Institut für Schweißtechnik u. Ingenieurbüro Dr. Möll GmbH

Dr. Möll GmbH An der Schleifmühle 6 · 64289 Darmstadt · Tel: (06151) 74097 + 713051 · Fax: 74140

Akkreditiert zum Zertifizieren von Schweißfachpersonal

BITTE NUR ZUR ANSICHT

Test Report
VB - 83/2007

Object: **Upright of a pallet rack of Stow**

Here: Compression tests on undamaged and repaired uprights

Client: Company
IKEA Distribution Services GmbH
Ellinghauser Straße 213
44359 Dortmund

Pages: - 1 to 26 -

Darmstadt, 28th March 2008

Dipl. Ing. P. Stangenberg

Dipl. Ing. J. Anders

Geschäftsführer: Dipl.-Ing. J. Anders, R. Niebel, Dipl.-Ing. W. Möll, Dipl.-Ing. P. Stangenberg
Handelsregister Darmstadt B 3036

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1. Introduction

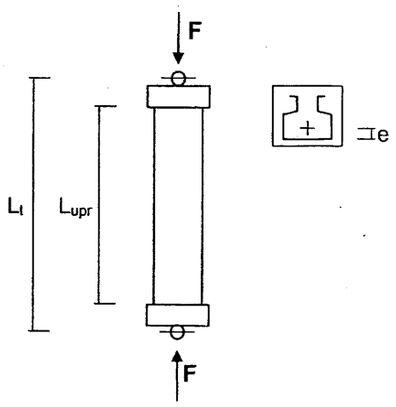
In December 2007 the Institut für Schweißtechnik und Ingenieurbüro Dr. Möll GmbH received from the IKEA Distribution Services GmbH pieces of uprights of a pallet rack installation in order to conduct compression tests. According to IKEA three piece have been taken out of undamaged parts of the racks and three others out of parts, that have been damaged before and repaired afterwards. Each one pair of damaged and undamaged upright pieces was taken from one rack upright.

The purpose of the tests is compare the load bearing capacity of the damaged and repaired uprights. Further the test result are compared with the theoretic load bearing capacity.

In order to check the material properties, tensile tests on strips, that have been taken out of the tested uprights, were carried out. The results of these tests are documented in annex A.4.

2. Versuchsaufbau und -durchführung

For the tests cap plates with a thickness of ca. 30 mm were welded to both ends of the upright pieces.



The specimen were loaded axially through ball bearings at their ends. The load is increased slowly until failure.

The length L_t between the ball bearings was in all tests 1232 mm. The Length L_{upr} the upright pieces between the cap plates was in all tests ca. 1150 mm.
The load was applied on the axis of symmetry at a distance of e = 26,5 mm from the front of the upright.

The upright type was PLU 15 of the rack manufacturer STOW International NV.

Significant deformations of the repaired uprights could not be observed. According to IKEA these uprights have been repaired for the first time.

3. Test results

In the compression test the following maximum loads F_{max} could be reached:

Test No	F_{max} [kN]	Condition
N I	139,20	undamaged
R I	143,20	repaired
N II	147,20	undamaged
R II	142,65	repaired
N III	154,90	undamaged
R III	157,80	repaired

The test pieces with the same roman numerals are from also taken out of the same rack upright and therefore can be compared directly with each other. The comparison shows, that the repaired specimen fail - within the usual tolerances - at the same load as the undamaged upright pieces. That means, that the repair lead here to no measurable reduction of the load bearing capacity.

The following values for the yield stress ($R_{p0,2}$) and material thickness t result from the tensile tests on the material strips:

Versuch Nr.	$R_{p0,2}$ [N/mm^2]	t [mm]
N I	396	2,03
R II	396	2,00
N III	433	2,01

The uprights with the marking I und II have the same yield stress, while the yield stress of the upright with the marking III is ca. 9% greater. This fact is reflected also in the results of the compression tests. The failure loads of the specimen N III und R III are on average also ca. 9% greater than the failure loads of the other specimen.

The calculation according to FEM 10.2.02 with respect to flexural buckling and flexural torsional buckling (see annex A.2) gives the following design values for the failure load $N_{b,Rd,min}$:

Specimen NI to RII : $N_{b,Rd,min} = 134{,}2$ kN
Specimen NIII and RIII: $N_{b,Rd,min} = 143{,}2$ kN

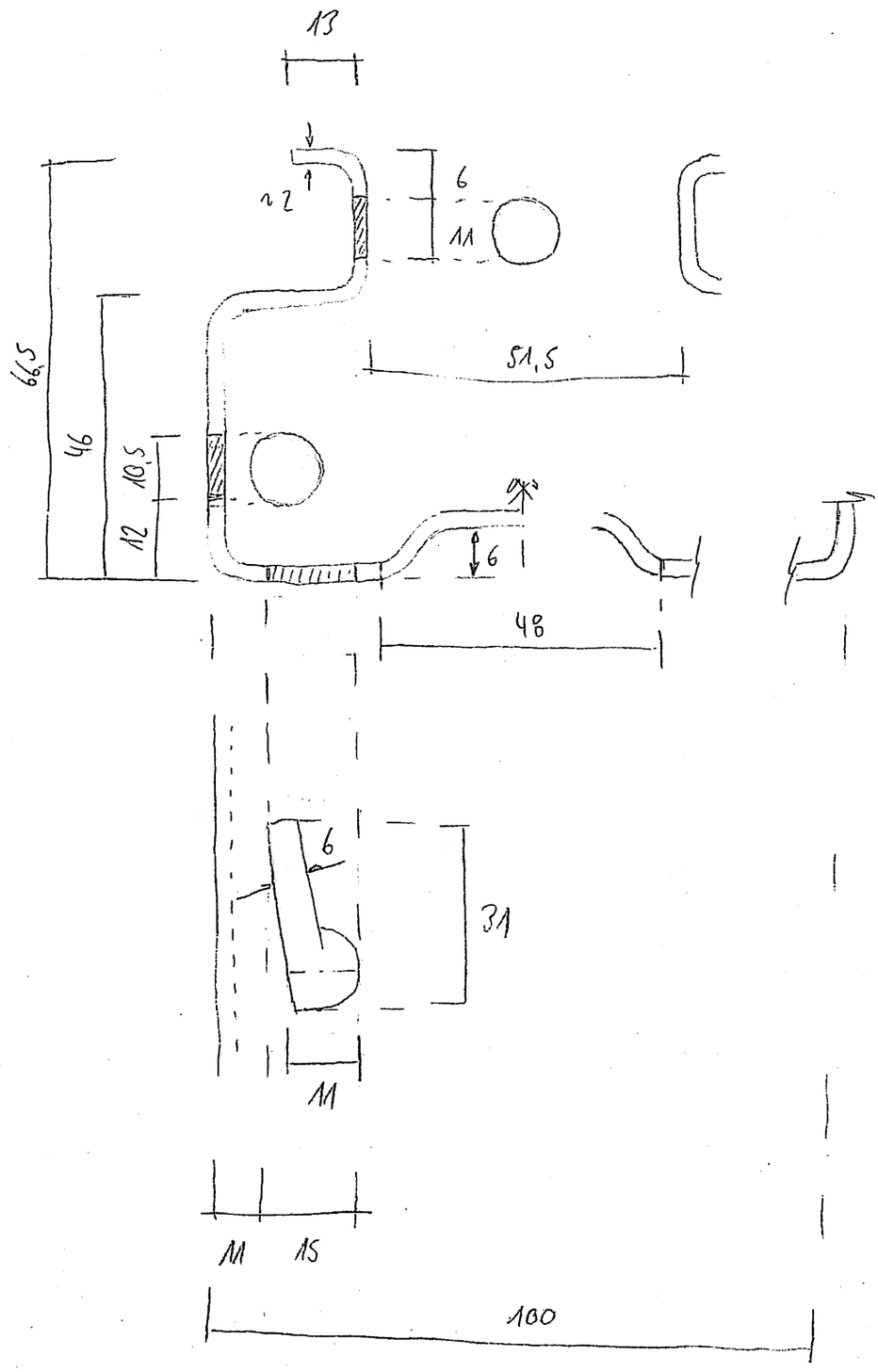
The failure loads reached in the tests are greater than the calculated values.

