Büro für Tragwerksplanung und Ingenieurbau
vom Felde + Keppler GmbH

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Structural Report

Modular Drop System

25496

for the system by

Global Truss GmbH
Im Stöckmädle 27

76307 Karlsbad

compiled by:

responsible engineer:

assisting engineer:

Aachen, 05.09.2025

INGENIEURKAMMER-BAU NORDRHEIN-WESTFALEN
BERATENDER INGENIEUR
716397

This Structural Report includes pages 1 – 10 + Annexes

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Büro für Tragwerksplanung und Ingenieurbau
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1 GENERAL REMARKS

1.1 Basics

The currently applicable regulations and standards, in particular:

DIN EN 1991-1	Loadings for buildings (Eurocode 1)
DIN EN 13814	Temporary structures
DIN EN 13782	Temporary structures – Tents
DIN EN 1993-1	Steel structures (Eurocode 3)
DIN EN 1995-1	Wooden Structures (Eurocode 5)
DIN EN 1999-1	Aluminium Structures (Eurocode 9)
DIN 4113	Aluminium Structures
DIN 4114	Stability
DIN 15920	Part 2: Stage and Studio structures
DIN 18800	Part 1: Steel Structures
DIN 2448	Steel tubes
DIN EN 12385	Steel cables
DGUV 215-313	Loads above persons

1.2 Building Materials

EN AW-6082 T6	Aluminium alloy of the Tubes (T-piece and F31 spacers)
EN AW-6061 T6	Aluminium alloy of the stirrup plates

1.3 General description

Subject of this calculation is the verification of a so-called Modular Drop System and its attachment to a substructure (pipe with a diameter of 48-51 mm). The substructure itself is not the subject of this static calculation and must be verified separately.

The structure consists of several T-pieces arranged one above the other, which are connected to each other via conical connector. The Modular Drop System is suspended from a substructure using half couplers 5034 or 5034-1 (manufacturer: Globaltruss).

Optionally, the distance between two T-pieces can be extended by F31 spacers. In this case, the allowable loading per T-piece has to be reduced by the weight of the spacers (see also notes chap. 1.4).

For the lower end, it is possible to arrange so-called stirrups (end brackets).
=> see chapter 1.4 variant G or optionally for variants A to F (reduce loading acc. chap. 1.4).

In this calculation only the indoor setup is taken into account

The components (T-piece and stirrup) are verified in accordance with the principles of DGUV 215-313 as load lifting devices acc. EN 1999-1.

The top fixation (half coupler) is calculated acc. DGUV 215-313 as lifting tackles with doubled operation coefficient.

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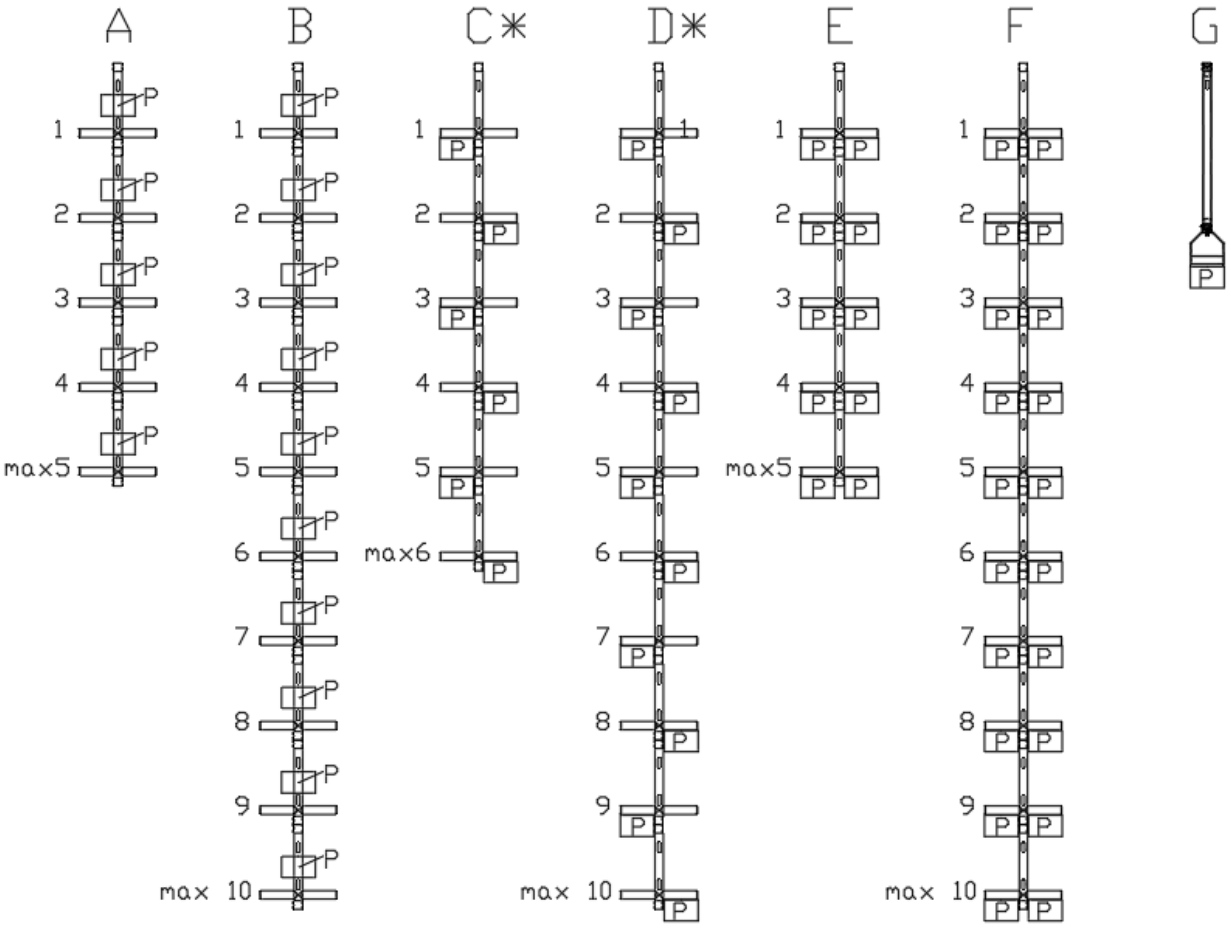
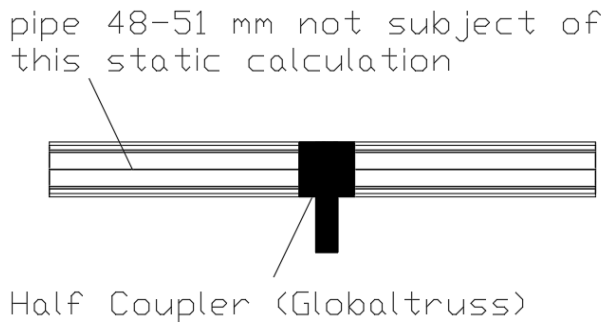
1.4 Advice on setting up and operation

