Büro für Tragwerksplanung und Ingenieurbau
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Structural Analysis

PA-Tower

0955

H = 9.20 m / 10.0 yd
Working load 1050 kg / 2315 lb
Wind Surface A=3.8 (2.6) m² / 4.55 (3.11) yd²

for the sytem of the company

Design Quintessence Pty Ltd.

Edited by :

Aachen, 16 th July 2008

INGENIEURKAMMER-BAU NORDRHEIN-WESTFALEN
BERATENDER INGENIEUR
101448

This Structural Analysis includes pages 1 - 70

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TABLE OF CONTENTS

1 INTRODUCTION 1

1.1 Basics 1
1.2 Used materials 1
1.3 General Description 1
1.4 Load assumptions 3

2 SYSTEM 4

3 EXPOSURE 13

4 CALCULATION / INTERNAL FORCES 16

5 VERIFICATION 61

5.1 Allowable stress single components 61
5.2 Verification 65

6 STABILITY 69

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1 INTRODUCTION

1.1 Basics

The currently applicable regulations and DIN standards, in particular:

DIN 1055	Load Assumptions for Buildings Especially Part 4 (edition 1986)
DIN 4112	Temporary structures (1983)
DIN 4113, Part 1:	Aluminum structures (1972)
Part 2:	Welded aluminum construction (2002)
DIN 4114	Stability
DIN 15 920, Part 2:	Stage and studio setups
DIN 18 800, Part 1:	Steel Buildings
DIN 3065	Ropes
DIN 2448	Steel Tubes
DIN 1480	Turnbuckles

1.2 Used building materials

EN AW 6082-T6	aluminum alloy used in the trusses
S 235 JR	pipes, support feet, etc.

1.3 General Description

Subject of the calculation is a tower construction made of F44- traverses of the manufacurer Global Truss, used as speakertower..

The height of the tower is about 9,20 m (10,0 yd) above terrain.

The tower consists of a 10° inclined pillar, two cantilevers which are arranged in a v-shape and two diagonal braces (pipes 60x5 EN AW 6082 T6).

At the top of the tower payloads with the following maximum weight and maximum windsurface can be applied:

up to 1050 kg (2315 lb) and a maximum area of

3.8 m² (4.55 yd²) to the front and 2.6 m² (3.11 yd²) transverse area

The payloads will be lifted up with a deflection roller.

Smaller loads with proportionally reduced windsurfaces are possible without further proof.

(Example: payload 750 kg, windsurface <750 / 1050 x 3.8 = 2.71 m²)

For smaller loads with disproportionately larger windsurface the cantilever has to be ballasted additionally with the differential payload to 1050 kg

(Example: payload 750 kg, windsurface 3.5 m²> 2.71 m² => 1050 - 750 = 300 kg ballast required)

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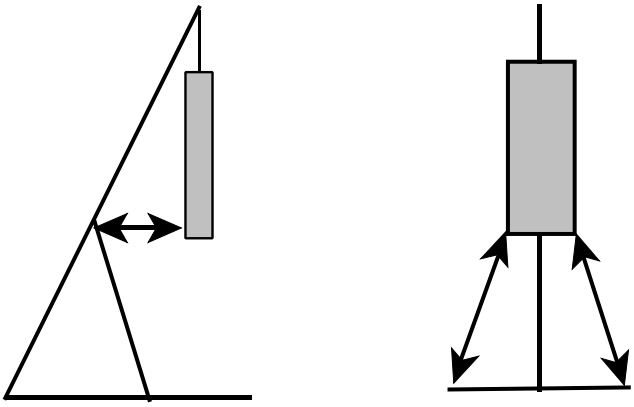
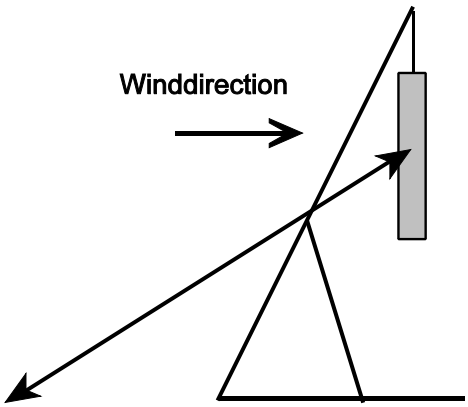
Payloads have to be anchored to the back and the sides if the frontal windsurface exceeds 1.9 m² (resp. 1.3m² transverse windsurface) in the operational state.



Dynamic increase from up- and downlifting of the loads is considered in this static calculation with a factor of 1.2.

When up- or downlifting and simultaneous wind, the payload has to be anchored with a rope from the centre of the windsurface to the ground.



Before excessing wind force beaufort 8 resp. wind speed > 20 m/s (21,8 yd/s) at the top of the tower, the speakers have to be downlifted (Regard the conditions for for downlifting with wind).

In the operational state (with load) no additional ballast is necessary.

The free-standing tower withouth loads and additional windsurface **has to be ballasted for unlimited wind forces according to DIN 1055 and DIN 4112 with 180 kg (400 lb) centered on each cantilever** .

If the tower is not ballasted, it has to be tilted down before crossing windforce beaufort 8.

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1.4 Load assumptions

Wind loads are applied according DIN 1055, part 4, edition 1986 and DIN 4112.

PA

Allowable payload **1050 kg (2315 lb)**

Windsurface PA: **# 3,8 m²** (4.55 yd²)
in direction of cantilevers

 # 2,6 m² (3.11 yd²) transverse
to cantilevers

When uplifting, the PA has to be anchored with a rope..

Case payload with dynamic factor and anchored PA:

=> Verification for $P = 1.2 \cdot 10.5$ kN with half of the wind-load from PA

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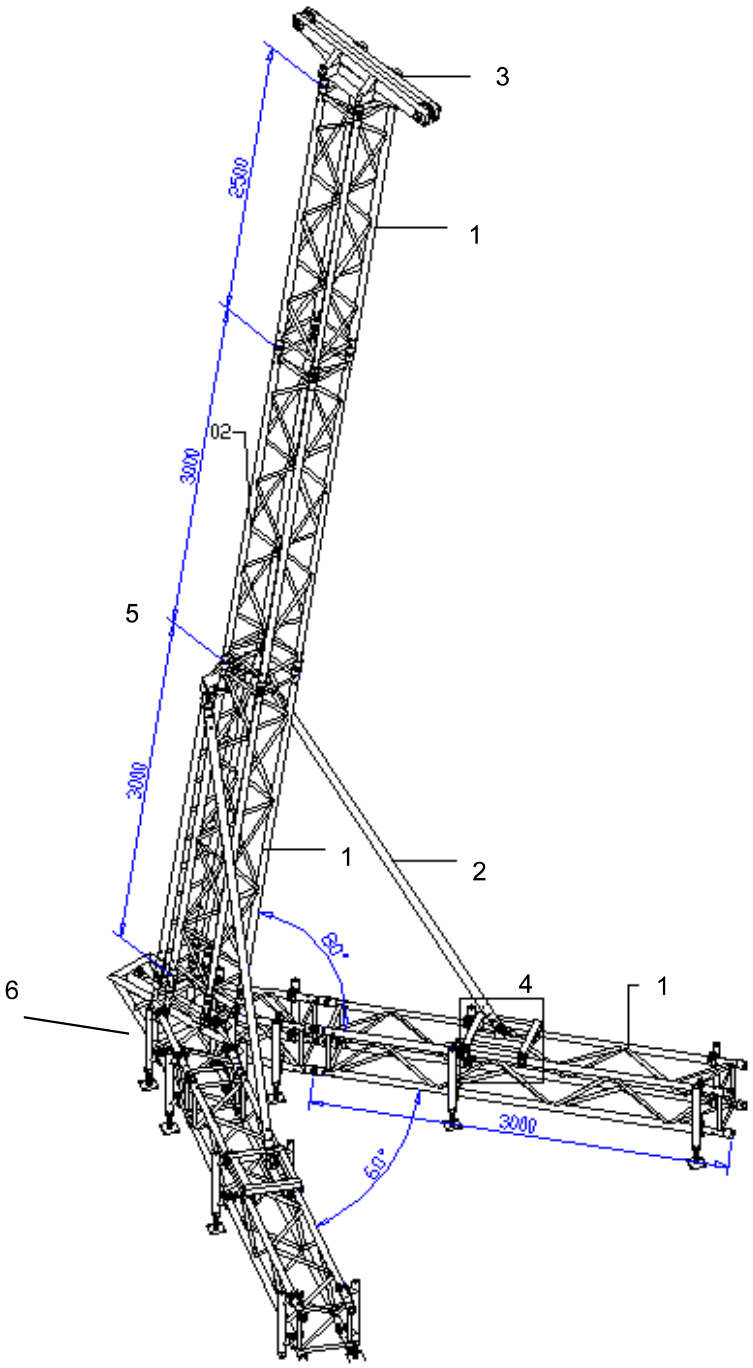
2 SYSTEM



Pos 1	Truss F44	Mainchords 50x4 mm Diagonals 25x3 mm	EN AW 6082 T6 EN AW 6082 T6
Pos 2	Diagonal-brace	Pipe 60x5 mm	EN AW 6082 T6
Pos 3 - 6	see following pages		

Pos 6 (V-corner) has to be braced additionally underneath the connection with a corner-plate (200x200x5 mm EN AW6082 T6) (see following page).

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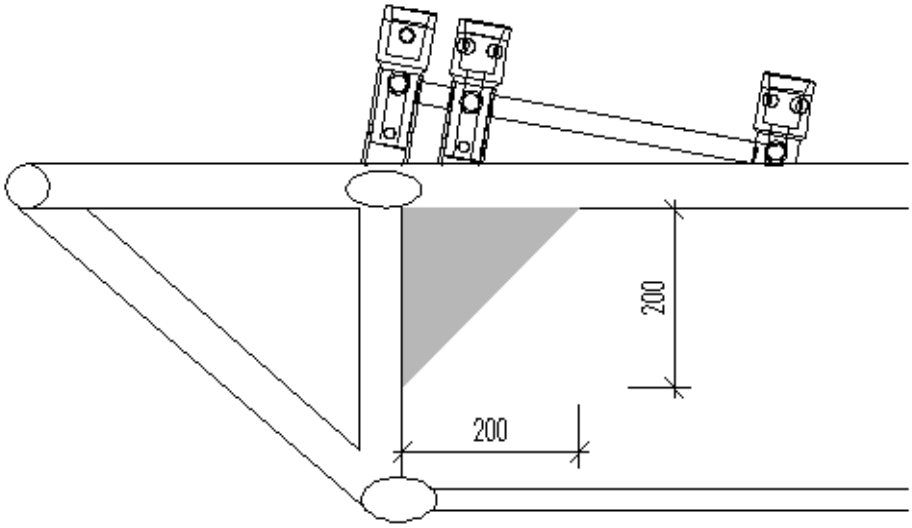
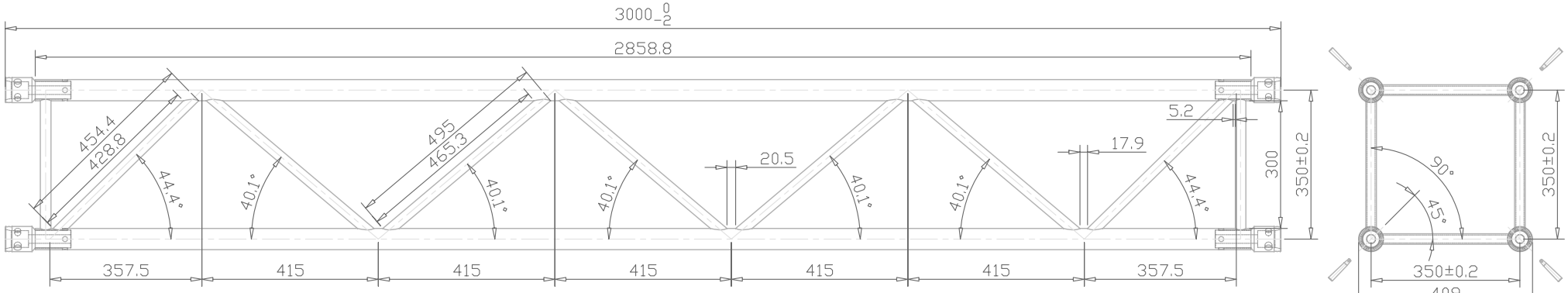
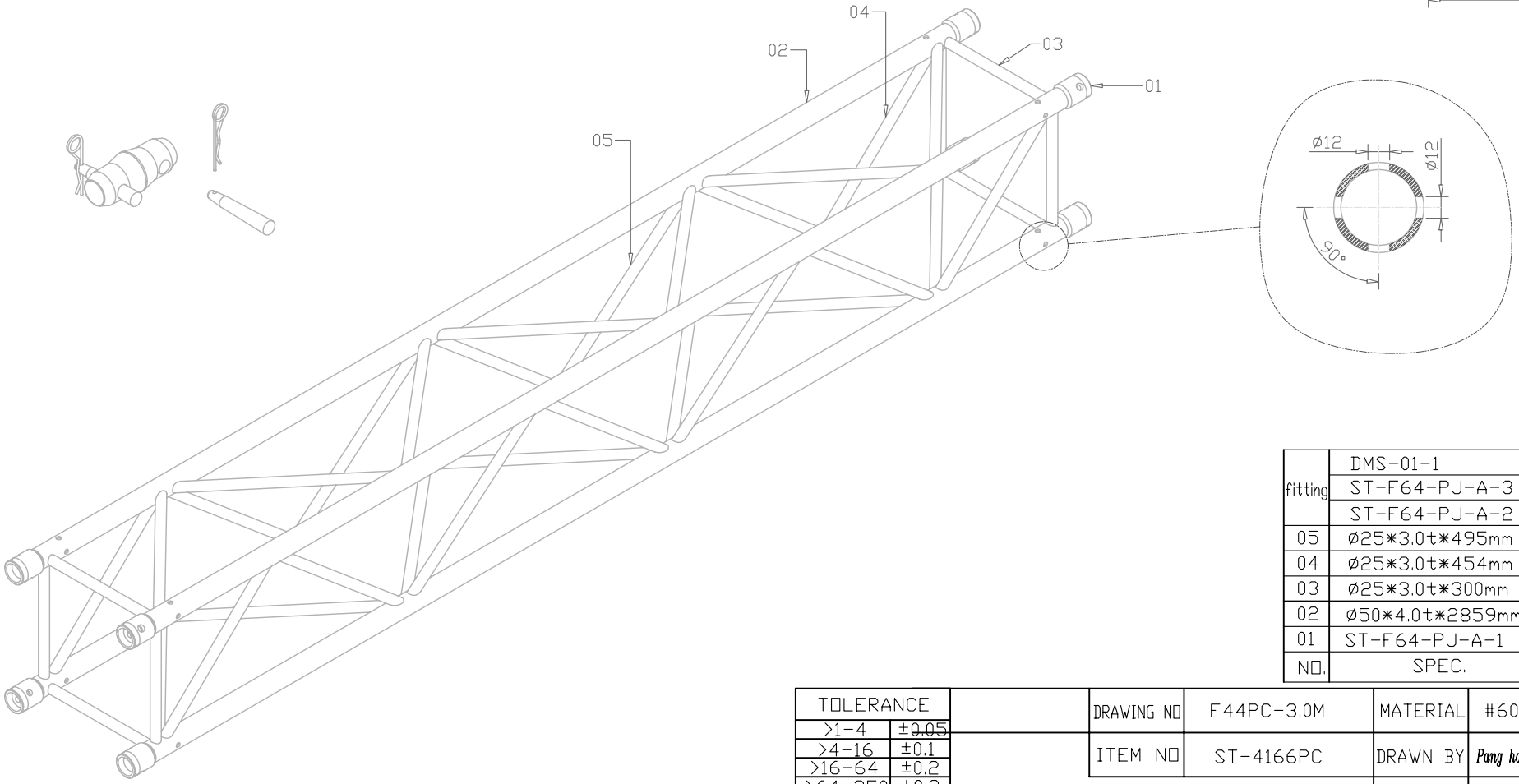
Cornerplate 200x200x5 mm underneath the rear coupling-connection of the tower.







fitting	DMS-01-1	steel	CP	8
	ST-F64-PJ-A-3	S45C	CP	8
	ST-F64-PJ-A-2	#2011	T6	4
05	ø25*3.0t*495mm	#6082	T6	20
04	ø25*3.0t*454mm	#6082	T6	8
03	ø25*3.0t*300mm	#6082	T6	8
02	ø50*4.0t*2859mm	#6082	T6	4
01	ST-F64-PJ-A-1	#6082	T6	8
NO.	SPEC.	MATERIAL	FIN.	QTY.

TOLERANCE	
>1-4	±0.05
>4-16	±0.1
>16-64	±0.2
>64-250	±0.3
>250-1000	±0.5
>1000-5000	±1.0
>5000-16000	±3.0
ANGULAR	±0.5°

DRAWING NO	F44PC-3.0M	MATERIAL	#6082	DATE	2008 07.17
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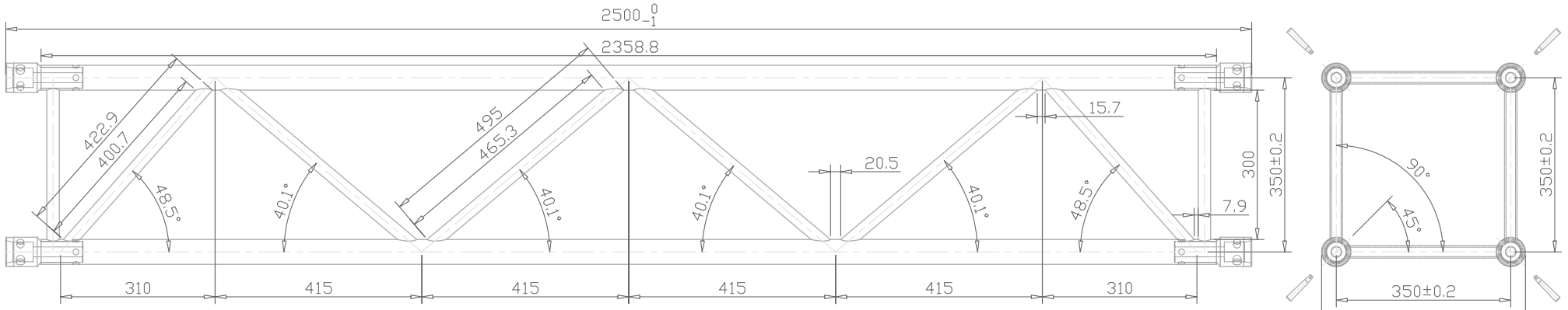
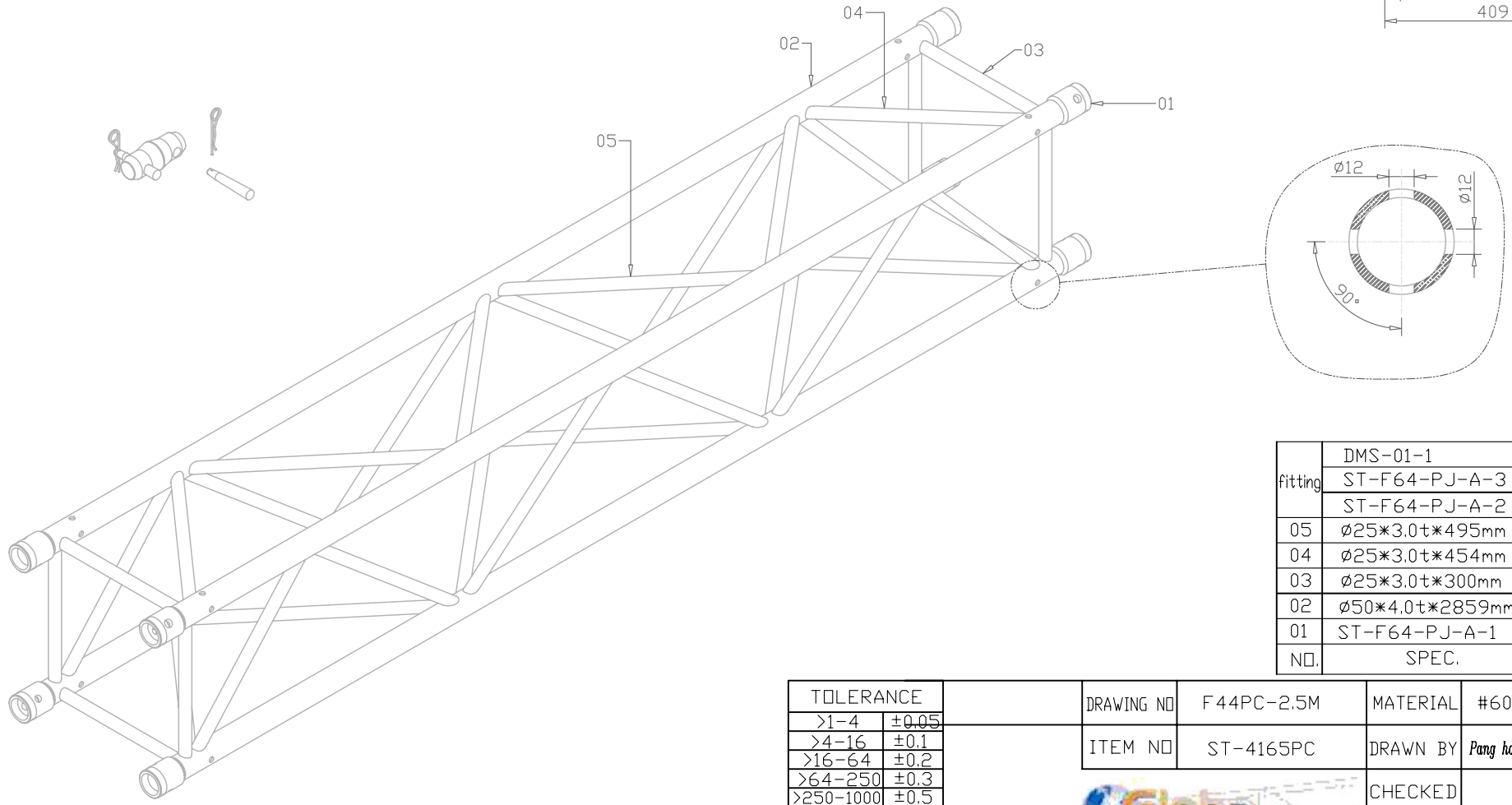
		APPROVED		SURFACE	RAW





fitting	DMS-01-1	steel	CP	8
	ST-F64-PJ-A-3	S45C	CP	8
	ST-F64-PJ-A-2	#2011	T6	4
05	ø25*3.0t*495mm	#6082	T6	20
04	ø25*3.0t*454mm	#6082	T6	8
03	ø25*3.0t*300mm	#6082	T6	8
02	ø50*4.0t*2859mm	#6082	T6	4
01	ST-F64-PJ-A-1	#6082	T6	8
NO.	SPEC.	MATERIAL	FIN.	QTY.

TOLERANCE	
>1-4	±0.05
>4-16	±0.1
>16-64	±0.2
>64-250	±0.3
>250-1000	±0.5
>1000-5000	±1.0
>5000-16000	±3.0
ANGULAR	±0.5°

DRAWING NO	F44PC-2.5M	MATERIAL	#6082	DATE	2008 07.17
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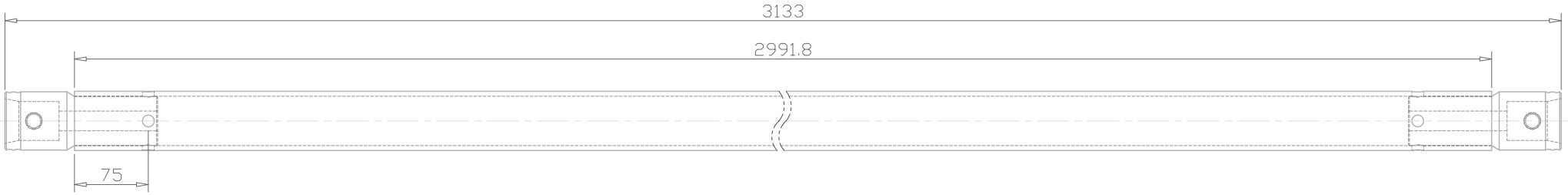