4. Summary

In the here conducted compression tests, no reduction of the load bearing capacity of uprights after a single repair could be observed.

The theoretic design failure loads according to FEM 10.2.02 for the specimen were exceeded in all tests.

A.1 Abmessungen des Stützenprofils



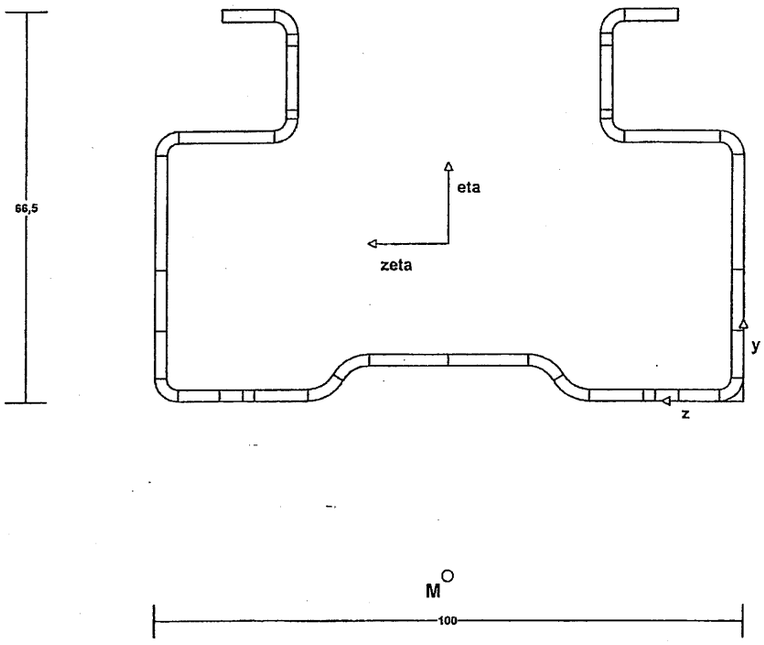
Maße wie am Versuchsstück gemessen

A.2 Calculated load bearing capacities

Profil :	PLU 15			
Position :			formula	unit
f_y =	**39,6**	**43,3**		[kN/cm²]
E =	21.000	21.000		[kN/cm²]
G =	8.100	8.100		[kN/cm²]
A =	4,81	4,81		[cm²]
N_{Rk} =	190,5	208,3	f_y x A	[kN]
L_y =	123,2	123,2		[cm]
L_z =	123,2	123,2		[cm]
L_{FT} =	123,2	123,2		[cm]
β_y =	1	1	reduction factors buckl.	[-]
β_z =	1	1	reduction factors buckl.	[-]
β_{FT} =	0,5	0,5	reduction factors buckl.	[-]
y_M =	5,83	5,83		[cm]
I_y =	73,0	73,0		[cm⁴]
I_z =	27,3	27,3		[cm⁴]
I_w =	989	989		[cm⁶]
I_T =	0,0708	0,0708		[cm⁴]
buckl. curve y-y :	b	b		{a,b,c,d}
buckl. curve z-z :	b	b		{a,b,c,d}
buckl. curve FT :	b	b		
α_y =	0,34	0,34		
α_z =	0,34	0,34		
α_{FT} =	0,34	0,34		
$N_{cr,y}$ =	996,1	996,1	$\pi^2 E I_y / (\beta_y L_y)^2$	[kN]
$N_{cr,z}$ =	372,8	372,8	$\pi^2 E I_z / (\beta_z L_z)^2$	[kN]
$\lambda_{y,rel}$ =	0,437	0,457	$(A f_y / N_{cr,y})^{0,5}$	
$\lambda_{z,rel}$ =	0,715	0,747	$(A f_y / N_{cr,z})^{0,5}$	
ϕ_y =	0,636	0,648	$0,5[1+\alpha_y(\lambda_{y,rel} - 0,2) + \lambda_{y,rel}^2]$	
ϕ_z =	0,843	0,872	$0,5[1+\alpha_z(\lambda_{z,rel} - 0,2) + \lambda_{z,rel}^2]$	
χ_y =	0,911	0,903	$1 / [\phi_y + (\phi_y^2 - \lambda_{y,rel}^2)]$	
χ_z =	0,775	0,756	$1 / [\phi_z + (\phi_z^2 - \lambda_{z,rel}^2)]$	
$N_{b,Rd,y}$ =	**157,75**	**170,91**	$\chi_y A f_y / \gamma_M$	[kN]
$N_{b,Rd,z}$ =	**134,25**	**143,19**	$\chi_z A f_y / \gamma_M$	[kN]
i_0 =	7,405	7,405	$[(I_y + I_z) / A + y_M]^{0,5}$	[cm]
β =	0,380	0,380	$1 - (y_M / i_0)^2$	
$N_{cr,T}$ =	996	996	$1/i_0^2 [G I_T + \pi^2 E I_w /(\beta_{FT} L_{FT})^2]$	[kN]
$N_{cr,FT}$ =	557,20	557,20	$1/(2\beta) [N_{cr,y} + N_{cr,T} - ((N_{cr,y} + N_{cr,T})^2 - 4 \beta N_{cr,y} N_{cr,T})^{0,5}]$	[kN]
$\lambda_{FT,rel}$ =	0,585	0,611	$(A f_y / N_{cr,FT})^{0,5}$	
ϕ_{FT} =	0,736	0,757	$0,5[1+\alpha_{FT}(\lambda_{FT,rel} - 0,2) + \lambda_{FT,rel}^2]$	
χ_{FT} =	0,845	0,831	$1 / [\phi_{FT} + (\phi_{FT}^2 - \lambda_{FT,rel}^2)]$	
$N_{b,Rd,FT}$ =	**146,26**	**157,40**	$\chi_{FT} A f_y / \gamma_M$	[kN]

$N_{b,Rd,min}$ =	**134,25**	**143,19**	$\chi_{FT} A f_y / \gamma_M$	[kN]

PLU 15 - Querschnitt Nr. 1



Querschnittswerte:

A	=	5,6904	[cm^2]
Iy	=	77,861	[cm^4]
Iz	=	29,463	[cm^4]
Iyz	=	0	[cm^4]
ys	=	2,6807	[cm]
zs	=	5,0002	[cm]
Wy+	=	15,571	[cm^3]
Wy-	=	-15,571	[cm^3]
Wz+	=	7,4227	[cm^3]
Wz-	=	-10,991	[cm^3]
Sy	=	9,795	[cm^3]
Sz	=	5,9199	[cm^3]
Alpha	=	0	[°]
Ieta	=	77,861	[cm^4]
Izeta	=	29,463	[cm^4]
It	=	0,075872	[cm^4]
Iw	=	1082,6	[cm^6]
Weta+	=	15,571	[cm^3]
Weta-	=	-15,571	[cm^3]
Wzeta+	=	7,4227	[cm^3]
Wzeta-	=	-10,991	[cm^3]
y-M	=	-5,6888	[cm]
z-M	=	0	[cm]
eta-M	=	-5,6888	[cm]
zeta-M	=	0	[cm]
I-y	=	3,699	[cm]
I-z	=	2,2754	[cm]
I-eta	=	3,699	[cm]
I-zeta	=	2,2754	[cm]

Elemente:

Einflußlänge: 85 Materialdicke: 2 [mm]

Nr.	Länge/ Winkel [mm]/[°]	Innen-radius [mm]
1	9	-
2	90	2
3	2	-
4	11	-
5	1,5	-
6	90	2
7	16,25	-
8	-90	2
9	19,5	-
10	10,5	-
11	8	-
12	-90	2
13	7	-
14	4	-
15	2	-
16	9	-
17	-60	5
18	60	5
19	13,61	-
20	13,61	-
21	60	5
22	-60	5
23	9	-
24	2	-
25	4	-
26	7	-
27	-90	2
28	8	-
29	10,5	-
30	19,5	-
31	-90	2
32	16,25	-
33	90	2
34	1,5	-
35	11	-
36	2	-
37	90	2
38	9	-

Querschnittslochungen gemäß obiger Zeichnung!