There are 7 different variants (A, B, C*, D*, E, F, G) of the Modular Drop System. Up to 10 T-pieces can be mounted together.
The suspended loadings P are mounted centered at the horizontal tubes or at their vertical tubes:



For the variants C* and D* the sum of loadings at the left and at the right side have to be equally. The number of frames has to be even.

The Drop System is attached to a pipe with a diameter of 48-51 mm using a Globaltruss Half Coupler (rated load capacity 500 kg) (item code: 5034 or 5034-1):



The pipe 48-51 mm is <u>not</u> part of this static calculation and must be verified separately!

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allowable loadings P in [kg] for variants A to G:

The allowable loadings P acc. DGUV 215-313 per T-piece or stirrup of the different variants (A, B, C*, D*, E, F, G) are shown in the following tables.
=> verification see chapter 3

Variante	A
max n	5
P [kg] ≤	**48**

Variante	B
max n	10
P [kg] ≤	**23**

Variante	C
max n	6
P [kg] ≤	**39**

Variante	D
max n	10
P [kg] ≤	**23**

Variante	E
max n	5
P [kg] ≤	**24**

Variante	F
max n	10
P [kg] ≤	**11**

Variante	G
max n	1
P [kg] ≤	**170**

(note: for variante G, the verification of the stirrup plate is decisive => see chapter 3.2)

i) Extension between two T-pieces for variants A to F:

Optionally, the distance between two T-pieces can be extended using F31 spacer. In this case, the permissible payload per T-piece must be reduced by the weight of the spacers:

Example: Extension with a 1,0m tube
Weight of extension tube ca. 1,80 kg
Weight of connection ca. 0,25 kg
=> allowable loading has to be reduced by 2,05 kg

for example for variant A:
now **allowable P= 45,95 kg** previously 48 kg

ii) Addition of stirrup/end bracket for variants A to F:

Optionally, a stirrup/end bracket can be added to variants A to F at the bottom. In this case, the permissiblle payload per T-piece must be reduced by the weight of the stirrup **+ payload on the stirrup**.

Example: Stirrup + 15 kg payload on the stirrup
Weight of the stirrup ca. 1,0 kg
Payload on the stirrup ca. 15 kg
=> allowable loading has to be reduced by 16 kg

for example for variant A:
n = 5 payloads
now **allowable P =** (48 - 16/5) **= 44,8 kg** previously 48 kg

for example for variant F:
n = 20 payloads
now **allowable P =** (11 - 16/20) **= 10,2 kg** previously 11 kg

iii) combination of i + ii:

A combination of i + ii is also possible:

Example: Extension with a 1,0m tube and addition of stirrup + 15 kg payload on the stirrup

vor example for variant A:
reduction due to extension: see i)
now allowable P= 45,95 kg
reduction due to addition of stirrup + payload see ii)
=> allowable loading reduced by 16 kg
now **allowable P =** (45,95 - 16/5) **= 42,75 kg**

iv) Extension variant G:

It is possible to extend variante G using F31 spacer until a total load of 250 kg (ELL of the Half Coupler from Globaltruss => see verification in chap. 3.3) is reached.
=> possible weight of extension: 250 - 170 - 3,6 = 76,4 kg => unrealistic scenario!

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1.5 Loadings

Selfweight

T-piece	approx. 1,50 kg		
Connector	approx. 0,25 kg		
Half Coupler	approx. 0,80 kg		
Stirrup	approx. 1,00 kg		
extension	F31	L = 1,00 m	approx. 1,80 kg
		L = 0,50 m	approx. 1,20 kg
		L = 0,25 m	approx. 0,90 kg