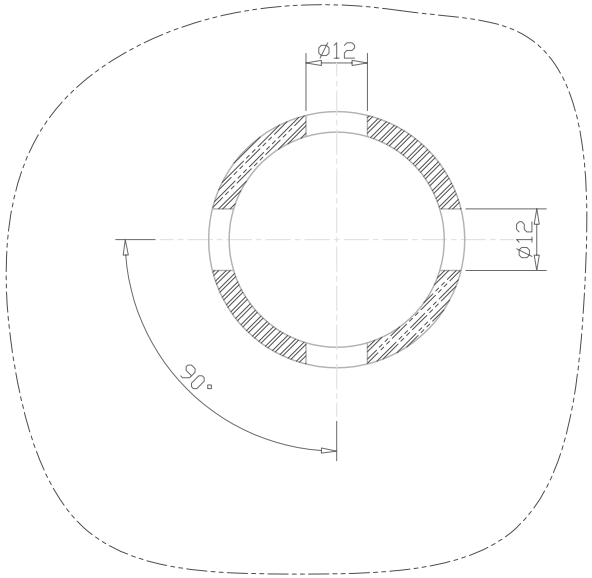

NO.	SPEC.	MATERIAL	FIN.	QTY.
02	ø60*5.0t*2992mm	#6082	T6	1
01	ST-F64-PJ-A-*	#6082	T6	2

TOLERANCE	
>1-4	±0.05
>4-16	±0.1
>16-64	±0.2
>64-250	±0.3
>250-1000	±0.5
>1000-5000	±1.0
>5000-16000	±3.0
ANGULAR	±0.5°

DRAWING NO	ø60*5.0t*3133L	MATERIAL	#6082	DATE	2008 07.17
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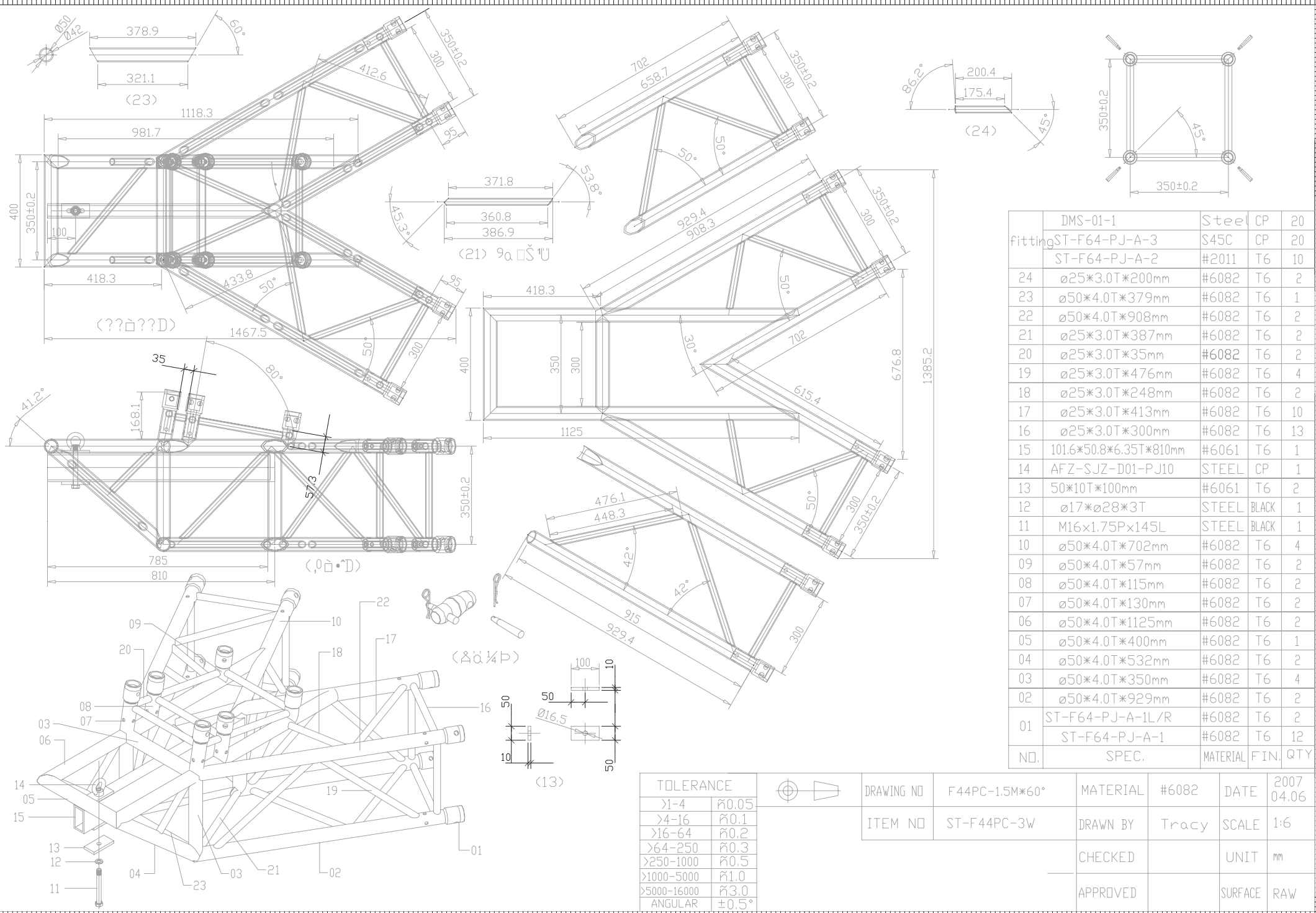
		CHECKED		UNIT	mm
		APPROVED		SURFACE	RAW



fitting	DMS-01-1	Steel	CP	20
	ST-F64-PJ-A-3	S45C	CP	20
	ST-F64-PJ-A-2	#2011	T6	10
24	ø25*3.0T*200mm	#6082	T6	2
23	ø50*4.0T*379mm	#6082	T6	1
22	ø50*4.0T*908mm	#6082	T6	2
21	ø25*3.0T*387mm	#6082	T6	2
20	ø25*3.0T*35mm	#6082	T6	2
19	ø25*3.0T*476mm	#6082	T6	4
18	ø25*3.0T*248mm	#6082	T6	2
17	ø25*3.0T*413mm	#6082	T6	10
16	ø25*3.0T*300mm	#6082	T6	13
15	101.6*50.8*6.35T*810mm	#6061	T6	1
14	AFZ-SJZ-D01-PJ10	STEEL	CP	1
13	50*10T*100mm	#6061	T6	2
12	ø17*ø28*3T	STEEL	BLACK	1
11	M16x1.75Px145L	STEEL	BLACK	1
10	ø50*4.0T*702mm	#6082	T6	4
09	ø50*4.0T*57mm	#6082	T6	2
08	ø50*4.0T*115mm	#6082	T6	2
07	ø50*4.0T*130mm	#6082	T6	2
06	ø50*4.0T*1125mm	#6082	T6	2
05	ø50*4.0T*400mm	#6082	T6	1
04	ø50*4.0T*532mm	#6082	T6	2
03	ø50*4.0T*350mm	#6082	T6	4
02	ø50*4.0T*929mm	#6082	T6	2
01	ST-F64-PJ-A-1L/R	#6082	T6	2
	ST-F64-PJ-A-1	#6082	T6	12
NO.	SPEC.	MATERIAL	FIN.	QTY

TOLERANCE	
>1-4	ñ0.05
>4-16	ñ0.1
>16-64	ñ0.2
>64-250	ñ0.3
>250-1000	ñ0.5
>1000-5000	ñ1.0
>5000-16000	ñ3.0
ANGULAR	±0.5°

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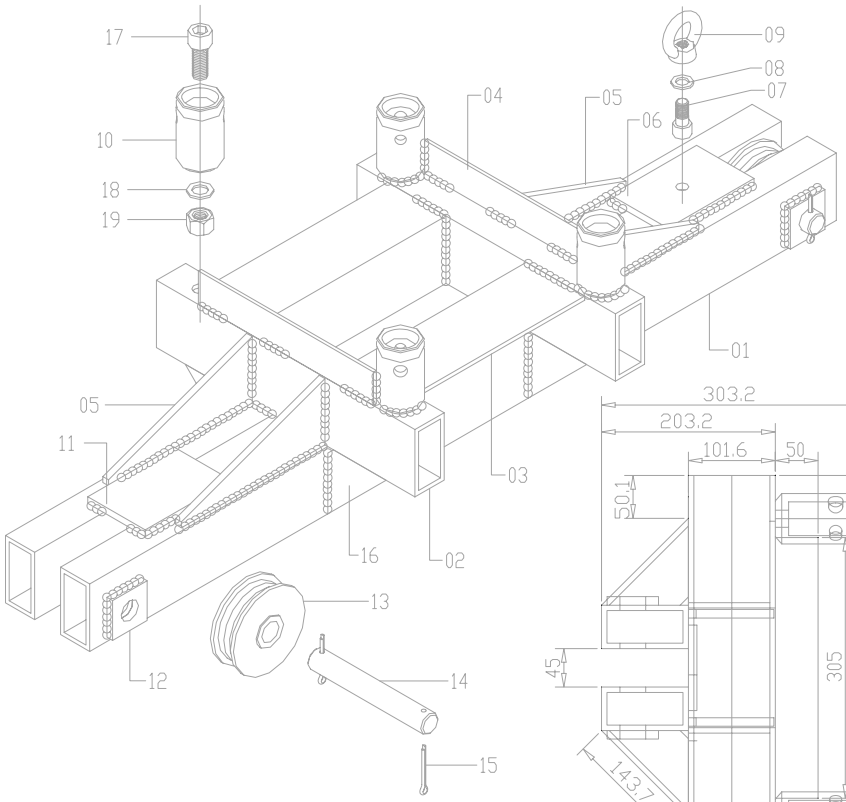
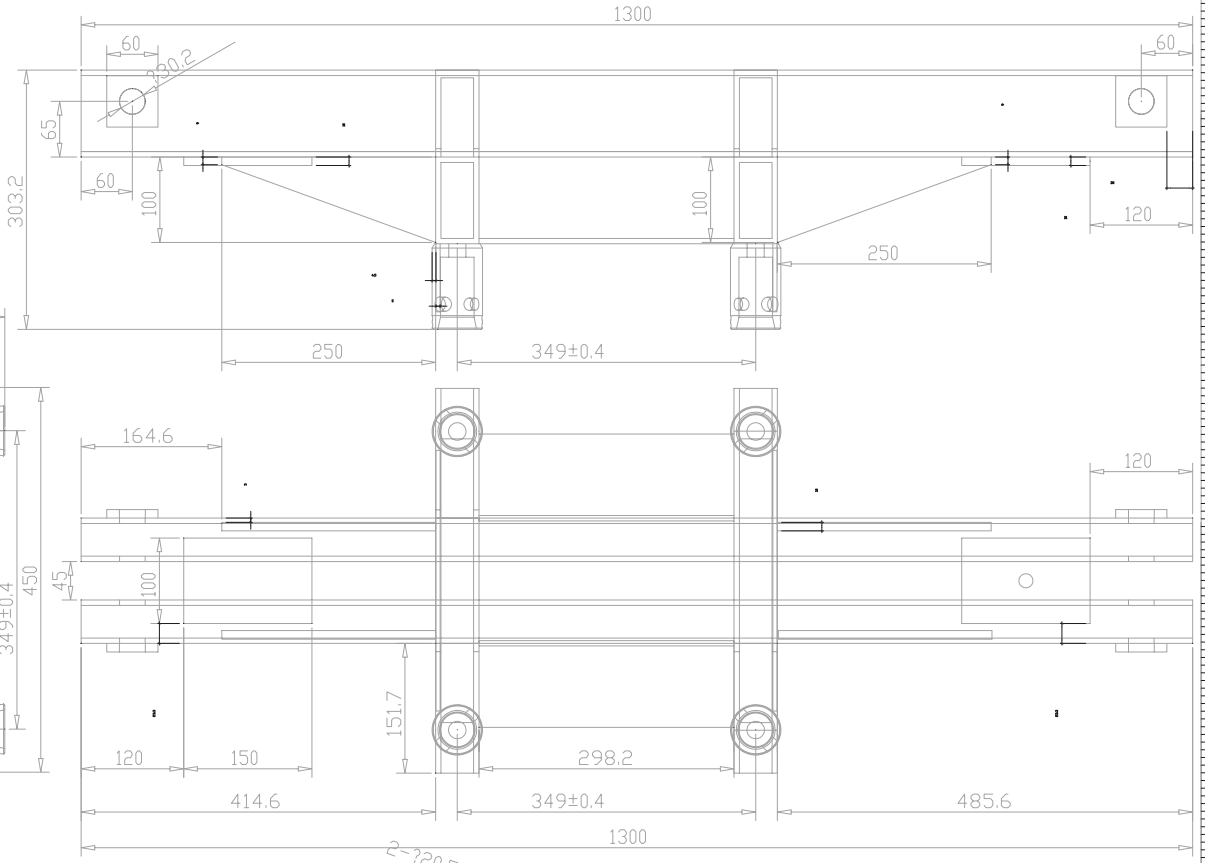
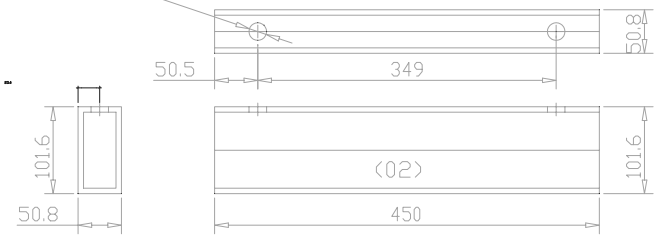
		APPROVED		SURFACE	RAW







NO.	SPEC.	MATERIAL	FIN.	QTY.
19	M16×1.75P×30L	Steel	Black	4
18	ø17×ø28×3.0T	Steel	Black	4
17	M16×1.75P×30L	Steel	Black	4
16	101.6×50.8×6.35T×145L	#6061	T6	4
15	ø5×73L	Steel	CP	4
14	ø30×200L	Steel	CP	2
13	AFZ-SJZ-D09-04	nylon		2
12	60*10T*60mm	#6061	T6	4
11	100*10T*150mm	#6061	T6	1
10	ST-F64-PJ-A-1F	#6061	T6	4
09	M20*2.0P(1.2Ton)	Steel	CP	1
08	ø20.2×ø33.8×5.1t	Steel	Black	1
07	M20×2.0P×45mm	Steel	Black	1
06	100*10T*150mm à??õ	#6061	T6	1
05	100×10T×250mm	#6061	T6	4
04	50*5.0T*305mm	#6061	T6	2
03	101.6*101.6*6.35T*298.2mm	#6061	T6	2
02	101.6×50.8×6.35T×450L	#6061	T6	2
01	101.6×50.8×6.35T×1300L	#6061	T6	2

TOLERANCE	
>1-4	ñ0.05
>4-16	ñ0.1
>16-64	ñ0.2
>64-250	ñ0.3
>250-1000	ñ0.5
>1000-5000	ñ1.0
>5000-16000	ñ3.0
ANGULAR°	

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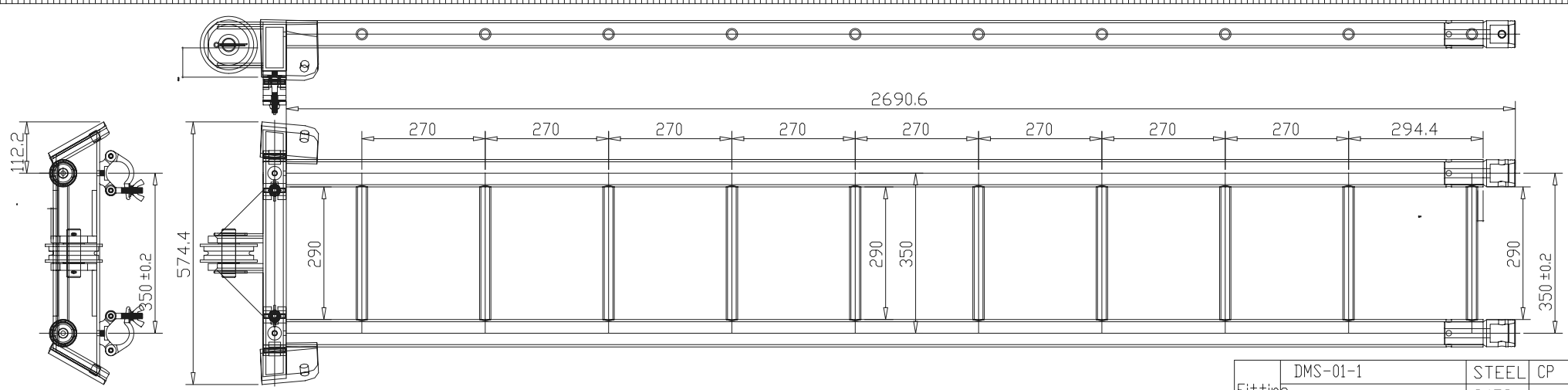
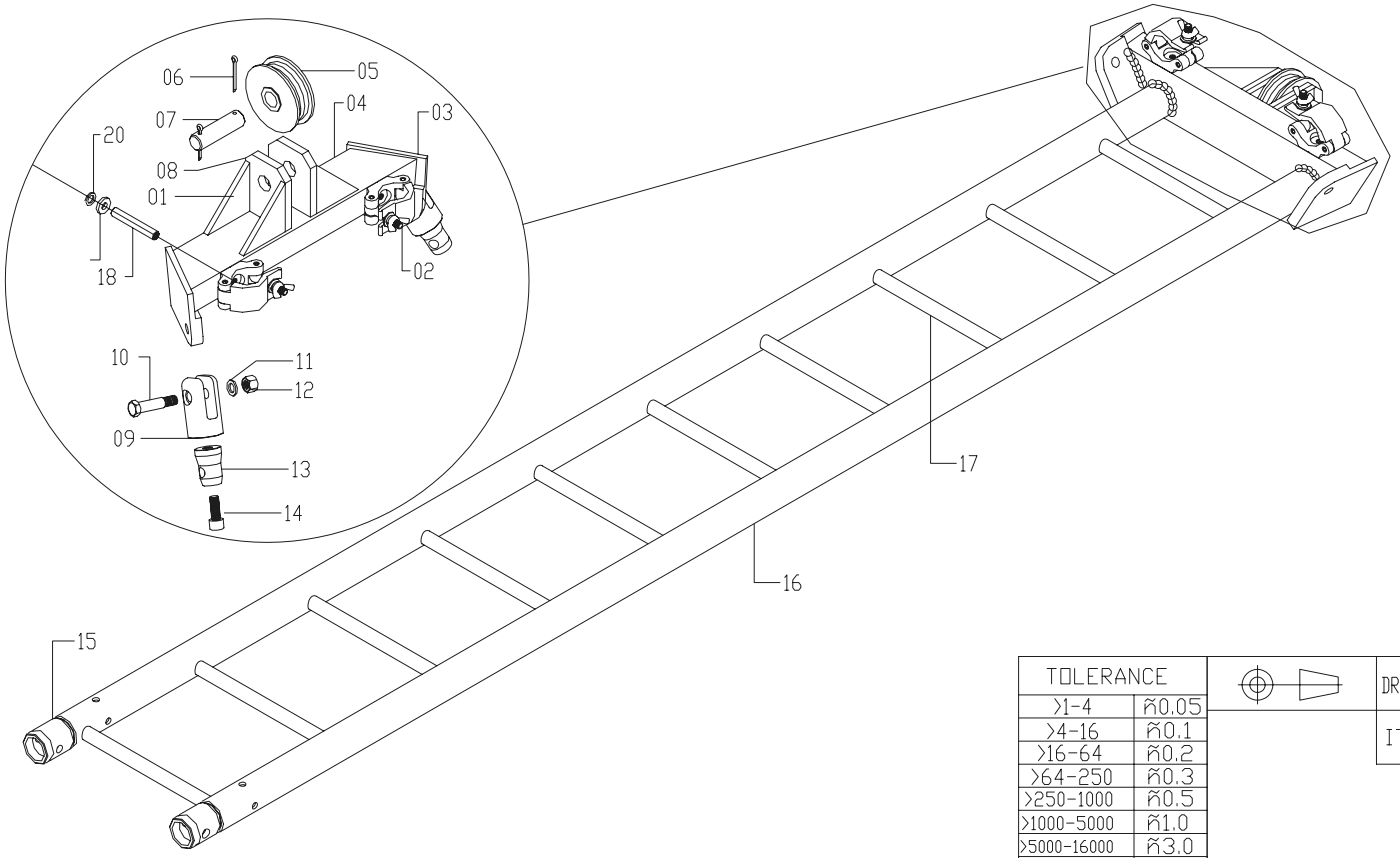
		APPROVED		SURFACE	RAW





Fitting	DMS-01-1	STEEL	CP	2
	ST-F64-PJ-A-3	S45C	CP	2
	ST-F64-PJ-A-2	#2011	T6	2
21	M12*1.75P*30mm	STEEL	BLACK	2
20	ø12.2*ø21.5*4.0t	STEEL	BLACK	2
19	ø13*ø30*5.0t	STEEL	BLACK	2
18	ø16*101mm-M12*1.75P	STEEL	BLACK	2
17	ø25*3.0t*290mm	#6082	T6	10
16	ø60*5.0t*2620mm	#6082	T6	2
15	ST-F64-PJ-A-*	#6082	T6	2
14	M16*2.0P*35mm	STEEL	BLACK	2
13	ST-F64-PJ-B-1	#2011	T6	2
12	M16*2.0P	STEEL	BLACK	2
11	ø17*ø30*3.0t	STEEL	BLACK	2
10	M16*2.0P*85mm	STEEL	BLACK	2
09	ST5029-B-01	#6061	T6	2
08	100*15t*120mm	#6061	T6	2
07	ø30*106mm	STEEL	CP	1
06	ø5x73L	STEEL	CP	2
05	AFZ-SJZ-D09-04		BLACK	1
04	AFZ-SJZ-D19-04	#6061	T6	1
03	AFZ-SZ-D19-03L/R	#6061	T6	2
02	ST-823C	#6061	T6	2
01	100*10t*100mm	#6061	T6	4
NO.	SPEC.	MATERIAL	FIN.	QTY

TOLERANCE	
>1-4	±0.05
>4-16	±0.1
>16-64	±0.2
>64-250	±0.3
>250-1000	±0.5
>1000-5000	±1.0
>5000-16000	±3.0
ANGULAR°	

DRAWING NO	YXJ-ZC02-09	MATERIAL	#6082	DATE	2008 0114
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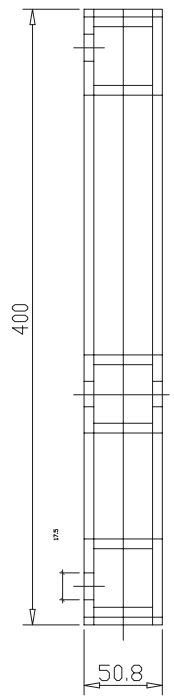
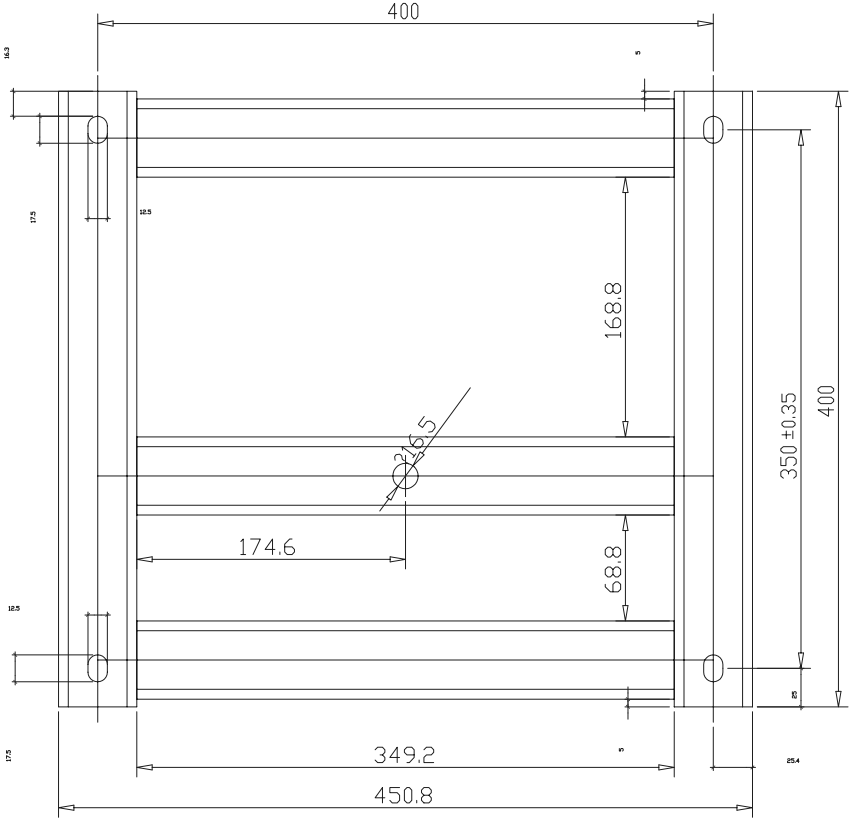
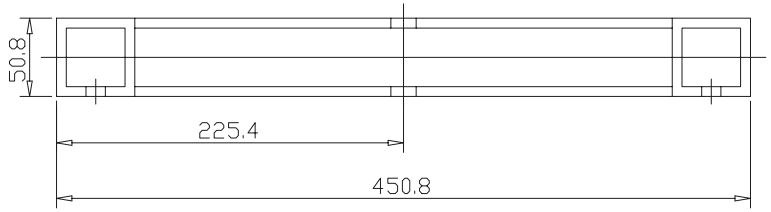
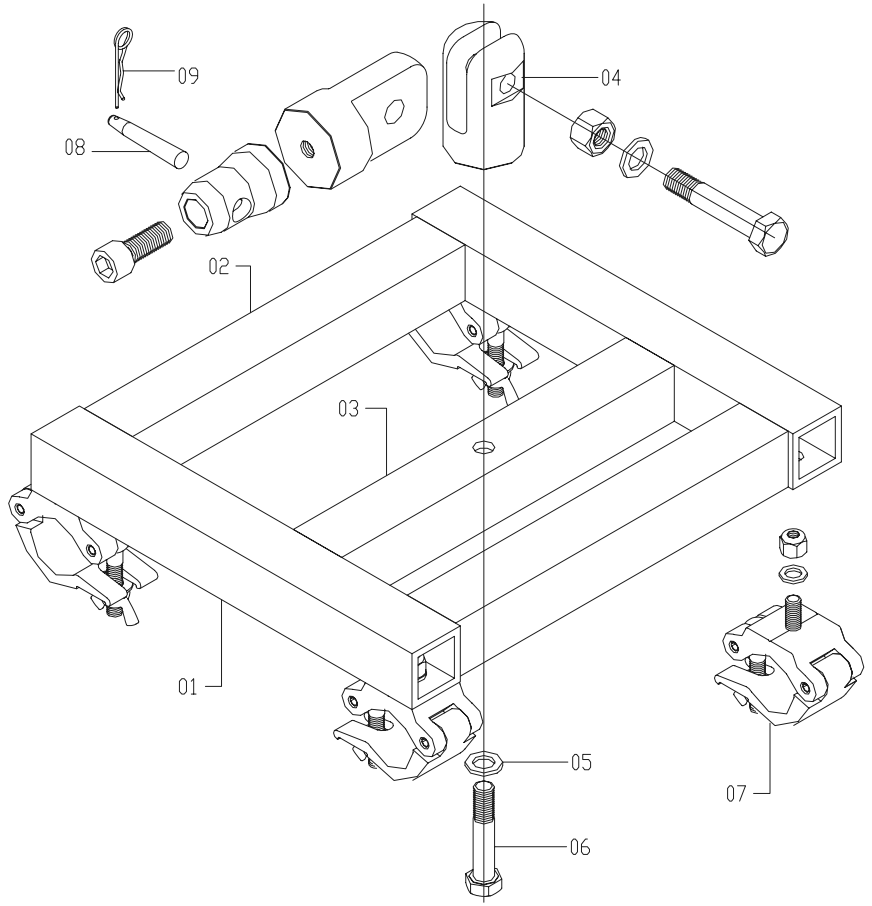
		APPROVED		SURFACE	RAW









NO.	SPEC.	MATERIAL	FIN.	QTY
09	DMS-01-1	Steel	CP	1
08	ST-F64-PJ-A-3	S45C	CP	1
07	ST-823C	#6061	T6	4
06	M16×2.0P×80L	STEEL	CP	1
05	ø17*ø30*3.0t	STEEL	CP	1
04	ST-5029-B1	#6061	T6	2
03	50.8×50.8×6.35t×349L	#6061	T6	1
02	50.8×50.8×6.35t×349L	#6061	T6	2
01	50.8×50.8×6.35t×400L	#6061	CP	2

TOLERANCE	
>1-4	±0.05
>4-16	±0.1
>16-64	±0.2
>64-250	±0.3
>250-1000	±0.5
>1000-5000	±1.0
>5000-16000	±3.0
ANGULAR°	±0.5

DRAWING NO		MATERIAL	#6082	DATE	2007 11.27
ITEM NO	YXJ-ZC02-07	DRAWN BY	Pang hong lei	SCALE	1:1
		CHECKED		UNIT	mm
		APPROVED		SURFACE	RAW

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3 LOADS

Selfweight and Payload

1. Selfweight F44: automatically in data processing
2. Pay-loads P = 10.5 kN

   In consideration of the dynamic factor P = 1.2 · 10.5 = 12.6 kN

Windloads

Following cases are analised according DIN 1055, part 4 (1987) and DIN 4112:

Loadcase operational state:

According DIN 4112 the following dynamic pressure can be applied, if the operation is shut down for windforce beaufort $ 8 (20.7 m/s (67.9 foot per second) (equivalent to downlifting the speakers)

For 0 ÷ 5.00 m above terrain q = 0,15 kN/m²

For > 5.00 m above terrain q = 0,25 kN/m²

Wind on speakers h > 5.00 m above terrain

Wind from rear in direction of cantilevers (+ X)

A = 3.8 m² cf = 1.3 => W = 1.3 · 3.8 · 0.25 < 1.25 kN

PA anchored to the rear => Load is distributed to 2 points towerhead and approx. towercenter.