Dateiname: PLU15.qdo

Datum: 28.03.2008

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An der Schleifmühle 6
D-64289 Darmstadt

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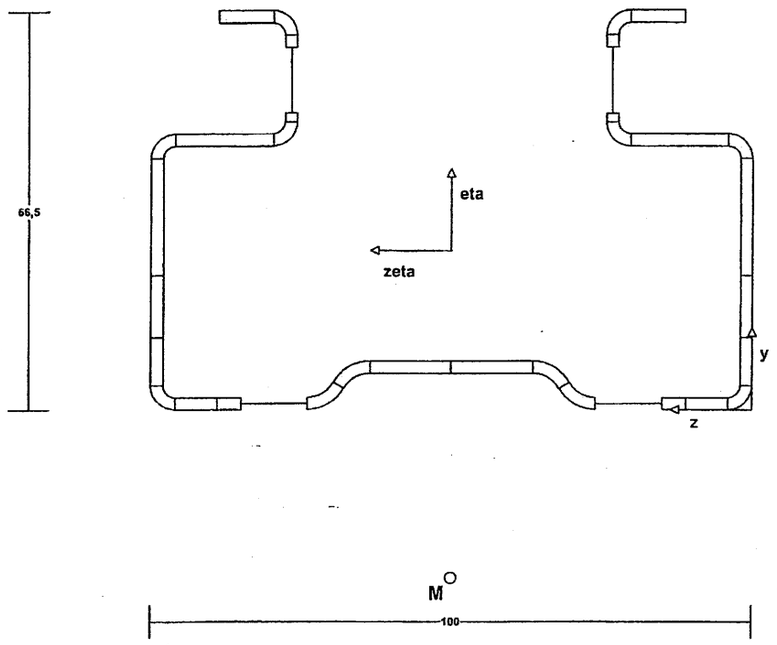
PLU 15 - Querschnitt Nr. 2



Querschnittswerte:

A	=	4,8104	[cm^2]
Iy	=	70,836	[cm^4]
Iz	=	22,987	[cm^4]
Iyz	=	0	[cm^4]
ys	=	2,6589	[cm]
zs	=	5,0002	[cm]
Wy+	=	14,167	[cm^3]
Wy-	=	-14,167	[cm^3]
Wz+	=	5,7596	[cm^3]
Wz-	=	-8,6454	[cm^3]
Sy	=	8,6574	[cm^3]
Sz	=	4,7288	[cm^3]
Alpha	=	0	[°]
Ieta	=	70,836	[cm^4]
Izeta	=	22,987	[cm^4]
It	=	0,064139	[cm^4]
Iw	=	780,72	[cm^6]
Weta+	=	14,167	[cm^3]
Weta-	=	-14,167	[cm^3]
Wzeta+	=	5,7596	[cm^3]
Wzeta-	=	-8,6454	[cm^3]
y-M	=	-5,4891	[cm]
z-M	=	0	[cm]
eta-M	=	-5,4891	[cm]
zeta-M	=	0	[cm]
I-y	=	3,8374	[cm]
I-z	=	2,186	[cm]
I-eta	=	3,8374	[cm]
I-zeta	=	2,186	[cm]

Elemente:

Einflußlänge: 110 Materialdicke: 2 [mm]

Nr.	Länge/ Winkel [mm]/[°]	Innen-radius [mm]
1	9	-
2	90	2
3	2	-
4	11	-
5	1,5	-
6	90	2
7	16,25	-
8	-90	2
9	19,5	-
10	10,5	-
11	8	-
12	-90	2
13	7	-
14	4	-
15	2	-
16	9	-
17	-60	5

Nr.	Länge/ Winkel [mm]/[°]	Innen-radius [mm]
18	60	5
19	13,61	-
20	13,61	-
21	60	5
22	-60	5
23	9	-
24	2	-
25	4	-
26	7	-
27	-90	2
28	8	-
29	10,5	-
30	19,5	-
31	-90	2
32	16,25	-
33	90	2
34	1,5	-

Nr.	Länge/ Winkel [mm]/[°]	Innen-radius [mm]
35	11	-
36	2	-
37	90	2
38	9	-

Querschnittslochungen gemäß obiger Zeichnung!

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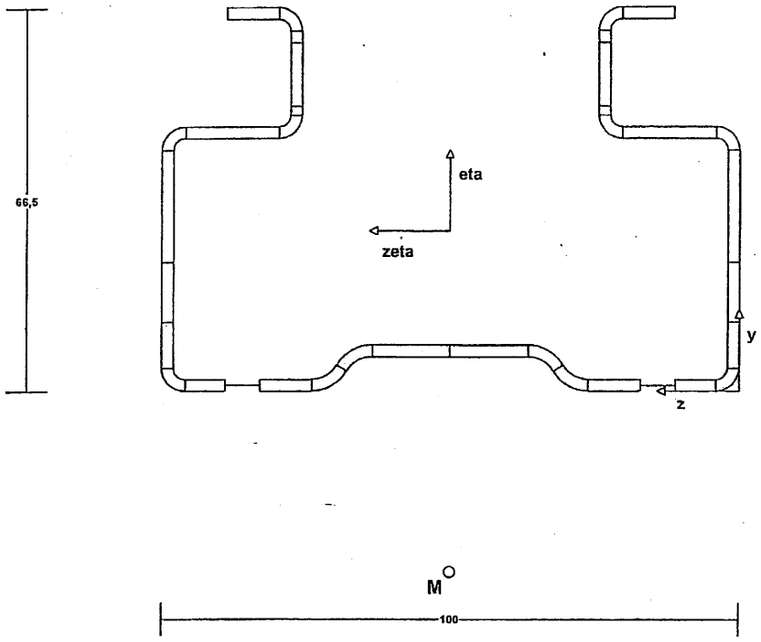
PLU 15 - Querschnitt Nr. 3



Querschnittswerte:

A	=	5,4504	[cm^2]
Iy	=	74,743	[cm^4]
Iz	=	27,793	[cm^4]
Iyz	=	0	[cm^4]
ys	=	2,7843	[cm]
zs	=	5,0002	[cm]
Wy+	=	14,948	[cm^3]
Wy-	=	-14,948	[cm^3]
Wz+	=	7,2085	[cm^3]
Wz-	=	-9,9463	[cm^3]
Sy	=	9,363	[cm^3]
Sz	=	6,616	[cm^3]
Alpha	=	0	[°]
Iota	=	74,743	[cm^4]
Izeta	=	27,793	[cm^4]
It	=	0,072672	[cm^4]
Iw	=	1037,4	[cm^6]
Weta+	=	14,948	[cm^3]
Weta-	=	-14,948	[cm^3]
Wzeta+	=	7,2085	[cm^3]
Wzeta-	=	-9,9463	[cm^3]
y-M	=	-5,9582	[cm]
z-M	=	0	[cm]
eta-M	=	-5,9582	[cm]
zeta-M	=	0	[cm]
i-y	=	3,7031	[cm]
i-z	=	2,2582	[cm]
i-ota	=	3,7031	[cm]
i-zeta	=	2,2582	[cm]

Elemente:

Einflußlänge: 200 Materialdicke: 2 [mm]

Nr.	Länge/ Winkel [mm]/[°]	Innen-radius [mm]
1	9	-
2	90	2
3	2	-
4	11	-
5	1,5	-
6	90	2
7	16,25	-
8	-90	2
9	19,5	-
10	10,5	-
11	8	-
12	-90	2
13	7	-
14	4	-
15	2	-
16	9	-
17	-60	5
18	60	5
19	13,61	-
20	13,61	-
21	60	5
22	-60	5
23	8	-
24	2	-
25	4	-
26	7	-
27	-90	2
28	8	-
29	10,5	-
30	19,5	-
31	-90	2
32	16,25	-
33	90	2
34	1,5	-
35	11	-
36	2	-
37	90	2
38	9	-