Total weight variants A – G

Variante	A	B	C	D	E	F	G
in [kg]	9,3	18,1	11,1	18,1	9,3	18,1	3,6

Payloads P

Depending on the variant see chapter 1.4

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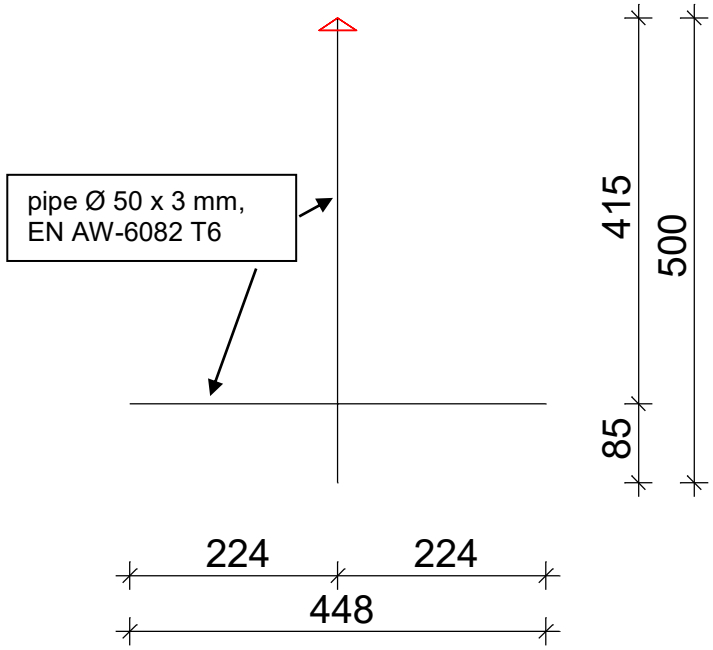
2 SYSTEM

Overview of isometric T-piece - axial dimensions in [mm]

(All dimensions refer tot he system lines of the pipes.)

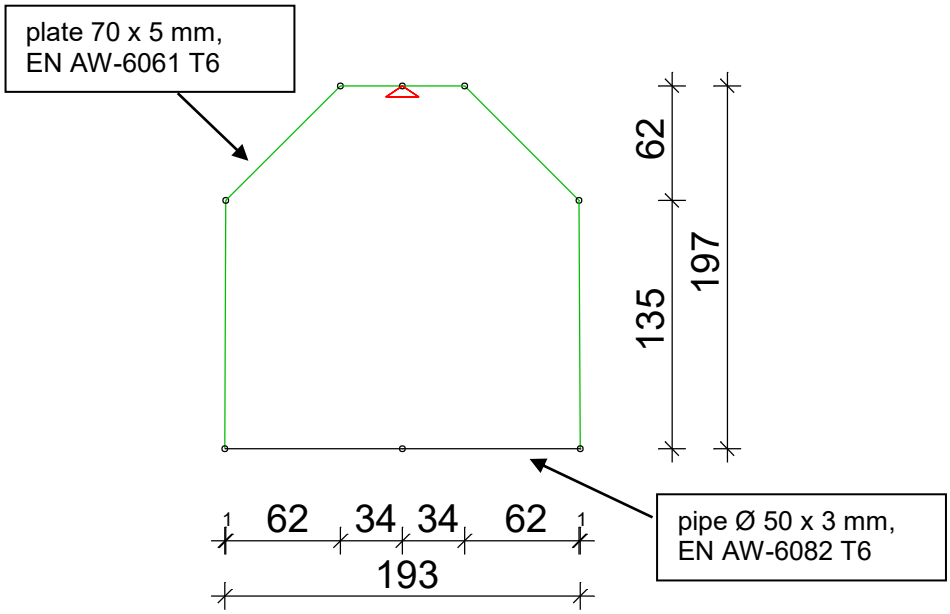
see also drawing in the annex



Overview of isometric stirrup/end bracket - axial dimensions in [mm]

(All dimensions refer tot he system lines of the pipes and plates)

see also drawing in the annex



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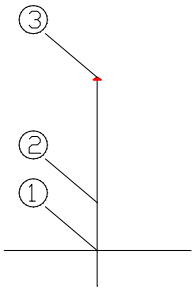
3 STRUCTURAL INTEGRITY

3.1 Veriftication T-piece (chords)

Section- and material properties:

chords	material	fo [N/mm²]	fu [N/mm²]	fo,haz [N/mm²]	fu,haz [N/mm²]
50x3mm	6082 T6	250	290	125	185

The verifications are only carried out for variant C, as this variant allows the highest payloads P to be attached to the lateral cantilevers and the stress on the T-pieces is maximum.

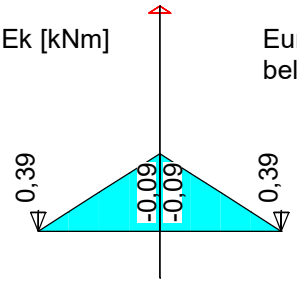


The decisive factor for verifying the horizontal tube is point 1. To be on the safe side, it is assumed that the entire cross-section is located in the heat-affected-zone (HAZ).

The decisive factor for verifying the vertical tube is point 2 with a reduced cross-section due to two openings with a diameter of 20 mm (see drawing in the appendix). To be on the safe side, it is assumed that the entire cross-section is located in the heat-affected-zone (HAZ).

T-piece: bending moment in [kNm] for max. payload P of 39 kg at the lateral cantilevers

MEk [kNm]



Eurocode safety factors are taken into account in the verification below!

