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 F43P

17334

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 - 30

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

TABLE OF CONTENTS

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 a trusssystem produced by the company GLOBAL TRUSS. The truss type goes by the name F43P. 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 Trusses consist of one upper and two lower main chords (round tube 50 x 3mm), which are arranged in a triangular shape. The trusses also consist of welded diagonal bracings (round tube 25 x 3mm). The truss type F43P is stiffened by diagonal bracings at all three sides.

The distance between the system lines of the mainchords is 35 cm.

The trusses are connected with couplers consisting of female fittings, connectors and bolts.

The allowable loads are listed in tables (see chapter 6).

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, y_F = 1.35 for payloads).

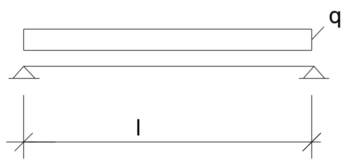
To use the resulting allowable loads with British Standard (BS) and ANSI, the allowable loads listed in tables have to be multiplied by 0.85.

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

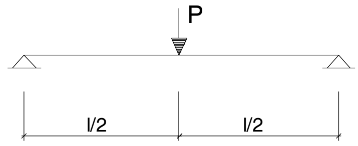
1.4 Geometry and Loadings

the following loadcases are taken into account

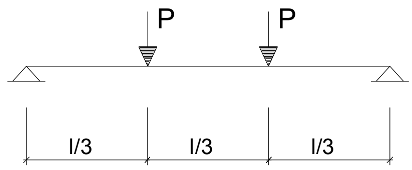
uniformly distributed load (UDL)



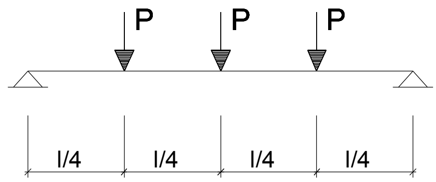
Single-load in 1/2 point



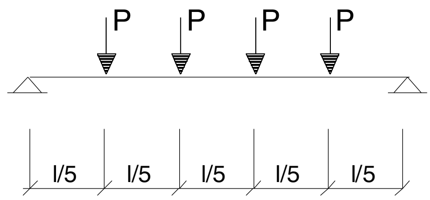
Single-load in 1/3 points



Single-load in 1/4 points



Single-load in 1/5 points

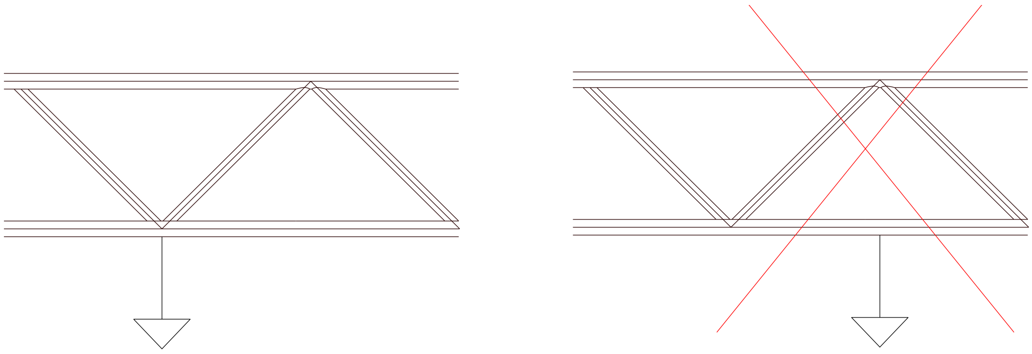


The selfweight of the truss is approx. 7.5 kg/m.