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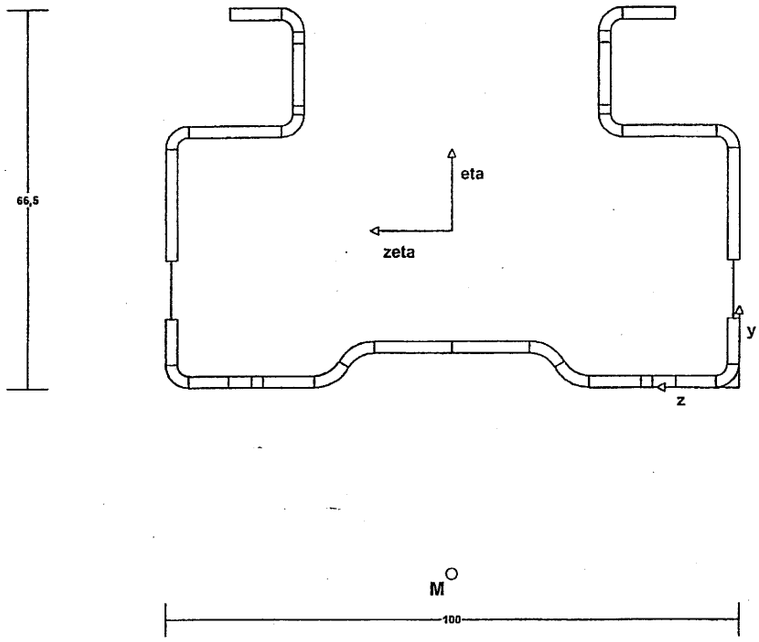
PLU 15 - Querschnitt Nr. 4



Querschnittswerte:

A	=	5,2704	[cm^2]
Iy	=	67,774	[cm^4]
Iz	=	29,01	[cm^4]
Iyz	=	0	[cm^4]
ys	=	2,7569	[cm]
zs	=	5,0002	[cm]
Wy+	=	13,554	[cm^3]
Wy-	=	-13,554	[cm^3]
Wz+	=	7,4517	[cm^3]
Wz-	=	-10,523	[cm^3]
Sy	=	8,7659	[cm^3]
Sz	=	5,7157	[cm^3]
Alpha	=	0	[°]
Ieta	=	67,774	[cm^4]
Izeta	=	29,01	[cm^4]
It	=	0,070272	[cm^4]
Iw	=	1037,6	[cm^6]
Weta+	=	13,554	[cm^3]
Weta-	=	-13,554	[cm^3]
Wzeta+	=	7,4517	[cm^3]
Wzeta-	=	-10,523	[cm^3]
y-M	=	-6,0553	[cm]
z-M	=	0	[cm]
eta-M	=	-6,0553	[cm]
zeta-M	=	0	[cm]
I-y	=	3,586	[cm]
I-z	=	2,3461	[cm]
I-eta	=	3,586	[cm]
I-zeta	=	2,3461	[cm]

Elemente:

Einflußlänge: 105 Materialdicke: 2 [mm]

Nr.	Länge/ Winkel [mm]/[°]	Innen-radius [mm]
1	9	-
2	90	2
3	2	-
4	11	-
5	1,5	-
6	90	2
7	16,25	-
8	-90	2
9	19,5	-
10	10,5	-
11	8	-
12	-90	2
13	7	-
14	4	-
15	2	-
16	9	-
17	-60	5

Nr.	Länge/ Winkel [mm]/[°]	Innen-radius [mm]
18	60	5
19	13,61	-
20	13,61	-
21	60	5
22	-60	5
23	9	-
24	2	-
25	4	-
26	7	-
27	-90	2
28	8	-
29	10,5	-
30	19,5	-
31	-90	2
32	16,25	-
33	90	2
34	1,5	-

Nr.	Länge/ Winkel [mm]/[°]	Innen-radius [mm]
35	11	-
36	2	-
37	90	2
38	9	-

Querschnittslochungen gemäß obiger Zeichnung!

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Zusammenstellung der Querschnittswerte

		Querschnitt Nr.				Mittelwert
		1	2	3	4	
Einfluß.	[-]	85	110	200	105	500
A	[cm^2]	5,6904	4,8104	5,4504	5,2704	5,3125
Iy	[cm^4]	77,861	70,836	74,743	67,774	72,95
Iz	[cm^4]	29,463	22,987	27,793	29,01	27,275
Iyz	[cm^4]	0	0	0	0	0
ys	[cm]	2,6807	2,6589	2,7943	2,7569	2,7374
zs	[cm]	5,0002	5,0002	5,0002	5,0002	5,0002
Wy+	[cm^3]	15,571	14,167	14,948	13,554	14,589
Wy-	[cm^3]	-15,571	-14,167	-14,948	-13,554	-14,589
Wz+	[cm^3]	7,4227	5,7596	7,2085	7,4517	6,9772
Wz-	[cm^3]	-10,991	-8,6454	-9,9463	-10,523	-9,9587
Sy	[cm]	9,795	8,5574	9,363	8,7659	9,1338
Sz	[cm]	5,9199	4,7288	5,816	5,7157	5,4934
Alpha	[°]	0	0	0	0	0
Ieta	[cm^4]	77,861	70,836	74,743	67,774	72,95
Izeta	[cm^4]	29,463	22,987	27,793	29,01	27,275
It	[cm^4]	0,075872	0,054139	0,072672	0,070272	0,070835
Iw	[cm^6]	1082,6	780,72	1037,4	1037,6	988,65
Weta+	[cm^3]	15,571	14,167	14,948	13,554	14,589
Weta-	[cm^3]	-15,571	-14,167	-14,948	-13,554	-14,589
Wzeta+	[cm^3]	7,4227	5,7596	7,2085	7,4517	6,9772
Wzeta-	[cm^3]	-10,991	-8,6454	-9,9463	-10,523	-9,9587
y-M	[cm]	-5,6888	-5,4891	-5,9582	-6,0553	-5,8296
z-M	[cm]	0	0	0	0	0
eta-M	[cm]	-5,6888	-5,4891	-5,9582	-6,0553	-5,8296
zeta-M	[cm]	0	0	0	0	0
i-y	[cm]	3,699	3,8374	3,7031	3,586	3,7074
i-z	[cm]	2,2754	2,186	2,2582	2,3461	2,2637
i-eta	[cm]	3,699	3,8374	3,7031	3,586	3,7074
i-zeta	[cm]	2,2754	2,186	2,2582	2,3461	2,2637

A.3 Record of taking out the specimen (by IKEA)

Probennahme durch: M. Lucas, IKEA
Ort: DC Oosterhout
Datum: 24.10.2007
Hersteller: STOW

Proben Nr.:	Kennung	Zustand	Anzahl Reparaturen	Länge
1	N I	Neu	0	1.150 mm
2	R I	Repariert	1	1.150 mm
3	N II	Neu	0	1.150 mm
4	R II	Repariert	1	1.150 mm
5	N III	Neu	0	1.150 mm
6	R III	Repariert	1	1.150 mm

Datei: 2007RACK12_Proben.xls

Stand: 31.10.2007

Prüflaboratorium
der Institut für Schweißtechnik und Ingenieurbüro Dr. Möll GmbH

An der Schleifmühle 6, 64289 Darmstadt, Tel. (06151) 74097 und 713051, Fax (06151) 74141

Number of the PLISIB-report: **PLISIB - VB - 83/2007**
(corresponds to section A.4 of the total report)

Tensile tests and determination of the yield stresses

Client: Company
IKEA Distribution Services GmbH
Ellinghauser Straße 213
44359 Dortmund

Arrival: December 2007

The report comprises: 8 pages (page 16 to 23)

The results of this report exclusively refer to the specimen tested according to this test report.

