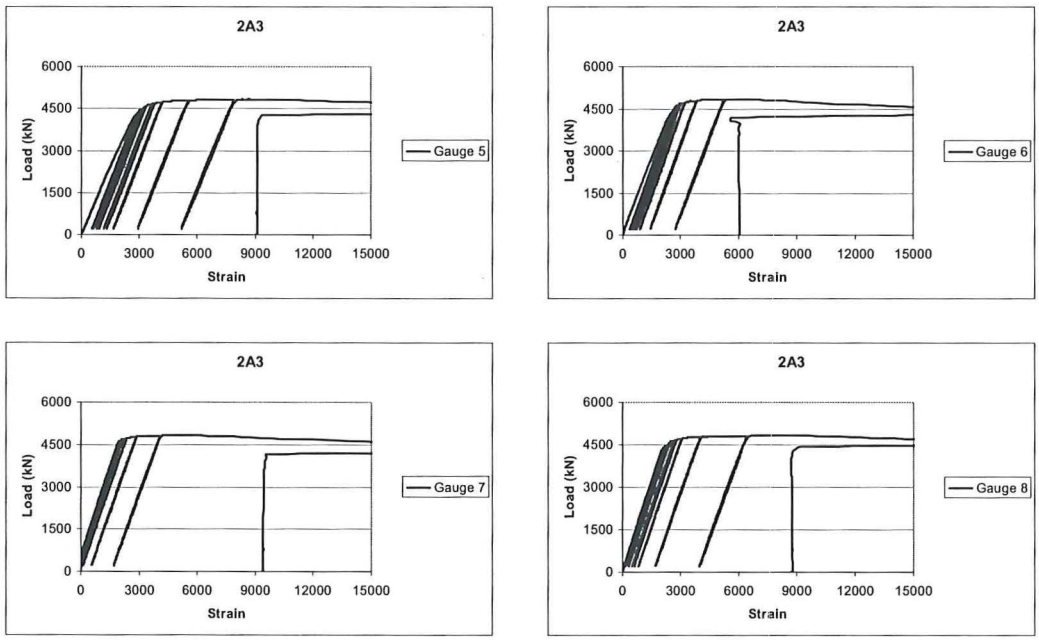


Figure 2A3-8a, b, c and d: Measured strains plate 2 where final failure occurred

SPECIMEN 2A3

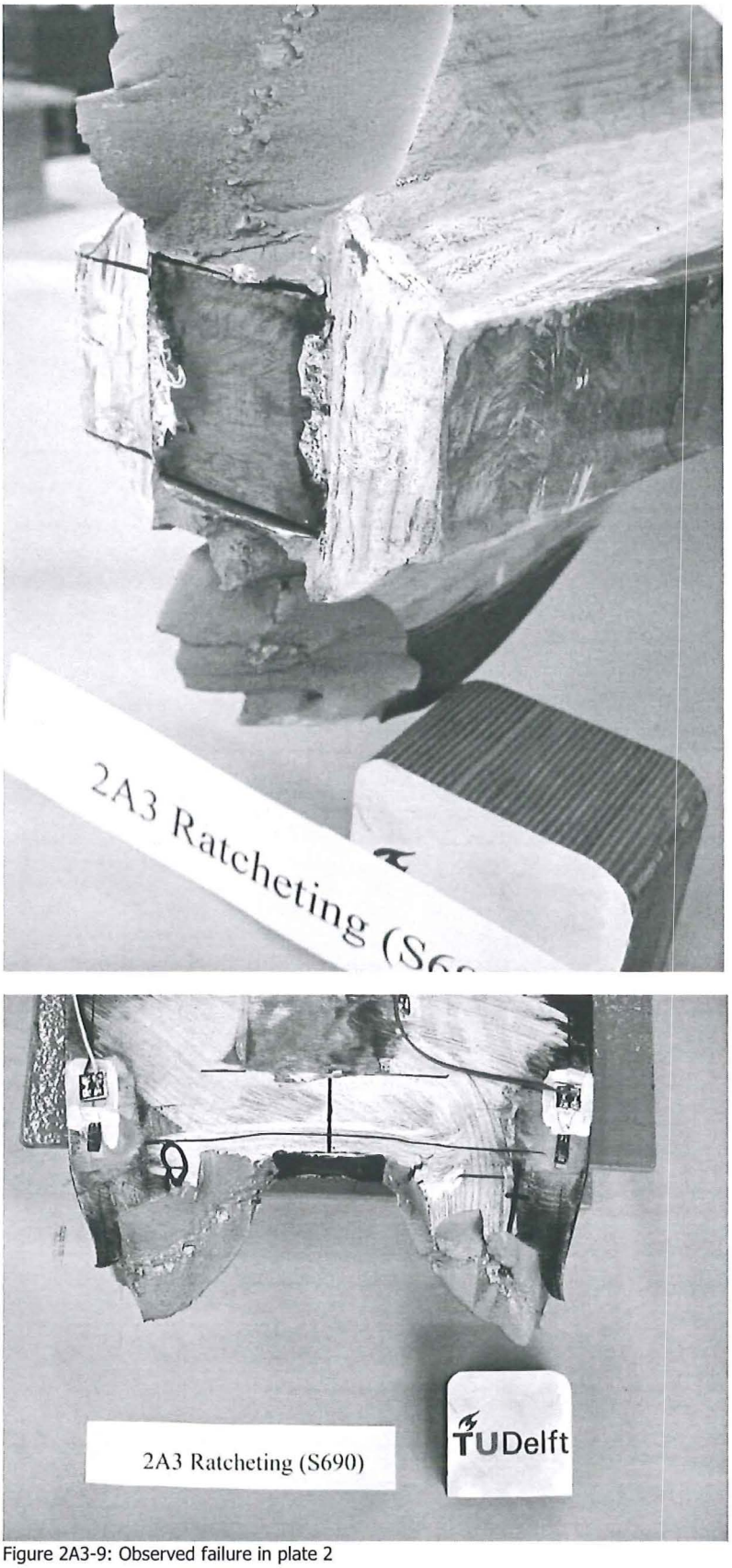


Figure 2A3-9: Observed failure in plate 2

SPECIMEN 2B1

Table 2B1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2B1 (16.1)
	Type of specimen	X-joint with low SCF
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2B
Test	Type of test	Static strength
	Parameter	Thickness effect
	Remark	High SCF
	Failure	**Clamping area**

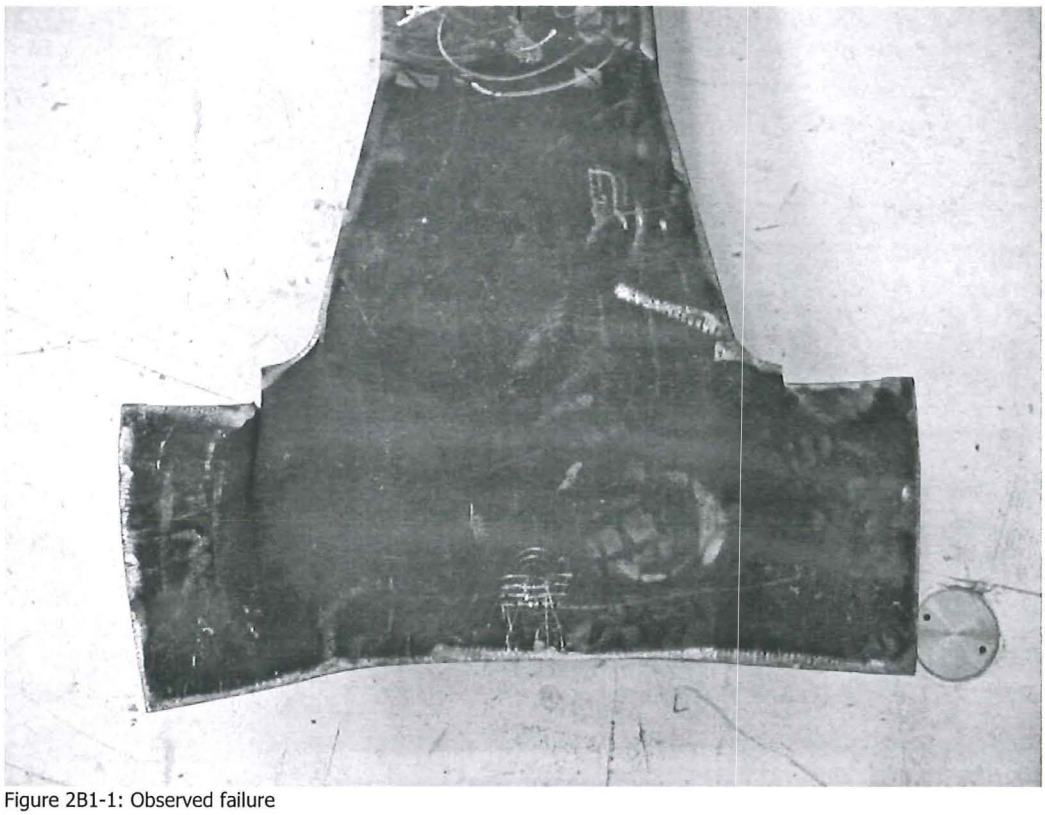


Figure 2B1-1: Observed failure

SPECIMEN 2B2

Table 2B2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2B2 (17)
	Type of specimen	X-joint with low SCF
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2B
Test	Type of test	Fatigue
	Parameter	Thickness effect
	Remark	High SCF
	Failure	**Clamping area**

Figure 2B2-1: Observed failure

SPECIMEN 2B3

Table 2B3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2B3 (18)
	Type of specimen	X-joint with low SCF
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2B
Test	Type of test	Ratcheting
	Parameter	Thickness effect
	Remark	High SCF
	Failure	Plate

SPECIMEN 2B3

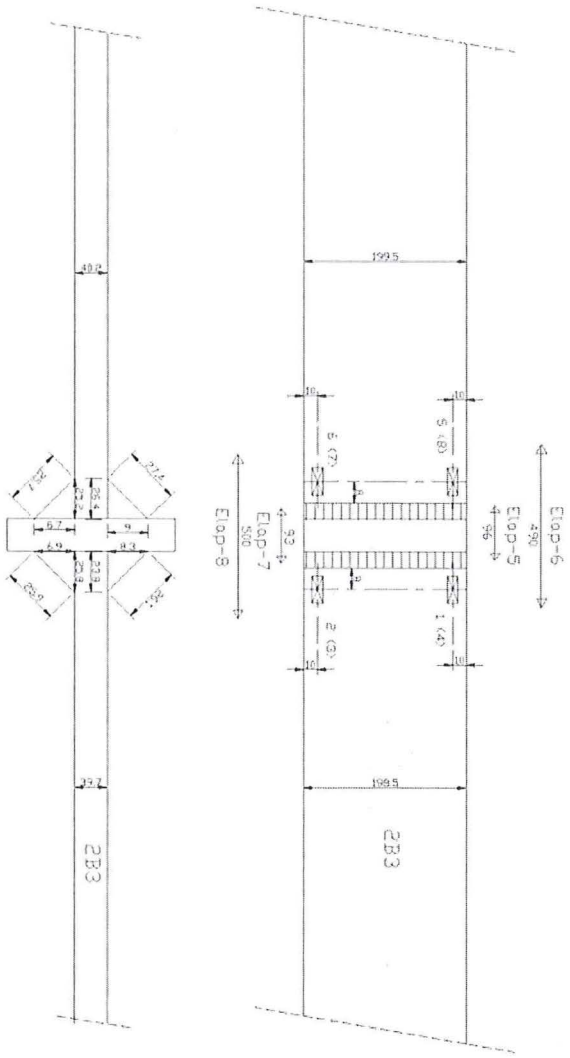


Figure 2B3-1: Dimensions of the test specimen

Figure 2B3-2: Dimensions of the welds

Figure 2B3-3: Position of strain gauges and LVDT's

SPECIMEN 2B3

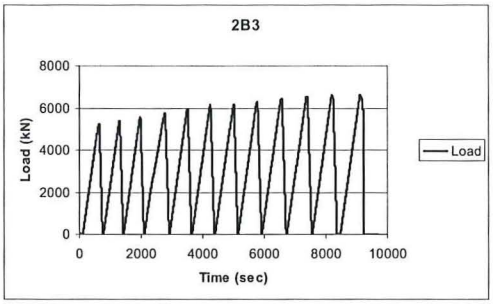


Figure 2B3-4: Test load controlled

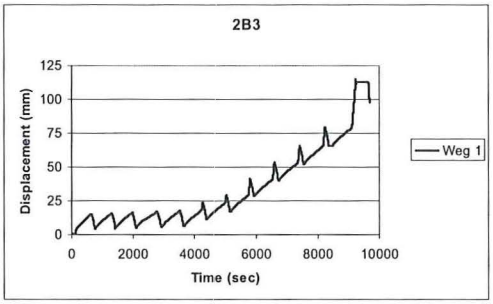
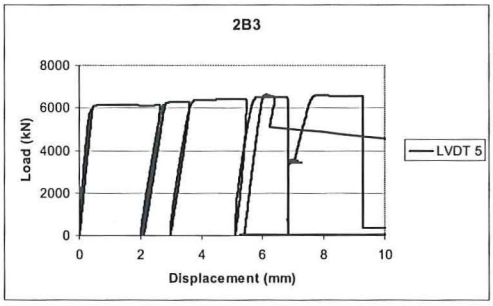


Figure 2B3-4: Total displacements



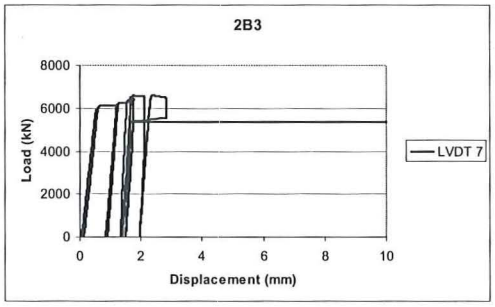
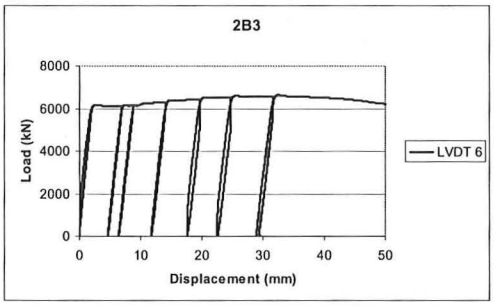


Figure 2B3-5 and 2B3-6: Local deformation of the connection



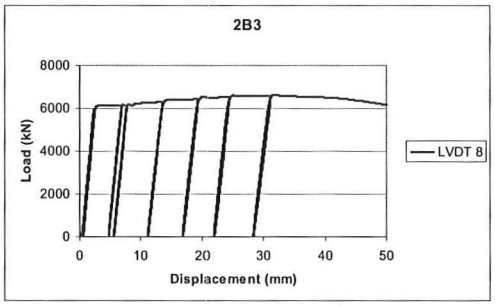


Figure 2B3-7 and 2B3-8: Deformation of the whole connection

SPECIMEN 2B3

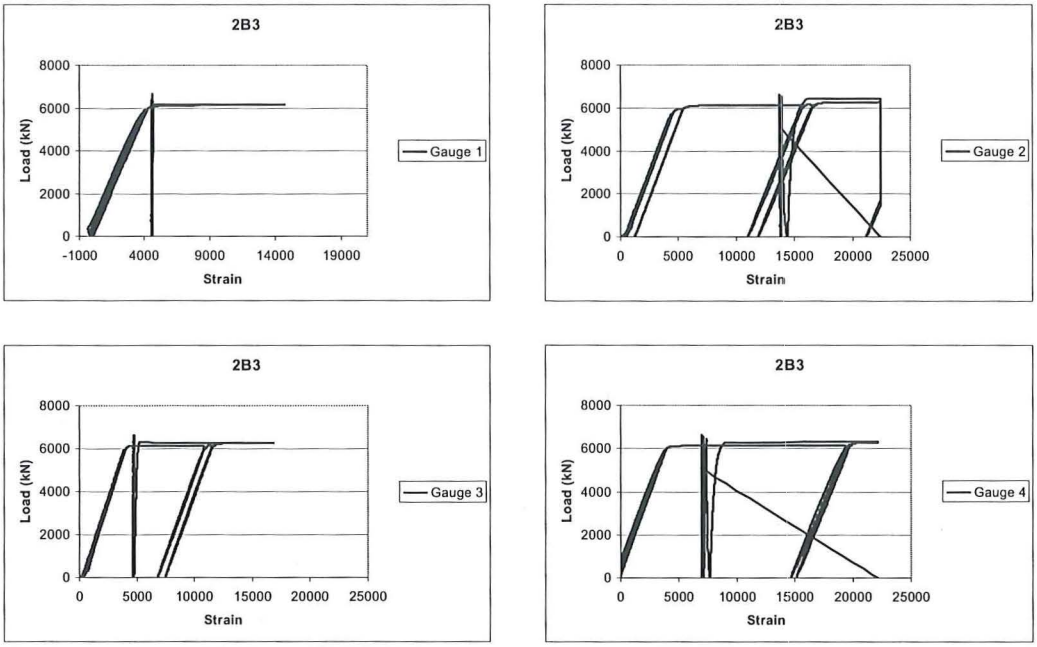


Figure 2B3-9a, b, c and d: Measured strains

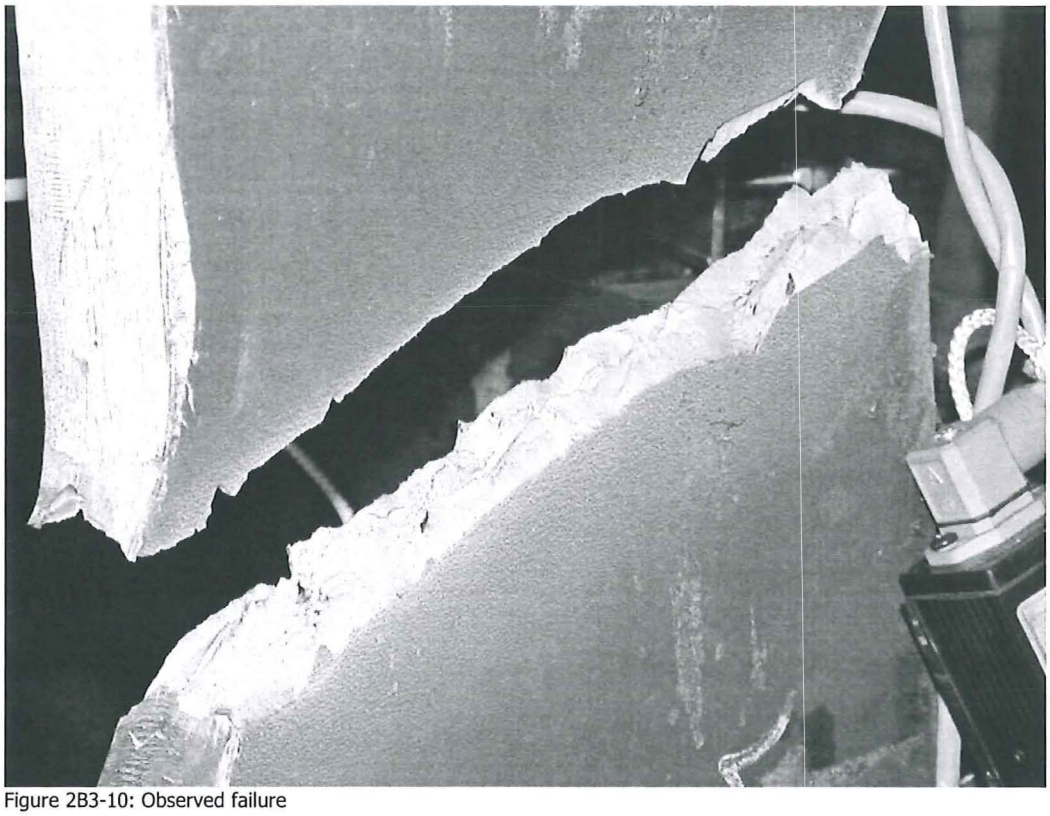


Figure 2B3-10: Observed failure

SPECIMEN 2B4

Table 2C1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2B4 (16)
	Type of specimen	X-joint with low SCF
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2B
Test	Type of test	Static strength
	Parameter	Thickness effect
	Remark	High SCF
	Failure	Plate

SPECIMEN 2B4

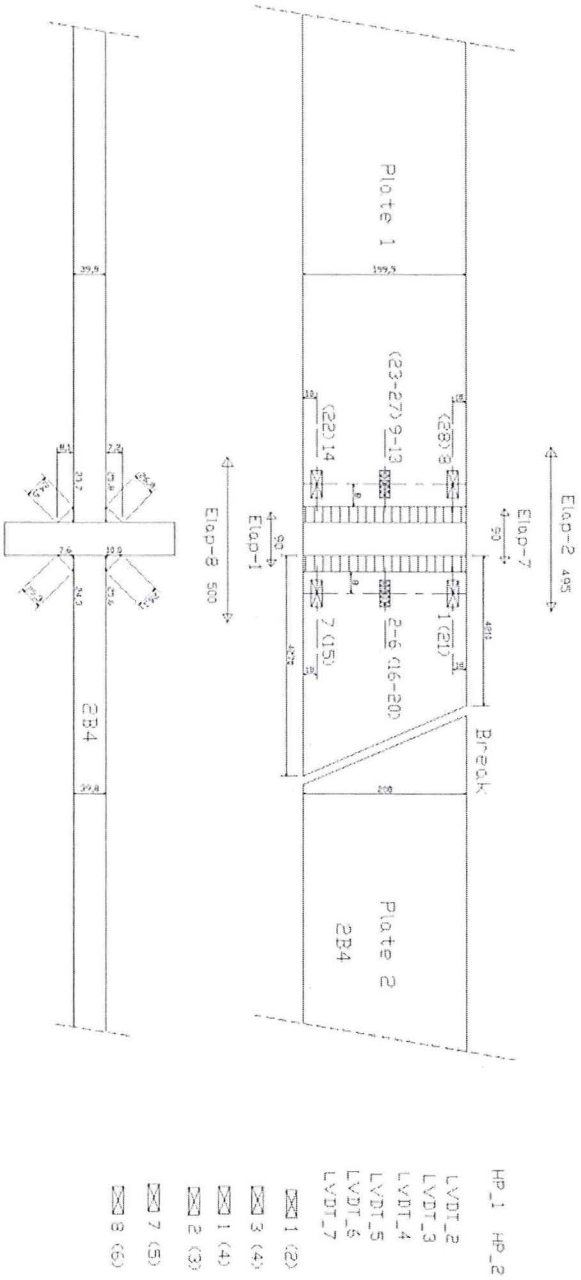


Figure 2B4-1: Dimensions of the test specimen

Figure 2B4-2: Dimensions of the welds

Figure 2B4-2: Position of strain gauges and LVDT's

SPECIMEN 2B4

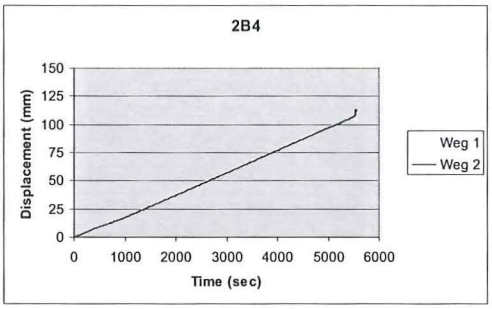


Figure 2B4-3: Test displacement controlled

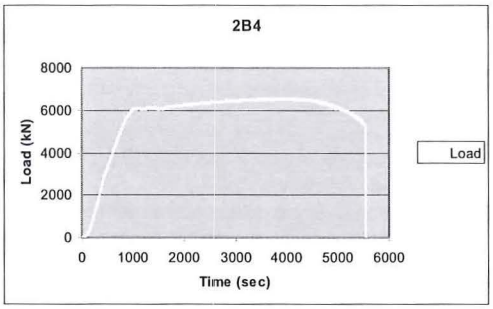


Figure 2B4-4: Test load

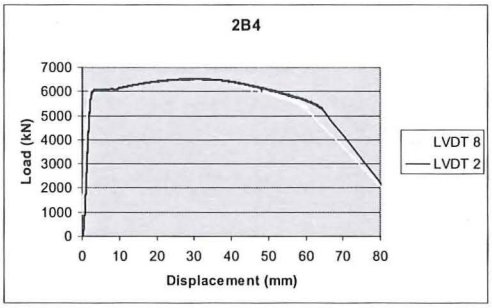


Figure 2B4-5: Deformation of the whole connection

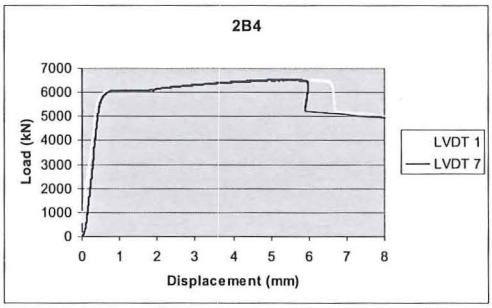


Figure 2B4-6: Local displacements

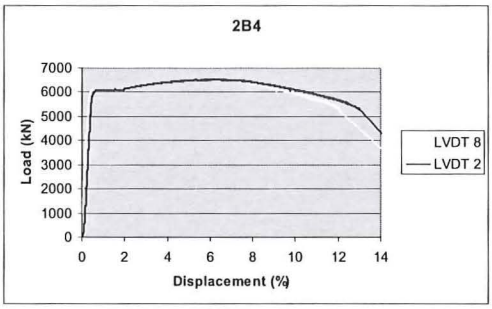


Figure 2B4-7: Relative deformation of the connection

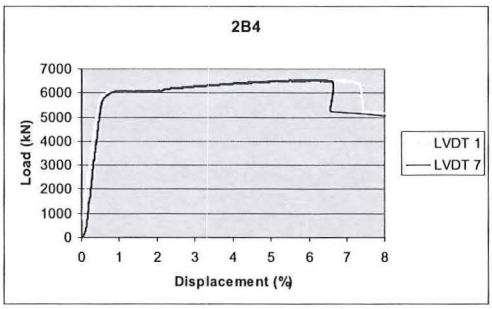


Figure 2B4-8: Relative displacements, locally

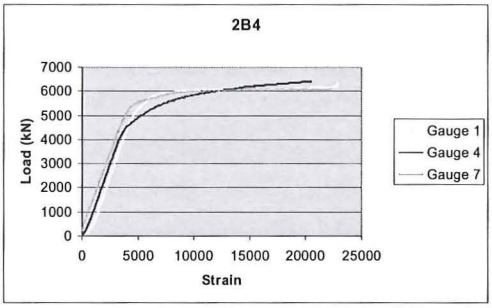


Figure 2B4-9: Measured strains plate 1 side 1

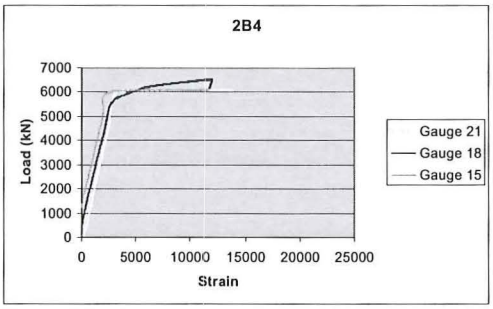


Figure 2B4-10: Measured strains plate 1 side 2

SPECIMEN 2B4

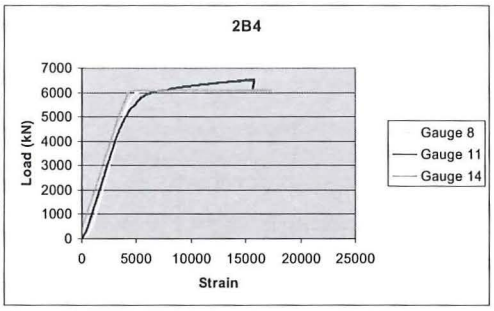


Figure 2B4-11: Measured strains plate 2 side 1

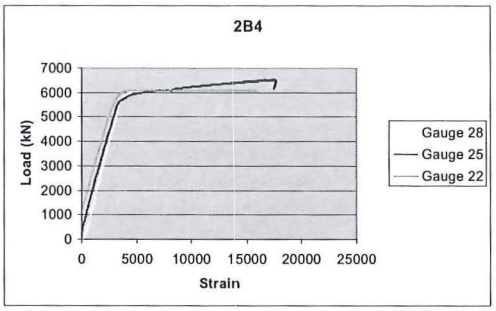


Figure 2B4-12: Measured strains plate 2 side 2

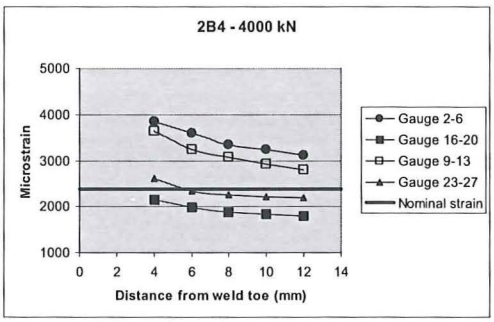
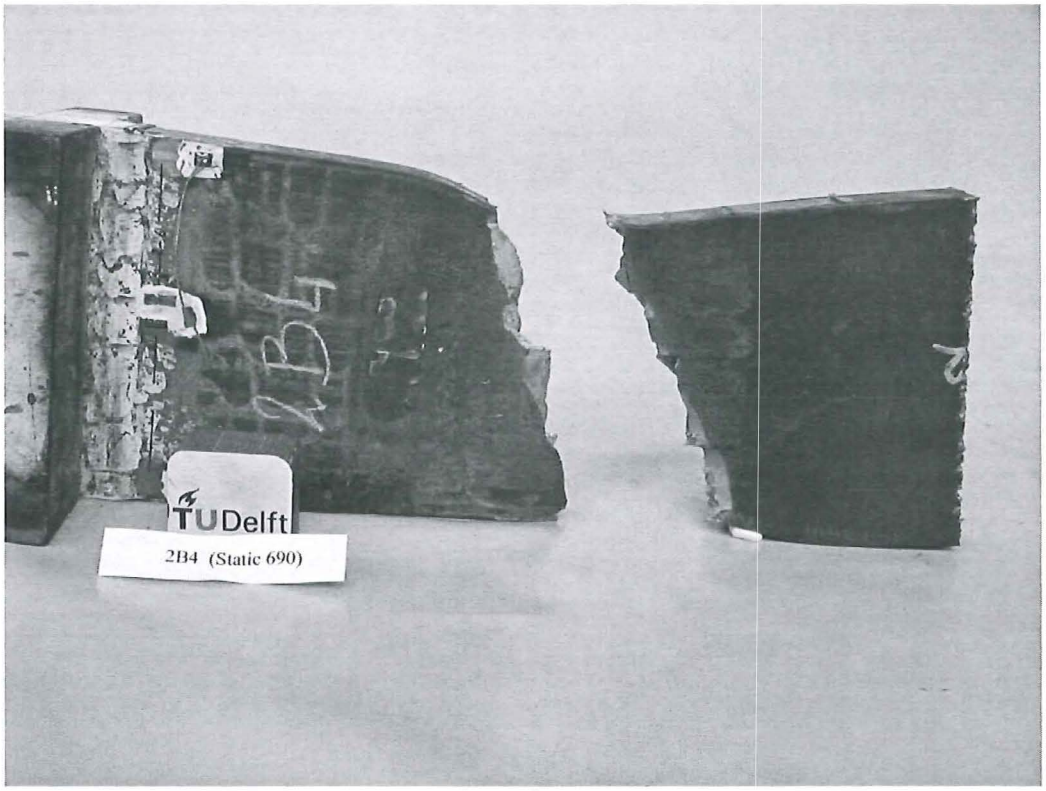


Figure 2B4-13: Measured strains strip gauges

SPECIMEN 2B4



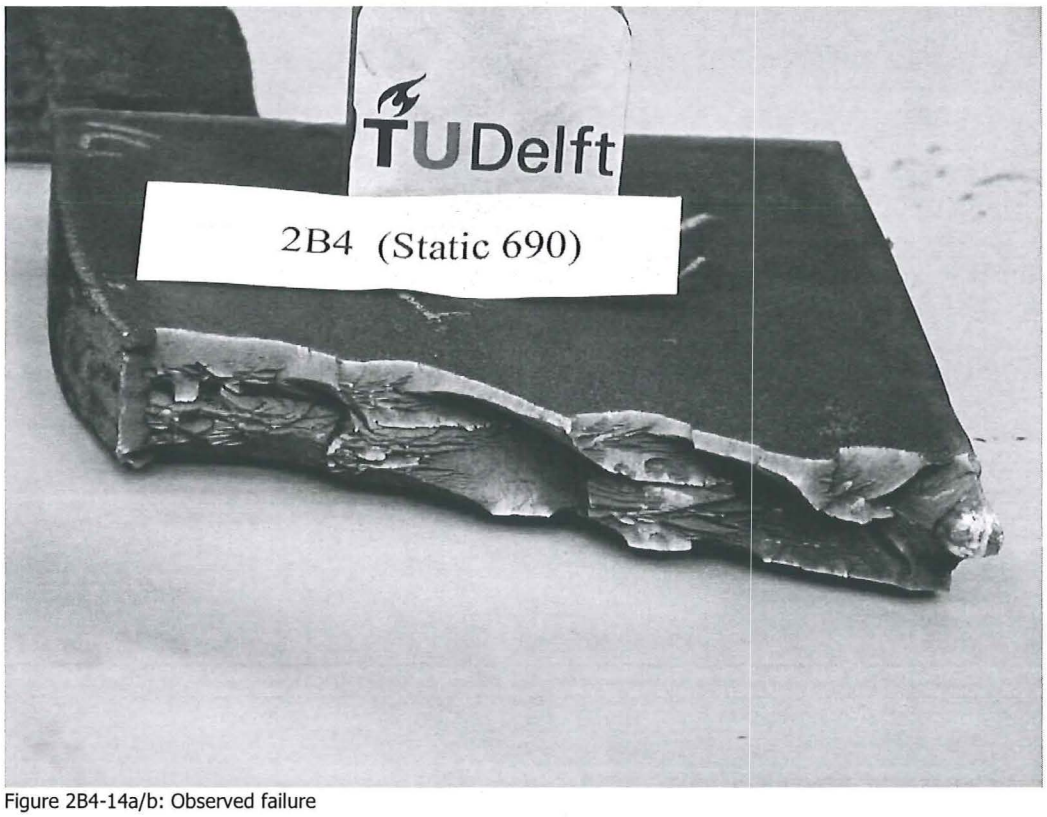


Figure 2B4-14a/b: Observed failure

SPECIMEN 2C1

Table 2C1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2C1 (19)
	Type of specimen	X-joint with high SCF
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2C
Test	Type of test	Static strength
	Parameter	Thickness effect
	Remark	High SCF
	Failure	Weld/plate

SPECIMEN 2C1

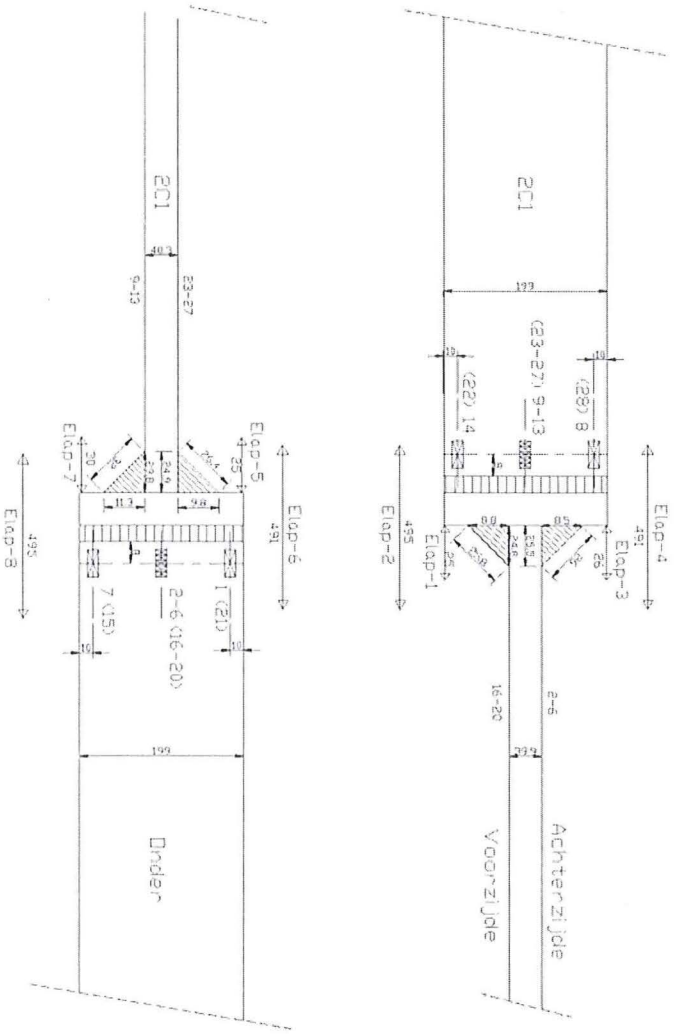


Figure 2C1-1: Dimensions of the test specimen

Figure 2C1-2: Dimensions of the welds

Figure 2C1-2: Position of strain gauges and LVDT's

SPECIMEN 2C1

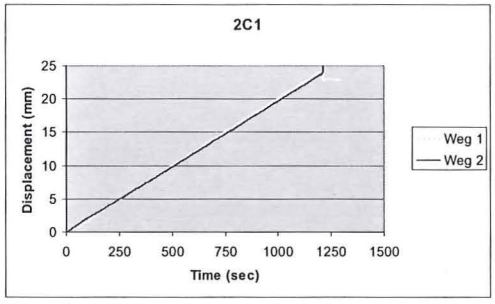


Figure 2C1-3: Test displacement controlled

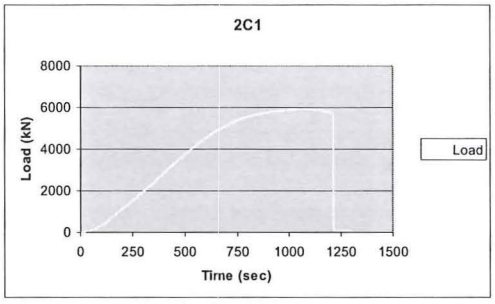


Figure 2C1-4: Test load

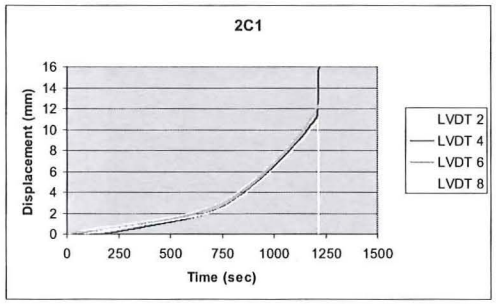


Figure 2C1-5: Deformation of the whole connection

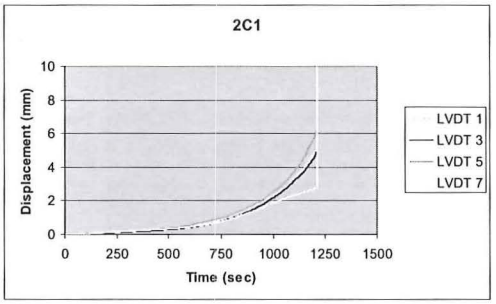


Figure 2C1-6: Local displacements

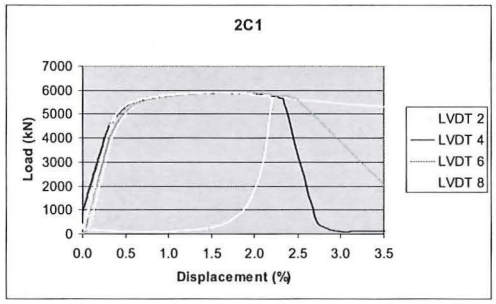


Figure 2C1-7: Relative deformation of the connection

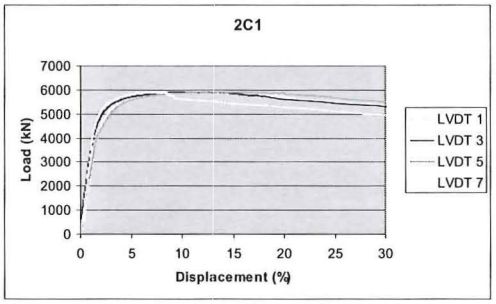


Figure 2C1-8: Relative displacements, locally

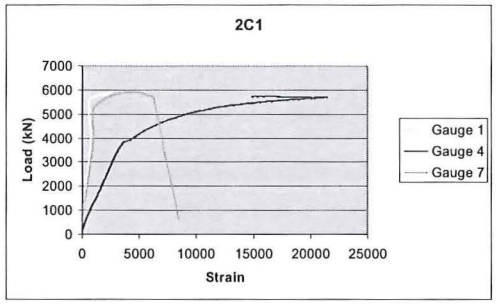


Figure 2C1-9: Measured strains plate 1 side 1

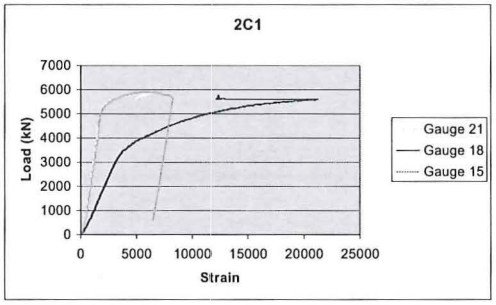


Figure 2C1-10: Measured strains plate 1 side 2

SPECIMEN 2C1

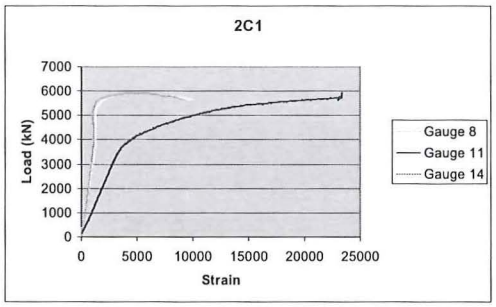


Figure 2C1-11: Measured strains plate 2 side 1

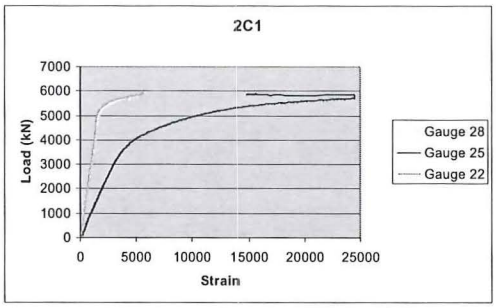


Figure 2C1-12: Measured strains plate 2 side 2

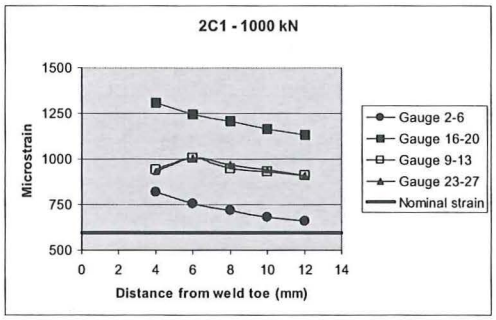


Figure 2C1-13: Measured strains strip gauges

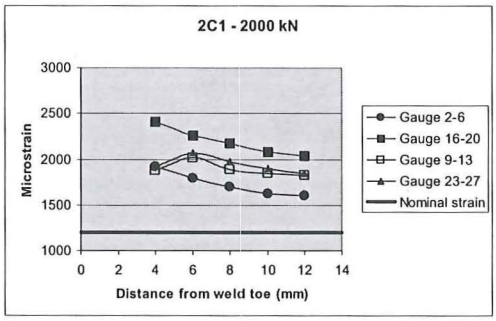


Figure 2C1-14: Measured strains strip gauges

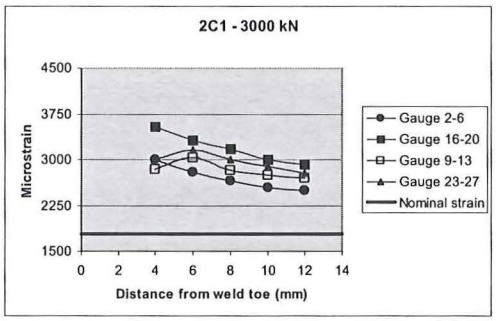


Figure 2C1-15: Measured strains strip gauges

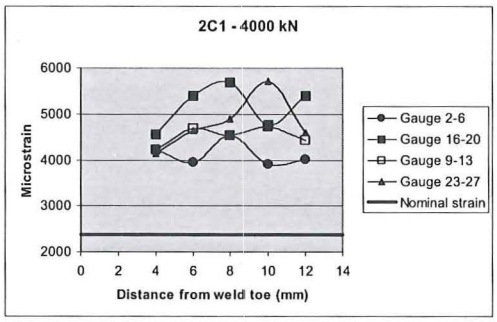
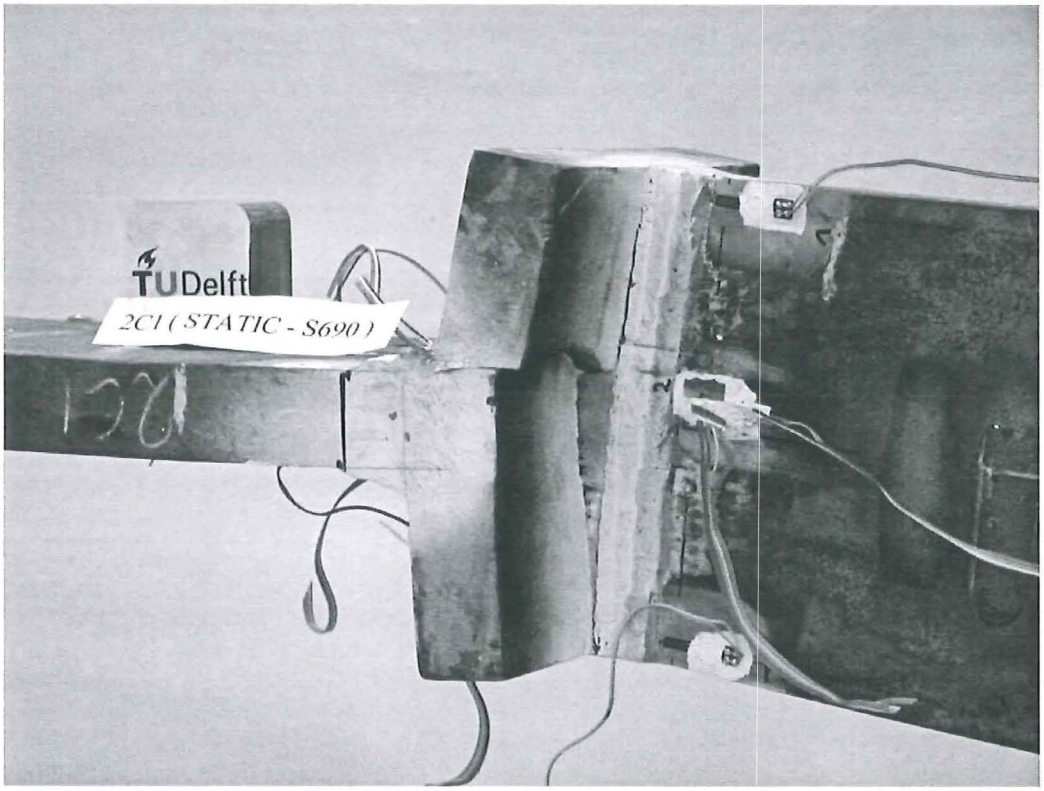


Figure 2C1-16: Measured strains strip gauges

SPECIMEN 2C1



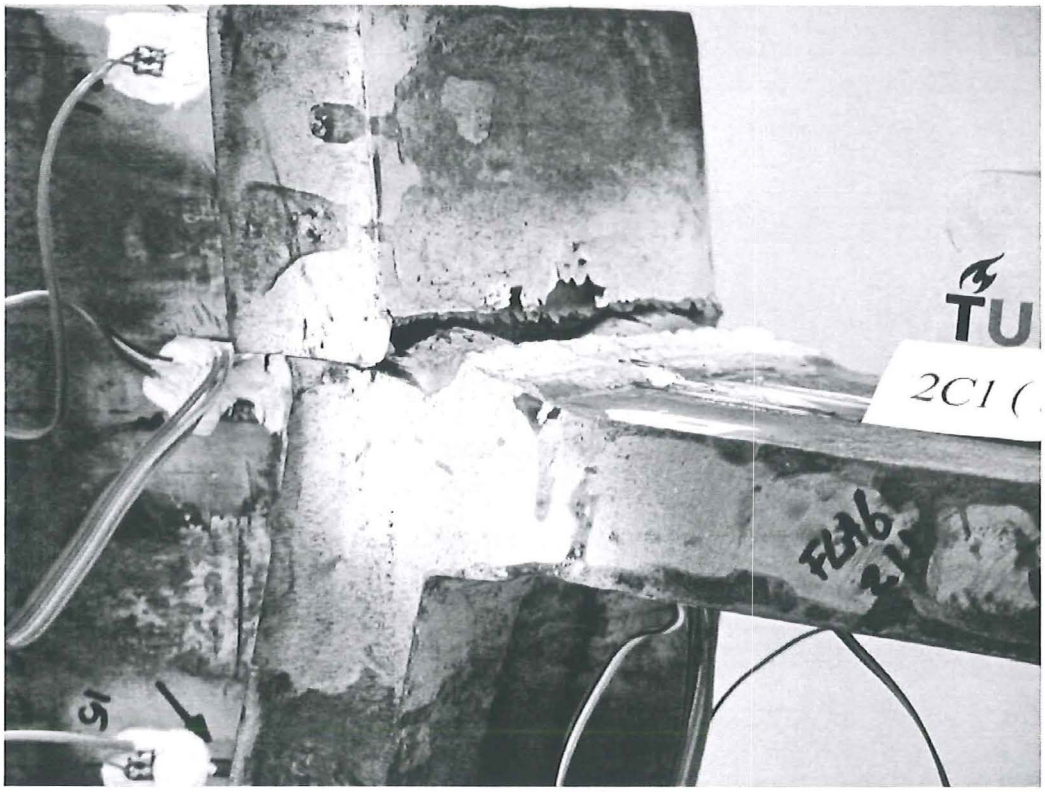


Figure 2C1-17 a/b: Observed failure

SPECIMEN 2C2

Table 2C2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2C2 (20)
	Type of specimen	X-joint with low SCF
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2C
Test	Type of test	Fatigue
	Parameter	Thickness effect
	Remark	High SCF
	Failure	Weld

SPECIMEN 2C2

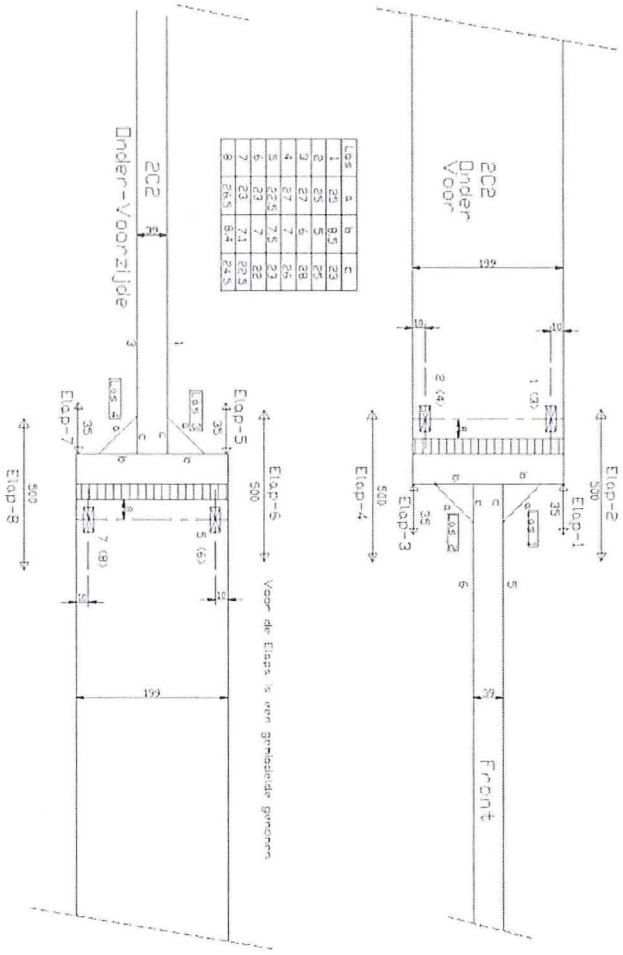


Figure 2C2-1: Dimensions of the test specimen

Figure 2C2-2: Dimensions of the welds

Figure 2C2-3: Position of strain gauges and LVDT's

SPECIMEN 2C2

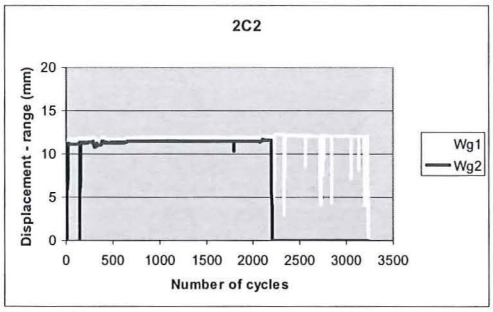


Figure 2C2-4: Test displacement controlled (range)

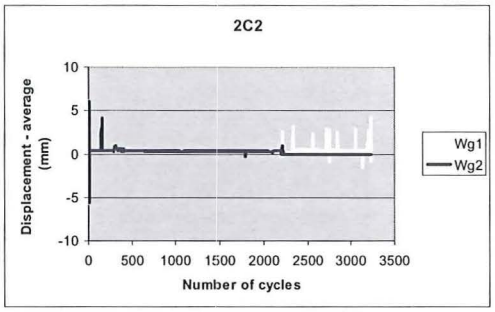


Figure 2C2-5: Test displacement controlled (average)

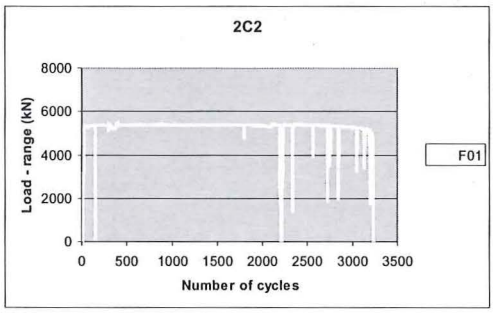


Figure 2C2-6: Test load (range)

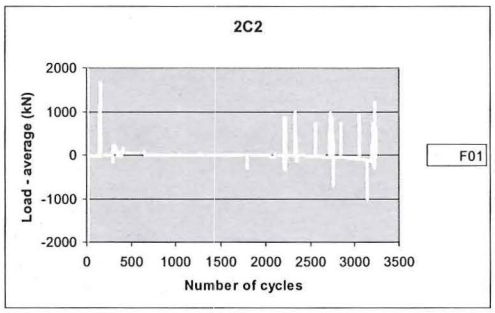


Figure 2C2-7: Test load (average)

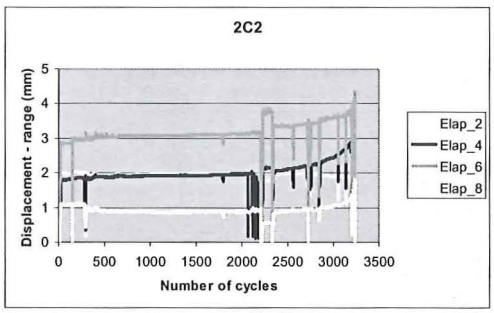


Figure 2C2-8: Deformation whole connection (range)

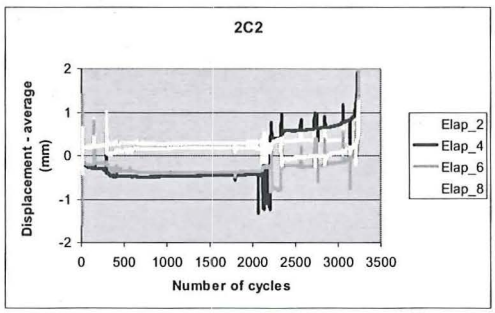


Figure 2C2-9: Deformation whole connection (average)

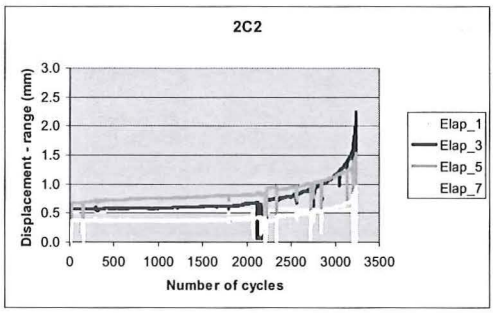


Figure 2C2-10: Local deformation (range)

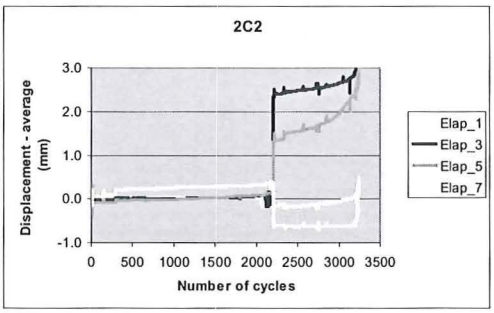


Figure 2C2-11: Local deformation (average)

SPECIMEN 2C2

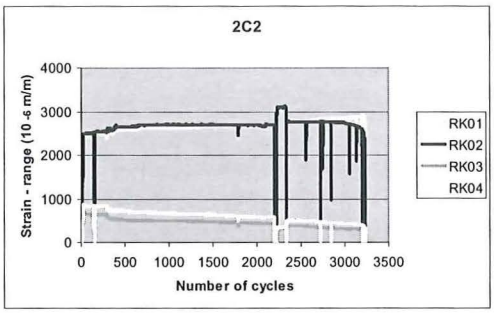


Figure 2C2-12: Measured strains (range)

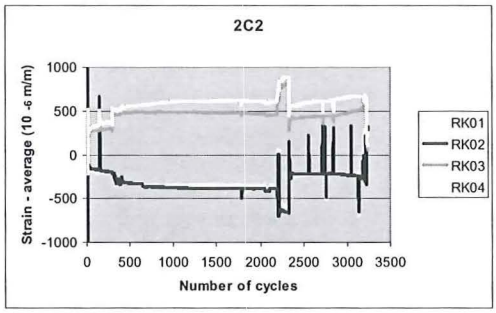


Figure 2C2-13: Measured strains (average)

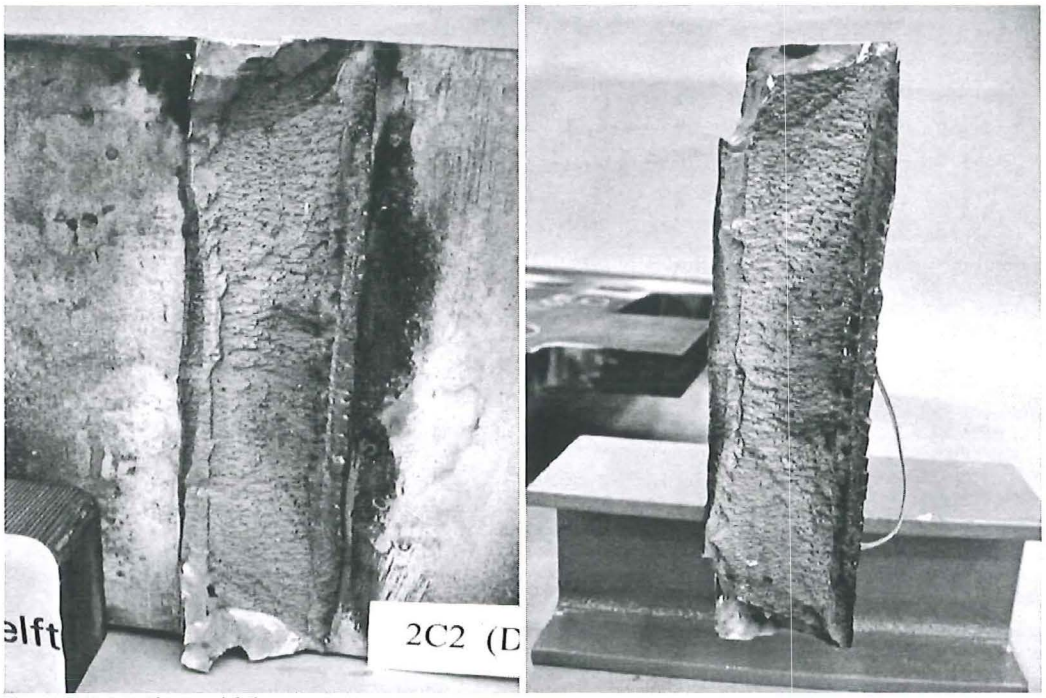


Figure 2C2-14: Observed failure

SPECIMEN 2C3

Table 2C3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	2C3 (21)
	Type of specimen	X-joint with low SCF
	Plate thickness	40 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Overmatched
	Welding procedure specification	Appendix B-2C
Test	Type of test	Ratcheting
	Parameter	Thickness effect
	Remark	High SCF
	Failure	Weld/Plate

SPECIMEN 2C3

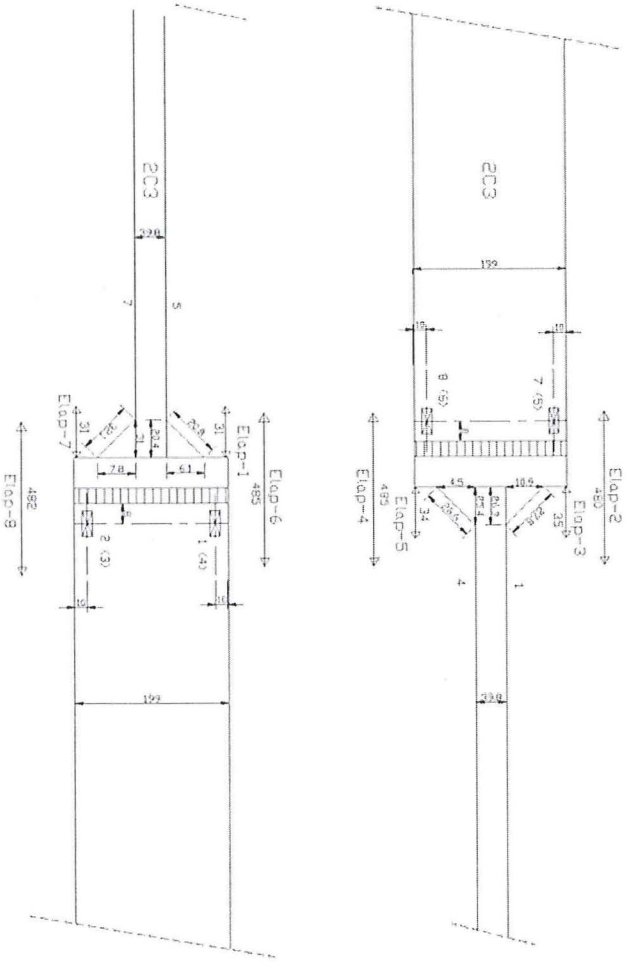


Figure 2C3-1: Dimensions of the test specimen

Figure 2C3-2: Dimensions of the welds

Figure 2C3-3: Position of strain gauges and LVDT's

SPECIMEN 2C3

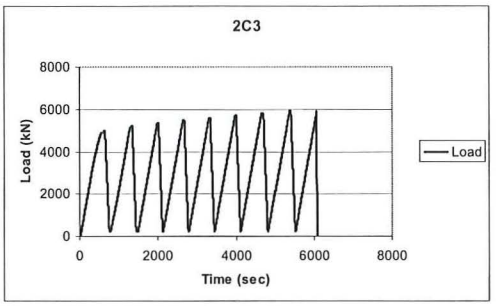


Figure 2C3-4: Test load controlled

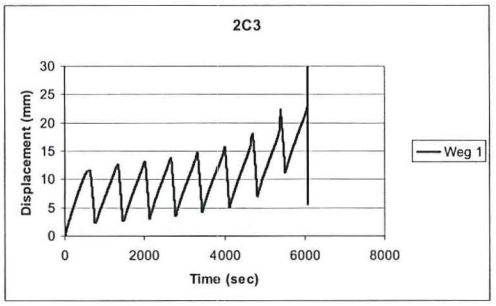
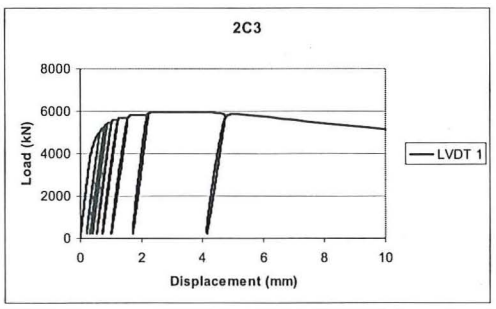
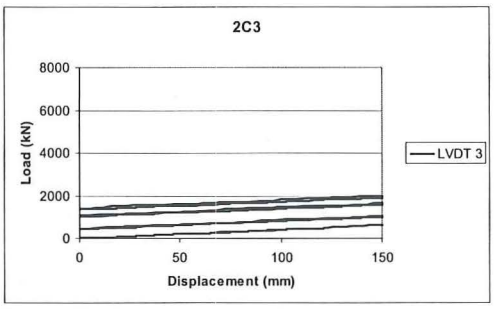
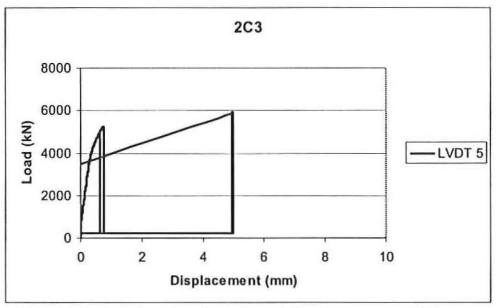