Wind from front (- X)

W < 1.25 kN (see above)

Payload not anchored => Windload applied completely at the towerhead

Wind transverse to cantilever

A = 2.6 m² cf = 1.3 => W = 1.3 · 2.6 · 0.25 < 0.85 kN

Payload anchored to the sides => Load is distributed to 2 points towerhead and center of cantilever.

In case of up- or downlifting simultaneaously with wind half of the windload of the PA is applied (simplification, theoretical windload due to anchoring in the center =0)

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Wind on F44-Typ Tower

F44 **:** (Acc.. Tab. 8.2) :

d_1 = 5 cm, d = 40 cm,
A_u = 40 · 1.0 (cm) = 40 cm/cm
A = (5 · 2 + 2.5 / cos45°) · 1.0 = 13.54 cm/cm

Solidity of n = 40 / 13,54 = 0,34:

mit $d_1 \cdot q^{1/2}$ = $0.05 \cdot 0.25^{1/2}$ = 0.025 acc. fig. 9b and
l/d = 9.0 / 0.40 = 22.5 (Tab. 16.1) acc. fig. 14:

c_{f0} = 1.60ψ = 0.95 q_H = 0.40 · 0.34 · 0.95 · 1.60 · q = 0.21 x q

Up to windforce 8 < 5m : 0.21 · 0.15 = 0.032 kN/m
> 5m : 0.2 · 0.25 = 0.052 kN/m

Loadcase Operation shut down (windloads only on tower-construction)

Windloads on F44-Type acc. DIN 1055 Part4 analogue zu LC operational state

< 5m: 0,21 · 0,30 = 0,063 kN/m

< 8m: 0,21 · 0,50 = 0,105 kN/m

> 8m: 0,21 · 0,80 = 0,168 kN/m

Case b is not decisive, because it causes considerable lower internal forces:

For comparison:

Moment from wind only from PA at wf 8 M > 0,625 · 9,2 = 5,75 kNm

Moment from wind on F44

M = 0,063 ·5² / 2 + 0,105 · 3,0· 6,5 + 0,168 ·1,16· 8,58 = 4,50 kNm

Therefore case b is not further verificated.

Stabilisation-loads are negligible compared to the windloads.

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C Loadcases for data-processing (DP):

For verification of the tower the calculation are made according to the 2nd order theory.

Therefore the following loadcases are calculated with a safety factor of 1.7 acc. DIN 4113 and superposed.

LC 1	selfweight
LC 2	pay-load
LC 3	wind on truss from the front (+X)
LC 4	wind on truss from the rear (-X)
LC 5	wind on truss from the side (Y)
LC 6	wind on payload from the front
LC 7	wind on payload from the rear
LC 8	wind on payload from the side

Loadcases for calculation acc. 2nd order theory

Safety-factor acc. DIN 4113 (f = 1.7)

Operation without dynamic factor

LC 20	= 1.70 x (LC1 + LC12 + LC3 + LC6)
LC 21	= 1.70 x (LC1 + LC12 + LC4 + LC7)
LC 22	= 1.70 x (LC1 + LC12 + LC5 + LC8)

Operation without dynamic factor + half of the windload on payload

LC 23	= 1.70 x (LC1 + 1,2xLC12 + LC3 + 0.5xLC6)
LC 24	= 1.70 x (LC1 + 1,2xLC12 + LC4 + 0.5xLC7)
LC 25	= 1.70 x (LC1 + 1,2xLC12 + LC5 + 0.5x LC8)

For the documentaion of the results a combination of the loadcases LC20-25 is created in which each loadcase is defined as an exlusive variable load.

For the verifications acc. DIN 4112 the inner forces are reduced from the 1.7-fold loads to 1.0-fold loads (f = 1/1.7 = 0.588)

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4 CALCULATION / INTERNAL FORCES

Only the inner forces of loadcombination 100 are documented graphically.
Additionally the necessary inner forces for the verifications are documented tabularly.

For the verification of the tower -construction the tower-construction is generated as framework.

Bearings are calculated acc. 2nd order theory with failure in case of tractive force. .

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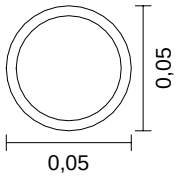
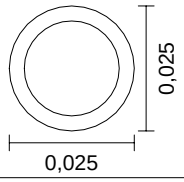
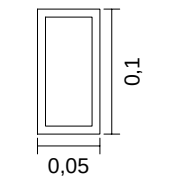
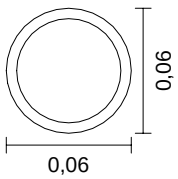
System characteristics

355	Nodes		
616	Elements	584	Beams
14	Supports	0	Slabs
7	Link elements	0	Plains
7	Material properties	32	Shells
7	Section properties	0	Cables
14	Load cases	0	Solids
1	LC Combinations	0	Spring elements
0	Tendon groups		

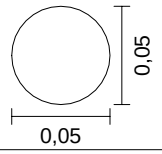
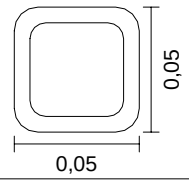
Result location in area elements: Node
2 Result locations in beam elements

Rotated element systems
26 Element systems
0 Internal force systems
0 Reinforcement systems

Section properties

1	Polygon 	50x4				
		Centroid [m]	ys	= -0,000	zs	= -0,000
		Area [m²]	A	= 5,7435e-04		
		Moments of inertia [m4]	Ix	= 3,0396e-07	Iyz	= 0,0000e+00
			Iy	= 1,5208e-07	I1	= 1,5208e-07
			Iz	= 1,5208e-07	I2	= 1,5208e-07
		Main axis angle [Grad]	Phi	= 0,000		
2	Polygon 	25x3				
		Centroid [m]	ys	= -0,000	zs	= -0,000
		Area [m²]	A	= 2,0602e-04		
		Moments of inertia [m4]	Ix	= 2,5217e-08	Iyz	= 0,0000e+00
			Iy	= 1,2614e-08	I1	= 1,2614e-08
			Iz	= 1,2614e-08	I2	= 1,2614e-08
		Main axis angle [Grad]	Phi	= 0,000		
3	Polygon 	100x50x6,3				
		Centroid [m]	ys	= -0,000	zs	= 0,075
		Area [m²]	A	= 1,7437e-03		
		Moments of inertia [m4]	Ix	= 1,6254e-06	Iyz	= 0,0000e+00
			Iy	= 2,0986e-06	I1	= 2,0986e-06
			Iz	= 6,6413e-07	I2	= 6,6413e-07
		Main axis angle [Grad]	Phi	= -0,000		
4	Polygon 	60x5				
		Centroid [m]	ys	= -0,000	zs	= -0,000
		Area [m²]	A	= 8,5840e-04		
		Moments of inertia [m4]	Ix	= 6,4990e-07	Iyz	= 0,0000e+00
			Iy	= 3,2517e-07	I1	= 3,2517e-07
			Iz	= 3,2517e-07	I2	= 3,2517e-07
		Main axis angle [Grad]	Phi	= 0,000		

Section properties

5	Area	Element thickness [m]	dz = 0,0050	torsion-free
		Orthotropy dzy/dz	= 1	
		E-Modulus slab/plain	= 1	
6	Polygon 	Centroid [m]	ys = -0,000	zs = 0,000
		Area [m²]	A = 1,9509e-03	
		Moments of inertia [m4]	Ix = 1,0000e-06	Iyz = 0,0000e+00
			Iy = 3,0288e-07	I1 = 3,0288e-07
			Iz = 3,0288e-07	I2 = 3,0288e-07
		Main axis angle [Grad]	Phi = 0,000	
9	Library se 	QRO 50 x 50 x 6,3 (MSH); 50x50x6,3		
		Centroid [m]	ys = 0,000	zs = 0,000
		Area [m²]	A = 1,0600e-03	
		Moments of inertia [m4]	Ix = 5,5200e-07	Iyz = 0,0000e+00
			Iy = 3,2800e-07	I1 = 3,2800e-07
			Iz = 3,2800e-07	I2 = 3,2800e-07
		Main axis angle [Grad]	Phi = 0,000	

Material properties

	No.	Type	E-Modu. [MN/m²]	G-Modu. [MN/m²]	Poiss. ratio	alpha.t [1/K]	gamma [kN/m³]
1	1	Frei	70000	27000	0,20	1,000e-05	27,000
2	2	Frei	70000	27000	0,20	1,000e-05	27,000
3	3	Frei	70000	27000	0,30	1,200e-05	27,000
4	4	Frei	700000	27000	0,20	1,000e-05	27,000
5	5	Frei	70000	10400	0,20	1,000e-05	27,000
6	6	Frei	70000	27000	0,20	1,000e-05	27,000
7	9	Frei	70000	27000	0,30	1,200e-05	27,000

Supports

	Node	Rotation around axis [°]			'F' = fixed, '-' = free or coeff. of resilience [MN/m] and/or [MNm]						Ter
	1	x	y	z	ux	uy	uz	phi.x	phi.y	phi.z	lc
1	1000	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
2	1001	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
3	1002	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
4	1003	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
5	1010	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
6	1011	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
7	1012	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
8	1013	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
9	1021	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
10	1022	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
11	1023	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
12	1031	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
13	1032	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z
14	1033	0,0	0,0	0,0	0,10	0,10	F	-	-	-	L:z

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Link elements

	Depen. Node	Degr. free.	No.	Related node and factors for degrees of freedom ux	uy	uz	phi.x	phi.y	phi.z
1	97	SS	74						
2	100	SS	77						
3	104	SS	78						
4	113	SS	18						
5	117	SS	94						
6	128	SS	27						
7	256	SS	34						

SS Stiff link element

List of load cases

LC.	Label
1	g
2	Nutzlast
3	wind +x
4	Wind -x
5	Wind y
6	Wind PA +x
7	Wind PA -x
8	Wind PA y
20	Th II.O LF1+2+3+6
21	TH II.O LF1+2+4+7
22	Th II.O LF1+2+5+8
23	Th II.O LF1+1,2x2+3+0,5x6
24	Th II.O LF1+1,2x2+4+0,5x7
25	Th II.O LF1+1,2x2+5+0,5x8

Load case combination 100

1. Variable exclusive action		Factor
20	Th II.O LF1+2+3+6	0,588
21	TH II.O LF1+2+4+7	0,588
22	Th II.O LF1+2+5+8	0,588
23	Th II.O LF1+1,2x2+3+0,5x6	0,588
24	Th II.O LF1+1,2x2+4+0,5x7	0,588
25	Th II.O LF1+1,2x2+5+0,5x8	0,588

Sum of installed loads and support reactions

LC.	Label	Fx [kN]	Fy [kN]	Fz [kN]
1	g	-0,000	0,000	2,368
	Support reactions	-0,000	0,000	2,368
2	Nutzlast	0,000	0,000	10,500
	Support reactions	-0,000	0,000	10,500

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Sum of installed loads and support reactions

LC.	Label	Fx [kN]	Fy [kN]	Fz [kN]
3	wind +x	0,340	0,000	0,060
	Support reactions	0,340	0,000	0,060
4	Wind -x	-0,340	-0,000	-0,060
	Support reactions	-0,340	-0,000	-0,060
5	Wind y	0,000	0,356	0,000
	Support reactions	0,000	0,356	-0,000
6	Wind PA +x	1,240	0,000	0,000
	Support reactions	1,240	0,000	0,000
7	Wind PA -x	-1,250	0,000	0,000
	Support reactions	-1,250	-0,000	-0,000
8	Wind PA y	0,000	0,425	0,000
	Support reactions	0,000	0,425	-0,000
20	Th II.O LF1+2+3+6	2,686	0,000	21,977
	Support reactions	2,686	-0,000	21,977
21	TH II.O LF1+2+4+7	-2,703	0,000	21,774
	Support reactions	-2,703	0,000	21,774
22	Th II.O LF1+2+5+8	-0,000	1,328	21,875
	Support reactions	0,000	1,328	21,875
23	Th II.O LF1+1,2x2+3+0,5x6	1,632	0,000	25,547
	Support reactions	1,632	-0,000	25,547
24	Th II.O LF1+1,2x2+4+0,5x7	-1,641	0,000	25,344
	Support reactions	-1,641	0,000	25,344
25	Th II.O LF1+1,2x2+5+0,5x8	0,000	0,967	25,445
	Support reactions	0,000	0,967	25,445

Location of load resultant

	Load c.	x [m]	y [m]	z [m]
1	1	1,26	0,20	0,00
2	2	2,37	0,20	0,00
3	3	0,00	0,20	-5,56
4	4	0,00	0,20	-5,56
5	5	1,09	0,00	-5,31
6	6	0,00	0,20	-6,26
7	7	0,00	0,20	-9,16
8	8	2,37	0,00	-9,16
9	20	2,90	0,20	0,00
10	21	1,13	0,20	0,00
11	22	2,16	0,65	0,00
12	23	2,57	0,20	0,00

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Location of load resultant

	Load c.	x [m]	y [m]	z [m]
13	24	1,69	0,20	0,00
14	25	2,19	0,46	0,00

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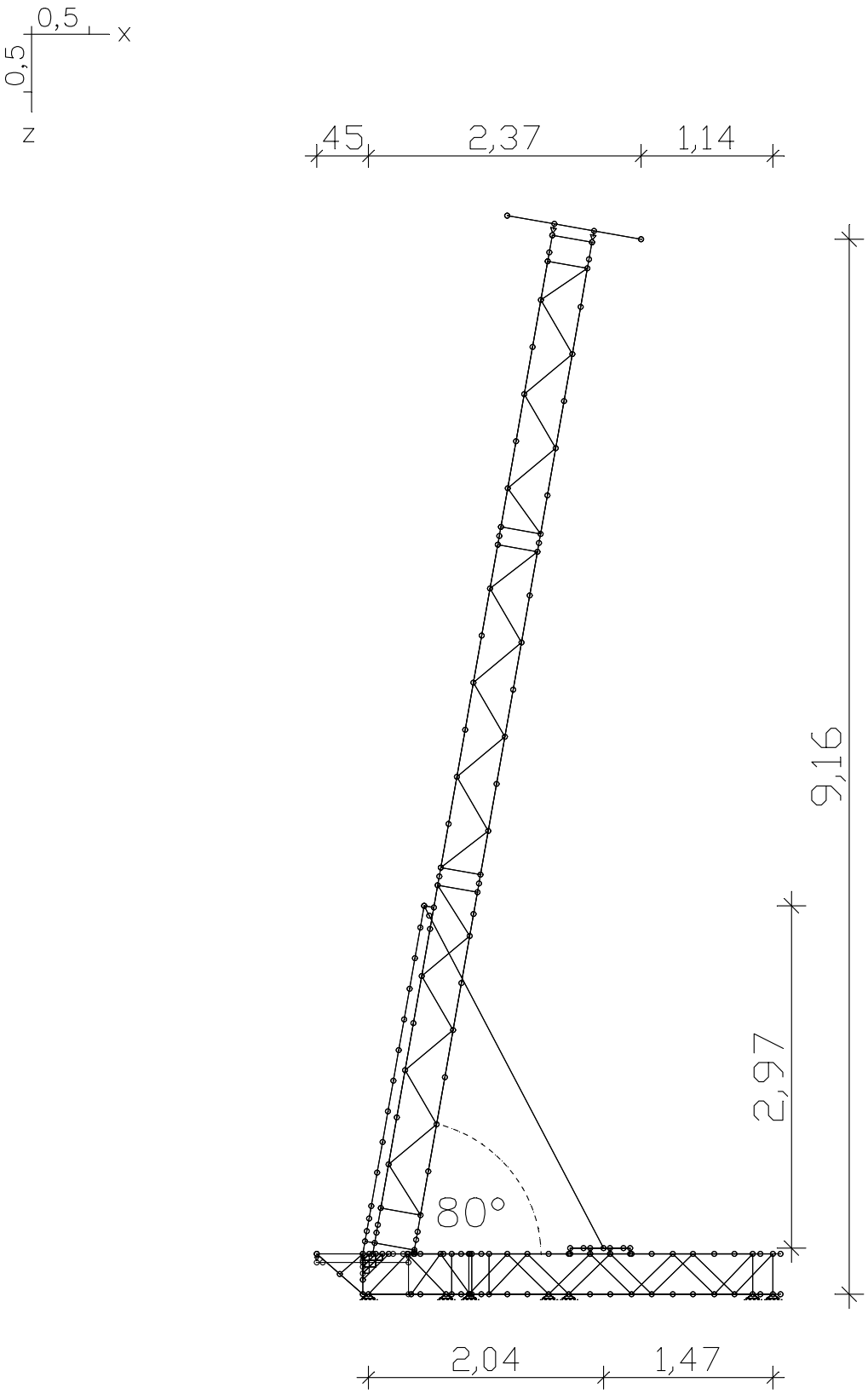
Bem-XZ

M 1 : 56



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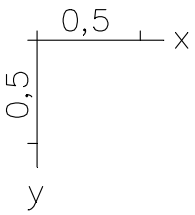
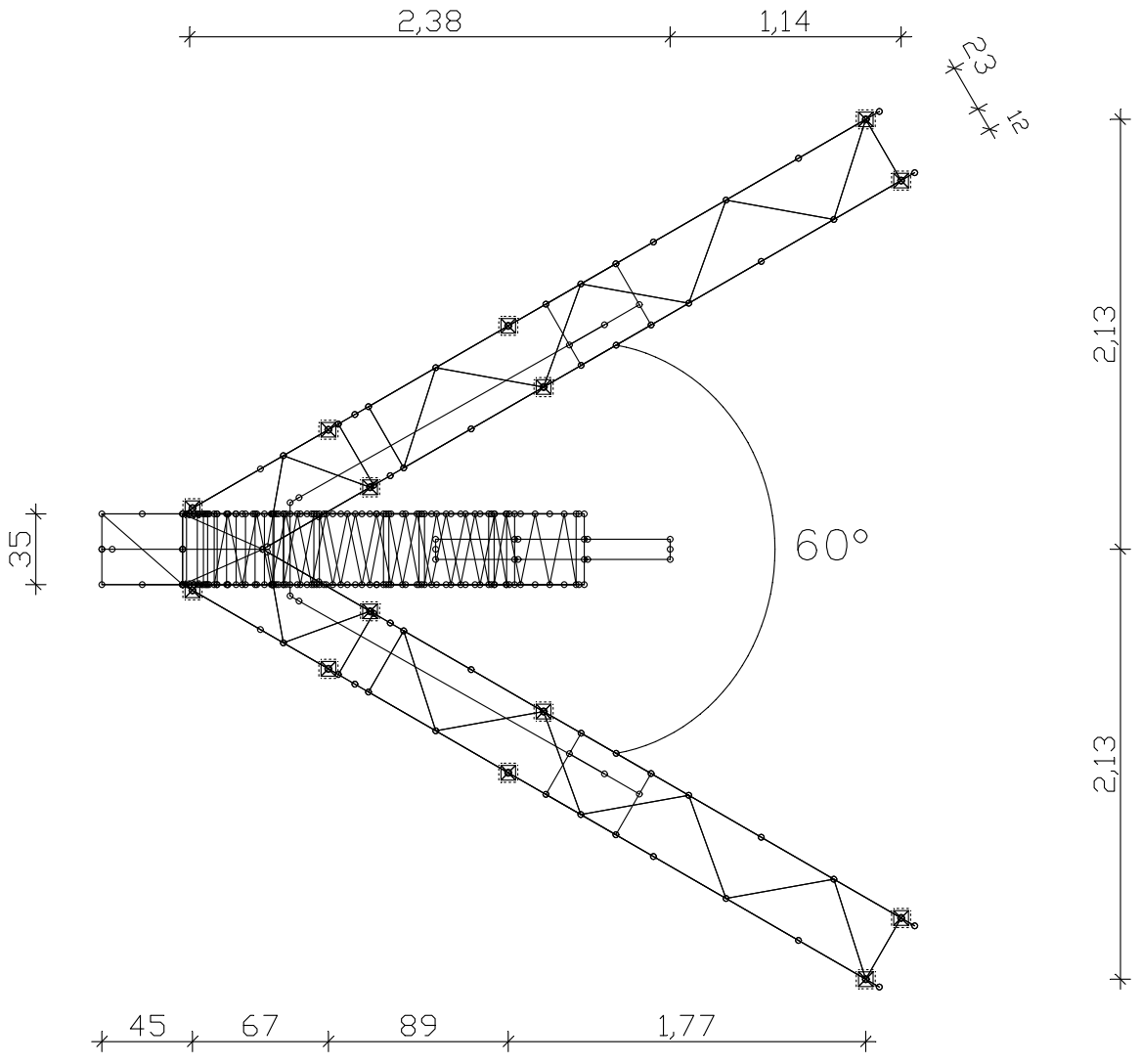
Bem-XY

M 1 : 37



Vermaßung Hängepunkt Nutzlast zu Auflager



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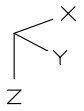
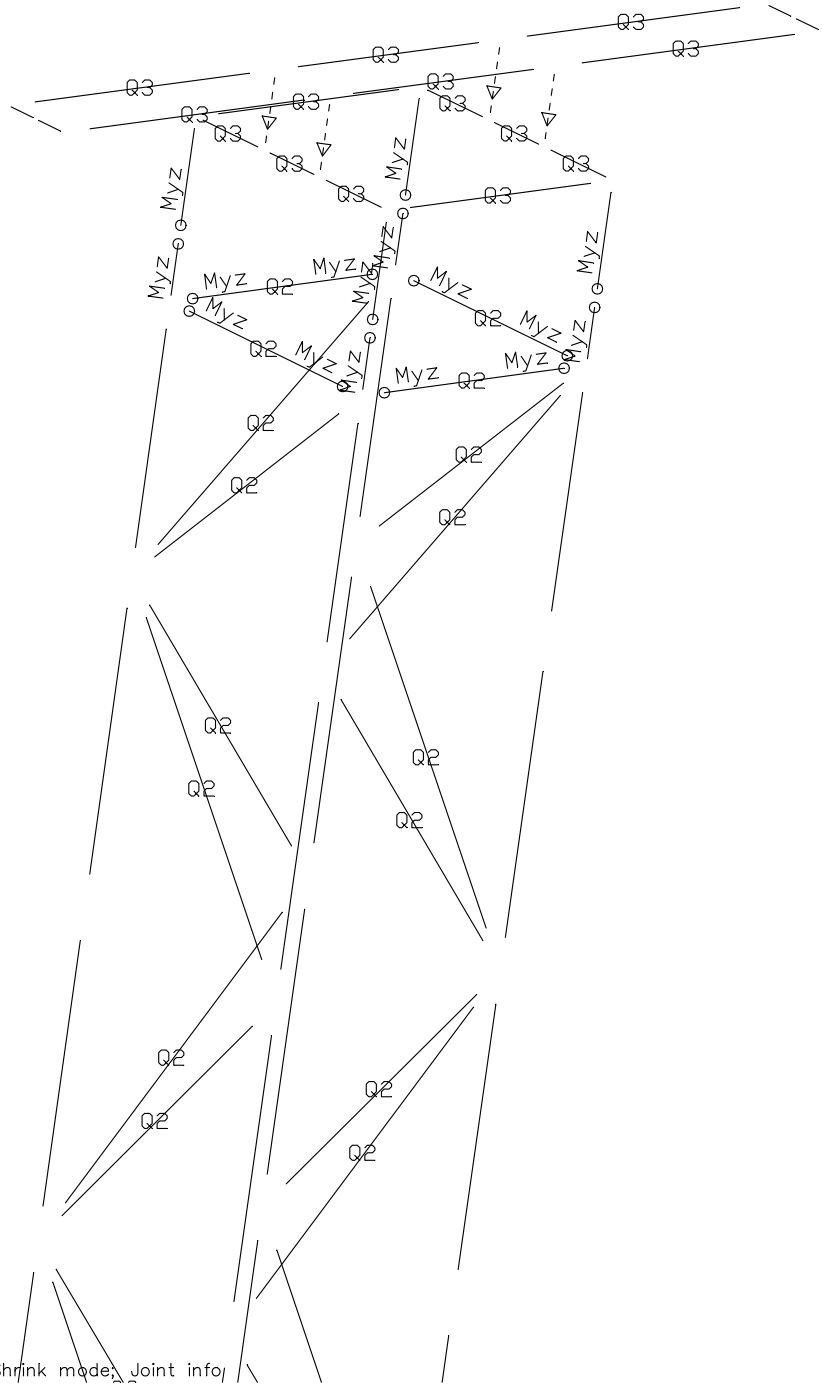
Querschnittsnummern (>1); Schrumpfdarstellung; Gelenkinfo

M 1 : 9





Section numbers (>1); Shrink mode; Joint info

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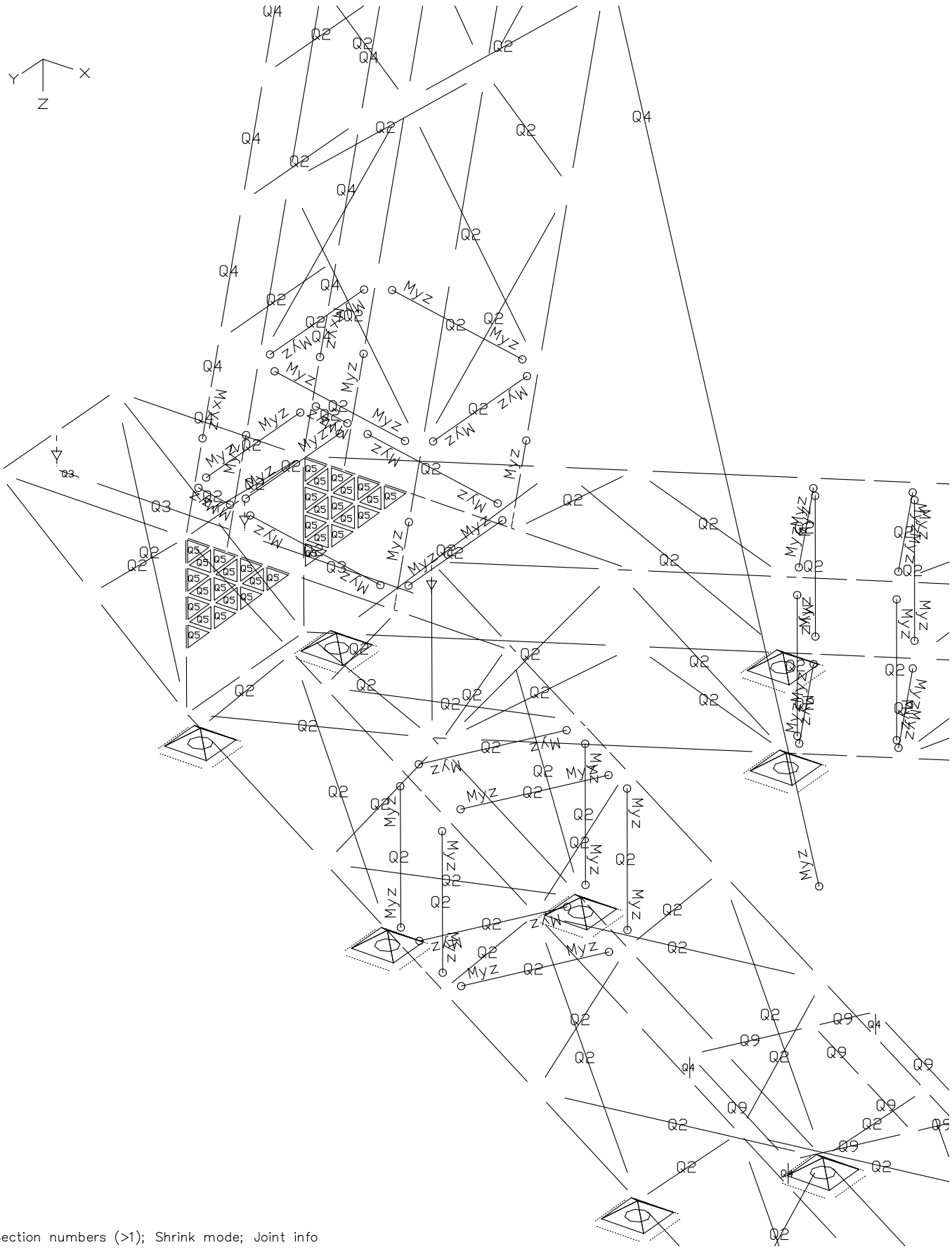
M 1 : 9