Darmstadt, 28th March 2008

Head of PLISIB:

Dipl.-Ing. P. Stangenberg

This report is permitted to spread further only entirely and unchanged.
Extracts- or Changes require a written permission of the testing laboratory of the ISIB Dr. Möll GmbH

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64289 Darmstadt
An der Schleifmühle 6
Tel.: (0 61 51) 7 40 97 u. 71 30 51
Fax: (0 61 51) 7 41 40

Pos. VB-83/2007

Seite 17

Report:
VB - 83/2007

Basic material: ---

No	member, test	specimen taken from	type of specimen	a od. Ø mm	b mm	S_0 mm²	$R_{p0,2}$ N/mm²	R_m N/mm²	L_0 mm	L_u mm	A %
1	2	3	4	5	6	7	8	9	10	11	12
83B1/IN	Stütze PLU15	s. sketch	B	2,03	12,48	25,33	396	480	50	65,1	30,2
83B4/RII	Stütze PLU15	s. sketch	B	2,00	12,49	24,98	396	478	50	64,5	29,0
83B5IIIN	Stütze PLU15	s. sketch	B	2,01	12,48	25,08	433	496	50	64,9	29,9

Universalprüfmaschine UPM 120, Schenck - Trebel | check : 08.05.2007 | by : MPA Darmstadt

[1] Annex B, C or D acc. to EN 10002, part 1

Sketch:

	Datum	Unterschrift
Preparation :	28.03.2008	
Conduction of tests :	28.03.2008	
Evaluation :	28.03.2008	
Checked :	28.03.2008	

Institut für Schweißtechnik und
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An der Schleifmühle 6, D-64289 Darmstadt
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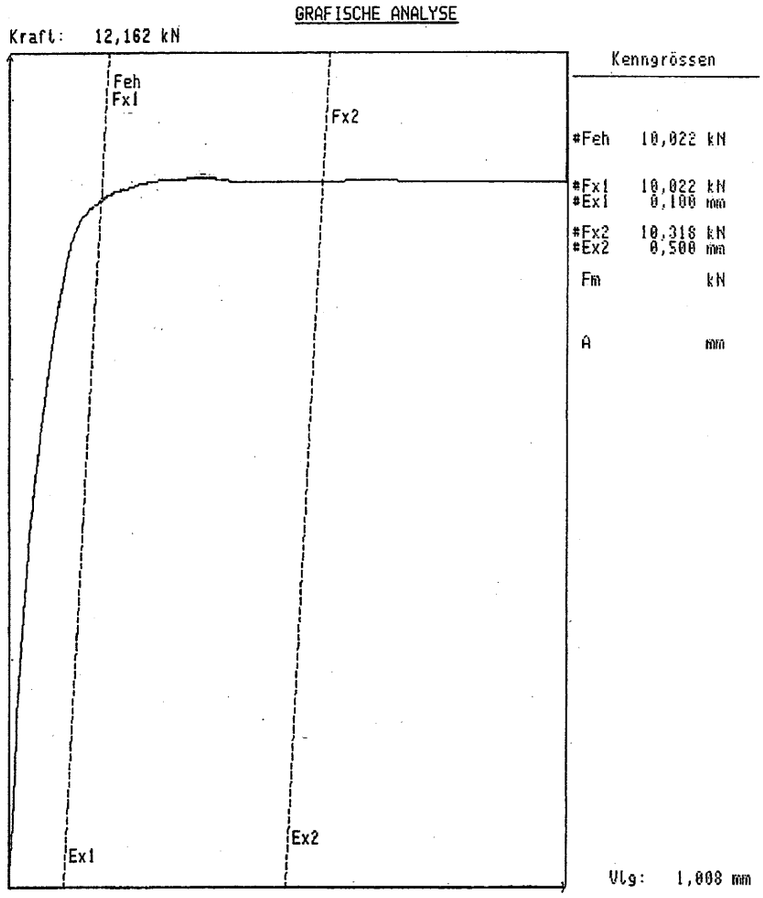
Auftrags-Nr.: B07088
Auftraggeber: Stow
Kom.-Nr. :
Werkstoff :
Datum/Prüfer: 21.12.2007

Los-Nr. : 1
Artikel :
Chargen-Nr. :
Abnahme :

ZUGVERSUCH

Proben-Nr.	d0/a0 mm	b0 mm	L0 mm	S0 mm²	d1/a1 mm	b1 mm	L1 mm	FeH kN	ReH N/mm²	F0.2 kN	Rp0.2 N/mm²	F1.0 kN	Rp1.0 N/mm²	Fm kN	Rm N/mm²	A %	Z %	ε
Soll-werte																		
8381/1N	2,03	12,48	50,0	25,33			65,1	~~10,0~~	~~396~~	10,0	396	10,3	407	12,2	480	30,2		

GRAFISCHE ANALYSE



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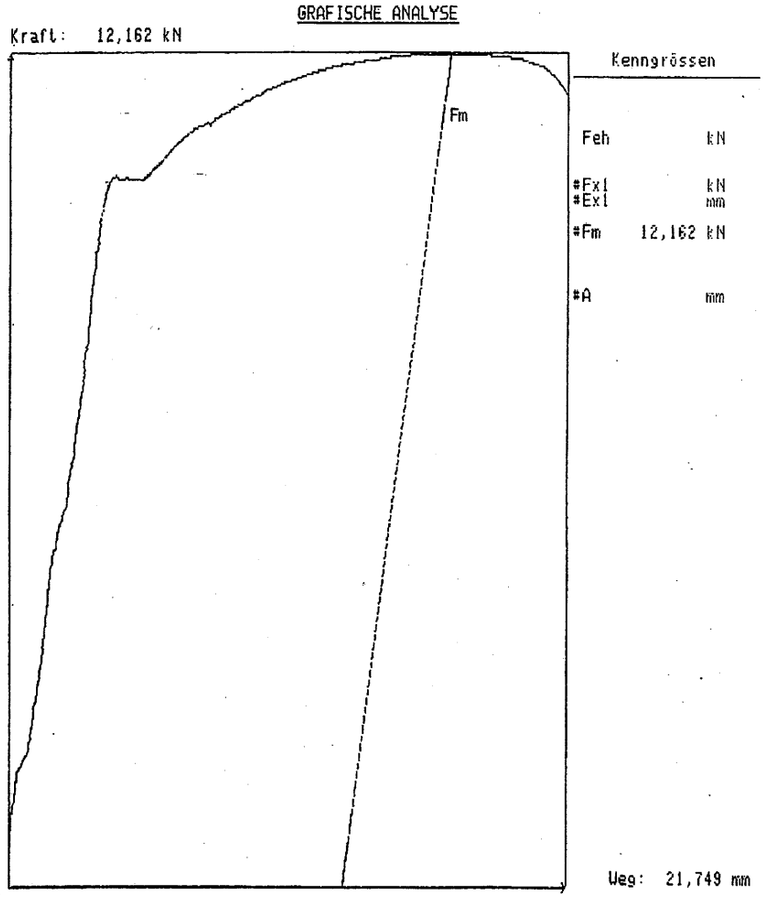
Auftrags-Nr.: B07088 Los-Nr. : 1
Auftraggeber: Stow Artikel :
Kom.-Nr. : Chargen-Nr. :
Werkstoff : Abnahme :
Datum/Prüfer: 21.12.2007

ZUGVERSUCH

Proben-Nr.	d0/a0 mm	b0 mm	L0 mm	S0 mm²	d1/a1 mm	b1 mm	L1 mm	FeH kN	ReH N/mm²	F0.2 kN	Rp0.2 N/mm²	F1.0 kN	Rp1.0 N/mm²	Fm kN	Rm N/mm²	A %	Z %	E
Soll-werte																		
83B1/IN	2,03	12,48	50,0	25,33			65,1	~~10,0~~	~~396~~	10,0	396	10,3	407	12,2	480	30,2		