Verifications at point 1 - Verification horizontal pipe: (including safety factor 1,5 according to Eurocode)

Maximum loading	max M_{Ed} = 1,5 · 9 kNcm = 13,5 kNcm
Resistance	min fu,haz = 18,5 kN/cm² (EN AW 6082 T6) A = 4,43 cm²
	Reduction factor 0,8 acc. EN 1999-1
	ρu,haz = 185 / 290 = 0,64 teff = 0,8 · 0,64 · 3 = 1,53 mm => W,net = π · 2,35² · 0,153 = 2,65cm³ min fu = 29 kN/cm² (EN AW 6082 T6) MRd = 2,65 · 29 / 1,25 = 61,48 kNcm
Verification acc. EN 1999-1:	13,5 / 61,48 = 0,22 < 1,0

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Verifications at point 2 - Verification vertical pipe: (including safety factor 1,5 according to Eurocode)

Maximum loading	max N_{Ed} = 1,5 · 5,0 / 2 = 3,75 kN (from max. load-capacity of the fixations, see chapter. 3.3)
Resistance	min fu,haz = 18,5 kN/cm² (EN AW 6082 T6) A = 4,43 cm²
	Reduction factor 0,8 acc. EN 1999-1 for welded aluminium
	Reduction factor 0,9 acc. EN 1999-1 for local failure in cross-section with holes
	A,holes = 2 cm · 0,3 cm · 2 = 1,2 cm²
	NRd = 0,8 · 18,5 / 1,25 · (4,43 - 1,2)cm² · 0,9 = 34,42 kN
Verification acc. EN 1999-1:	$(3,75 / 34,42)^{1,3}$ = 0,06 < 1,0

Verification at position 3 is covered by the verification at position 2.

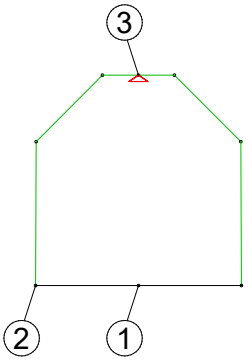
3.2 Verification of stirrup / end bracket

Section- and material properties:

chords	material	fo [N/mm²]	fu [N/mm²]	fo,haz [N/mm²]	fu,haz [N/mm²]
50x3mm	6082 T6	250	290	125	185

plates	material	fo [N/mm²]	fu [N/mm²]	fo,haz [N/mm²]	fu,haz [N/mm²]
70x5mm	6061 T6	240	290	115	175

The verifications are only performed for variant G, as this variant allows the highest payloads P to be attached to the stirrup and the stress on the stirrup is maximum.

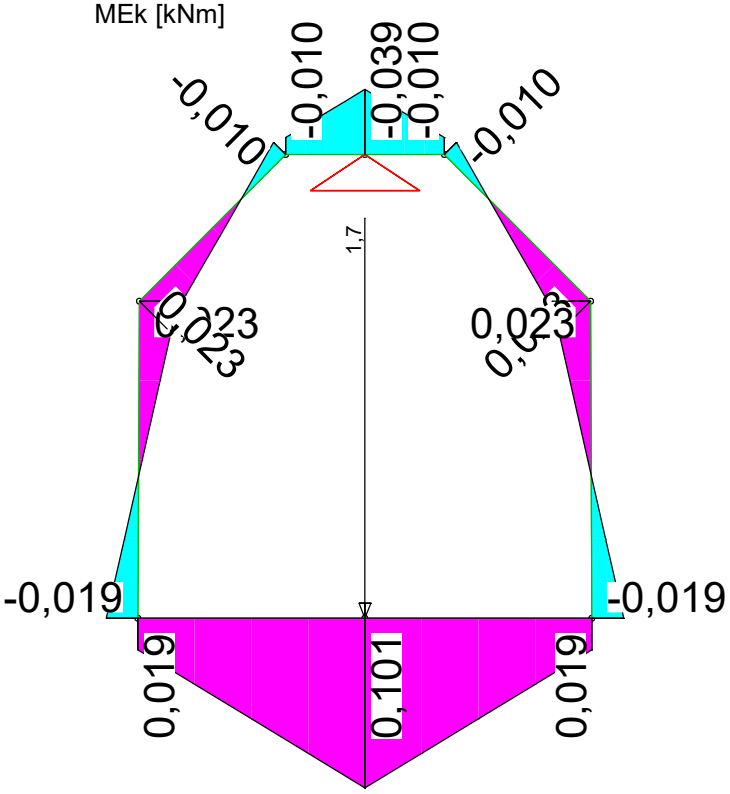


Verification point 2 is decisive for the chords. To be on the safe side, it is assumed that the entire cross-section is located in the heat-affected-zone (HAZ).

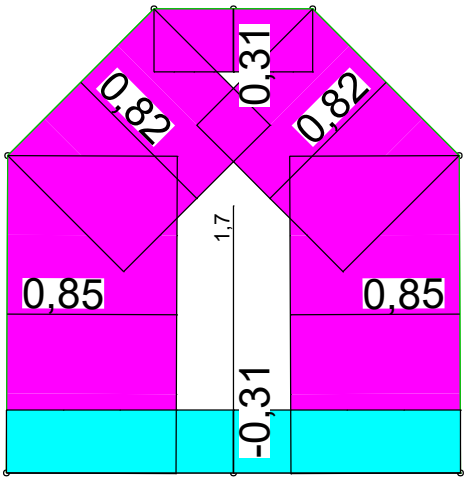
Verification points 2 + 3 are considered for the verification of the plates, assuming that the entire cross-section is located in the HAZ at verification point 2.

Stirrup: bending moment in [kNm] and normal force in [kN] for max. payload P with 170 kg

MEk [kNm]



NEk [kN]



Eurocode safety factors are taken into account in the verification (see following page).