Section numbers (>1); Shrink mode; Joint info

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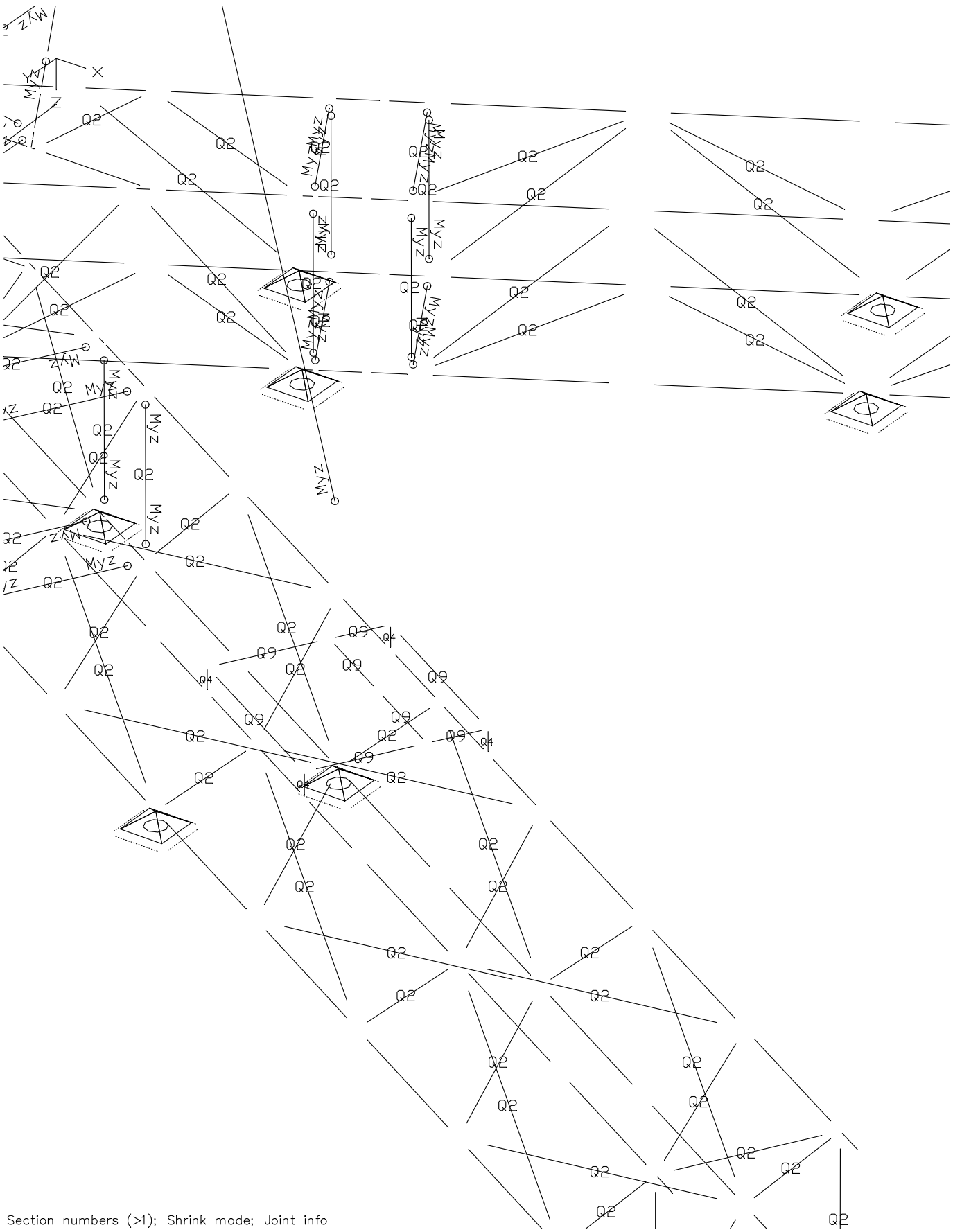
Querschnittsnummern (>1); Schrumpfdarstellung; Gelenkinfo

M 1 : 9



Section numbers (>1); Shrink mode; Joint info

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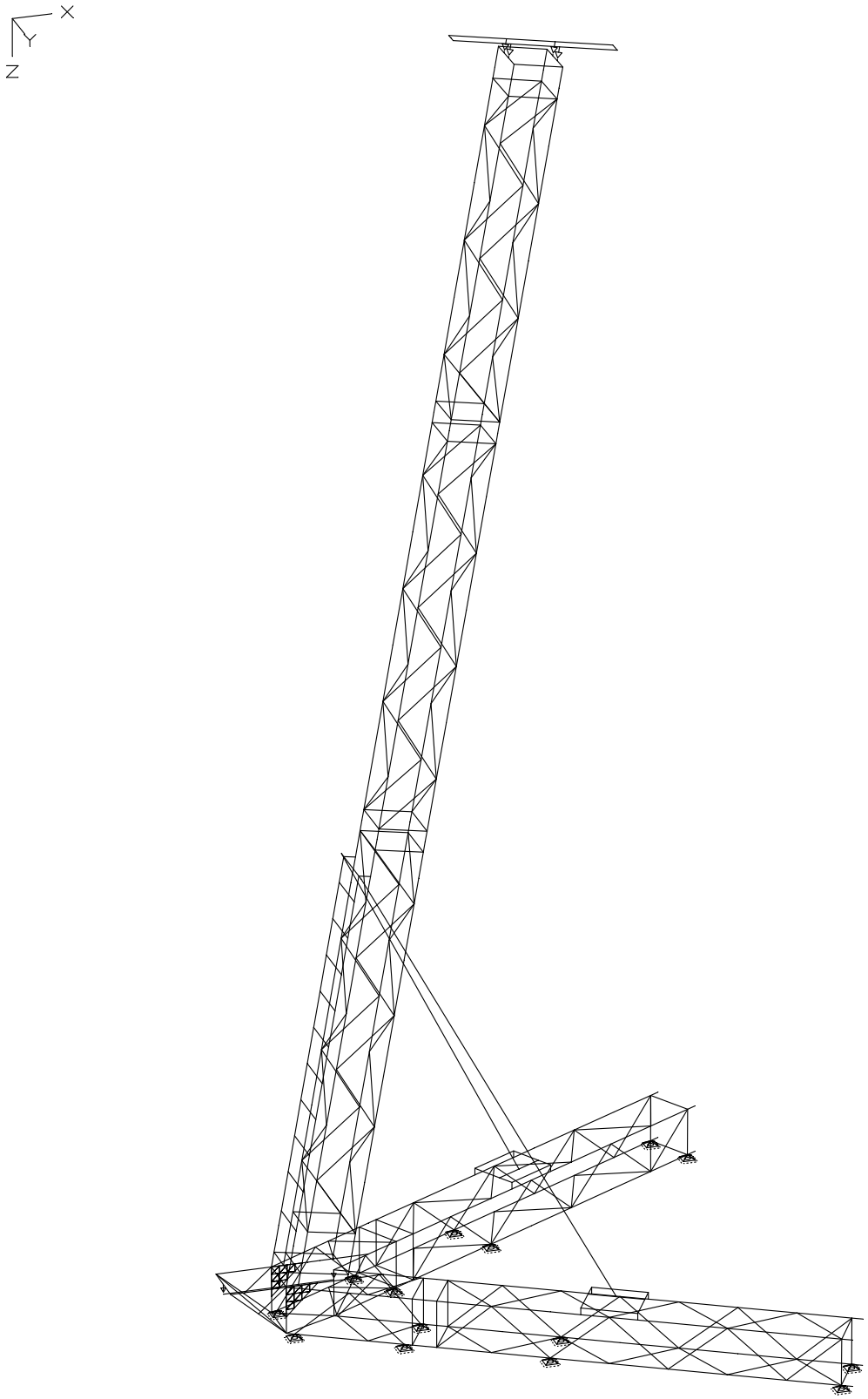
LF 1: Belastung, g

M 1 : 45

DEAD LOAD



LC 1: Load, g

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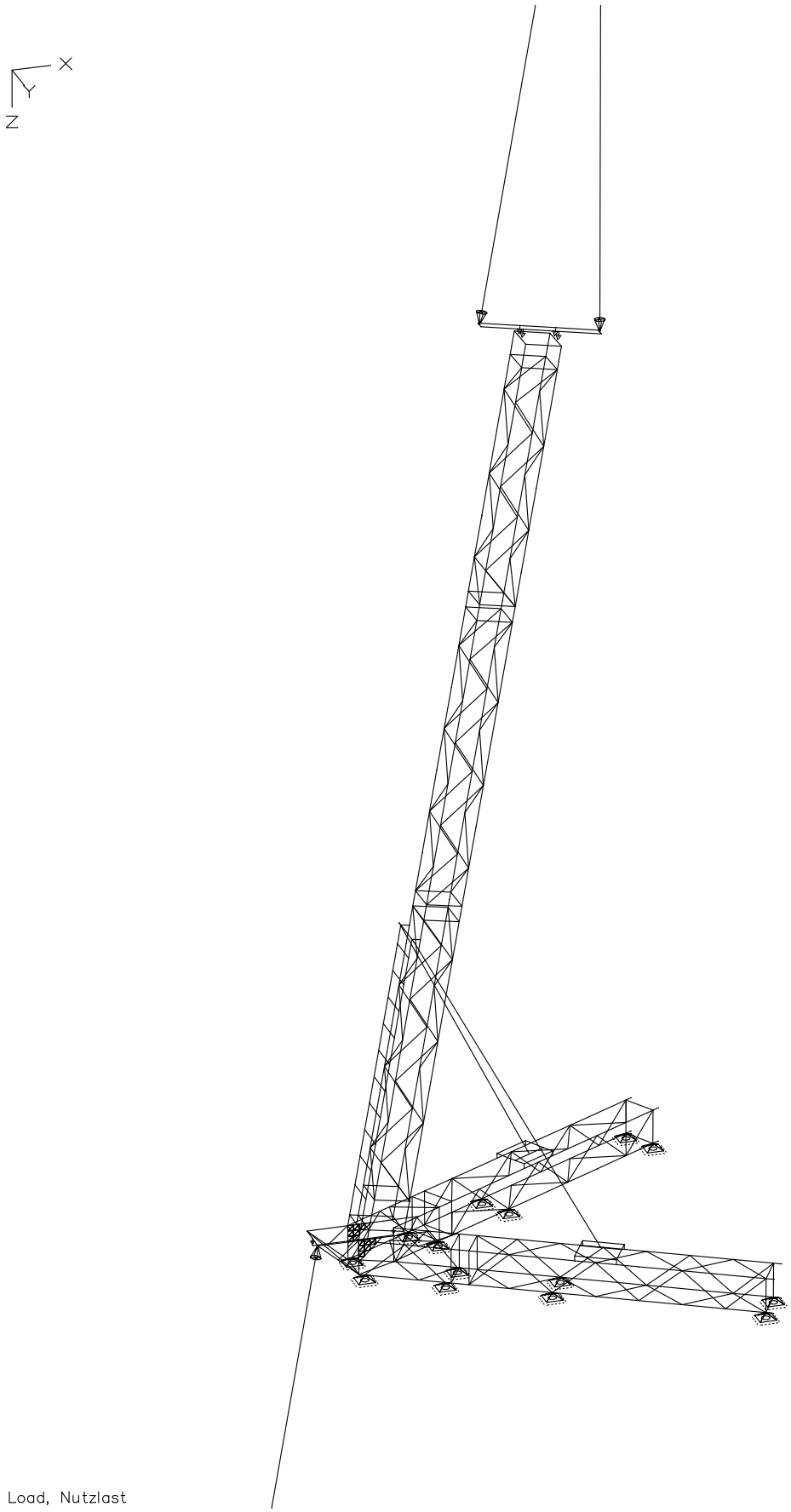
0955 - PA Tower Global Truss

LF 2: Belastung, Nutzlast

M 1 : 60



LC 2: Load, Nutzlast

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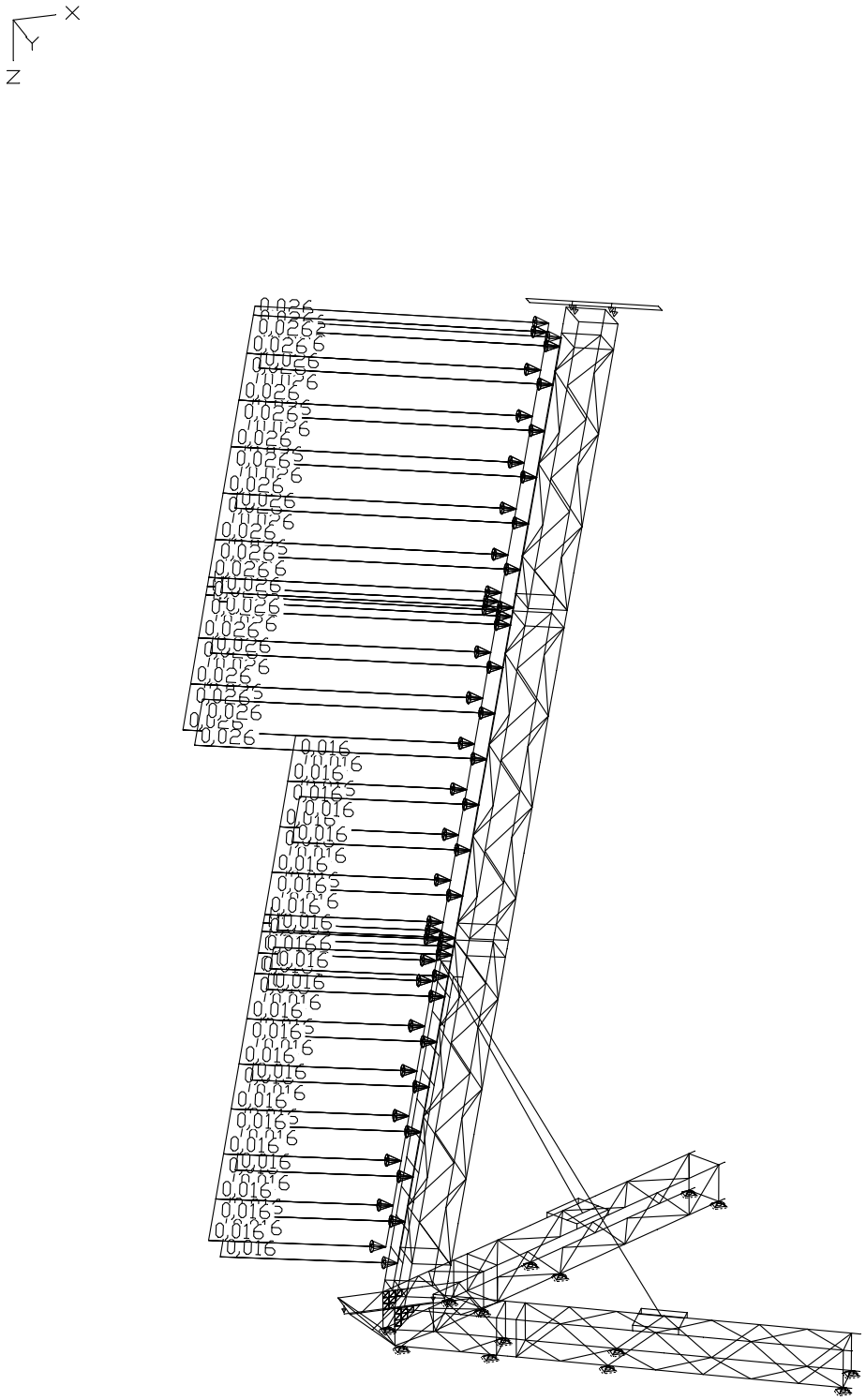
LF 3: Belastung, wind +x

M 1 : 60



LC 3: Load, wind +x

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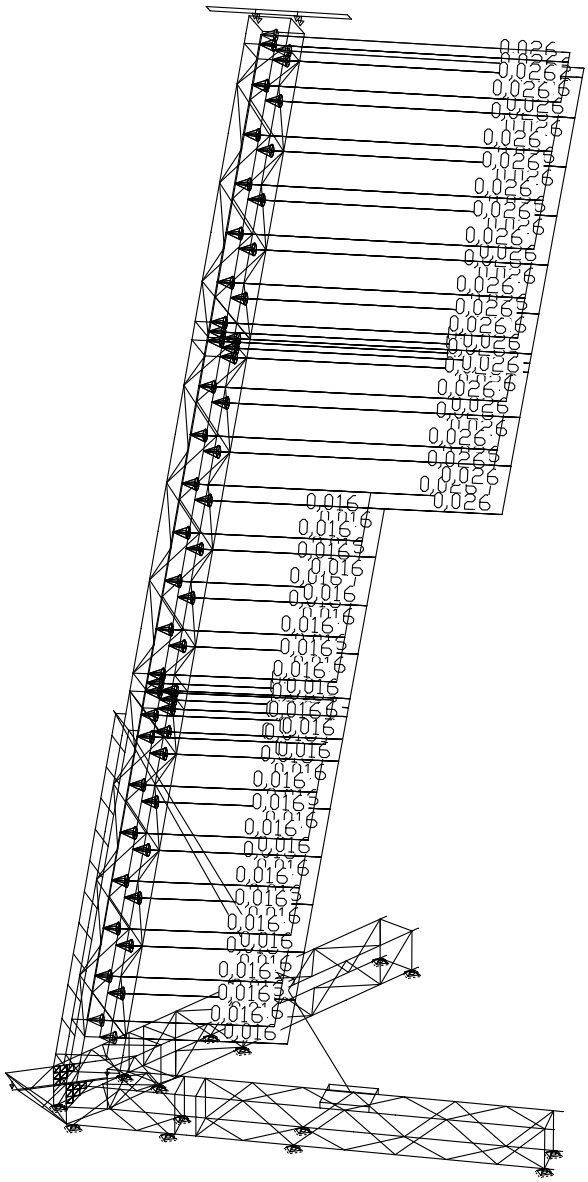
LF 4: Belastung, Wind -x

M 1 : 60



LC 4: Load, Wind -x

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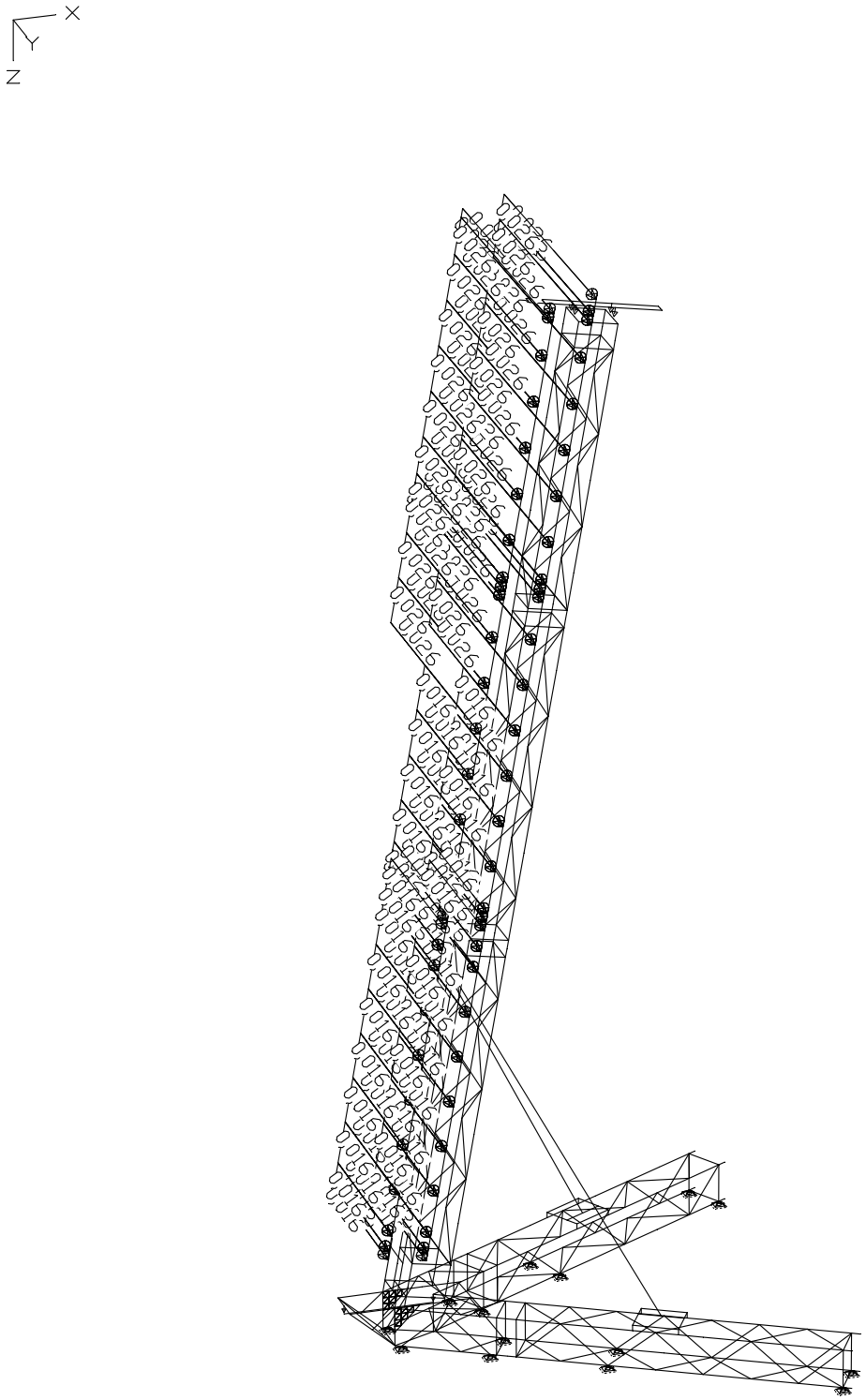
LF 5: Belastung, Wind y

M 1 : 60



LC 5: Load, Wind y

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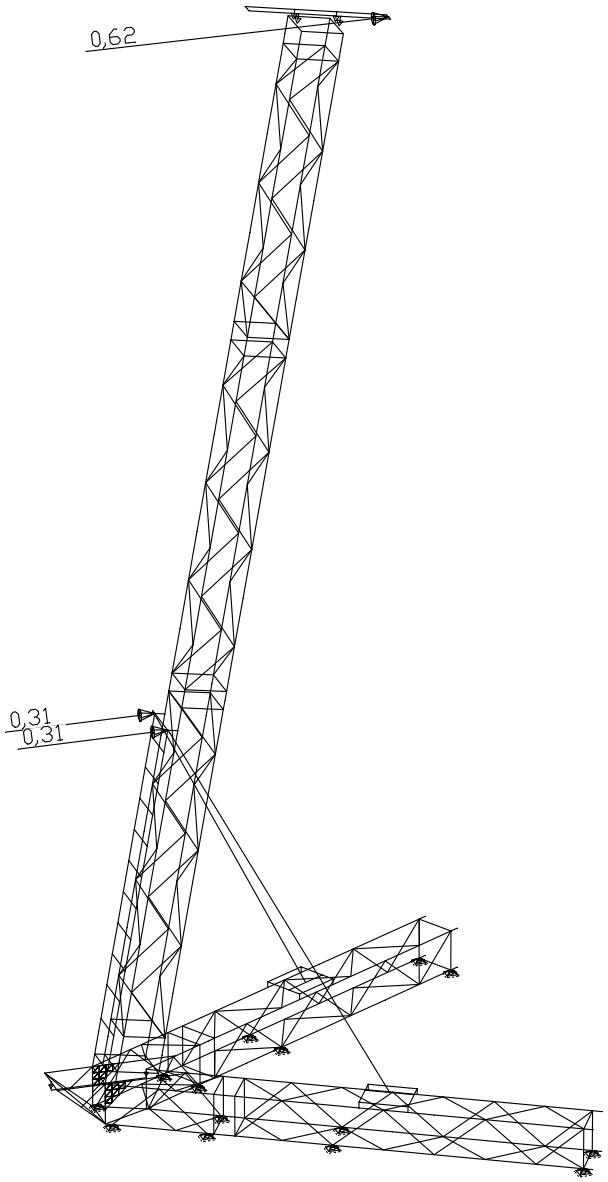
LF 6: Belastung, Wind PA +x