GRAFISCHE ANALYSE



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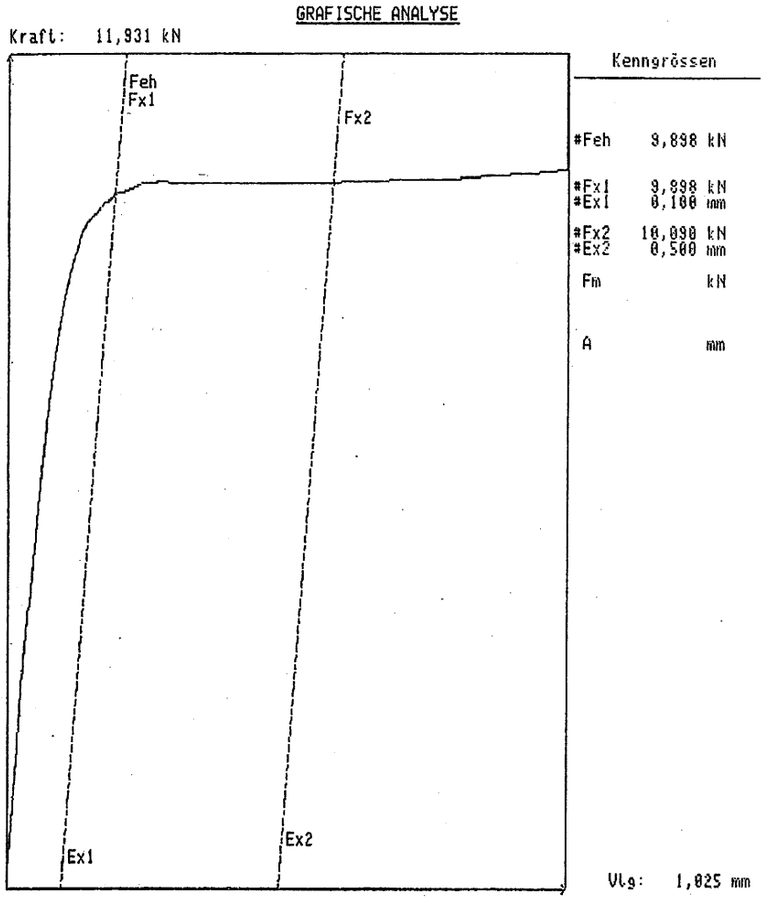
Werkstoff :
Datum/Prüfer: 21.12.2007

Los-Nr. : 1
Artikel :
Chargen-Nr. :
Abnahme :

ZUGVERSUCH

Proben-Nr.	d0/a0 mm	b0 mm	L0 mm	S0 mm²	d1/a1 mm	b1 mm	L1 mm	FeH kN	ReH N/mm²	F0.2 kN	Rp0.2 N/mm²	F1.0 kN	Rp1.0 N/mm²	Fm kN	Rm N/mm²	A %	Z %	E
Soll-werte																		
83B4/RII	2,00	12,49	50,0	24,98			64,5	~~9,9~~	~~396~~	9,9	396	10,1	404	11,9	478	29,0		

GRAFISCHE ANALYSE



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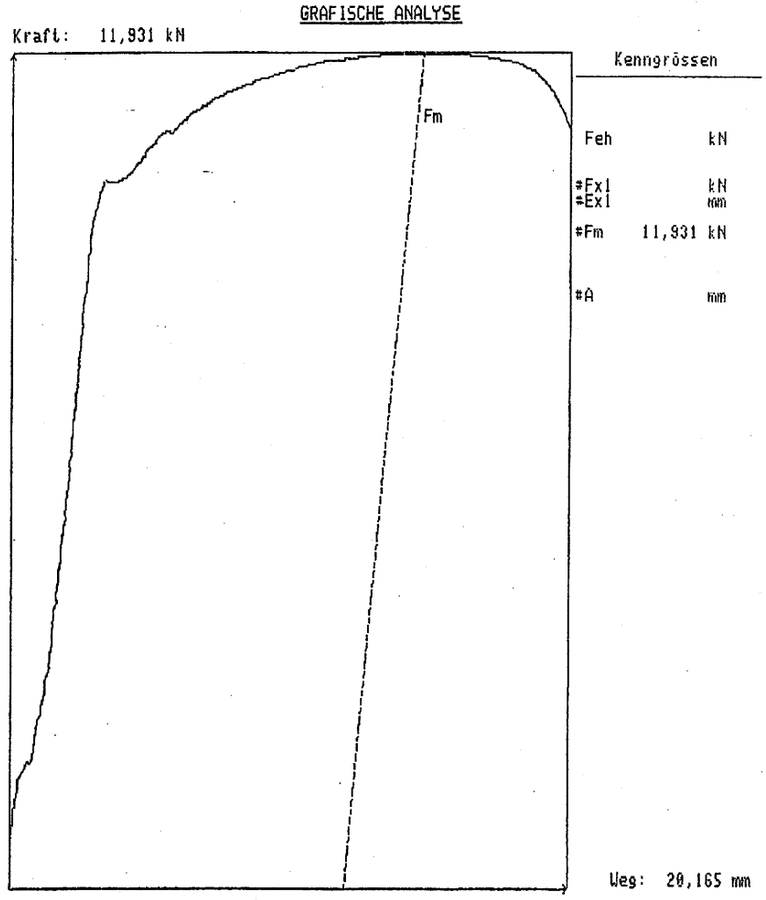
Werkstoff :
Datum/Prüfer: 21.12.2007

Los-Nr. : 1
Artikel :
Chargen-Nr. :
Abnahme :

ZUGVERSUCH

Proben-Nr.	d0/a0 mm	b0 mm	L0 mm	S0 mm²	d1/a1 mm	b1 mm	L1 mm	FeH kN	ReH N/mm²	F0.2 kN	Rp0.2 N/mm²	F1.0 kN	Rp1.0 N/mm²	Fm kN	Rm N/mm²	A %	Z %	E
Soll-werte																		
8384/RII	2,00	12,49	50,0	24,98			64,5	~~9,9~~	~~396~~	9,9	396	10,1	404	11,9	478	29,0		

GRAFISCHE ANALYSE



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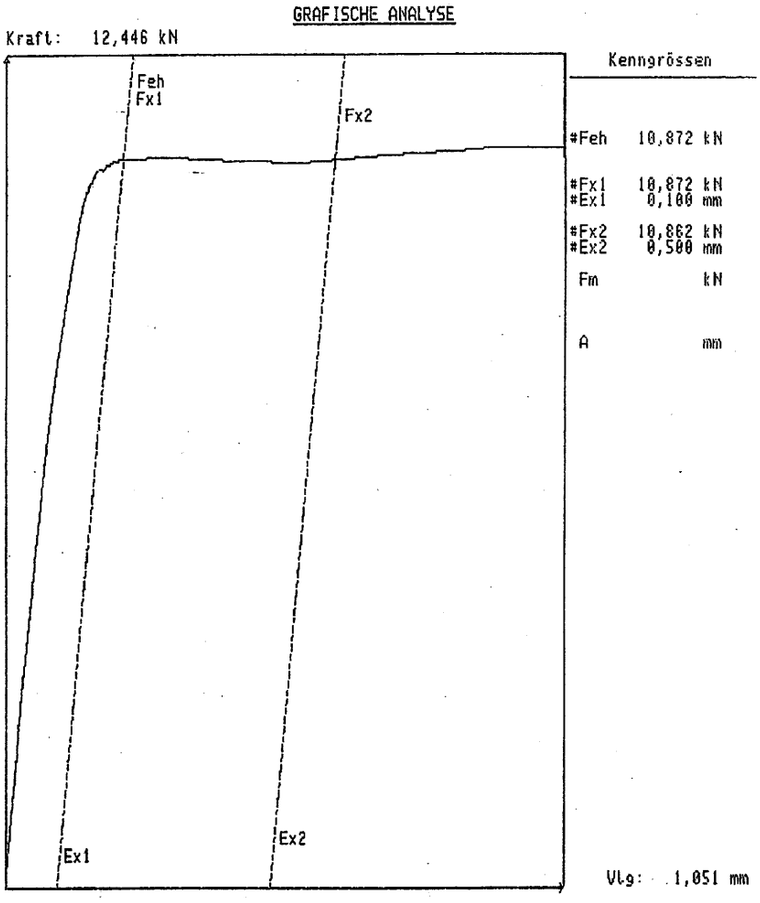
Los-Nr. : 1
Artikel :
Chargen-Nr. :
Abnahme :