Verification chord 50 x 3 mm - EN AW 6082 T6:

Verification includes safety factor 1,5 according to Eurocode

max. bending moment:	MEd = 1,5 · 10,1 kNcm	= 15,2 kNcm
max. normal force:	NEd = 1,5 · 0,31 kN	= 0,47 kN
Resistance:	safe side assumption cross-section completely in HAZ (see also chap. 3.1) NRd = 52,45 kN MRd = 61,48 kNcm	
Verification:	Interaction acc. EN 1999-1: $(0,47 / 52,45)^{1,3} + 15,2 / 61,48 = 0,25$	< 1,0

Verification plate 70 x 5 mm - EN AW 6061 T6:

Verification includes safety factor 1,5 according to Eurocode

Verification point 2 - cross-section completely in the heaf-affected-zone (HAZ)

max. bending moment:	MEd = 1,5 · 1,9 kNcm	= 2,85 kNcm	
max. normal force:	NEd = 1,5 · 0,85 kN	= 1,28 kN	
Resistance:	Wel = 7 · 0,5² / 6 = 0,292 cm³ Wpl = 7 · 0,5² / 4 = 0,438 cm³ A = 7 · 0,5 = 3,5 cm²		
	EN AW 6061 T6	fo,haz = 11,5 kN/cm² fu,haz = 17,5 kN/cm²	γ_{M1} = 1,10 γ_{M2} = 1,25
	MRd,el = 0,8 · 0,292 · 17,5 / 1,25		= 3,27 kNcm
	MRd,pl = 0,8 · 0,438 · 11,5 / 1,10		= 3,66 kNcm
	NRd = 0,8 · 3,5 · 11,5 / 1,10		= 29,27 kN
Verification:	Interaction acc. EN 1999-1: $(1,28 / 29,27)^{1,3} + 2,85 / 3,27 = 0,89$		< 1,0

Verification point 3 - cross-section not in the HAZ

max. bending moment:	MEd = 1,5 · 3,9 kNcm	= 5,85 kNcm	
max. normal force:	NEd = 1,5 · 0,31 kN	= 0,47 kN	
Resistance:	Wel = 7 · 0,5² / 6 = 0,292 cm³ Wpl = 7 · 0,5² / 4 = 0,438 cm³ A = 7 · 0,5 = 3,5 cm²		
	EN AW 6061 T6	fo = 24,0 kN/cm² fu = 29,0 kN/cm²	γ_{M1} = 1,10 γ_{M2} = 1,25
	MRd,el = 0,292 · 29,0 / 1,25		= 6,77 kNcm
	MRd,pl = 0,438 · 24,0 / 1,10		= 9,56 kNcm
	NRd = 3,5 · 24,0 / 1,10		= 76,36 kN
Verification:	Interaction acc. EN 1999-1: $(0,47 / 76,36)^{1,3} + 5,85 / 6,77 = 0,87$		< 1,0

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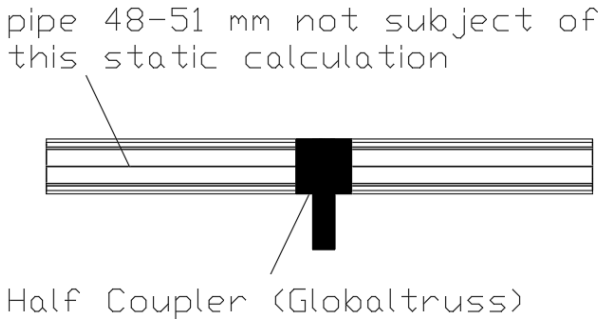
3.3 Verification of fixation

The Drop System is attached to a pipe with a diameter of 48-51 mm using a Globaltruss Half Coupler (rated load capacity 500 kg) (item code: 5034 or 5034-1):



The pipe 48-51 mm is not part of this static calculation and must be verified separately!

Acc. DGUV 215-313 only 50% of the load-capacity given by the manufacturer can be taken into account for loadings above persons.

Fixation with Half Coupler (Globaltruss) variants A-G (item code: 5034/5034-1)
WLL 500 kg
allowable P_{total} = 500 / 2 = 250 kg (ELL)

The calculation is done acc. the following principle:

$$\mathbf{P = (all\ P_{total} - G_{ges}) / k}$$

The results are shown in the tables of chapter 1.4

Example for variant A

Number of frames n = 5
Number of mounted payloads k = 5

selfweight G:

G = n x 1,5 kg + 0,8 kg + (n-1) x 0,25
= 5 x 1,5 + 0,8 + 4 x 0,25 = 9,3 kg

Allowable payloads P:

P = (250 kg- 9,3 kg) / 5 = 48,14 kg = approx. 48 kg

Example for variant F

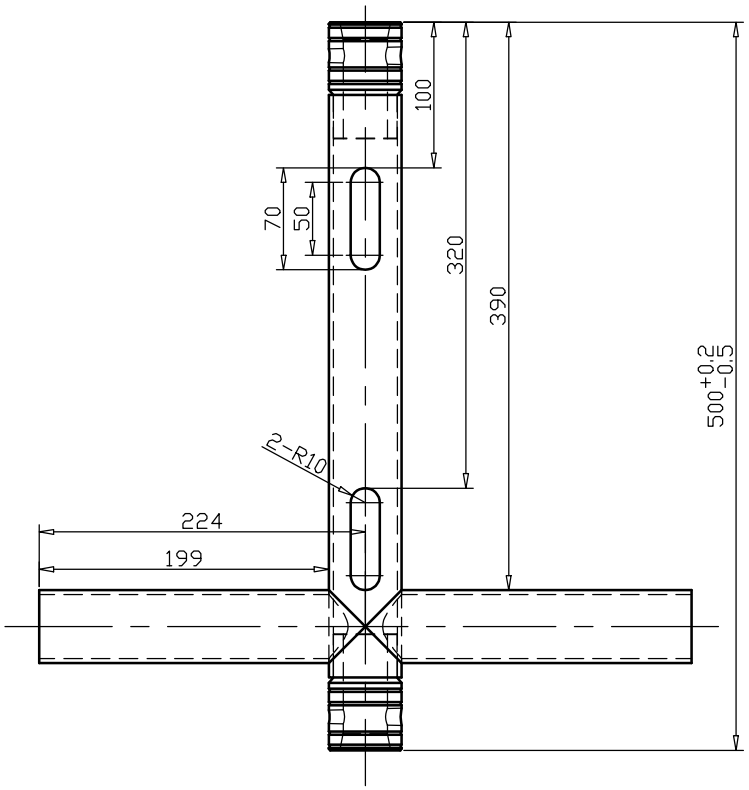
Number of frames n = 10
Number of mounted payloads k = 20