M 1 : 60



LC 6: Load, Wind PA +x

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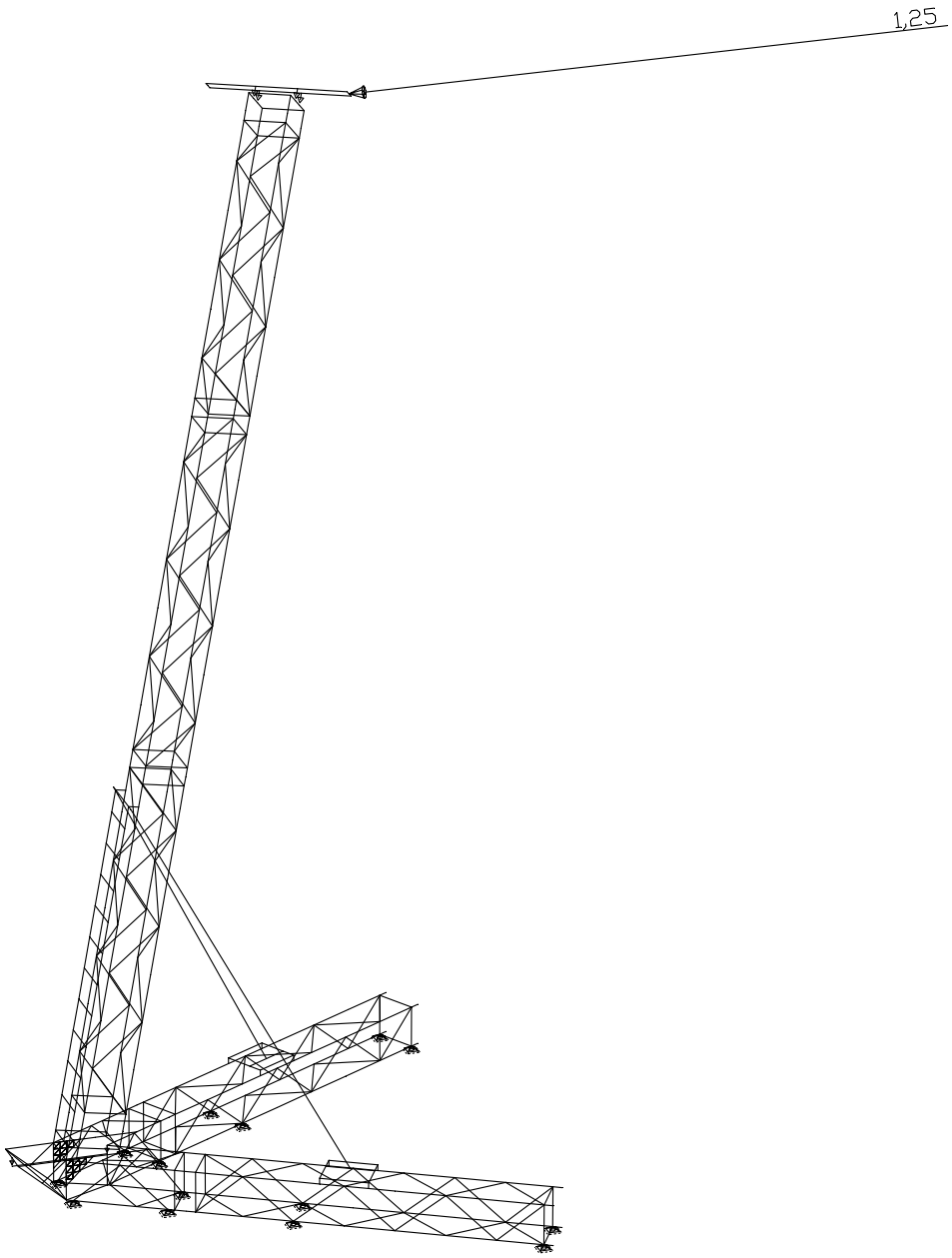
0955 - PA Tower Global Truss
LF 7: Belastung, Wind PA -x

M 1 : 60



LC 7: Load, Wind PA -x

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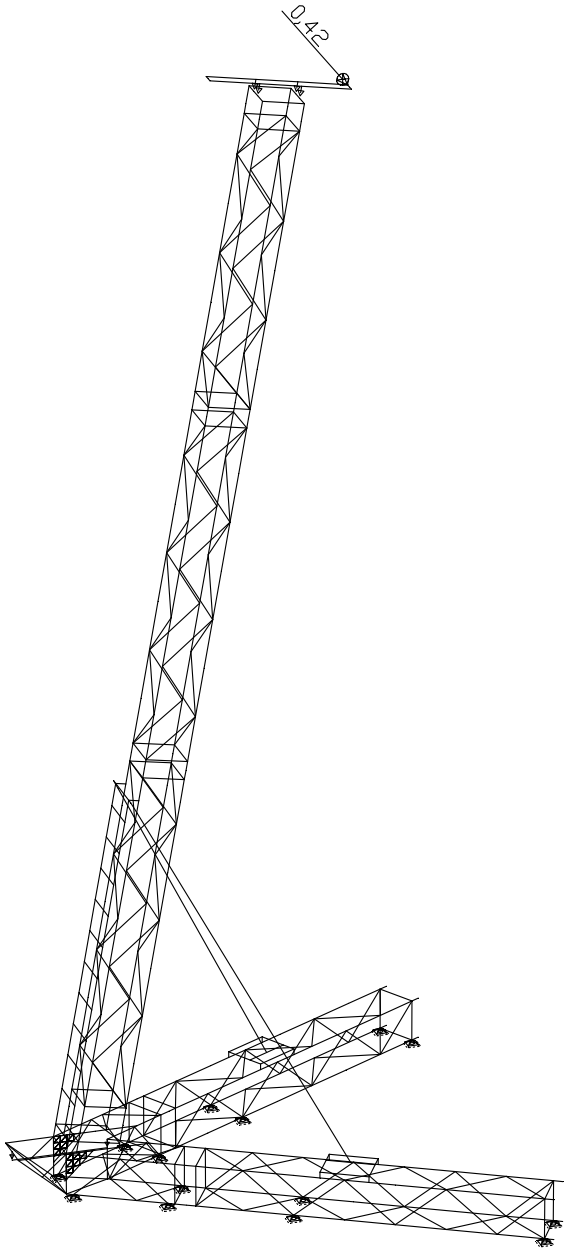
0955 - PA Tower Global Truss
LF 8: Belastung, Wind PA y

M 1 : 60



LC 8: Load, Wind PA y

Load data load case 20: Th II.O LF1+2+3+6

Load group (GRL)
Theory: Theory 2. order
No soil pressure > 0: No; No support reac. < 0: Yes; Error threshold [%]: 0,10
Additional global load factor: 1,70; Predeformation: 0
Consider concrete creeping in the nonlinear analysis: Yes

Selected load cases

No.\Label	Factor	
1	g	1
2	Nutzlast	1
3	wind +x	1
6	Wind PA +x	1

Creep coefficients for sections

Load data load case 21: TH II.O LF1+2+4+7

Load group (GRL)
Theory: Theory 2. order
No soil pressure > 0: No; No support reac. < 0: Yes; Error threshold [%]: 0,10
Additional global load factor: 1,70; Predeformation: 0
Consider concrete creeping in the nonlinear analysis: Yes

Selected load cases

No.\Label	Factor	
1	g	1
2	Nutzlast	1
4	Wind -x	1
7	Wind PA -x	1

Creep coefficients for sections

Load data load case 22: Th II.O LF1+2+5+8

Load group (GRL)
Theory: Theory 2. order
No soil pressure > 0: No; No support reac. < 0: Yes; Error threshold [%]: 0,10
Additional global load factor: 1,70; Predeformation: 0
Consider concrete creeping in the nonlinear analysis: Yes

Selected load cases

No.\Label	Factor	
1	g	1
2	Nutzlast	1
5	Wind y	1
8	Wind PA y	1

Creep coefficients for sections

Load data load case 23: Th II.O LF1+1,2x2+3+0,5x6

Load group (GRL)
Theory: Theory 2. order
No soil pressure > 0: No; No support reac. < 0: Yes; Error threshold [%]: 0,10
Additional global load factor: 1,70; Predeformation: 0
Consider concrete creeping in the nonlinear analysis: Yes

Selected load cases

No.\Label	Factor	
1	g	1
2	Nutzlast	1,2
3	wind +x	1
6	Wind PA +x	0,5

Creep coefficients for sections

Load data load case 24: Th II.O LF1+1,2x2+4+0,5x7

Load group (GRL)
Theory: Theory 2. order
No soil pressure > 0: No; No support reac. < 0: Yes; Error threshold [%]: 0,10
Additional global load factor: 1,70; Predeformation: 0
Consider concrete creeping in the nonlinear analysis: Yes

Selected load cases

No.\Label	Factor	
1	g	1
2	Nutzlast	1,2
4	Wind -x	1
7	Wind PA -x	0,5

Creep coefficients for sections

Load data load case 25: Th II.O LF1+1,2x2+5+0,5x8

Load group (GRL)
Theory: Theory 2. order
No soil pressure > 0: No; No support reac. < 0: Yes; Error threshold [%]: 0,10
Additional global load factor: 1,70; Predeformation: 0
Consider concrete creeping in the nonlinear analysis: Yes

Selected load cases

No.\Label	Factor	
1	g	1
2	Nutzlast	1,2
5	Wind y	1
8	Wind PA y	0,5

Creep coefficients for sections

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Load case combination 100

	1. Variable exclusive action	Factor
20	Th II.O LF1+2+3+6	0,588
21	TH II.O LF1+2+4+7	0,588
22	Th II.O LF1+2+5+8	0,588
23	Th II.O LF1+1,2x2+3+0,5x6	0,588
24	Th II.O LF1+1,2x2+4+0,5x7	0,588
25	Th II.O LF1+1,2x2+5+0,5x8	0,588

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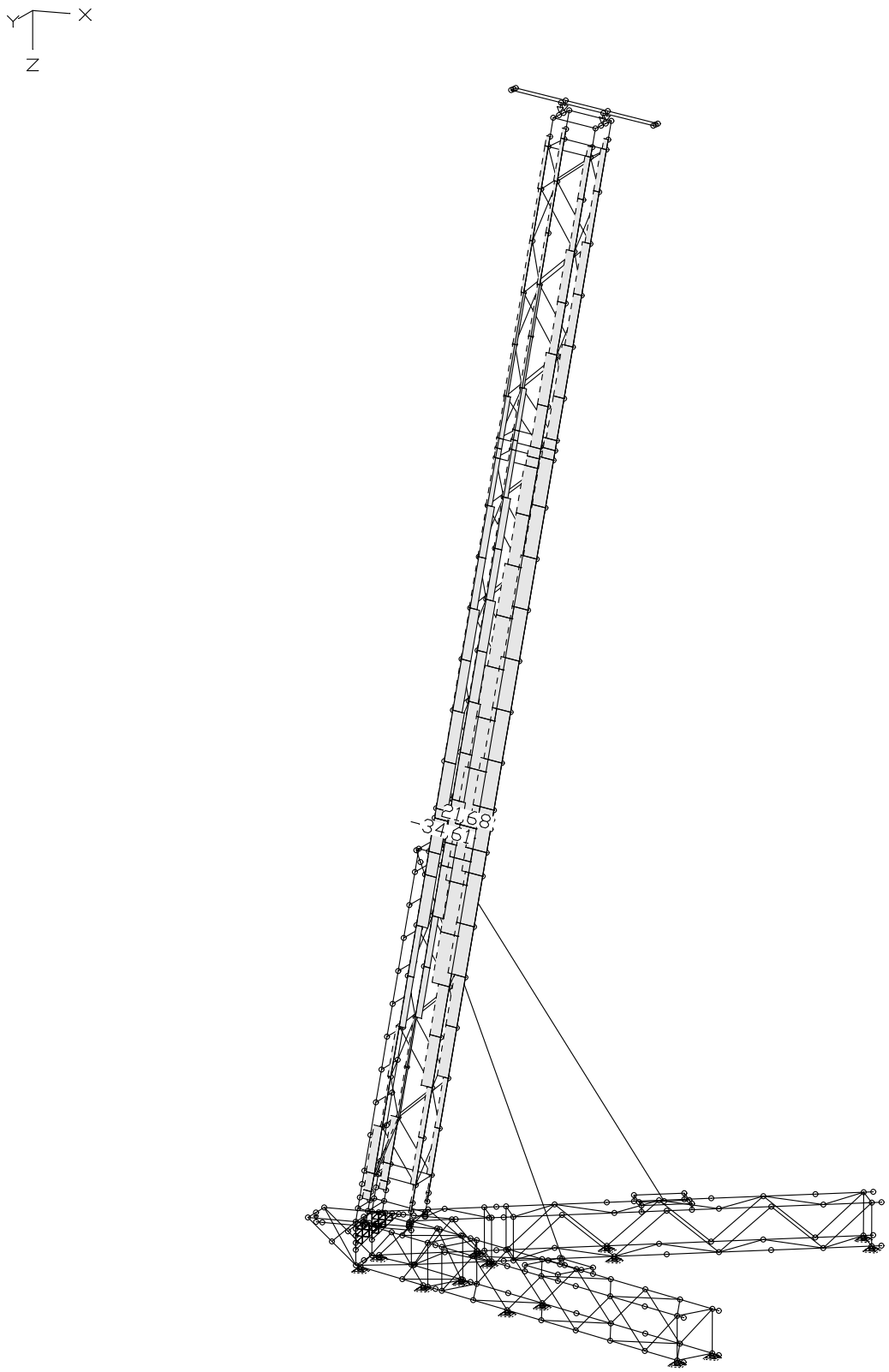
Schnittgrößen Nx min, max; K100

M 1 : 50

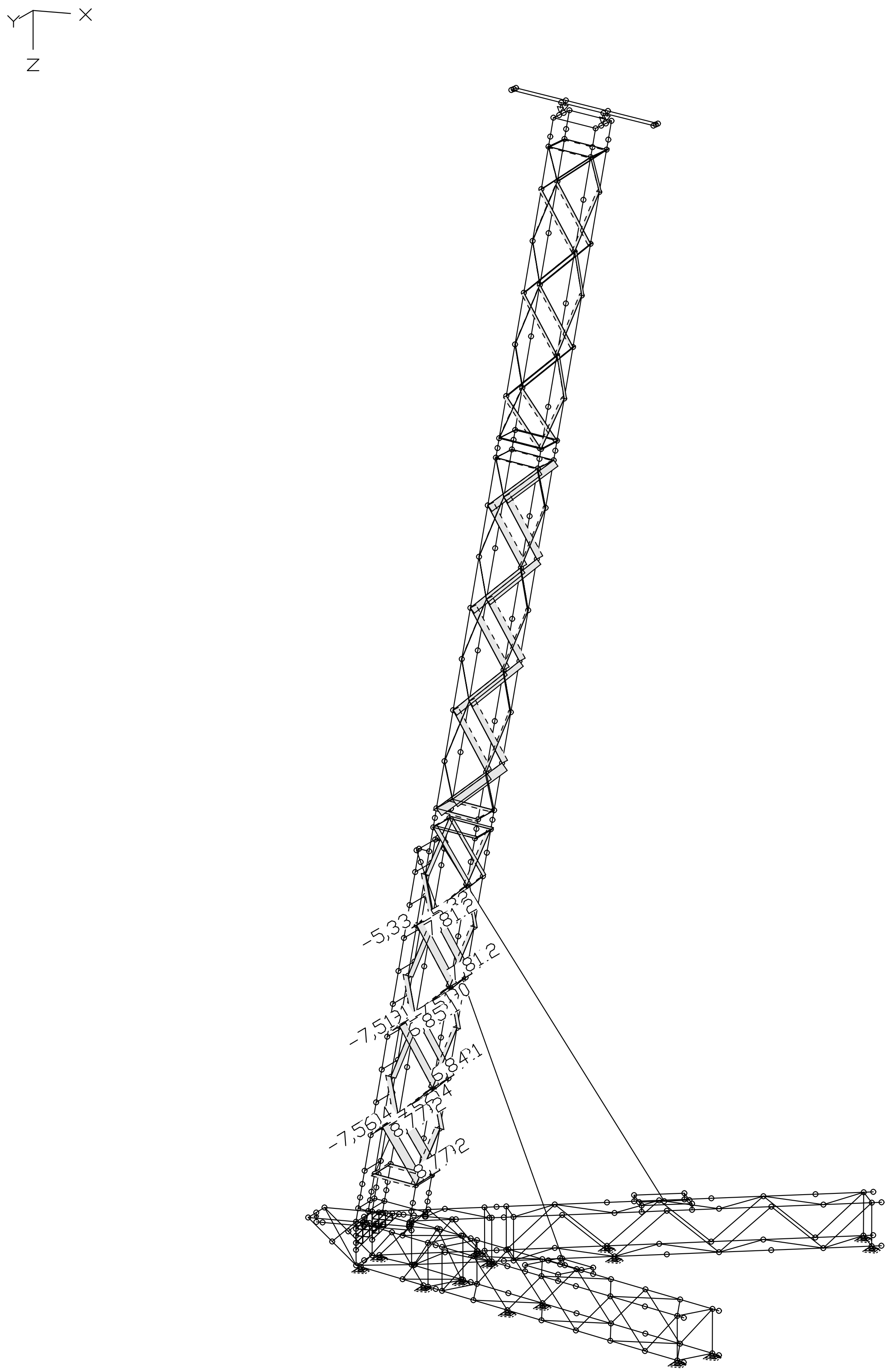


LFK 100: Selected Internal forces min,max Nx [kN]
Value range (overall system, min/max): -34,67/21,96 [kN]
Section color

0955 - PA Tower Global Truss

Schnittgrößen Nx min, max; K100

M 1 : 50



LFK 100: Selected Internal forces min,max Nx [kN]

Value range (subsystem, min/max): -7,56/8,92 [kN]

Section color

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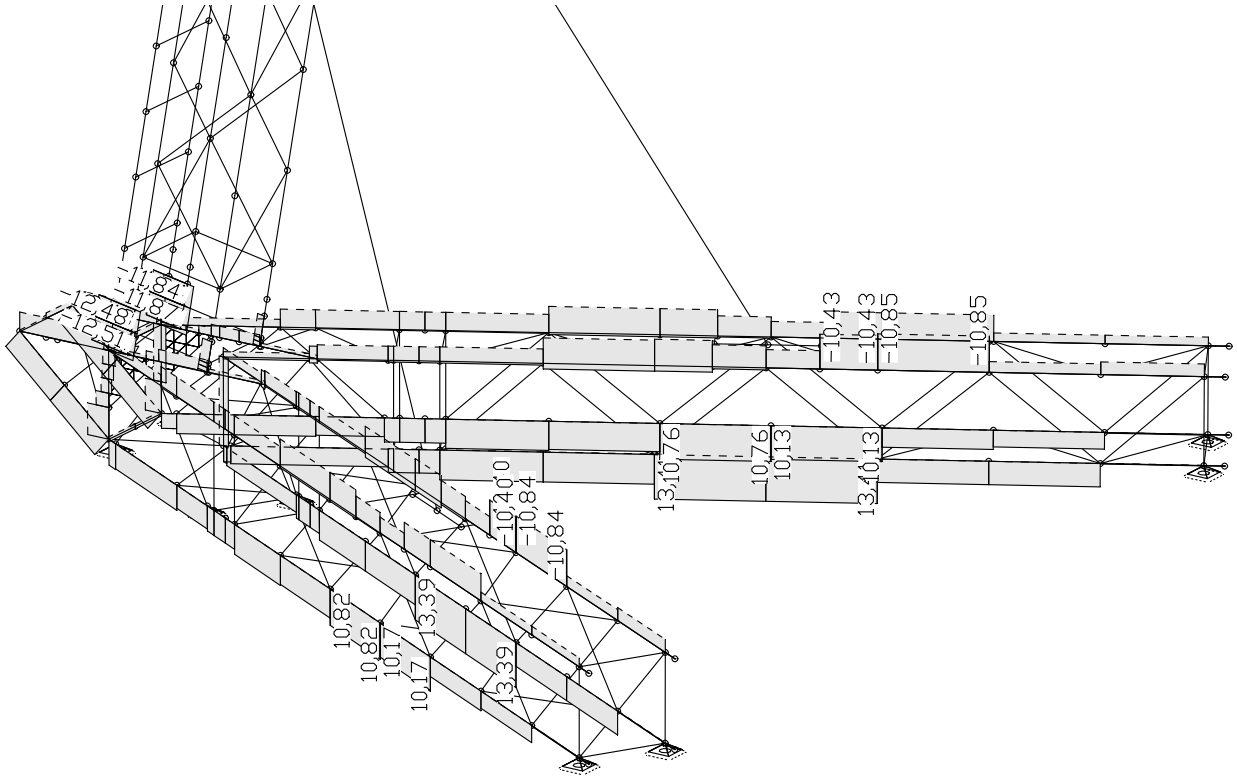
M 1 :



Schnittgrößen Nx min, max; K100

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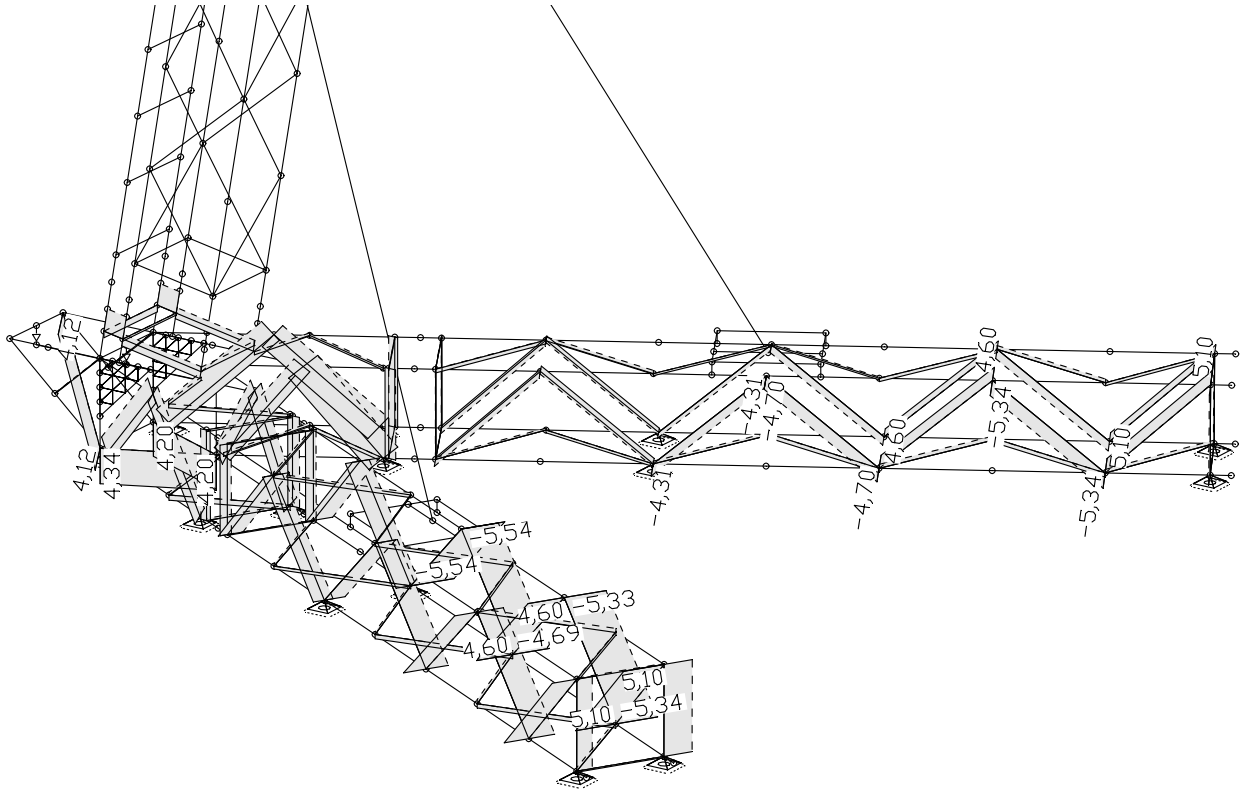
M 1 :



Schnittgrößen Nx min, max; K100

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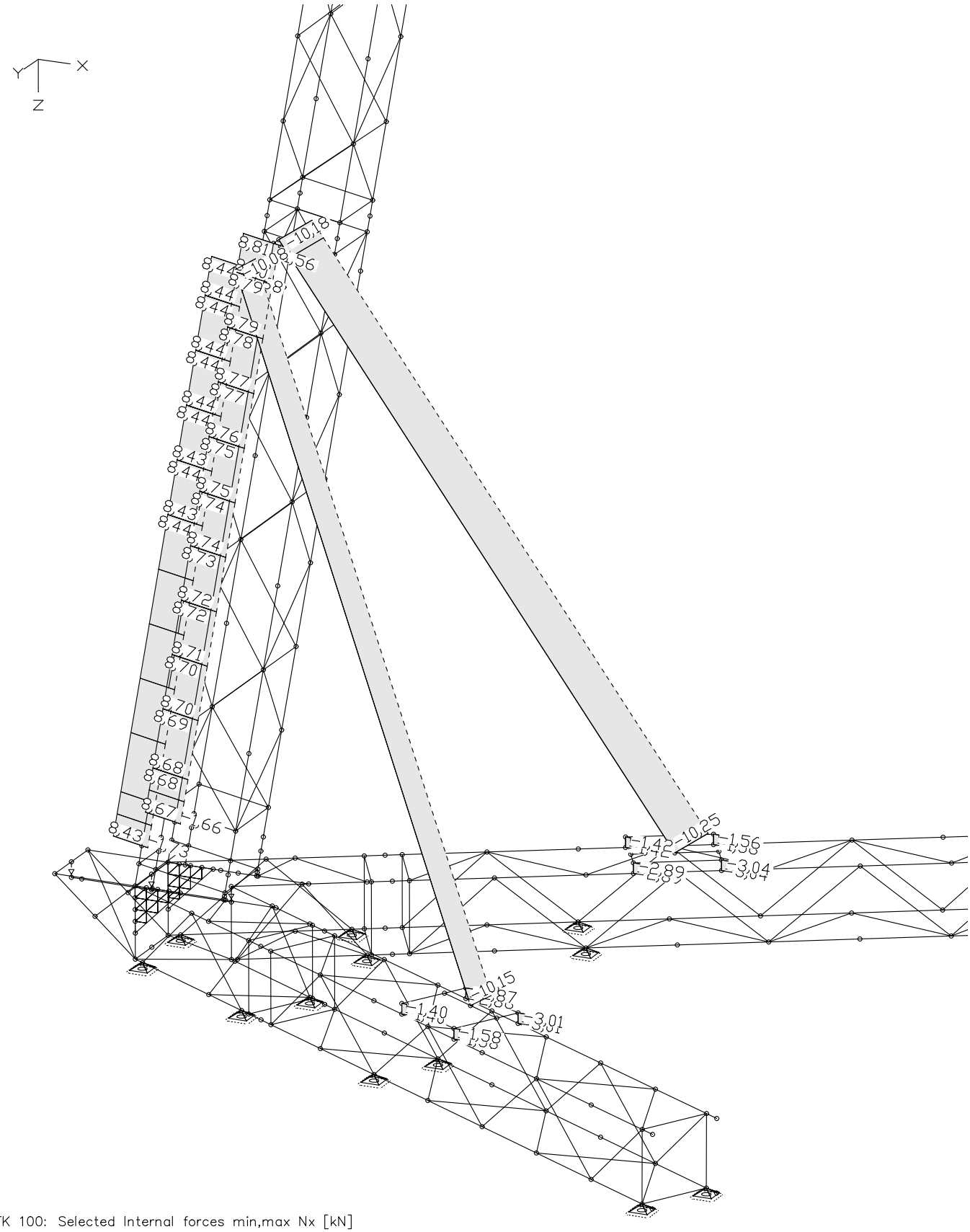
Schnittgrößen Nx min, max; K100

M 1 : 20



LFK 100: Selected Internal forces min,max Nx [kN]
Value range (subsystem, min/max): -10,25/8,81 [kN]
Section color