Figure 2C3-4: Total displacements







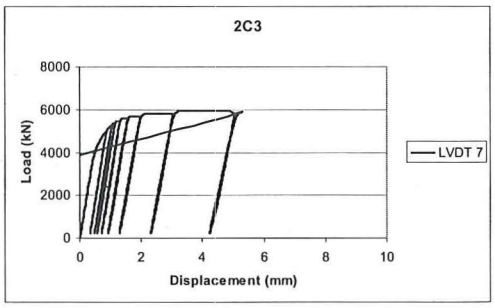
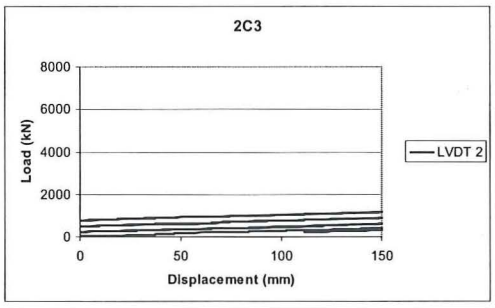
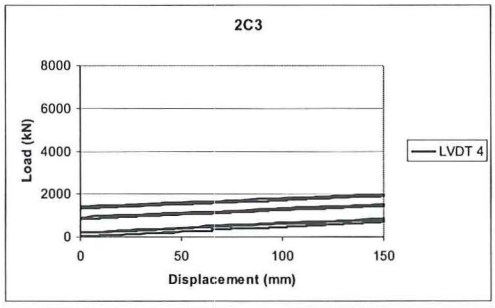
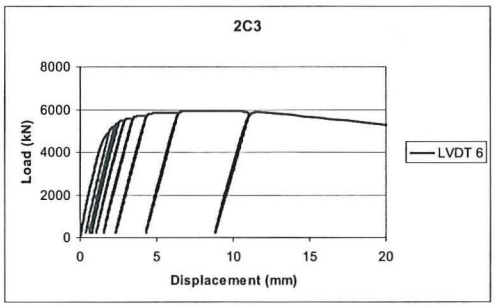


Figure 2C3-5a, b, c and d: Local deformation of the connection







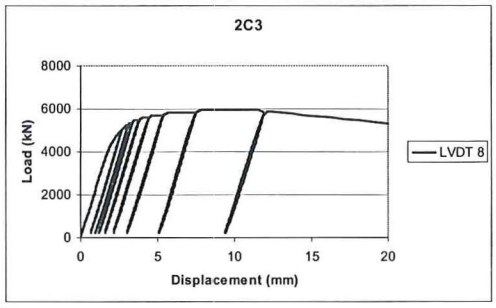


Figure 2C3-6a, b, c and d: Deformation of the whole connection

SPECIMEN 2C3

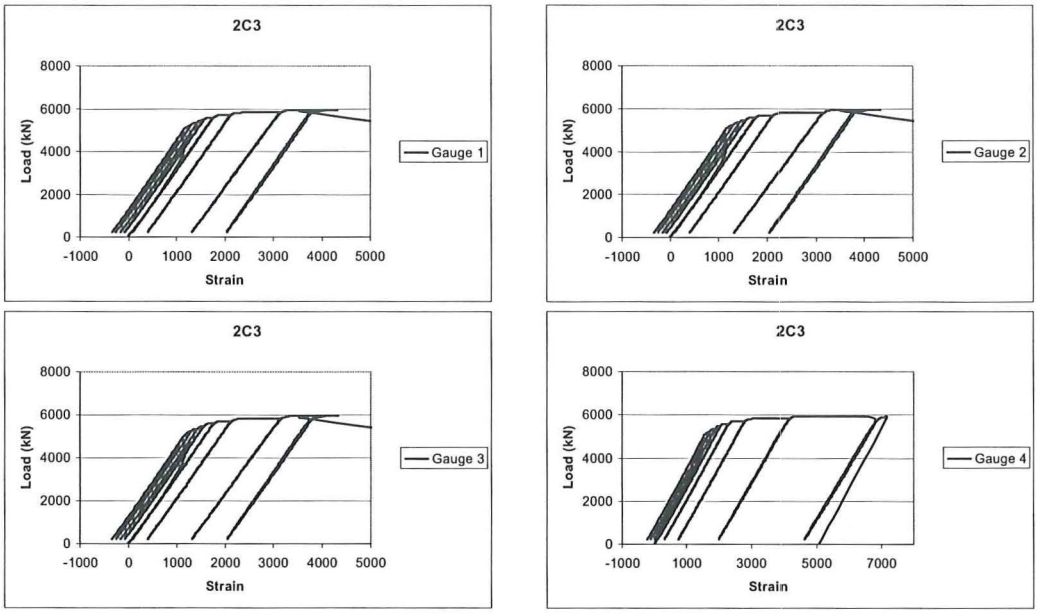


Figure 2C3-7a, b, c and d: Measured strains plate 1

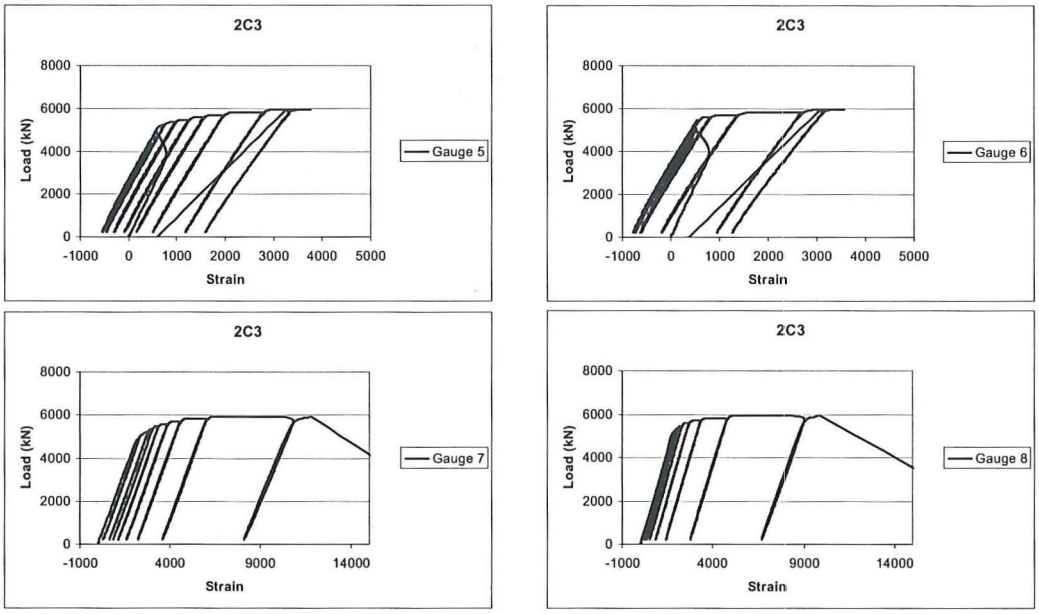


Figure 2C3-8a, b, c and d: Measured strains plate 2

SPECIMEN 2C3

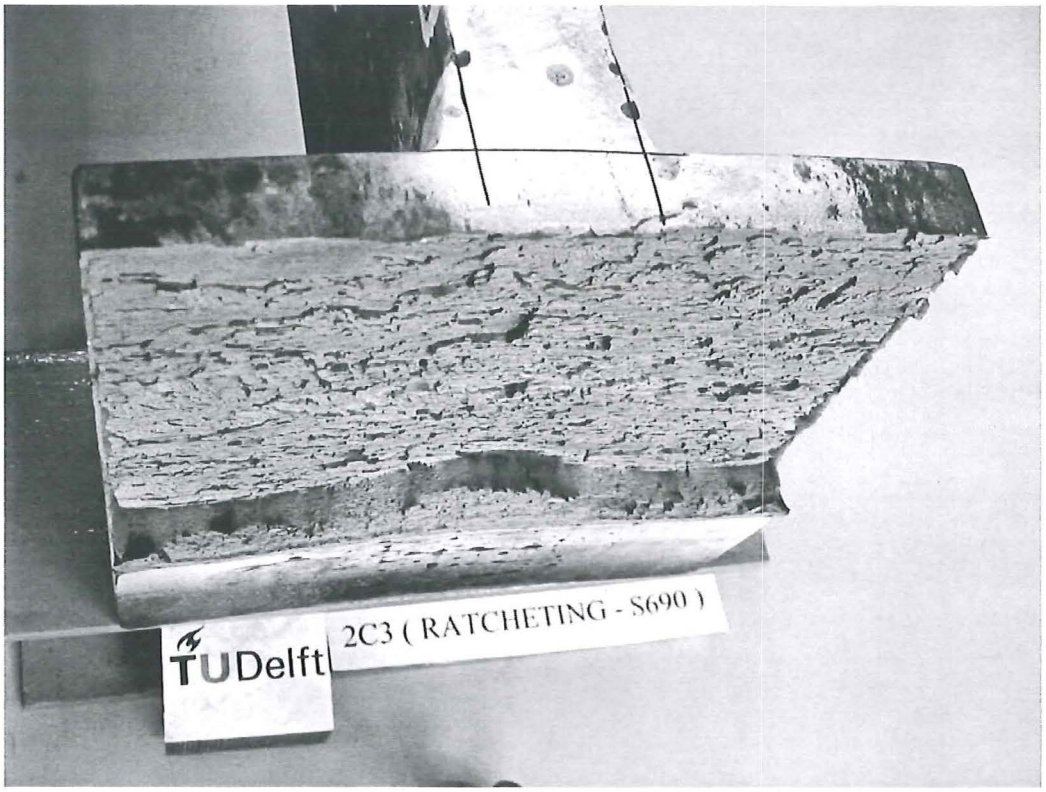


Figure 2C3-10 a/b: Observed failure

SPECIMEN 3A1

Table 3A1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	3A1 (22)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3A
Test	Type of test	Static strength
	Parameter	Under matched
	Remark	Fillet welds loaded in shear
	Failure	Plate

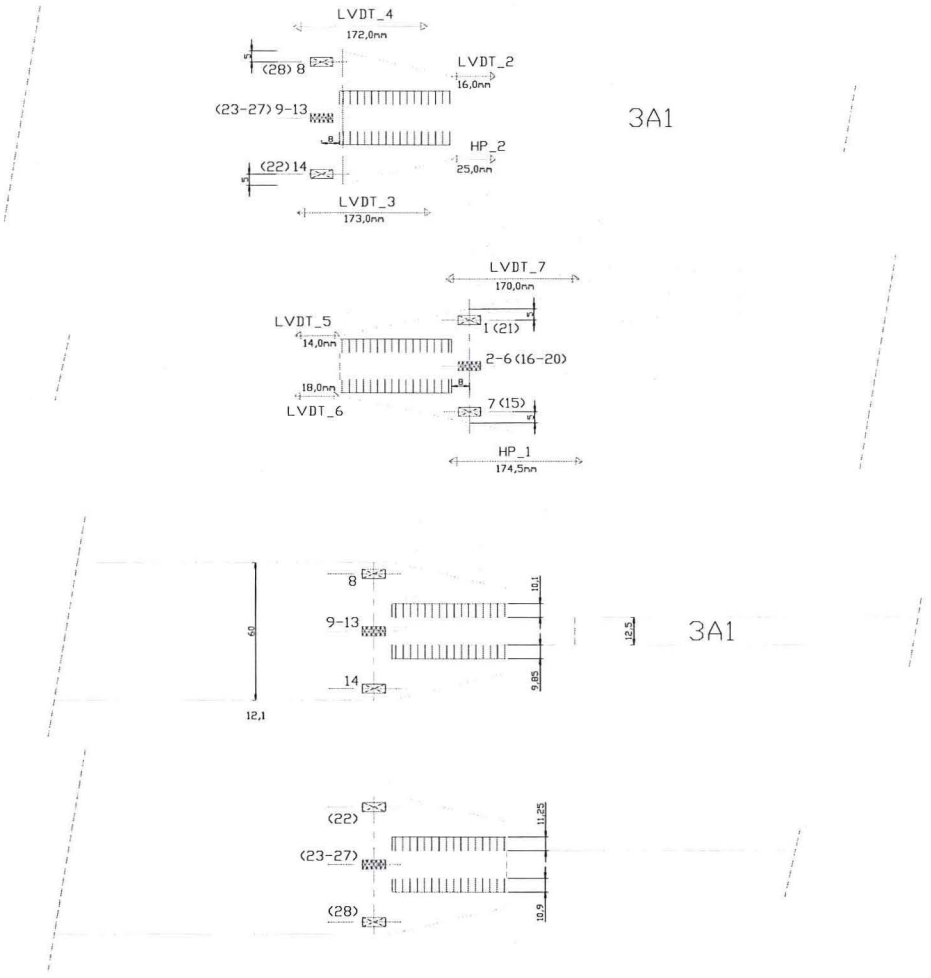
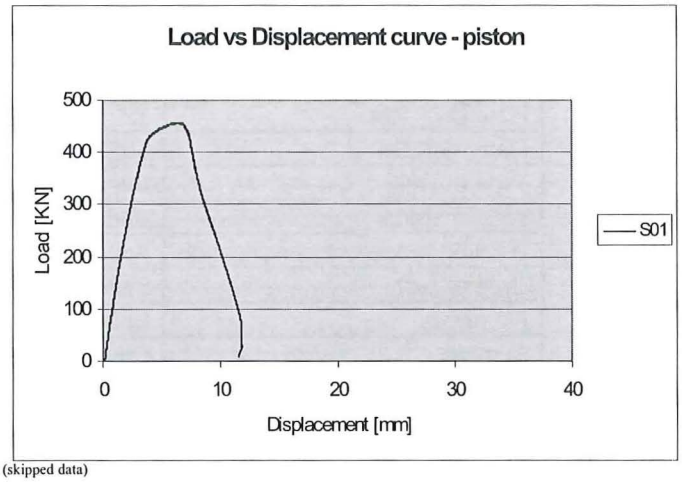


Figure 22.1: Top views of the test specimen with the position of the strain gauges and sizes of the measuring equipment.

SPECIMEN 3A1



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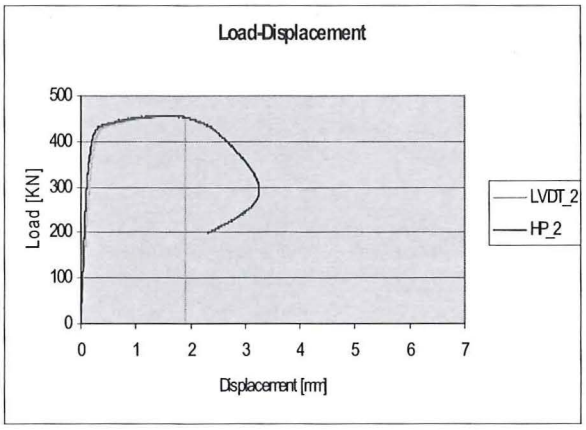
F_{max} [KN]	457
S_{Fmax} [mm]	6.59
S_{max} [mm]	11.88



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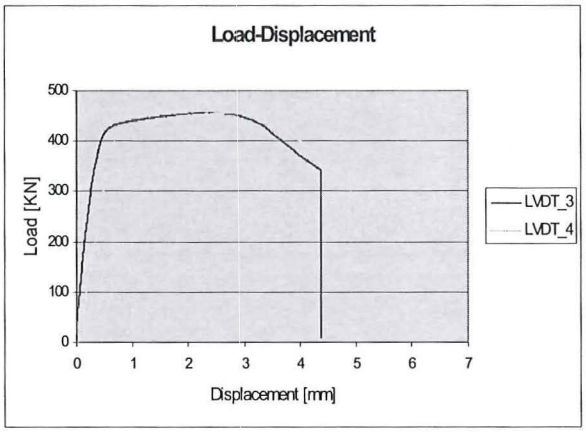
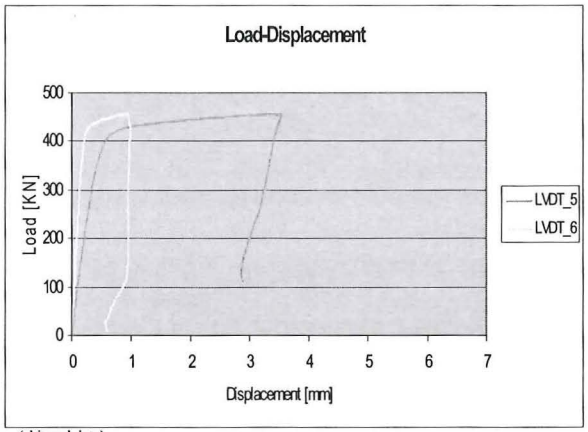
	Range [mm]	S_{Fmax} [mm]
HP_2	25.0	1.68
LVDT_2	16.0	1.69



	Range [mm]	S_{Fmax} [mm]
LVDT_3	173.0	2.60
LVDT_4	172.0	2.90



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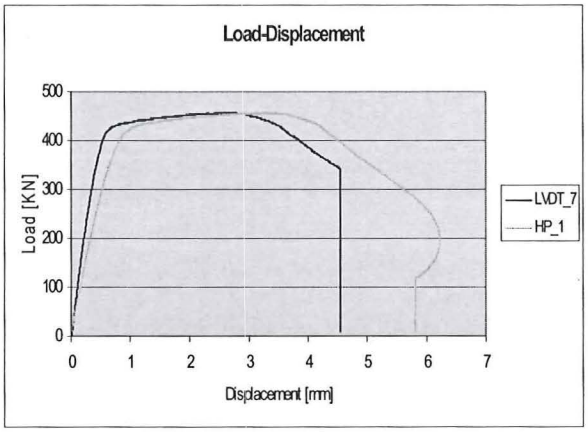
	Range [mm]	S_{Fmax} [mm]
LVDT_5	14.0	3.49
LVDT_6	18.0	0.93



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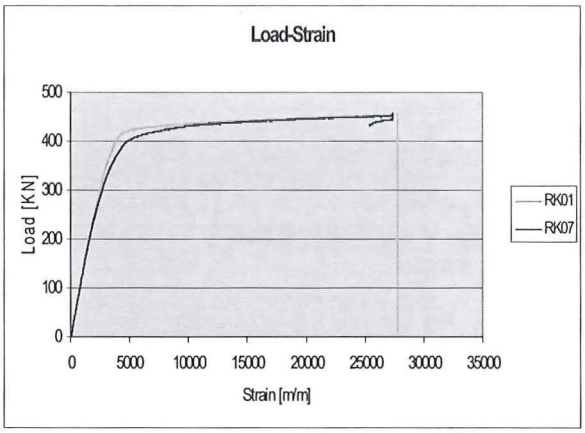
	Range [mm]	S_{Fmax} [mm]
LVDT_7	170.0	2.73
HP_1	174.5	3.41

SPECIMEN 3A1



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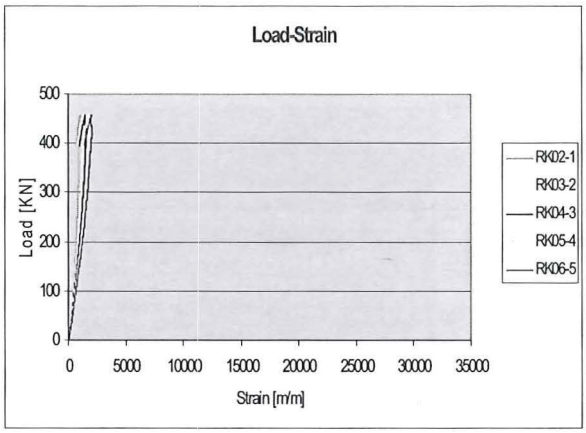
	ε_{Fmax} [m/m]
RK01	27754.90
RK07	27353.10



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	ε_{Fmax} [m/m]
RK02-1	1063.67
RK03-2	1283.74
RK04-3	1485.48
RK05-4	1778.90
RK06-5	2017.31

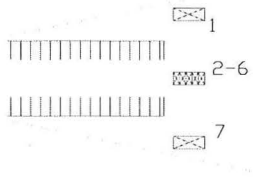
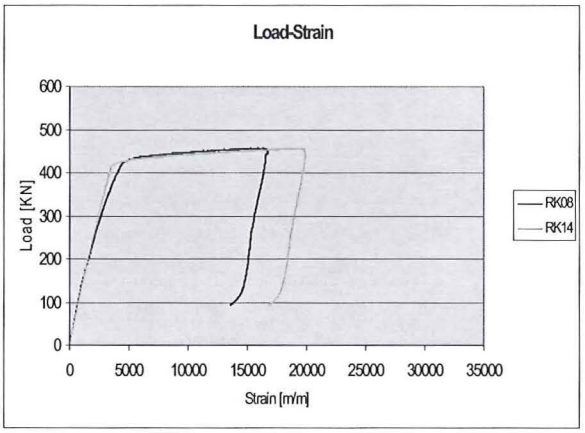


Figure 22.2: Drawing of the test specimen face with the position of the strain gauges 1 to 7.



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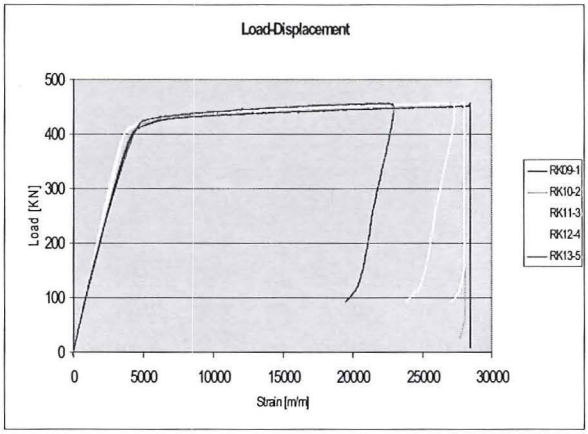
	ε_{Fmax} [m/m]
RK08	16316.50
RK14	19512.60



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	ε_{Fmax} [m/m]
RK09-1	28425.80
RK10-2	28059.00
RK11-3	28004.00
RK12-4	26766.10
RK13-5	22456.40

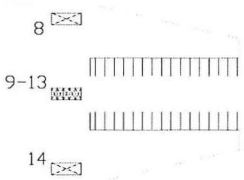
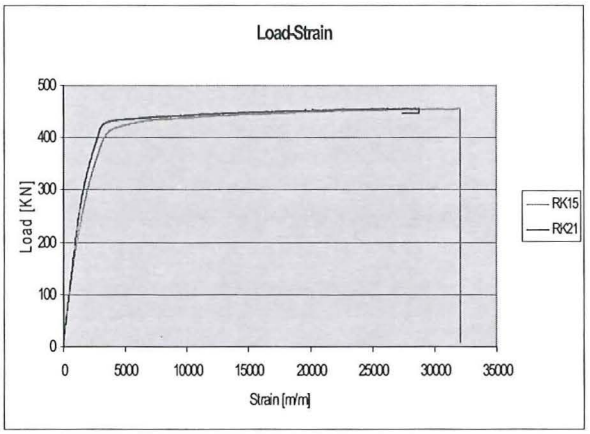


Figure 22.3: Test specimen face with the position of the strain gauges 8 to 14.

SPECIMEN 3A1



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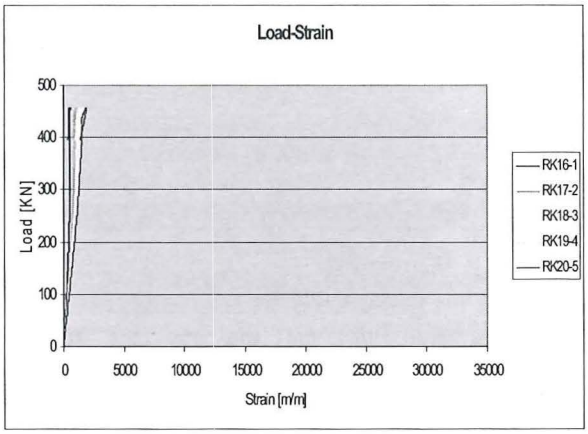
	ε_{Fmax} [m/m]
RK15	32044.30
RK21	28745.50



(skipped data)

	ε_{Fmax} [m/m]
RK16-1	512.56
RK17-2	1008.66
RK18-3	1402.95
RK19-4	1650.53
RK20-5	1916.45

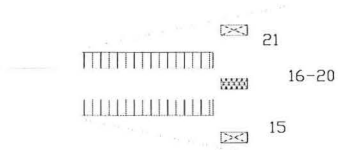
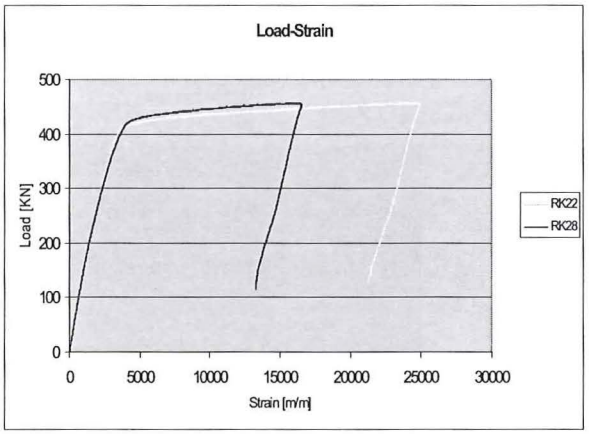
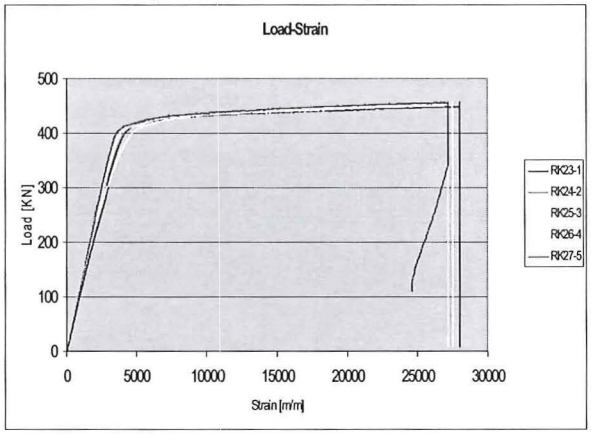


Figure 22.4: Drawing of the test specimen face with the position of the strain gauges 15 to 21.



(some data was skipped)

	ε_{Fmax} [m/m]
RK22	24596.30
RK28	16325.90



(skipped data)

	ε_{Fmax} [m/m]
RK23-1	27994.80
RK24-2	27490.50
RK25-3	27518.00
RK26-4	27206.20
RK27-5	27206.20

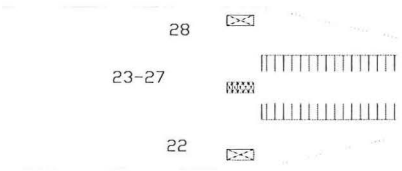


Figure 22.5: Drawing of the test specimen face with the position of the strain gauges 22 to 28.

SPECIMEN 3A1

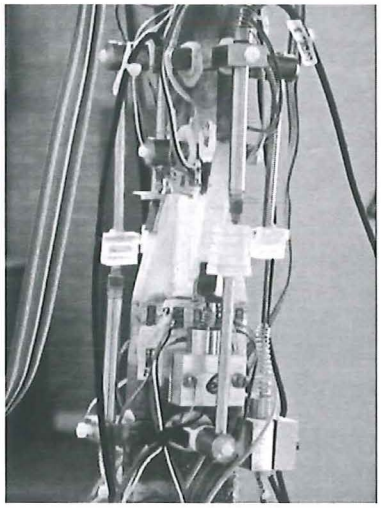
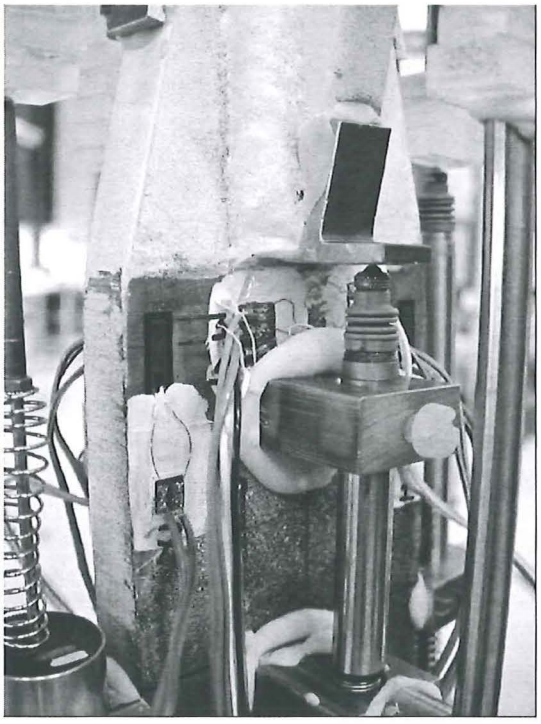
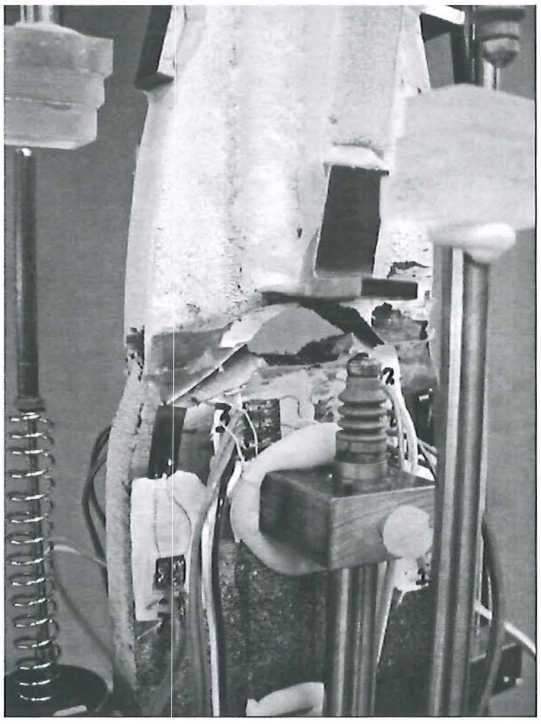


Figure 22.6: Test specimen during the test.





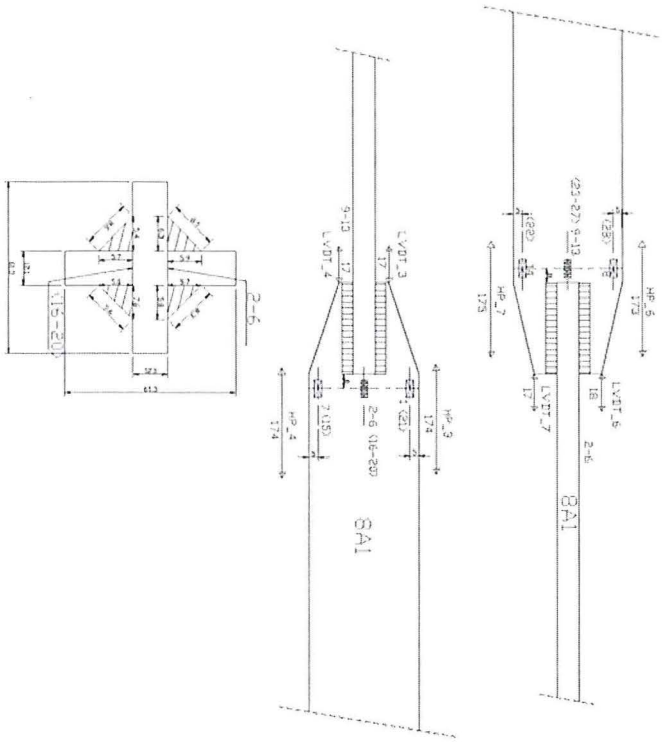
Figures 22.7 and 22.8: Detailed perspectives of weld toe during the test and after failure.

SPECIMEN 8A1

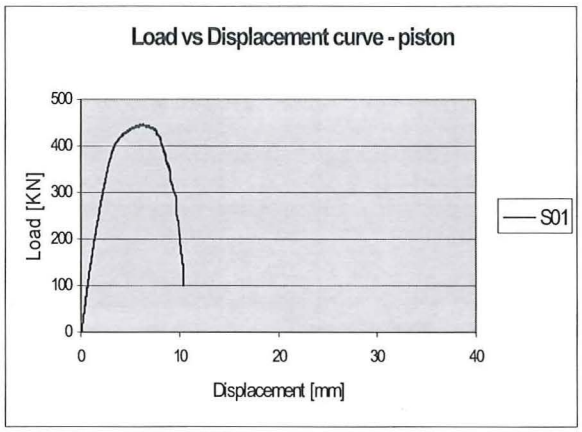
Table 8A1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	8A1 (22.2)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-1A
Test	Type of test	Static strength
	Parameter	Under matched
	Remark	Fillet welds loaded in shear
	Failure	Plate

SPECIMEN 8A1

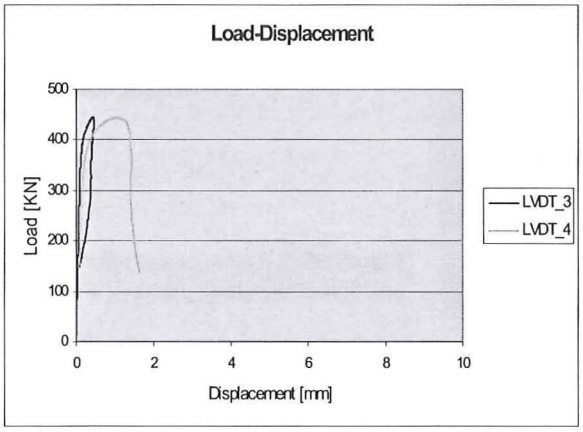


SPECIMEN 8A1



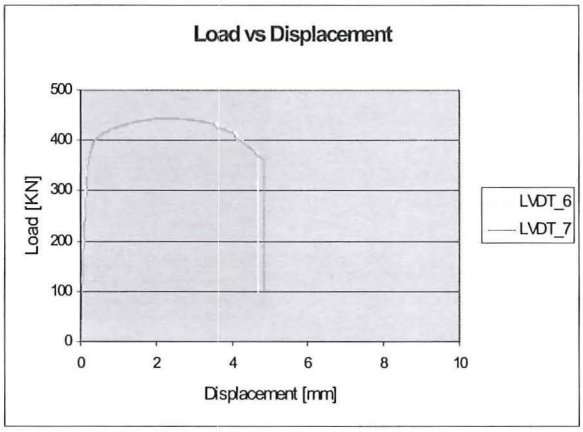
F_{max} [KN]	446
S_{Fmax} [mm]	6.34
S_{max} [mm]	10.42

(skipped data)



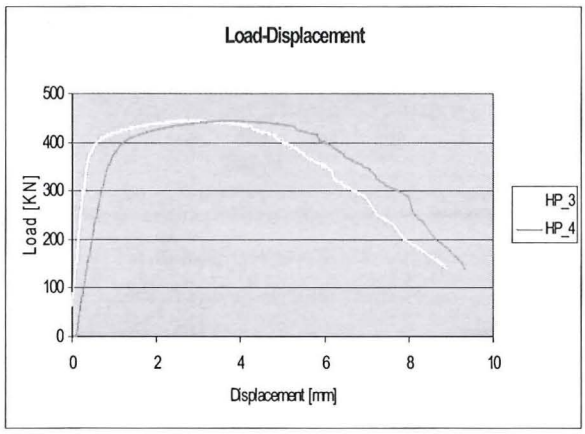
(skipped data)

	Range [mm]	S_{Fmax} [mm]
LVDT_3	17.0	0.44
LVDT_4	17.0	1.05



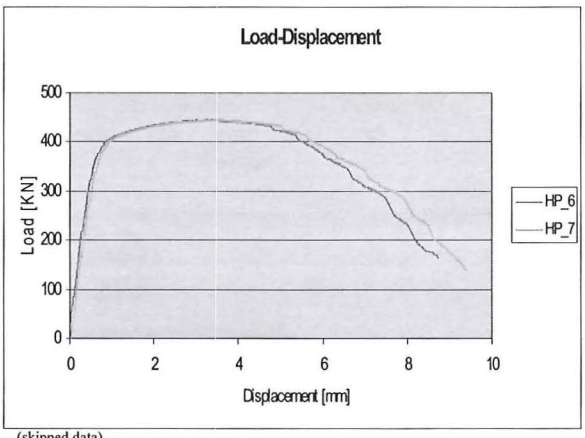
(skipped data)

	Range [mm]	S_{Fmax} [mm]
LVDT_6	18.0	2.43
LVDT_7	17.0	2.40



(skipped data)

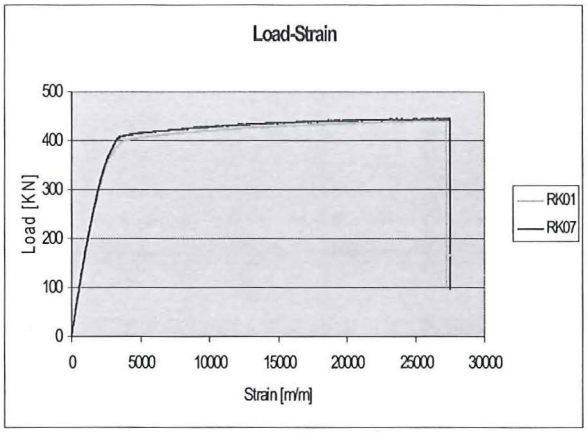
	Range [mm]	S_{Fmax} [mm]
HP_3	174.0	2.90
HP_4	174.0	3.84



(skipped data)

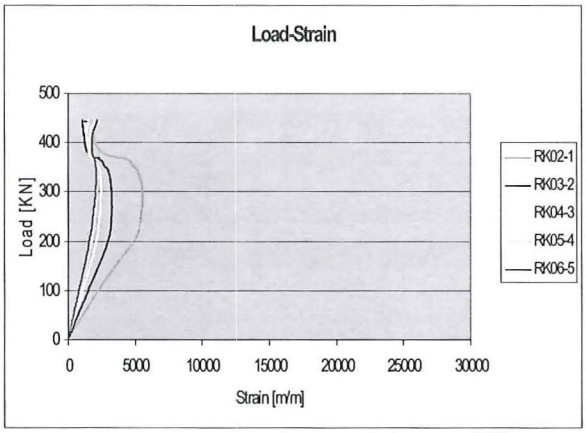
	Range [mm]	S_{Fmax} [mm]
HP_6	173.0	3.36
HP_7	175.0	3.55

SPECIMEN 8A1



(skipped data)

	ε_{Fmax} [m/m]
RK01	27232.70
RK07	26556.90



(skipped data)

	ε_{Fmax} [m/m]
RK02-1	1850.82
RK03-2	1078.87
RK04-3	1506.70
RK05-4	1943.82
RK06-5	2213.54

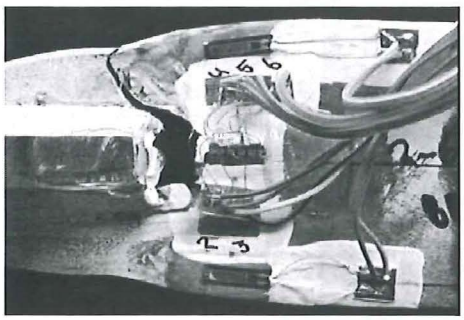
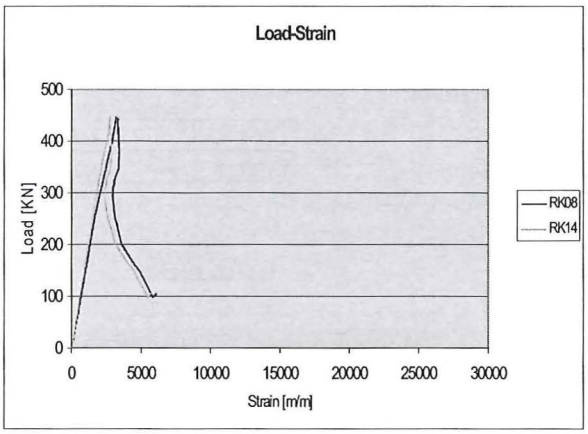
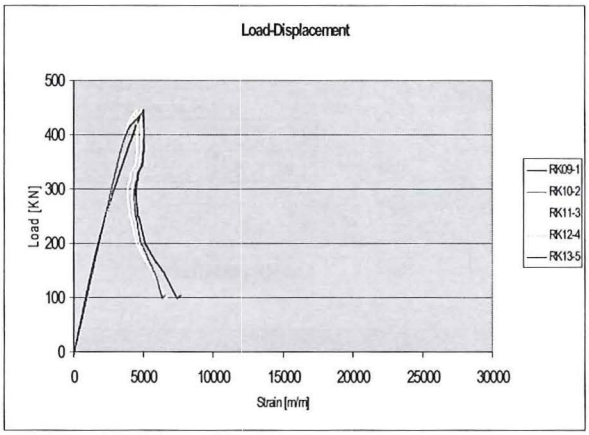


Figure 55.3: Test specimen face with the position of the strain gauges 1 to 7.



(skipped data)

	ε_{Fmax} [m/m]
RK08	3202.76
RK14	2767.70



(skipped data)

	ε_{Fmax} [m/m]
RK9-1	5040.92
RK10-2	5719.87
RK11-3	4547.99
RK12-4	4901.41
RK13-5	5087.43

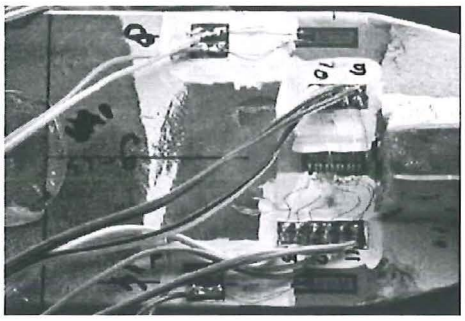
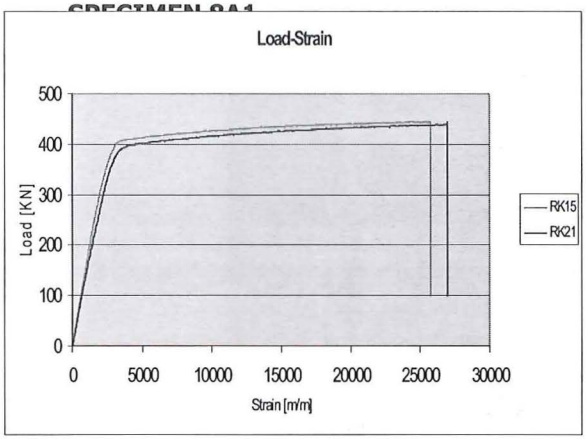
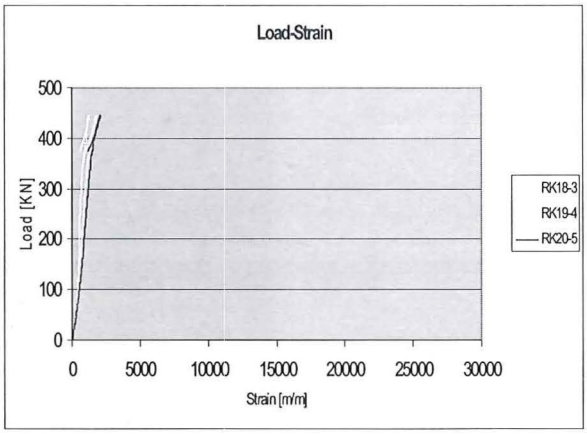


Figure 55.4: Test specimen face with the position of the strain gauges 8 to 14.



(skipped data)

	ε_{Fmax} [m/m]
RK15	25788.70
RK21	27001.30



(skipped data)

	ε_{Fmax} [m/m]
RK16-1	Measuring Error
RK17-2	Measuring Error
RK18-3	1218.38
RK19-4	1795.02
RK20-5	2092.63

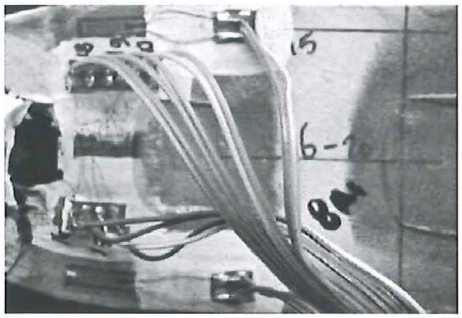
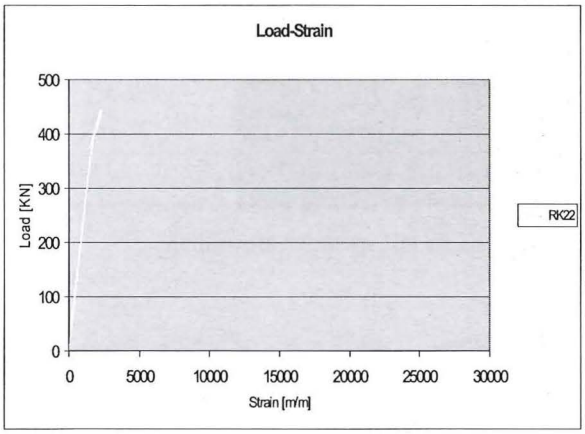
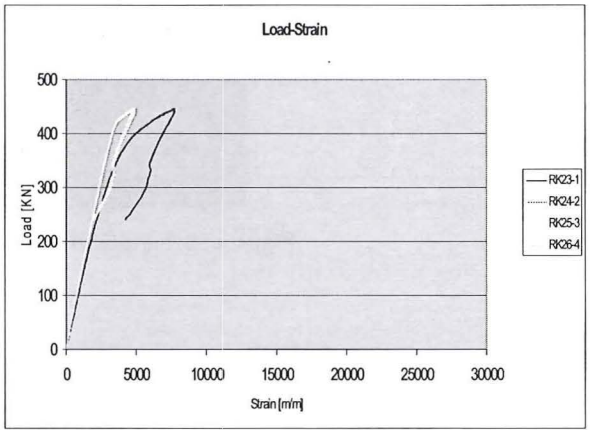


Figure 55.5: Test specimen face with the position of the strain gauges 15 to 21.



(skipped data)

	ε_{Fmax} [m/m]
RK22	2314.13
RK28	Measuring Error



(skipped data)

	ε_{Fmax} [m/m]
RK23-1	7719.49
RK24-2	5031.62
RK25-3	4892.11
RK26-4	4743.30
RK27-5	Measuring Error

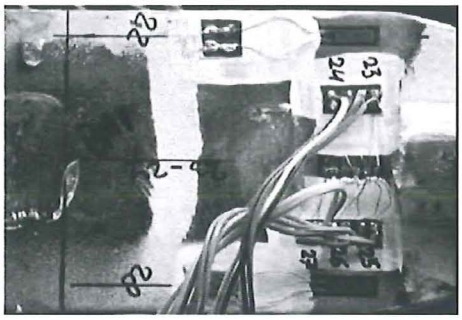
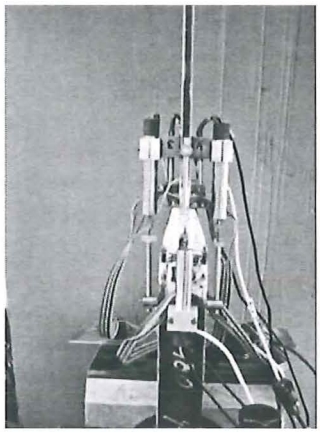
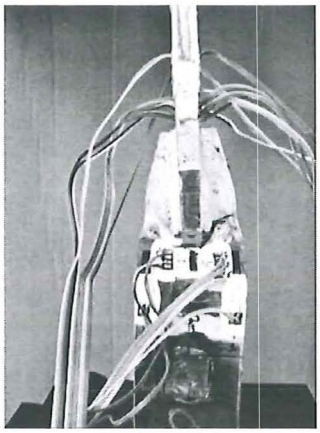


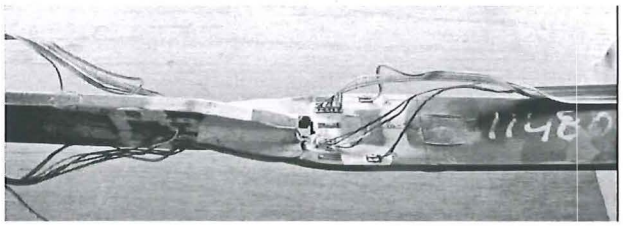
Figure 55.6: Test specimen face with the position of the strain gauges 22 to 28.

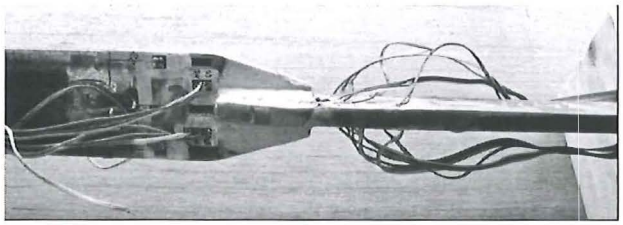
SPECIMEN 8A1



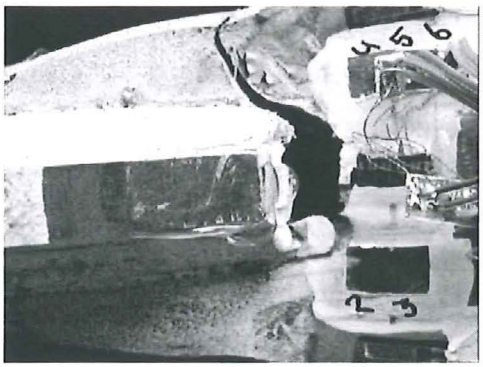


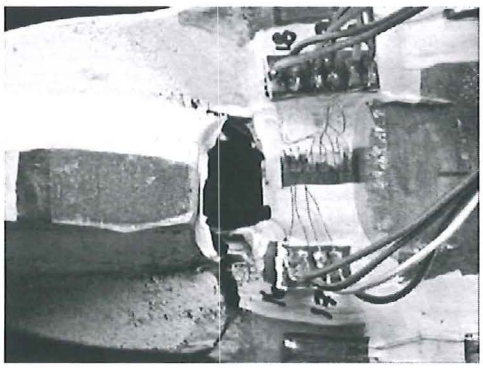
Figures 55.7 and 55.8: Test specimen during the test and after failure.





Figures 55.9 and 55.10: Two side views of the test specimen after failure.





Figures 55.11 and 55.12: Upper views of the region of the weld toe. Perspectives of the crack.

SPECIMEN 8A2

Table 8A2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	8A2 (23)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3A
Test	Type of test	Fatigue
	Parameter	Reference
	Remark	Fillet welds loaded in shear
	Failure	Weld

SPECIMEN 8A2

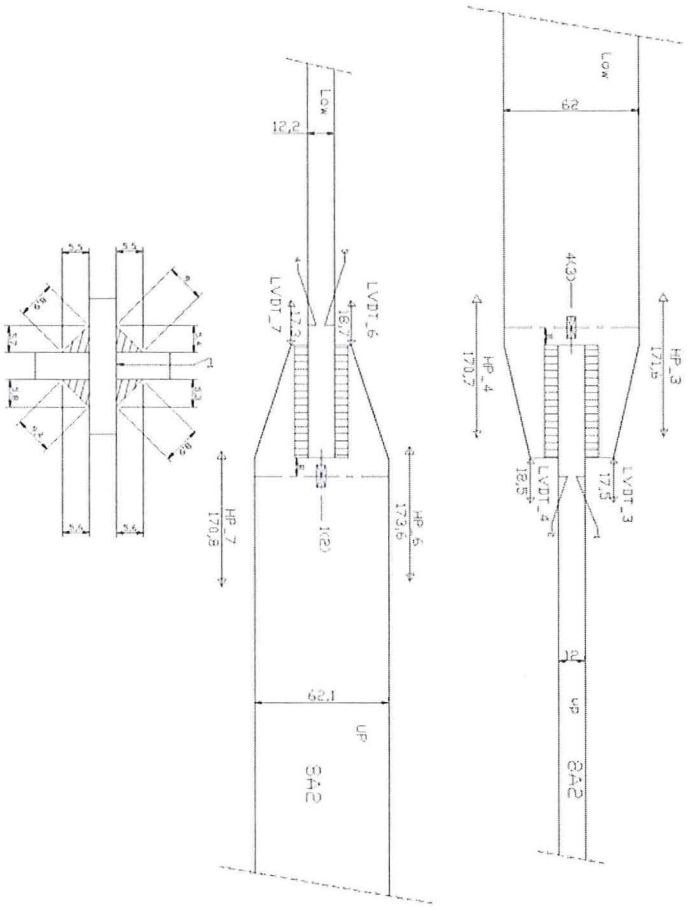


Figure 8A2-1: Dimensions of the test specimen

Figure 8A2-2: Dimensions of the welds

Figure 8A2-3: Position of strain gauges and LVDT's

SPECIMEN 8A2

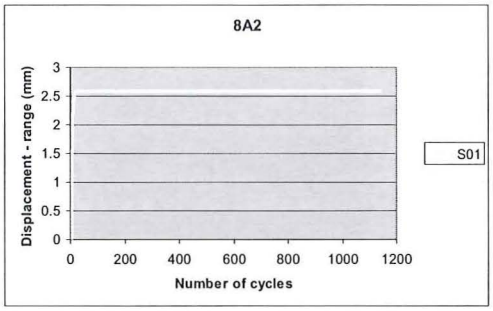


Figure 8A2-4: Test displacement controlled (range)

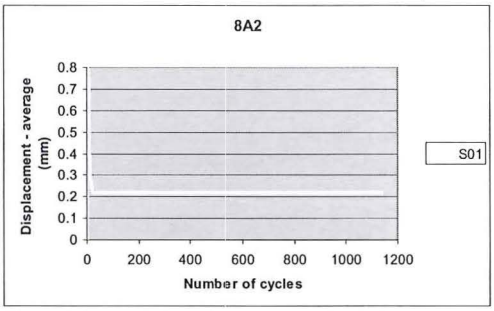


Figure 8A2-5: Test displacement controlled (average)

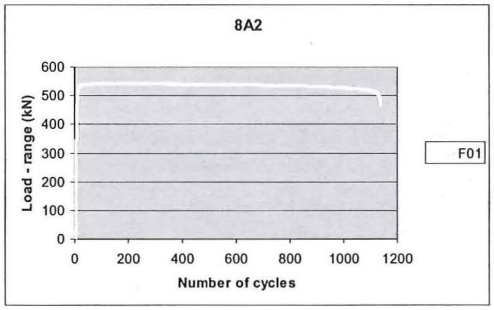


Figure 8A2-6: Test load (range)

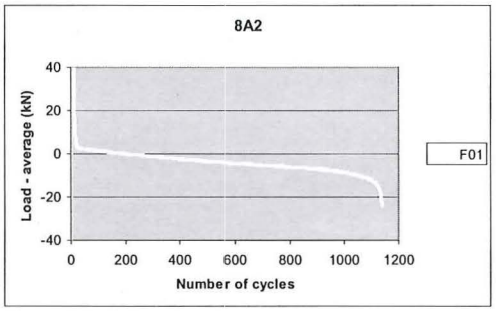


Figure 8A2-7: Test load (average)

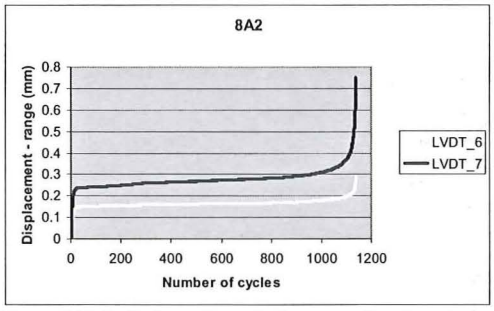


Figure 8A2-8: Deformation whole connection (range)

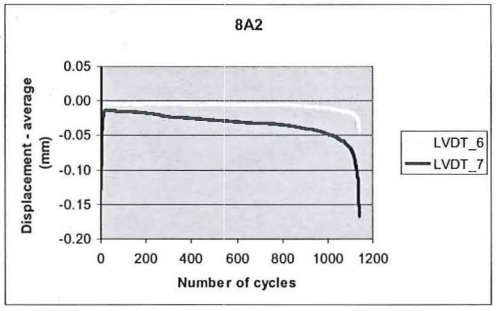


Figure 8A2-9: Deformation whole connection (average)

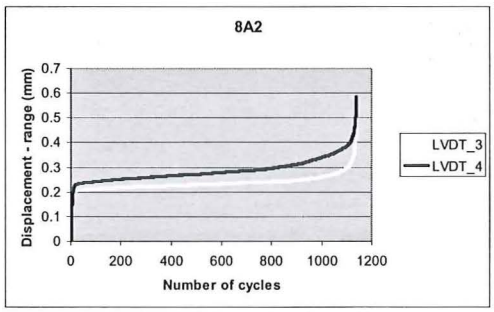


Figure 8A2-10: Local deformation (range)

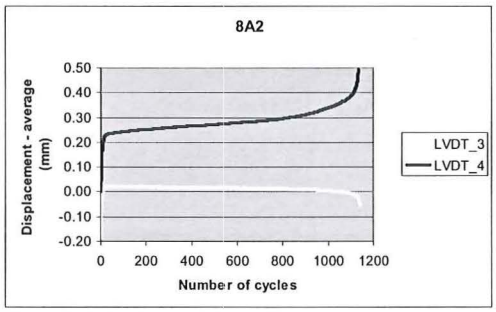


Figure 8A2-11: Local deformation (average)

SPECIMEN 8A2

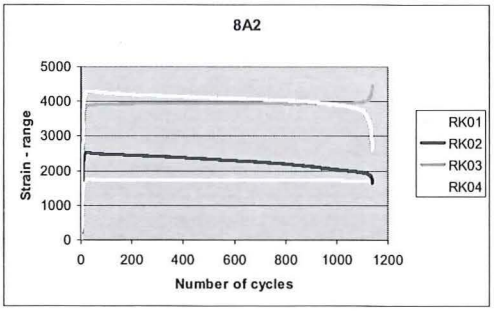


Figure 8A2-12: Measured strains (range)

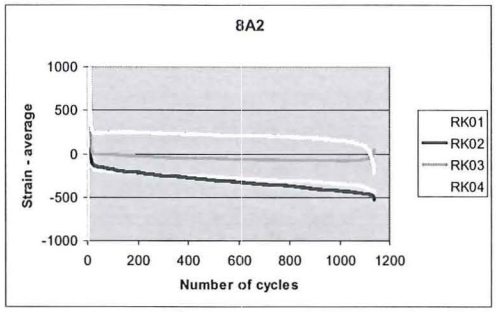


Figure 8A2-13: Measured strains (average)

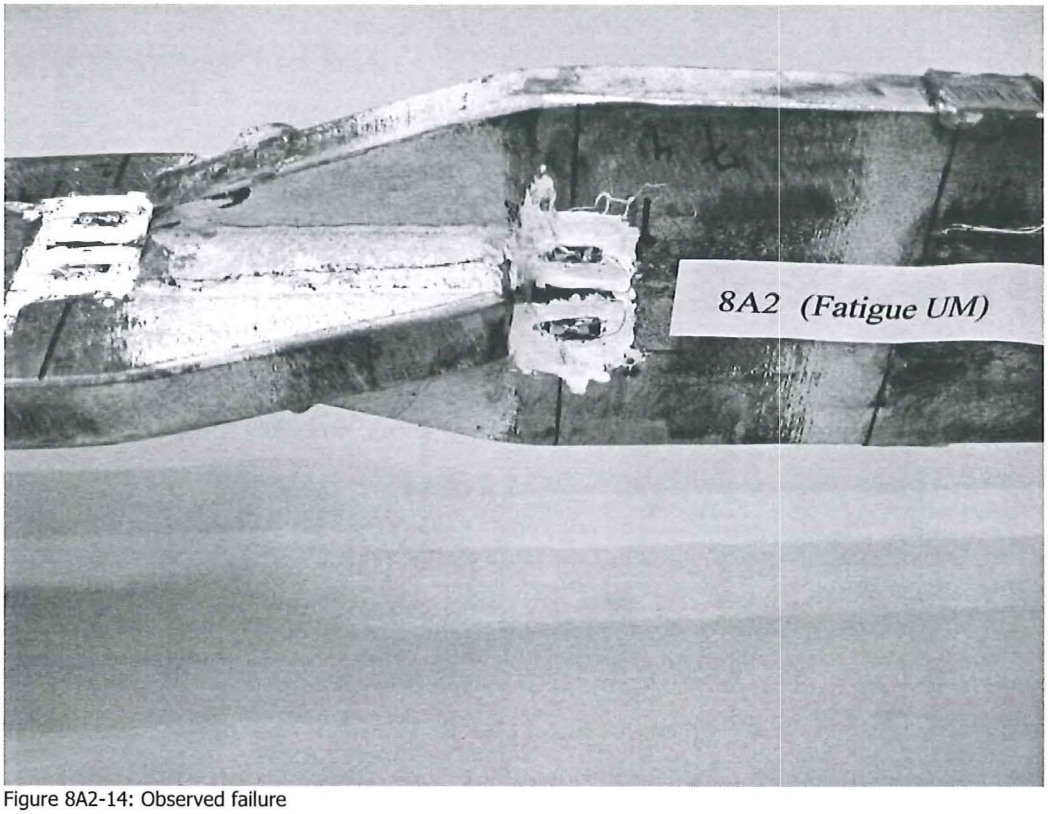


Figure 8A2-14: Observed failure

SPECIMEN 8A3

Table 8A3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	8A3 (24)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3A
Test	Type of test	Fatigue
	Parameter	Reference
	Remark	Fillet welds loaded in shear
	Failure	Weld