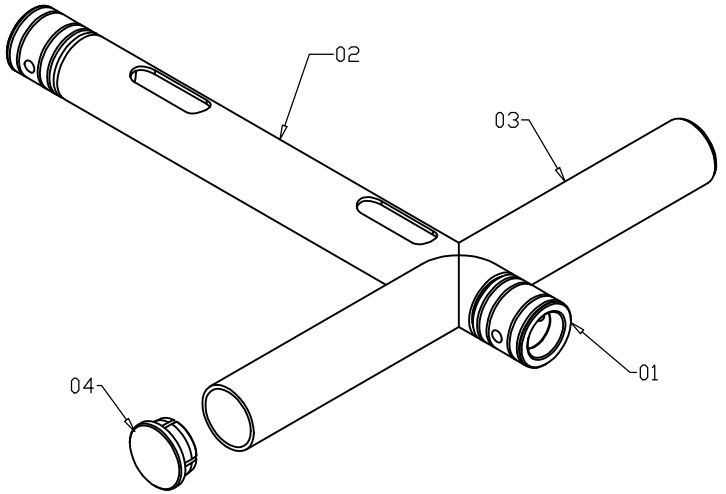
selfweight G:

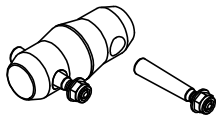
G = n x 1,5 kg + 0,8 kg + (n-1) x 0,25
= 10 x 1,5 + 0,8 + 9 x 0,25 = 18,05 kg

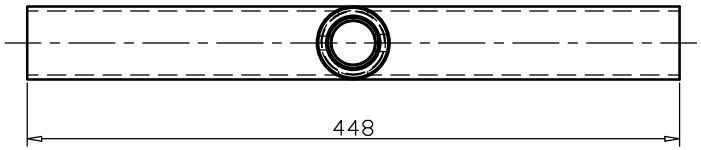
Allowable payloads P:

P = (250 kg- 18,05 kg)/ 20 = 11,60 kg = approx. 11 kg









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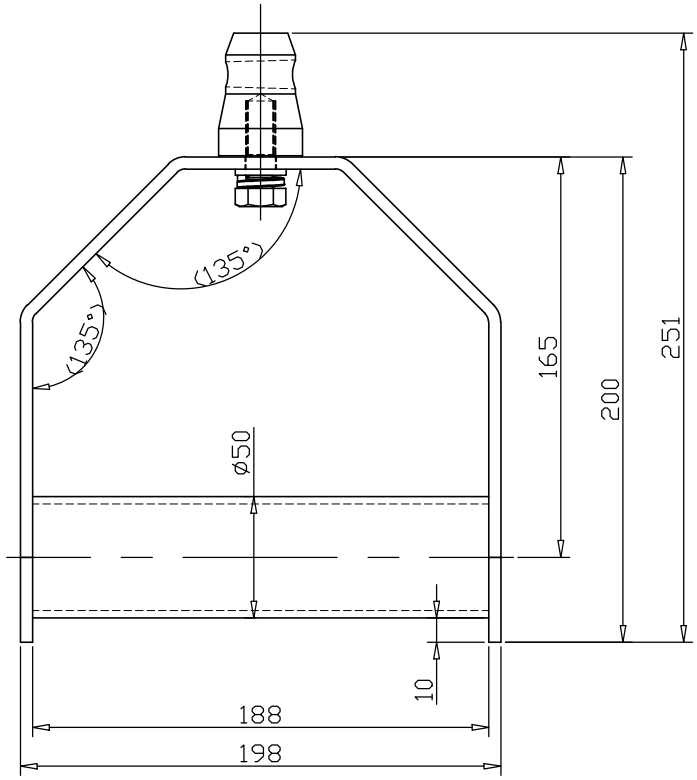
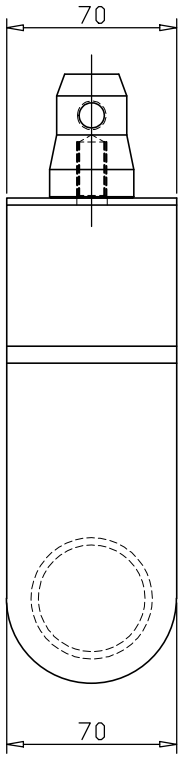
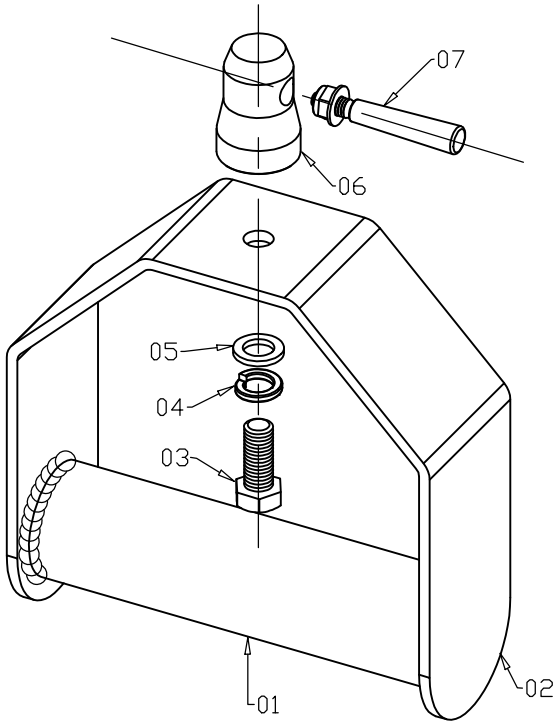
	DMS-01-3	#2011	T6	1
04	PJ-NS017C		RAW	2
03	ø50*3.0t*224mm	#6082	T6	2
02	ø50*3.0t*400mm	#6082	T6	2
01	DMS-01-2CR	#6082	T6	2
NO.	SPEC.	MATERIAL	FIN.	QTY.