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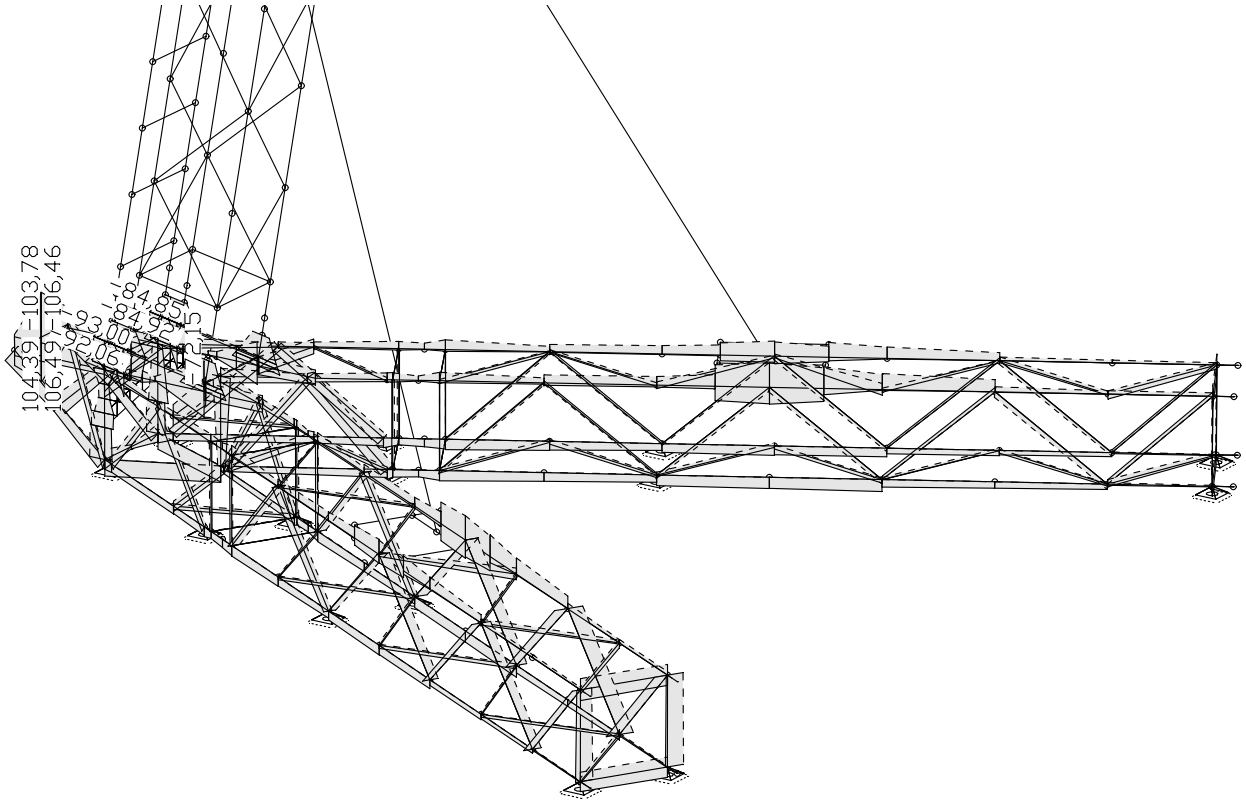
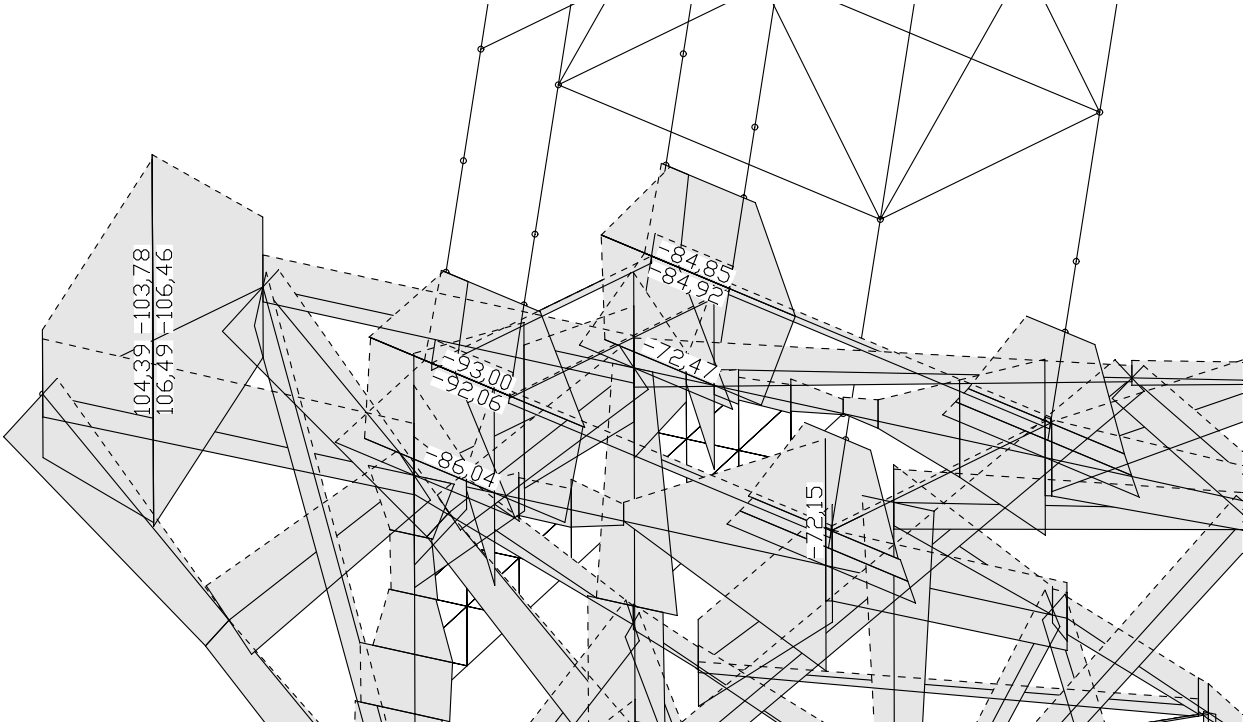
M 1 :



Sigma.x min, max; K100



Sigma.x min, max; K100

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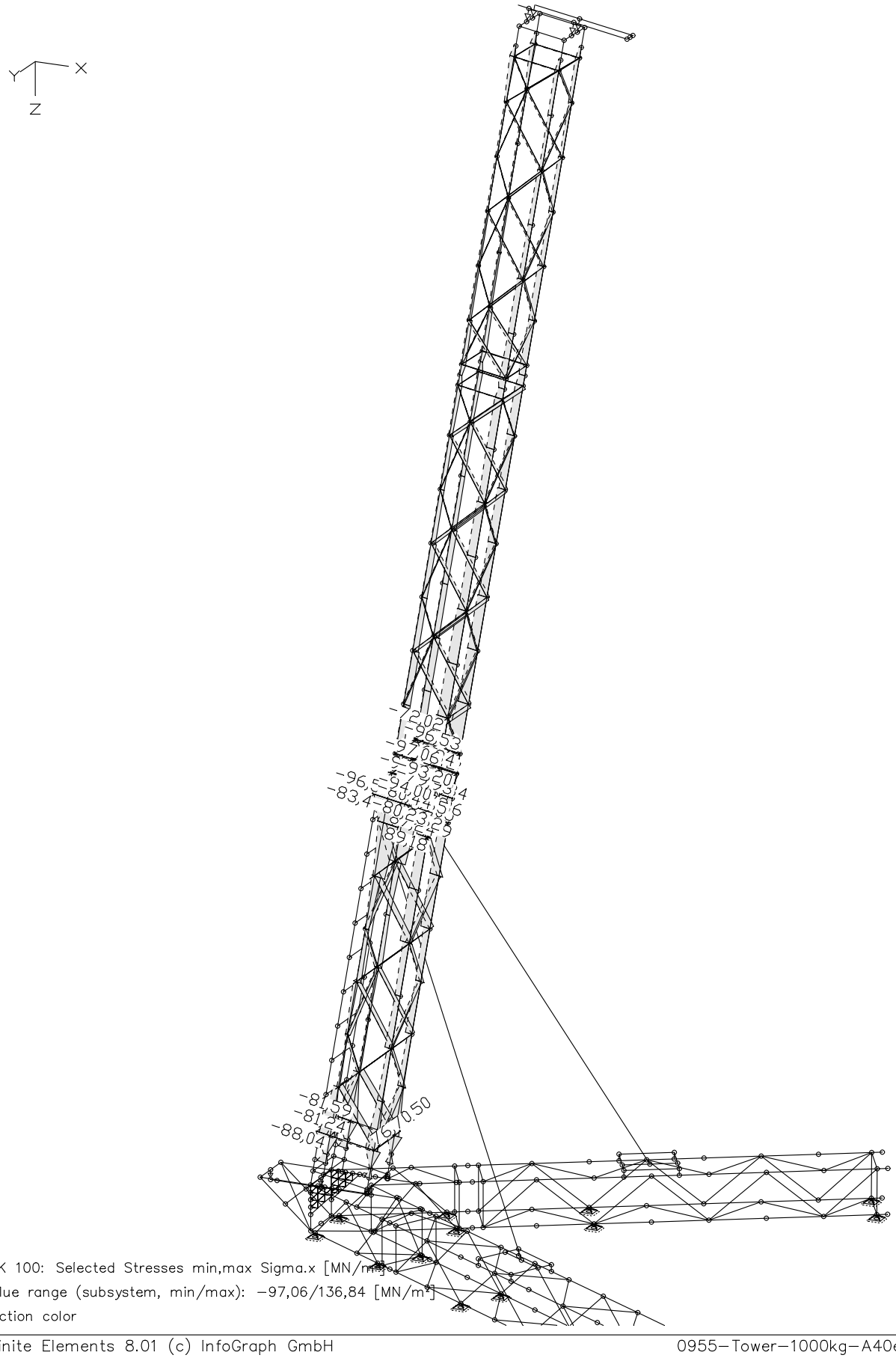
Sigma.x min, max; K100

M 1 : 40



LFK 100: Selected Stresses min,max Sigma.x [MN/m²]
Value range (subsystem, min/max): -97,06/136,84 [MN/m²]
Section color

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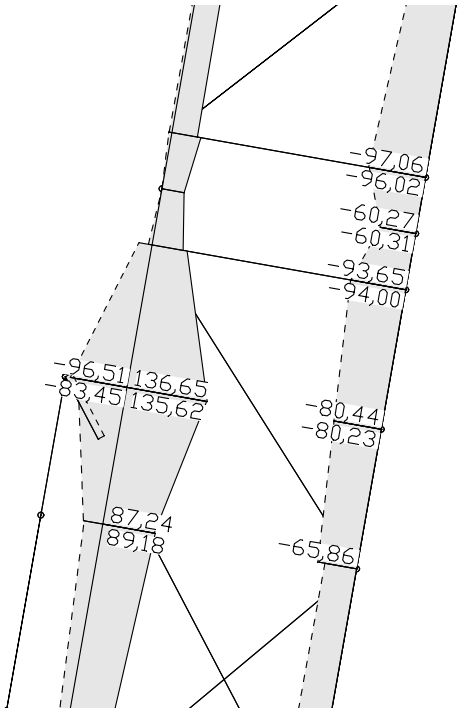
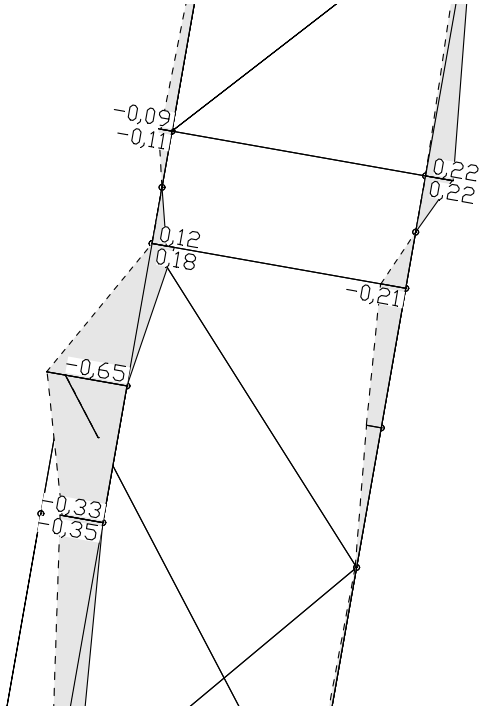
M 1 :



Sigma.x min, max; K100



Schnittgrößen My min, max; K100

Combination information - Beam 503 - Node 386 - My min, max
K100 :

Load case	Factor	Nx [kN]	My [kNm]	Mz [kNm]	Qy [kN]	Qz [kN]	Mx [kNm]
25 : Th II.O LF1+1,2x2+5+0,5x8	0,59	10,04	-0,65	-0,11	0,50	4,51	0,01
My min		10,04	-0,65	-0,11	0,50	4,51	0,01
My max		0,00	0,00	0,00	0,00	0,00	0,00

Combination information - Beam 240 - Node 81 - My min, max
K100 :

Load case	Factor	Nx [kN]	My [kNm]	Mz [kNm]	Qy [kN]	Qz [kN]	Mx [kNm]
My min		0,00	0,00	0,00	0,00	0,00	0,00
23 : Th II.O LF1+1,2x2+3+0,5x6	0,59	-34,53	0,22	0,01	-0,01	-1,44	0,00
My max		-34,53	0,22	0,01	-0,01	-1,44	0,00

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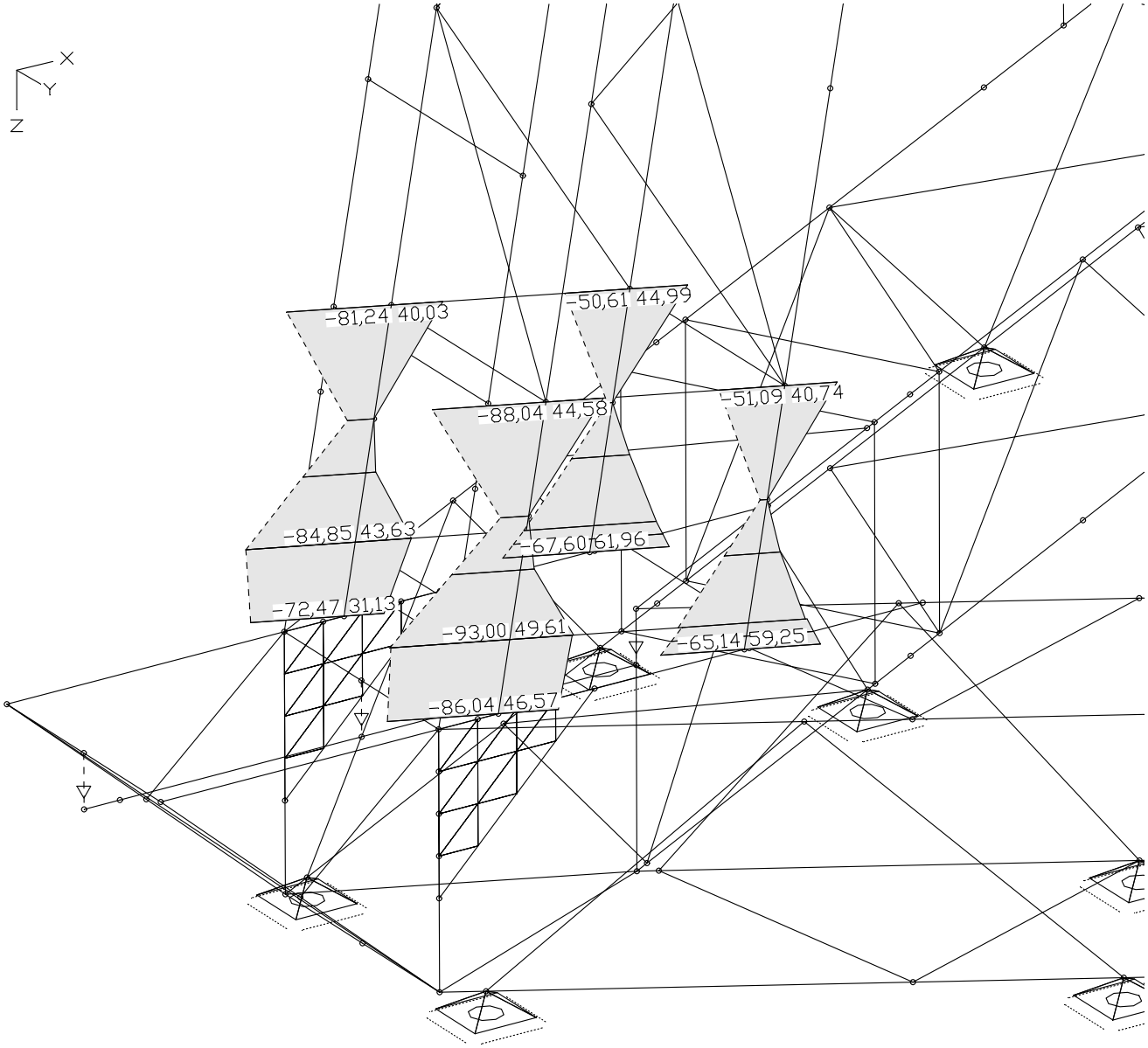
Sigma.x min, max; K100

M 1 : 8



LFK 100: Selected Stresses min,max Sigma.x [MN/m²]
Value range (subsystem, min/max): -93,00/61,96 [MN/m²]
Section color

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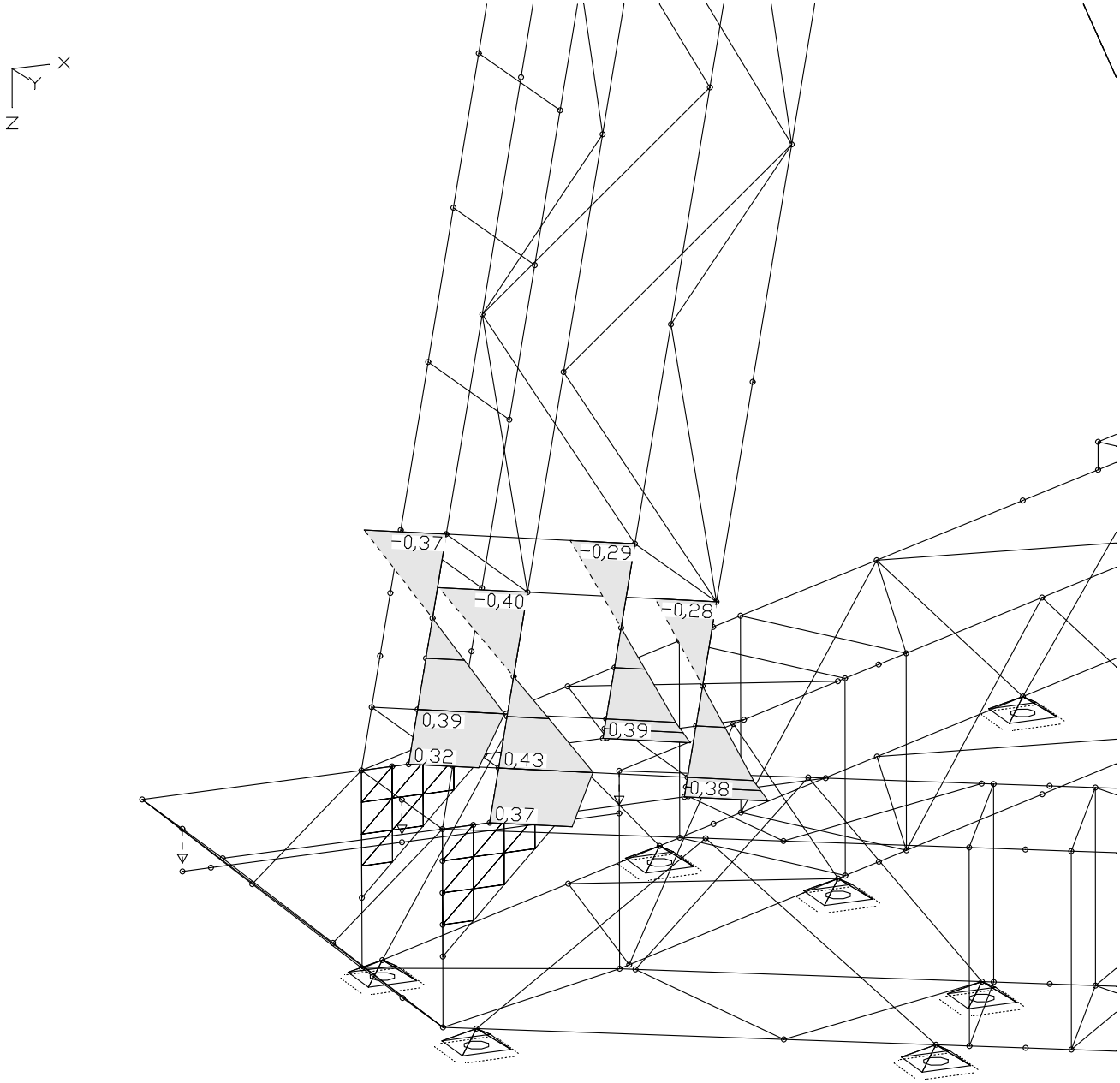
Schnittgrößen My min, max; K100

M 1 : 10



LFK 100: Selected Internal forces min,max My [kNm]
Value range (subsystem, min/max): -0,40/0,43 [kNm]
Section color

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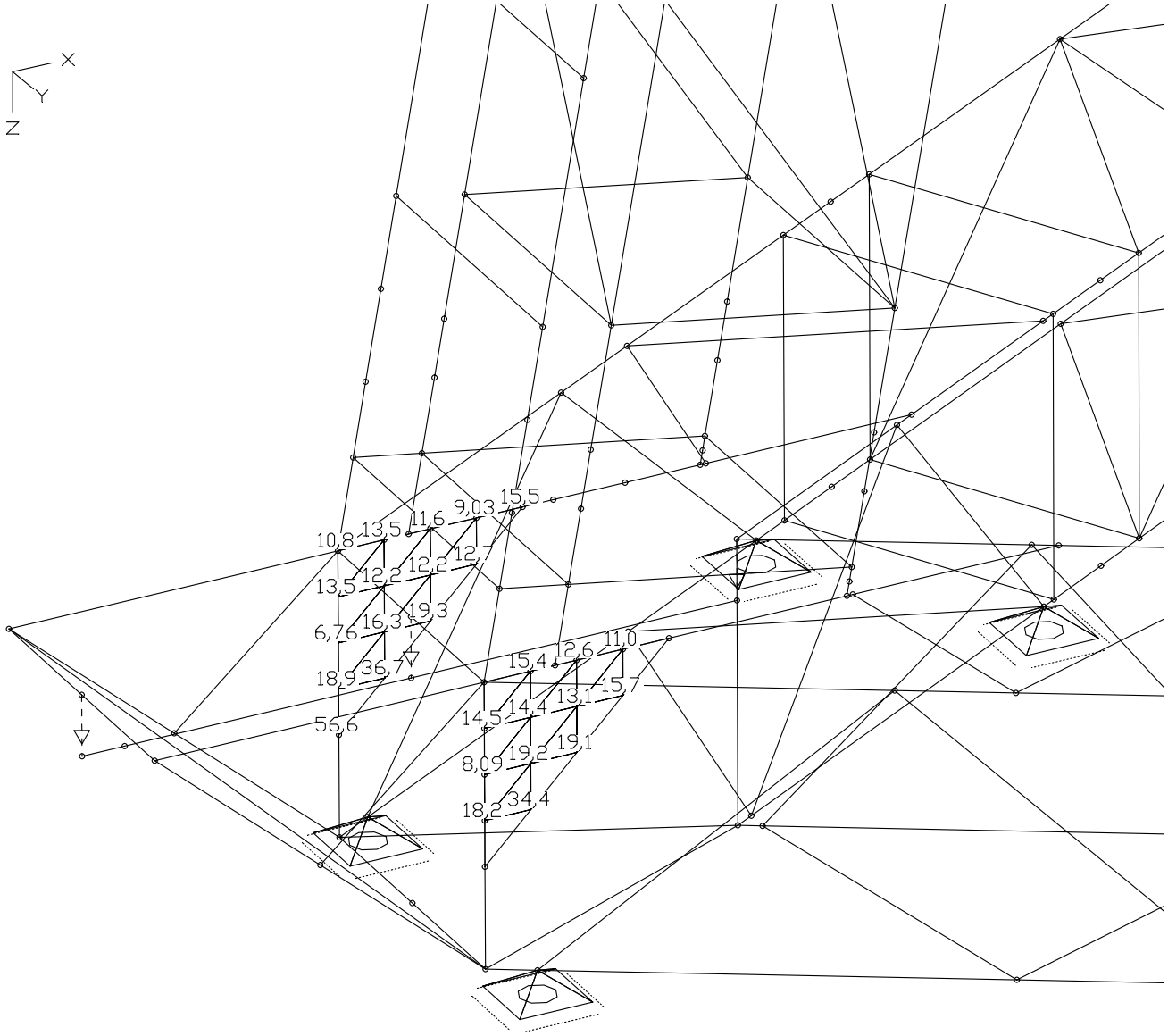
Sigma.v oben, max; K100

M 1 : 7



LFK 100: Selected Stresses max Sigma.v top [MN/m²]
Value range (overall system, min/max): 4,16/61,28 [MN/m²]
Analysis at the element nodes, mean of values in the representation
Section color

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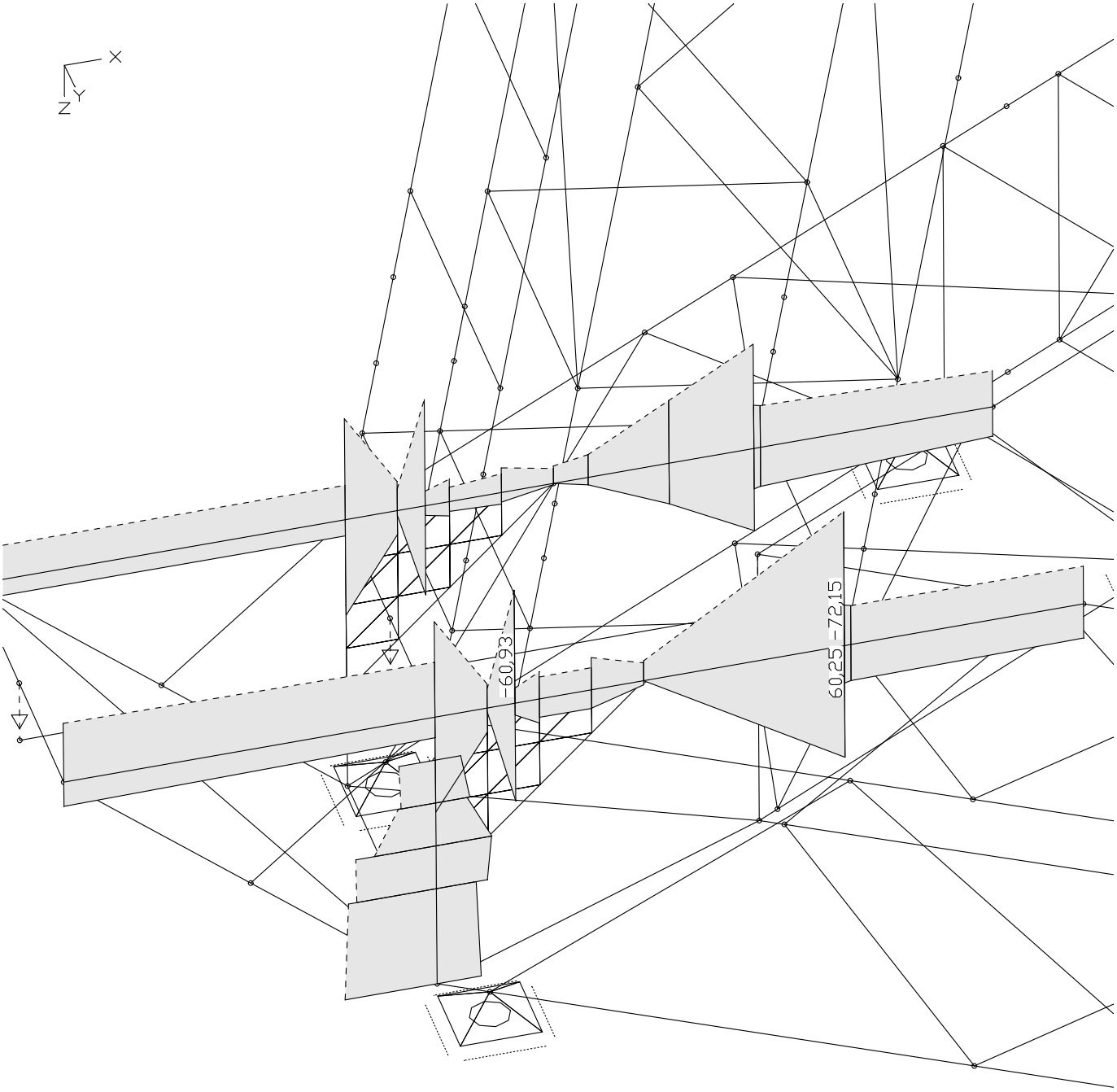
Sigma.x min, max; K100