SPECIMEN 8A3

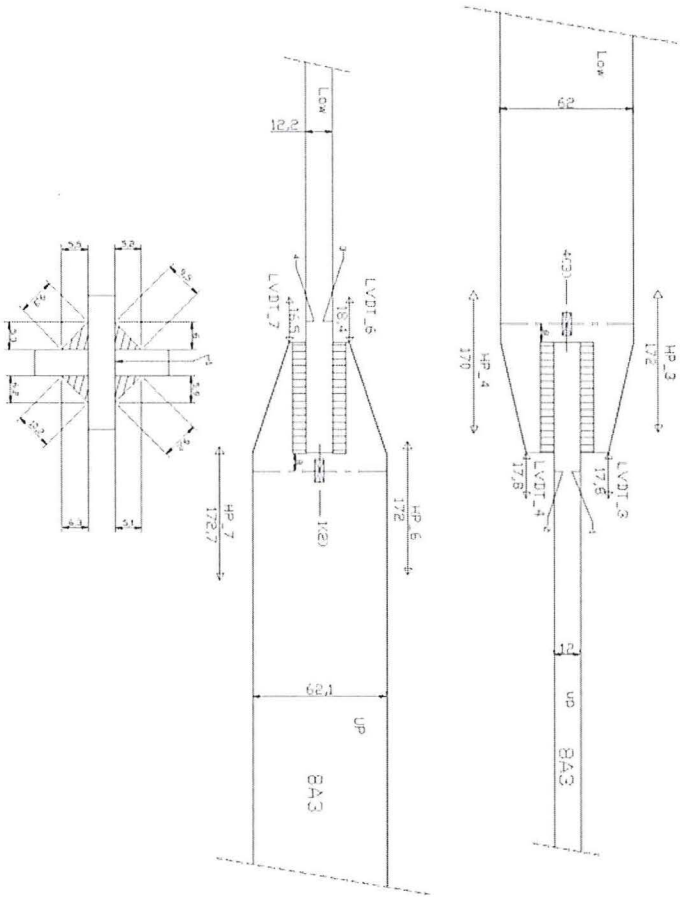


Figure 8A3-1: Dimensions of the test specimen

Figure 8A3-2: Dimensions of the welds

Figure 8A3-3: Position of strain gauges and LVDT's

SPECIMEN 8A3

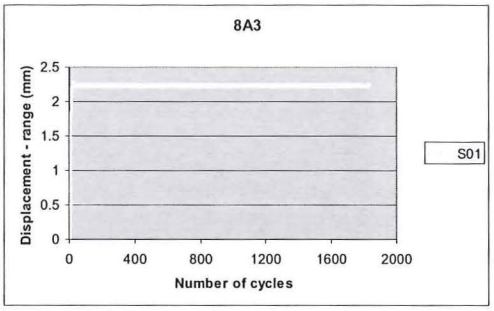


Figure 8A3-4: Test displacement controlled (range)

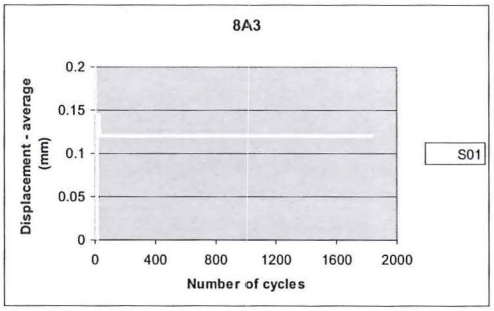


Figure 8A3-5: Test displacement controlled (average)

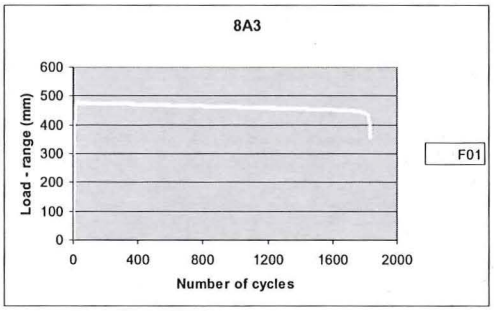


Figure 8A3-6: Test load (range)

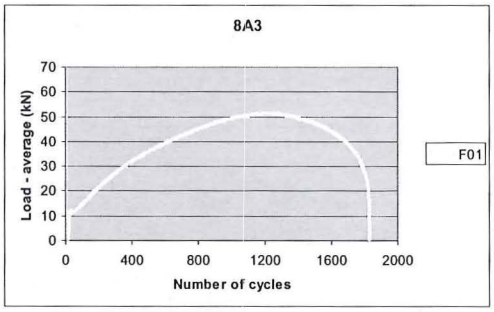


Figure 8A3-7: Test load (average)

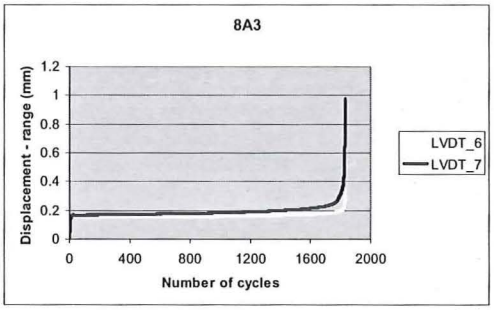


Figure 8A3-8: Deformation whole connection (range)

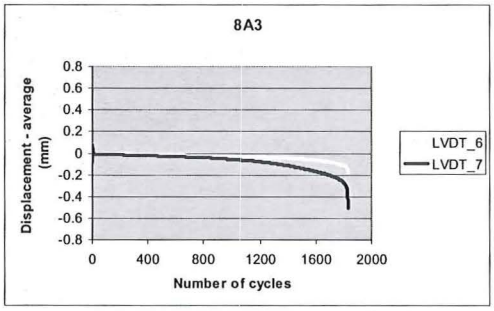


Figure 8A3-9: Deformation whole connection (average)

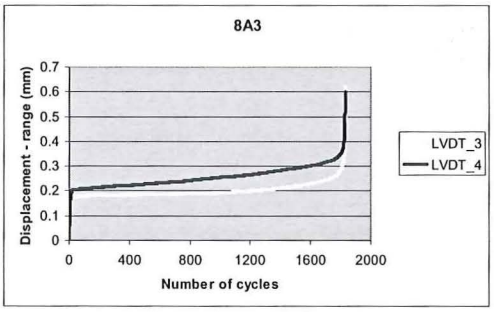


Figure 8A3-10: Local deformation (range)

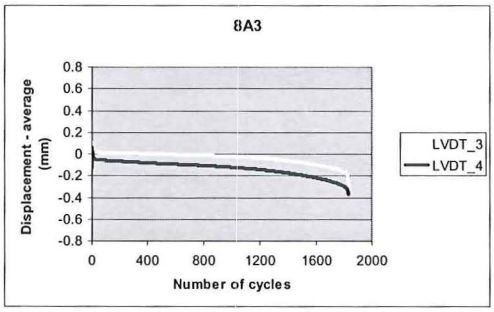


Figure 8A3-11: Local deformation (average)

SPECIMEN 8A3

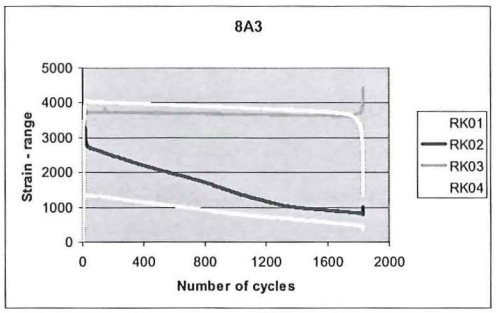


Figure 8A3-12: Measured strains (range)

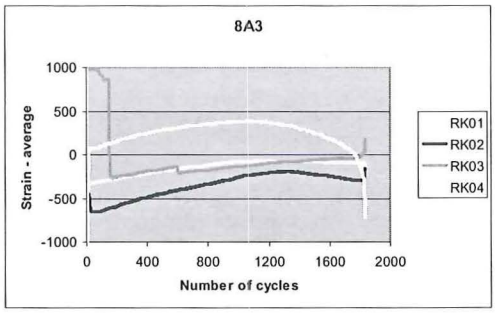


Figure 8A3-13: Measured strains (average)

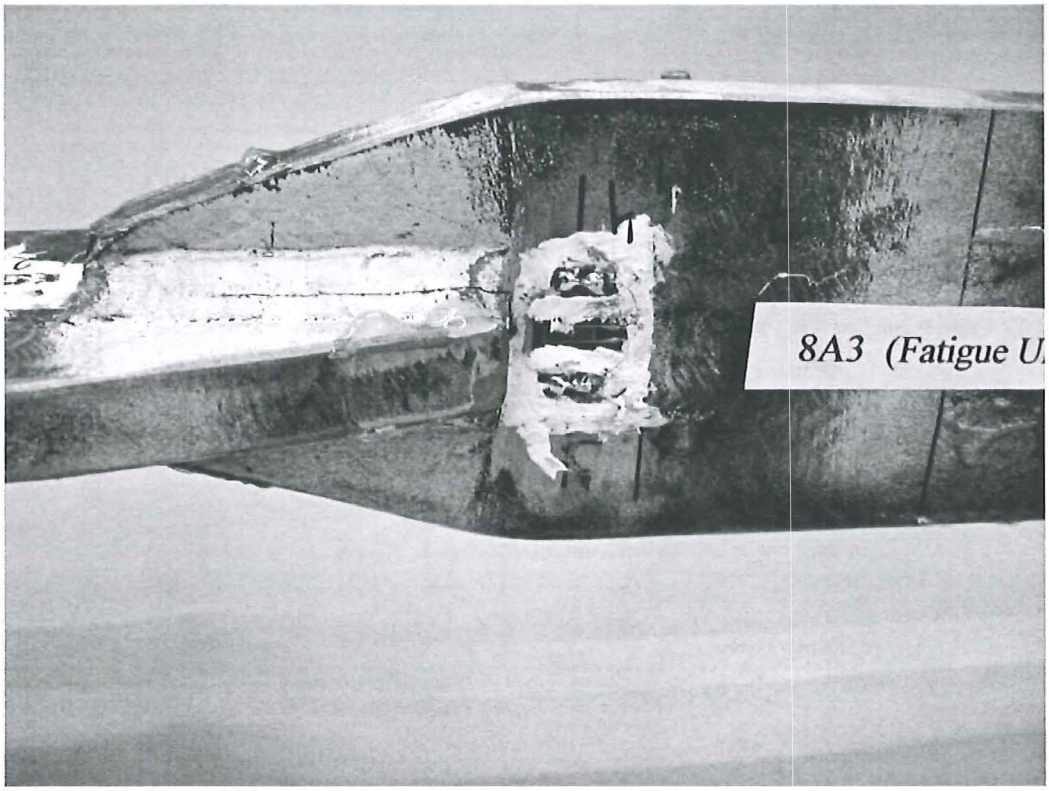


Figure 8A3-14: Observed failure

SPECIMEN 8A4

Table 8A4-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	8A4 (25)
	Type of specimen	Cross plate connection
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Fillet welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3A
Test	Type of test	Ratcheting
	Parameter	Under matched
	Remark	Fillet welds loaded in shear
	Failure	Weld

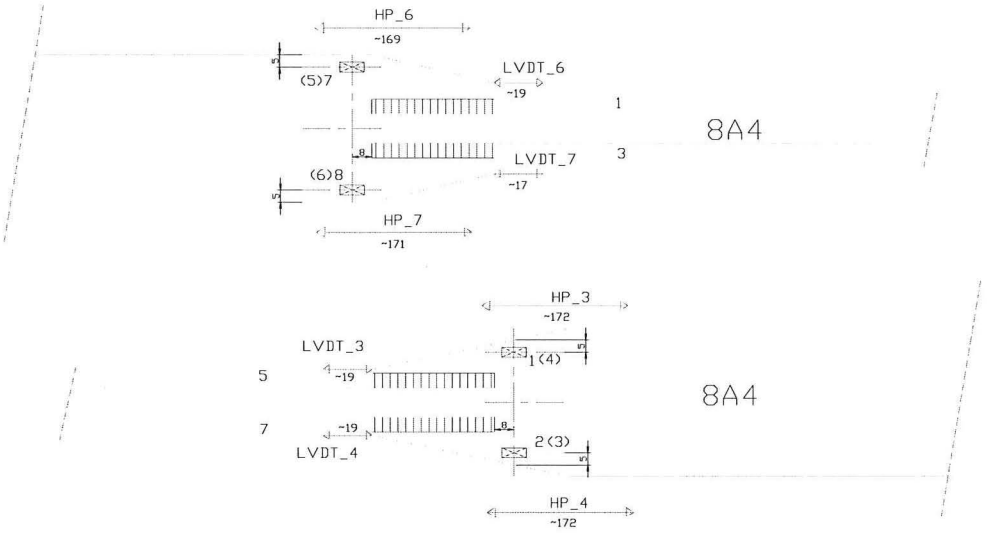


Figure 58.1: Top views of the test specimen with the position of the strain gauges. The sizes of the measuring equipment were not measured. The dimensions presented are the ones used for 1A4.

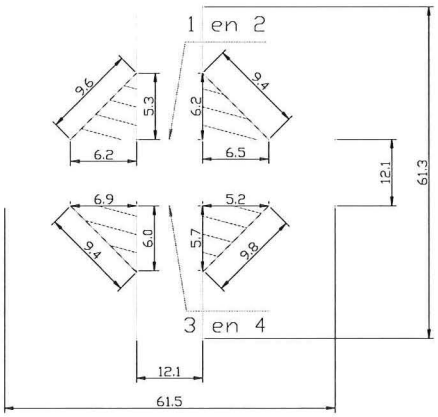
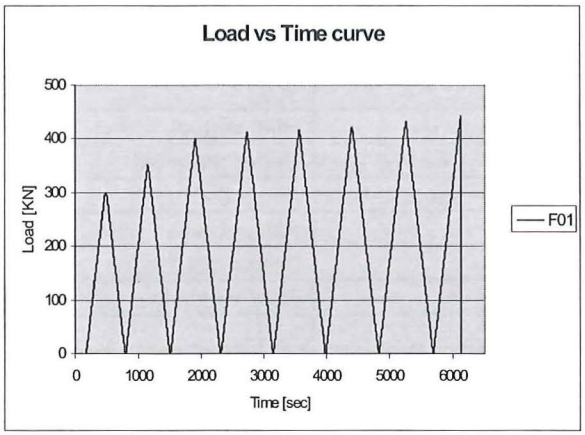
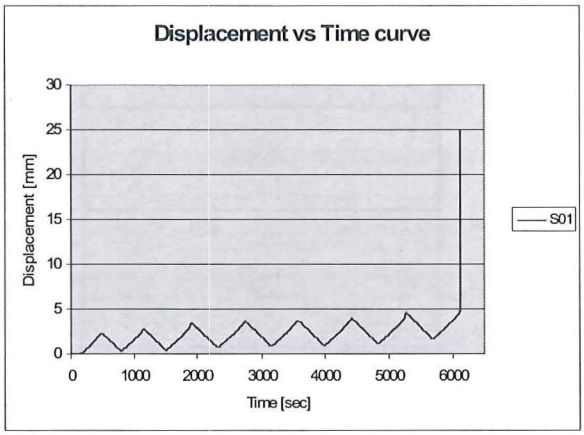


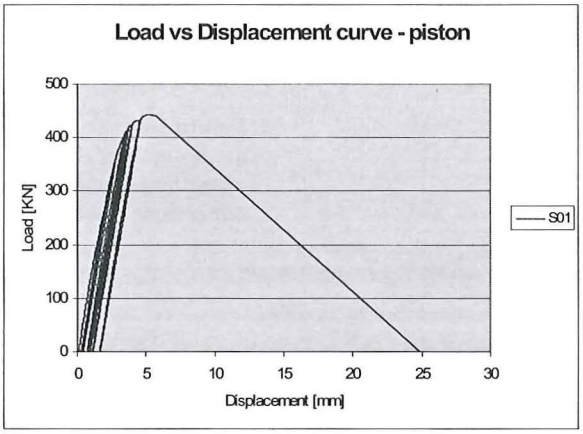
Figure 58.2: Top view, with the sizes of the welds.

SPECIMEN 8A4



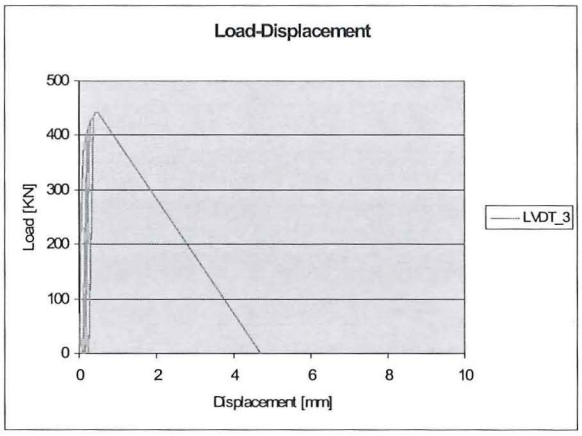


Cycle	Time [sec]	Peak Force [KN]	Displacement [mm]
1	493	299	2.28
2	1146	352	2.75
3	1911	402	3.44
4	2737	411	3.64
5	3567	416	3.74
6	4408	422	3.97
7	5259	431	0.00
8	6118	442	5.32

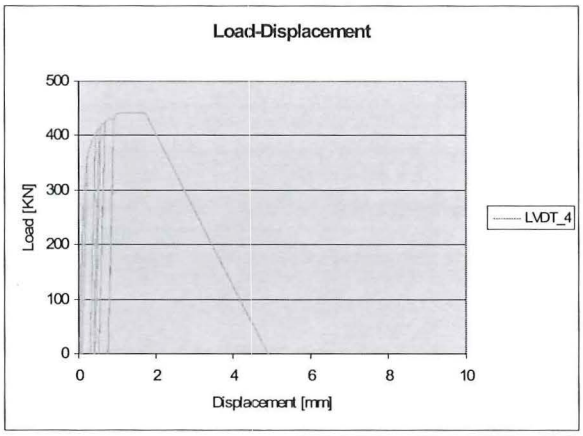


F_{max} [KN]	442
S_{Fmax} [mm]	5.32
S_{max} [mm]	24.98

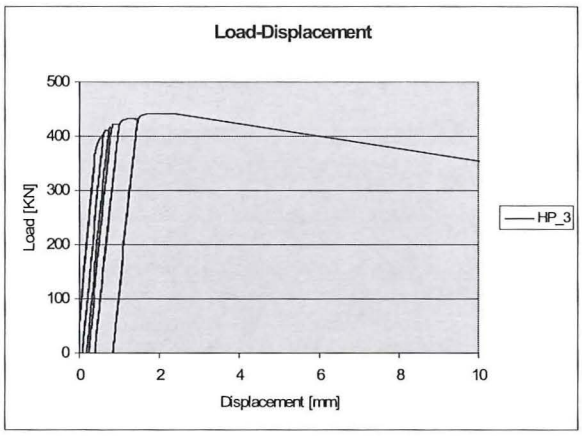
SPECIMEN 8A4



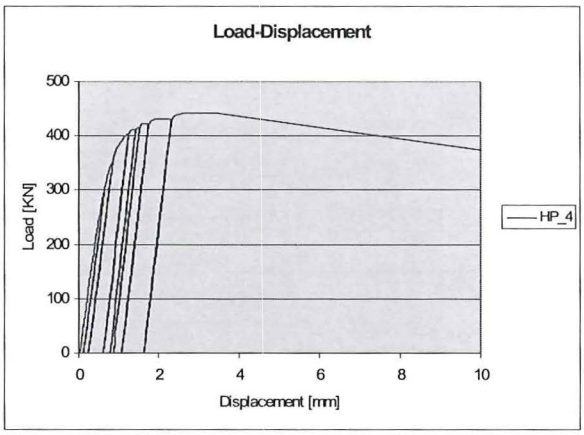
	Range [mm]	S_{Fmax} [mm]
LVDT_3	~ 19.0	0.46



	Range [mm]	S_{Fmax} [mm]
LVDT_4	~ 19.0	1.34

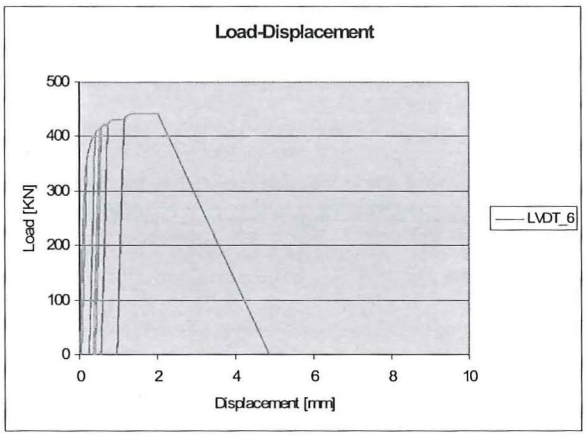


	Range [mm]	S_{Fmax} [mm]
HP_3	~ 172.0	2.03

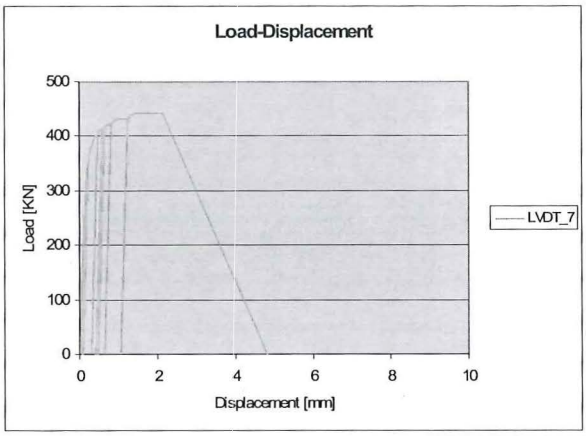


	Range [mm]	S_{Fmax} [mm]
HP_4	~ 172.0	3.01

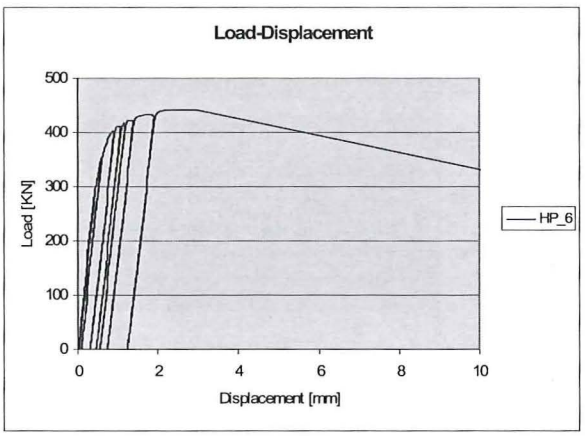
SPECIMEN 8A4



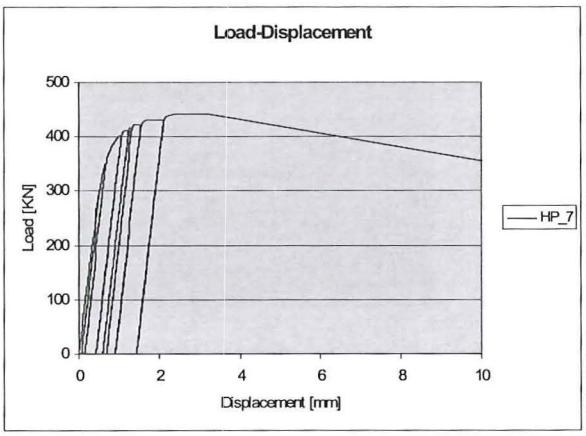
	Range [mm]	S_{Fmax} [mm]
LVDT_6	~ 19.0	1.67



	Range [mm]	SFmax [mm]
LVDT_7	~ 17.0	1.77

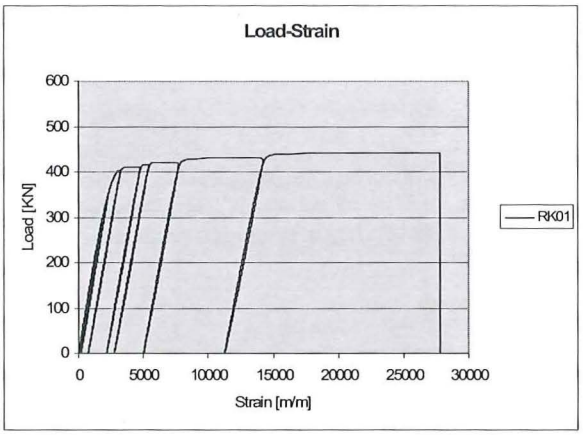


	Range [mm]	S_{Fmax} [mm]
HP_6	~ 169.0	2.55

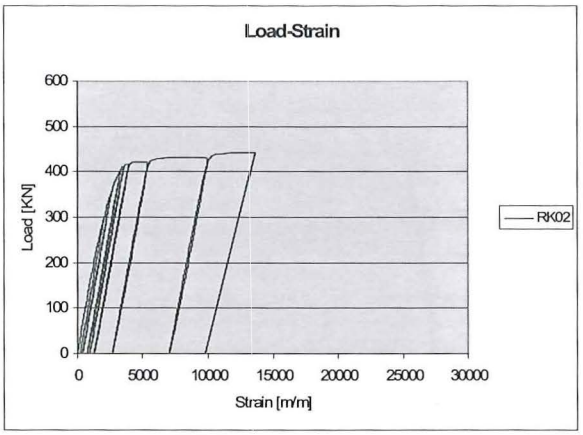


	Range [mm]	S_{Fmax} [mm]
HP_7	~ 171.0	2.78

SPECIMEN 8A4



	ε_{Fmax} [m/m]
RK01	24085.50



	ε_{Fmax} [m/m]
RK02	12885.10

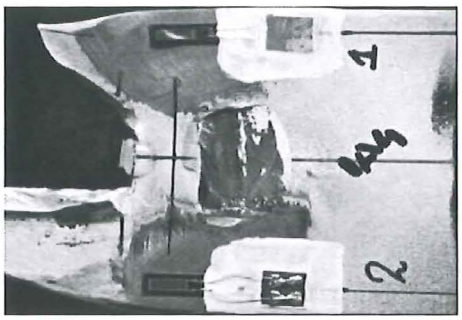
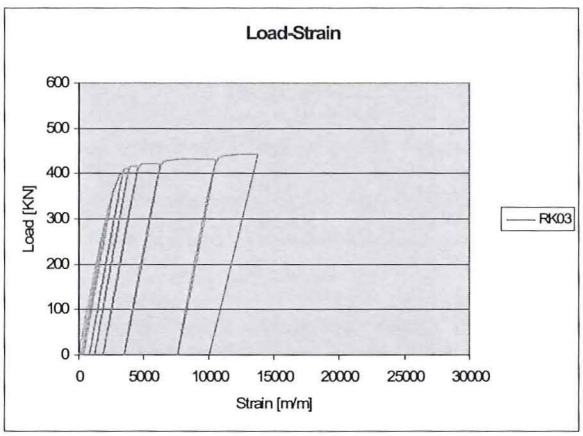
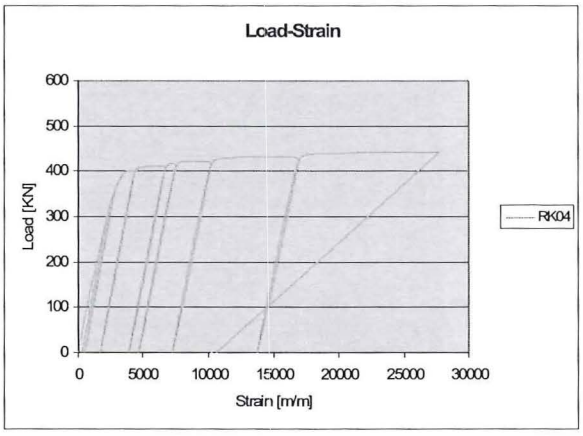


Figure 58.3: Test specimen face with the position of the strain gauges 1 and 2.



	ε_{Fmax} [m/m]
RK03	13190.50



	ε_{Fmax} [m/m]
RK04	26010.80

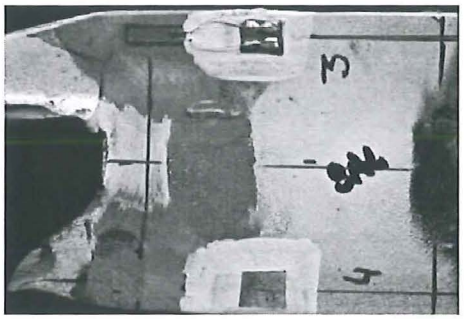
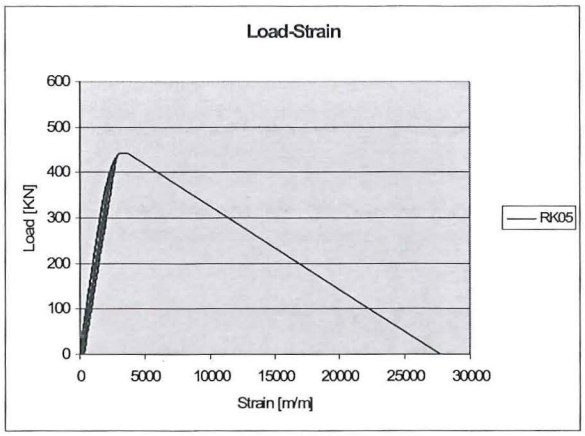
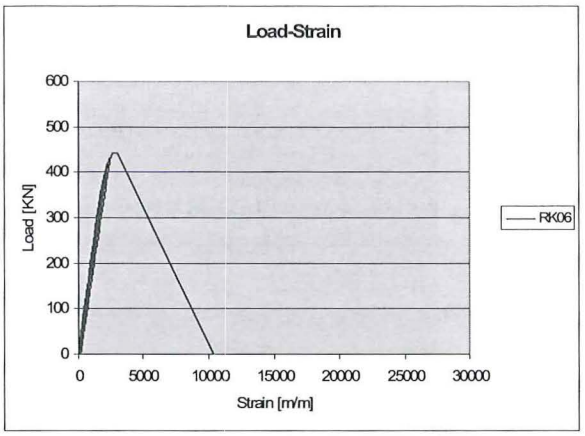


Figure 58.4: Test specimen face with the position of the strain gauges 3 and 4.

SPECIMEN 8A4



	ε_{Fmax} [m/m]
RK05	3082.42



	ε_{Fmax} [m/m]
RK06	2739.93

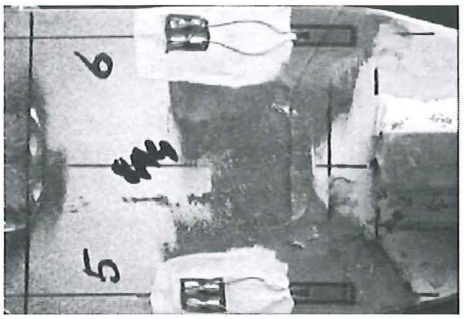
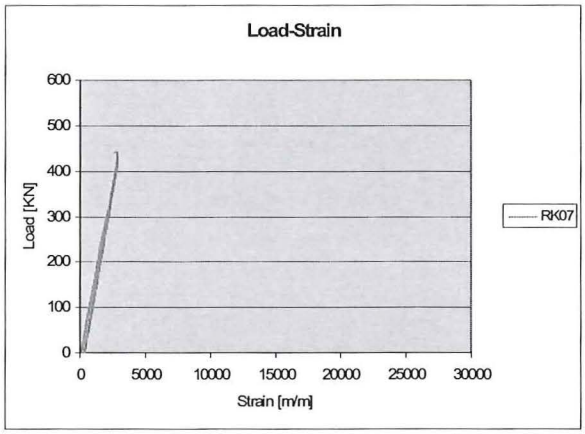
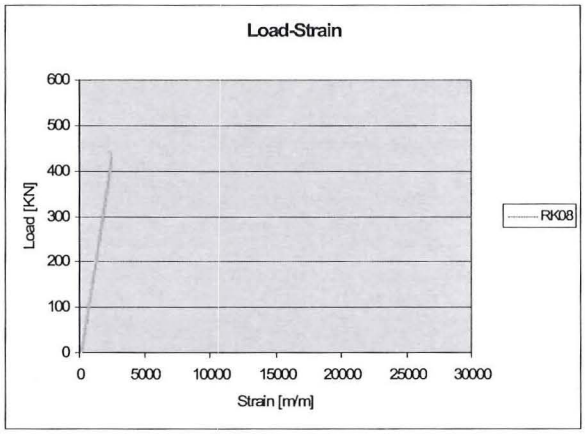


Figure 58.5: Test specimen face with the position of the strain gauges 5 and 6.



	ε_{Fmax} [m/m]
RK07	2813.98



	ε_{Fmax} [m/m]
RK08	2360.41

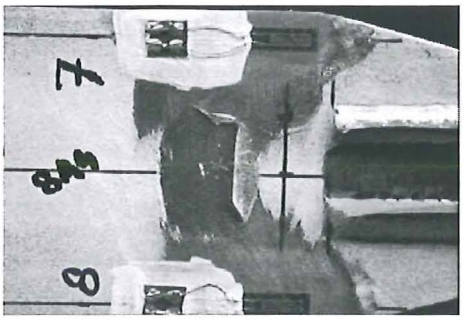
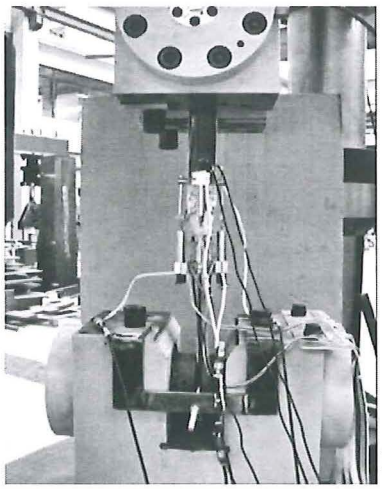
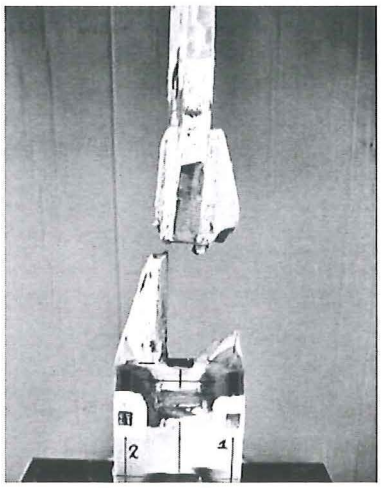


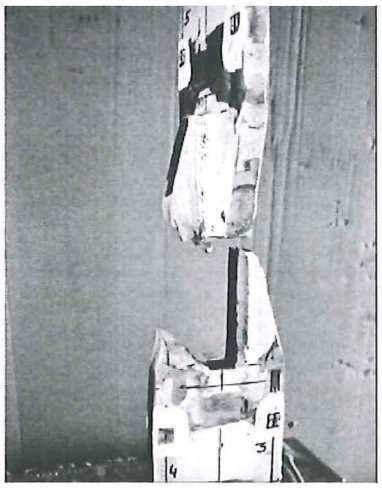
Figure 58.6: Test specimen face with the position of the strain gauges 7 and 8.

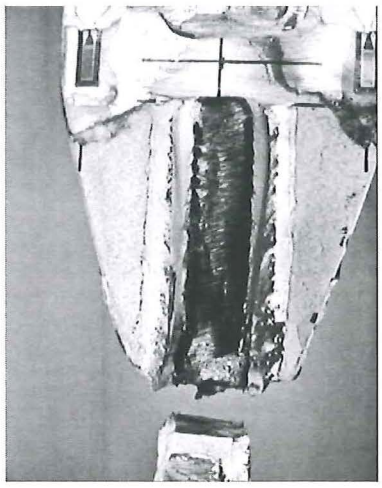
SPECIMEN 8A4



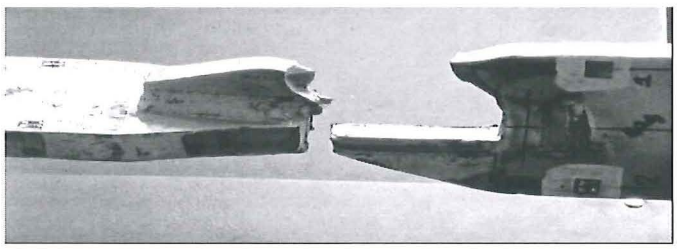
Figures 53.7: Test specimen during the test.

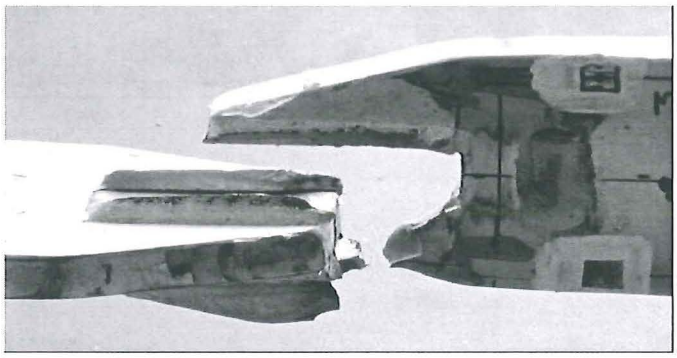






Figures 53.8, 53.9 and 53.10: Different side views of the test specimen after failure.





Figures 53.11 and 53.12: Detailed prespectives of the failure in the weld.

SPECIMEN 3B1

Table 3B1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	3B1 (26)
	Type of specimen	X-joint with low SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3B
Test	Type of test	Static strength
	Parameter	Under matched
	Remark	Low SCF
	Failure	Plate

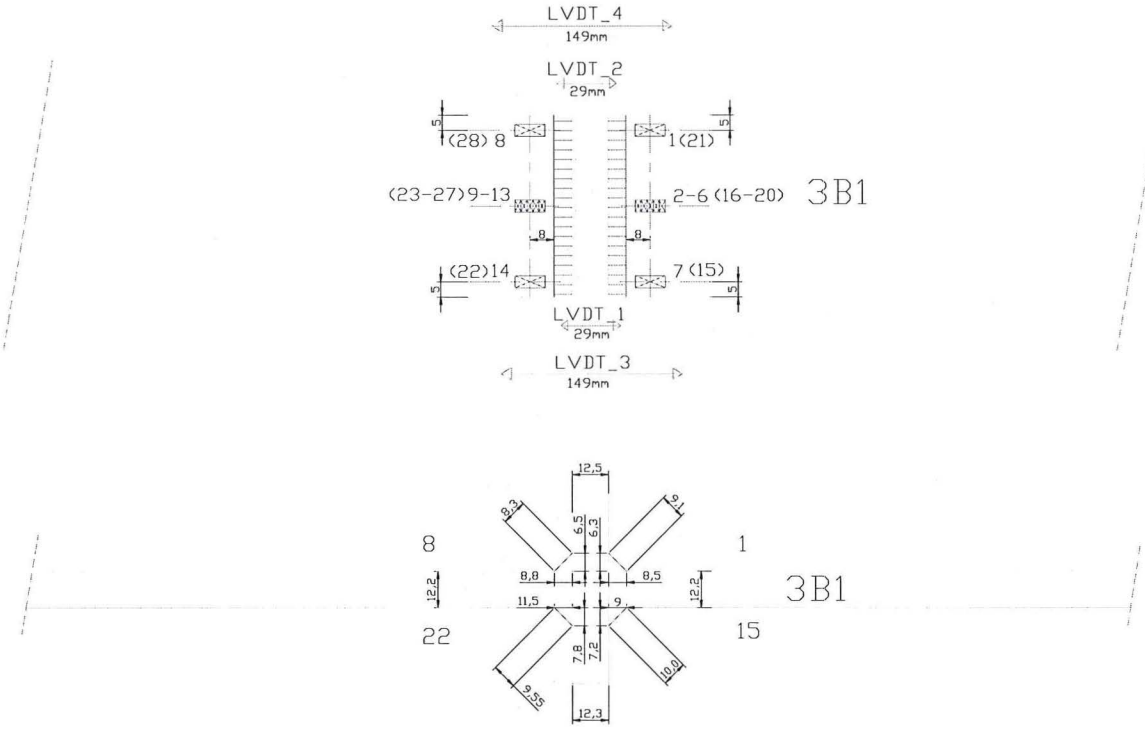
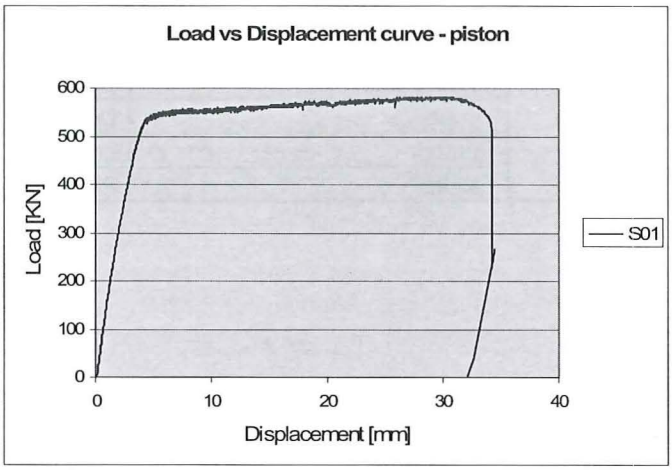
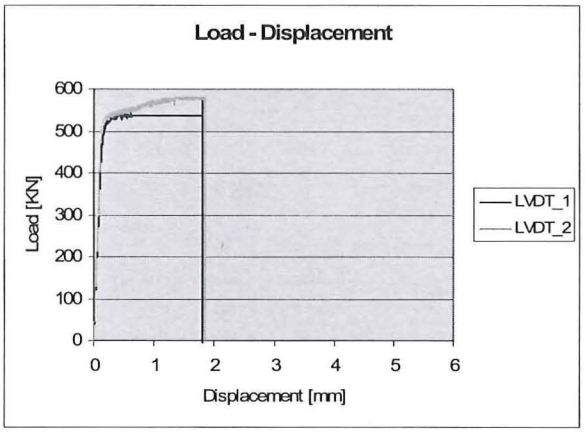


Figure 26.1: Top and side views of the test specimen with the position of the strain gauges and sizes of the measuring equipment and welds.

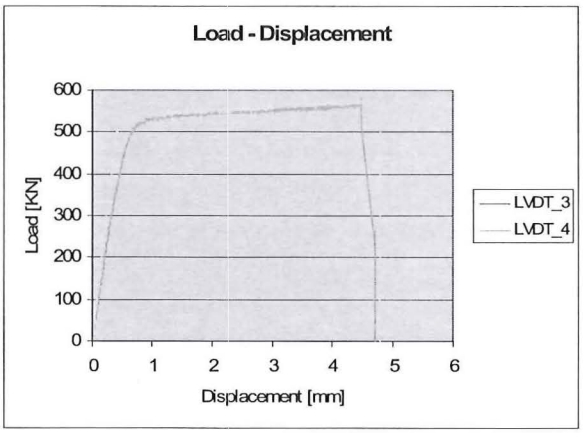
SPECIMEN 3B1



F_{max} [KN]	582
S_{Fmax} [mm]	28.02
S_{max} [mm]	34.48

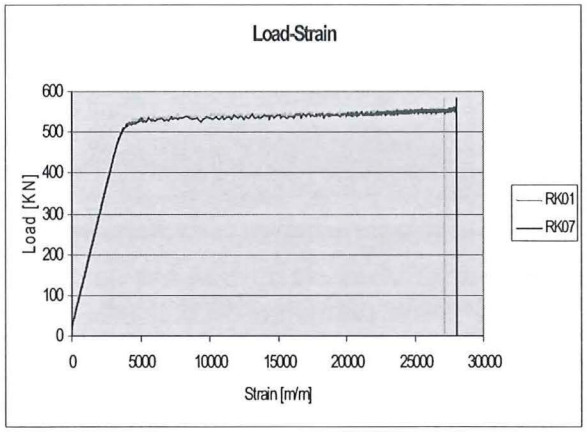


	Range [mm]	S_{Fmax} [mm]
LVDT_1	29	1.81
LVDT_2	29	1.78

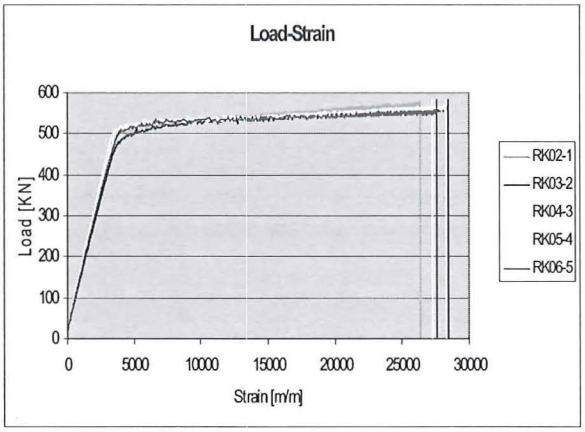


	Range [mm]	S_{Fmax} [mm]
LVDT_3	149	4.47
LVDT_4	149	4.80

SPECIMEN 3B1



	ε_{Fmax} [m/m]
RK01	27147.50
RK07	28044.60



	ε_{Fmax} [m/m]
RK02-1	26390.10
RK03-2	28444.10
RK04-3	28279.10
RK05-4	27215.40
RK06-5	27591.30

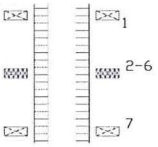
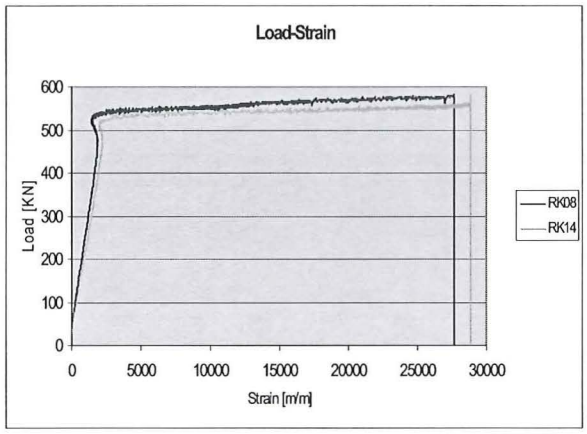
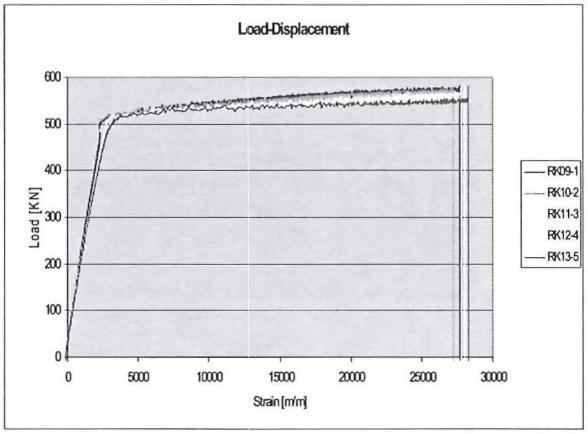


Figure 26.2: Drawing of the test specimen face with the position of the strain gauges 1 to 7.



	ε_{Fmax} [m/m]
RK08	27670.80
RK14	28829.60



	ε_{Fmax} [m/m]
RK09-1	27692.20
RK10-2	27224.50
RK11-3	27747.20
RK12-4	28013.10
RK13-5	28242.40

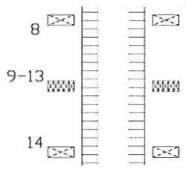
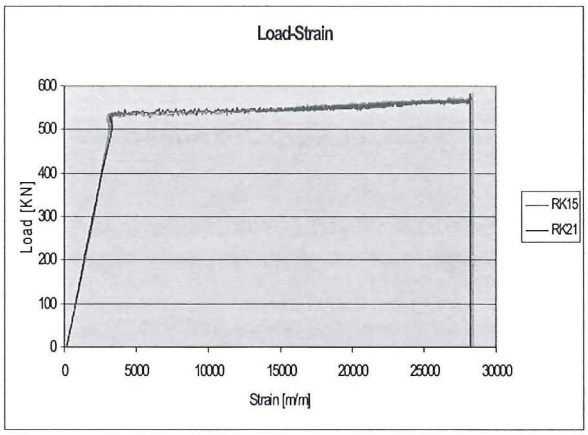
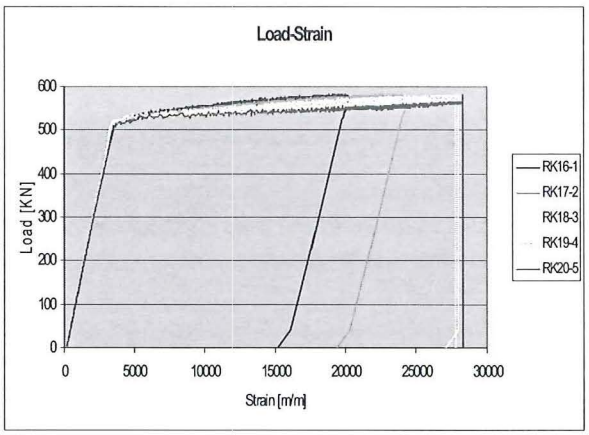


Figure 26.3: Drawing of the test specimen face with the position of the strain gauges 8 to 14.

SPECIMEN 3B1



	ε_{Fmax} [m/m]
RK15	28381.10
RK21	28259.60



	ε_{Fmax} [m/m]
RK16-1	18845.70
RK17-2	22107.90
RK18-3	27939.80
RK19-4	27774.70
RK20-5	28324.90

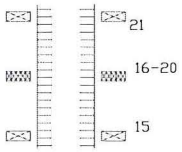
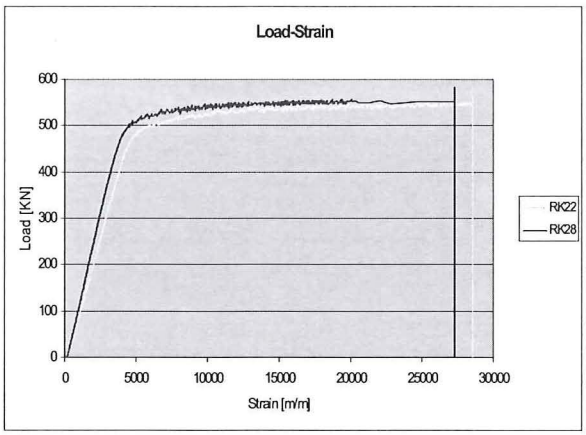
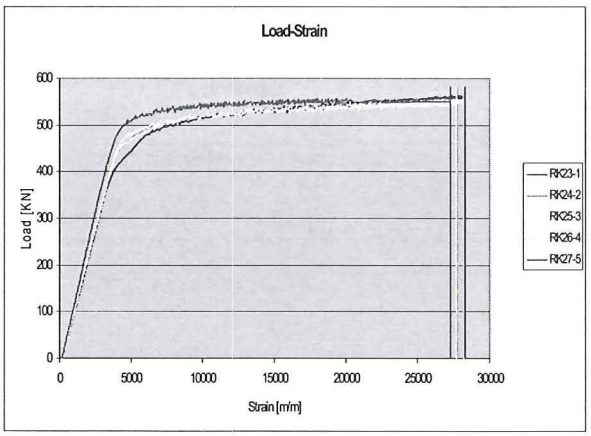


Figure 26.4: Drawing of the test specimen face with the position of the strain gauges 15 to 21.



	ε_{Fmax} [m/m]
RK22	28549.30
RK28	27269.00



	ε_{Fmax} [m/m]
RK23-1	28315.70
RK24-2	27793.10
RK25-3	28178.20
RK26-4	27655.50
RK27-5	27710.50

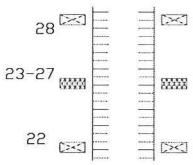


Figure 26.5: Drawing of the test specimen face with the position of the strain gauges 22 to 28.

SPECIMEN 3B1

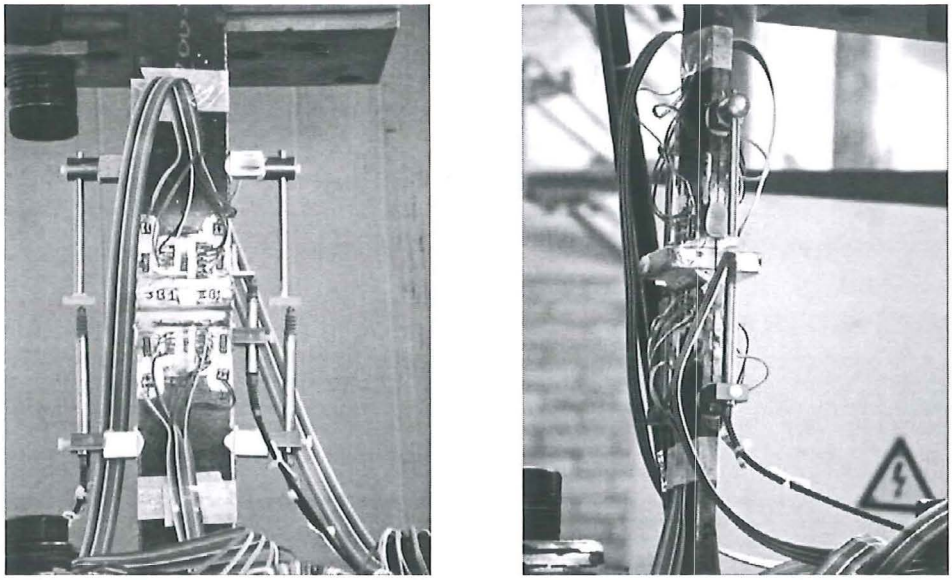


Figure 22.6: Test specimen during the test.

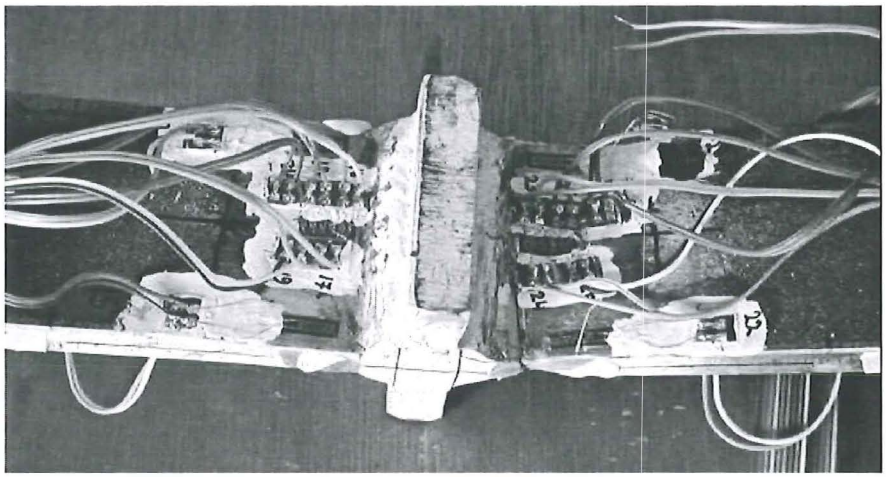


Figure 22.7: Test specimen after failure.

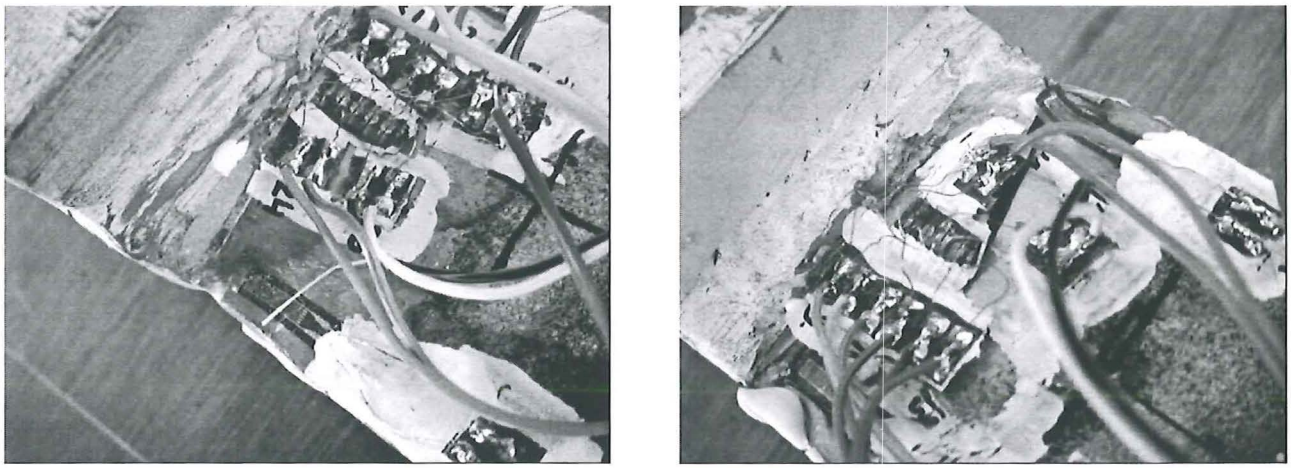


Figure 22.8 and 22.9: Perspectives of the crack in the plate.

