Büro für Tragwerksplanung und Ingenieurbau
vom Felde + Keppler GmbH & Co. KG

Lütticher Straße 10-12
52064 Aachen
www.vom-felde.de

Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

Structural Report F31P 17335

für das System der Firma
for the system by

Global Truss
Furong Industrial Area
Shajing Town

Baoan District Shenzen China

compiled by: A. Rumpel

Aachen, 27.06.2017

INGENIEURKAMMER-BAU NORDRHEIN-WESTFALEN
BERATENDER INGENIEUR
101448

This Structural Report includes pages 1 - 12

Büro für Tragwerksplanung und Ingenieurbau
vom Felde + Keppler GmbH & Co. KG
Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

TABLE OF CONTENTS

Büro für Tragwerksplanung und Ingenieurbau
vom Felde + Keppler GmbH & Co. KG
Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

1 PRELIMINARY NOTES

1.1 Basics

The currently applicable regulations and standards, in particular:

DIN EN 1991-1	Actions on structures (Eurocode 1)
DIN EN 13814	Fairground and amusement park machinery and structures
DIN EN 13782	Temporary Structures – Tents
DIN EN 1993-1	Design of steel structures (Eurocode 3)
DIN EN 1999-1	Design of aluminium structures (Eurocode 9)

1.2 Materials

Tubes	Aluminium EN AW-6082 T6
Bolts	grade min. 8.8

1.3 General Remarks

This structural report is a structural calculation concerning the System F31P produced by the company GLOBAL TRUSS. The structural report is the basis for the certification by TÜV based on EN 1999-1.

The truss system is part of a "modular construction system" with the different truss lengths 500mm, 1000mm, 1500mm, 2000mm, 2500mm, 3000mm, 3500mm, 4000mm, 4500mm and 5000mm.

The system consist of round tubes 50 x 3mm, which are connected with couplers consisting of female fittings, connectors and bolts.

The allowable loads are listed in tables (see chapter 5).

The verification of the single parts is done according the safety concept of EN 1990 with a partial safety factor on the loading side of 1.50 for payloads.

For applications which can be calculated on the basis of other codes, the partial safety factors can be adjusted (for example temporary structures acc. EN 13814, yF = 1.35 for payloads).

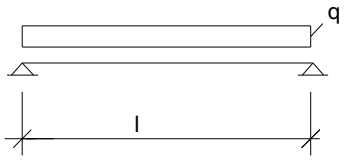
To use the resulting allowable loads with British Standard (BS) and ANSI, the allowable loads listed in tables have to be multiplied by 0.85.

Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

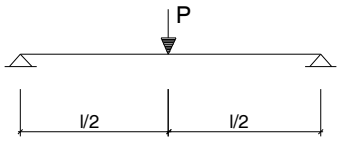
1.4 Geometry and Loadings

The following loadcases are taken into account:

uniformly distributed load (UDL)



Single-load in 1/2 point



The allowable load is calculated for couplers at any position and for spans without coupler.

The selfweight of the truss is calculated with 2,0 kg/m.

Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

2 SYSTEM

Drawing F31. . . . . .

see annex

Büro für Tragwerksplanung und Ingenieurbau
vom Felde + Keppler GmbH & Co. KG
Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

3 SECTION- AND MATERIAL PROPERTIES

Properties Tubes

	D	t	A	I	Wel	i
	[mm]	[mm]	[cm²]	[cm⁴]	[cm³]	[cm]
main chords	50,0	3	4,43	12,28	4,91	1,67

Material properties

Pipes EN AW 6082 T6 (AlMgSi1)

allowable stress acc. to EN-1999-1-1

Partial safety factors material

γ_{M1}=	1,10	buckling class / BC=	A
γ_{M2}=	1,25		

0,2%-Proof Strength			ultimate tensile strength		
fo t≤5mm=	250	[N/mm²]	fu t≤5mm=	290	[N/mm²]
fo t>5mm=	260	[N/mm²]	fu t>5mm=	310	[N/mm²]
fo,haz=	125	[N/mm²]	fu,haz=	185	[N/mm²]

Strength of welding seams fw= 190 [N/mm²]

Factor for HAZ-values for TIG-welding: 0,8

Büro für Tragwerksplanung und Ingenieurbau
vom Felde + Keppler GmbH & Co. KG
Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

Bolt	min. grade 8.8

Connector EN AW 2011 (AlCuBiPb F37)

0,2%-Proof Strength		ultimate tensile strength	
fo>	230 [N/mm²]	fu>	310 [N/mm²]