ZUGVERSUCH

Proben-Nr.	d0/a0 mm	b0 mm	L0 mm	S0 mm²	d1/a1 mm	b1 mm	L1 mm	FeH kN	ReH N/mm²	F0.2 kN	Rp0.2 N/mm²	F1.0 kN	Rp1.0 N/mm²	Fm kN	Rm N/mm²	A %	Z %	E
Soll-werte																		
83B511IN	2,01	12,48	50,0	25,08			64,9	~~10,9~~	~~433~~	10,9	433	10,9	433	12,4	496	29,9		

GRAFISCHE ANALYSE



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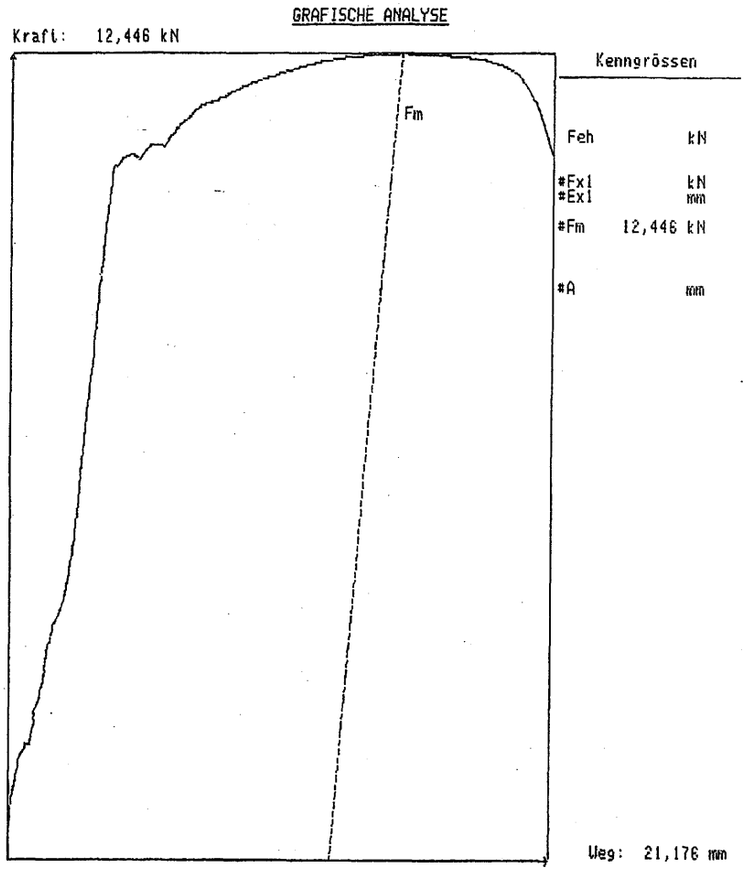
Werkstoff :
Datum/Prüfer: 21.12.2007

Los-Nr. : 1
Artikel :
Chargen-Nr. :
Abnahme :

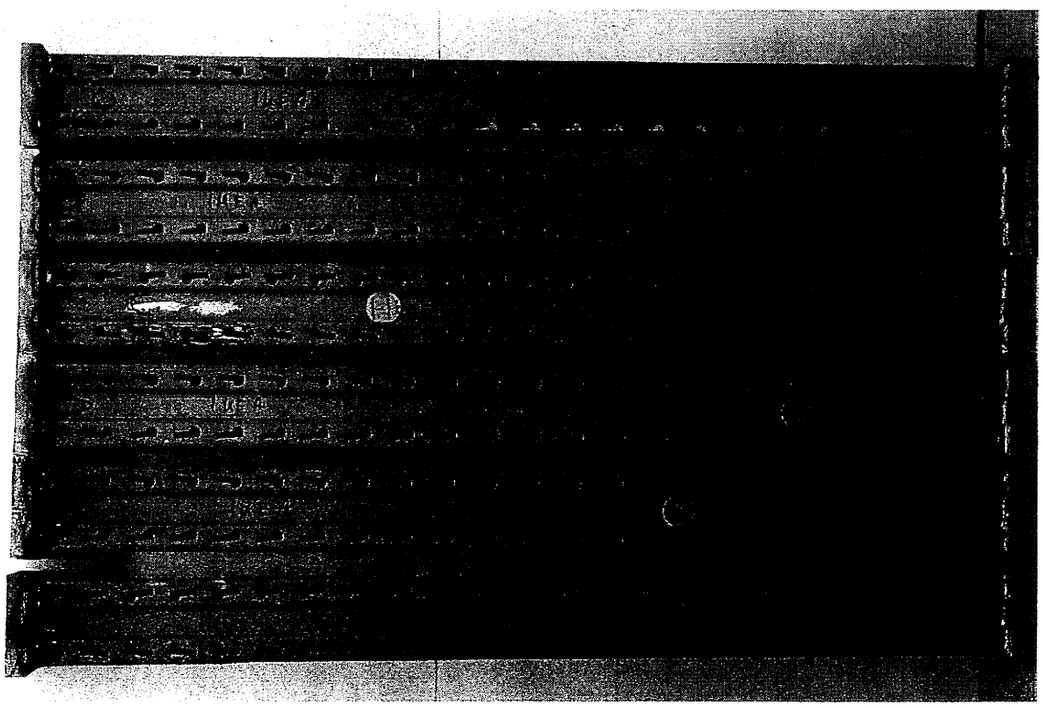
ZUGVERSUCH

Proben-Nr.	d0/a0 mm	b0 mm	L0 mm	S0 mm²	d1/a1 mm	b1 mm	L1 mm	FeH kN	ReH N/mm²	F0.2 kN	Rp0.2 N/mm²	F1.0 kN	Rp1.0 N/mm²	Fm kN	Rm N/mm²	A %	Z %	E
Soll-werte																		
8385111N	2,01	12,48	50,0	25,08			64,9	~~10,9~~	~~433~~	10,9	433	10,9	433	12,4	496	29,9		