SPECIMEN 3B2

Table 3B2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	3B2 (27)
	Type of specimen	X-joint with low SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3B
Test	Type of test	Fatigue
	Parameter	Under matched
	Remark	Low SCF
	Failure	Weld

SPECIMEN 3B2

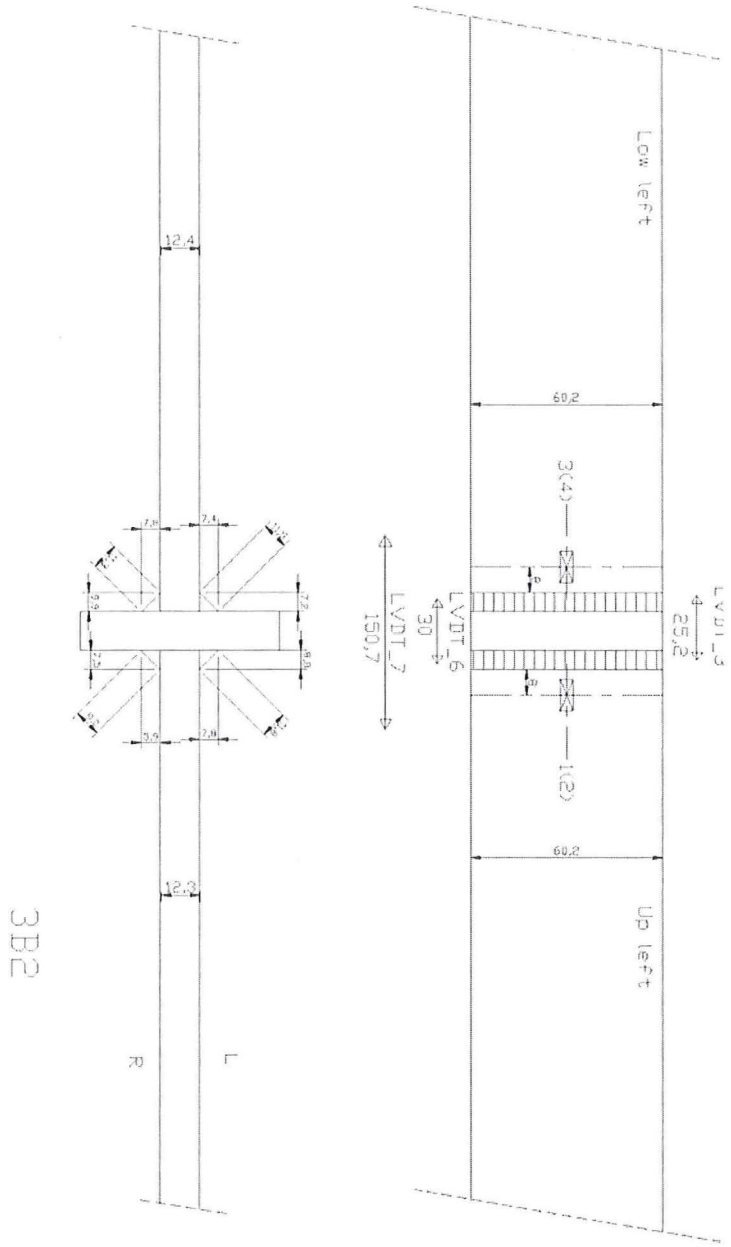


Figure 3B2-1: Dimensions of the test specimen

Figure 3B2-2: Dimensions of the welds

Figure 3B2-3: Position of strain gauges and LVDT's

SPECIMEN 3B2

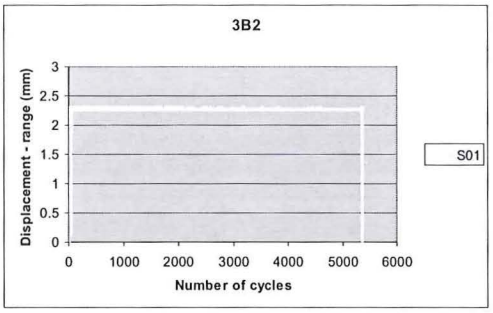


Figure 3B2-4: Test displacement controlled (range)

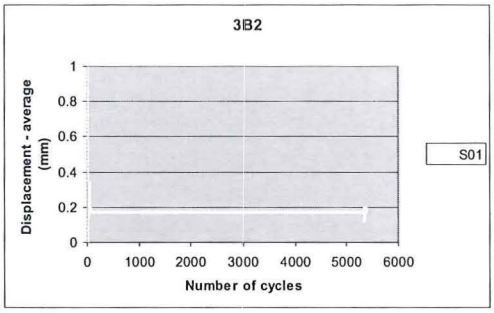


Figure 3B2-5: Test displacement controlled (average)

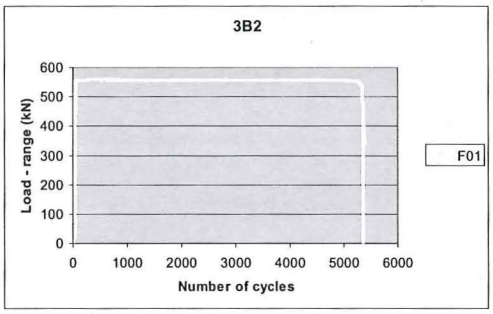


Figure 3B2-6: Test load (range)

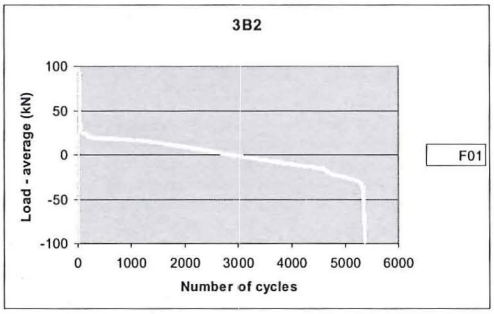


Figure 3B2-7: Test load (average)

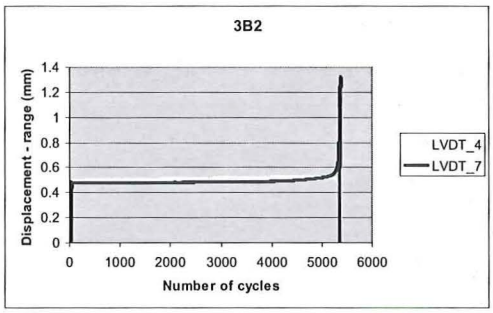


Figure 3B2-8: Deformation whole connection (range)

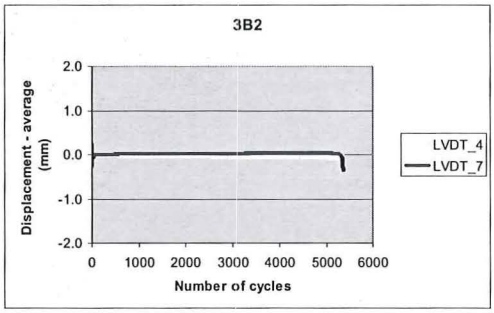


Figure 3B2-9: Deformation whole connection (average)

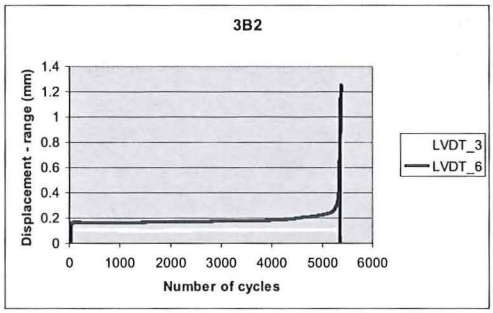


Figure 3B2-10: Local deformation (range)

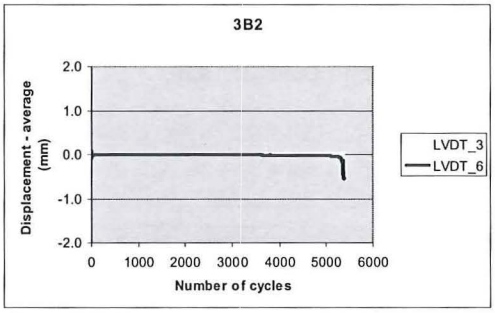


Figure 3B2-11: Local deformation (average)

SPECIMEN 3B2

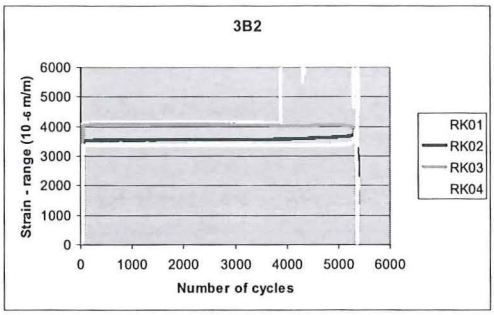


Figure 3B2-12: Measured strains (range)

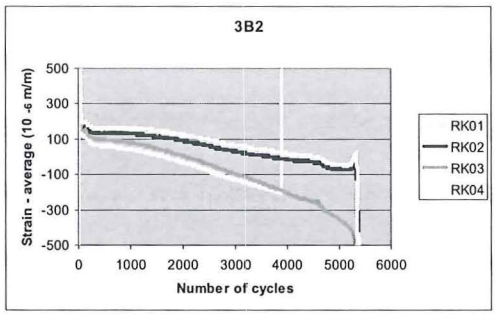


Figure 3B2-13: Measured strains (average)

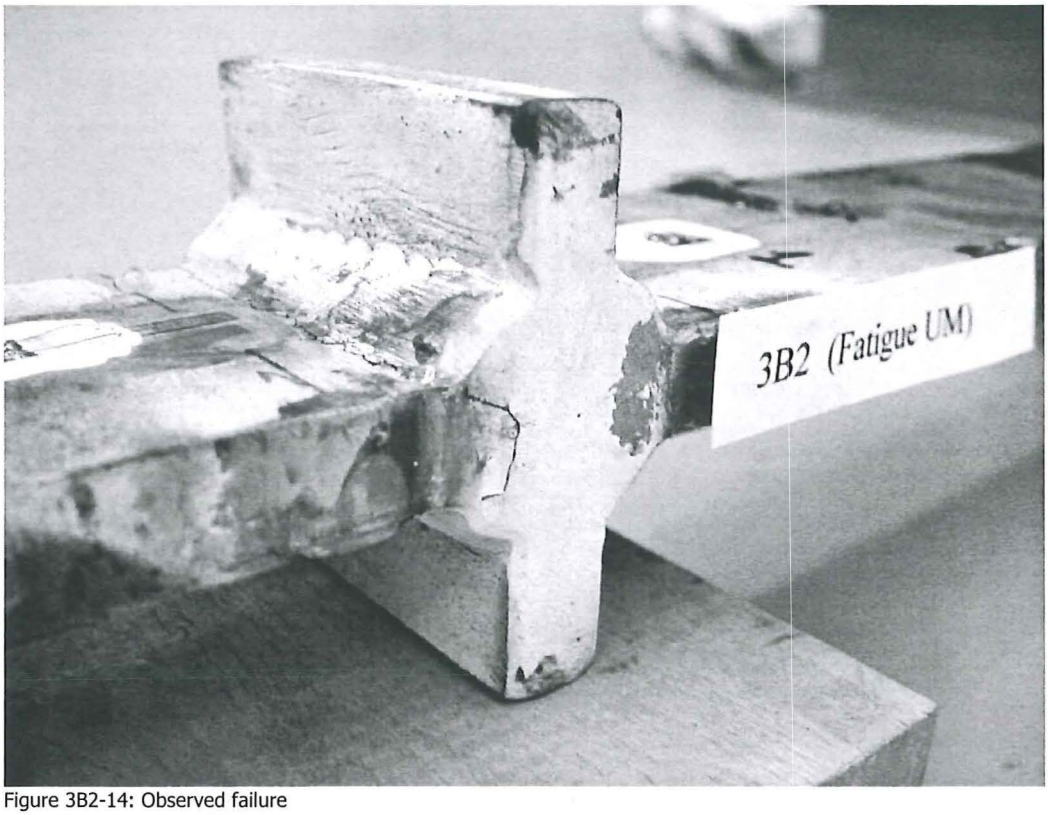


Figure 3B2-14: Observed failure

SPECIMEN 3B3

Table 3B3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	3B3 (28)
	Type of specimen	X-joint with low SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3B
Test	Type of test	Fatigue
	Parameter	Under matched
	Remark	Low SCF
	Failure	Weld

SPECIMEN 3B3

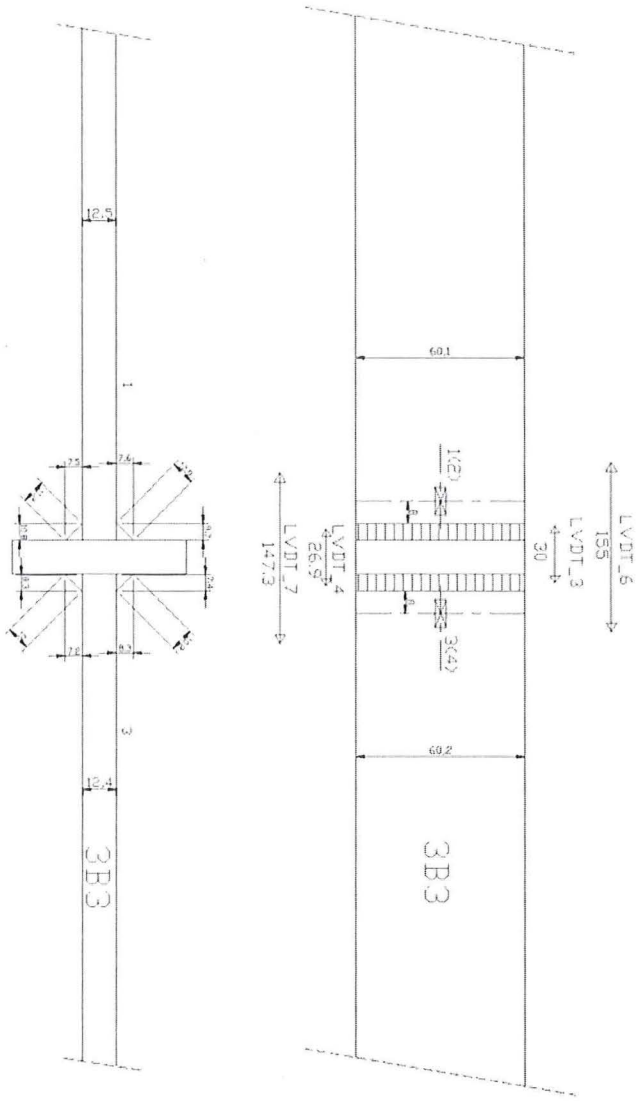


Figure 3B3-1: Dimensions of the test specimen

Figure 3B3-2: Dimensions of the welds

Figure 3B3-3: Position of strain gauges and LVDT's

SPECIMEN 3B3

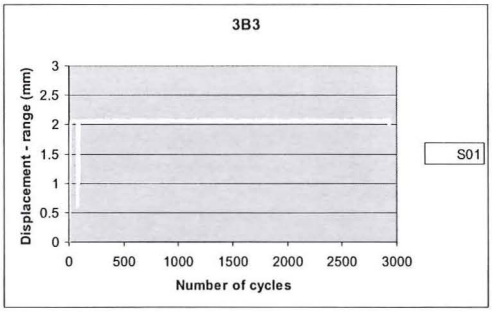


Figure 3B3-4: Test displacement controlled (range)

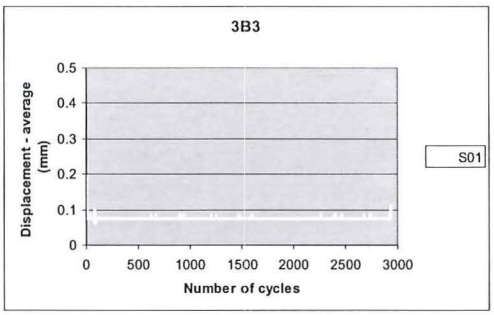


Figure 3B3-5: Test displacement controlled (average)

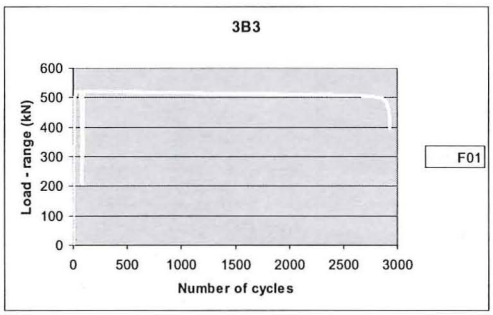


Figure 3B3-6: Test load (range)

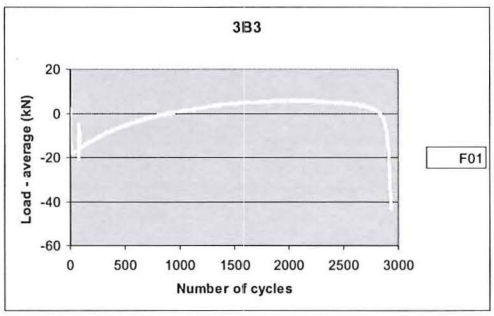


Figure 3B3-7: Test load (average)

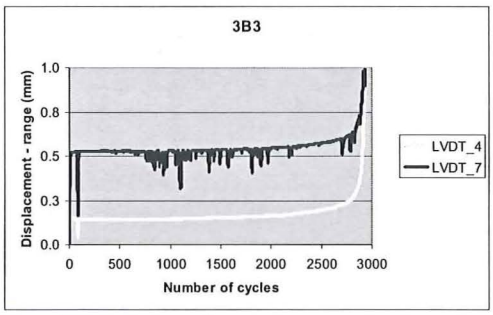


Figure 3B3-8: Deformation whole connection (range)

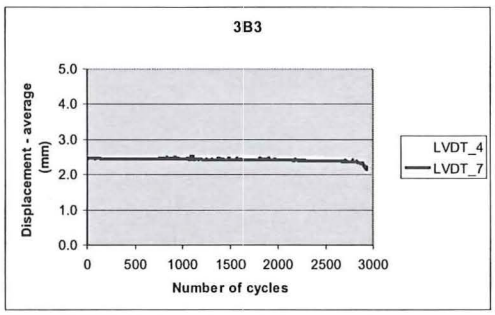


Figure 3B3-9: Deformation whole connection (average)

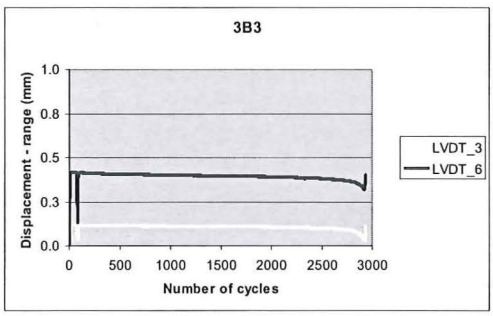


Figure 3B3-10: Local deformation (range)

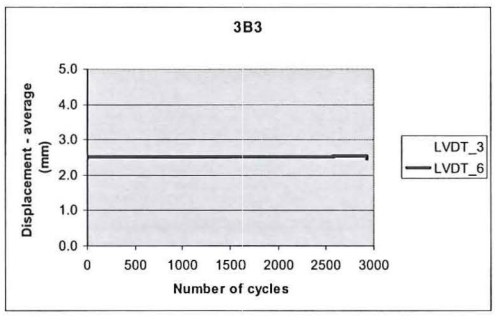


Figure 3B3-11: Local deformation (average)

SPECIMEN 3B3

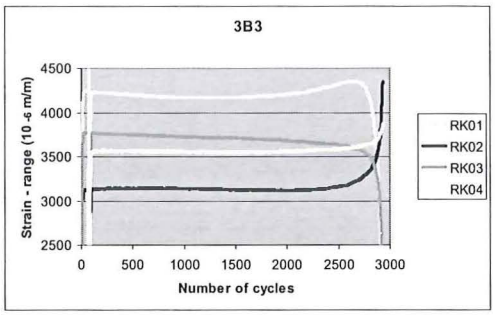


Figure 3B3-12: Measured strains (range)

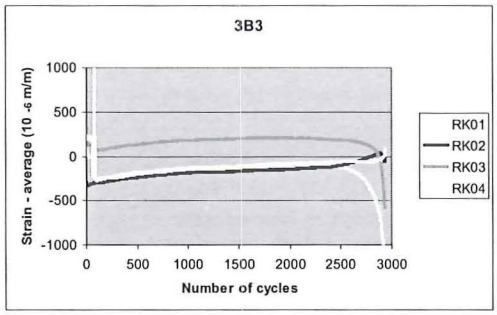


Figure 3B3-13: Measured strains (average)

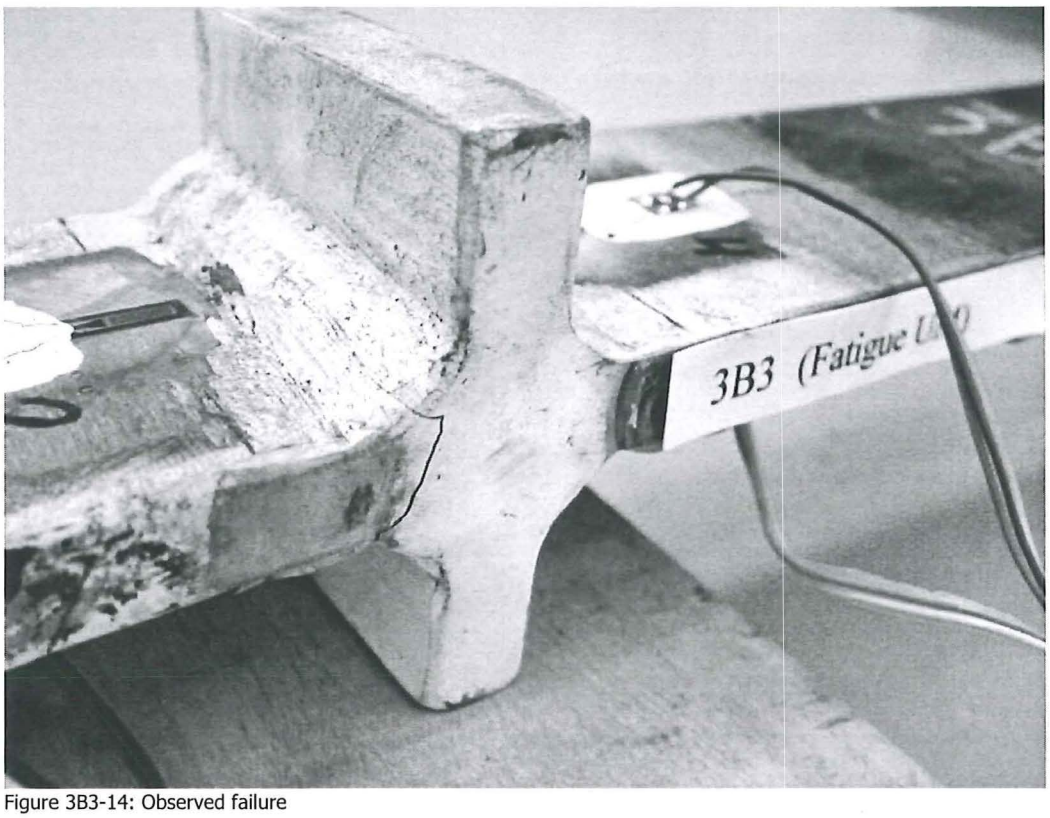


Figure 3B3-14: Observed failure

SPECIMEN 3B4

Table 3B4-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	3B4 (29)
	Type of specimen	X-joint with low SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3B
Test	Type of test	Ratcheting
	Parameter	Under matched
	Remark	Low SCF
	Failure	Weld

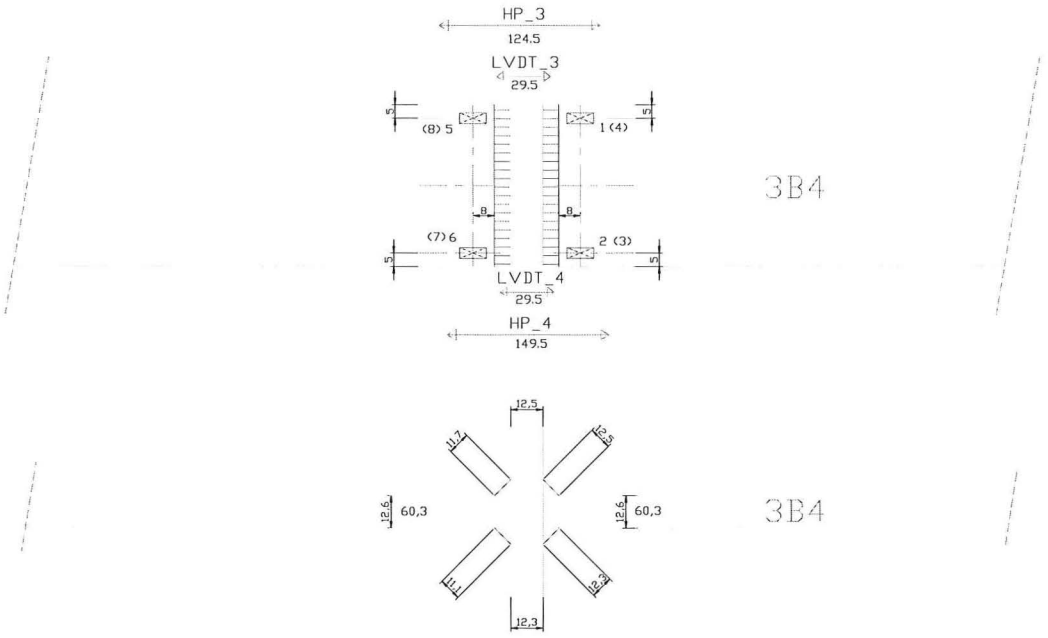
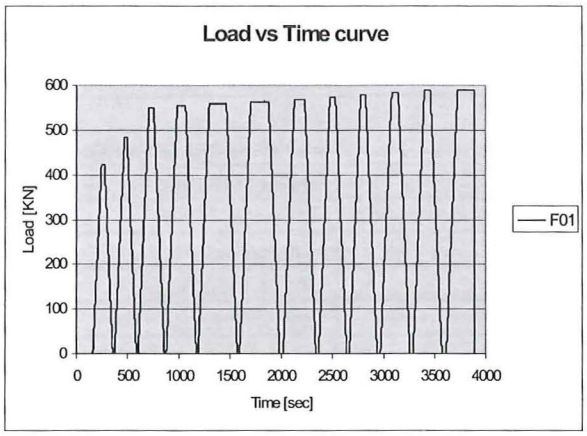
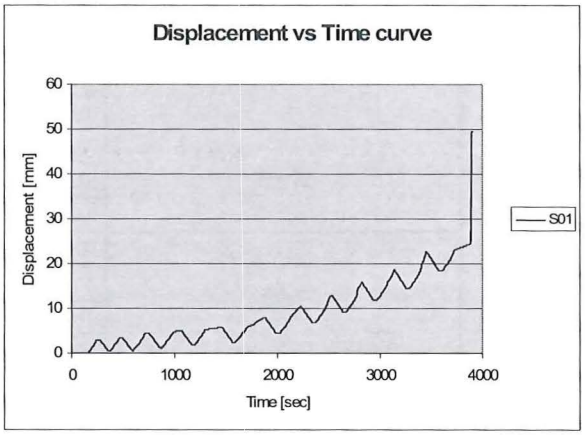


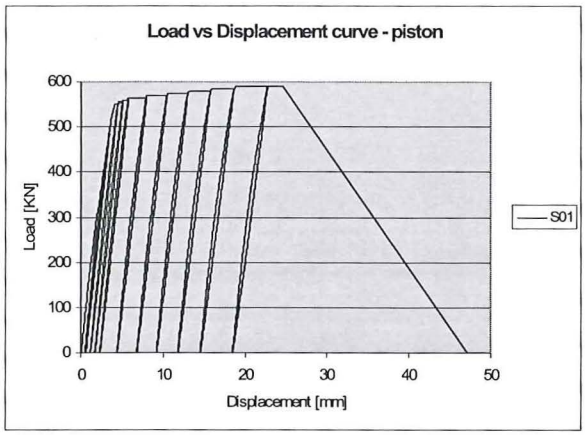
Figure 29.1 Top and side views of the test specimen with the position of the strain gauges and sizes of the measuring equipment and welds.

SPECIMEN 3B4



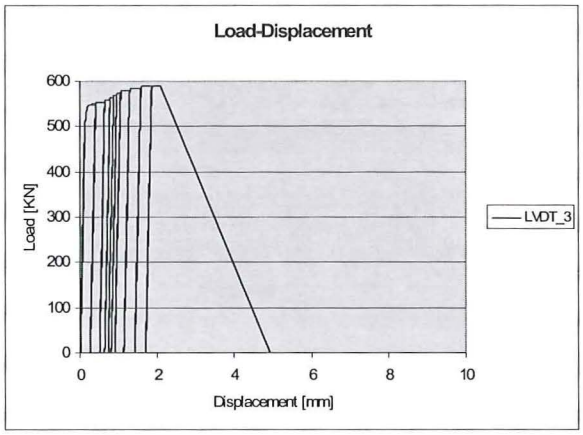


Cycle	Time [sec]	Peak Force [KN]	Displacement [mm]
1	248	424	2.98
2	490	484	3.48
3	999	554	4.69
4	1461	559	5.76
5	1872	564	7.93
6	2224	569	10.39
7	2528	574	12.96
8	2824	579	15.72
9	3144	584	18.55
10	3457	589	22.66
11	3888	589	24.49

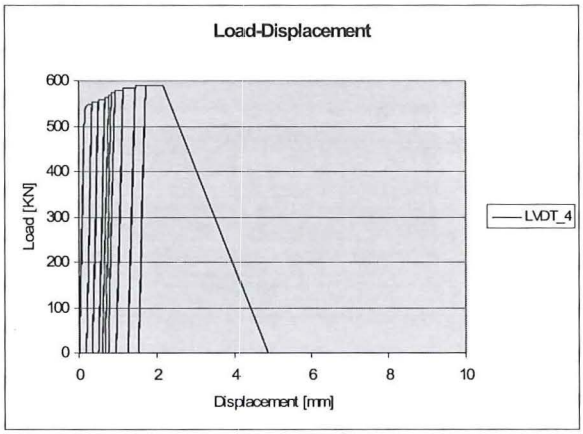


F_{max} [KN]	589
S_{Fmax} [mm]	24.49
S_{max} [mm]	49.41

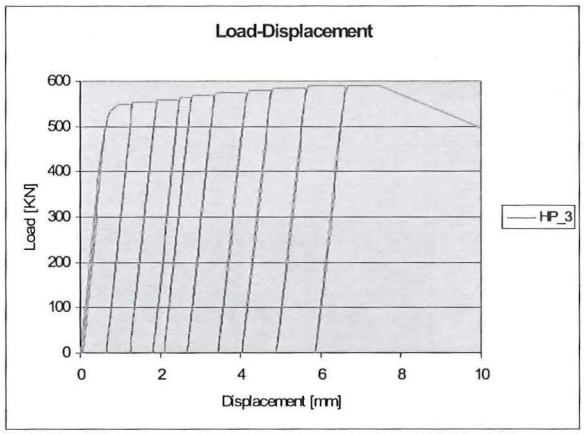
SPECIMEN 3B4



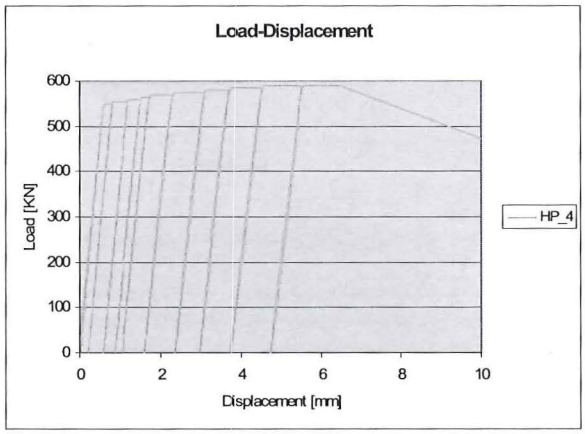
	Range [mm]	S_{Fmax} [mm]
LVDT_3	29.5	2.10



	Range [mm]	S_{Fmax} [mm]
LVDT_4	29.5	2.10

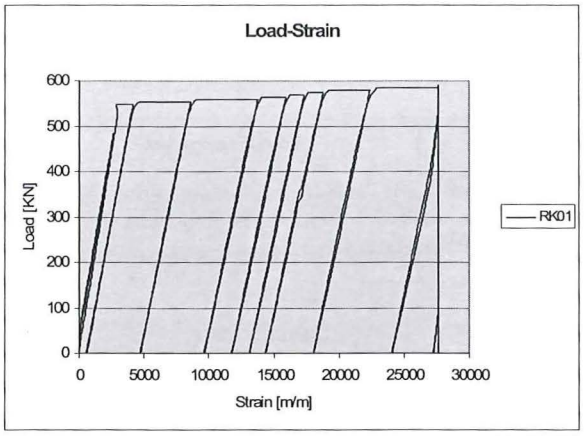


	Range [mm]	S_{Fmax} [mm]
HP_3	149.5	7.44

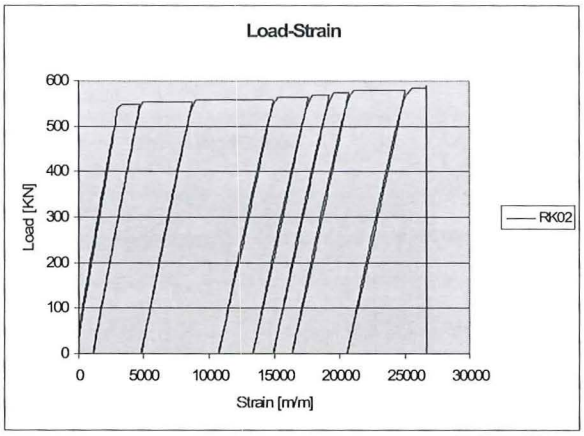


	Range [mm]	S_{Fmax} [mm]
HP_4	149.5	6.38

SPECIMEN 3B4



	ε_{Fmax} [m/m]
RK01	27649.20



	ε_{Fmax} [m/m]
RK02	26686.50

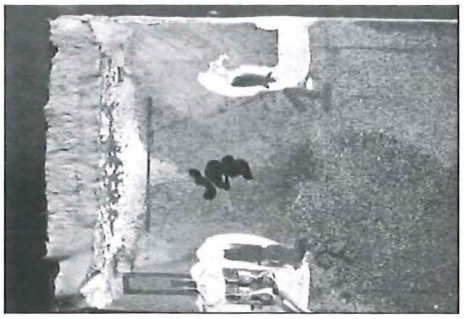
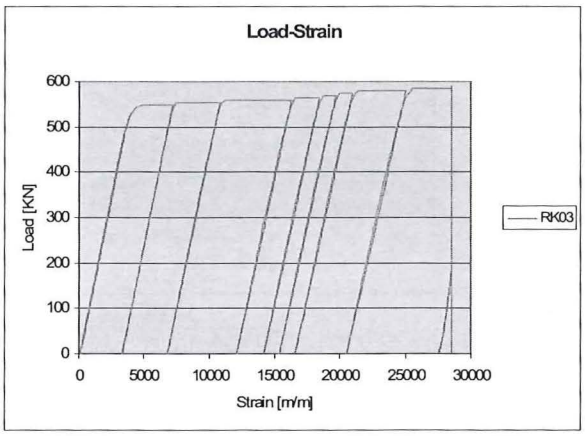
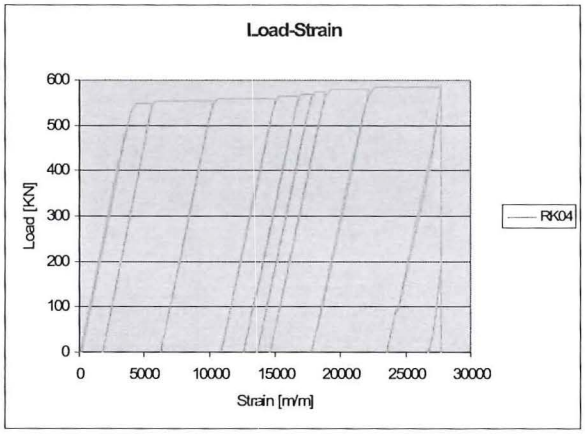


Figure 29.2 Test specimen face with the position of the strain gauges 1 and 2.



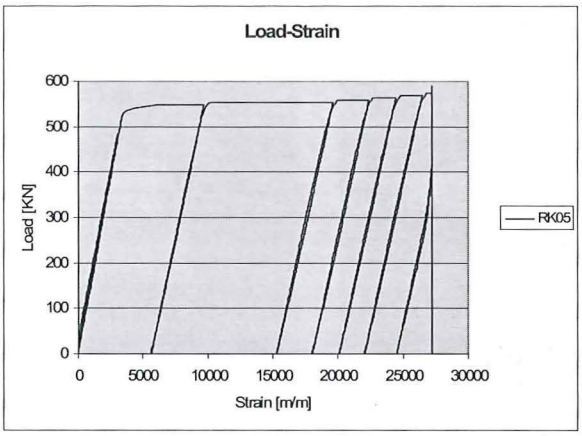
	ε_{Fmax} [m/m]
RK03	28537.80



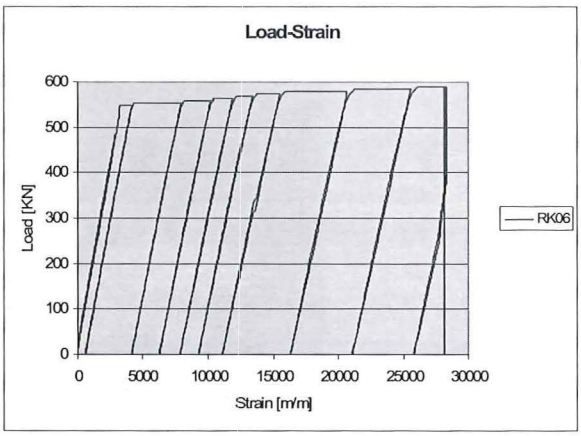
	ε_{Fmax} [m/m]
RK04	27695.50

Figure 29.3: Test specimen face with the position of the strain gauges 3 and 4.

SPECIMEN 3B4

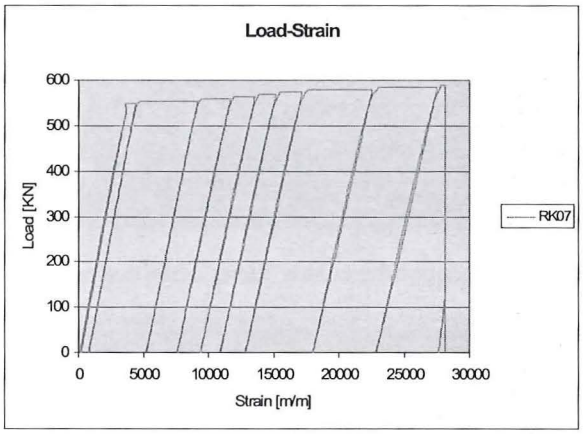


	ε_{Fmax} [m/m]
RK05	27260.40

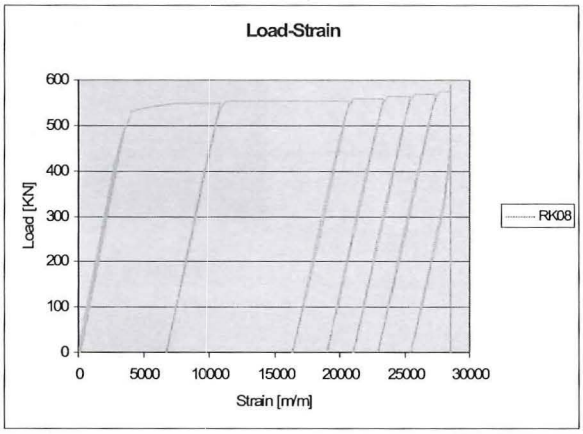


	ε_{Fmax} [m/m]
RK06	28269.40

Figure 29.4: Test specimen face with the position of the strain gauges 5 and 6.



	ε_{Fmax} [m/m]
RK07	28121.30



	ε_{Fmax} [m/m]
RK08	28500.80

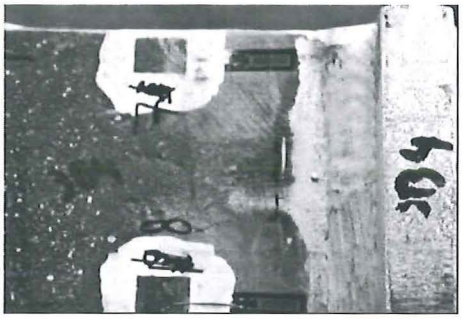
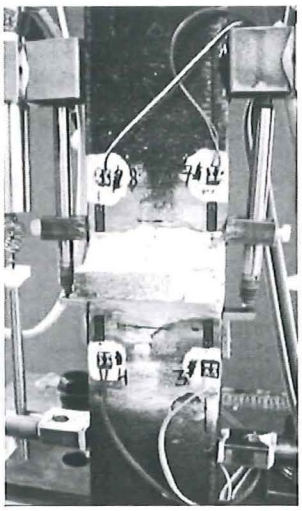
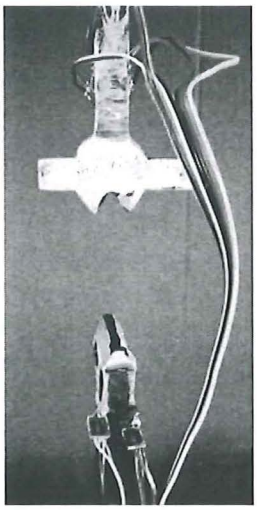
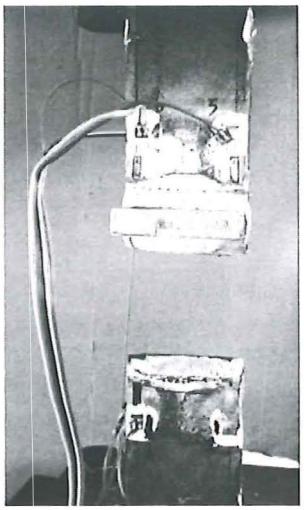
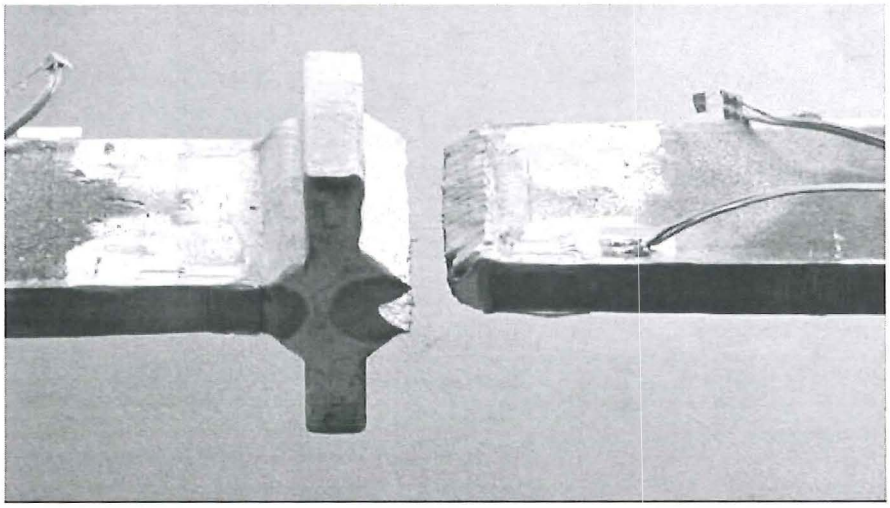


Figure 29.5: Test specimen face with the position of the strain gauges 7 and 8.

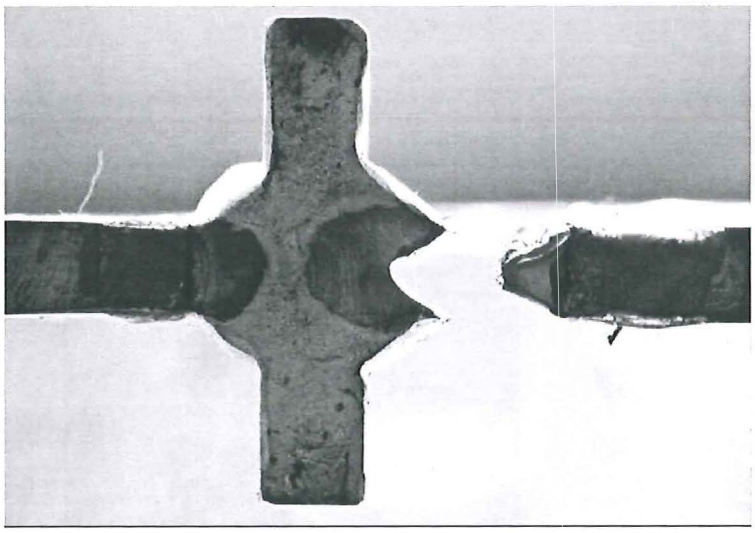
SPECIMEN 3B4

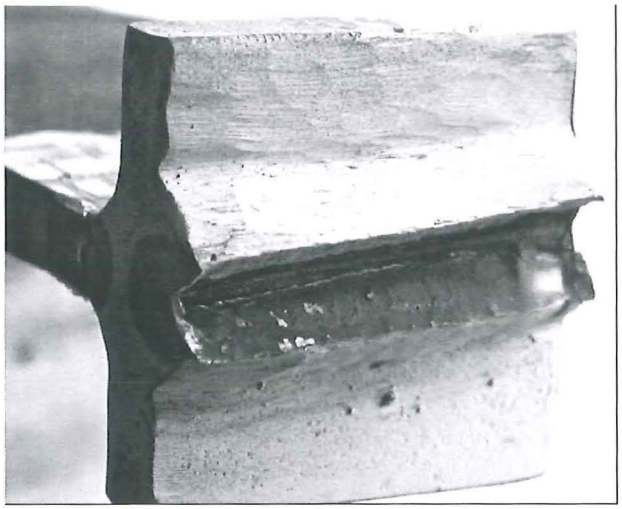
Figures 29.6, 29.7 and 29.8: Test specimen during the test and after failure of the weld.

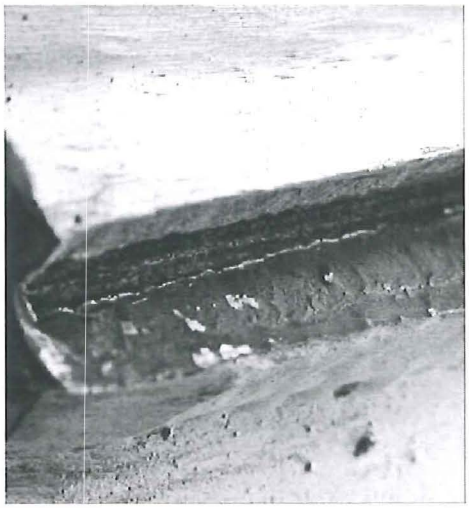


Figures 29.9 and 29.10: Test specimen after failure. Views of the two parts.



SPECIMEN 3B4





Figures 29.11 and 29.12: Detailed perspectives of the weld area.

Figure 29.13: Detailed view of the plate after failure in the weld.

SPECIMEN 3C1

Table 3C1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	3C1 (30)
	Type of specimen	X-joint with high SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3C
Test	Type of test	Static strength
	Parameter	Under matched
	Remark	High SCF
	Failure	Weld

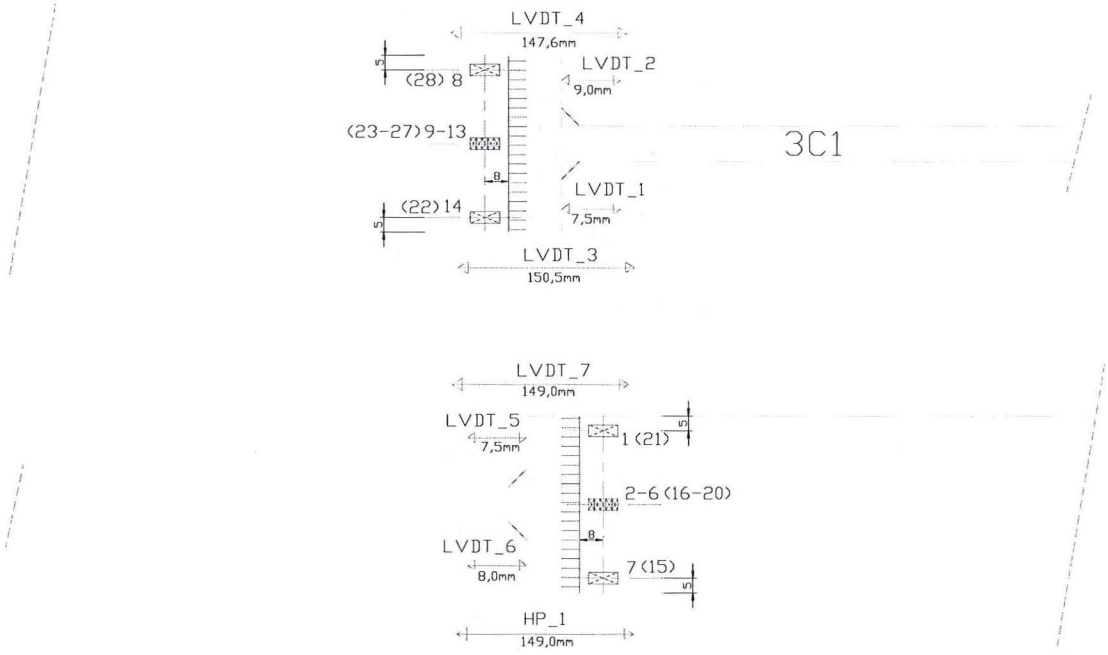


Figure 30.1: Top views of the test specimen with the position of the strain gauges and sizes of the measuring equipment.

SPECIMEN 3C1

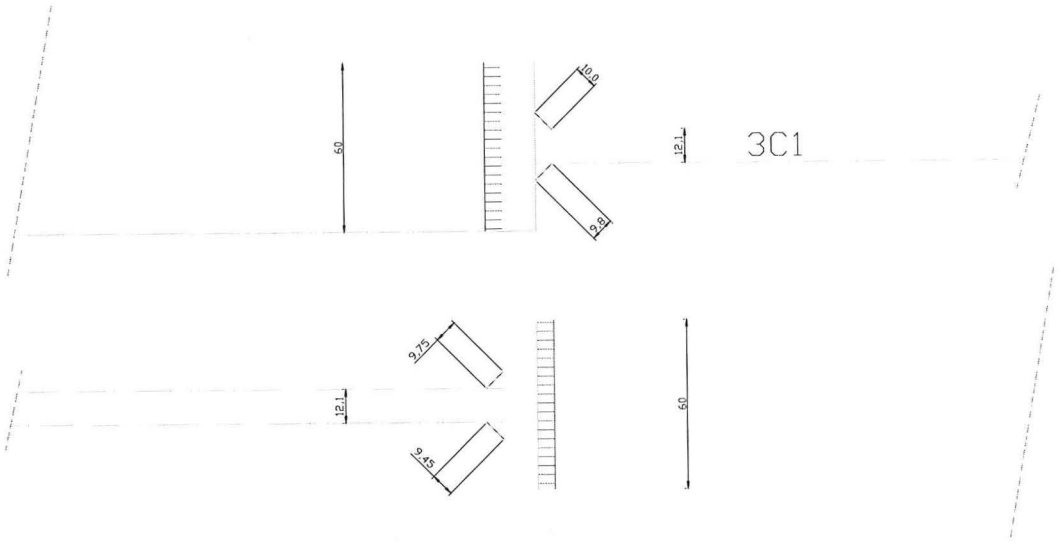
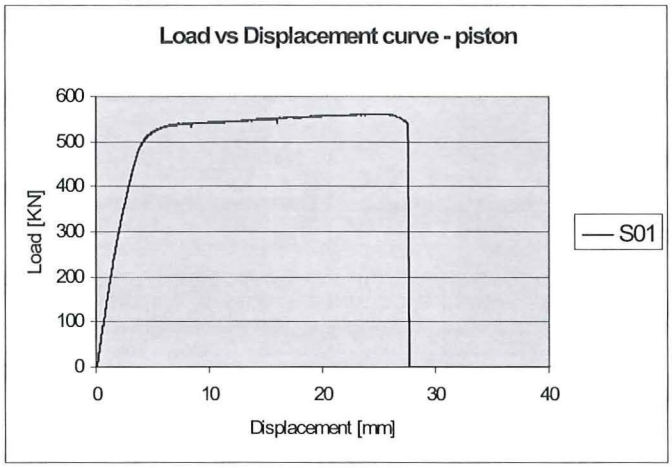
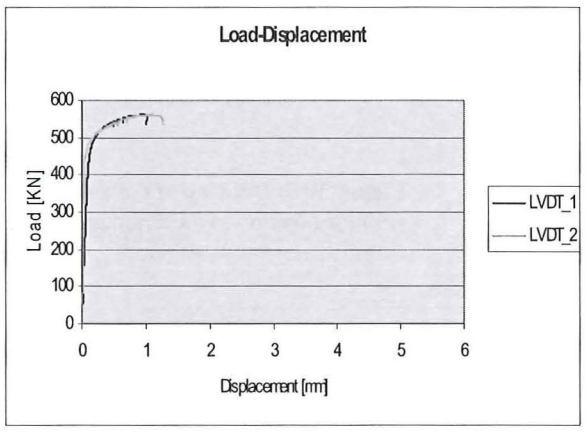


Figure 30.2: Side views, with the sizes of the welds.

SPECIMEN 3C1

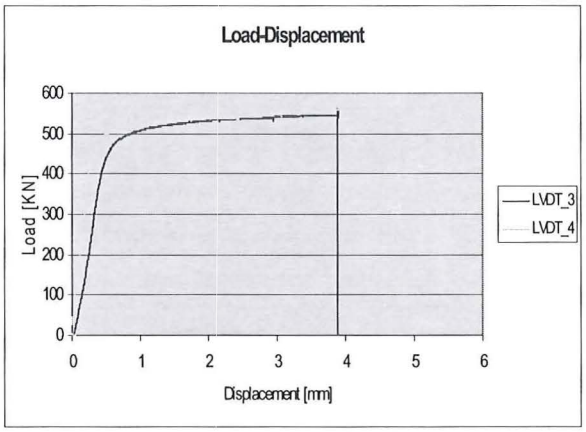


F_{max} [KN]	561
S_{Fmax} [mm]	24.45
S_{max} [mm]	27.76



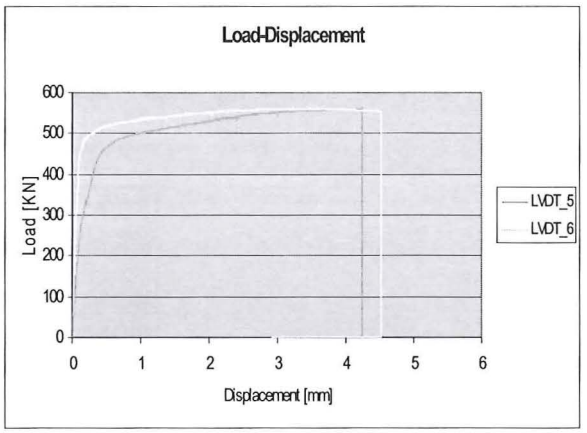
(skipped data)

	Range [mm]	S_{Fmax} [mm]
LVDT_1	7.5	0.95
LVDT_2	9.0	1.06

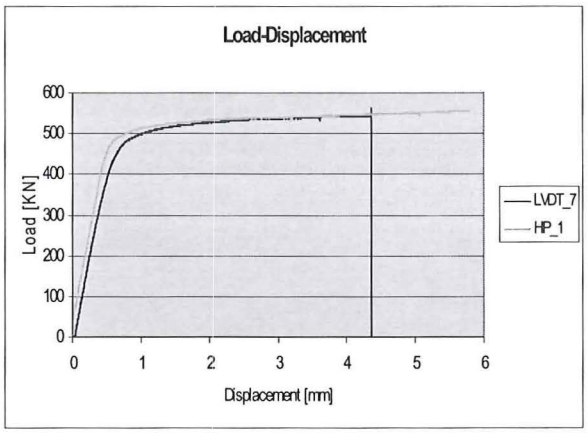


(skipped data)

	Range [mm]	S_{Fmax} [mm]
LVDT_3	150.5	3.90
LVDT_4	147.6	3.58

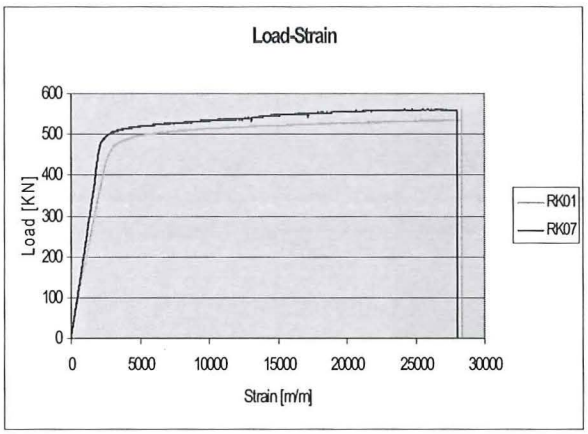


	Range [mm]	S_{Fmax} [mm]
LVDT_5	7.5	4.24
LVDT_6	8.0	3.46

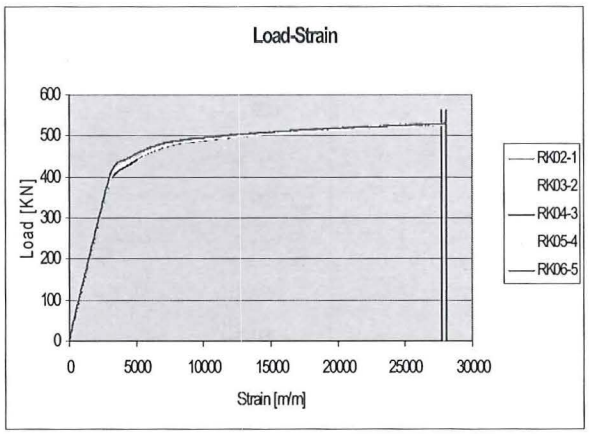


	Range [mm]	S_{Fmax} [mm]	S_{max} [mm]
LVDT_7	149.0	4.36	
HP_1	149.0	Failure before F_{max}	5.79

SPECIMEN 3C1



	ε_{Fmax} [m/m]
RK01	28343.70
RK07	25876.60



	ε_{Fmax} [m/m]
RK02-1	28004.00
RK03-2	27912.30
RK04-3	27738.00
RK05-4	27893.90
RK06-5	28068.20

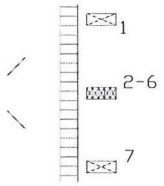
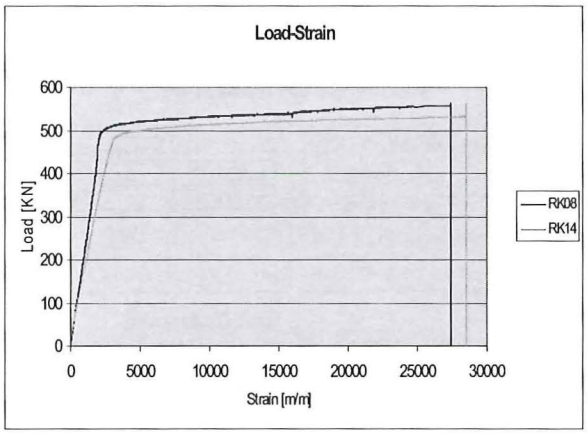
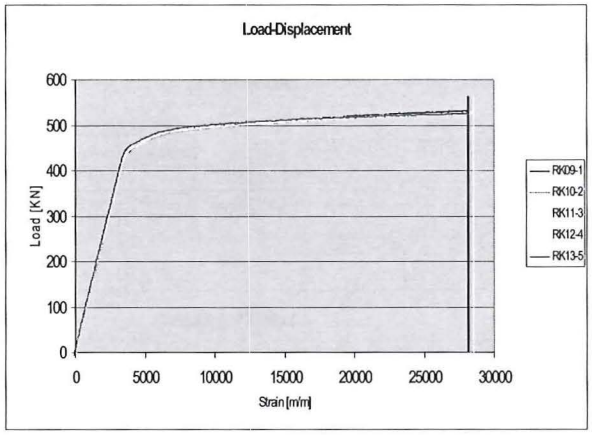


Figure 30.3: Drawing of the test specimen face with the position of the strain gauges 1 to 7.



	ε_{Fmax} [m/m]
RK08	27427.90
RK14	28493.20



	ε_{Fmax} [m/m]
RK09-1	28132.30
RK10-2	28306.60
RK11-3	28526.60
RK12-4	28535.80
RK13-5	28242.40

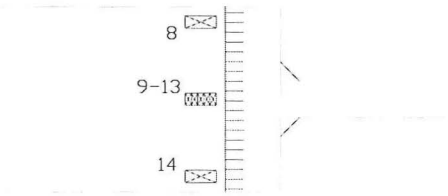
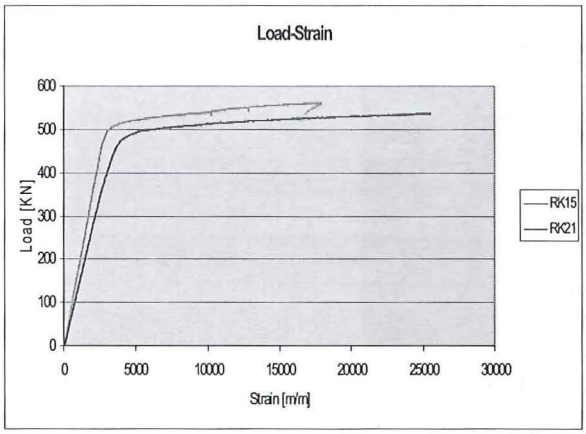


Figure 30.4: Drawing of the test specimen face with the position of the strain gauges 8 to 14.

SPECIMEN 3C1



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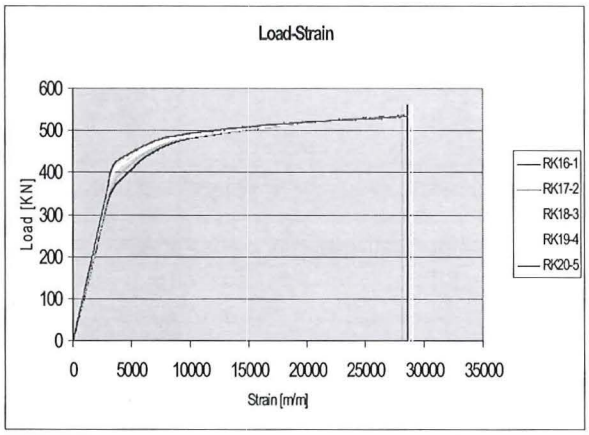
	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK15	17475.30	17923.90
RK21	Failure before F_{max}	25521.50



	ε_{Fmax} [m/m]
RK16-1	28657.50
RK17-2	28132.30
RK18-3	29031.00
RK19-4	28700.90
RK20-5	28581.60

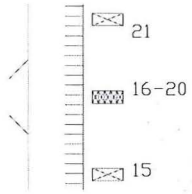
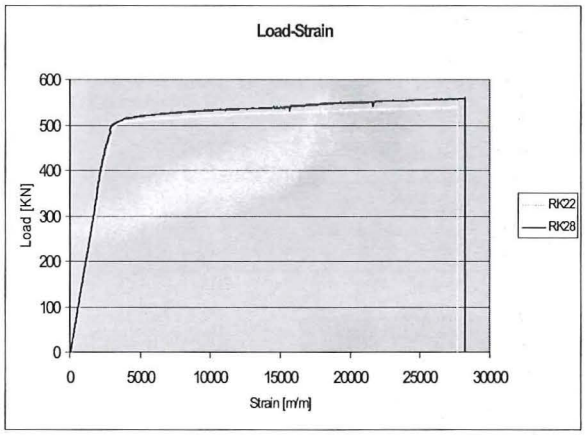
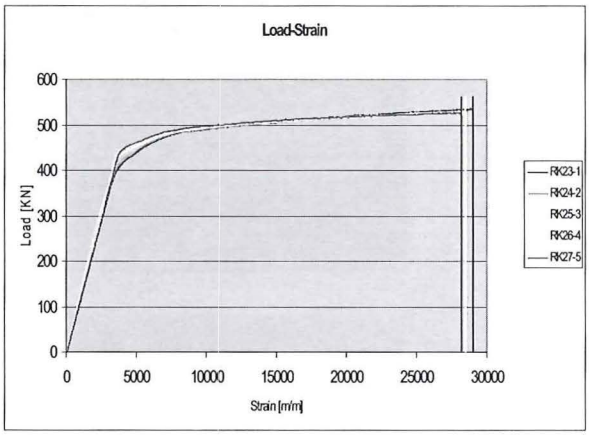


Figure 30.5: Drawing of the test specimen face with the position of the strain gauges 15 to 21.



	ε_{Fmax} [m/m]
RK22	27689.50
RK28	28212.80



	ε_{Fmax} [m/m]
RK23-1	29003.40
RK24-2	28224.00
RK25-3	28499.10
RK26-4	28444.10
RK27-5	28159.80

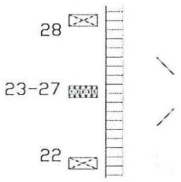


Figure 30.6: Drawing of the test specimen face with the position of the strain gauges 22 to 28.

SPECIMEN 3C1

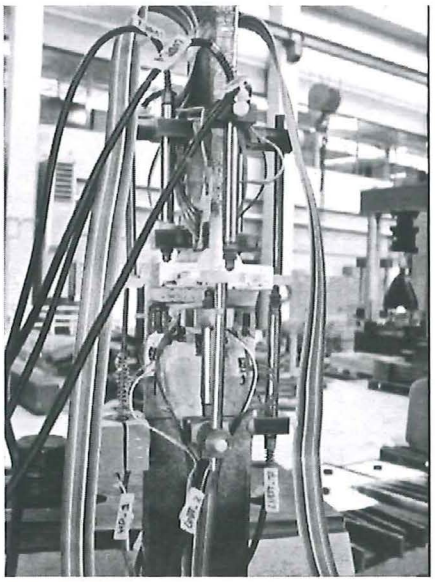
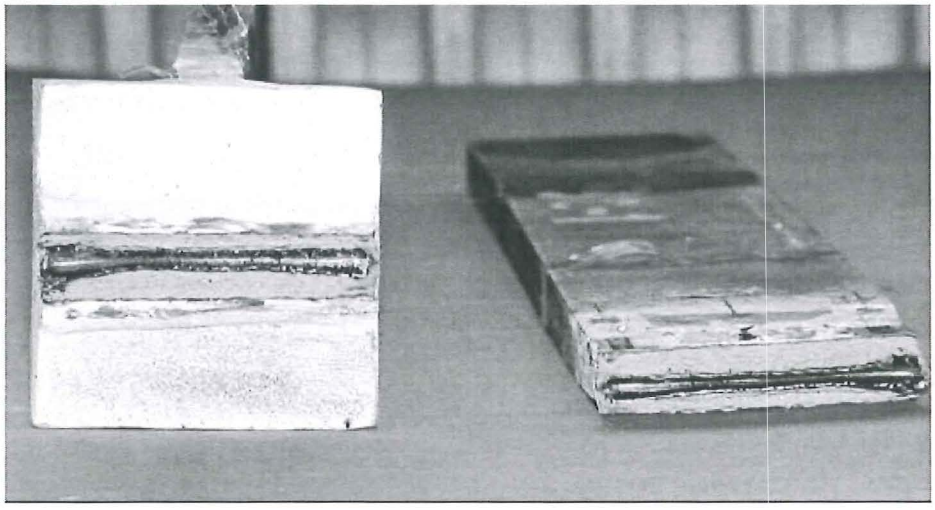
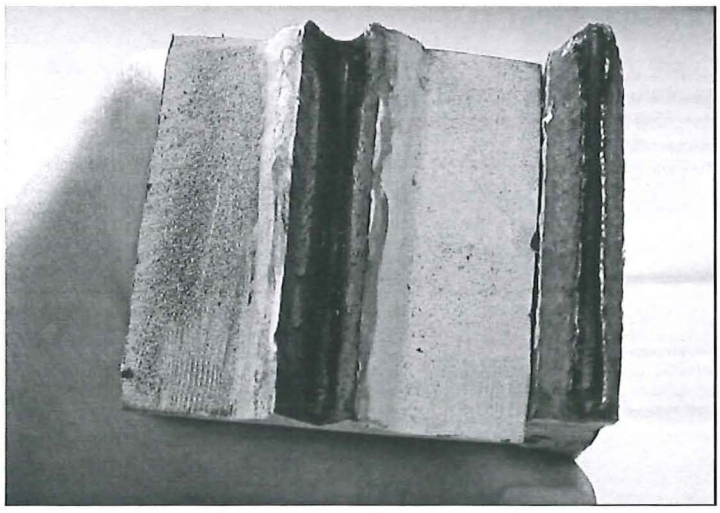


Figure 30.7: Test specimen during the test.





Figures 30.8 and 30.9: Test specimen after failure in the weld.

SPECIMEN 3C1

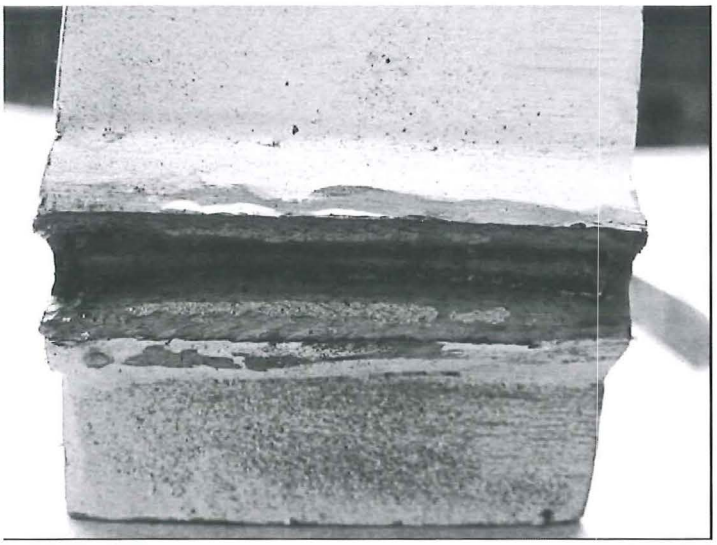


Figure 30.10 and 30.11: Test specimen after failure.