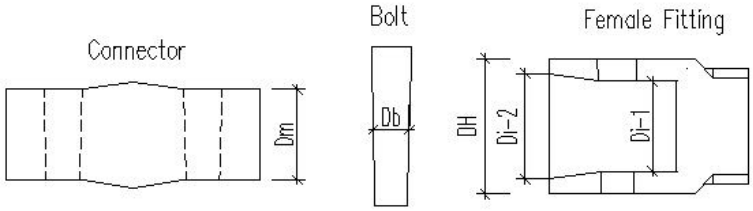
Female fitting EN AW 6082 T6

allowable stress acc. to EN-1999-1-1

Partial safety factors material

γ_{M1}=	1,10
γ_{M2}=	1,25

0,2%-Proof Strength		ulltimate tensile strength	
fo=	250 [N/mm²]	fu=	290 [N/mm²]



Section- and material properties of the tubes

Material	E=	70000	[N/mm²]	
	fo=	250,00	[N/mm²]	
	fo/γ_{M1}=	227,27	[N/mm²]	
	fo,haz=	125,00	[N/mm²]	
	fu=	290,00	[N/mm²]	
	fu/γ_{M2}=	232,00	[N/mm²]	
	fu,haz=	185,00	[N/mm²]	
	fu,haz/γ_{M2}=	148,00	[N/mm²]	
Cross section	D0=	50,00	[mm]	
	A=	4,43	[cm²]	
	I=	12,28	[cm^4]	
	i=	1,67	[cm]	
Determination of section-clas	β=	12,25	[-]	$3 \cdot (D0 / t)^{0,5}$ nach 6.10
	ε=	1,00	[-]	$(250 / fo)^{0,5}$
	section class=	2		acc. chapter 6.1.4.4
Coefficients for buckling	BC=	A	[-]	
	α=	0,20	[-]	
	λo=	0,10	[-]	

Büro für Tragwerksplanung und Ingenieurbau
vom Felde + Keppler GmbH & Co. KG
Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

4 ZULÄSSIGE BELASTUNGEN EINZELBAUTEILE

ALLOWABLE LOADING SINGLE COMPONENTS

Zulässiges Moment im Gurtrohr:
Allowable bending moment at main chord:

Local bending of chord out of HAZ

D=	50,0	[mm]	
t=	3	[mm]	
Wel=	4,91	[cm³]	
Wpl= 4 x Rn² x t=	6,63	[cm³]	Rn = D / 2 - t / 2
α=	Wpl/Wel		acc. Tab. 6.4 for section-class 2
MoRd = α · Wel · fo / yM1=	**150,61**	[kNcm]	acc. equation 6.24

Local bending of chord at the coupler (completely in HAZ)

local welding seam acc. Chapter 6.2.9.3 (1)

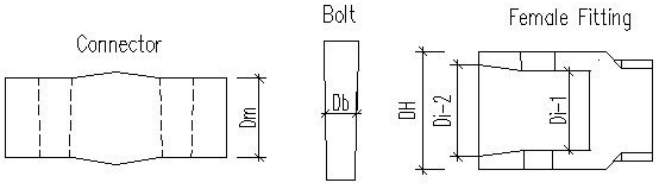
D=	50	[mm]	
red-Faktor=	0,8	[-]	(WIG TIG)
ρu,haz=	0,64	[-]	fu,haz / fu
tu,eff=	1,53	[mm]	red-Faktor · ρu,haz · t
Wu,eff= π x R² x tu,eff=	2,66	[cm³]	mit R = D / 2 - t / 2
MuRd = Wu,eff · fu / yM2=	**61,63**	[kNcm]	acc. equation 6.24

relevant for main chord tubes with coupler: **MRd_G = 61,63 kNcm**

relevant for main chord tubes without coupler: **MRd_G = 150,61 kNcm**

Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

Allowable moment at coupler:



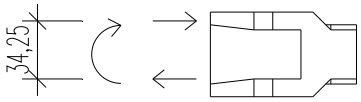
Bolt

Material min grade 8.8	fy,bk=	64,00 [kN/cm²]
	fu,bk=	80,00 [kN/cm²]
Geometry	Db=	1,08 [cm]
	Ab=	0,91 [cm²]

allowable loading due to shearing acc. to EN 1999-1-1

N_{Rd} = 0,60 x Ab x fub,k / 1,25= **34,85** [kN]

lever arm: $(D_H - D_{i-1}) / 4 + D_{i-1}$ = (50-29) / 4 + 29 = 34,25 mm



$M_{Rd,Bolt}$ = 34,85 · 3,425 = **119,36 kNcm**

Female Fitting

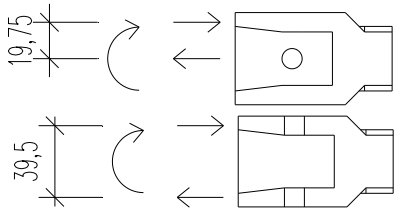
Geometry	DH=	50 [mm]
	Di-1=	29 [mm]
	Di-2=	35 [mm]
	Di-m=	32 [mm]
Bearing stress in female fitting	fu / γ_{M2}=	232 [N/mm²]
	do=	13 [mm]
	t = (DH - Di-m)/2=	9 [mm]
	e1>	23 [mm]
	αb=	0,59
	e2>	20 [mm]
	k1=	2,5