M 1 : 6



LFK 100: Selected Stresses min,max Sigma.x [MN/m²]
Value range (subsystem, min/max): -72,15/60,25 [MN/m²]
Section color

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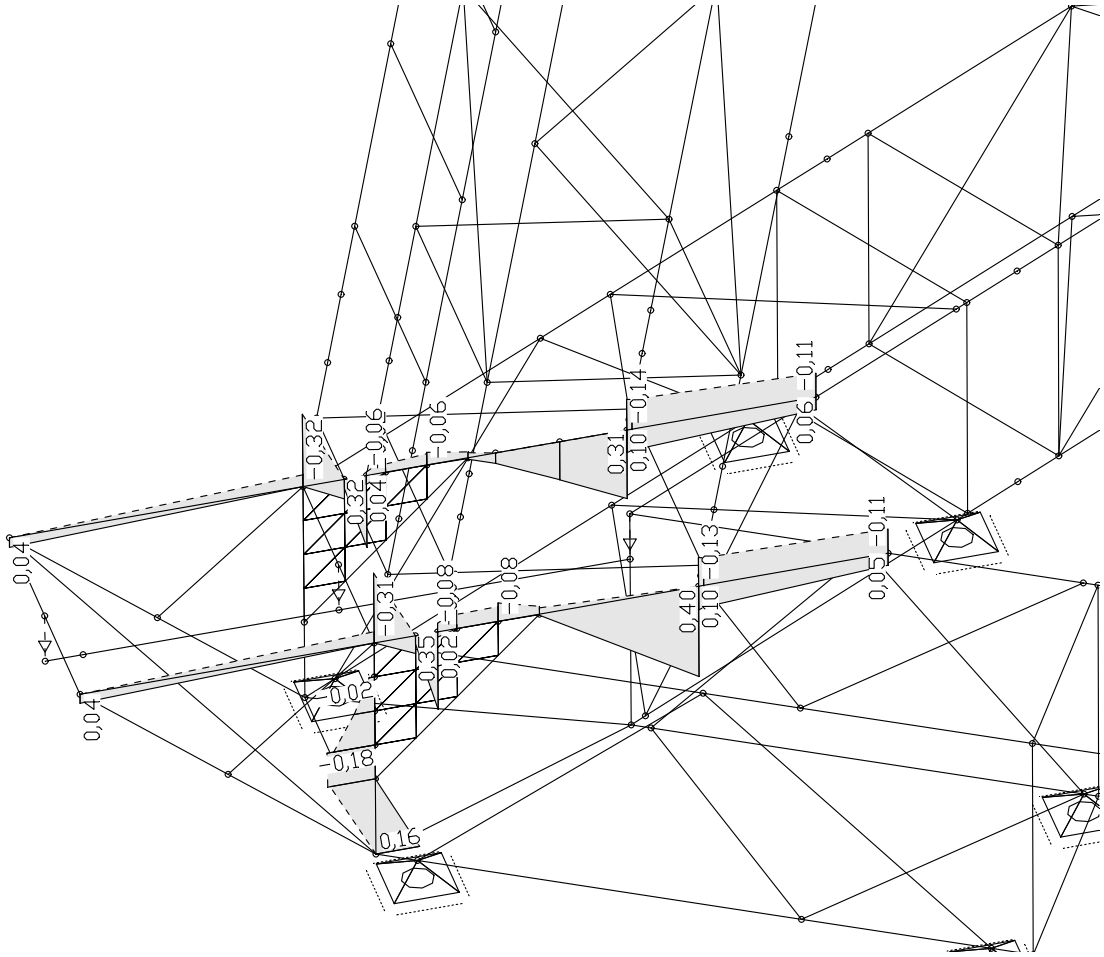
M 1 :



Schnittgrößen My min, max; K100

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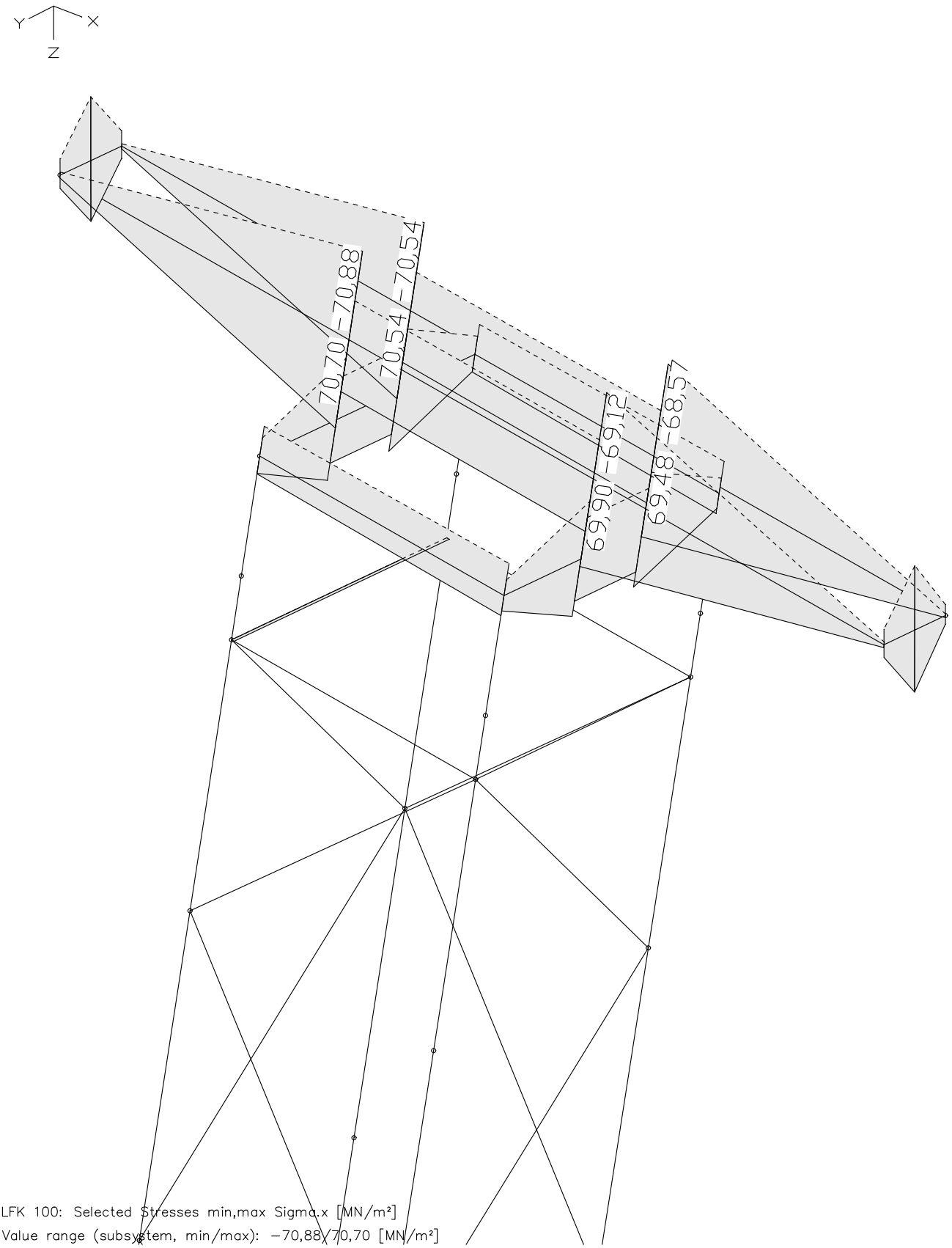
0955 - PA Tower Global Truss
Sigma.x min, max; K100

M 1 : 6



LFK 100: Selected Stresses min,max Sigma.x [MN/m²]
Value range (subsystem, min/max): -70,88/70,70 [MN/m²]

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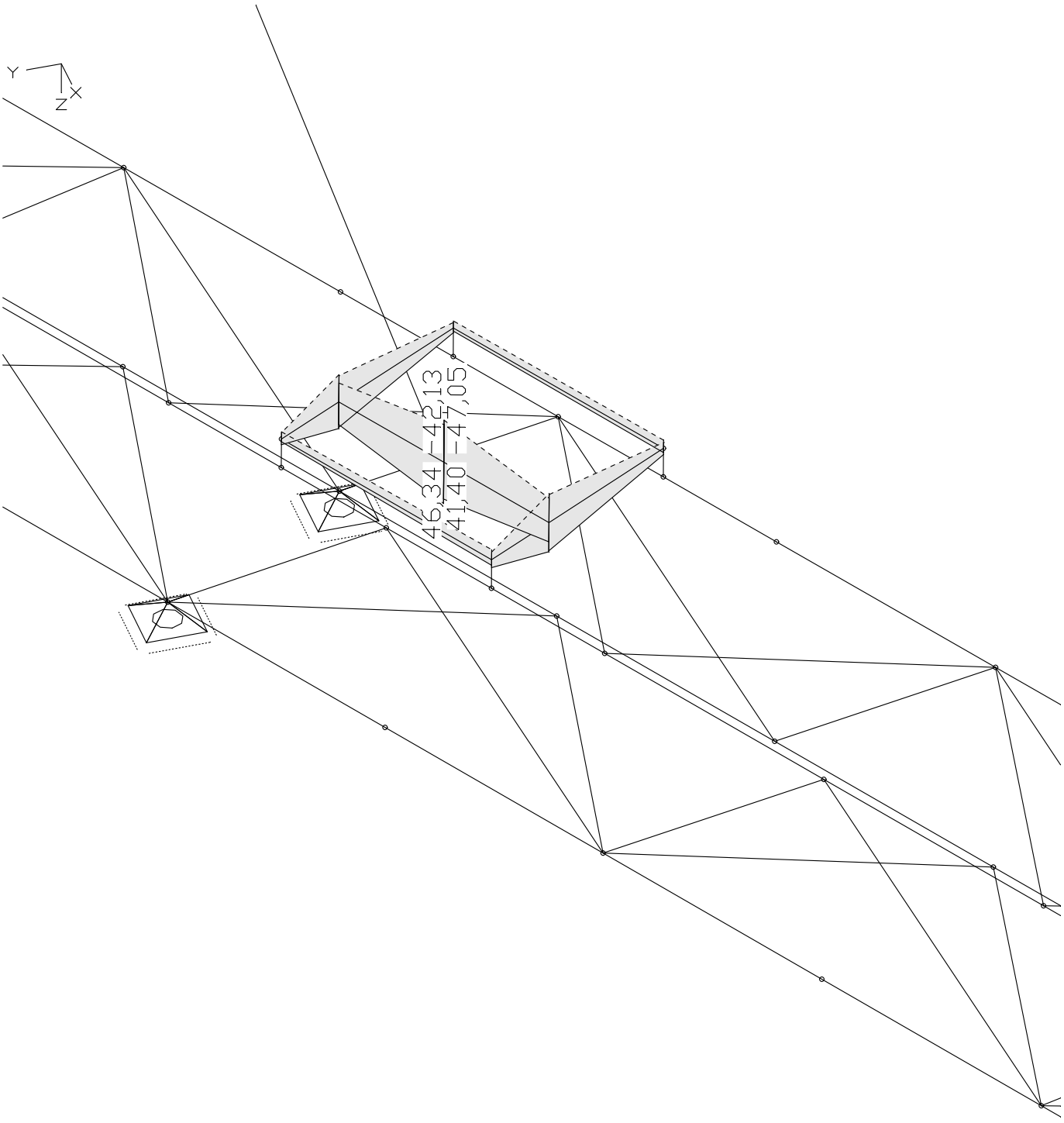
0955 - PA Tower Global Truss
Sigma.x min, max; K100

M 1 : 8



LFK 100: Selected Stresses min,max Sigma.x [MN/m²]
Value range (subsystem, min/max): -70,88/70,70 [MN/m²]

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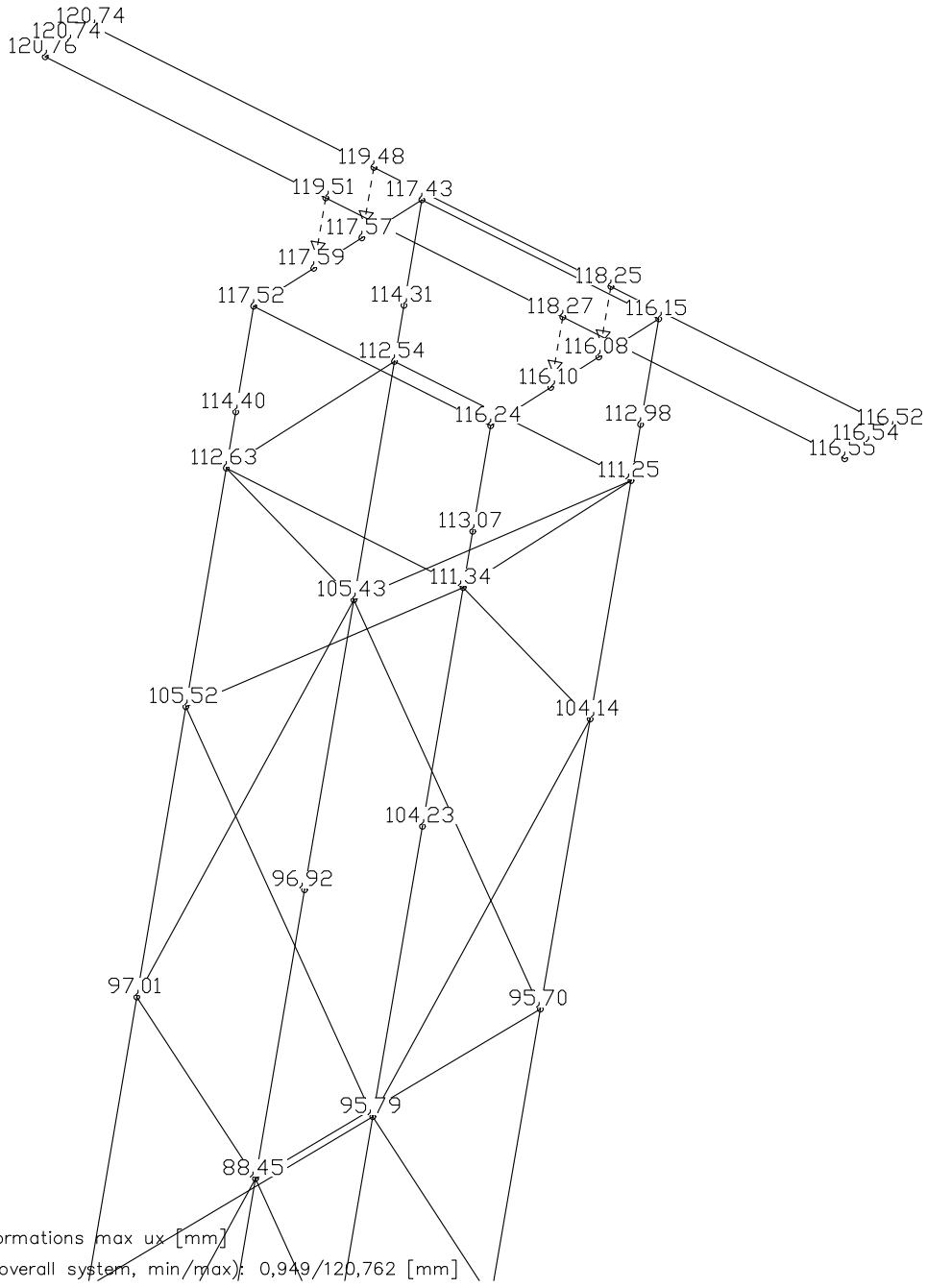
0955 - PA Tower Global Truss
Deformationen ux max; K100

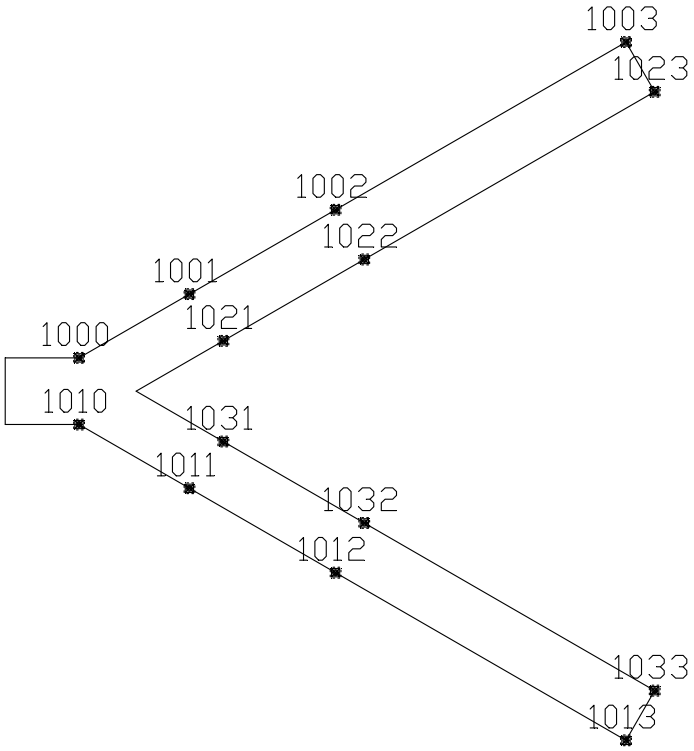
M 1 : 8



LFK 100: Deformations max ux [mm]
Value range (overall system, min/max): 0,949/120,762 [mm]

0955 - PA Tower Global Truss

M 1 :



Knotennummern

Support reactions from all load cases

Node	LC	Rx [kN]	Ry [kN]	Rz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1000	1	0,00	0,00	0,39	0,00	0,00	0,00
	2	-0,01	-0,00	-2,13	0,00	0,00	0,00
	3	0,03	-0,00	-0,47	0,00	0,00	0,00
	4	-0,03	0,00	0,47	0,00	0,00	0,00
	5	-0,00	0,03	-1,90	0,00	0,00	0,00
	6	0,10	-0,00	-2,01	0,00	0,00	0,00
	7	-0,10	0,00	2,97	0,00	0,00	0,00
	8	0,00	0,02	-4,90	0,00	0,00	0,00
	20	0,16	-0,00	0,00	0,00	0,00	0,00
	21	-0,22	-0,00	2,57	0,00	0,00	0,00
	22	-0,01	0,06	0,00	0,00	0,00	0,00
	23	0,08	-0,00	0,00	0,00	0,00	0,00
	24	-0,14	-0,00	0,00	0,00	0,00	0,00
	25	-0,03	0,05	0,00	0,00	0,00	0,00
1001	1	0,00	-0,00	0,02	0,00	0,00	0,00
	2	0,00	-0,00	1,05	0,00	0,00	0,00
	3	0,03	-0,00	0,05	0,00	0,00	0,00
	4	-0,03	0,00	-0,05	0,00	0,00	0,00
	5	-0,00	0,03	0,02	0,00	0,00	0,00
	6	0,09	-0,00	0,18	0,00	0,00	0,00

Support reactions from all load cases

Node	LC	Rx [kN]	Ry [kN]	Rz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	7	-0,09	0,00	-0,25	0,00	0,00	0,00
	8	0,01	0,02	0,10	0,00	0,00	0,00
	20	0,18	-0,01	0,00	0,00	0,00	0,00
	21	-0,20	0,00	1,32	0,00	0,00	0,00
	22	0,00	0,08	0,00	0,00	0,00	0,00
	23	0,10	-0,01	0,00	0,00	0,00	0,00
	24	-0,13	-0,00	0,38	0,00	0,00	0,00
	25	-0,01	0,06	0,00	0,00	0,00	0,00
1002	1	-0,00	-0,00	0,21	0,00	0,00	0,00
	2	0,00	-0,01	1,45	0,00	0,00	0,00
	3	0,02	-0,00	0,11	0,00	0,00	0,00
	4	-0,02	0,00	-0,11	0,00	0,00	0,00
	5	-0,01	0,03	-0,17	0,00	0,00	0,00
	6	0,09	-0,01	0,47	0,00	0,00	0,00
	7	-0,09	0,01	-0,70	0,00	0,00	0,00
	8	0,01	0,03	-0,35	0,00	0,00	0,00
	20	0,20	-0,04	0,00	0,00	0,00	0,00
	21	-0,19	0,02	1,53	0,00	0,00	0,00
	22	0,02	0,08	0,00	0,00	0,00	0,00
	23	0,13	-0,03	0,00	0,00	0,00	0,00
	24	-0,11	0,00	3,12	0,00	0,00	0,00
	25	0,01	0,05	0,00	0,00	0,00	0,00
1003	1	-0,00	-0,00	0,07	0,00	0,00	0,00
	2	-0,00	-0,02	0,36	0,00	0,00	0,00
	3	0,02	-0,01	0,03	0,00	0,00	0,00
	4	-0,02	0,01	-0,03	0,00	0,00	0,00
	5	-0,01	0,02	-0,06	0,00	0,00	0,00
	6	0,08	-0,03	0,13	0,00	0,00	0,00
	7	-0,08	0,04	-0,19	0,00	0,00	0,00
	8	0,01	0,04	-0,11	0,00	0,00	0,00
	20	0,19	-0,17	3,05	0,00	0,00	0,00
	21	-0,17	0,04	0,37	0,00	0,00	0,00
	22	0,02	0,06	0,72	0,00	0,00	0,00
	23	0,13	-0,14	3,22	0,00	0,00	0,00
	24	-0,10	-0,00	0,80	0,00	0,00	0,00
	25	0,02	0,01	1,69	0,00	0,00	0,00
1010	1	0,00	-0,00	0,40	0,00	0,00	0,00
	2	-0,01	0,00	-2,49	0,00	0,00	0,00
	3	0,03	0,00	-0,47	0,00	0,00	0,00
	4	-0,03	-0,00	0,47	0,00	0,00	0,00
	5	0,00	0,03	1,90	0,00	0,00	0,00
	6	0,10	0,00	-2,01	0,00	0,00	0,00
	7	-0,10	-0,00	2,96	0,00	0,00	0,00
	8	-0,00	0,02	4,89	0,00	0,00	0,00
	20	0,16	0,00	0,00	0,00	0,00	0,00
	21	-0,22	0,00	1,93	0,00	0,00	0,00
	22	-0,03	0,06	0,00	0,00	0,00	0,00
	23	0,08	0,00	0,00	0,00	0,00	0,00
	24	-0,14	0,00	0,00	0,00	0,00	0,00
	25	-0,03	0,06	0,00	0,00	0,00	0,00

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Support reactions from all load cases

Node	LC	Rx [kN]	Ry [kN]	Rz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1011	1	0,00	0,00	0,02	0,00	0,00	0,00
	2	-0,00	0,00	1,19	0,00	0,00	0,00
	3	0,03	0,00	0,05	0,00	0,00	0,00
	4	-0,03	-0,00	-0,05	0,00	0,00	0,00
	5	0,00	0,03	-0,02	0,00	0,00	0,00
	6	0,09	0,00	0,18	0,00	0,00	0,00
	7	-0,09	-0,00	-0,26	0,00	0,00	0,00
	8	-0,01	0,02	-0,10	0,00	0,00	0,00
	20	0,18	0,02	0,00	0,00	0,00	0,00
	21	-0,20	-0,00	1,57	0,00	0,00	0,00
	22	-0,02	0,09	0,00	0,00	0,00	0,00
	23	0,10	0,01	0,00	0,00	0,00	0,00
	24	-0,13	0,00	0,48	0,00	0,00	0,00
	25	-0,02	0,08	0,00	0,00	0,00	0,00
1012	1	-0,00	0,00	0,21	0,00	0,00	0,00
	2	0,00	0,01	1,44	0,00	0,00	0,00
	3	0,02	0,00	0,11	0,00	0,00	0,00
	4	-0,02	-0,00	-0,11	0,00	0,00	0,00
	5	0,01	0,03	0,17	0,00	0,00	0,00
	6	0,09	0,01	0,47	0,00	0,00	0,00
	7	-0,09	-0,01	-0,70	0,00	0,00	0,00
	8	-0,01	0,03	0,35	0,00	0,00	0,00
	20	0,20	0,04	0,00	0,00	0,00	0,00
	21	-0,19	-0,02	1,51	0,00	0,00	0,00
	22	-0,00	0,11	4,14	0,00	0,00	0,00
	23	0,13	0,03	0,00	0,00	0,00	0,00
	24	-0,11	-0,00	3,10	0,00	0,00	0,00
	25	0,01	0,09	3,23	0,00	0,00	0,00
1013	1	-0,00	0,00	0,07	0,00	0,00	0,00
	2	-0,00	0,02	0,36	0,00	0,00	0,00
	3	0,02	0,01	0,03	0,00	0,00	0,00
	4	-0,02	-0,01	-0,03	0,00	0,00	0,00
	5	0,01	0,02	0,06	0,00	0,00	0,00
	6	0,08	0,03	0,13	0,00	0,00	0,00
	7	-0,08	-0,04	-0,19	0,00	0,00	0,00
	8	-0,01	0,04	0,11	0,00	0,00	0,00
	20	0,19	0,17	3,06	0,00	0,00	0,00
	21	-0,17	-0,04	0,37	0,00	0,00	0,00
	22	-0,00	0,17	2,22	0,00	0,00	0,00
	23	0,13	0,14	3,23	0,00	0,00	0,00
	24	-0,10	0,00	0,79	0,00	0,00	0,00
	25	0,01	0,15	2,52	0,00	0,00	0,00
1021	1	0,00	-0,00	0,11	0,00	0,00	0,00
	2	0,00	-0,00	1,23	0,00	0,00	0,00
	3	0,03	-0,00	0,01	0,00	0,00	0,00
	4	-0,03	0,00	-0,01	0,00	0,00	0,00
	5	-0,00	0,03	-0,10	0,00	0,00	0,00
	6	0,10	-0,00	-0,01	0,00	0,00	0,00
	7	-0,10	0,01	0,01	0,00	0,00	0,00