SPECIMEN 3C2

Table 3C2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	3C2 (31)
	Type of specimen	X-joint with high SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3C
Test	Type of test	Fatigue
	Parameter	Under matched
	Remark	High SCF
	Failure	Weld

SPECIMEN 3C2

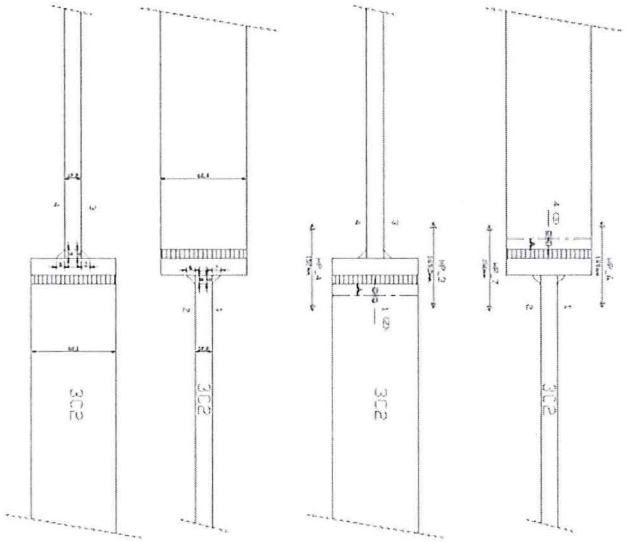


Figure 3C2-1: Dimensions of the test specimen

Figure 3C2-2: Dimensions of the welds

Figure 3C2-3: Position of strain gauges and LVDT's

SPECIMEN 3C2

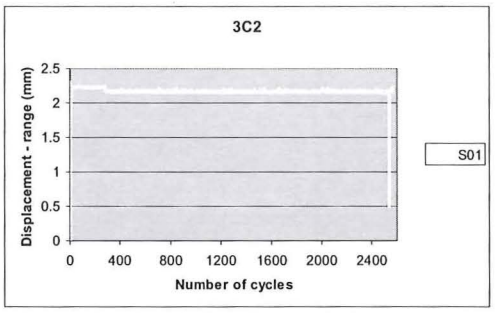


Figure 3C2-4: Test displacement controlled (range)

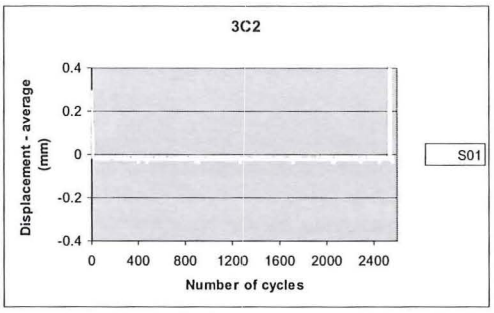


Figure 3C2-5: Test displacement controlled (average)

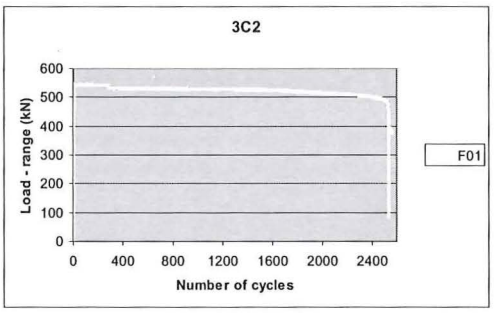


Figure 3C2-6: Test load (range)

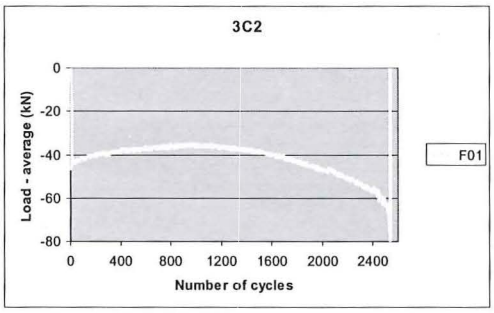


Figure 3C2-7: Test load (average)

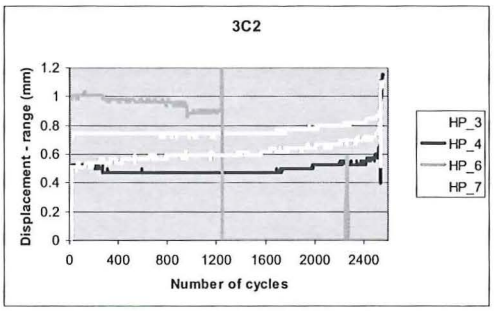


Figure 3C2-8: Deformation whole connection (range)

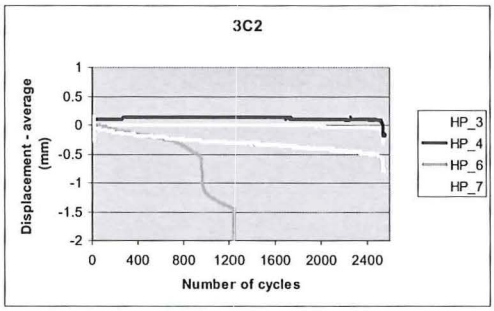


Figure 3C2-9: Deformation whole connection (average)

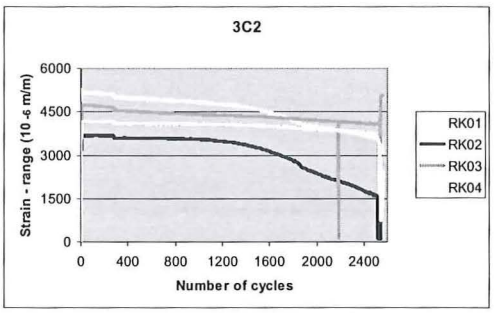


Figure 3C2-10: Measured strains (range)

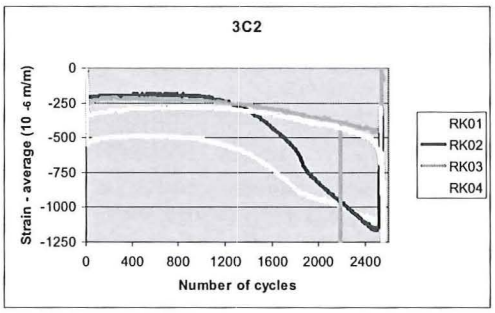


Figure 3C2-11: Measured strains (average)

SPECIMEN 3C2

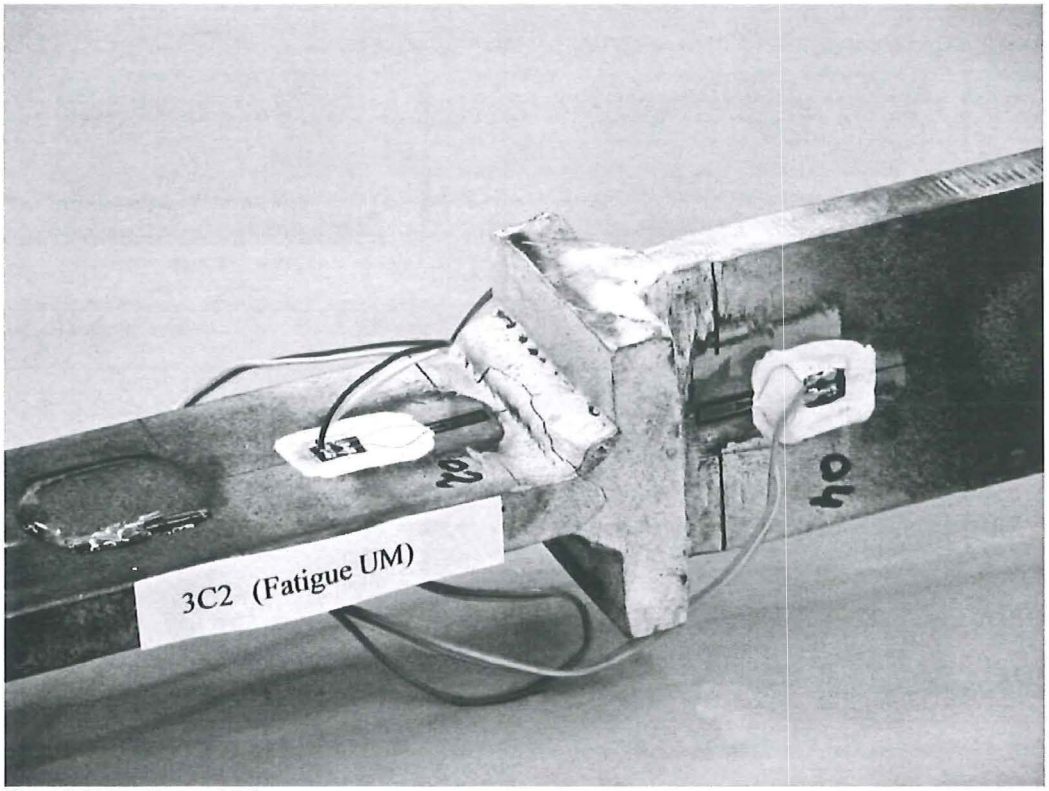


Figure 3C2-12: Observed failure

SPECIMEN 3C3

Table 3C3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	3C3 (32)
	Type of specimen	X-joint with high SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3C
Test	Type of test	Fatigue
	Parameter	Under matched
	Remark	High SCF
	Failure	Weld

SPECIMEN 3C3

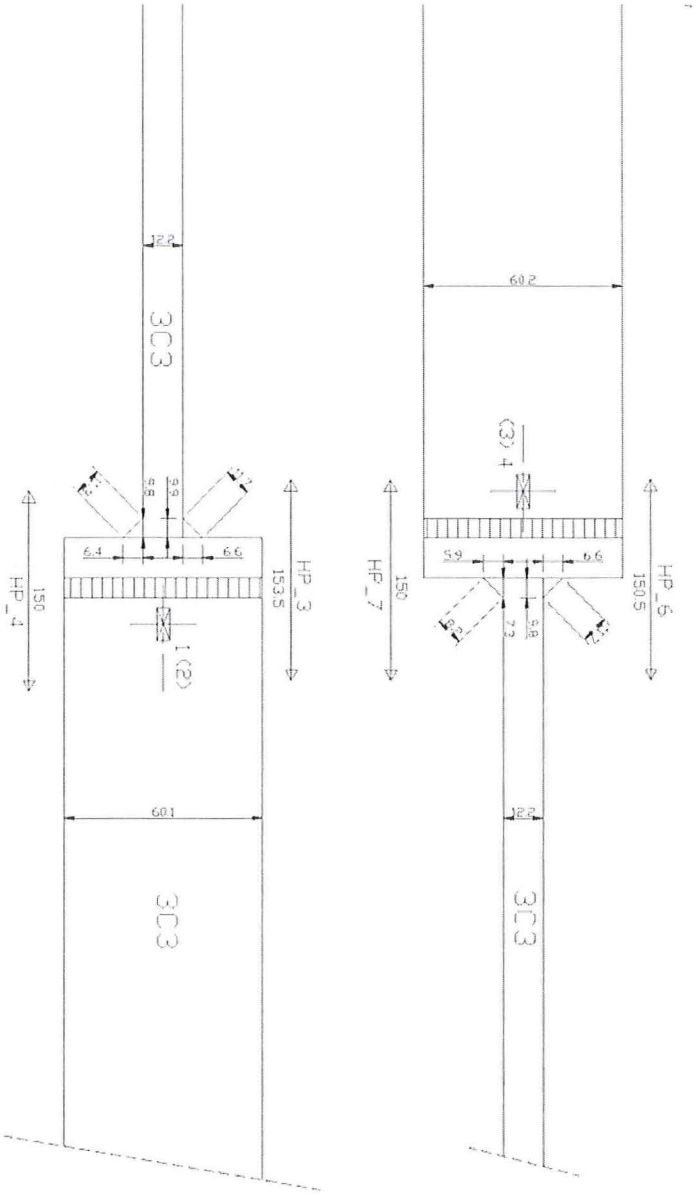


Figure 3C3-1: Dimensions of the test specimen

Figure 3C3-2: Dimensions of the welds

Figure 3C3-3: Position of strain gauges and LVDT's

SPECIMEN 3C3

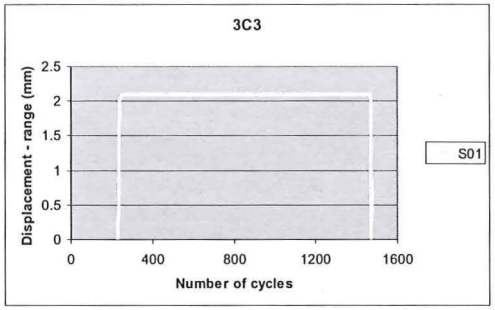


Figure 3C3-4: Test displacement controlled (range)

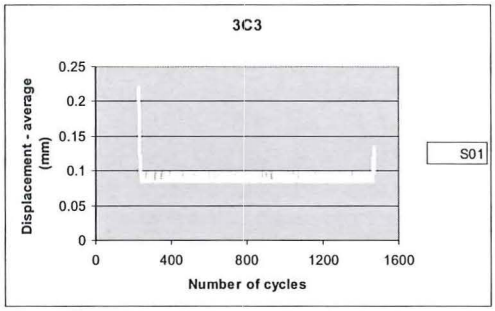


Figure 3C3-5: Test displacement controlled (average)

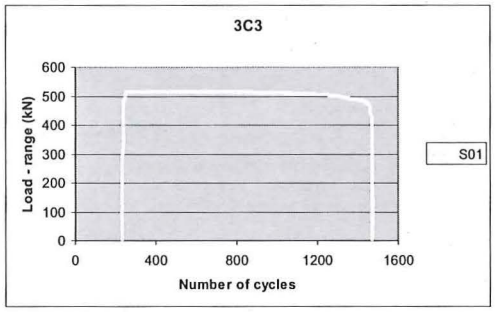


Figure 3C3-6: Test load (range)

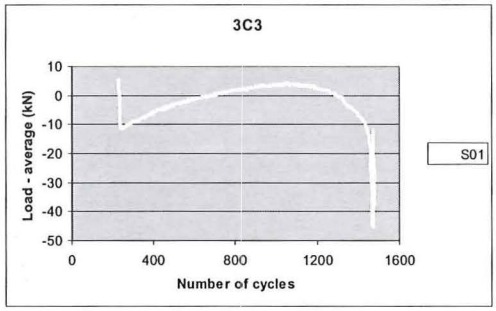


Figure 3C3-7: Test load (average)

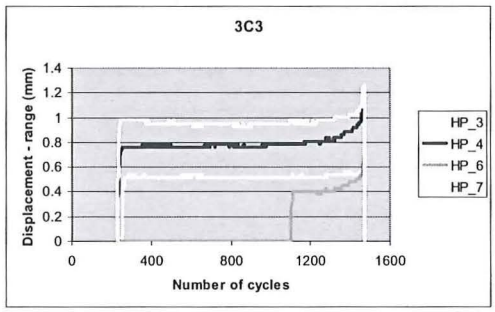


Figure 3C3-8: Deformation whole connection (range)

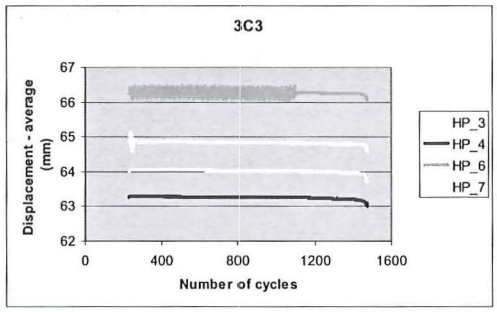


Figure 3C3-9: Deformation whole connection (average)

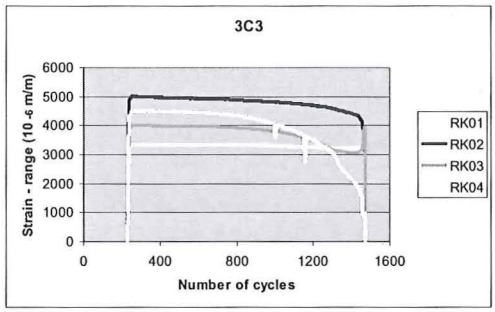


Figure 3C3-10: Measured strains (range)

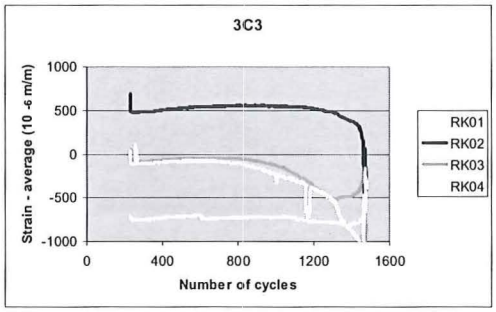


Figure 3C3-11: Measured strains (average)

SPECIMEN 3C3

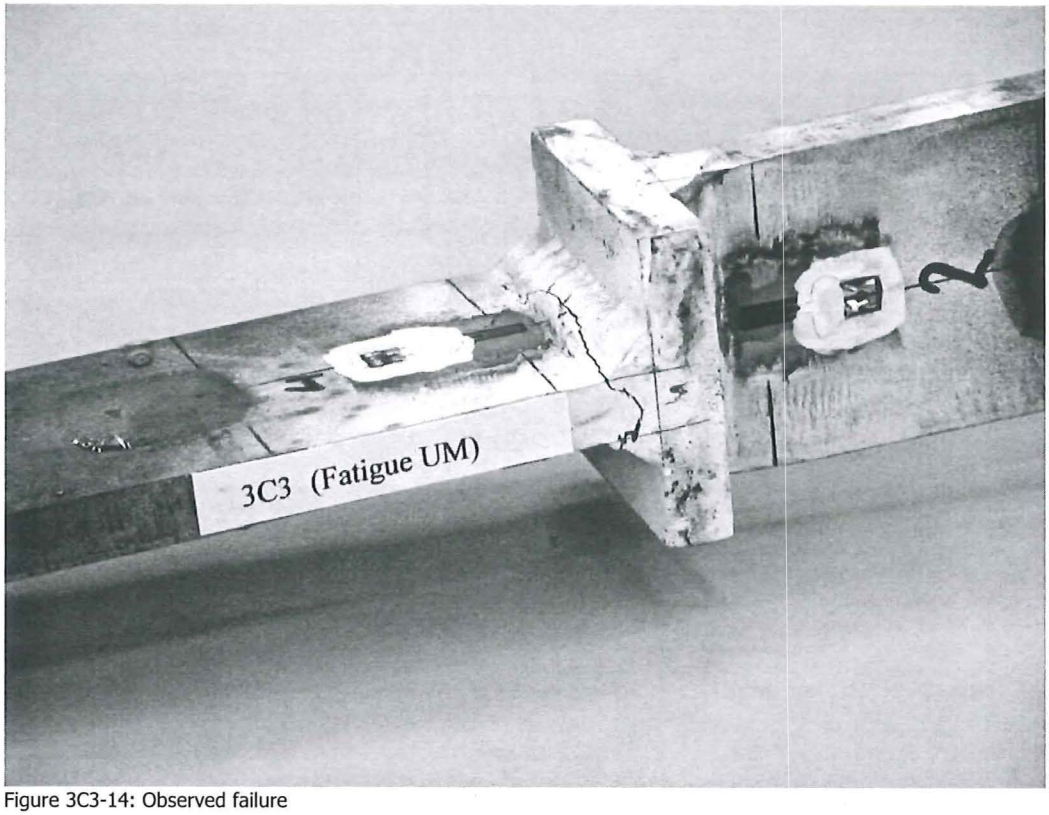


Figure 3C3-14: Observed failure

SPECIMEN 3C4

Table 3C4-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	3C4 (33)
	Type of specimen	X-joint with high SCF
	Plate thickness	12 mm
	Plate material	S690
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-3C
Test	Type of test	Ratcheting
	Parameter	Under matched
	Remark	High SCF
	Failure	Weld

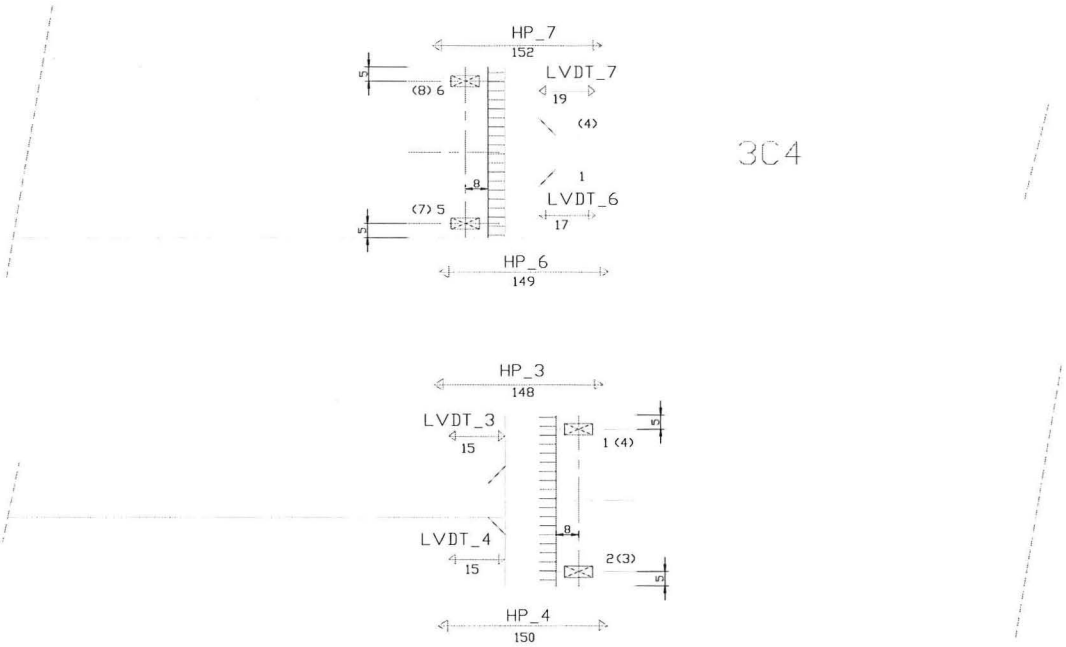


Figure 33.1: Top views of the test specimen with the position of the strain gauges and sizes of the measuring equipment.

SPECIMEN 3C4

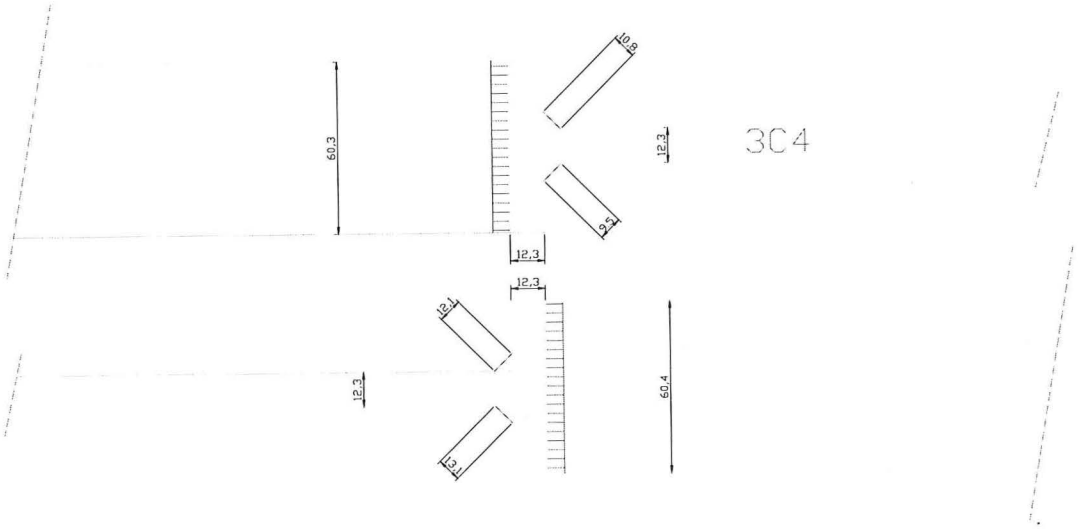
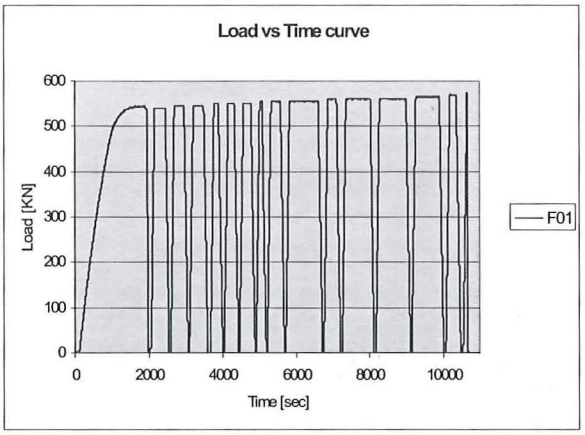
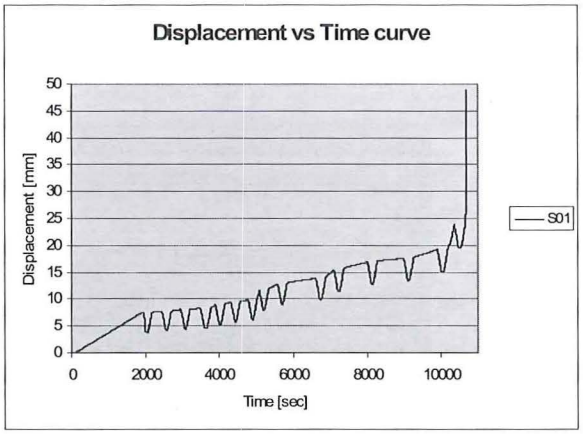


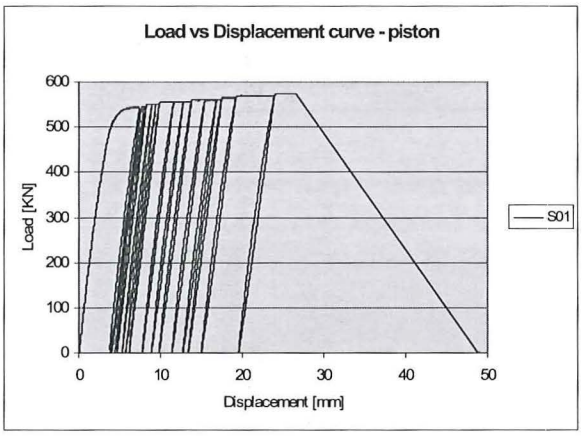
Figure 33.2: Side views, with the sizes of the welds.

SPECIMEN 3C4



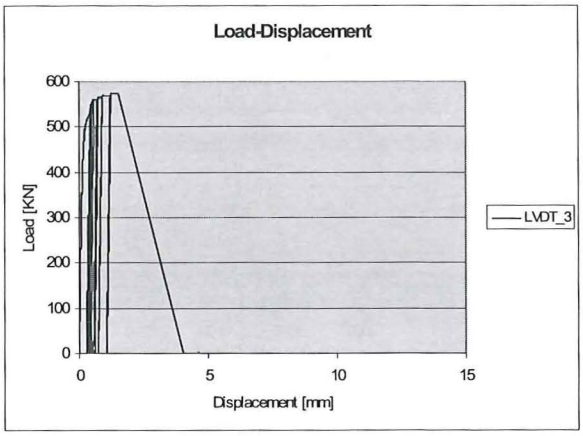


Cycle	Time [sec]	Peak Force [KN]	Displacement [mm]
1	1848	545	7.26
2	2218	541	7.57
3	2954	545	8.03
4	3481	545	8.28
5	3888	550	8.98
6	4172	550	9.14
7	4594	550	9.61
8	5061	555	11.29
9	5530	555	12.66
10	5830	555	12.95
11	6895	560	14.20
12	8001	560	16.86
13	8990	560	17.52
14	9879	565	19.16
15	10213	570	19.91
16	10668	575	25.45

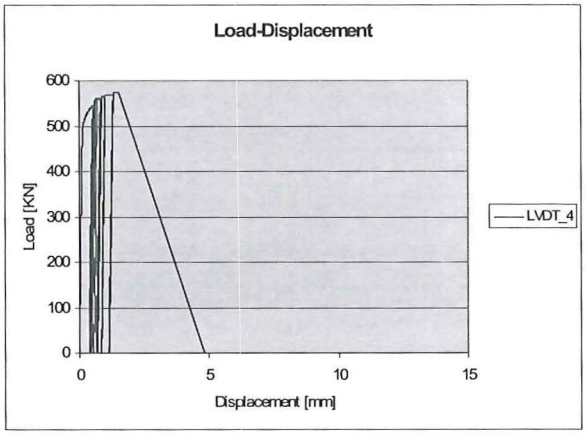


F_{max} [KN]	575
S_{Fmax} [mm]	25.45
S_{max} [mm]	25.45

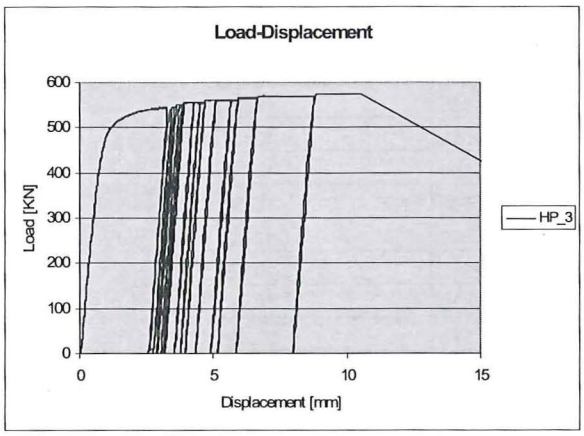
SPECIMEN 3C4



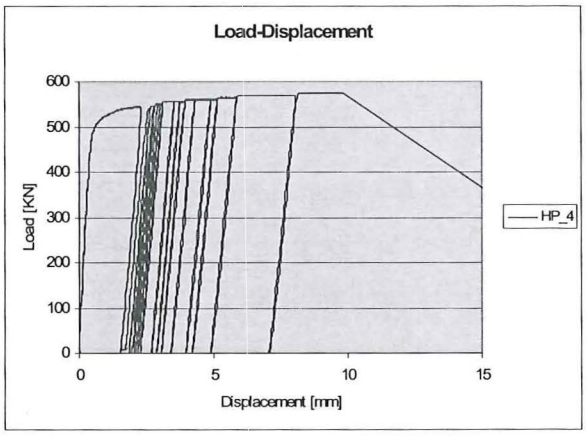
	Range [mm]	S_{Fmax} [mm]
LVDT_3	15.0	1.38



	Range [mm]	S_{Fmax} [mm]
LVDT_4	15.0	1.44

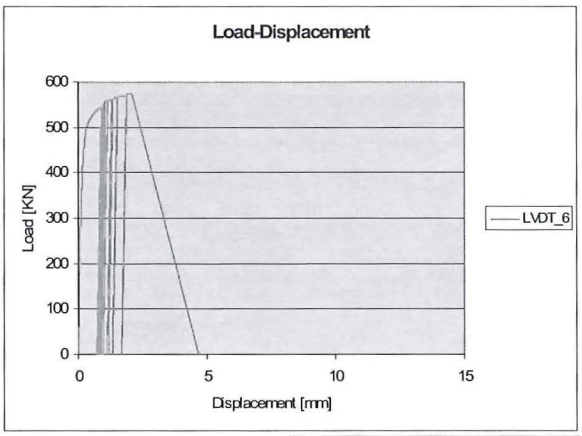


	Range [mm]	S_{Fmax} [mm]
HP_3	148.0	9.57

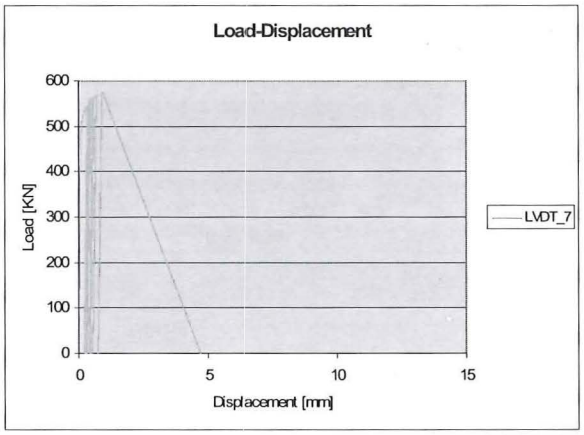


	Range [mm]	S_{Fmax} [mm]
HP_4	150.0	8.86

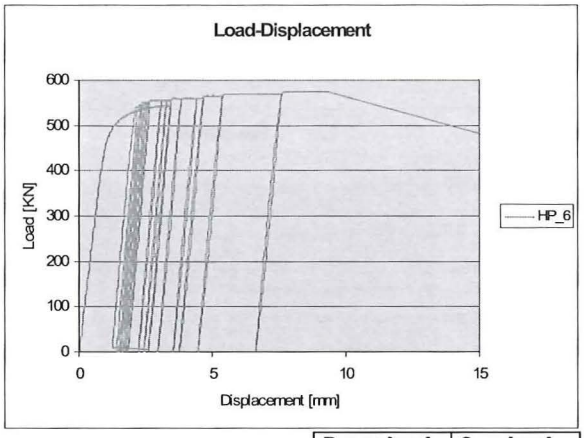
SPECIMEN 3C4



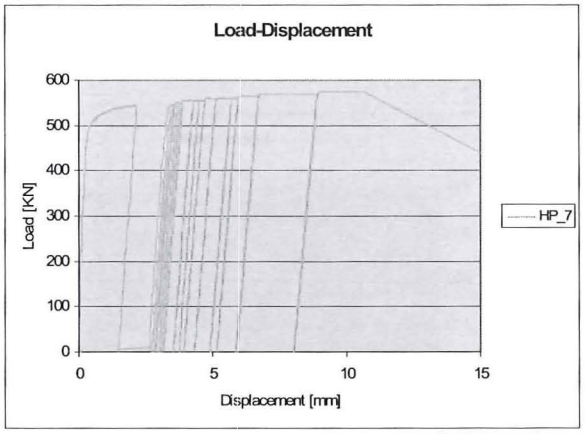
	Range [mm]	S_{Fmax} [mm]
LVDT_6	17.0	2.02



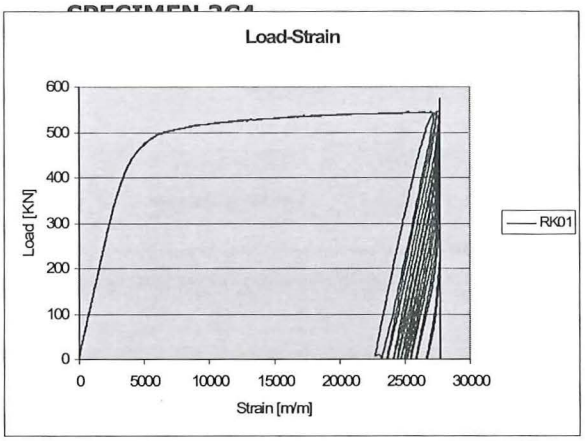
	Range [mm]	S_{Fmax} [mm]
LVDT_7	19.0	0.96



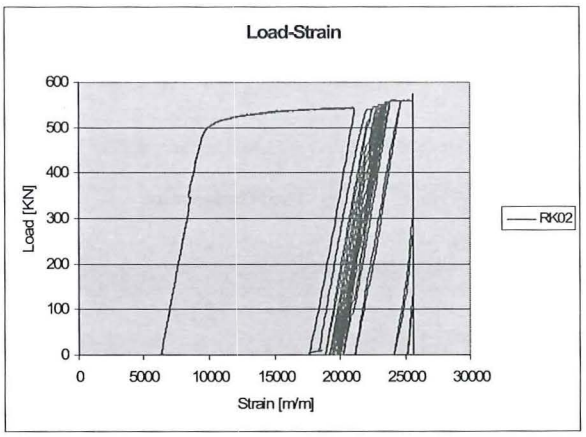
	Range [mm]	S_{Fmax} [mm]
HP_6	149.0	8.38



	Range [mm]	S_{Fmax} [mm]
HP_7	152.0	9.69



	ε_{Fmax} [m/m]
RK01	27704.80



	ε_{Fmax} [m/m]
RK02	25603.50

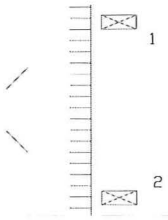
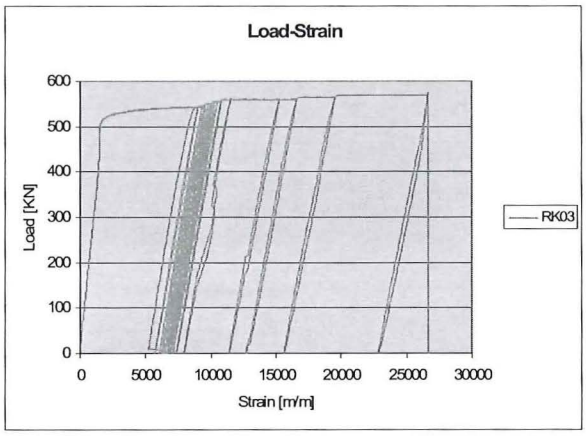
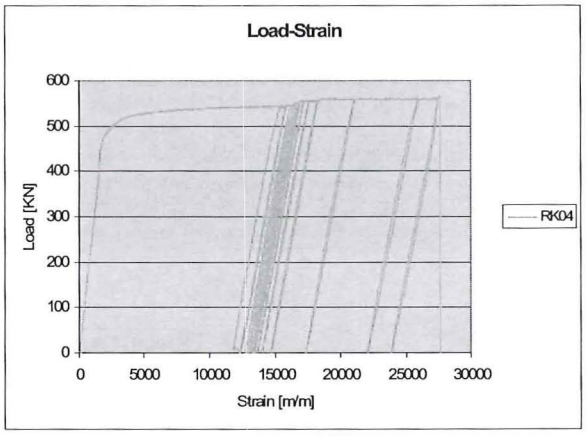


Figure 33.3: Test specimen face with the position of the strain gauges 1 and 2.



	ε_{Fmax} [m/m]
RK03	26695.80



	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK04	Failure before F_{max}	27612.2

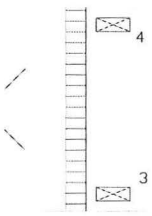
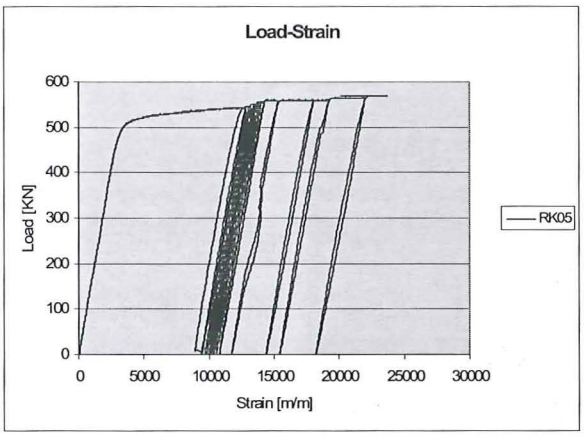
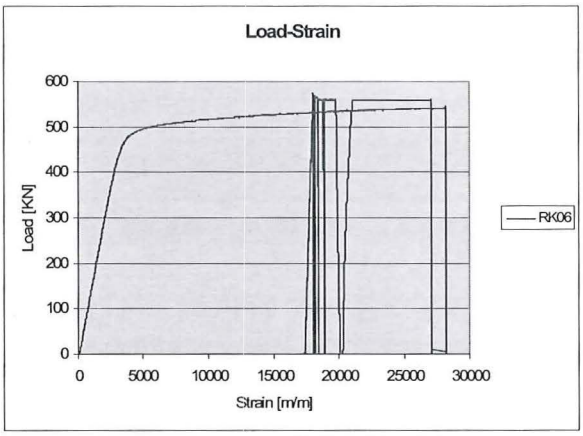


Figure 33.4: Test specimen face with the position of the strain gauges 3 and 4.

SPECIMEN 3C4



	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK05	Failure before F_{max}	23733.70



	ε_{Fmax} [m/m]	ε_{max} [m/m]
RK06	Failure before Fmax	28195.40

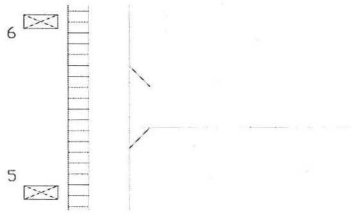
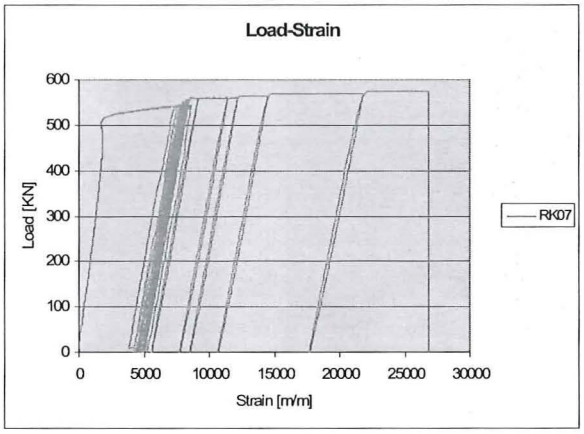
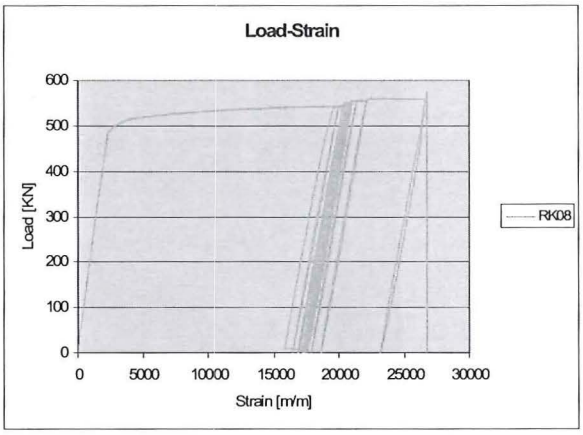


Figure 33.5: Test specimen face with the position of the strain gauges 5 and 6.



	ε_{Fmax} [m/m]
RK07	24853.80



	ε_{Fmax} [m/m]
RK08	26732.80

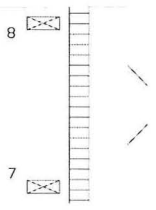
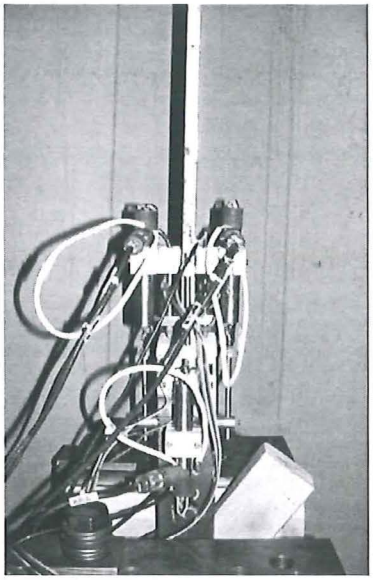
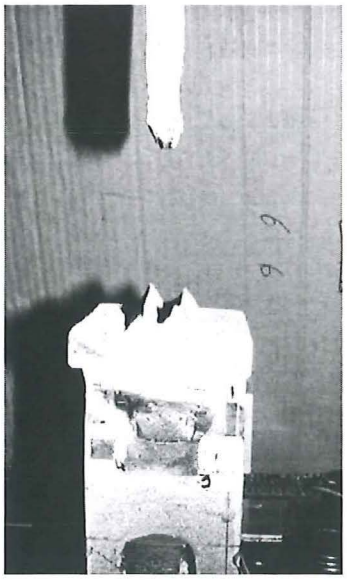


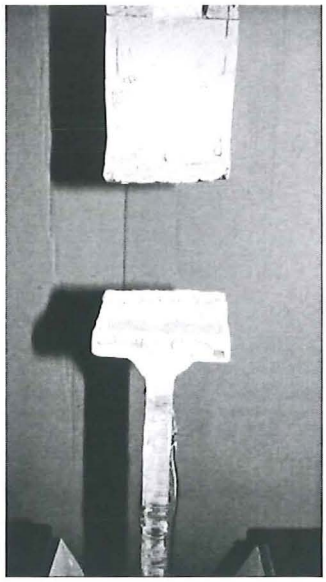
Figure 33.6: Test specimen face with the position of the strain gauges 7 and 8.

SPECIMEN 3C4



Figures 33.7: Test specimen during the test.





Figures 33.8. 33.9 and 33.10: Different side views of the test specimen after failure.

SPECIMEN 4A1

Table 4A1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	4A1 (34)
	Type of specimen	Cross plate connection
	Plate thickness	10 mm
	Plate material	S1100
Weld	Type of weld	Fillet welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-4A
Test	Type of test	Static strength
	Parameter	High strength
	Remark	Fillet welds loaded in shear
	Failure	Weld

SPECIMEN 4A1

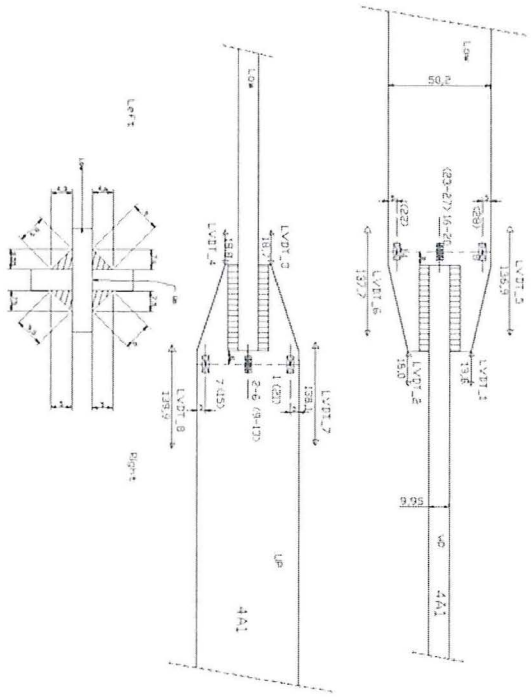


Figure 4A1-1: Dimensions of the test specimen

Figure 4A1-2: Dimensions of the welds

Figure 4A1-2: Position of strain gauges and LVDTs

SPECIMEN 4A1

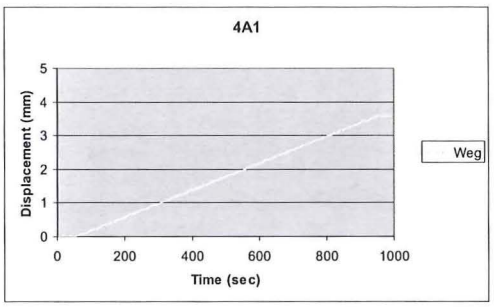


Figure 4A1-3: Test displacement controlled

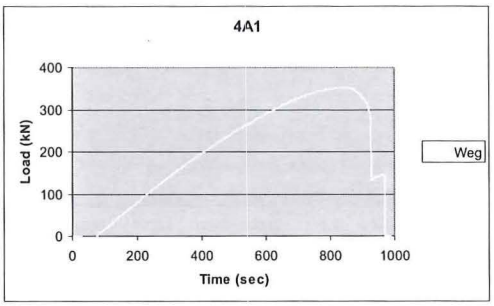


Figure 4A1-4: Test load

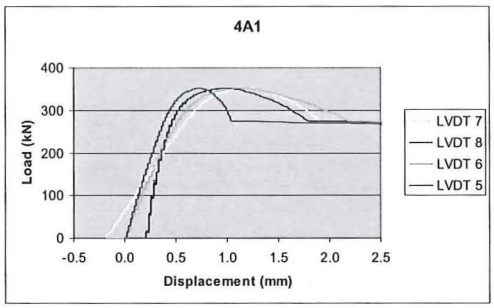


Figure 4A1-5: Deformation of the whole connection

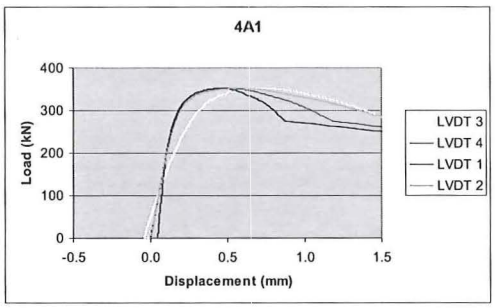


Figure 4A1-6: Local displacements

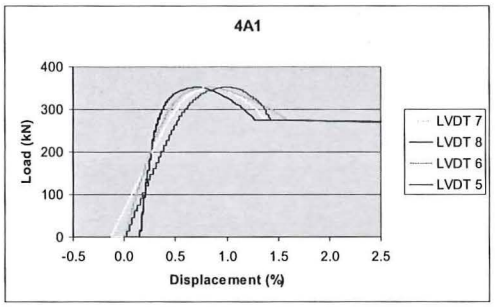


Figure 4A1-7: Relative deformation of the connection

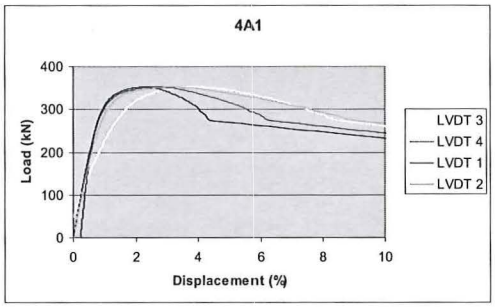


Figure 4A1-8: Relative displacements, locally

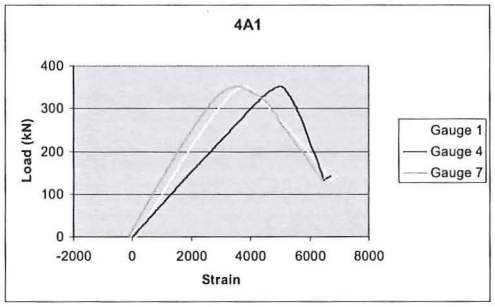


Figure 4A1-9: Measured strains plate 1 side 1

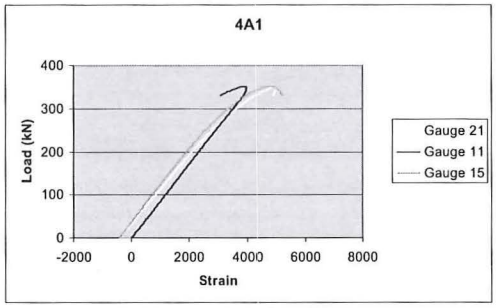


Figure 4A1-10: Measured strains plate 1 side 2

SPECIMEN 4A1

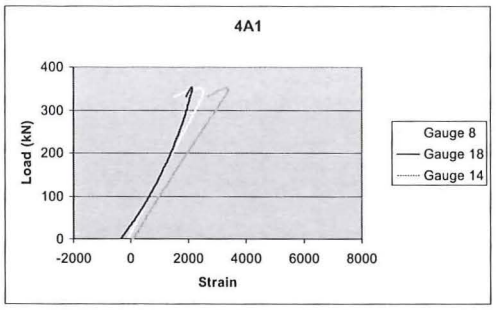


Figure 4A1-11: Measured strains plate 2 side 1

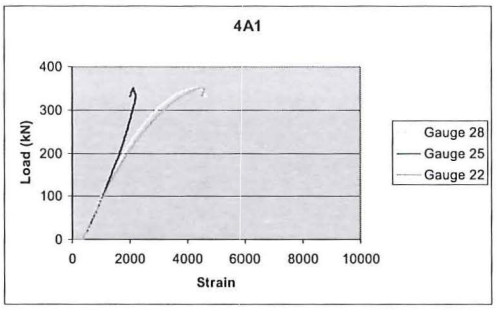


Figure 4A1-12: Measured strains plate 2 side 2

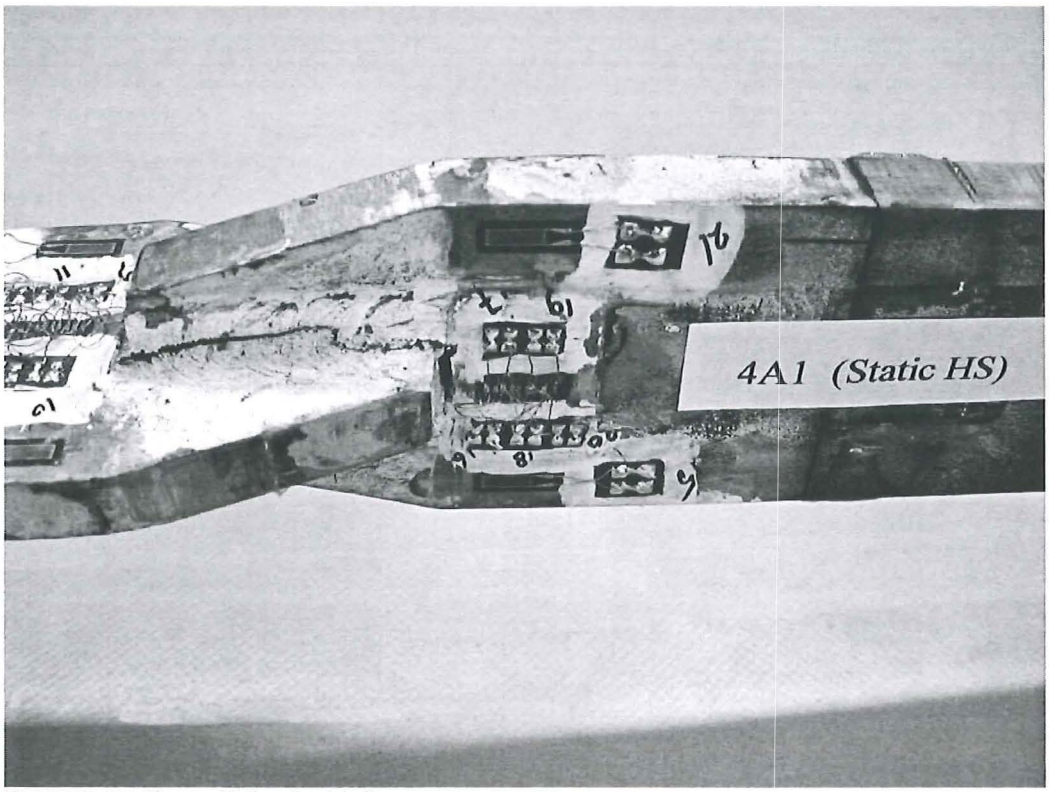


Figure 4A1-13: Observed failure in plate 2

SPECIMEN 4A2

Table 4A2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	4A2 (35)
	Type of specimen	Cross plate connection
	Plate thickness	10 mm
	Plate material	S1100
Weld	Type of weld	Fillet welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-4A
Test	Type of test	Fatigue
	Parameter	High strength
	Remark	Fillet welds loaded in shear
	Failure	Weld

SPECIMEN 4A2

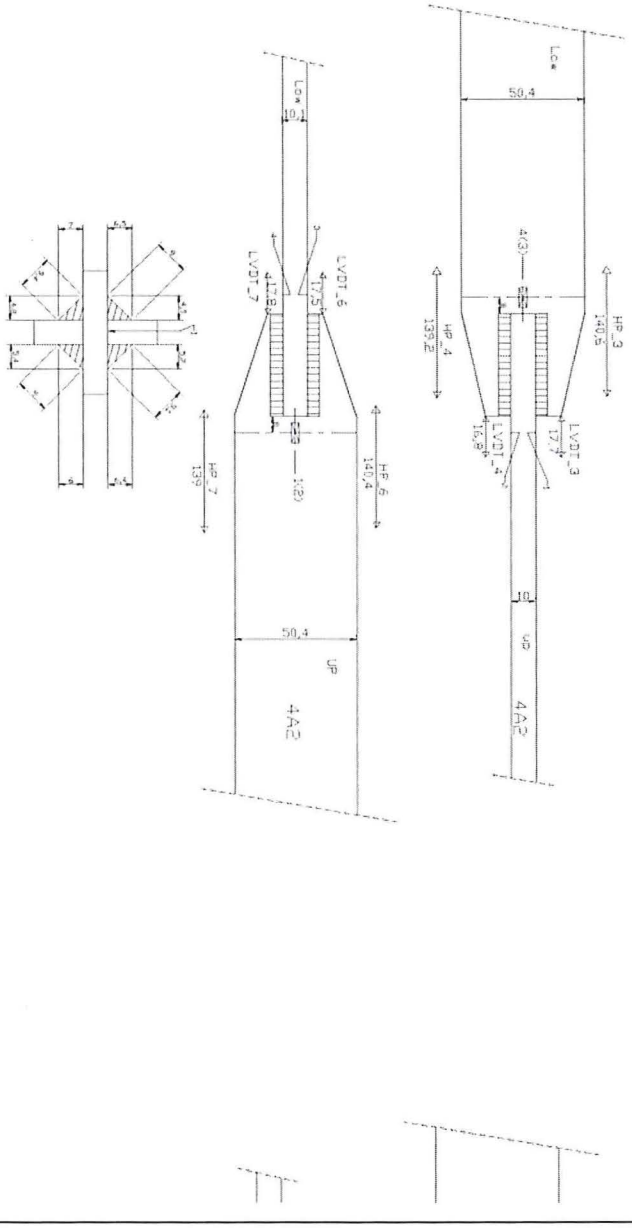


Figure 4A2-1: Dimensions of the test specimen

Figure 4A2-2: Dimensions of the welds

Figure 4A2-3: Position of strain gauges and LVDT's

SPECIMEN 4A2

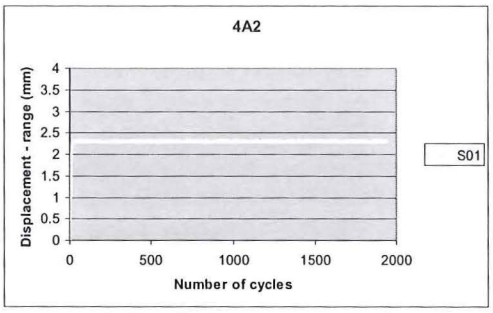


Figure 4A2-4: Test displacement controlled (range)

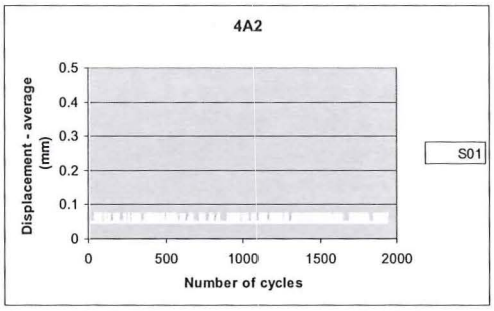


Figure 4A2-5: Test displacement controlled (average)

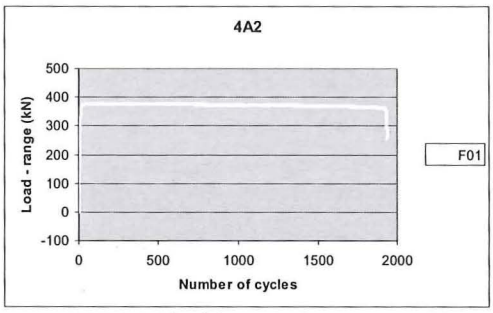


Figure 4A2-6: Test load (range)

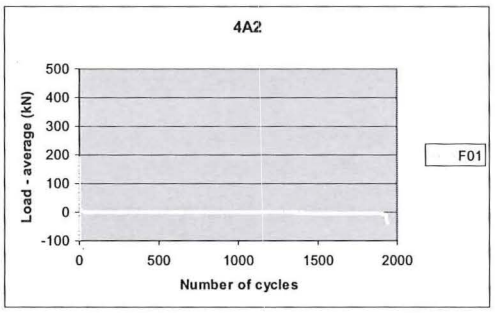


Figure 4A2-7: Test load (average)

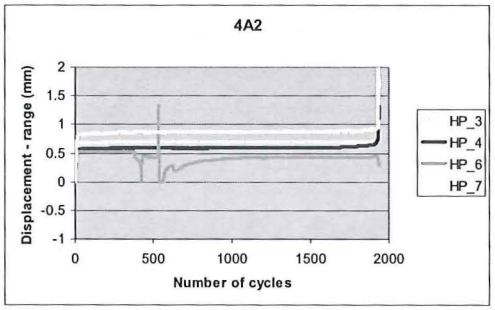


Figure 4A2-8: Deformation whole connection (range)

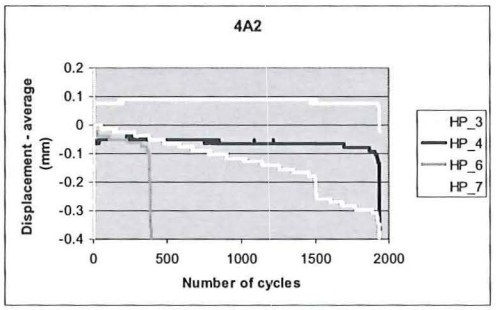


Figure 4A2-9: Deformation whole connection (average)

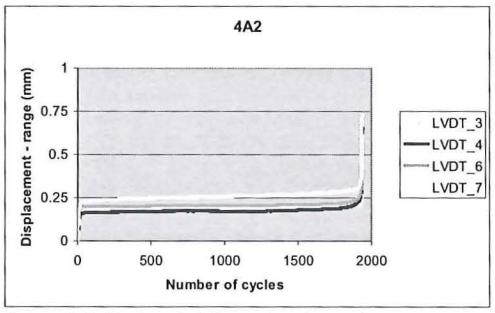


Figure 4A2-10: Local deformation (range)

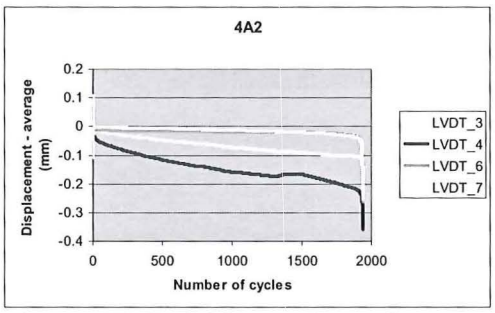


Figure 4A2-11: Local deformation (average)

SPECIMEN 4A2

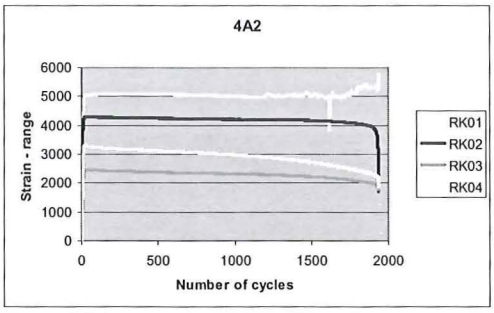


Figure 4A2-12: Measured strains (range)

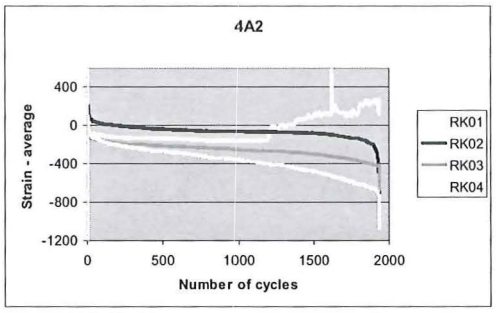


Figure 4A2-13: Measured strains (average)