DRAWN		DRAW NO	QDOLLY05D		DOLLY05D	edition	1
Specification	***	DESIGN	*Bin Lee*	DATE 17.11.15	2D/3D	APPROVED	
Weight	1.42kgs/pcs	UNITS	*mm*	Proofread	CHECKED		
SURFACE	RAW	SCALE	*1:5*				

MARK	NAME	RETRIEVE CONTENTS	DATE







NO.	SPEC.	MATERIAL	FIN.	QTY.
07	ST5005	S45C	ZP	1
06	YZ-DMS-05	#2011	T6	1
05	ø13*ø24*2.3t	steel	ZP	1
04	ø12.5*ø19*3.4t	steel	ZP	1
03	M12*1.75P*30mm	12.9DIN	black	1
02	PJ-LB229	#6061	T6	1
01	ø50*3.0t*188mm	#6082	T6	1

DRAWN	***	DRAW NO	QLJJ25A		2D/3D	edition	1
Specification	198*70*251mm	DESIGN	Iris	DATE 23.10.21	CHECKED	APPROVED	
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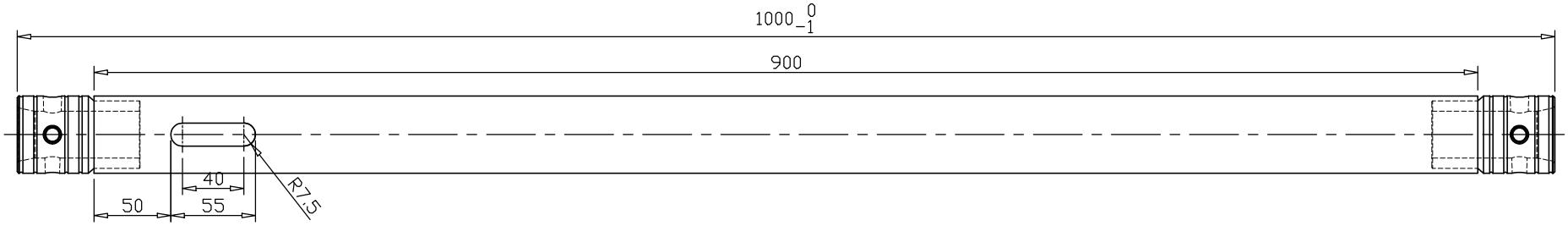
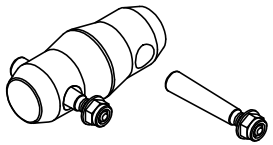
SURFACE	RAW	SCALE	1:3				