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Support reactions from all load cases

Node	LC	Rx [kN]	Ry [kN]	Rz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
	8	0,00	0,03	-0,20	0,00	0,00	0,00
	20	0,19	-0,02	0,00	0,00	0,00	0,00
	21	-0,20	0,00	2,27	0,00	0,00	0,00
	22	0,00	0,08	0,00	0,00	0,00	0,00
	23	0,11	-0,02	0,00	0,00	0,00	0,00
	24	-0,12	-0,01	1,63	0,00	0,00	0,00
	25	-0,01	0,05	0,00	0,00	0,00	0,00
1022	1	-0,00	-0,00	0,29	0,00	0,00	0,00
	2	0,00	-0,01	2,72	0,00	0,00	0,00
	3	0,02	-0,00	0,23	0,00	0,00	0,00
	4	-0,02	0,00	-0,23	0,00	0,00	0,00
	5	-0,00	0,02	-0,21	0,00	0,00	0,00
	6	0,09	-0,01	0,98	0,00	0,00	0,00
	7	-0,09	0,02	-1,46	0,00	0,00	0,00
	8	0,01	0,03	-0,35	0,00	0,00	0,00
	20	0,20	-0,06	1,51	0,00	0,00	0,00
	21	-0,20	0,02	2,41	0,00	0,00	0,00
	22	0,01	0,08	2,13	0,00	0,00	0,00
	23	0,13	-0,05	4,11	0,00	0,00	0,00
	24	-0,12	-0,00	5,32	0,00	0,00	0,00
	25	0,01	0,04	3,98	0,00	0,00	0,00
1023	1	0,00	-0,00	0,09	0,00	0,00	0,00
	2	0,00	-0,02	0,68	0,00	0,00	0,00
	3	0,02	-0,01	0,06	0,00	0,00	0,00
	4	-0,02	0,01	-0,06	0,00	0,00	0,00
	5	-0,01	0,02	-0,03	0,00	0,00	0,00
	6	0,08	-0,04	0,25	0,00	0,00	0,00
	7	-0,08	0,04	-0,37	0,00	0,00	0,00
	8	0,01	0,04	-0,03	0,00	0,00	0,00
	20	0,22	-0,19	6,45	0,00	0,00	0,00
	21	-0,17	0,04	0,62	0,00	0,00	0,00
	22	0,03	0,05	2,58	0,00	0,00	0,00
	23	0,15	-0,15	5,46	0,00	0,00	0,00
	24	-0,10	-0,00	1,40	0,00	0,00	0,00
	25	0,02	0,00	3,21	0,00	0,00	0,00
1031	1	0,00	0,00	0,11	0,00	0,00	0,00
	2	0,00	0,01	1,25	0,00	0,00	0,00
	3	0,03	0,00	0,01	0,00	0,00	0,00
	4	-0,03	-0,00	-0,01	0,00	0,00	0,00
	5	0,00	0,03	0,10	0,00	0,00	0,00
	6	0,10	0,00	-0,00	0,00	0,00	0,00
	7	-0,10	-0,01	0,00	0,00	0,00	0,00
	8	-0,00	0,03	0,20	0,00	0,00	0,00
	20	0,19	0,02	0,00	0,00	0,00	0,00
	21	-0,20	-0,00	2,28	0,00	0,00	0,00
	22	-0,01	0,10	0,00	0,00	0,00	0,00
	23	0,11	0,02	0,00	0,00	0,00	0,00
	24	-0,12	0,01	1,64	0,00	0,00	0,00
	25	-0,01	0,08	0,00	0,00	0,00	0,00

Support reactions from all load cases

Node	LC	Rx [kN]	Ry [kN]	Rz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
1032	1	-0,00	0,00	0,29	0,00	0,00	0,00
	2	0,00	0,01	2,70	0,00	0,00	0,00
	3	0,02	0,00	0,23	0,00	0,00	0,00
	4	-0,02	-0,00	-0,23	0,00	0,00	0,00
	5	0,00	0,03	0,21	0,00	0,00	0,00
	6	0,09	0,01	0,98	0,00	0,00	0,00
	7	-0,09	-0,02	-1,46	0,00	0,00	0,00
	8	-0,01	0,03	0,35	0,00	0,00	0,00
	20	0,20	0,06	1,46	0,00	0,00	0,00
	21	-0,20	-0,02	2,38	0,00	0,00	0,00
	22	-0,01	0,13	7,21	0,00	0,00	0,00
	23	0,12	0,06	4,06	0,00	0,00	0,00
	24	-0,12	0,00	5,25	0,00	0,00	0,00
	25	0,00	0,10	7,32	0,00	0,00	0,00
1033	1	0,00	0,00	0,09	0,00	0,00	0,00
	2	0,00	0,02	0,69	0,00	0,00	0,00
	3	0,02	0,01	0,06	0,00	0,00	0,00
	4	-0,02	-0,01	-0,06	0,00	0,00	0,00
	5	0,01	0,02	0,03	0,00	0,00	0,00
	6	0,08	0,04	0,25	0,00	0,00	0,00
	7	-0,08	-0,04	-0,36	0,00	0,00	0,00
	8	-0,01	0,04	0,03	0,00	0,00	0,00
	20	0,22	0,19	6,44	0,00	0,00	0,00
	21	-0,17	-0,04	0,63	0,00	0,00	0,00
	22	0,00	0,18	2,88	0,00	0,00	0,00
	23	0,15	0,14	5,46	0,00	0,00	0,00
	24	-0,10	0,00	1,41	0,00	0,00	0,00
	25	0,02	0,15	3,49	0,00	0,00	0,00

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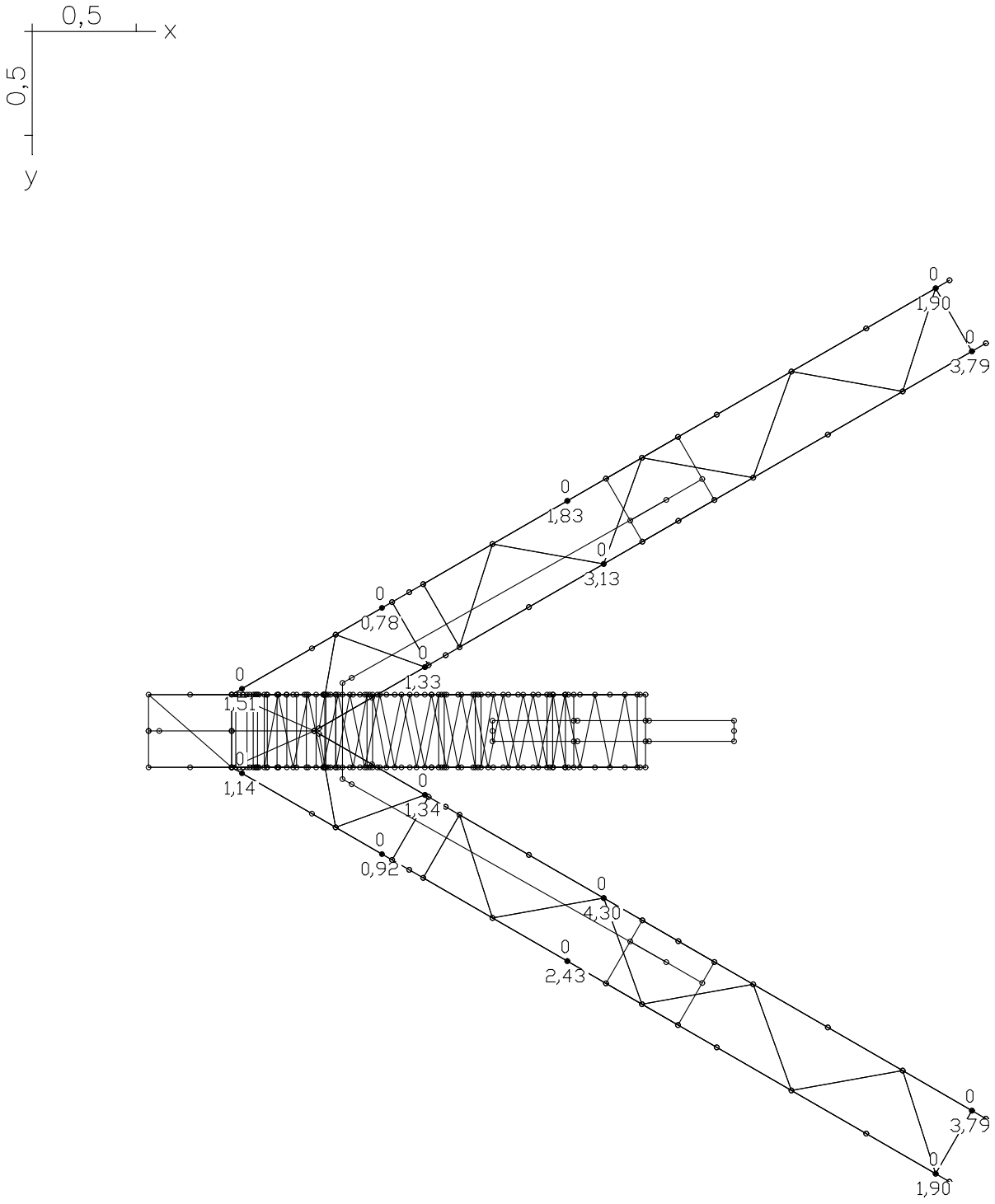
0955 - PA Tower Global Truss
Auflagerreaktionen Rz min, max; K100

M 1 : 30



LFK 100: Support reactions in the local system min,max Rz(l) [kN]

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5 VERIFICATIONS

5.1 Allowable exposure of single components

5.1.1 Allowable stress

Main chords 50x4 + diagonals 25x3 + rectangular profile for adapter-piece

material EN AW 6082 T6 (F31)

Allowable stress outside of heat effected zone (HEZ)

Acc. DIN 4112 - 2 $\sigma_{allowed}$ = 14.5 kN/cm² (LC H)

= 16.5 kN/cm² (LC HZ)

Allowable stress within HEZ

Section completely in heat effected zone

Acc. DIN 4112 - 2 $\sigma_{allowed\text{-}HEZ}$ = 8.0 kN/cm² (LC H)

= 9.0 kN/cm² (LC HZ)

Mainchords with connection of one diagonal

U-HEZ = 25+2·30 = 85 mm Uges = 157mm κ = 0.5

Ak = A - (1-0,5) · A (U-WEZ/Uges) = 0.73 A

=> $\sigma_{allowed\text{-}HEZ}$ = 0.73 · 14.5 = 10.58 kN/cm² (12,05 kN/cm² LC HZ)

Mainchords with connection of two diagonals

U-HEZ = π/2 · 25 + 25 + 2 · 30 = 124.26

Uges = 157mm κ = 0.5

Ak = A - (1-0.5) · A (U-WEZ/Uges) = 0.60· A

=> $\sigma_{allowed\text{-}HEZ}$ = 0.60 · 14.5 = 8.7 kN/cm² (9.9 kN/cm² LC HZ)

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5.1.2 Buckling of truss diagonals

Pipe 25x3 mm EN AW 6082 T6

A = 2.07 cm² I = 1.28 cm⁴ => i = 0.786 cm

Buckling lenght sk < 50 cm

=> λ = 50 / 0.786 < 64 => ω = 1.80

Allowable min N = 2.07 · 14.5 / 1.80 = 16.675 kN

allowable N at n joints in heat effected zone (HEZ)

Allowable N = 2.07 · 8.0 = 16.56 kN (18.63 LF HZ) decisive

5.1.3 Buckling main chords locally (between two nodes)

Pipe 50x4 mm EN AW 6082 T6

A = 5.78 cm² I = 15.40 cm⁴ => i = 2.67 cm

Buckling lenght sk < 90 cm

=> λ = 90 / 2.67 < 34 => ω = 1.08

Allowable s in HEZ in buckling-endangered zone, node with 1 diagonal

=> allowable σ HEZ = 10.58 kN/cm²

=> allowable min N = 5.78 · 10.58 / 1.08 = 56.62 kN

For comparison all. N at a node with 2 diagonals

=> all. min N = 5.78 · 8.7 = 50.286 kN decisive

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5.1.4 Couplings

Shear forces and bending moments transmitted by contact of the fitting with the main-chord.

=> mainchord decisive => covered by the stress-verification

allowable normal foce at coupling

1. weld seam a = 4mm

EN AW 6082 T6 welding consumable SG-AlSi5

Acc. DIN 4113-2

Allowable σ = 7.2 kN/cm² (LC HZ 8.2 kN/cm²)

$A = \pi \cdot (2.5^2 - 2.1^2) = 5.78$ cm²

=> all. N = 5.78 · 7.2 = 41.6 kN (LC HZ 47.4 kN) decisive

2. Bolt min d = 15 mm Quality 10.9

A = 1.77 cm² fu,bk = 100 kN/cm²

Alllowable exposure acc. DIN 18800 T1

Vrd = 2 · 0.44 · 1.76 · 100 / 1.1 = 140.8 >> 1.5 · 41.6 kN not decisive

3. Bush ENAW 6082 T6

External diameter da = 59 mm
External diameter di < 40 mm => t = 19mm
Bolt diameter d = 15 mm

Bearing stress all. σL = 21.5 kN/cm²

=> all. N = 1.9 · 1.5 · 21.5 = 61.3 kN >> 41.6 kN not decisive

4. Connector AlCuBiPb F37

External diameter da = 37 mm
Bolt diameter d = 15 mm

Bearing stress all. σL = 21.0 kN/cm²

=> all. N = 3.7 · 1.5 · 21 = 116.6 kN >> 41.6 kN not decisive

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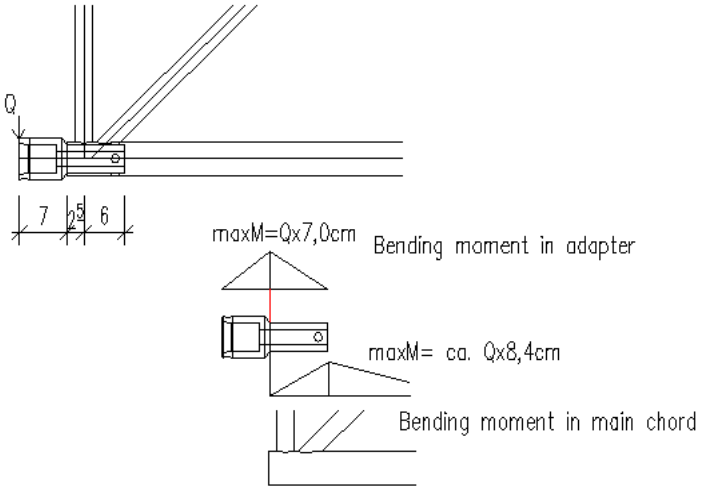
5.1.5 Bending at coupling and intersection to mainchord

Due to the adapters the the couplings form one unit with the mainchords under bending.

Therefore relevant for the verifications are the areas before and after the intersections between the adapters and the mainchords.

The decisive point for the stress verification is determined by comparison of the bending moments with the associated sections and impacts of heat effected zones.



Max M in mainchord results from the following regard:

Max res-M at node M = Q · 9.5 cm
Distance to zero point of moment = appr. 50 cm
Distance node to end of adapter = 6.0 cm

=> M_{chord} = 9.5 · Q (50-6) / 50 = 8.4·Q

Adapter compact D= 4.2 cm Wel = 7.27 cm³

Section completely in heat-effected zone Alll σ= 8.0

=> zulM = 58.16 kNcm => zul Q = 8.3 kN

Main chord 50x4 Wel = 6.06 cm³

Section in HEZ from connection with 2 diagonals zulσ = 8.7

=> zulM = 52.72 kNcm => zul Q = 52.72 / 8.7 = 6.06 kN

=> Verification in the mainchord with all. σ-HEZ = 8.7 kN/cm² (9.9 LF HZ) decisive

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5.2Verifications

The following points are verified in detail:

1. Bending in the mainchord at connection of ladder
2. Bending in the mainchord at coupling (decisive: coupling above connection of ladder)
3. Bending in the mainchord at corner-element, connection to tower
4. Bending pipe at anchor-point at the rear / bottoom
5. Maximal normal-force in the mainchord of truss F44
6. Maximal normal-force in the diagonals of truss F44
7. Compressive force in the diagonal brace
8. Stress in the tower head and adapter for brace

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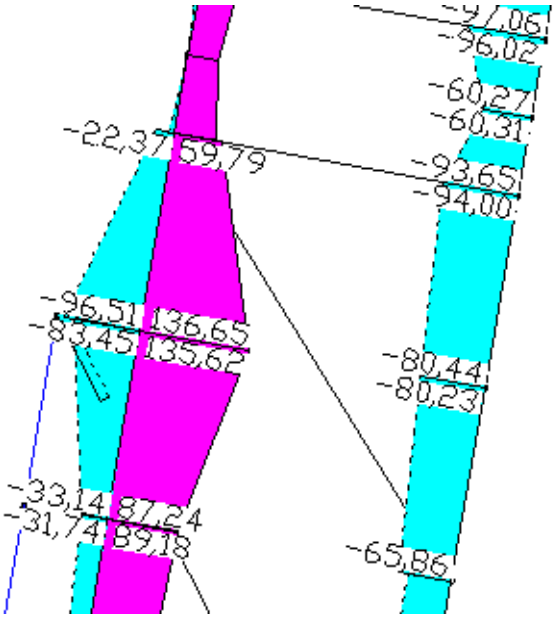
To 1. from DP max s = 13,665 kN/cm² LC HZ



Area lies outside HEZ => all. σ = 16.5 kN/cm²

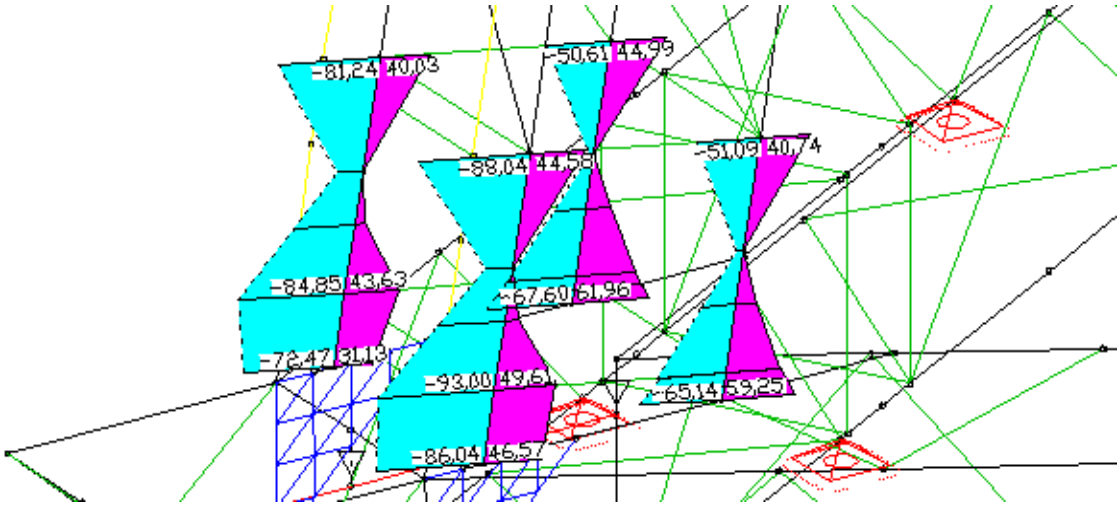
Within HEZ max σ = 8.918 < all σ = 9.9 kN/cm²

To 2. from DP max σ = 9.7 kN/cm² LC HZ

Main chord within HEZ from connection of 2 diagonals (decisive)

all. σ = 9.9 kN/cm²

To 3.



Main chord before vor weld seam (completely in HEZ)

from DP max s = 8.6 kN/cm² < 9.0 kN/cm² LC HZ

Weld seam is not decisive because it is leaded at the oustide of the mainchord and therefore features more favourable section properties.

Mainchord with connection of 2 diagonals

From DP max σ = 9.3 kN/cm² all. σ = 9.9 kN/cm²

To 4. Main chord with hollow section, welde from from below

Equals case HEZ with connection of 1 diagonal

From DP max σ = 10.65 kN/cm² (See page 43)

all. σ = 12.05 kN/cm²

To 5. Min N_{chord} = -34.67 kN (See page 38)

all. N = 47.4 kN (Weld seam at coupling LC HZ))

To 6. Min / Max N = -7.65 / 8.92 kN (See page 39)

all. N = 18.63 kN (LC HZ)

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To 7. Buckling of diagonal-braces

Pipe 60x5 mm EN AW 6082 T6

A = 8.64 cm² I = 32.94 cm^4 => i = 1.952cm

Buckling lenght sk = 330 cm

=> λ = 330 / 1.952= 169 => ω = 12.57

all. min N = 8.64 · 14.5 / 12.57 = 9.97 kN (LC HZ 11.34 kN)

min N =10.25 - kN < zul. Min N = 11.34 kN (see page 42)

To 8. Stresses in tower-head and adapter-parts are far below allowable stresses

See DP pages 52 + 53

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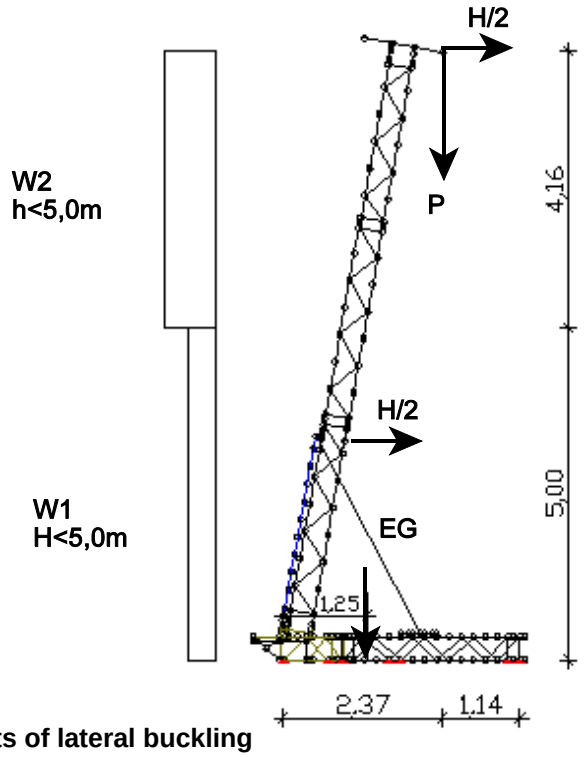
6 STABILITY

Stability acc. DIN 4112

Height of tower above terrain h =appr. 9.20 m (appr. 10 yd)

Total weight tower 230 kg (see load summaries DP)

Center of gravity tower x = 1.25m from right bearing (see DP)



Moments of lateral buckling

Loadcase Operational state with payload

w1 = 0.032 kN/m w2 = 0.052 kN/m H_{tot} = 1.25 kN Height < 8.0m

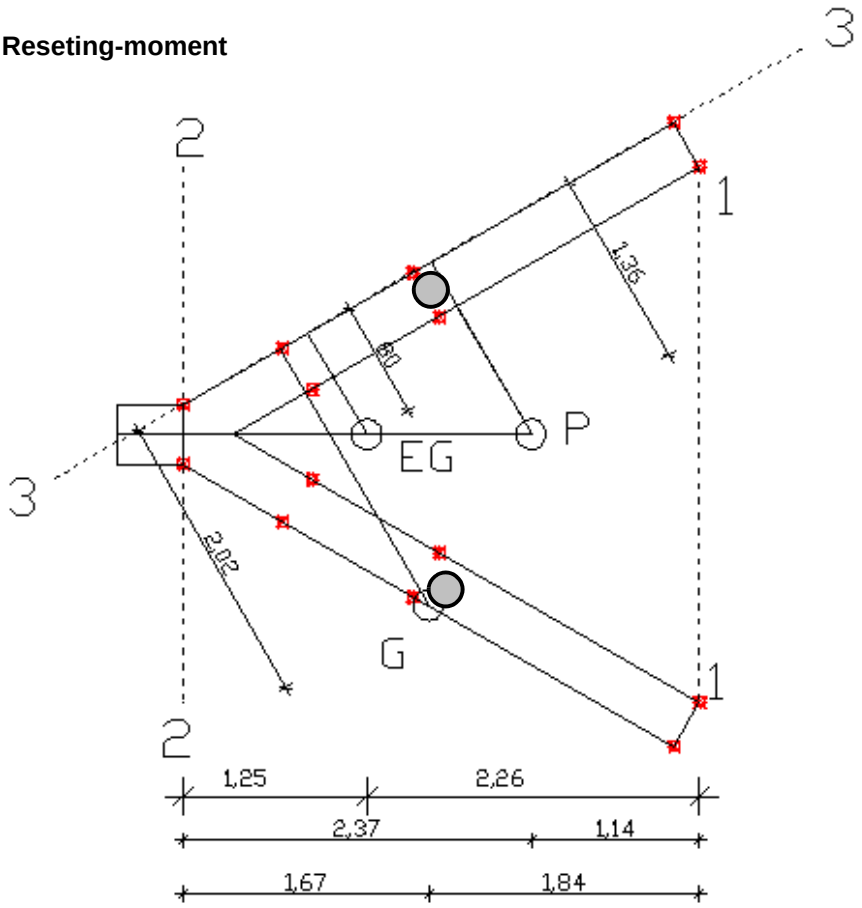
Mkw = 0.032 ·5² / 2 + 0.052 · 4.16 · 7.08 + 1.25 · 8.0 = 11.93 kNm

Loadcase no operation (without payload)

w1 = 0.064 kN/m w2 (up to 8m) = 0.104 kN/m
w2 (> 8m) = 0.168 kN/m

Mkw = 0.064 ·5² / 2 + 0.104 · 3.0· 6.5 + 0.168 ·1.16· 8.58 = 4.50 kNm

Reseting-moment



P = Payload ; EG = Selfweight Tower ; G = nec. Ballast

Loadcase Operational state with payload Lateral buckling around axis 1 is decisive

Additional deformation from calculation acc. 2nd order theory ux < 12 cm

Ms = 10.5 · (1.14-0.12) + 2.3 · 2.26 = 15.9 kNm > 1.2 Mk = 14.31

=> no Ballast necessary

Loadcase no operation (without payload)

Case lateral buckling around axis 3

Ms = 2.3·0.8 = 1.84 < 1.2 Mk => Ballast necessary

Ballast centered at each cantilever

=> nec G · 2.02 > 1.2 · 4.5 - 1.84 = 1.76 kN **elected: 2 x 180 kg (2 x 400 lb)**

Lateral buckling around axis 2 is not decisive