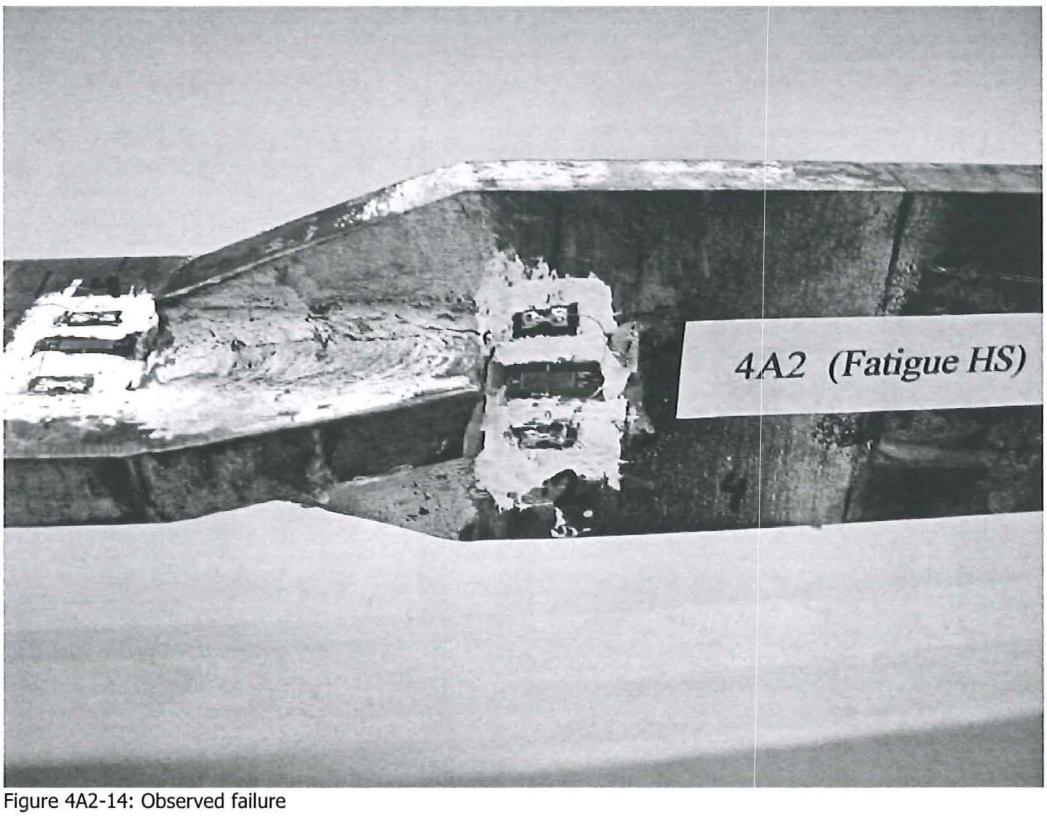


Figure 4A2-14: Observed failure

SPECIMEN 4A3

Table 4A3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	4A3 (36)
	Type of specimen	Cross plate connection
	Plate thickness	10 mm
	Plate material	S1100
Weld	Type of weld	Fillet welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-4A
Test	Type of test	Fatigue
	Parameter	High strength
	Remark	Fillet welds loaded in shear
	Failure	Weld

SPECIMEN 4A3

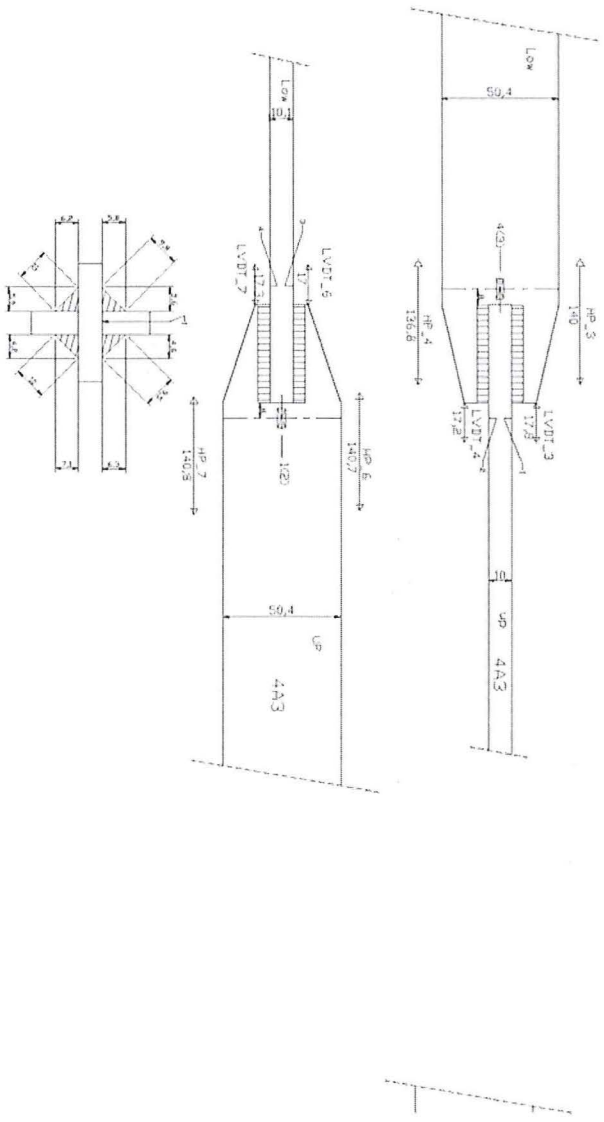


Figure 4A3-1: Dimensions of the test specimen

Figure 4A3-2: Dimensions of the welds

Figure 4A3-3: Position of strain gauges and LVDT's

SPECIMEN 4A3

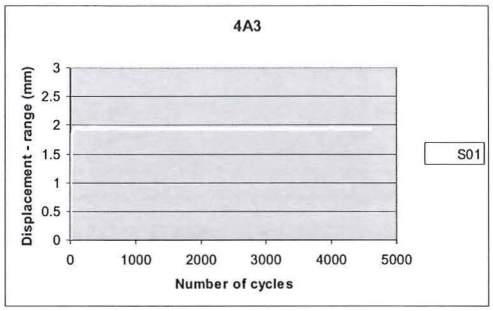


Figure 4A3-4: Test displacement controlled (range)

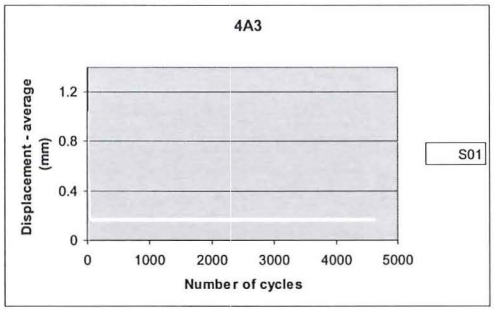


Figure 4A3-5: Test displacement controlled (average)

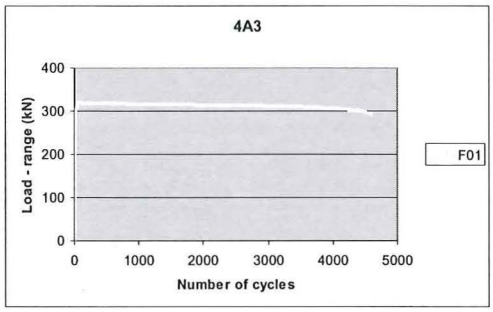


Figure 4A3-6: Test load (range)

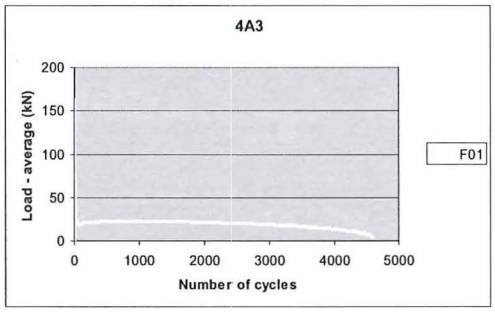


Figure 4A3-7: Test load (average)

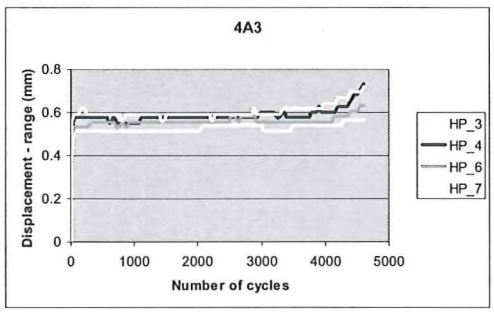


Figure 4A3-8: Deformation whole connection (range)

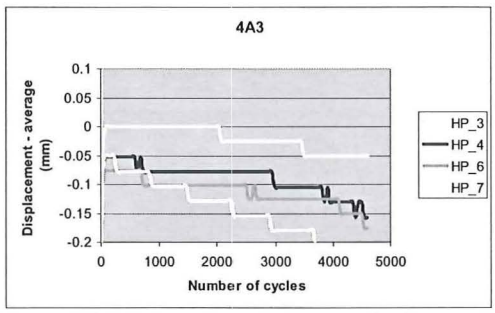


Figure 4A3-9: Deformation whole connection (average)

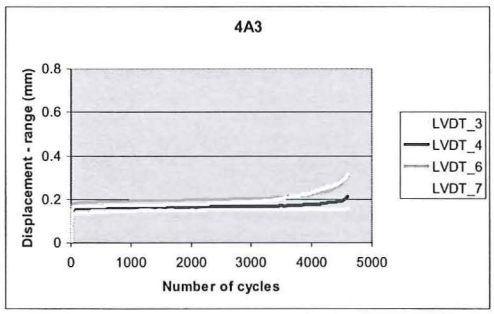


Figure 4A3-10: Local deformation (range)

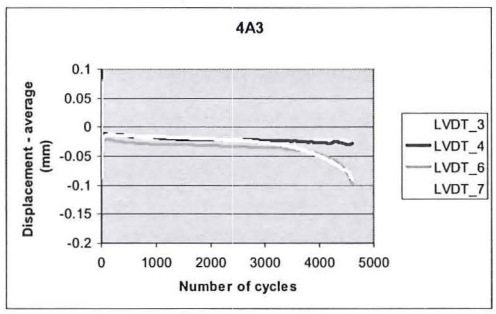


Figure 4A3-11: Local deformation (average)

SPECIMEN 4A3

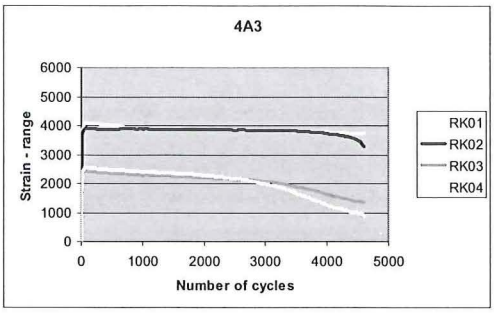


Figure 4A3-12: Measured strains (range)

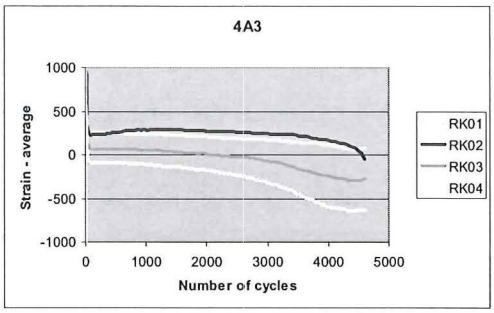


Figure 4A3-13: Measured strains (average)

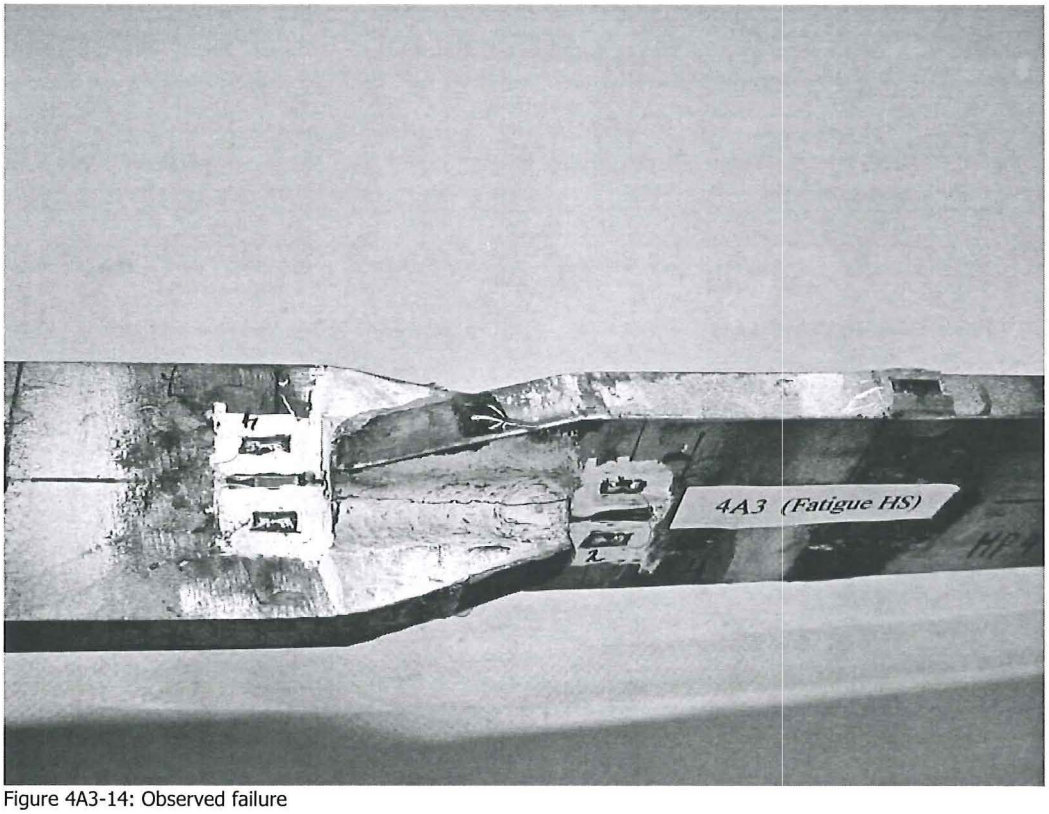


Figure 4A3-14: Observed failure

SPECIMEN 4B1

Table 4B1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	4B1 (37)
	Type of specimen	X-joint with low SCF
	Plate thickness	10 mm
	Plate material	S1100
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-4B
Test	Type of test	Static strength
	Parameter	High strength
	Remark	Low SCF
	Failure	Weld

SPECIMEN 4B1

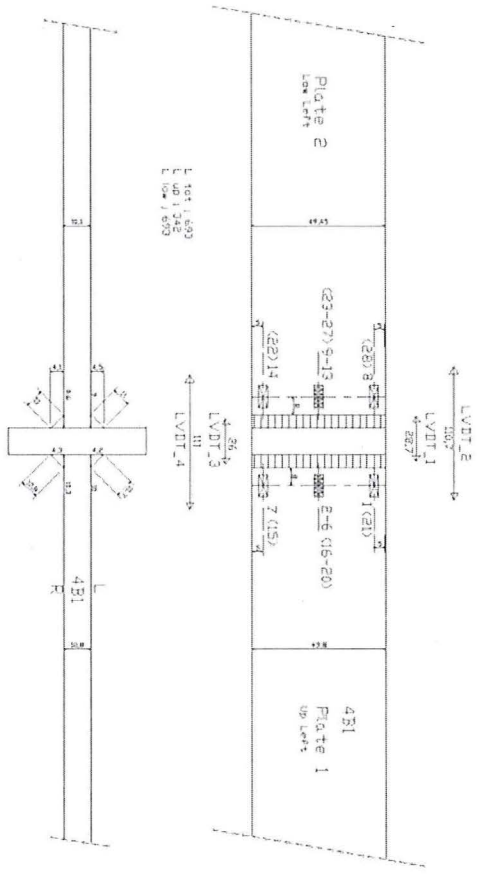


Figure 4B1-1: Dimensions of the test specimen

Figure 4B1-2: Dimensions of the welds

Figure 4B1-3: Position of strain gauges and LVDTs

SPECIMEN 4B1

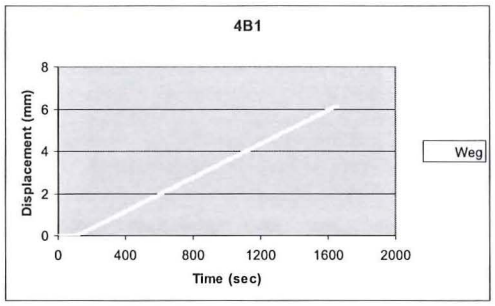


Figure 4B1-4: Test displacement controlled

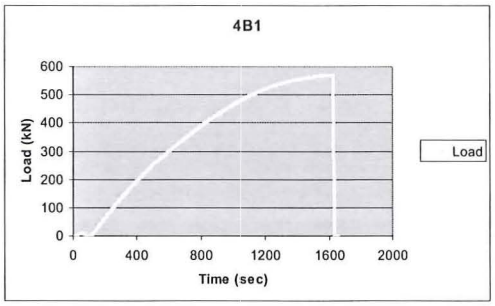


Figure 4B1-5: Test load

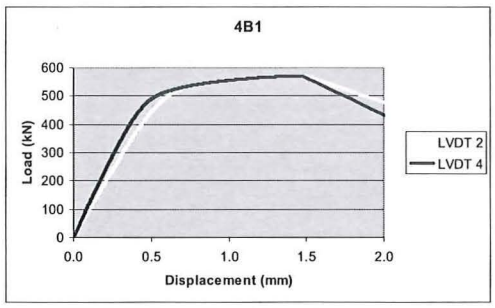


Figure 4B1-6: Deformation of the whole connection

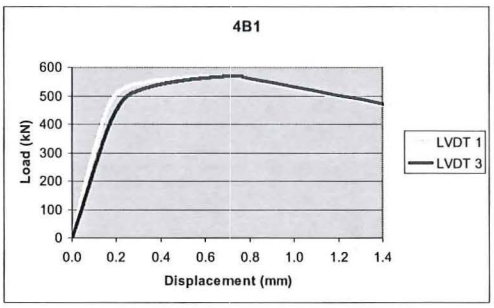


Figure 4B1-7: Local displacements

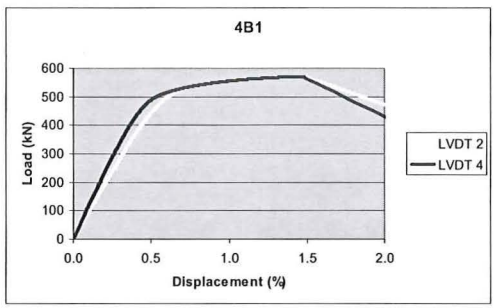


Figure 4B1-8: Relative deformation of the connection

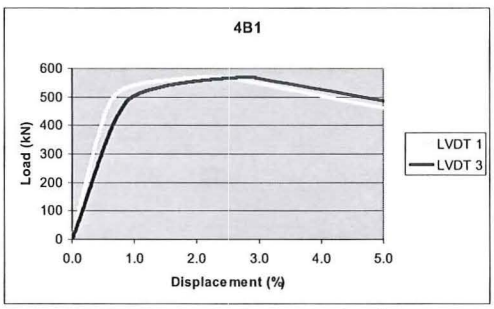


Figure 4B1-9: Relative displacements, locally

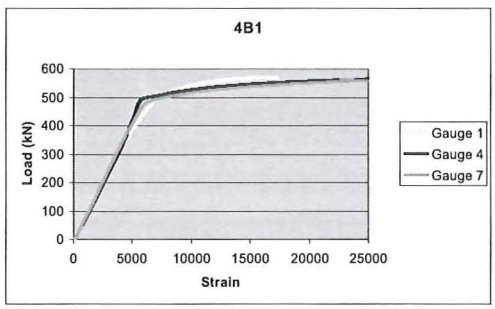


Figure 4B1-10: Measured strains plate 1 side 1

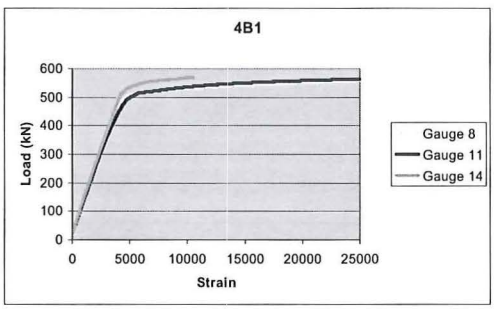


Figure 4B1-11: Measured strains plate 1 side 2

SPECIMEN 4B1

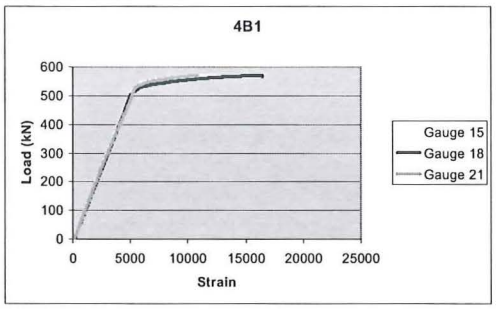


Figure 4B1-12: Measured strains plate 2 side 1

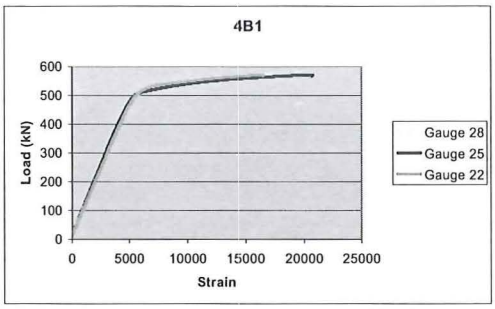


Figure 4B1-13: Measured strains plate 2 side 2

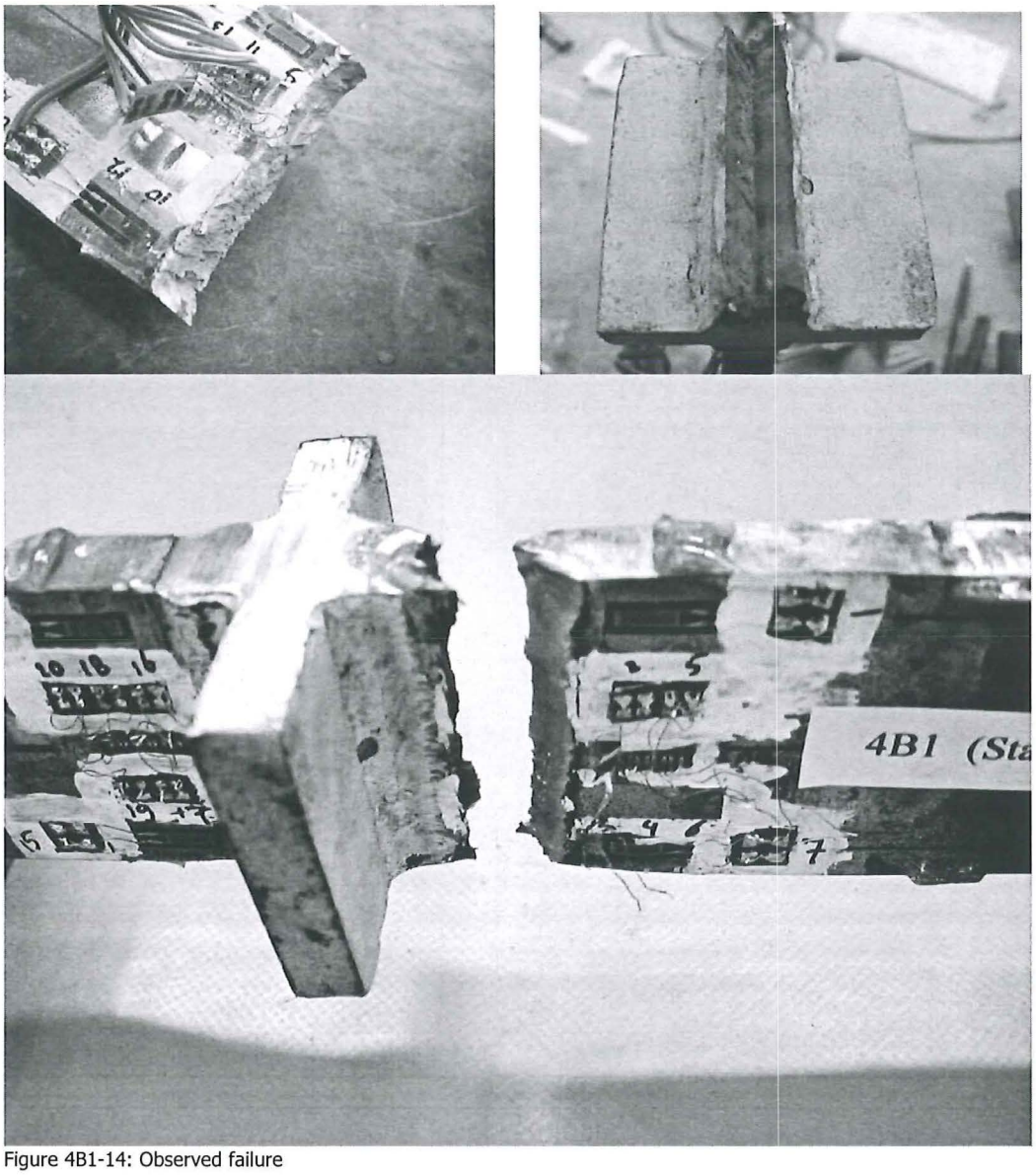


Figure 4B1-14: Observed failure

SPECIMEN 4B2

Table 4B2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	4B2 (38)
	Type of specimen	X-joint with low SCF
	Plate thickness	10 mm
	Plate material	S1100
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-4B
Test	Type of test	Fatigue
	Parameter	High strength
	Remark	Low SCF
	Failure	Weld

SPECIMEN 4B2

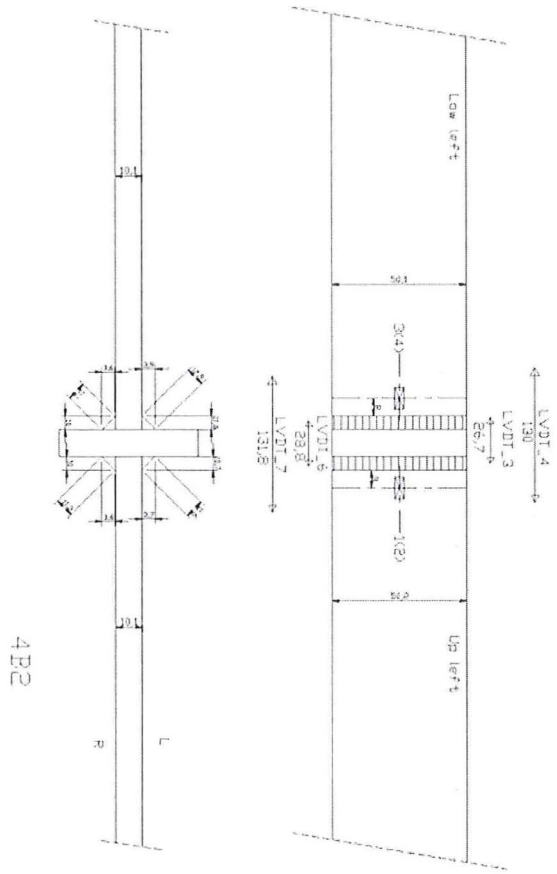


Figure 4B2-1: Dimensions of the test specimen

Figure 4B2-2: Dimensions of the welds

Figure 4B2-3: Position of strain gauges and LVDTs

SPECIMEN 4B2

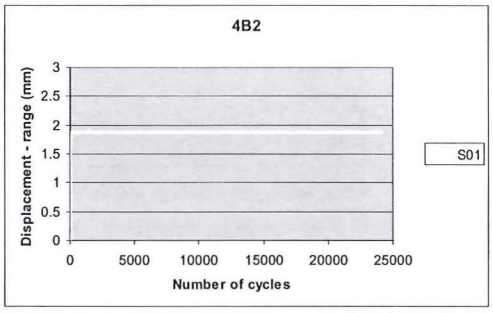


Figure 4B2-4: Test displacement controlled (range)

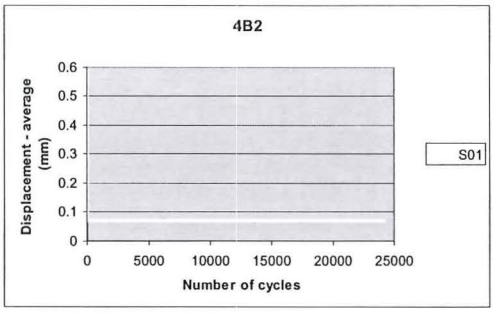


Figure 4B2-5: Test displacement controlled (average)

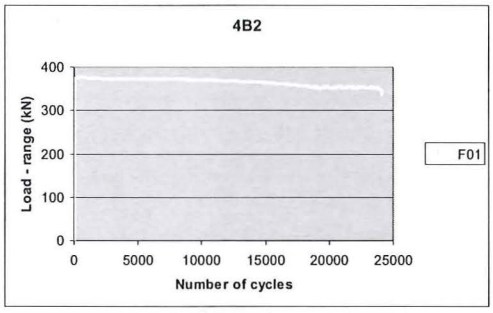


Figure 4B2-6: Test load (range)

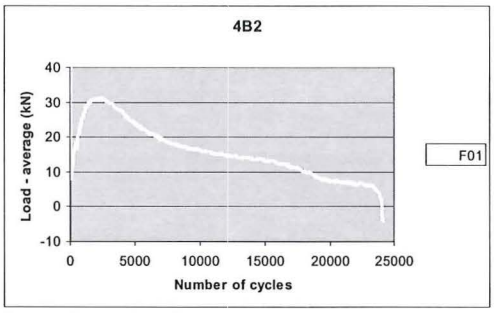


Figure 4B2-7: Test load (average)

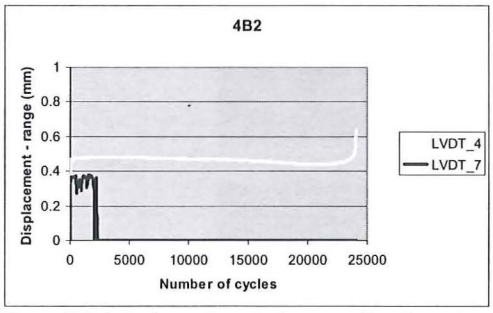


Figure 4B2-8: Deformation whole connection (range)

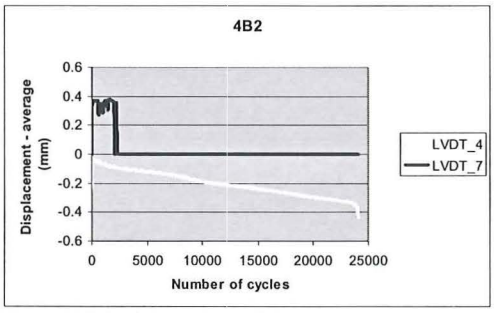


Figure 4B2-9: deformation whole connection (average)

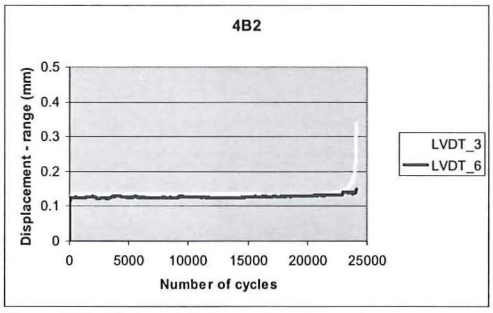


Figure 4B2-10: Local deformation (range)

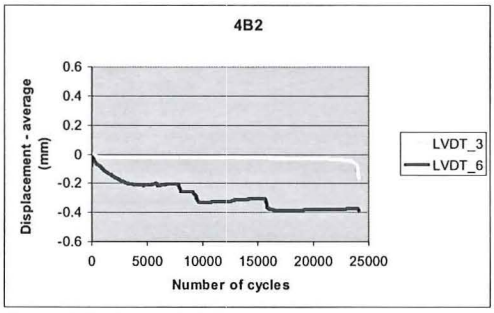


Figure 4B2-11: Local deformation (average)

SPECIMEN 4B2

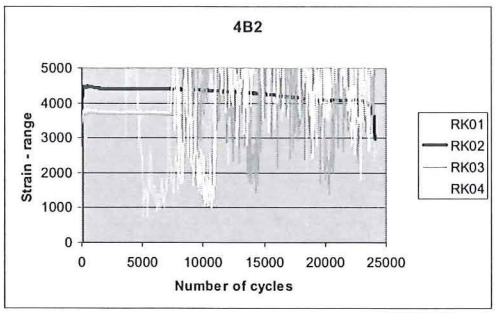


Figure 4B2-12: Measured strains (range)

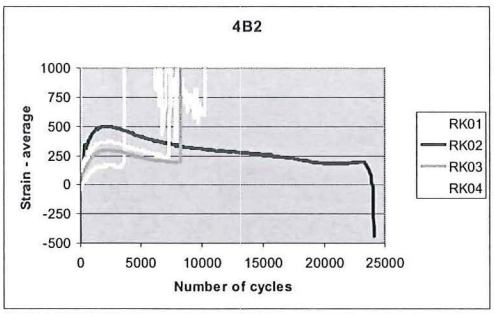
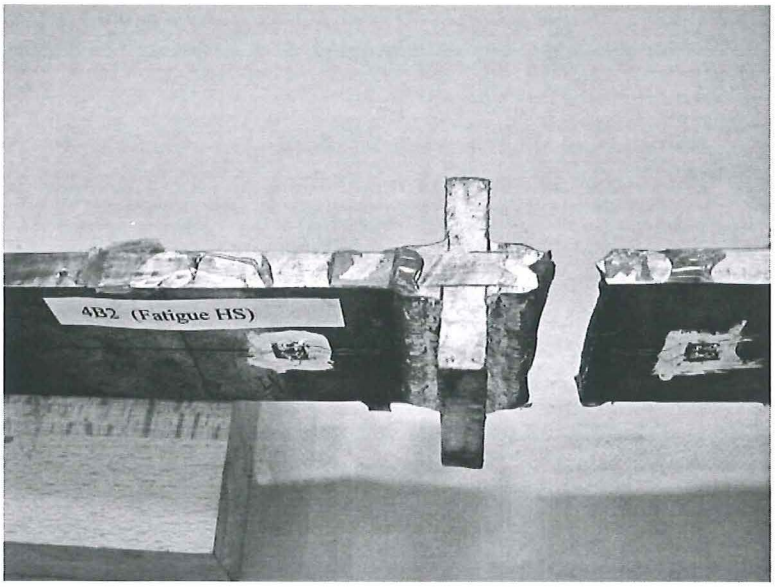


Figure 4B2-13: Measured strains (average)



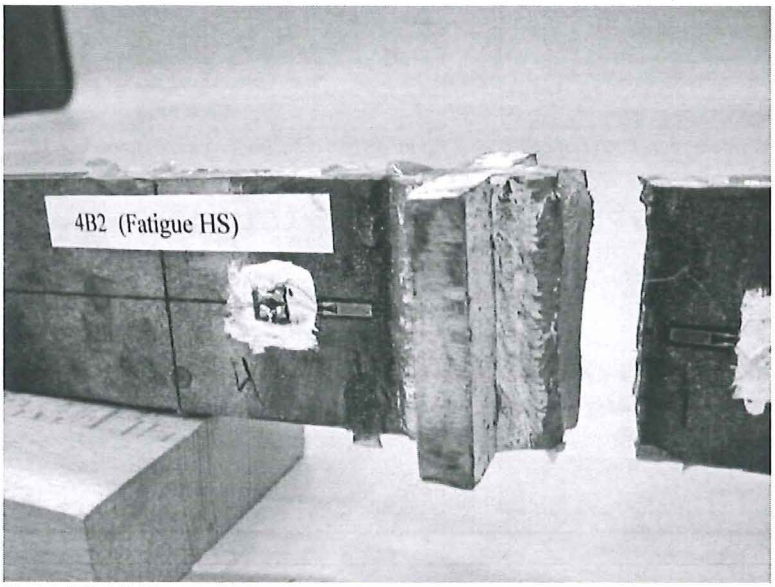


Figure 4B2-14: Observed failure

SPECIMEN 4B3

Table 4B3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	4B3 (39)
	Type of specimen	X-joint with low SCF
	Plate thickness	10 mm
	Plate material	S1100
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-4B
Test	Type of test	Fatigue
	Parameter	High strength
	Remark	Low SCF
	Failure	Weld

SPECIMEN 4B3

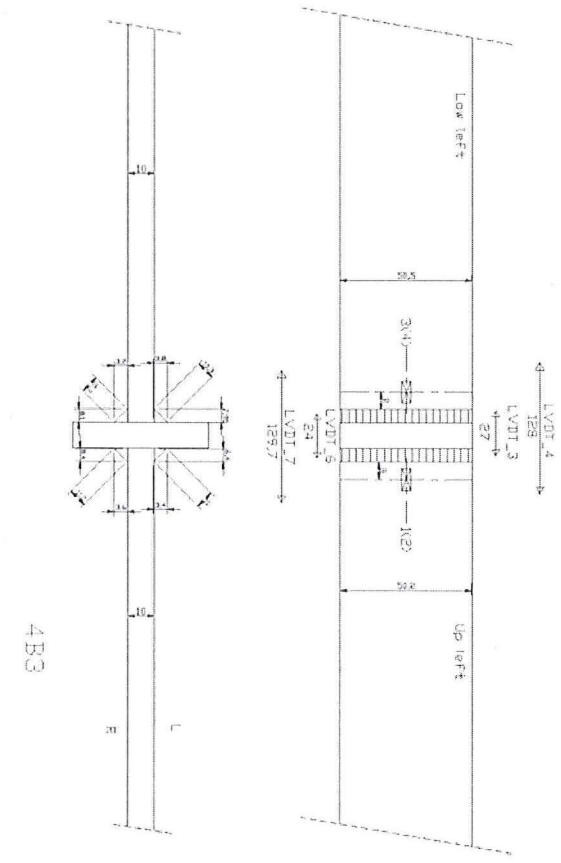


Figure 4B3-1: Dimensions of the test specimen

Figure 4B3-2: Dimensions of the welds

Figure 4B3-3: Position of strain gauges and LVDTs

SPECIMEN 4B3

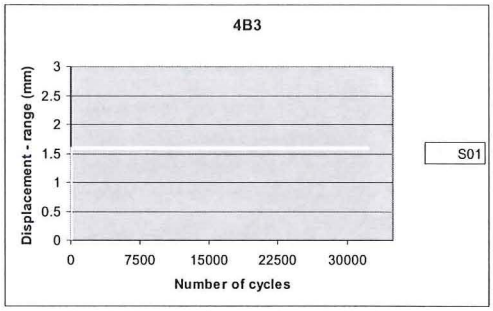


Figure 4B3-4: Test displacement controlled (range)

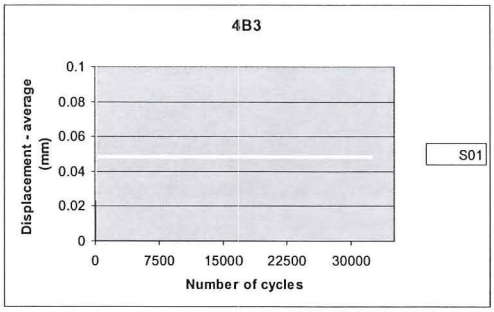


Figure 4B3-5: Test displacement controlled (average)

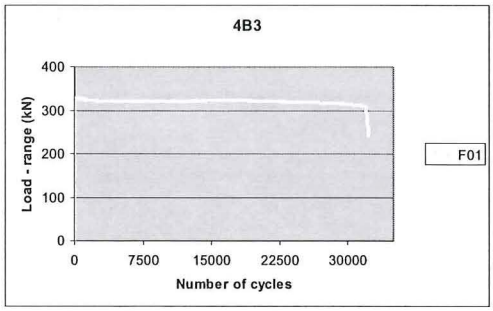


Figure 4B3-6: Test load (range)

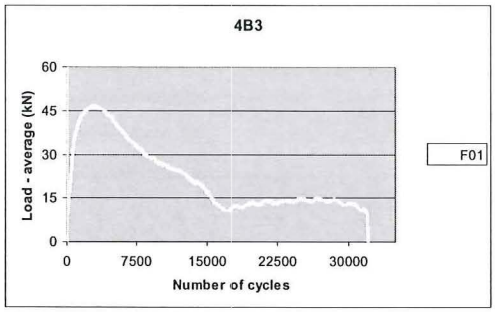


Figure 4B3-7: Test load (average)

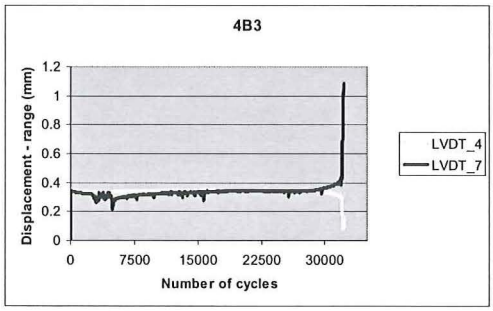


Figure 4B3-8: Deformation whole connection (range)

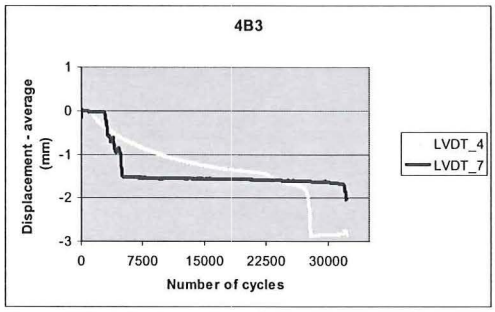


Figure 4B3-9: Deformation whole connection (average)

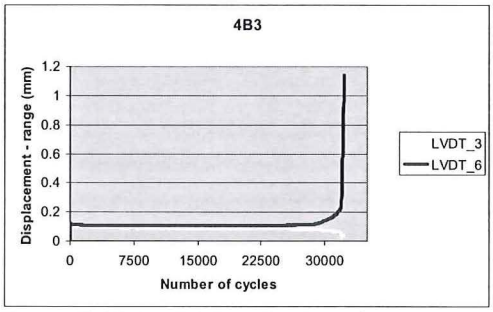


Figure 4B3-10: Local deformation (range)

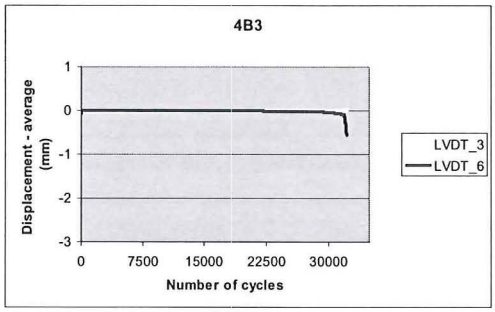


Figure 4B3-11: Local deformation (average)

SPECIMEN 4B3

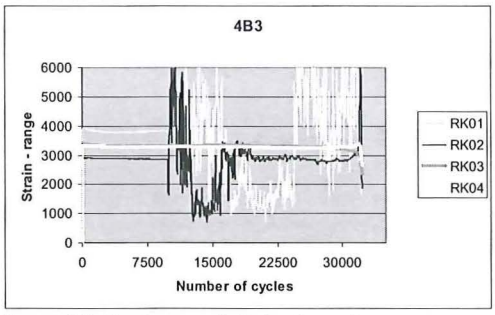


Figure 4B3-12: Measured strains (range)

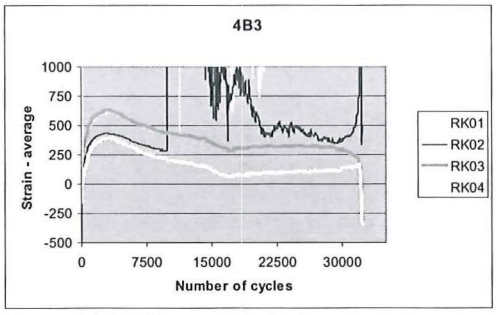


Figure 4B3-13: Measured strains (average)

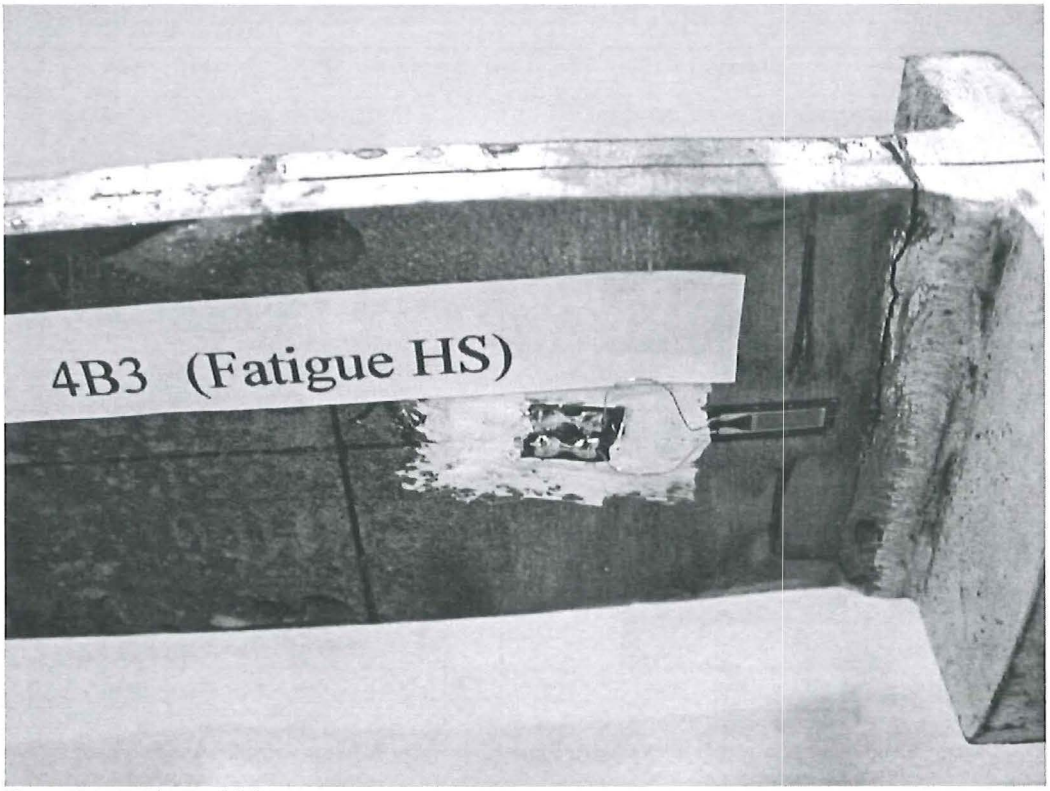


Figure 4B3-14: Observed failure

SPECIMEN 4C1

Table 4C1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	4C1 (40)
	Type of specimen	X-joint with high SCF
	Plate thickness	10 mm
	Plate material	S1100
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-4C
Test	Type of test	Static strength
	Parameter	High strength
	Remark	High SCF
	Failure	Weld

SPECIMEN 4C1

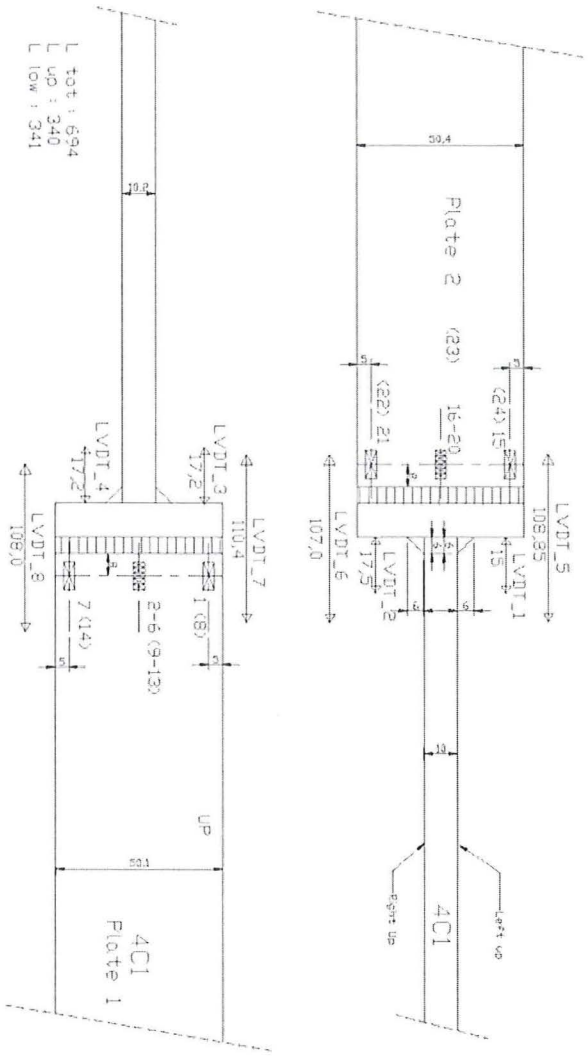


Figure 4C1-1: Dimensions of the test specimen

Figure 4C1-2: Dimensions of the welds

Figure 4C1-3: Position of strain gauges and LVDTs

SPECIMEN 4C1

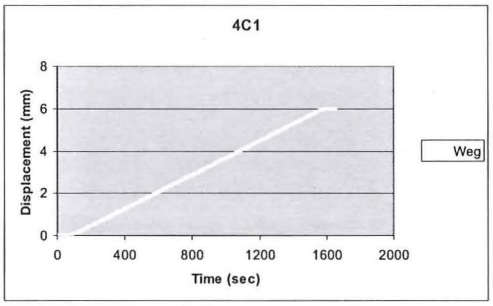


Figure 4C1-4: Test displacement controlled

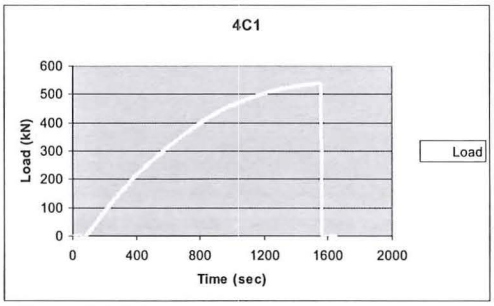


Figure 4C1-5: Test load

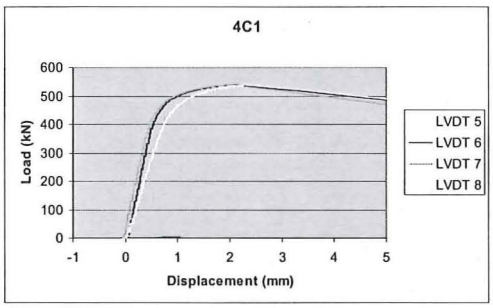


Figure 4C1-6: Deformation of the whole connection

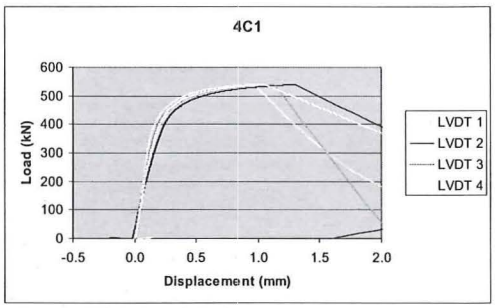


Figure 4C1-7: Local displacements

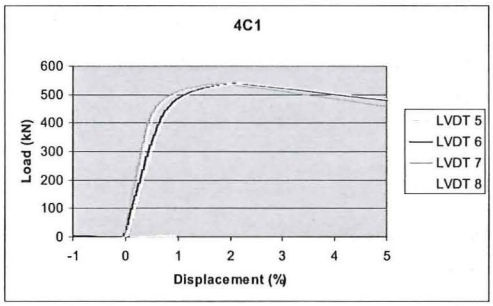


Figure 4C1-8: Relative deformation of the connection

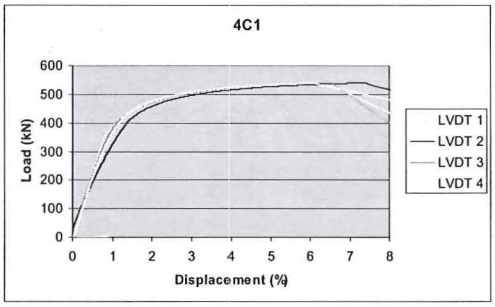


Figure 4C1-9: Relative displacements, locally

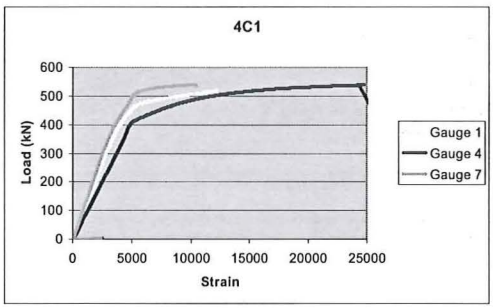


Figure 4C1-10: Measured strains plate 1 side 1

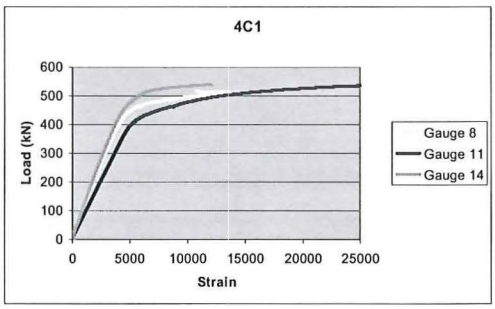


Figure 4C1-11: Measured strains plate 1 side 2

SPECIMEN 4C1

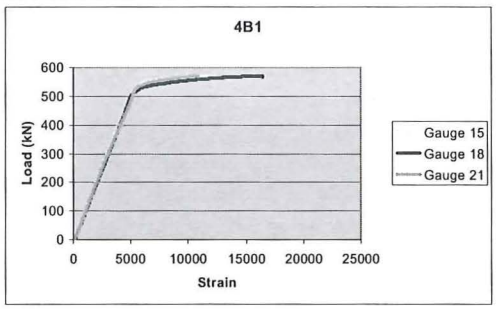


Figure 4C1-12: Measured strains plate 2 side 1

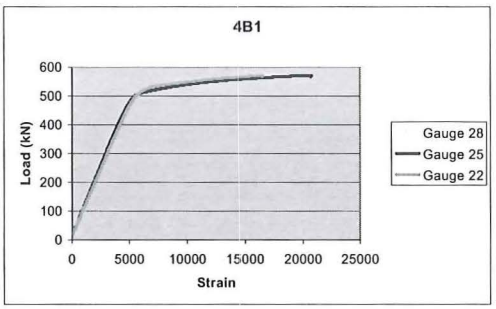


Figure 4C1-13: Measured strains plate 2 side 2

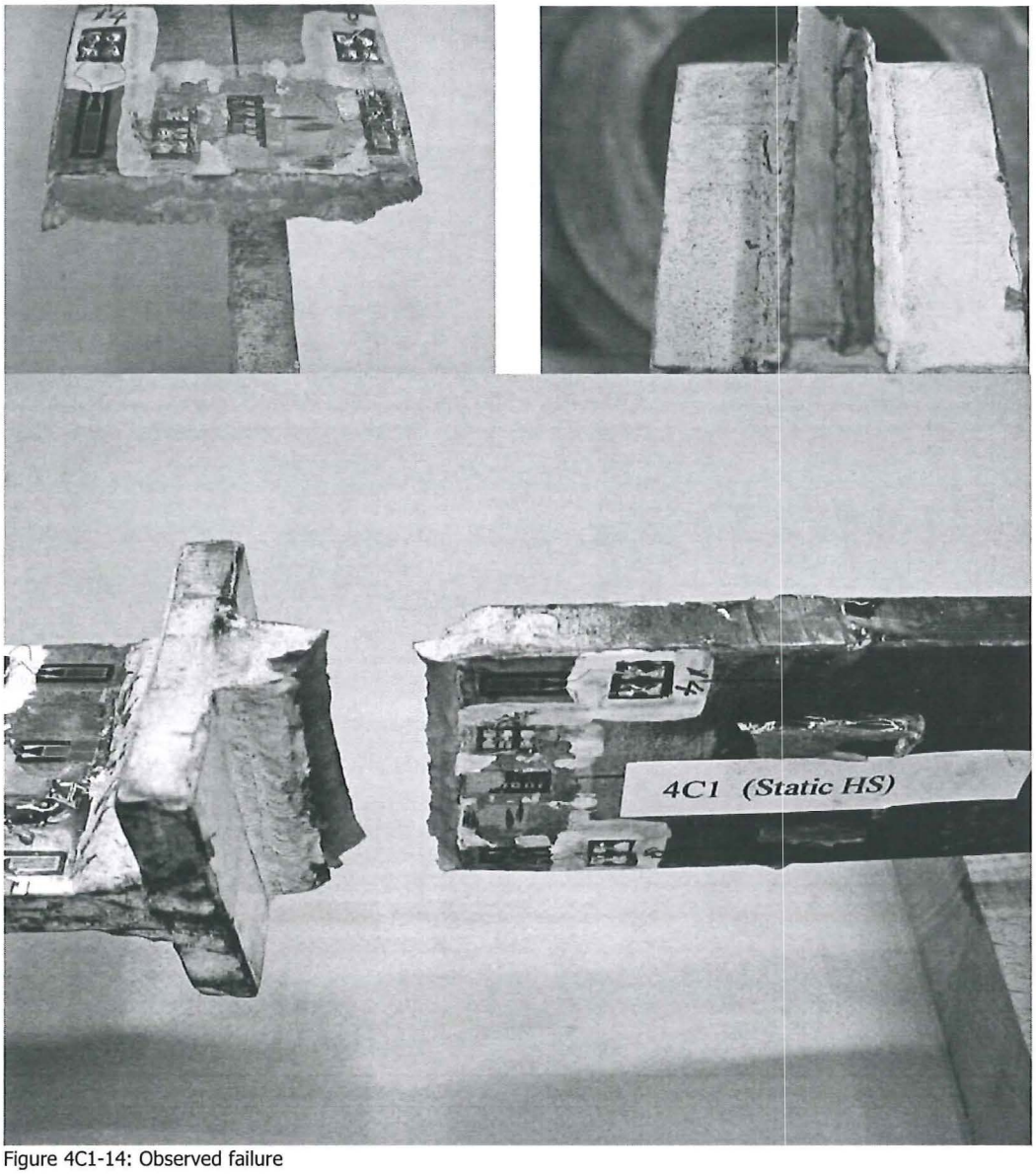


Figure 4C1-14: Observed failure

SPECIMEN 4C2

Table 4C2-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	4C2 (41)
	Type of specimen	X-joint with high SCF
	Plate thickness	10 mm
	Plate material	S1100
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-4C
Test	Type of test	Fatigue
	Parameter	High strength
	Remark	High SCF
	Failure	Weld

SPECIMEN 4C2

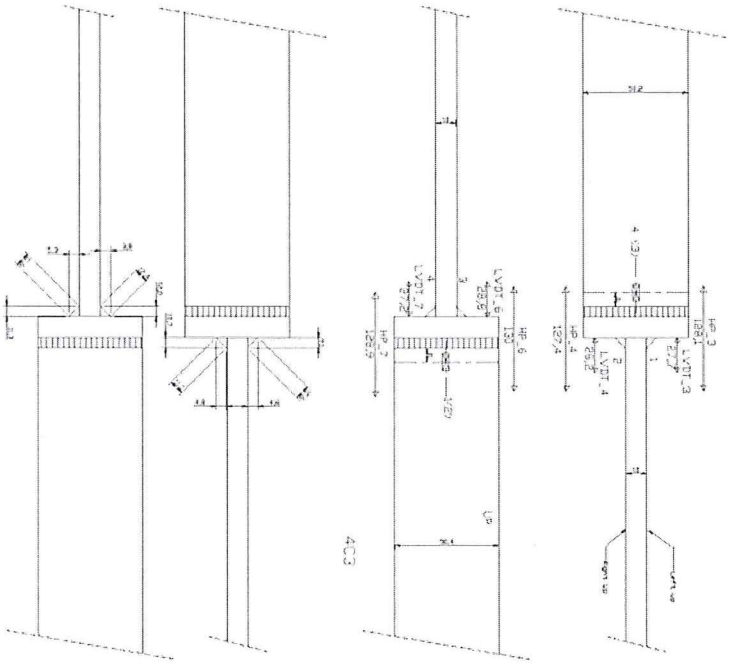


Figure 4C2-1: Dimensions of the test specimen

Figure 4C2-2: Dimensions of the welds

Figure 4C2-3: Position of strain gauges and LVDTs

SPECIMEN 4C2

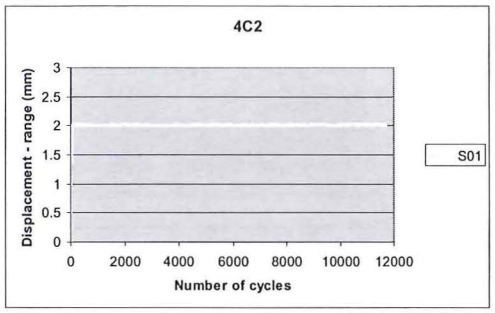


Figure 4C2-4: Test displacement controlled (range)

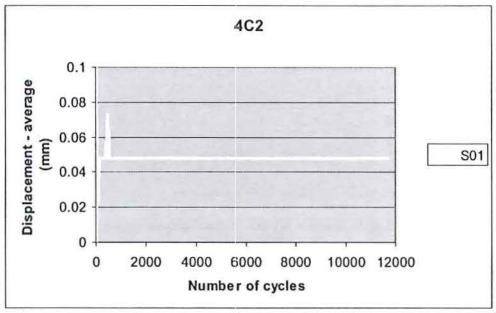


Figure 4C2-5: Test displacement controlled (average)

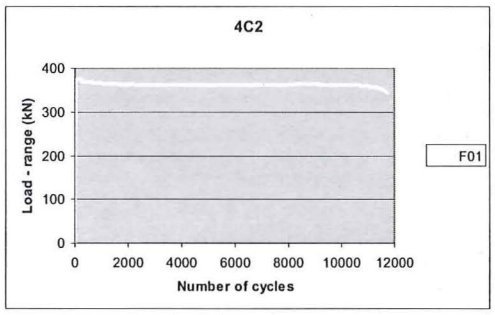


Figure 4C2-6: Test load (range)

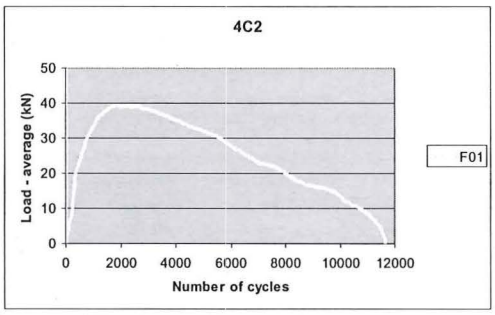


Figure 4C2-7: Test load (average)

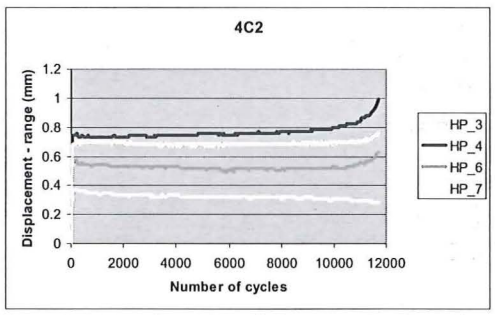


Figure 4C2-8: Deformation whole connection (range)

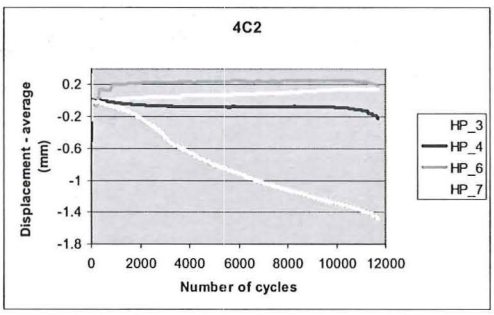


Figure 4C2-9: deformation whole connection (average)

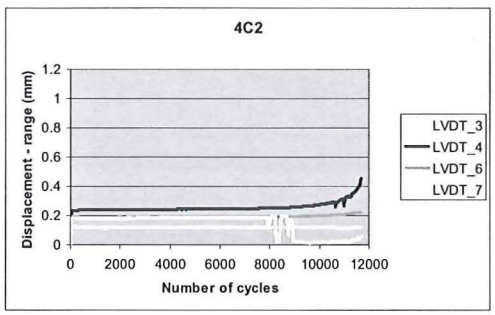


Figure 4C2-10: Local deformation (range)