MARK	NAME	RETRIEVE CONTENTS	DATE

Global Truss





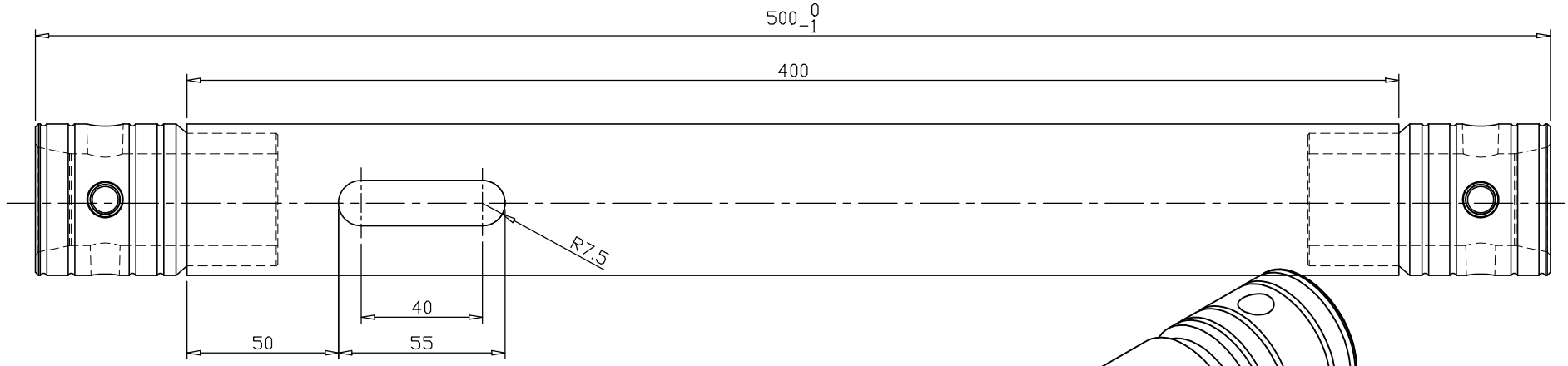
fitting

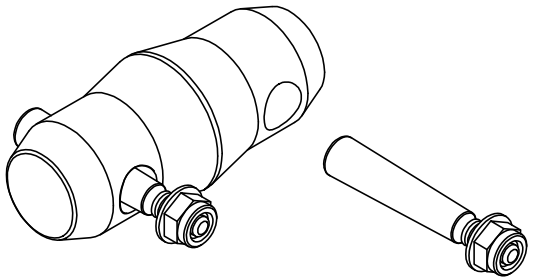
fitting	ST5005	S45C	ZP	2
	DMS-01-3	#2011	T6	1
02	ø50*3.0t*902mm	#6082	T6	1
01	DMS-01-2CUR	#6082	T6	2
NO.	SPEC.	MATERIAL	FIN.	QTY.

	DRAWN	DOLLY	DRAW NO	QDJ007D-L100		2D/3D	edition	1
	Specification	***	DESIGN	Bin Lee	DATE 17.11.15	CHECKED	APPROVED	
	Weight	**kgs/pcs	UNITS	mm	Proofread			
	SURFACE	RAW	SCALE	1:4				

MARK	NAME	RETRIEVE CONTENTS	DATE

Global Truss





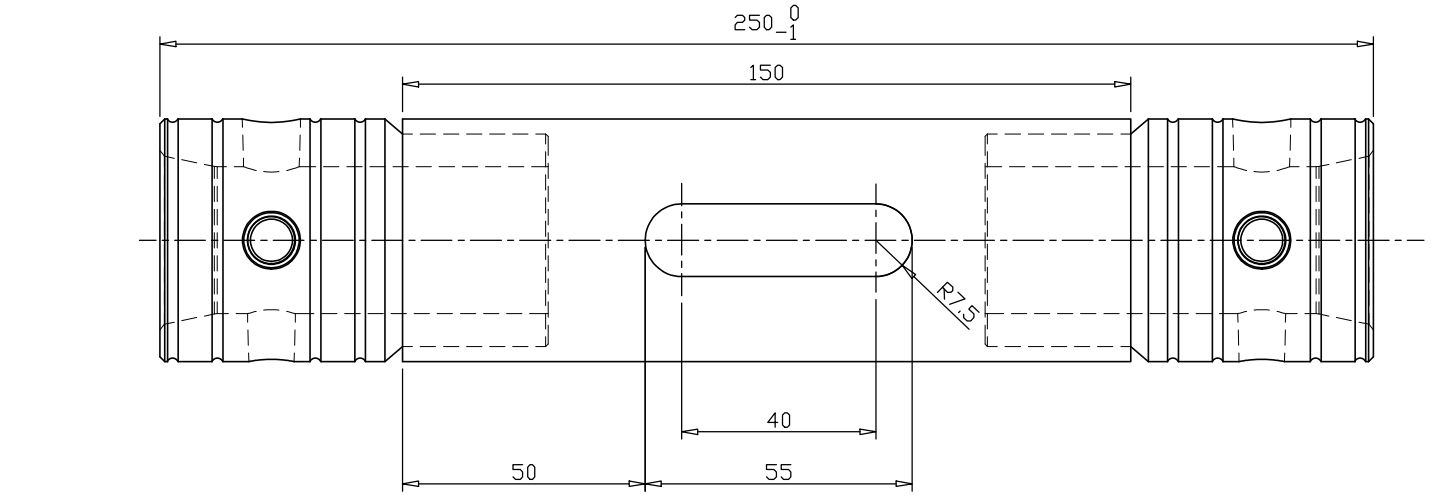
fitting

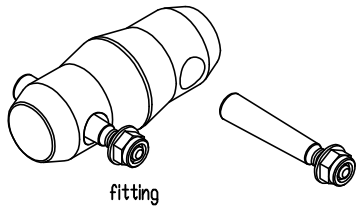
NO.	SPEC.	MATERIAL	FIN.	QTY.
fitting	ST5005	S45C	ZP	2
	DMS-01-3	#2011	T6	1
02	ø50*3.0t*402mm	#6082	T6	1
01	DMS-01-2CUR	#6082	T6	2

DRAWN	DOLLY	DRAW NO	QDJ007D-L050		2D/3D	edition	1
Specification	***	DESIGN	Bin Lee	DATE 17.11.15	CHECKED	APPROVED	
Weight	**kgs/pcs	UNITS	mm	Proofread			
SURFACE	RAW	SCALE	1:2				

MARK	NAME	RETRIEVE CONTENTS	DATE

Global Truss





NO.	SPEC.	MATERIAL	FIN.	QTY.
fitting	ST5005	S45C	ZP	2
	DMS-01-3	#2011	T6	1
02	ø50*3.0t*150mm	#6082	T6	1
01	DMS-01-2CUR	#6082	T6	2

DRAWN	DOLLY	DRAW NO	QDJ07D-L025		2D/3D	edition	1
Specification	***	DESIGN	Bin Lee	DATE 17.11.15	CHECKED	APPROVED	
Weight	**kgs/pcs	UNITS	mm	Proofread			
SURFACE	RAW	SCALE	1:1.5				

MARK	NAME	RETRIEVE CONTENTS	DATE

Global Truss