NRd = k1 x αb x fu x d x t / γ_{M2}= **40,02** [kN]

lever arm: $(D_H - D_{i-1}) / 4 + D_{i-1} / 2$ = (50-29) / 4 + 29 / 2 = 19,75 mm

resp.

lever arm: $(D_H - D_{i-1}) / 2 + D_{i-1}$ = (50-29) / 2 + 29 = 39,5 mm



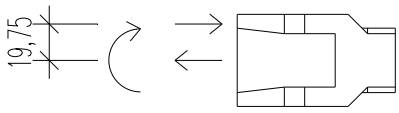
M_{RdG} = 2 · 40,02 · 1,975 = 40,02 · 3,95 = **158,79 kNcm**

Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

Connector

Material	EN AW 2011 (AlCuBiPb F37)		
Geometry	Dm=	29	[mm]
Bearing stress in connector	fu / γ_{M2}=	248,00	[N/mm²]
	do=	11	[mm]
	t=	29	[mm]
	e_1=	17,1	[mm]
	αb=	0,52	[-]
	e2=	14,5	[mm]
	k_1=	1,99	[-]
	NRd = k1 x αb x fu x d x t / γ_{M2}=	81,62	[kN]
Remaining section under tension			
	NRd = 0,9 x A,net x fu / γ_{M2}=	**76,23**	[kN]

lever arm: $(D_H - D_{i-1}) / 4 + D_{i-1} / 2 = (50-29) / 4 + 29 / 2 = 19{,}75$ mm



M_{RdG} = 76,23 · 1,975 = **150,55 kNcm**

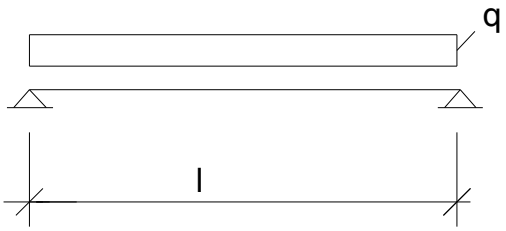
The allowable moment of the coupler is not relevant compared to the allowable moment of the tube. (MRd_G = 61,63 kNcm < 119,36 kNcm).

Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

5 ALLOWABLE LOADING SINGLE SPAN GIRDER

5.1 Uniformly distributed load (UDL)

System:



Permissible load:

max M = $1{,}5 \cdot q \cdot L^2 / 8 + 1{,}35 \cdot g \cdot L^2 / 8 \leq$ zul. M_{Rd}
=> $q \leq$ (zul. M_{Rd} - $1{,}35 \cdot g \cdot L^2 / 8$) / $(1{,}5 \cdot L^2 / 8)$

permissible moment for coupler at any position:
zul. M_{Rd} = 61,63 kNcm

permissible Moment without coupler:
zul. M_{Rd} = 150,61 kNcm

Deflection:

u = $q \cdot L^4 / (76{,}8 \cdot E \cdot I) + g \cdot L^4 / (76{,}8 \cdot E \cdot I)$

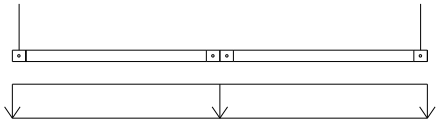
Permissible load for deflection < l/100:

max u = $q \cdot L^4 / (76{,}8 \cdot E \cdot I) + g \cdot L^4 / (76{,}8 \cdot E \cdot I) \leq L / 100$
=> $q \leq (L / 100 - g \cdot L^4 / (76{,}8 \cdot E \cdot I)) / (L^4 / (76{,}8 \cdot E \cdot I))$

Loading tables: see next page

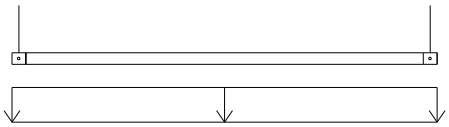
Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

Permissible load for coupler at any position:



Span [m]	max. allowable uniformly distributed load [kg/m]	deflection at max. load [cm]	allowable load for deflection < l/100 [kg/m]
0,5	1312	0,1	1312
1,0	326	0,5	326
1,5	144	1,1	144
2,0	80	2,0	80
2,5	50	3,1	40
3,0	34	4,4	22
3,5	25	6,1	13
4,0	18	7,8	8
4,5	14	9,9	5
5,0	11	12,3	3
5,5	9	15,2	1
6,0	7	17,7	1

Permissible load without coupler:



Span [m]	max. allowable uniformly distributed load [kg/m]	deflection at max. load [cm]	allowable load for deflection < l/100 [kg/m]
0,5	3211	0,3	3211
1,0	801	1,2	658
1,5	355	2,7	193
2,0	199	4,9	80
2,5	126	7,6	40
3,0	87	10,9	22
3,5	63	14,8	13
4,0	48	19,4	8
4,5	37	24,2	5
5,0	30	30,3	3

= deflection > L/100

The values of the table are only valid for single-span girder.

The specified values include partial safety coefficients on the loadings side acc. EN 1990 of yF = 1.50 for payloads and yG = 1.35 for selfweight of the truss.

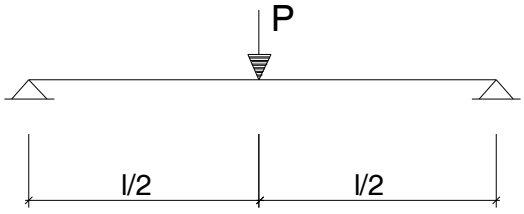
For applictaions which can be calculated on the basis of other codes, the partial safety factors can be adjusted (for example temporary structures acc. EN 13814, yF = 1.35 for payloads).

To use the resulting allowable loads with British Standard (BS) and ANSI, allowable loads listed in tables have to be multiplied by 0.85.

Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

5.2 Single-load in 1/2 point

System:



Permissible load:

max M = 1,5 x P x L / 4 + 1,35 x g x L² / 8 ≤ zul. M_{Rd} = 142,2 kN/cm²
=> P ≤ (142,2 kN/cm² - 1,35 x g x L² / 8) / (1,5 x L / 4)

permissible moment for coupler at any position:
zul. M_{Rd} = 61,63 kNm

permissible Moment without coupler:
zul. M_{Rd} = 150,61 kNm

Deflection:

max u = P x L³ / (48 x E x I) + g x L^4 / (76,8 x E x I)

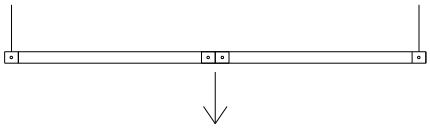
Permissible load for deflection < l/100:

max u = P x L³ / (48 x E x I) + g x L^4 / (76,8 x E x I) ≤ L / 100
=> P ≤ (L / 100 - g x L^4 / (76,8 x E x I)) / (L³ / (48 x E x I))

Loading tables: see next page

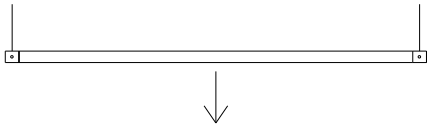
Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

Permissible load for coupler at any position:



Span [m]	max. allowable single load in 1/2-point [kg]	deflection at max. load [cm]	allowable load for deflection < l/100 [kg]
0,5	328	0,1	328
1,0	163	0,4	163
1,5	108	0,9	108
2,0	80	1,6	80
2,5	63	2,5	62
3,0	52	3,6	42
3,5	43	4,9	29
4,0	37	6,5	20
4,5	32	8,3	14
5,0	28	10,4	10
5,5	24	12,4	6
6,0	21	14,9	3

Permissible load without coupler:



Span [m]	max. allowable single load in 1/2-point [kg]	deflection at max. load [cm]	allowable load for deflection < l/100 [kg]
0,5	802	0,2	802
1,0	400	1,0	400
1,5	266	2,2	181
2,0	199	3,9	100
2,5	158	6,1	62
3,0	131	8,8	42
3,5	111	12,0	29
4,0	96	15,7	20
4,5	85	20,0	14
5,0	75	24,6	10

= deflection $\geq$ L/100

The values of the table are only valid for single-span girder.

The specified values include partial safety coefficients on the loadings side acc. EN 1990 of yF = 1.50 for payloads and yG = 1.35 for selfweight of the truss.

For applictaions which can be calculated on the basis of other codes, the partial safety factors can be adjusted (for example temporary structures acc. EN 13814, yF = 1.35 for payloads).

To use the resulting allowable loads with British Standard (BS) and ANSI, allowable loads listed in tables have to be multiplied by 0.85.