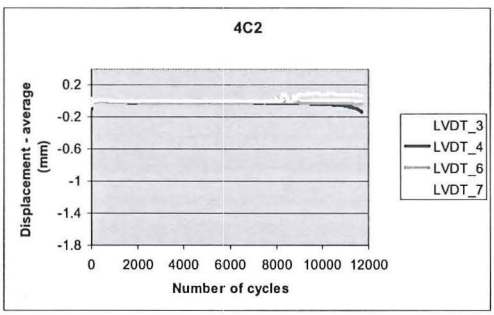


Figure 4C2-11: Local deformation (average)

SPECIMEN 4C2

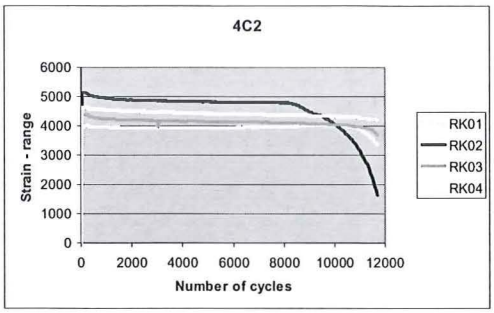


Figure 4C2-12: Measured strains (range)

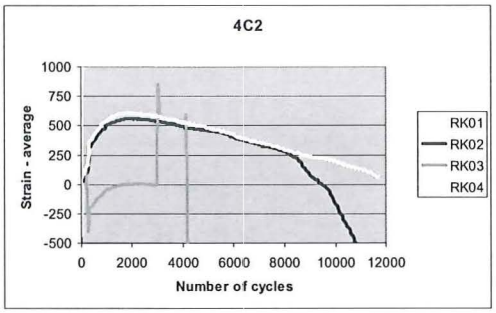


Figure 4C2-13: Measured strains (average)

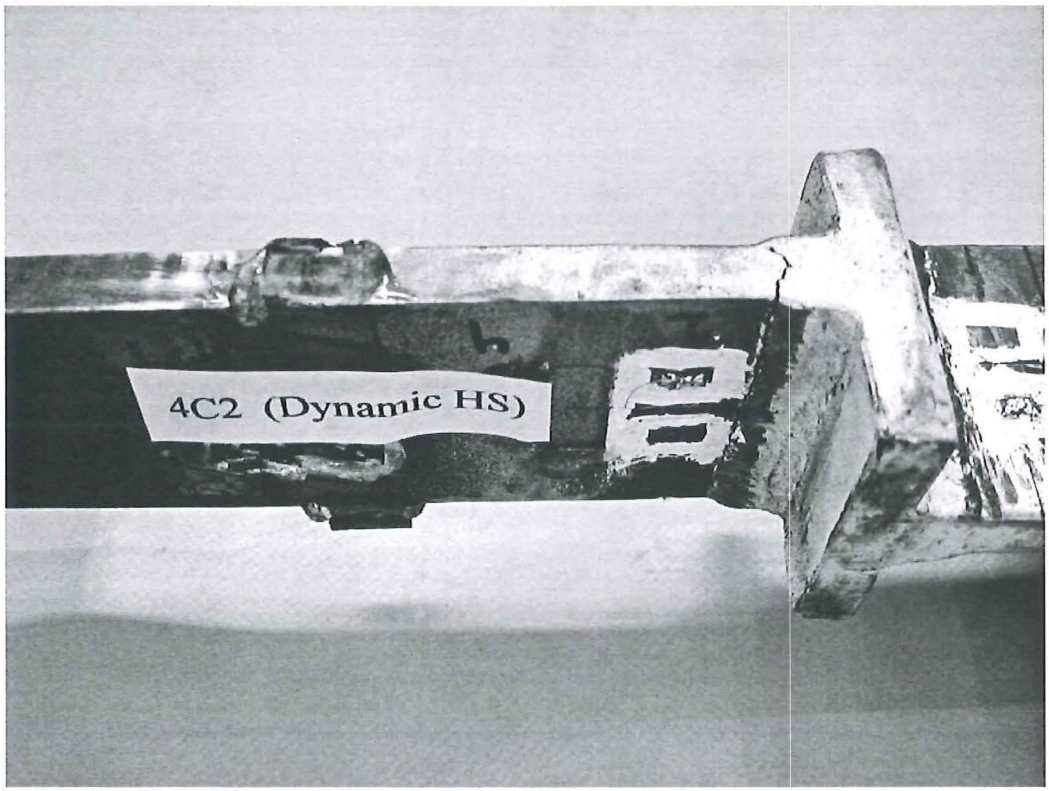


Figure 4C2-14: Observed failure

SPECIMEN 4C3

Table 4C3-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	4C3 (42)
	Type of specimen	X-joint with high SCF
	Plate thickness	10 mm
	Plate material	S1100
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-4C
Test	Type of test	Fatigue
	Parameter	High strength
	Remark	High SCF
	Failure	Weld

SPECIMEN 4C3

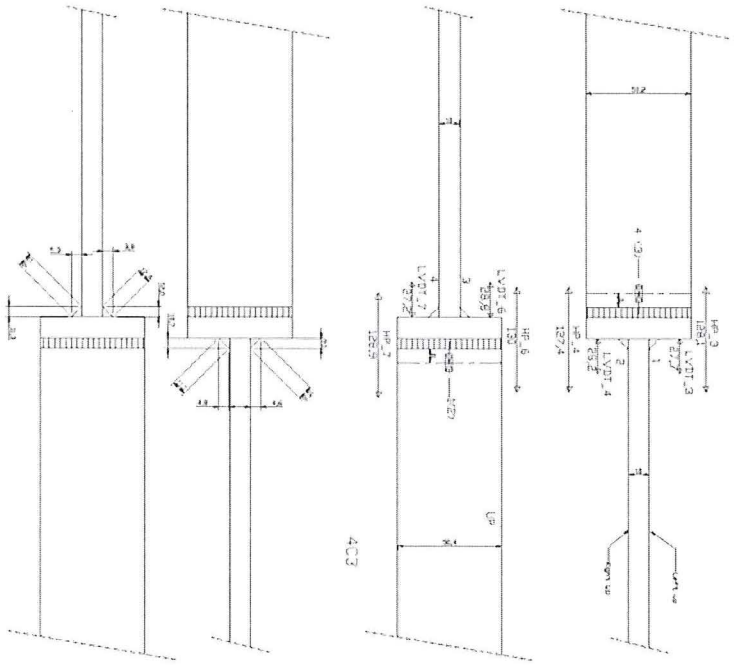


Figure 4C3-1: Dimensions of the test specimen

Figure 4C3-2: Dimensions of the welds

Figure 4C3-3: Position of strain gauges and LVDTs

SPECIMEN 4C3

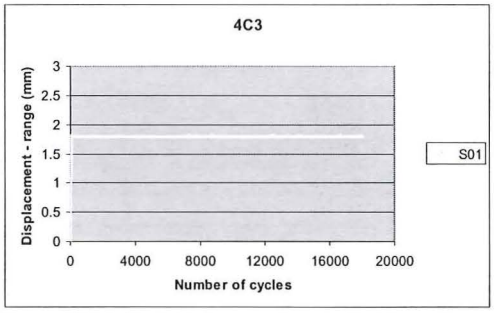


Figure 4C3-4: Test displacement controlled (range)

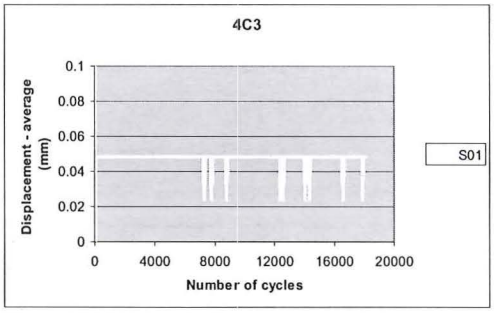


Figure 4C3-5: Test displacement controlled (average)

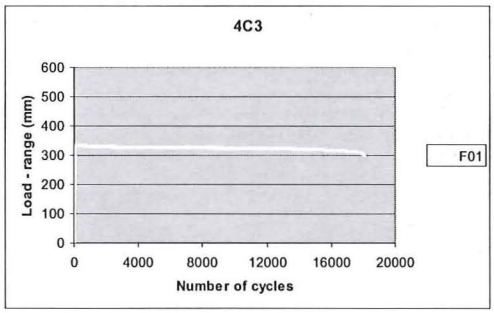


Figure 4C3-6: Test load (range)

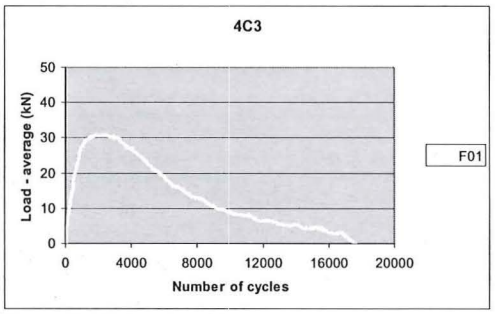


Figure 4C3-7: Test load (average)

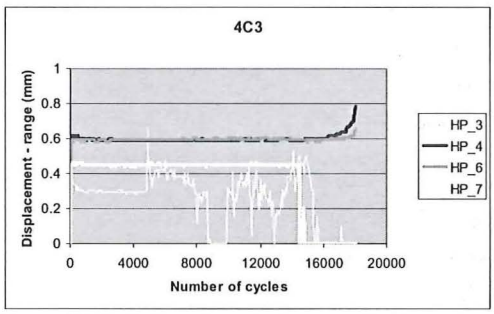


Figure 4C3-8: Deformation whole connection (range)

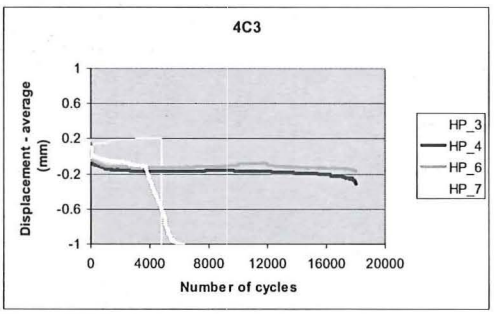


Figure 4C3-9: deformation whole connection (average)

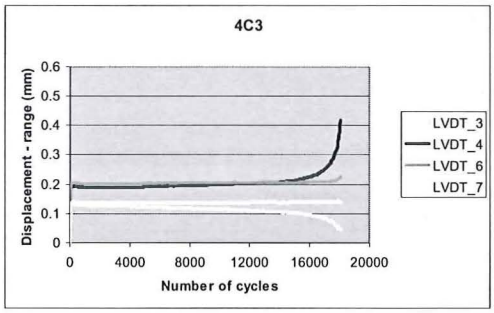


Figure 4C3-10: Local deformation (range)

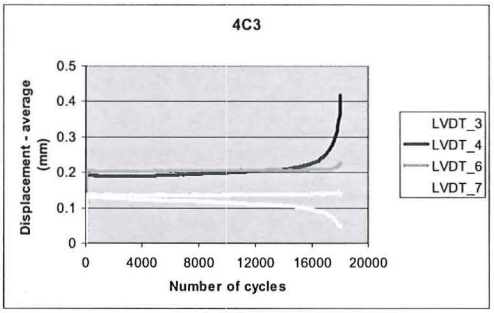


Figure 4C3-11: Local deformation (average)

SPECIMEN 4C3

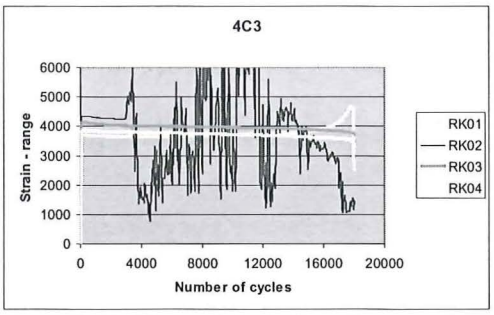


Figure 4C3-12: Measured strains (range)

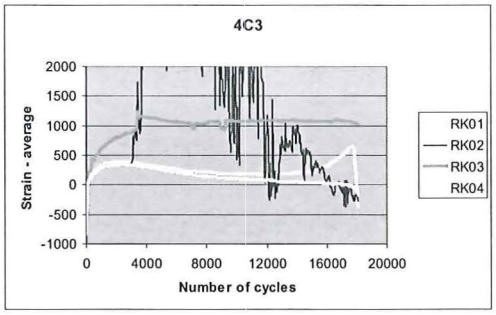


Figure 4C3-13: Measured strains (average)

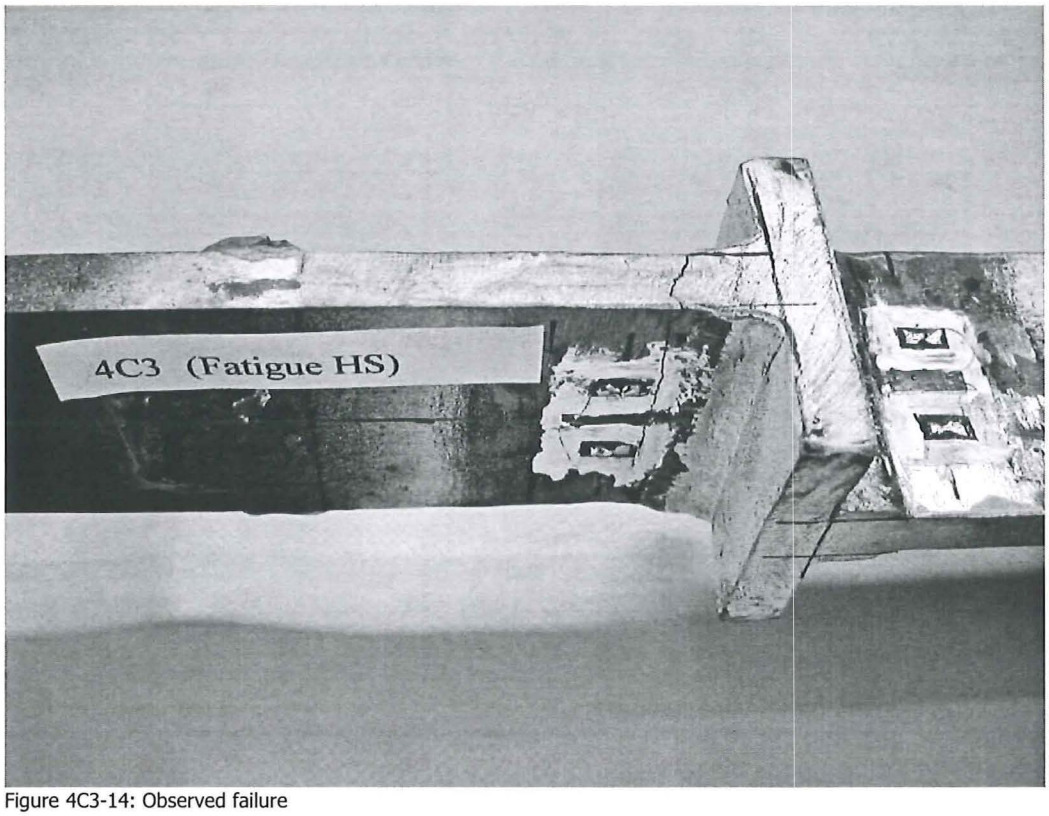


Figure 4C3-14: Observed failure

SPECIMEN 5A1

Table 5A1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	5A1 (43)
	Type of specimen	Cross plate connection
	Plate thickness	40 mm
	Plate material	S1100
Weld	Type of weld	Fillet welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-5A
Test	Type of test	Static strength
	Parameter	Thickness / High strength
	Remark	Fillet welds loaded in shear
	Failure	Welds

SPECIMEN 5A1

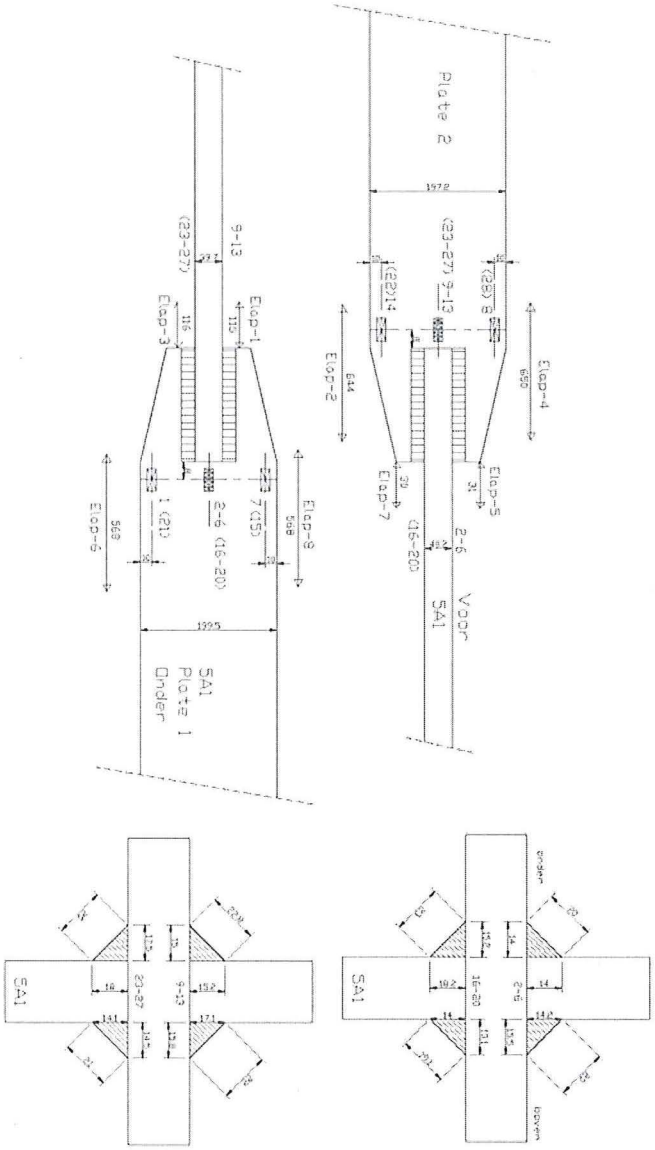


Figure 5A1-1: Dimensions of the test specimen

Figure 5A1-2: Dimensions of the welds

Figure 5A1-2: Position of strain gauges and LVDT's

SPECIMEN 5A1

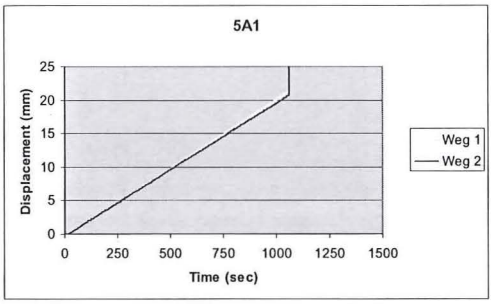


Figure 5A1-3: Test displacement controlled

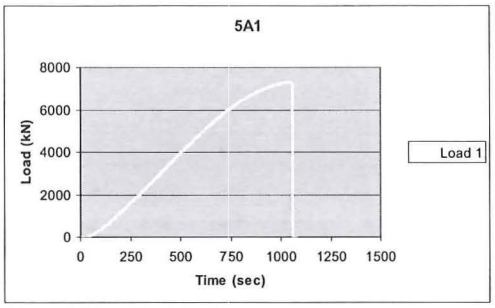


Figure 5A1-4: Test load

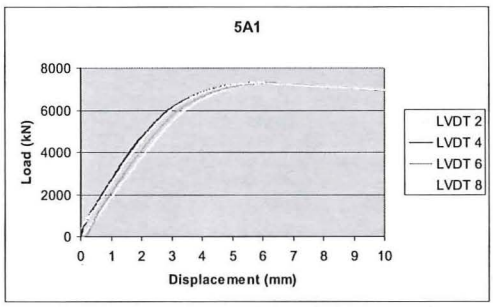


Figure 5A1-5: Deformation of the whole connection

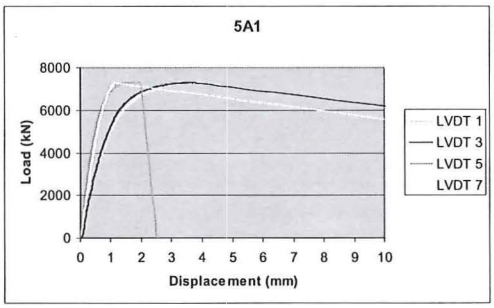


Figure 5A1-6: Local displacements

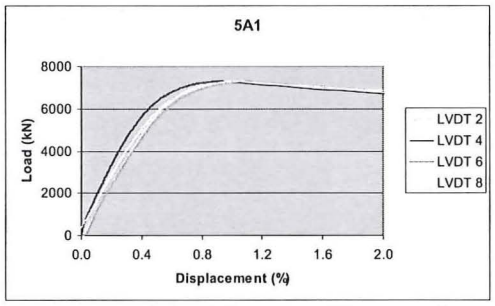


Figure 5A1-7: Relative deformation of the connection

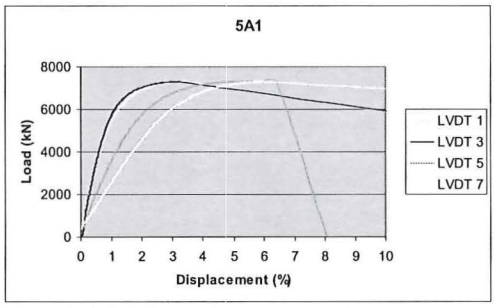


Figure 5A1-8: Relative displacements, locally

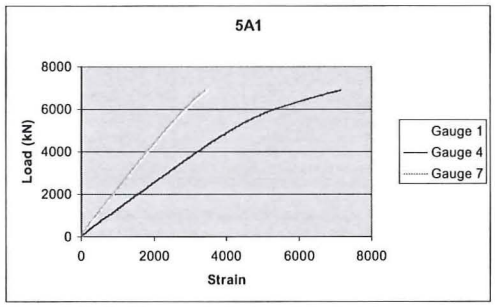


Figure 5A1-9: Measured strains plate 1 side 1

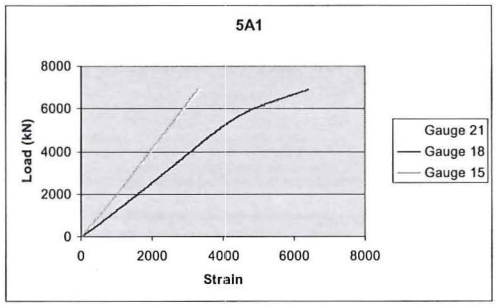


Figure 5A1-10: Measured strains plate 1 side 2

SPECIMEN 5A1

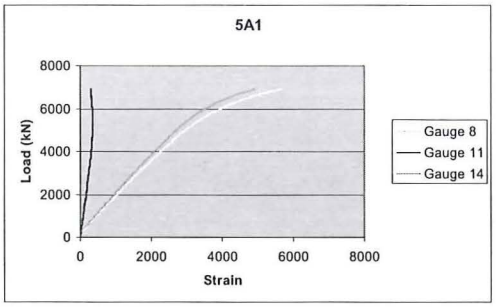


Figure 5A1-11: Measured strains plate 2 side 1

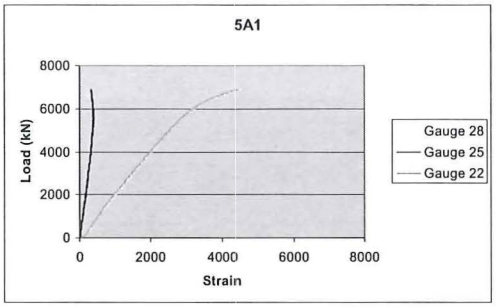


Figure 5A1-12: Measured strains plate 2 side 2

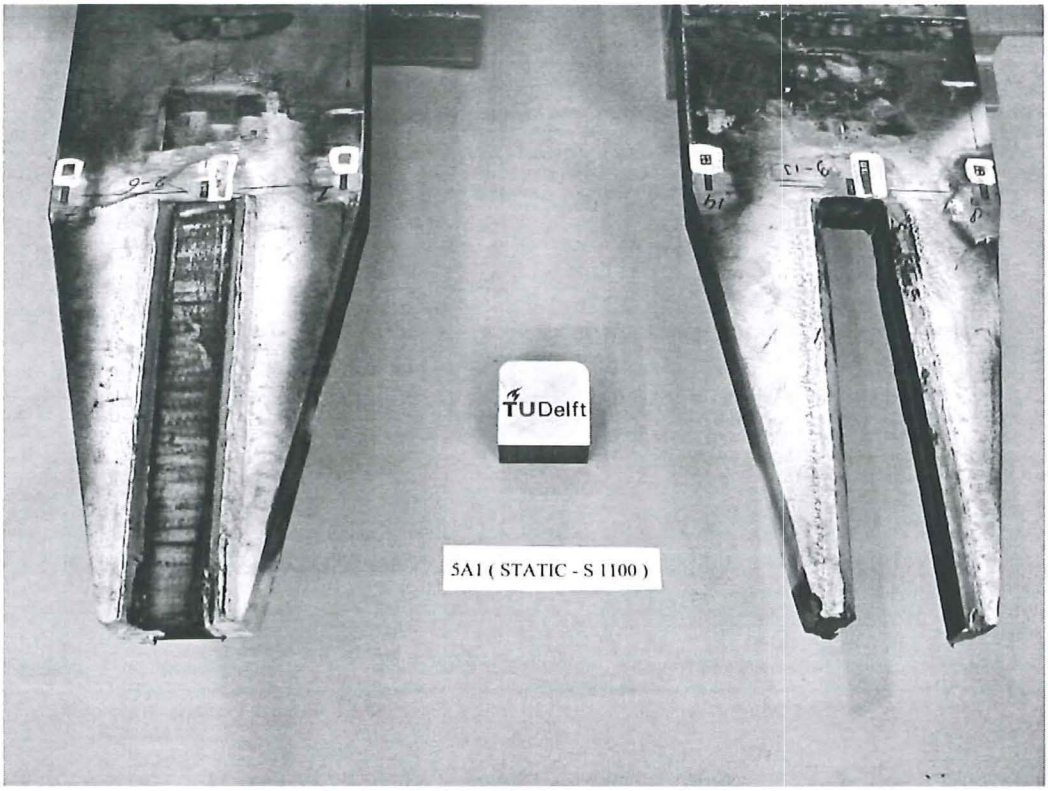


Figure 5A1-13a: Observed failure in the weld

SPECIMEN 5A1

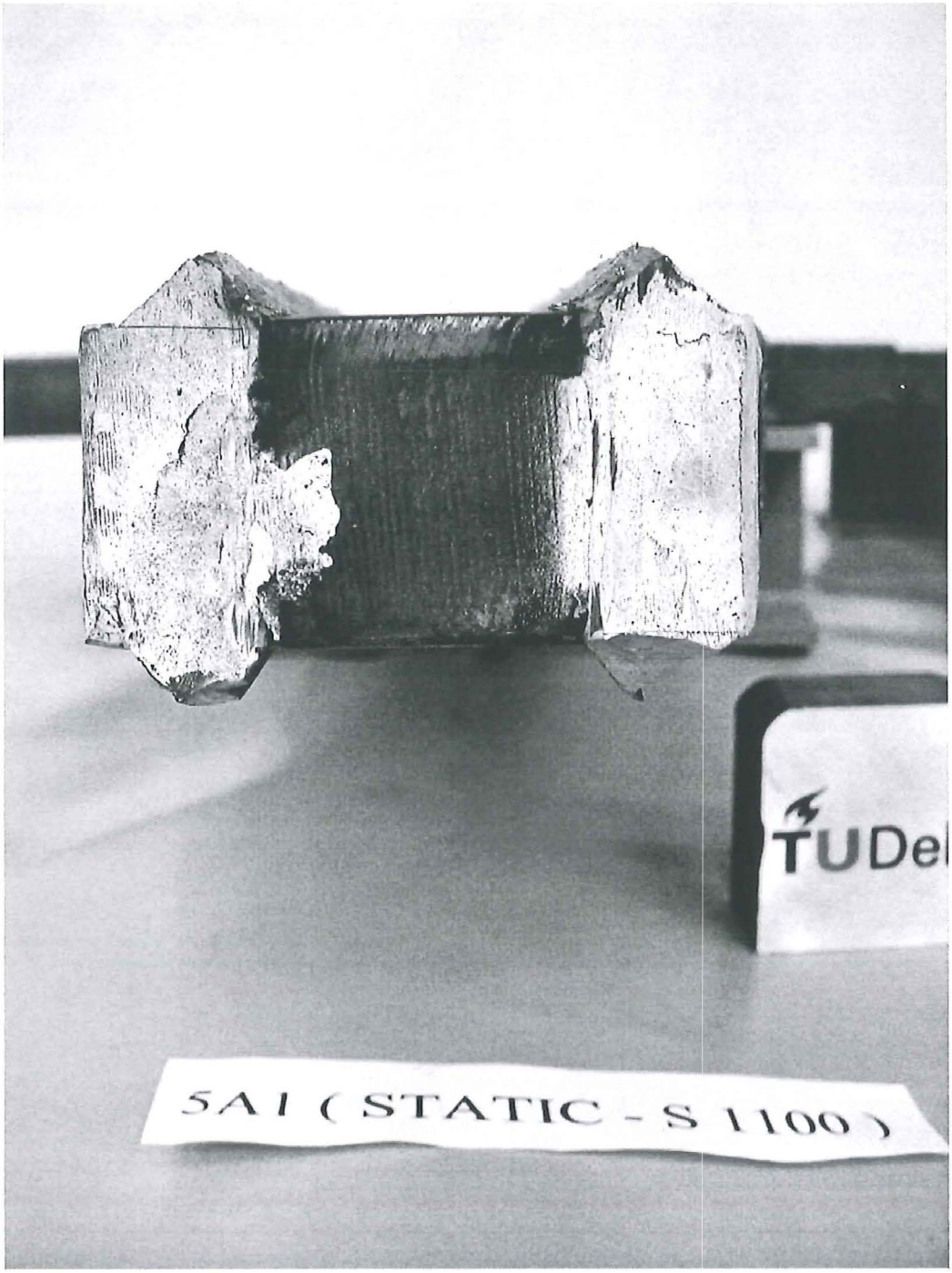


Figure 5A1-13b: Observed failure in the weld

SPECIMEN 5B1

Table 5B1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	5B1 (45)
	Type of specimen	X-joint with low SCF
	Plate thickness	40 mm
	Plate material	S1100
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-5B
Test	Type of test	Static strength
	Parameter	Thickness / High strength
	Remark	High SCF
	Failure	**Test stopped before failure**

SPECIMEN 5B1

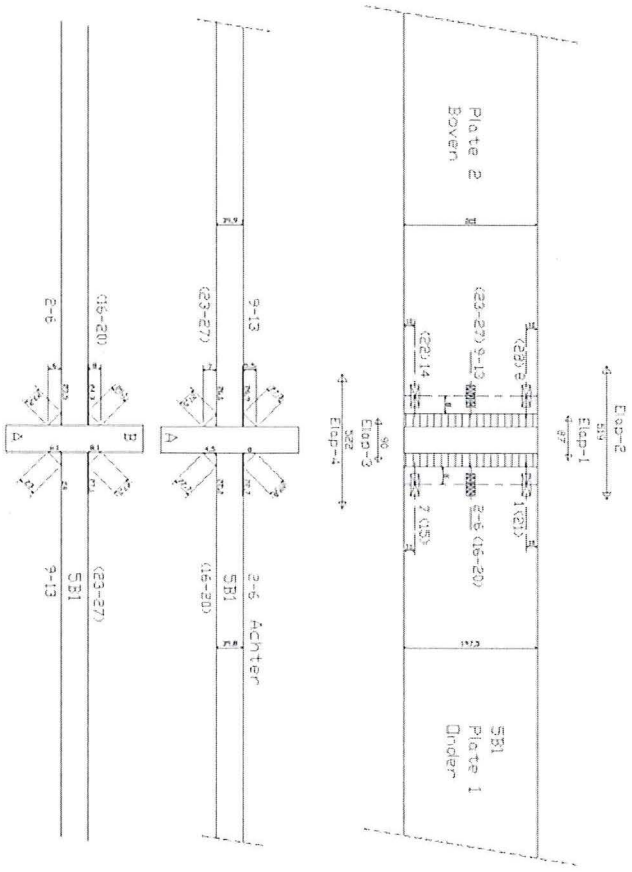


Figure 5B1-1: Dimensions of the test specimen

Figure 5B1-2: Dimensions of the welds

Figure 5B1-2: Position of strain gauges and LVDT's

SPECIMEN 5B1

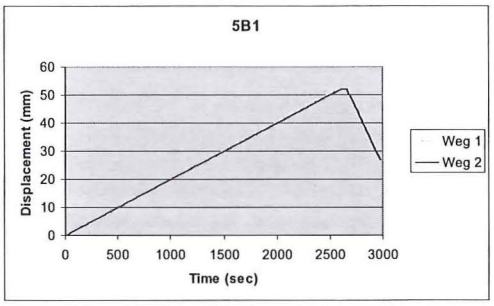


Figure 5B1-3: Test displacement controlled

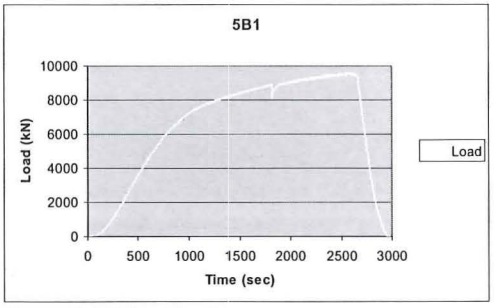


Figure 5B1-4: Test load

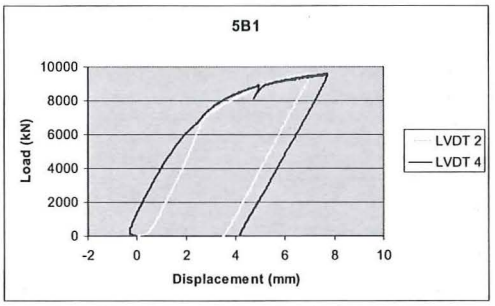


Figure 5B1-5: Deformation of the whole connection

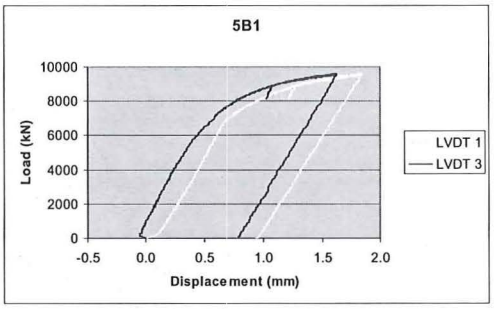


Figure 5B1-6: Local displacements

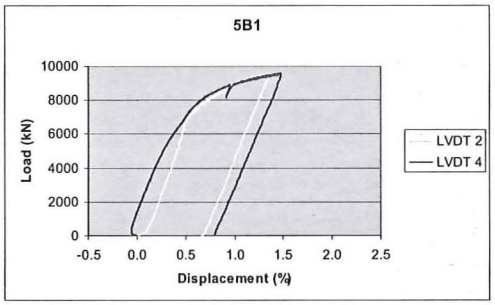


Figure 5B1-7: Relative deformation of the connection

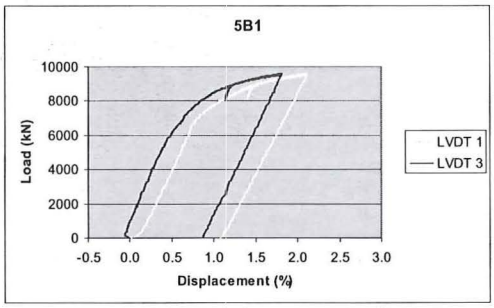


Figure 5B1-8: Relative displacements, locally

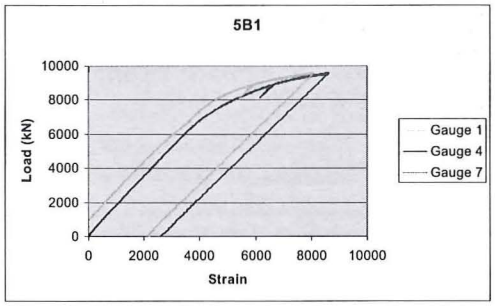


Figure 5B1-9: Measured strains plate 1 side 1

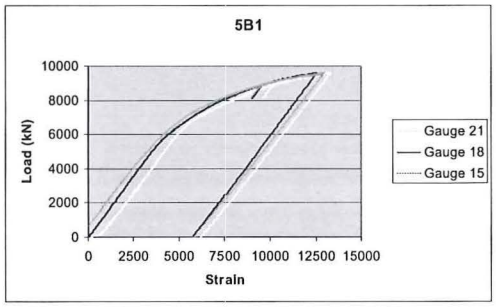


Figure 5B1-10: Measured strains plate 1 side 2

SPECIMEN 5B1

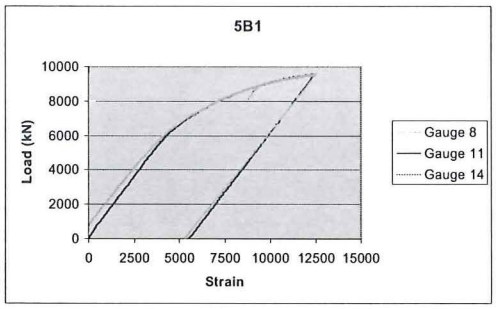


Figure 5B1-11: Measured strains plate 2 side 1

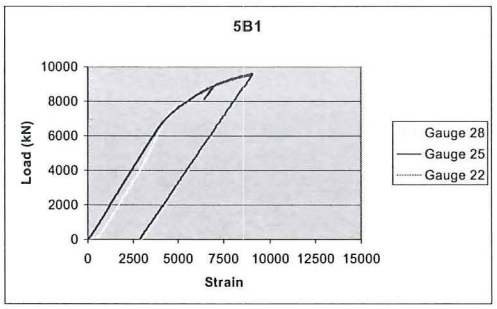


Figure 5B1-12: Measured strains plate 2 side 2

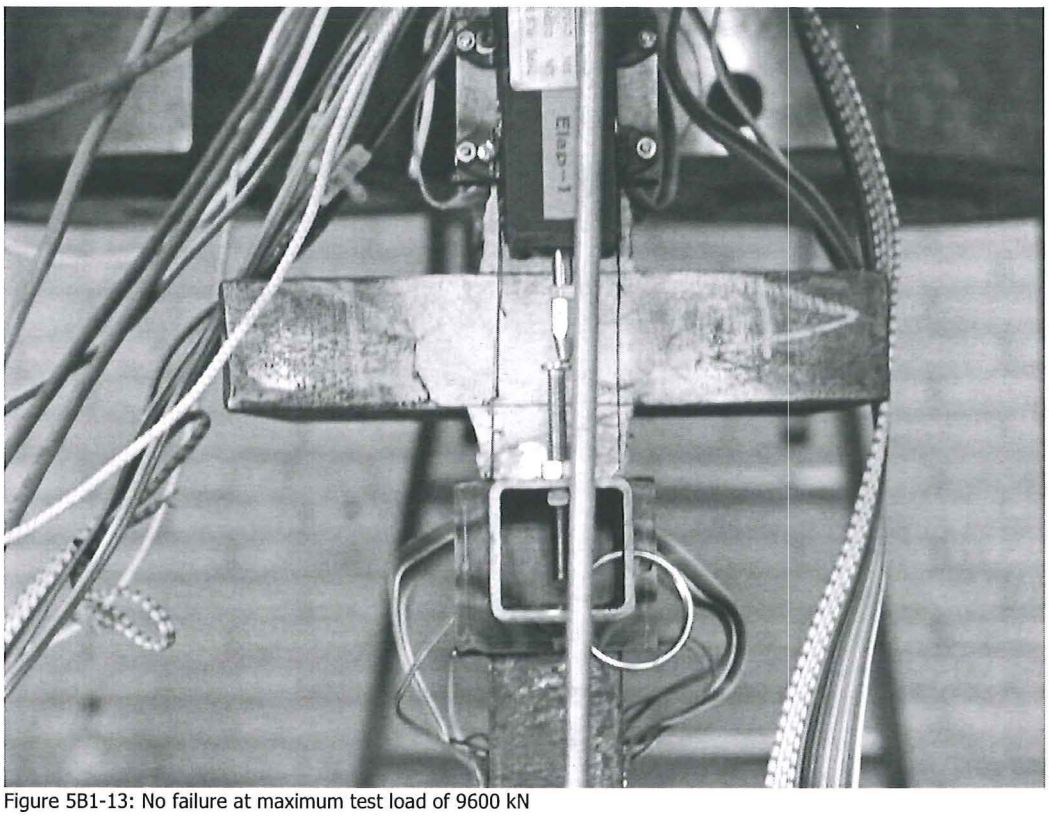


Figure 5B1-13: No failure at maximum test load of 9600 kN

SPECIMEN 5C1

Table 2C1-1: Characteristics of the test specimen, weld material and test

Specimen	Test Nr.	5C1 (47)
	Type of specimen	X-joint with high SCF
	Plate thickness	40 mm
	Plate material	S1100
Weld	Type of weld	Full penetration welds
	Weld material	Under matched
	Welding procedure specification	Appendix B-5C
Test	Type of test	Static strength
	Parameter	Thickness / High strength
	Remark	High SCF
	Failure	Weld

SPECIMEN 5C1

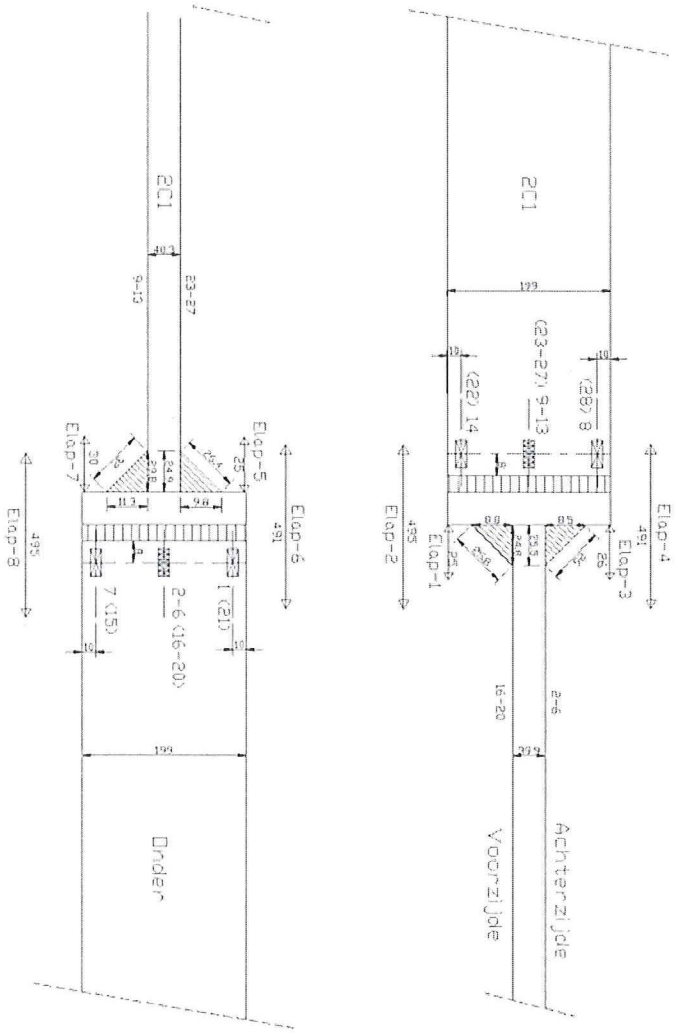


Figure 5C1-1: Dimensions of the test specimen

Figure 5C1-2: Dimensions of the welds

Figure 5C1-2: Position of strain gauges and LVDT's

SPECIMEN 5C1

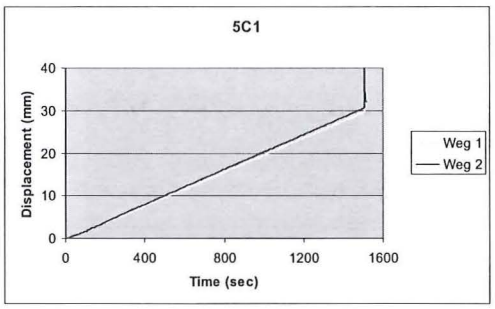


Figure 5C1-3: Test displacement controlled

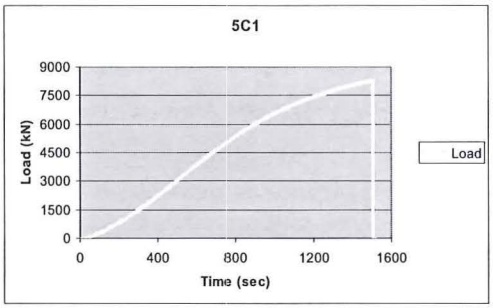


Figure 5C1-4: Test load

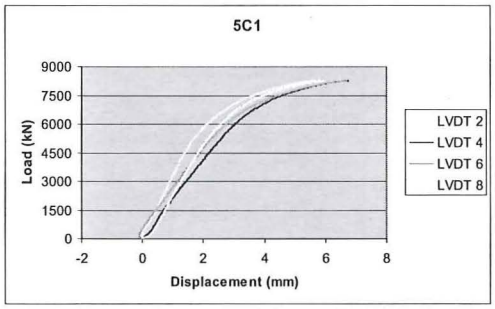


Figure 5C1-5: Deformation of the whole connection

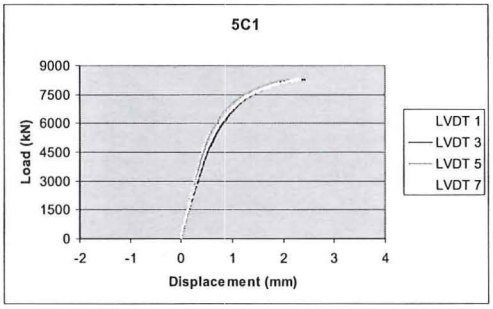


Figure 5C1-6: Local displacements

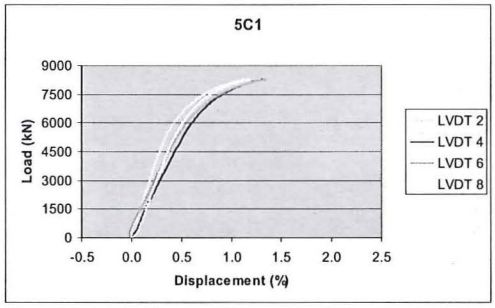


Figure 5C1-7: Relative deformation of the connection

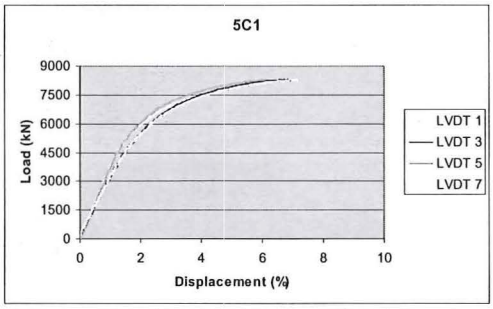


Figure 5C1-8: Relative displacements, locally

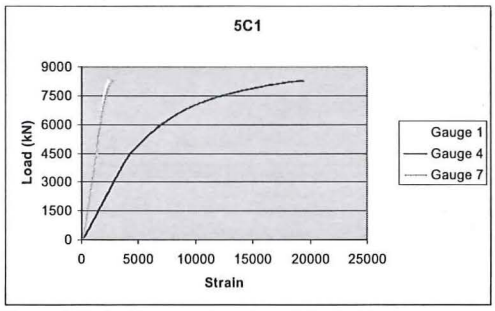


Figure 5C1-9: Measured strains plate 1 side 1

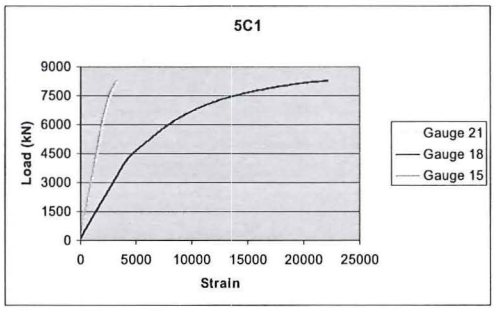


Figure 5C1-10: Measured strains plate 1 side 2

SPECIMEN 5C1

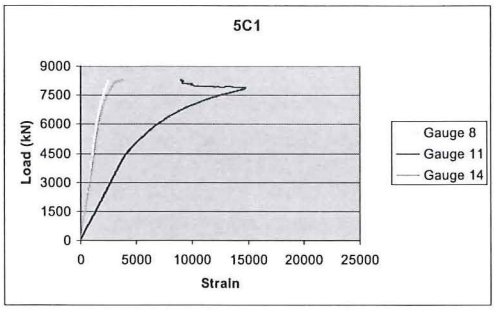


Figure 5C1-11: Measured strains plate 2 side 1

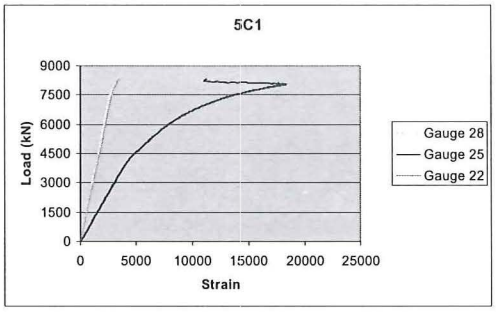


Figure 5C1-12: Measured strains plate 2 side 2

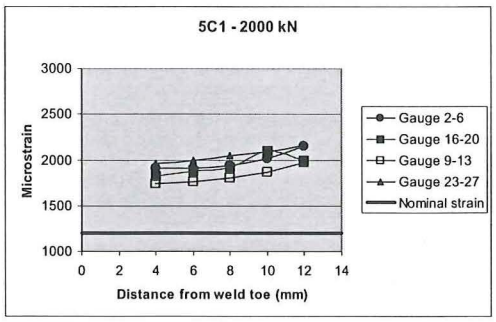


Figure 5C1-13: Measured strains strip gauges

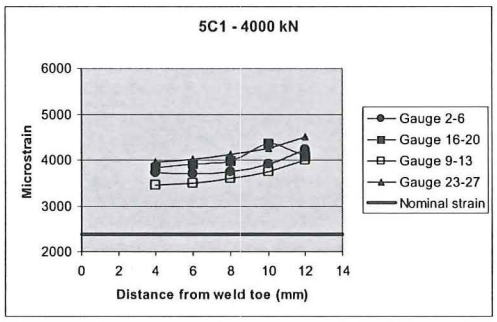


Figure 5C1-14: Measured strains strip gauges

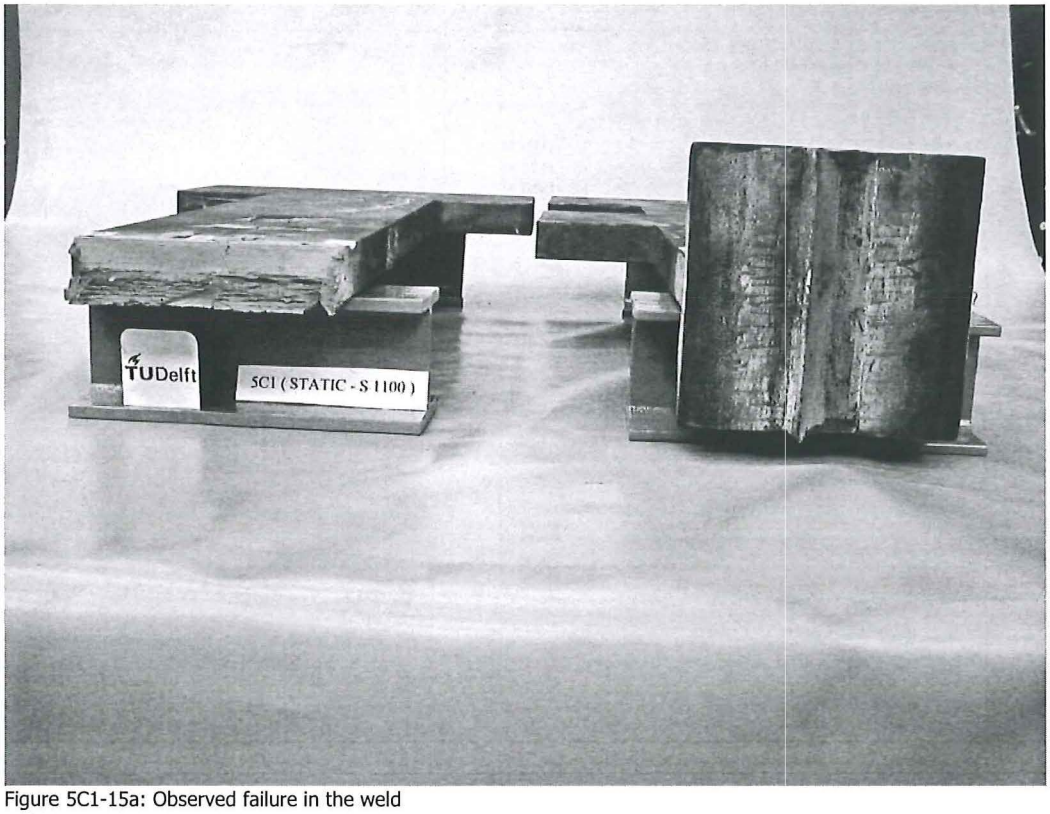


Figure 5C1-15a: Observed failure in the weld

SPECIMEN 5C1

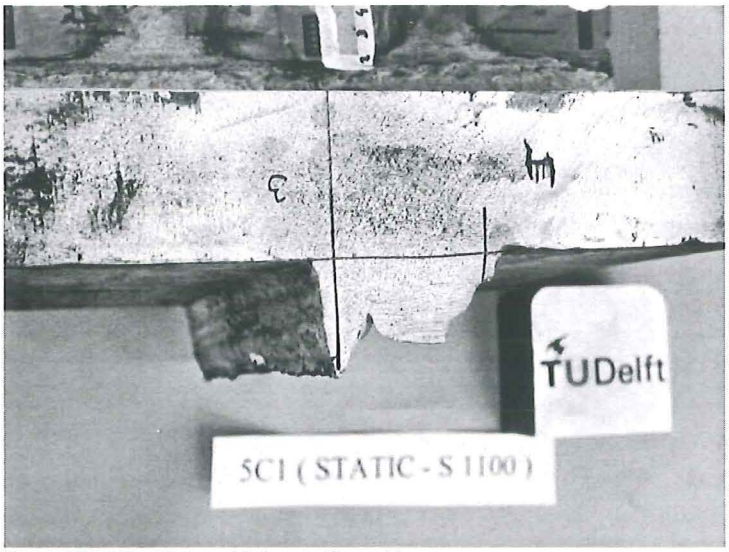


Figure 5C1-15b: Observed failure in the weld

Figure 5C1-15c: Observed failure in the weld

SPECIMEN 5C1

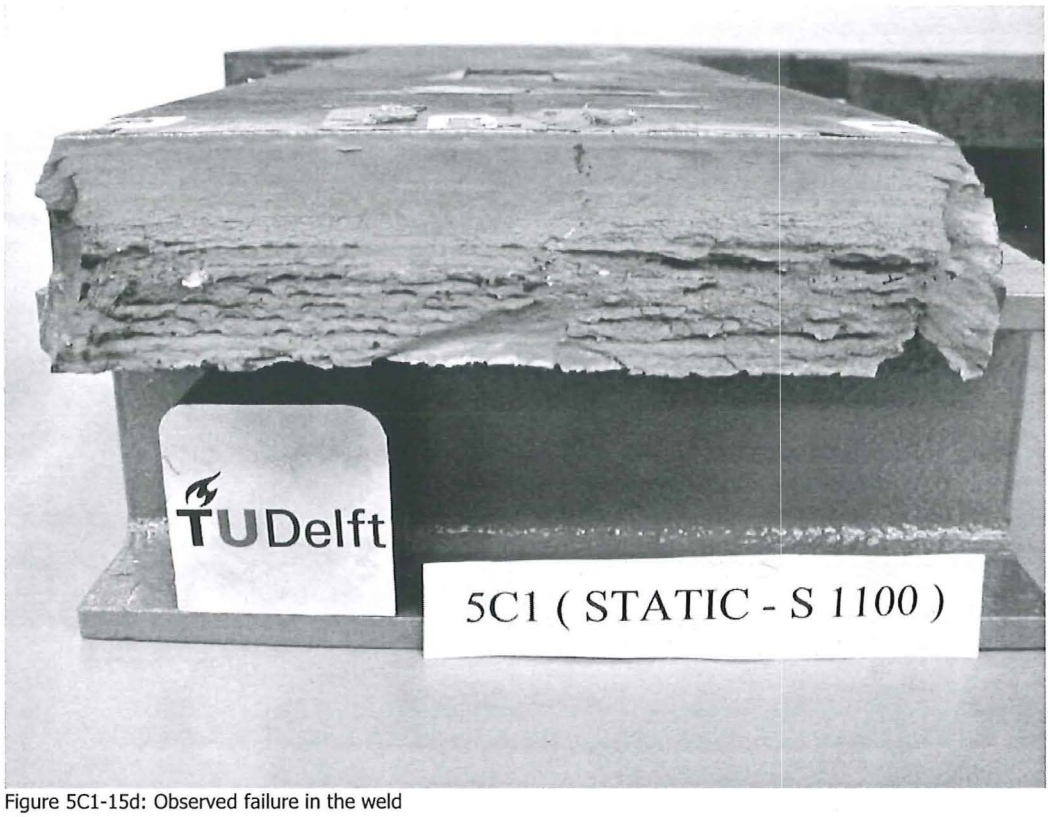


Figure 5C1-15d: Observed failure in the weld

APPENDIX B: Welding procedure specifications

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie I A
Type A
Prep.by R.Croon
PQR.nr: na

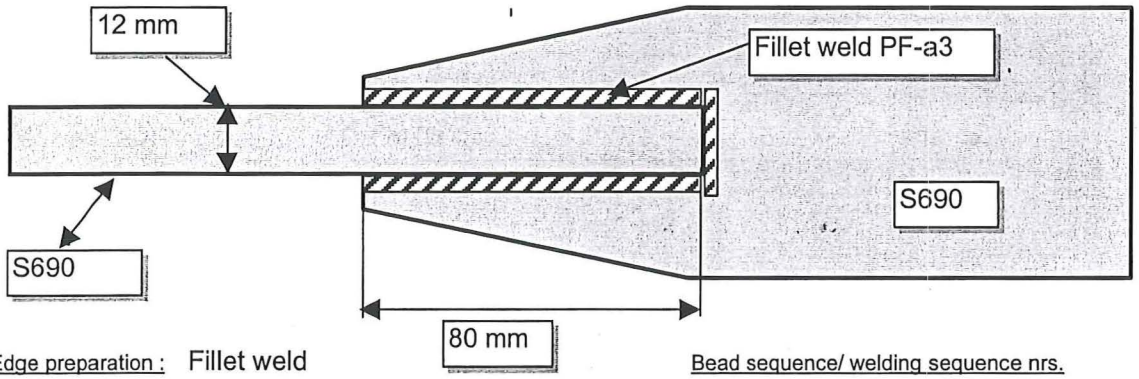
pWelding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie I (Type A) 12 mm**	MCB
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S690 Naxtra 70	12 mm
Sub.ordernr	na	Base.mat 2 S690 Naxtra 70	12 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	FCAW	1 FCAW PF-up	Preheat temp.	100 >°C
eheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : Fillet weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
fill	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	Fillet weld	Size na	80/20	LRS AWS
MPI	100	Edges prep:	Cutting	Amp na	80%Argon 20%Co2	EN.287
		Backing mat:	no	Depth na	M21	DNV

	Customer :	Authority :
date : name:	date name	date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie I B
Type B
Prep.by **R.Croon**
PQR.nr: na

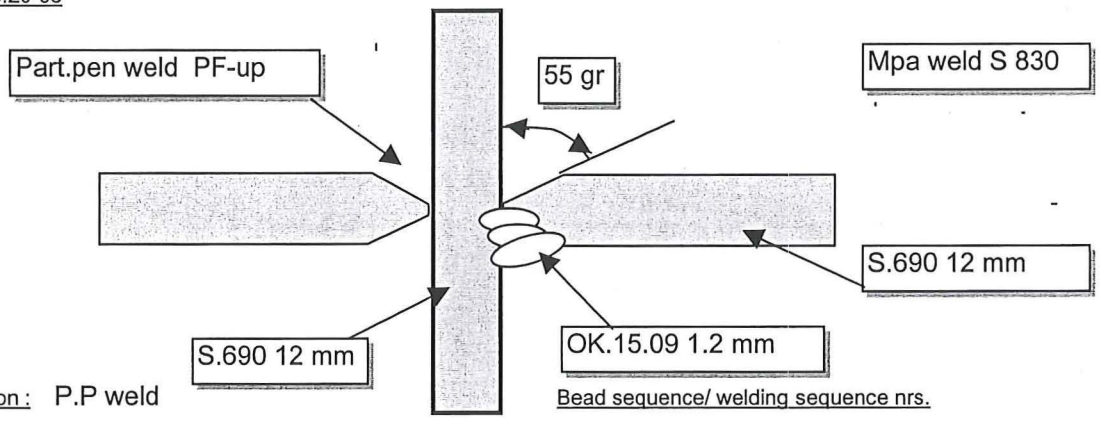
pWelding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie I (Type B) 12 mm**	MCB
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S690 Naxtra 70	12 mm
Sub.ordernr	na	Base.mat 2 S690 Naxtra 70	12 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	FCAW	1 FCAW PF-up	Preheat temp.	100 >°C
eheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : P.P weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
root	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160 - 200	24 - 26	1,0 - 1,3	15-20	4 4
fill	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3
cap	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	Part.Pen	Size na	80/20	LRS AWS
MPI	100	Edges prep:	Cutting	Amp na	80%Argon 20%Co2	EN.287
		Backing mat:	no	Depth na	M21	DNV

	Customer :	Authority :
date : name:	date name	date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie I C
Type C
Prep.by **R.Croon**
PQR.nr: na

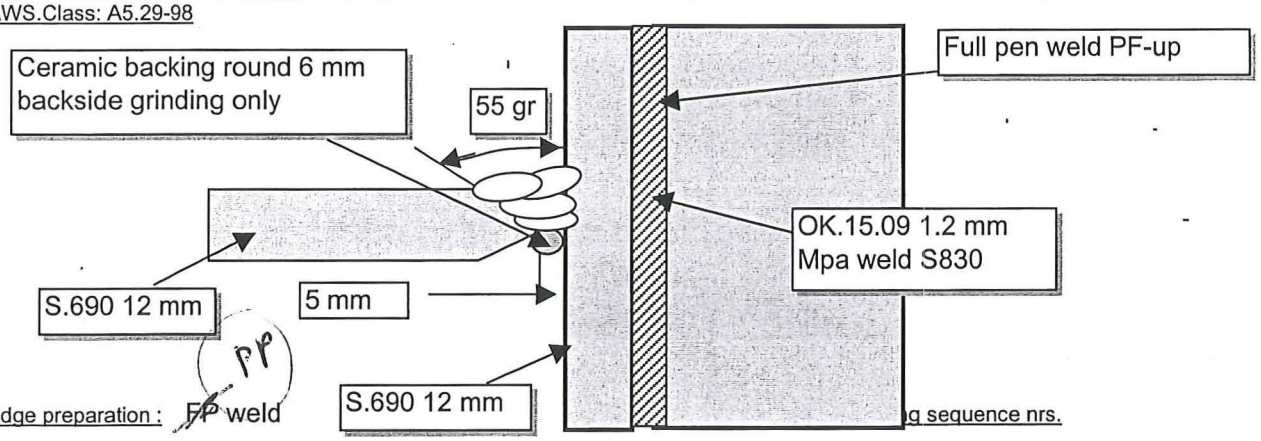
pWelding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie I (Type C) 12 mm**	MCB
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S690 Naxtra 70	12 mm
Sub.ordernr	na	Base.mat 2 S690 Naxtra 70	12 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	FCAW	1 FCAW PF-up	Preheat temp.	100 >°C
Preheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min*	*Ampere max*	*Volt min*	*Volt max*	*H.I. kj/mm min*	*H.I. kj/mm max*	*Gas L/min*	*speed mm/sec.*
root	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160	200	24	26	1,0	1,3	15-20	4 4
fill	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160	200	24	26	1,3	1,7	15-20	3 3
cap	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160	200	24	26	1,3	1,7	15-20	3 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*		*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	FP weld	Size	na	80/20	LRS AWS
MPI	100	Edges prep:	Cutting	Amp	na	80%Argon 20%Co2	EN.287
UT	100	Backing mat:	Yes 6 mm	Depth	na	M21	DNV

date :	name:	Customer : date	name
		Authority : date:	name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie II A
Type A
Prep.by **R.Croon**
PQR.nr: na