GRAFISCHE ANALYSE



A.5 Photos



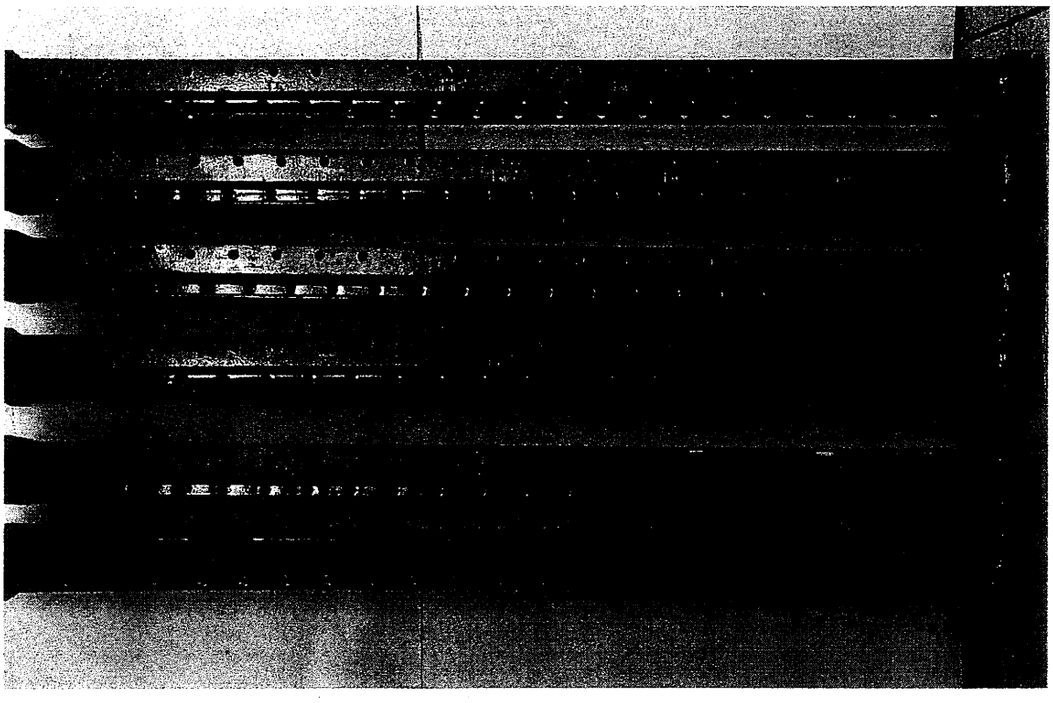
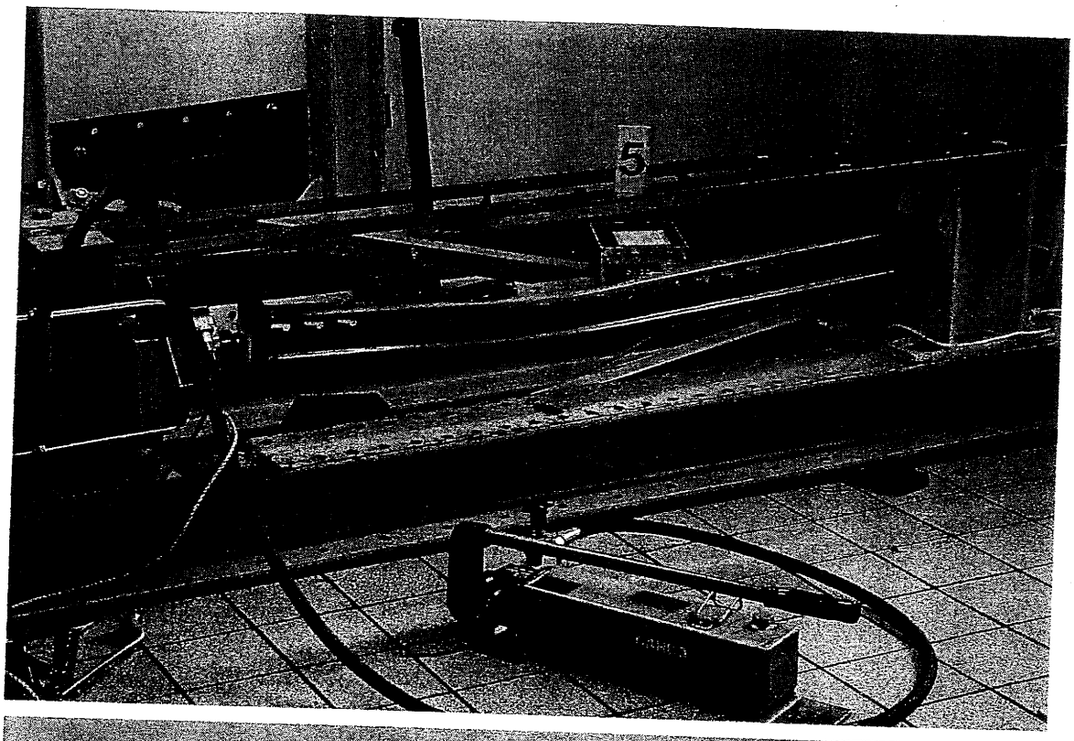


Photo 1 and 2 Upright pieces before testing



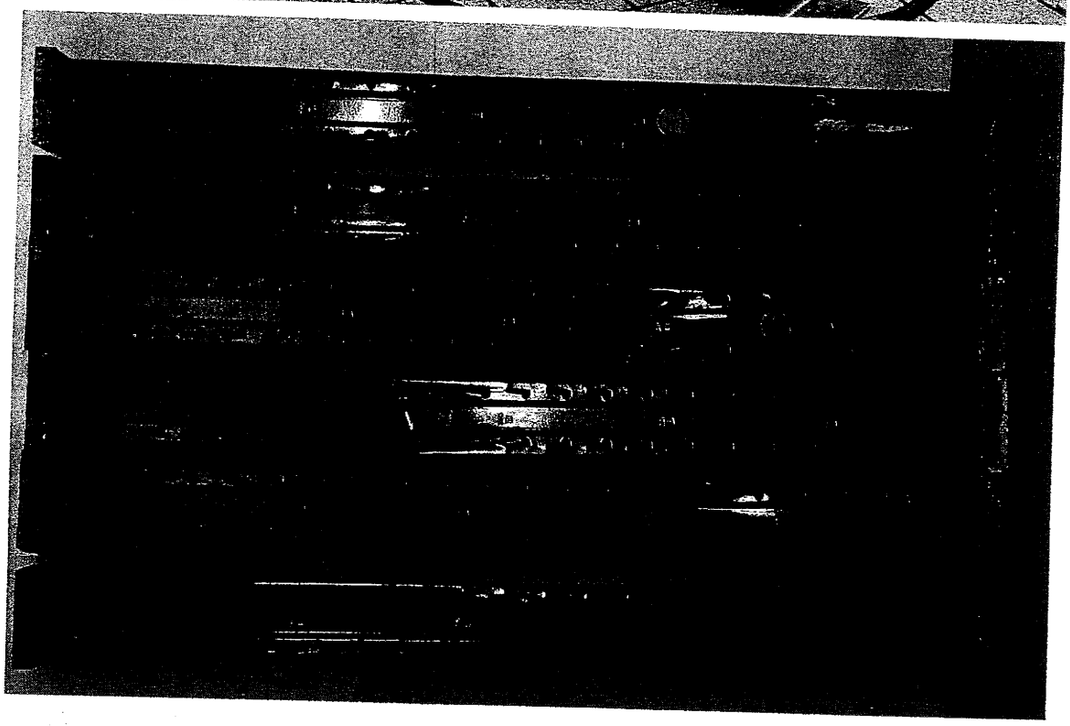


Photo 3 Test arrangment

Photo 4 Upright pieces after testing

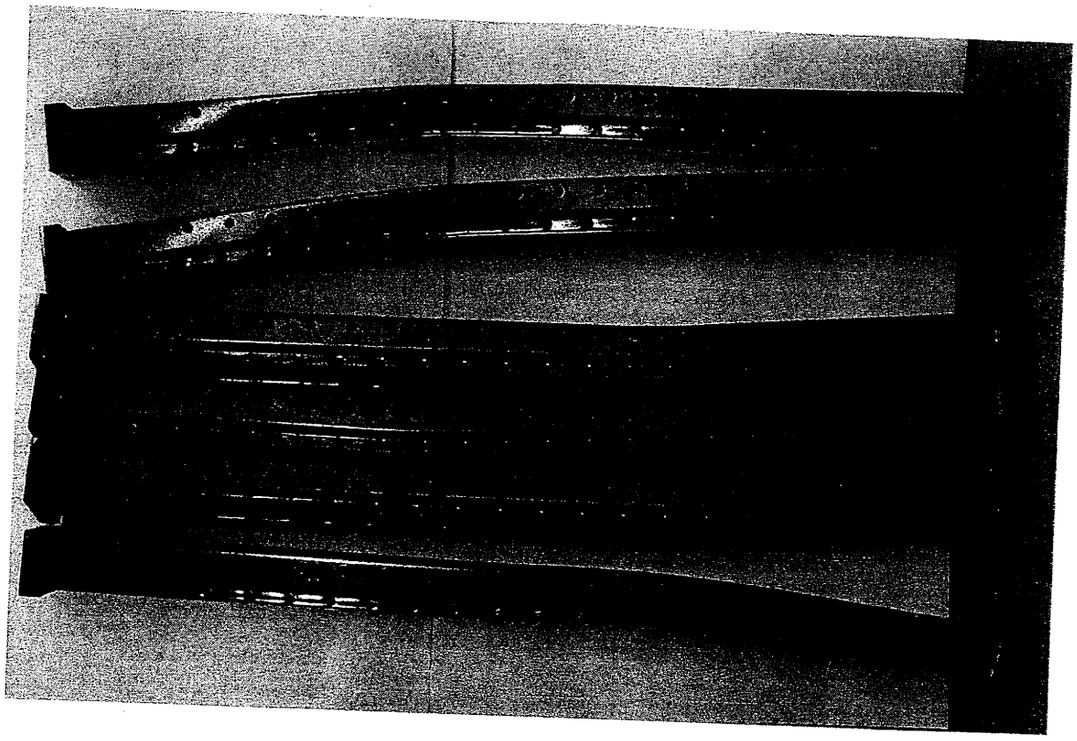


Photo 5 Upright pieces after testing