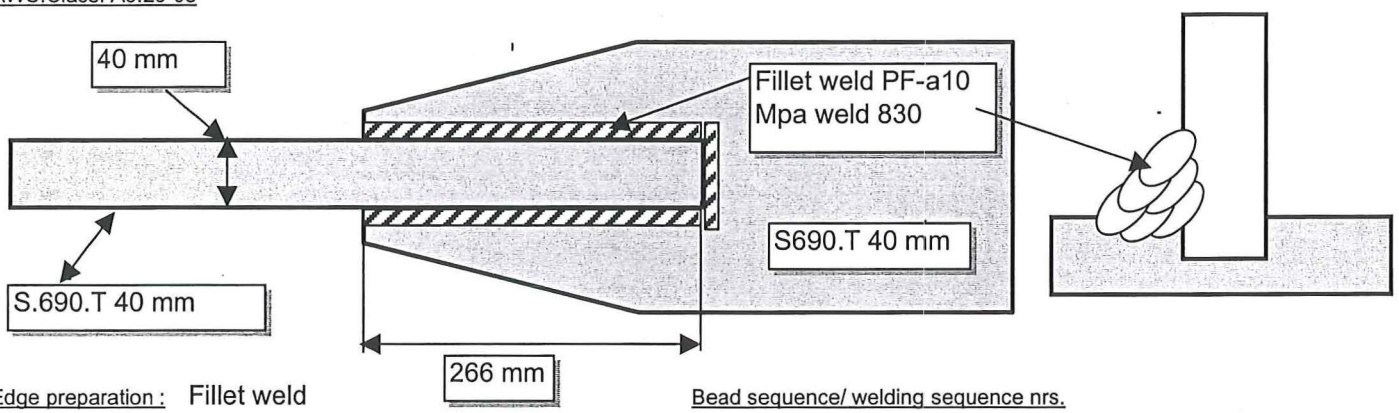
pWelding Procedure Specification

Project :	High strength steel structures	*VALIDTY RANGE*
Subject:	**Serie II (Type A) 40 mm**	Waldram
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S690.T Dillimax 690T	40 mm
Sub.ordernr	na	Base.mat 2 S690.T Dillimax 690T	40 mm

Tackweld		*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	FCAW		1 FCAW PF-up	Preheat temp.	100 >°C
eheat tackw.	T+50°C			Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons			Method.	Propane / burners
				Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : Fillet weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
1	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3
2-6	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	Fillet weld	Size na	80/20	LRS AWS
MPI	100	Edges prep:	Cutting	Amp na	80%Argon 20%Co2	EN.287
		Backing mat:	no	Depth na	M21	DNV

	Customer :	Authority :
date : name:	date name	date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie II B
Type B
Prep.by **R.Croon**
PQR.nr: na

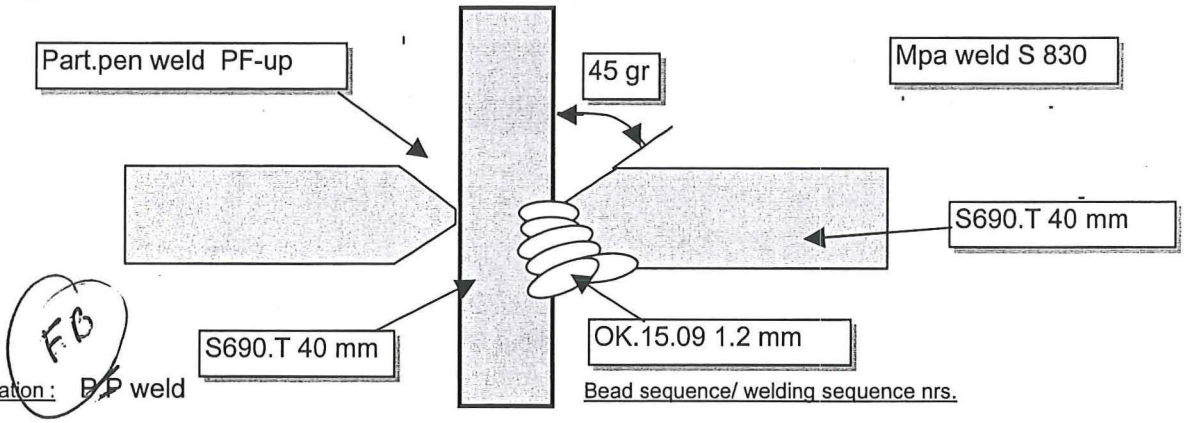
pWelding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie II (Type B) 40 mm**	Waldram
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S690.T Dillimax 690T	40 mm
Sub.ordernr	na	Base.mat 2 S690.T Dillimax 690T	40 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	FCAW	1 FCAW PF-up	Preheat temp.	100 >°C
Preheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : ~~P.P~~ weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
root	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160 - 200	24 - 26	1,0 - 1,3	15-20	4 4
fill	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3
cap	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %	*Prep.weld joint*	*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual 100	Groove : Part.Pen	Size na	80/20	LRS AWS
MPI 100	Edges prep: Cutting	Amp na	80%Argon 20%Co2	EN.287
	Backing mat: no	Depth na	M21	DNV

date : name:	Customer : date name	Authority : date: name:

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Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie 2 C
Type C
Prep.by R.Croon
PQR.nr: na

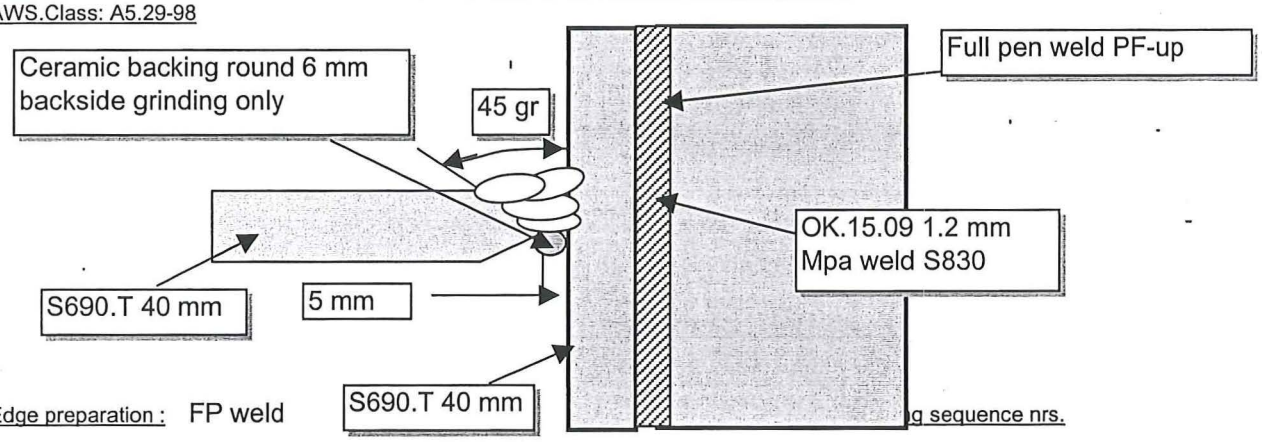
pWelding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie II (Type C) 40 mm**	Waldram
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S690 Dilimax 690T	40 mm
Sub.ordernr	na	Base.mat 2 S690 Dilimax 690T	40 mm

Tackweld		*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	FCAW		1 FCAW PF-up	Preheat temp.	100 >°C
Preheat tackw.	T+50°C			Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons			Method.	Propane / burners
				Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : FP weld

g sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min*	*Ampere max*	*Volt min*	*Volt max*	*H.I. kj/mm min*	*H.I. kj/mm max*	*Gas L/min*	*speed mm/sec.*
root	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160	200	24	26	1,0	1,3	15-20	4 4
fill	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160	200	24	26	1,3	1,7	15-20	3 3
cap	FCAW	OK.15.09	E111T1-H4	1.2	M21	DC+	160	200	24	26	1,3	1,7	15-20	3 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	FP weld	Size na	80/20	LRS AWS
MPI	100	Edges prep:	Cutting	Amp na	80%Argon 20%Co2	EN.287
UT	100	Backing mat:	Yes 6 mm	Depth na	M21	DNV

	Customer :	Authority :
date : name:	date name	date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie III A
Type A
Prep.by R.Croon
PQR.nr: na

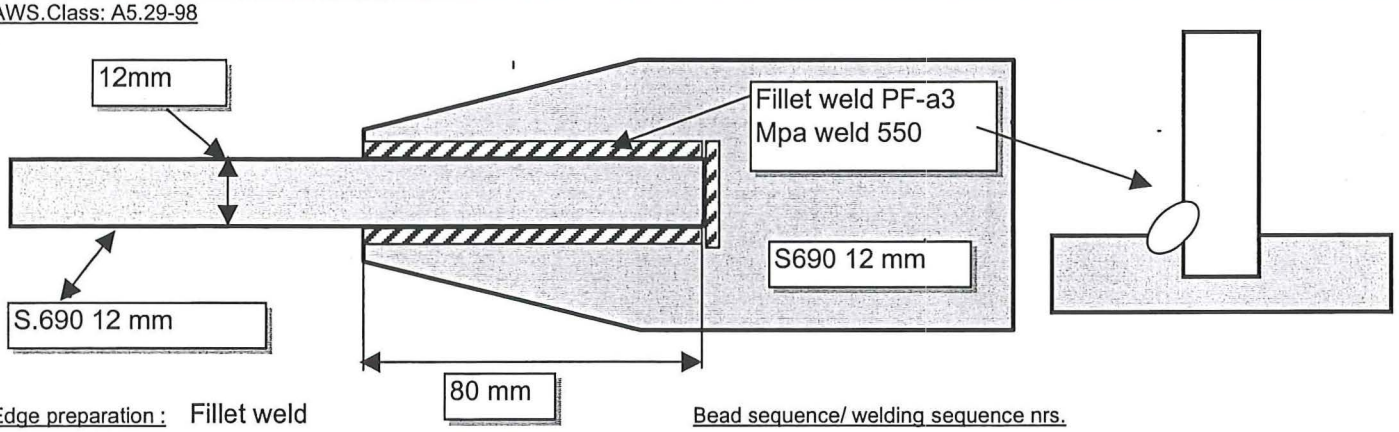
pWelding Procedure Specification

Project :	High strength steel structures	*VALIDTY RANGE*
Subject:	**Serie III (Type A) 12 mm**	MCB
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S690 Naxtra 70	12 mm
Sub.ordernr	na	Base.mat 2 S690 Naxtra 70	12 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	FCAW	1 FCAW PF-up	Preheat temp.	100 >°C
Preheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : Fillet weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
1	FCAW	DWA 55 SLR	E81T1-Ni1	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	Fillet weld	Size na	80/20	LRS AWS
MPI	100	Edges prep:	Cutting	Amp na	80%Argon 20%Co2	EN.287
		Backing mat:	no	Depth na	M21	DNV

	Customer :	Authority :
date : name:	date name	date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
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3115 HH Schiedam
Tel.010-2452273

WPS : serie III B
Type B
Prep.by **R.Croon**
PQR.nr: 135/128

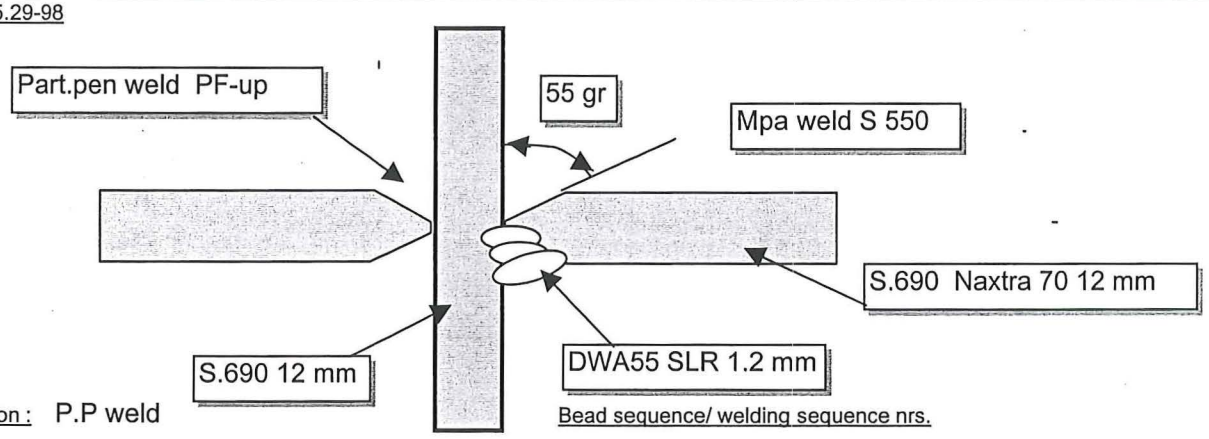
pWelding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie III (Type B) 12 mm**	MCB
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S690 Naxtra 70	12 mm
Sub.ordernr	na	Base.mat 2 S690 Naxtra 70	12 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	FCAW	1 FCAW PF-up	Preheat temp.	100 >°C
Preheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : P.P weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min*	*Ampere max*	*Volt min*	*Volt max*	*H.I. kj/mm min*	*H.I. kj/mm max*	*Gas L/min*	*speed mm/sec.*	
root	FCAW	DWA 55 SLR	E81T1-Ni1	1.2	M21	DC+	160	200	24	26	1,0	1,3	15-20	4	4
fill	FCAW	DWA 55 SLR	E81T1-Ni1	1.2	M21	DC+	160	200	24	26	1,3	1,7	15-20	3	3
cap	FCAW	DWA 55 SLR	E81T1-Ni1	1.2	M21	DC+	160	200	24	26	1,3	1,7	15-20	3	3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*		*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	Part.Pen	Size	na	80/20	LRS AWS
MPI	100	Edges prep:	Cutting	Amp	na	80%Argon 20%Co2	EN.287
		Backing mat:	no	Depth	na	M21	DNV

date :	name:	Customer : date	name
		Authority : date:	name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie III C
Type C
Prep.by R.Croon
PQR.nr: na

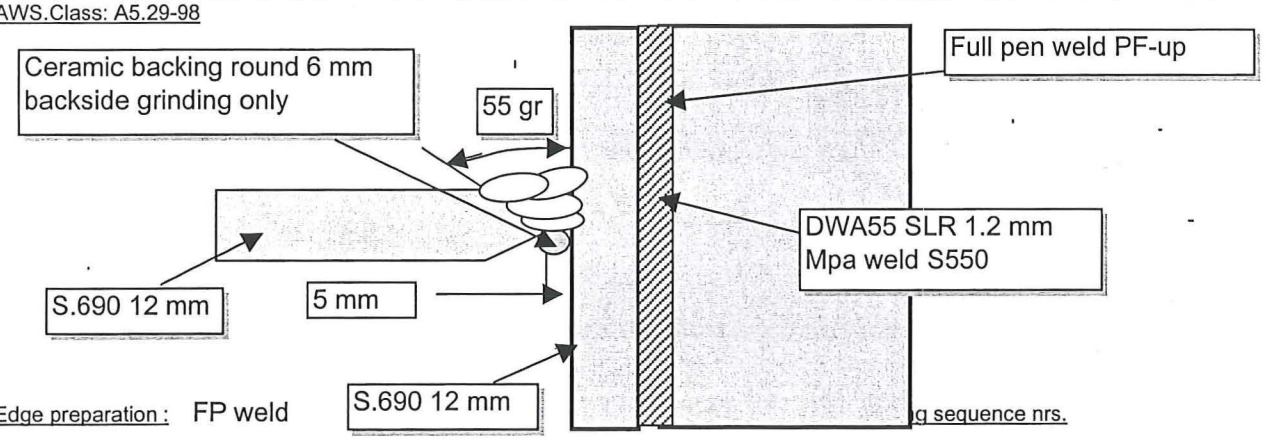
pWelding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie III (Type C) 12 mm**	MCB
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S690 Naxtra 70	12 mm
Sub.ordernr	na	Base.mat 2 S690 Naxtra 70	12 mm

Tackweld		*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.		FCAW	1 FCAW PF-up	Preheat temp.	100 >°C
Preheat tackw.		T+50°C		Max.interpass	200 °C
Tackweld cont.		tempelsticks/ crayons		Method.	Propane / burners
				Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : FP weld

g sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
root	FCAW	DWA 55 SLR	E81T1-Ni1	1.2	M21	DC+	160 - 200	24 - 26	1,0 - 1,3	15-20	4 4
fill	FCAW	DWA 55 SLR	E81T1-Ni1	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3
cap	FCAW	DWA 55 SLR	E81T1-Ni1	1.2	M21	DC+	160 - 200	24 - 26	1,3 - 1,7	15-20	3 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	FP weld	Size na	80/20	LRS AWS
MPI	100	Edges prep:	Cutting	Amp na	80%Argon 20%Co2	EN.287
UT	100	Backing mat:	Yes 6 mm	Depth na	M21	DNV

date : name:	Customer : date name	Authority : date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie 4 A
Type A
Prep.by **C.Fehres**
PQR.nr: na

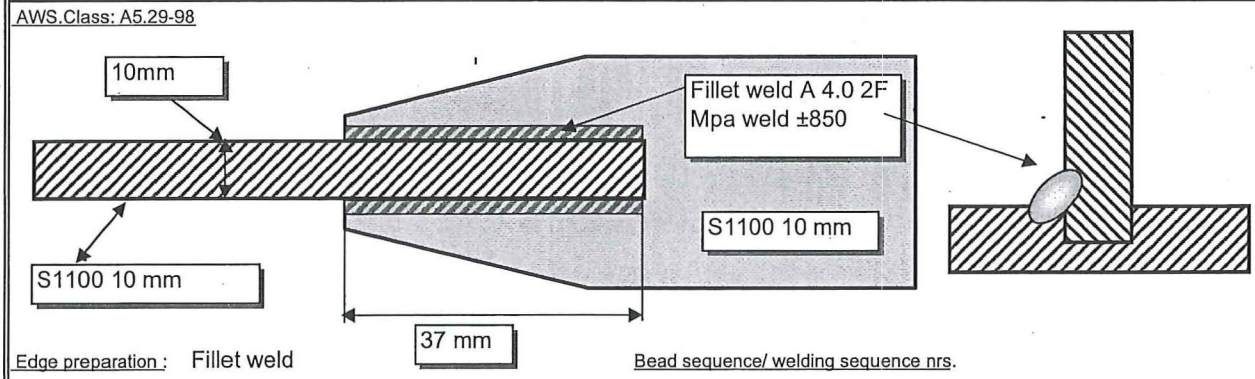
Welding Procedure Specification

Project :	TNO High strength steel structures	*VALIDTY RANGE*
Subject:	**Serie IV (Type A) 10 mm**	
Specification:	TNO	

Huisman order.	A03-11480	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S1100	10 mm
Sub.ordernr	na	Base.mat 2 S1100	10 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	SMAW	1 SMAW 2F	Preheat temp.	100 >°C
Preheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : Fillet weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
1	SMAW	Conarc 85	E12018	4	na	DC+	130 - 140	22 - 24	**0.7 - 1.1**	na	3 4

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds onl
Preped weldedges: Flame cutting and grinding

Inspection: %	*Prep.weld joint*	*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual 100	Groove : Fillet weld	Size na	na	LRS AWS
MPI 100	Edges prep: Cutting	Amp na		EN.287
	Backing mat: no	Depth na		DNV

date : name:	Customer : date name	Authority : date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : serie 4 B
Type B
Prep.by C.Fehres
PQR.nr: na

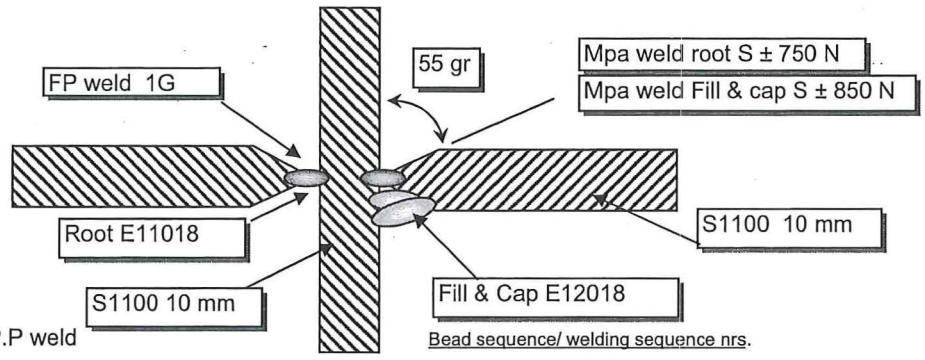
Welding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie IV (Type B) 10 mm**	
Specification:	TNO	

Huisman order.	A03-11480	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S1100	10 mm
Sub.ordernr	na	Base.mat 2 S1100	10 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	SMAW	1 SMAW 1G	Preheat temp.	100 >°C
Preheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : P.P weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr

Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
root	SMAW	Conarc 80	E11018	3.2	na	DC+	100 - 150	18 - 20	**0.7 - 1.5**	na	2.0 2.5
fill	SMAW	Conarc 85	E12018	3.2	na	DC+	140 - 150	20 - 21	**0.9 - 1.6**	na	2.0 3.0
cap	SMAW	Conarc 85	E12018	3.2	na	DC+	140 - 150	20 - 21	**0.9 - 1.6**	na	2.0 3.0

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds onl
Preped weldedges: Flame cutting and grinding

Inspection: %	*Prep.weld joint*	*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual 100	Groove : Part.Pen	Size na	80/20	LRS AWS
MPI 100	Edges prep: Cutting	Amp na	80%Argon 20%Co2	EN.287
	Backing mat: no	Depth na	M21	DNV

	Customer :	Authority :
date : name:	date name	date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie 4 C
Type C
Prep.by C.Fehres
PQR.nr: na

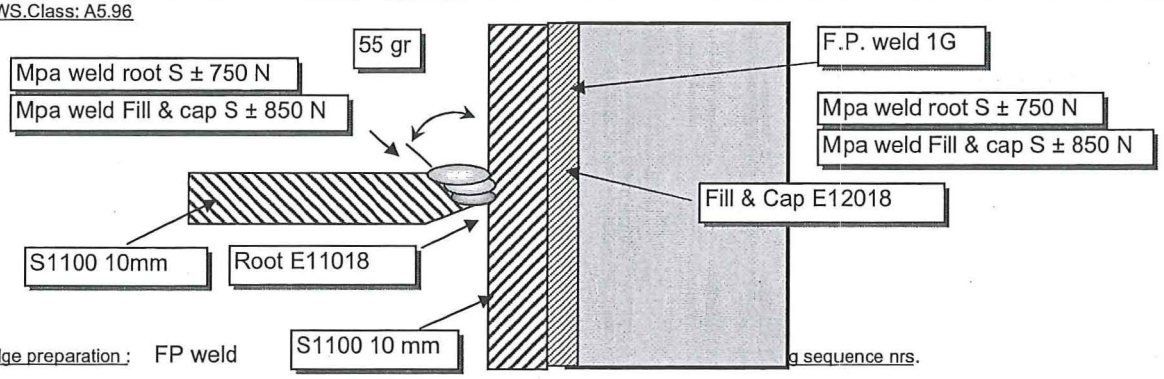
Welding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie IV (Type C) 10 mm**	
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S1100	10 mm
Sub.ordernr	na	Base.mat 2 S1100	10 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	SMAW	1 SMAW 1G	Preheat temp.	100 >°C
Preheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.96



Edge preparation : FP weld

g sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min*	*Ampere max*	*Volt min*	*Volt max*	*H.I. kj/mm min*	*H.I. kj/mm max*	*Gas L/min*	*speed mm/sec.*
root	SMAW	Conarc 80	E11018	3.2	na	DC+	100	150	18	20	**0.7**	**1.5**	na	2 2
fill	SMAW	Conarc 85	E12018	3.2	na	DC+	140	150	20	21	**0.9**	**1.6**	na	2 2
cap	SMAW	Conarc 85	E12018	3.2	na	DC+	140	150	20	21	**0.9**	**1.6**	na	2 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds onl
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	FP weld	Size na	na	LRS AWS
MPI	100	Edges prep:	Cutting	Amp na		EN.287
UT	NA	Backing mat:	No	Depth na		DNV

date : name:	Customer : date name	Authority : date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie 5 A
Type A
Prep.by R.Croon
PQR.nr: na

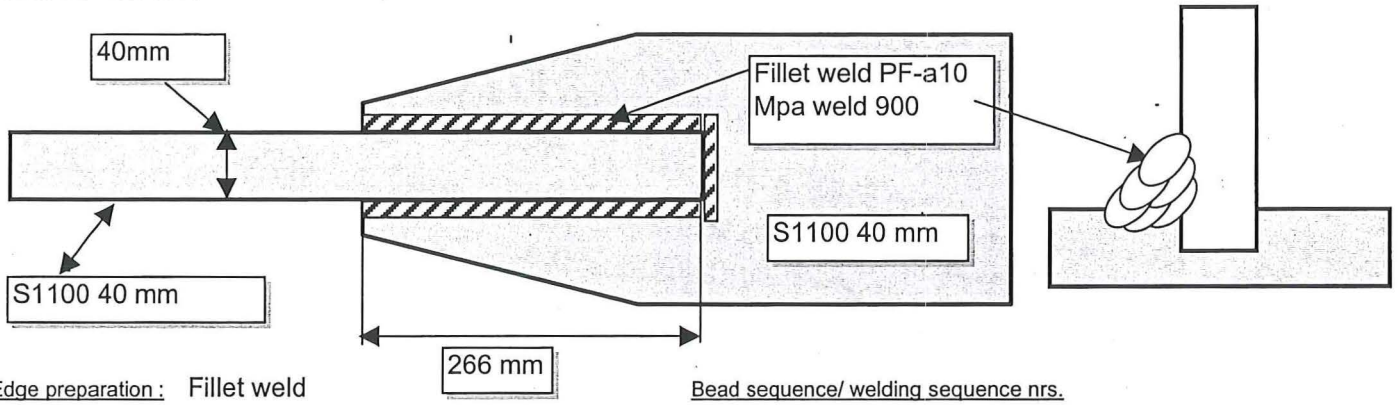
pWelding Procedure Specification

Project :	High strength steel structures	*VALIDTY RANGE*
Subject:	**Serie V (Type A) 40 mm**	Waldram
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S1100.T Dillimax	40 mm
Sub.ordernr	na	Base.mat 2 S1100.T Dillimax	40 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	SMAW	1 SMAW PF-up	Preheat temp.	100 >°C
eheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : Fillet weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
1	SMAW	Tenacito 140	E14018	3,25	na	DC+	90 - 135	18 - 20	0,8 - 1,4	na	2 2
2-6	SMAW	Tenacito 140	E14018	3,25	na	DC+	90 - 135	18 - 20	0,8 - 1,4	na	2 2

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %	*Prep.weld joint*	*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual 100	Groove : Fillet weld	Size na	na	LRS AWS
MPI 100	Edges prep: Cutting	Amp na		EN.287
	Backing mat: no	Depth na		DNV

	Customer :	Authority :
date : name:	date name	date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : serie 5 B
Type B
Prep.by R.Croon
PQR.nr: na

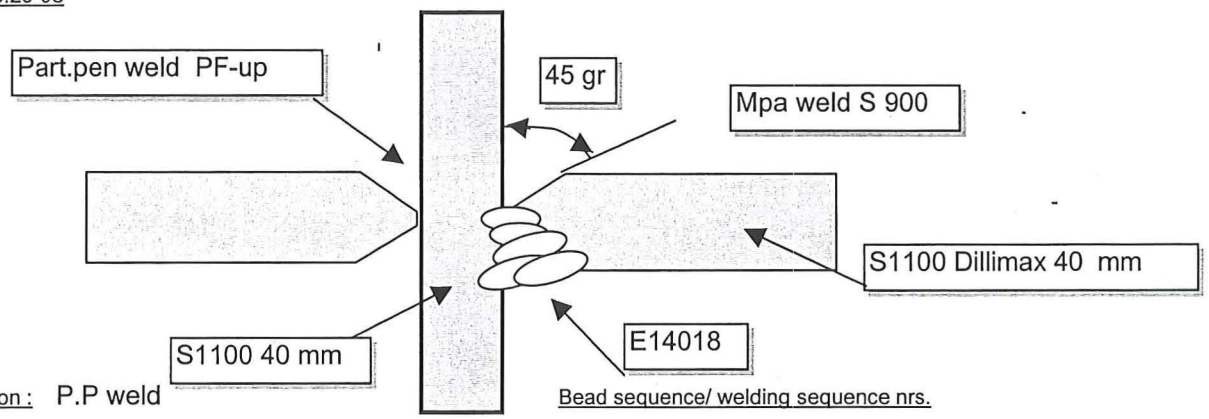
pWelding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie V (Type B) 40 mm**	Waldram
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S1100.T Dilimax	40 mm
Sub.ordernr	na	Base.mat 2 S1100.T Dillimax	40 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	SMAW	1 SMAW PF-up	Preheat temp.	100 >°C
eheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : P.P weld

Bead sequence/ welding sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr
Before welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
root	SMAW	Tenacito 140	E14018	2.5	na	DC+	60 - 100	18 - 20	0,5 - 1,0	na	2 2
fill	SMAW	Tenacito 140	E14018	3,25	na	DC+	90 - 135	18 - 20	0,8 - 1,1	na	3 2
cap	SMAW	Tenacito 140	E14018	3,25	na	DC+	90 - 135	18 - 20	0,8 - 1,4	na	2 2

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %	*Prep.weld joint*	*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual 100	Groove : Part.Pen	Size na	na	LRS AWS
MPI 100	Edges prep: Cutting	Amp na		EN.287
	Backing mat: no	Depth na		DNV

	Customer :	Authority :
date : name:	date name	date: name:

HUISMAN SPECIAL LIFTING EQUIPMENT BV.

Huisman Special Lifting Equipment
Admiraal Trompstr.2 Harbour nr.561
3115 HH Schiedam
Tel.010-2452273

WPS : Serie 5 C
Type C
Prep.by R.Croon
PQR.nr: na

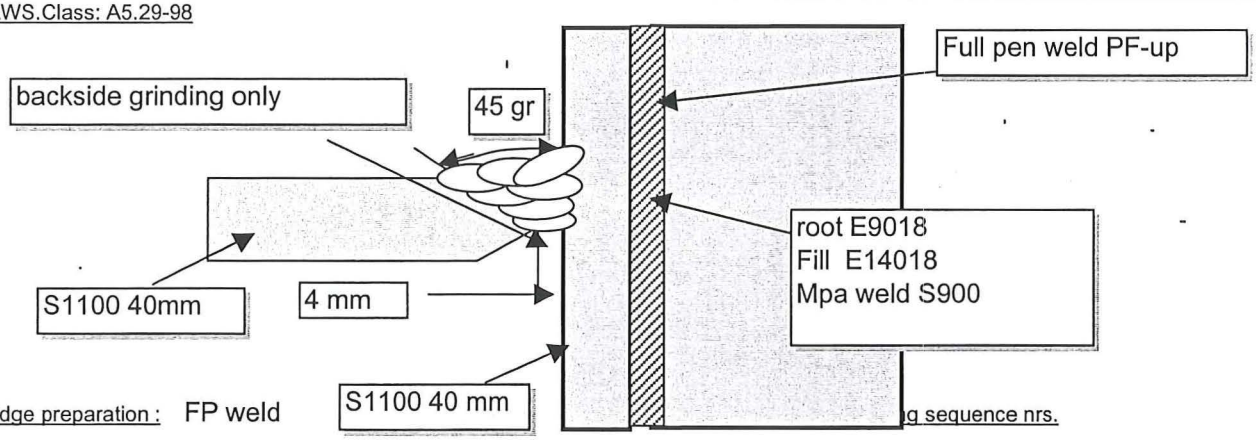
pWelding Procedure Specification

Project :	High strength steel structures	*Supplier material*
Subject:	**Serie V (Type C) 40 mm**	Waldram
Specification:	TNO	

Huisman order.	A03-20130	***Base Materials***	***Plate Thickness***
Customer	TNO	Base.mat 1 S1100.T Dillimax	40 mm
Sub.ordernr	na	Base.mat 2 S1100.T Dillimax	40 mm

Tackweld	*Proces Control*	*Weld Process*	*Preheat Details*	
Tackweld proc.	SMAW	1 SMAW PF-up	Preheat temp.	100 >°C
eheat tackw.	T+50°C		Max.interpass	200 °C
Tackweld cont.	tempelsticks/ crayons		Method.	Propane / burners
			Control	Tempelsticks / digital temp.

AWS.Class: A5.29-98



Edge preparation : FP weld

g sequence nrs.

Remarks: ALL CONSUMABLES ARE LOW HYDROGEN CONTROLLED < 5 ml/100 gr

efore welding over previously metal, all slag be removed and the weld and adjacent base metal shall be brushed

weld nr	*weld proces*	*filler metal*	*aws code*	*size mm*	*gas flux*	*DC AC*	*Ampere min max*	*Volt min max*	*H.I. kj/mm min max*	*Gas L/min*	*speed mm/sec.*
root	SMAW	Tenacito 75	E9018	2.5	na	DC+	80 - 100	18 - 20	0,7 - 1,0	na	2 2
fill	SMAW	Tenacito 140	E14018	3.25	na	DC+	90 - 135	18 - 20	0,8 - 1,1	na	3 2
cap	SMAW	Tenacito 140	E14018	3.25	na	DC+	90 - 135	18 - 20	0,5 - 0,9	na	3 3

Treatment of root : Grinding or backgouging and grinding (rootgap > 3mm for F.P welds only
Preped weldedges: Flame cutting and grinding

Inspection: %		*Prep.weld joint*		*Gouging with air*	*Gas Composition*	***Welders Qualif.***
Visual	100	Groove :	FP weld	Size na	na	LRS AWS
MPI	100	Edges prep:	Cutting	Amp na		EN.287
UT	100	Backing mat:	na	Depth na		DNV

date : name:	Customer : date name	Authority : date: name:

APPENDIX C: Material certificates

S690 12 mm

Stevin Laboratory
Delft University of Technology

ZEUGNIS/CERTIFICATE/CERTIFICAT
NR.(NO.): 000335457001 DUISBURG-SUED

ThyssenKrupp Stahl
Ein Unternehmen von ThyssenKrupp Stahl

DISPO-NR. *********	Werks-Nr. Works-No. No de l'usine	Bestell-Nr. Order-No. No de commande	02.05.01
0004195503	41.96244	230MCB2537	02035275207 / 02035275213

ThyssenKrupp Stahl · 47161 Duisburg

MCB NEDERLAND B.V.

J.F.KENNEDYLAAN 59
NL 5555 XC VALKENSWAARD

BESCHEINIGUNG ÜBER MATERIALPRÜFUNGEN EN 10204
DOCUMENT ON MATERIALS TESTS EN 10204
DOCUMENT DE CONTROLE DES MATERIAUX EN 10204
ABNAHMEPRUEFZEUGNIS 3.1 B
INSPECTION CERTIFICATE 3.1 B
CERTIFICAT DE RECEPTION 3.1 B

Blatt-Nr. Page-No. Pages-No 1

Werkstoff; Quality; Matériau / Lieferbedingungen; Specification; Conditions de livraison

N-A-XTRA M 70 / TKS-WBL. 215

Kennzeichnung: Marking: Marque: WERKSTOFF; SCHMELZ-NR., FERTIGUNGS-/PROBE-NR.
MATERIAL, HEAT-NO., MANUFACTURING/SAMPLE-NO.
MATERIEL, NO. DE COULEE,NO. DE FABRICATION/D'EPROUVETTE
Zeichen des Lieferwerkes: Supplier's mark: Marque d'usine:

ABNAHMEPRUEFSTEMPEL/INSPECTOR'S STAMP/POINCON DU RECEPTIONAIRR

ERZEUGNISFORM
TYPE OF PRODUCT
DESIGNATION DU PRODUIT

GROBBLECH, UNGEBEIZT

PLATES, FLAT, UNPICKLED

TOLE, PLAT, NON DECAPEES

POS. / ITEM / POS.	STUECK ZAHL / NUMBER PIECES / NOMBRE PIECES	GEWICHT GEWOG. / WEIGHT / POIDS	GENICHT THEOR. / WEIGHT THEO. / POIDS THEO.	SCHMELZE / HEAT NO. / NO. DE COULEE	BLECH-NR / PLATE-NO / NO. DE TOLE	PAKET / BUNDLE / PAQUET
001	12,0 X 2000,0 X 6000 [mm]					
		KG				
	1	1164,000		646415	59217101	
	1	1149,000		646415	59217102	
	1	1149,000		646415	59217203	
	1	1149,000		646415	59217204	
	1	1149,000		646415	59219101	X
	1	1149,000		646415	59219102	X
	1	1149,000		646415	59219203	

ThyssenKrupp Stahl
Abnahmetechnik

Es wird bestätigt, dass die Ergebnisse der Prüfungen den vereinbarten Lieferbedingungen entsprechen.
This is to certify, that the test results are in agreement with the specifications.
Nous confirmons que les résultats des essais sont conformes aux conditions convenues de vente.

ZERTIFIZIERT Dasch

ZEUGNIS/CERTIFICATE/CERTIFICAT
NR.(NO.): 000335457001 DUISBURG-SUED

ThyssenKrupp Stahl
Ein Unternehmen von ThyssenKrupp Steel

DISPO-NR. **********	Werks-Nr. Works-No. No de l'usine	Bestell-Nr. Order-No. no de commande	230MCB2537	02.05.01
0004195503	41.96244			FAX 02035275207 TEL 02035275213

ThyssenKrupp Stahl - 47161 Duisburg

MCB NEDERLAND B.V.

J.F.KENNEDYLAAN 59
NL 5555 XC VALKENSWAARD

BESCHEINIGUNG ÜBER MATERIALPRÜFUNGEN EN 10204
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ABNAHMEPRUEFZEUGNIS 3.1 B
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Blatt-Nr. Page-No. Pagina-No 2

Werkstoff; Quality; Matériau / Lieferbedingungen; Specification; Conditions de livraison

N-A-XTRA M 70 / TKS-WBL. 215

Kennzeichnung: Marking: Marque: WERKSTOFF, SCHMELZ-NR., FERTIGUNGS-/PROBE-NR.
MATERIAL, HEAT-NO., MANUFACTURING/SAMPLE-NO.
MATERIEL, NO. DE COULEE,NO. DE FABRICATION/D'EPROUVETTE

Zeichen des Lieferwerkes: Supplier's mark: Marque d'usine: ThyssenKrupp Steel

1	1149,000	646415	59219204
8	9207,000	*	
8	9207,000	**	

TRANSPORT-NR./TRANSPORT-NO./NO. DE TRANSPORT
VT-49 RP

CHEMISCHE ZUSAMMENSETZUNG VON SCHMELZPROBEN %
CHEMICAL COMPOSITION OF THE LADLE SAMPLES %
COMPOSITON CHIMIQUE SUR ECHANTILLONS DE COULEE %

SCHMELZE HEAT NR. NO. DE COULEE	C	SI	MN	P	S	SCHMELZVERFAHR. HEAT PROCESS COULEE LABORAT.
646415	,160	,190	,870	,012	,0020	
	AL-G	B-G	CR	CU	MO	
646415	,085	,0020	,330	,030	,220	
	N	NB	NI	TI	V	
646415	,0038	,026	,060	,004	,000	
	CE1					
646415	,42					OXYGENSTAHL OXYGEN STEEL OXYGEN PUR

CE1=C+MN/6+(CR+MO+V)/5+(NI+CU)/15

ThyssenKrupp Stahl
Abnahmetechnik

Es wird bestätigt, dass die Ergebnisse der Prüfungen den vereinbarten Lieferbedingungen entsprechen.
This is to certify, that the test results are in agreement with the specifications.
Nous confirmons que les résultats des essais sont conformes aux conditions convenues de vente.

QUALITÄTSMANAGEMENT nach DIN EN ISO 9001

ZEUGNIS/CERTIFICATE/CERTIFICAT
NR.(NO.): 000335457001 DUISBURG-SUED

ThyssenKrupp Stahl
Ein Unternehmen von ThyssenKrupp Steel

DISPO-NR. *********	Werks-Nr. Works-No. No de l'usine	Bestell-Nr. Order-No. No de commande		
0004195503	41.96244	230MCB2537	02.05.01	
			02035275207	
			02035275213	

ThyssenKrupp Stahl · 47161 Duisburg

MCB NEDERLAND B.V.

J.F.KENNEDYLAAN 59
NL 5555 XC VALKENSWAARD

BESCHEINIGUNG ÜBER MATERIALPRÜFUNGEN EN 10204
DOCUMENT ON MATERIALS TESTS EN 10204
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ABNAHMEPRUEFZEUGNIS 3.1 B
INSPECTION CERTIFICATE 3.1 B
CERTIFICAT DE RECEPTION 3.1 B

Blatt-Nr. Page-No. Page-No 3

Werkstoff; Quality; Matériau / Lieferbedingungen; Specification; Conditions de livraison
N-A-XTRA M 70 / TKS-WBL. 215

Kennzeichnung: WERKSTOFF; SCHMELZ-NR., FERTIGUNGS-/PROBE-NR.
Marking: MATERIAL, HEAT-NO., MANUFACTURING/SAMPLE-NO.
Marque: MATERIEL, NO. DE COULEE,NO. DE FABRICATION/D'EPROUVETTE
Zeichen des Lieferwerkes: Supplier's mark: Marque d'usine:

MECHANISCHE EIGENSCHAFTEN Z U G V E R S U C H
MECHANICAL CHARACTERISTICS T E N S I L E T E S T
CARACTERISTIQUES MECANIQUES E S S A I D E T R A C T I O N

SCHM.- NR.	PROBE- NR.	1)LAGE 2)ZUST. 3)ALTER	TEMP GR.C	FO.	R N/MM²	RM N/MM²	R/RM %	LO MM	A %	AGT %	Z %	RM X A
646415	592171	1)0401	+ 20	0002	800 RE H	830	96	109	16			13280
		2)0005										
		3)0000										
646415	592172	1)0601	+ 20	0002	800 RE H	836	96	107	16			13376
		2)0005										
		3)0000										
646415	592191	1)0401	+ 20	0002	811 RE H	843	96	110	15			12645
		2)0005										
		3)0000										
646415	592192	1)0601	+ 20	0002	811 RE H	841	96	107	14			11774
		2)0005										
		3)0000										

ThyssenKrupp Stahl
Abnahmetechnik

Es wird bestätigt, dass die Ergebnisse der Prüfungen den vereinbarten Lieferbedingungen entsprechen.
This is to certify, that the test results are in agreement with the specifications.
Nous confirmons que les résultats des essais sont conformes aux conditions convenues de vente.

ZERTIFIZIERT

ZEUGNIS/CERTIFICATE/CERTIFICAT
NR.(NO.): 000335457001 DUISBURG-SUED

ThyssenKrupp Stahl
Ein Unternehmen von ThyssenKrupp Stael

DISPO-NR. *********	Werks-Nr. Works-No. No de l'usine	Bestell-Nr. Order-No. No de commande	230MCB2537	02.05.01
0004195503	41.96244			02035275207 02035275213

ThyssenKrupp Stahl · 47161 Duisburg

MCB NEDERLAND B.V.

J.F.KENNEDYLAAN 59
NL 5555 XC VALKENSWAARD

BESCHEINIGUNG ÜBER MATERIALPRÜFUNGEN EN 10204
DOCUMENT ON MATERIALS TESTS EN 10204
DOCUMENT DE CONTROLE DES MATERIAUX EN 10204
ABNAHMEPRUEFZEUGNIS 3.1 B
INSPECTION CERTIFICATE 3.1 B
CERTIFICAT DE RECEPTION 3.1 B

Blatt-Nr. Page-No. Page-No 4

Werkstoff; Quality; Matériau / Lieferbedingungen; Specification; Conditions de livraison
N-A-XTRA M 70 / TKS-WBL. 215

Kennzeichnung: Marking: Marque: WERKSTOFF; SCHMELZ-NR., FERTIGUNGS-/PROBE-NR.
MATERIAL, HEAT-NO., MANUFACTURING/SAMPLE-NO.
MATERIEL, NO. DE COULEE,NO. DE FABRICATION/D'EPROUVETTE

Zeichen des Lieferwerkes: Supplier's mark: Marque d'usine:

MECHANISCHE EIGENSCHAFTEN K E R B S C H L A G BIEGEVERSUCH
MECHANICAL CHARACTERISTICS I M P A C T T E S T
CARACTERISTIQUES MECANIQUES E S S A I D E R E S I L I E N C E

SCHM.- NR.	PROBE- NR.	1)LAGE 2)ZUST. 3)ALTER	FORM	PRUEF- TEMP. GR.C	ARBEIT JOULE 1	2	3	M
646415	59217	1)0101 2)0005 3)0006	0007 - 20		249,0	250,0	255,0	251,0

W A E R M E B E H A N D L U N G P R O D U K T
H E A T T R E A T M E N T P R O D U C T
T R A I T E M E N T T H E R M I Q U E D E P R O D U I T

POS. 001

WAERMEBEHANDLUNG PRODUKT
HEAT TREATMENT PRODUCT
TRAITEMENT THERMIQUE DE PRODUIT

TEMP. GR.C	HALTEZEIT MIN.	ABKUEHLUNG
920	10,00	WASSER/WATER/L EAU
670	30,00	LUFT/AIR/L AIR

ThyssenKrupp Stahl
Abnahmetechnik

Es wird bestätigt, dass die Ergebnisse der Prüfungen den vereinbarten Lieferbedingungen entsprechen.
This is to certify, that the test results are in agreement with the specifications.
Nous confirmons que les résultats des essais sont conformes aux conditions convenues de vente.

ZERTIFIZIERT

ZEUGNIS/CERTIFICATE/CERTIFICAT
NR.(NO.): 000335457001 DUISBURG-SUED

ThyssenKrupp Stahl
Ein Unternehmen von ThyssenKrupp Stael

DISPO-NR. **********	Werks-Nr. Works-No. No de l'usine	Bestell-Nr. Order-No. No de commande	230MCB2537	02.05.01
0004195503	41.96244			☎ 02035275207 FAX 02035275213

ThyssenKrupp Stahl · 47161 Duisburg

MCB NEDERLAND B.V.

J.F.KENNEDYLAAN 59
NL 5555 XC VALKENSWAARD

BESCHEINIGUNG ÜBER MATERIALPRÜFUNGEN EN 10204
DOCUMENT ON MATERIALS TESTS EN 10204
DOCUMENT DE CONTROLE DES MATERIAUX EN 10204
ABNAHMEPRUEFZEUGNIS 3.1 B
INSPECTION CERTIFICATE 3.1 B
CERTIFICAT DE RECEPTION 3.1 B

Blatt-Nr. Page-No. Page-No 5

Werkstoff; Quality; Matériau / Lieferbedingungen; Specification; Conditions de livraison
N-A-XTRA M 70 / TKS-WBL. 215

Kennzeichnung: Marking: Marque: WERKSTOFF; SCHMELZ-NR., FERTIGUNGS-/PROBE-NR.
MATERIAL, HEAT-NO., MANUFACTURING/SAMPLE-NO.
MATERIEL, NO. DE COULEE,NO. DE FABRICATION/D'EPROUVETTE

Zeichen des Lieferwerkes: Supplier's mark: Marque d'usine: ThyssenKrupp Stahl

L E G E N D E N - L E G E N D S - L E G E N D E S

ABKUEHLUNG :COOL DOWN :REFROID	ALTER :AGED :VIEILLE	ARBEIT :ENERGY :TRAVAILLE
BREITUNG :LAT.EXP :LAT.EXP	BRUCHANT. :SHEAR FACE :DUCTILE	FO.=FORM :TYPE :TYPE
HALTEZEIT :HOLDINGTIME :TEMP D'ARRET	LAGE :POSIT :POSIT	PROBE-NR. :SAMPLE-NO :NO.D'ESS
SCHM.-NR. :HEAT-NO. :NO. DE COULEE	TEMP. :TESTTEMP :TESTTEMP	

ThyssenKrupp Stahl
Abnahmetechnik

Es wird bestätigt, dass die Ergebnisse der Prüfungen den vereinbarten Lieferbedingungen entsprechen.
This is to certify, that the test results are in agreement with the specifications.
Nous confirmons que les résultats des essais sont conformes aux conditions convenues de vente.

ZERTIFIZIERT nach

ZEUGNIS/CERTIFICATE/CERTIFICAT
NR.(NO.): 000335457001 DUISBURG-SUED

ThyssenKrupp Stahl
Ein Unternehmen von ThyssenKrupp Steel

DISPO-NR. *********	Werks-Nr. Works-No. No de l'usine	Bestell-Nr. Order-No. No de commande	
0004195503	41.96244	230MCB2537	02.05.01

02035275207
02035275213

ThyssenKrupp Stahl · 47161 Duisburg

MCB NEDERLAND B.V.

J.F.KENNEDYLAAN 59
NL 5555 XC VALKENSWAARD

BESCHEINIGUNG ÜBER MATERIALPRÜFUNGEN EN 10204
DOCUMENT ON MATERIALS TESTS EN 10204
DOCUMENT DE CONTROLE DES MATERIAUX EN 10204
ABNAHMEPRUEFZEUGNIS 3.1 B
INSPECTION CERTIFICATE 3.1 B
CERTIFICAT DE RECEPTION 3.1 B

Blatt-Nr. Page-No. Page-No 6

Werkstoff; Quality; Matériau / Lieferbedingungen; Specification; Conditions de livraison

N-A-KTRA M 70 / TKS-WBL. 215

Kennzeichnung: Marking: Marque: WERKSTOFF; SCHMELZ-NR., FERTIGUNGS-/PROBE-NR.
MATERIAL, HEAT-NO., MANUFACTURING/SAMPLE-NO.
MATERIEL, NO. DE COULEE,NO. DE FABRICATION/D'EPROUVETTE

Zeichen des Lieferwerkes: Supplier's mark: Marque d'usine: Werksmarke ThyssenKrupp Stahl

PROBENZUSTAND
STAT.
ETAT
0005=VERGUETET
QUENCHED AND TEMPERED
REVENUE

PROBENLAGE (IST)
POSIT (IST)
POSIT (IST)
0101=LAENGS KOPF OBERFLAECHE
LONG. TOP S
LONG. TETE S
0401=QUER KOPF OBERFLAECHE
TRANS. TOP S.
TRANS. TETE S.
0601=QUER FUSS OBERFLAECHE
TRANS. BOTTOM S
TRANS. PIED S

ALTERUNG
AGED
VIEILLE
0000=UNGEALTERT
NOT AGED
NON VIEILLE
0006=UNGEALTERT
NOT AGED
NON VIEILLE

PROBENFORM ZUGVERSUCH
TYPE TENSILE TEST
TYPE ESSAI DE TRACTION
0002=FLACHZUG
FLAT TENSILE TEST
EPROUVETTE PLATE DE D'ECHINEMENT

PROBENFORM KERBSCHLAG
TYPE IMPACT TEST
TYPE ESSAI DE RESILIENCE
0007=CHARPY- V
CHARPY- V
CHARPY- V

ThyssenKrupp Stahl
Abnahmetechnik

Es wird bestätigt, dass die Ergebnisse der Prüfungen den vereinbarten Lieferbedingungen entsprechen.
This is to certify, that the test results are in agreement with the specifications.
Nous confirmons que les résultats des essais sont conformes aux conditions convenues de vente.

ZERTIFIZIERT nach

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.biz/certificate)

DILLINGER HÜTTE

A02	A09 Advice of dispatch No./ Date of dispatch	A08/ Manufacturer's order/ A03 Certificate No.	Sheet
ABNAHMEPRUEFPROTOKOLL 3.2 DIN EN 10204 – EN 10204 – DIN 50049 PROCES-VERBAL DE RECEPTION 3.2 NF EN 10204 INSPECTION REPORT 3.2 BS EN 10204 – ISO 10474	110486-10.07.03	269575-001	2

A05 Established inspecting body	A06 Purchaser / Final receiver	A07.1 No. / A07.2 No.	B01 Product
LR	WALDRAM, ZALTBOMMEL WALDRAM, ZALTBOMMEL	2003.0551.0/JD	HOT ROLLED PLATES

B02/ Steel grade: DILLIMAX1100MOD
B03 Specification: DILLING-D55-D:02

C94 Heat analysis Carbon equivalent / Alloying restrictions

B08 Heat
40907 FO-51= 0,02

C94 Carbon equivalent formula / Alloying restrictions

FO-51 = V +NB

D01 Checking of marking, surface, shape and dimensions

ITEM NO.: 02
RESULT OF MARKING, SURFACE, SHAPE AND DIMENSIONS: NO REMARKS
SURFACE AS PER EN-10163-A2
THICKNESS AS PER EN-10029-A:91
LENGTH AND WIDTH AS PER EN-10029:91
FLATNESS AS PER EN-10029-T4H:91

Z01-Z99 Confirmations

ITEM NO.: 02
TERMS AND CONDITIONS OF A. M. SOCIETY (A05) APPLY:
LLOYDS REGISTER OF SHIPPING.

A04 D H Trademark

Z01/Z02 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

Inspector

B. MUELLER
Der Werkssachverständige

Inspector's stamp

Date 11.07.03

AHB

A01 AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

F 1

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.biz/certificate)

DILLINGER HÜTTE

A02							A09 Advice of dispatch No./ Date of dispatch	A06/ Manufacturer's order/ A03 Certificate No.	Sheet
ABNAHMEPRUEFPROTOKOLL	3.2	DIN EN 10204	-	EN 10204	-	DIN 50049			
PROCES-VERBAL DE RECEPTION	3.2	NF EN 10204							
INSPECTION REPORT	3.2	BS EN 10204	-	ISO 10474			113116-09,08.03	269575-002	1/...

A05 Established inspecting body	A06 Purchaser		A07.1 No.		B01 Product
LR		WALDRAM,ZALTBOMMEL		2003.0551.0/JD	HOT ROLLED PLATES
	Final receiver	WALDRAM,ZALTBOMMEL	A07.2 No.		

B02/ Steel grade: DILLIMAX1100MOD
B04 Specification: DILLING-D55-B:02
Ions

B01-B99 Product description

B09 Item No.	B10 Quantity	B11 Thickness		B12 Width		B13 Length	B14 Mass theoretical KG	B04 Delivery condition	B08 Heat No.	B07 Rolled plate No./ Test No.	B17 PE	B16 Customer reference
				MM								
01	1	40,00	x	2051	x	6000	3939	Q+A	40907	99497-01		
01	1	40,00	x	2051	x	6000	3938	Q+A	40907	99497-02		
**	2						7876					
***	2						7876					

B06 Marking

ITEM NO.: 01
STEEL GRADE DILLIMAX1100MOD
HEAT NO. / TRADEMARK / ROLLED PLATE NO./TEST NO. / INSPECTOR'S STAMP

C10-C29 Tensile test

B09 Item No.	B08 Heat No.	B07 Rol.plate/ Test No.	B17 PE	B05 Reference condition	C01	C02/ C01	C03 Temp. GR.C	C10 MPA RP02	C11	C12 RM	C13 A % L0=5D	C14-C15
01	40907	99497			K4	Q	RT	1149		1262	11,4	
					F4	Q	RT	1149		1261	11,4	

C40-C49 Impact test

B09 Item No.	B08 Heat No.	B07 Rol.plate/ Test No.	B17 PE	B05 Reference condition	C01	C02/ C01	C03 Temp. GR.C	C41 Specimen width	C40 Type of specimen	C44 Testing method	C46 Energy Joule	C45	C42 Individual values AVeJ			C43 Average value
01	40907	99497			K4	QO	-40		CHP-V		600	AV	15	19	15	16
					F4	QO	-40		CHP-V		600	AV	16	15	15	15

A04

D H
Trademark

Z01/Z02 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

H.J. Cyranski
Stuttgart Office
Lloyd's Register EMEA

12.08.03
Inspector

STU

03 10252 / 01 MUELLER
Der Werkssachverständige

AHB
Inspector's stamp

A01

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 11.08.03

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations (www.dillinger.biz/certificate)

DILLINGER HÜTTE

A02					A09 Advice of dispatch No./ Date of dispatch	A00/ Manufacturer's order/ A03 Certificate No.	Sheet
ABNAHMEPRUEFPROTOKOLL	3.2	DIN EN 10204	- EN 10204	- DIN 50049			
PROCES-VERBAL DE RECEPTION	3.2	NF EN 10204					
INSPECTION REPORT	3.2	BS EN 10204	- ISO 10474		113116-09.08.03	269575-002	2

A06 Established inspecting body	A05 Purchaser		A07.1 No.		001 Product
LR	Final receiver	WALDRAM,ZALTBOMMEL WALDRAM,ZALTBOMMEL	2003.0551.0/JD A07.2 No.		HOT ROLLED PLATES

B02/ Steel grade: DILLIMAX1100MOD
D01/ Specifications: DILLING-D55-B:02

C70-C99 Chemical composition % - Heat analysis

B08 Heat	C70	C	SI	MN	P	S	AL	MO	NI	CR	V	NB	TI	B
40907	Y	0,198	0,308	1,22	0,013	0,0008	0,077	0,215	0,365	1,028	0,002	0,016	0,004	0,0020

C94 Heat analysis Carbon equivalent / Alloying restrictions

B08 Heat		
40907	FO-51=	0,02

C94 Carbon equivalent formula / Alloying restrictions

FO-51 = V +NB

D01 Checking of marking, surface, shape and dimensions

ITEM NO.: 01
RESULT OF MARKING, SURFACE, SHAPE AND DIMENSIONS: NO REMARKS

SURFACE	AS PER EN-10163-A2
THICKNESS	AS PER EN-10029-A:91
LENGTH AND WIDTH	AS PER EN-10029:91
FLATNESS	AS PER EN-10029-T4H:91

Z01-Z99 Confirmations

ITEM NO.: 01
TERMS AND CONDITIONS OF A. M. SOCIETY (A05) APPLY:
LLOYDS REGISTER EMEA

A04

D H

Trademark

Z01/Z02 We hereby certify, that the above mentioned materials have been delivered in accordance with the terms of order.

Hrd. Cyranski
Stuttgart Office
Lloyd's Register EMEA

Inspector

B. MUELLER
Der Werkssachverständige

A H B

Inspector's stamp

Date 11.08.03

A01

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Bearbeitungsdatum: 24.04.2001 - Probebleche Schweißlabor - Dillimax1100 Stoß-Nr.: 6

Qualität : Dillimax1100 Legierungstyp : CuMoNiCrVNb Gießart : S
ReH-Klasse : 0 Werksauftrags-Nr.: 222591 Pos.:11 Auftr.-Nr./SL.: 19/2000
Schmelzen-Nr. : 81618 Wärmebehandlung : U+Q+A Stahltyp :
Referenz-Nr. : 37444 Bemerkung Abn. : Eing.12.09.00
Länge : 5930 Breite : 1960 Dicke : 40,00 Karte-Nr.: 431 Kartei-Nr.: 6.3

Schmelzenanalyse in %

C	Si	Mn	P	S	Al	N	Cu	Mo	Ni	Cr	V	Nb	Ti	B	Ca
0,16	0,27	0,87	0,012	0,000	0,061	0,005	0,220	0,460	1,95	0,47	0,020	0,013	0,003	0,0016	0,0045

Stückanalyse in % :

C	Si	Mn	P	S	Al	N	Cu	Mo	Ni	Cr	V	Nb	Ti	B	Ca
0,00	0,00	0,00	0,000	0,000	0,000	0,000	0,000	0,000	0,00	0,00	0,000	0,000	0,000	0,0000	0,0000

CE : 0,64 Pcm : 0,32 CET : 0,38

Mechanische Eigenschaften

Couponl.	Probenl.	Probenart	Reh	Rp0.2	Rm	A5%	A2"%	Z%	Härte HB5/750		
K4	QV	Z1	0	1117	1361	11,6	0,0	0,0	0	0	0
			0	0	0	0,0	0,0	0,0			
			0	0	0	0,0	0,0	0,0			
			0	0	0	0,0	0,0	0,0			

Couponl.	Probenl.	Probenform	Temp. °C	AV-Einzelwerte			AV-Mittelwert (Joule)
K4	QO	K3	-40	24	31	34	30
							0
							0
							0
							0

3300 x 1960 x 40

DILLINGER HÜTTE

Erläuterungen siehe Rückseite/Explications voir au verso/See reverse for explanations

A02 **BESCHEINIGUNG**
ATTESTATION
NOTE OF COMPLIANCE

A09 Advice of dispatch No./ Date of dispatch: 118602-14.10.03

A08/ Manufacturer's order/ A03 Certificate No.: 271099-N01

Sheet: 1/...

A05 Established Inspecting body: DH

A06 Purchaser: WALDRAM, ZALTBOMMEL — A07.1 No. 2003.34212/RW

Final receiver: WALDRAM, ZALTBOMMEL — A07.2 No.

B02/ B03 Steel grade / Specifications: HEAT TREATMENT AS PER CUSTOMER REQUIREMENTS

B01-B99 Product description

B09 Item No.	B10 Quant	B11 Thickness	B12 Width MM	B13 Length	B14 Mass theoretical KG	B04 Delivery condition	B07 Rolled plate No. / Test-No.	B16 Customer reference
01	1	11,99	x 2554	x 9144	2198	A	15127-01	228903/01
02	1	25,00	x 3000	x 5200	3062	A	15128-01	228904/01
03	1	40,00	x 2500	x 3800	2983	A	15129-01	221570/01
***	3				8243			

C10-C29 Tensile test

B09 Item No.	B07 Rol.plate/ Test No.	B17 PE	B05 Reference condition	C01	C02/ C01	C03 Temp. GR.C	C10 C11 N/MM2 RP02	REH	C12 RM	C13 A % LO=5D
01	15127			K4	Q	RT		939	962	17,0
02	15128			K4	Q	RT		957	990	16,4
03	15129			K4	Q	RT	955		1003	16,7

C40-C49 Impact test

B09 Item No.	B07 Rol.plate/ Test No.	B17 PE	B05 Reference condition	C01	C02/ C01	C03 Temp. GR.C	C41 Specimenwidth	C40 Type of specimen	C44 Testing method	C45	C42 Individual values AV=J			C43 Average Value
01	15127			K4	QO	-40		CHP-V		AV	92	60	65	72
02	15128			K4	QO	-40		CHP-V		AV	50	65	61	59
03	15129			K4	QO	-40		CHP-V		AV	50	52	47	50

B/ MUELLER

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 28.10.03

APPENDIX A: Drawings test pieces