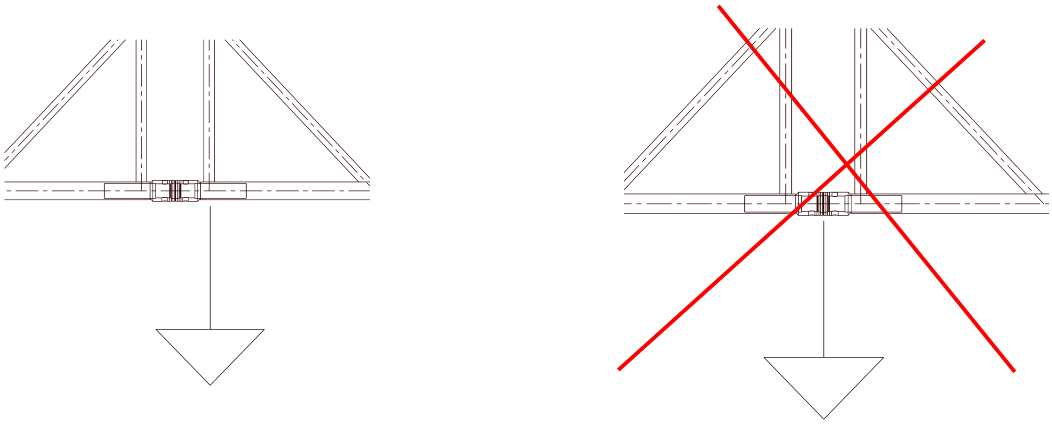
Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

For the application of the calculated allowable loadings the following rules have to be regarded:

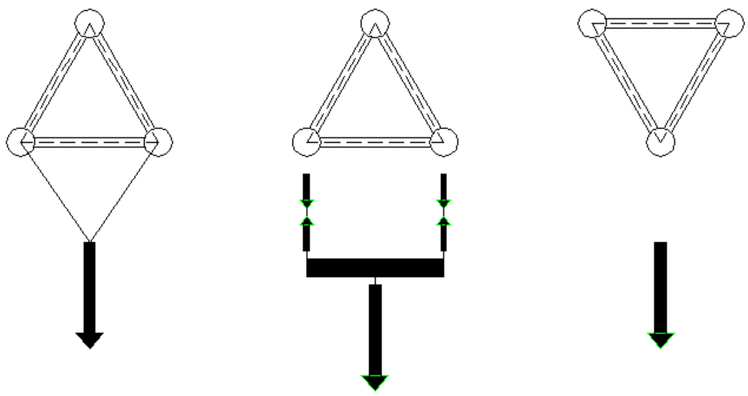
Large loads have to be applied at the nodes or have to be distributed by appropriate constructions.



Loads at the middle of the couplers are not allowed.

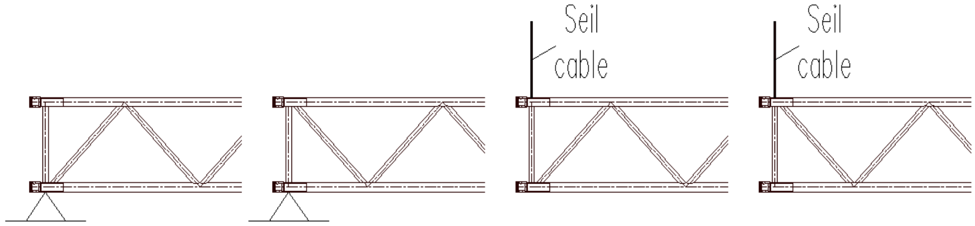


All loads have to be distributed equally to the chords.

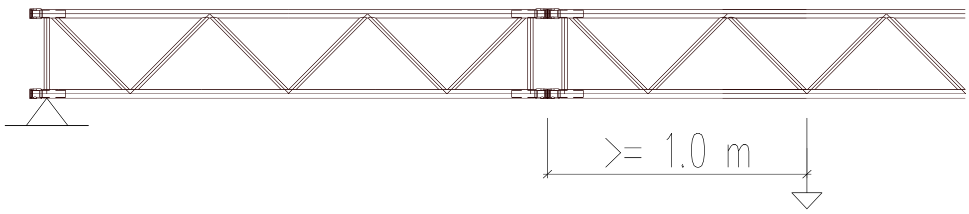


Lütticher Straße 10-12
52064 Aachen
Telefon: 0241 / 70 96 96
Telefax: 0241 / 70 96 46
buero@vom-felde.de

For the support or suspension there are the following possibilities:



When restricting the position of the coupler (see chapter 4, case 2), the coupler has to be located > 1,0 m from the loading point into the direction of the support.



2 SYSTEM

Drawings F43P . . . .

F43050P-Model, F43100P-Model, F43150P-Model, F43200P-Model, F43250P-Model, F43300P-Model, F43350P-Model, F43400P-Model, F43450P-Model, F43500P-Model

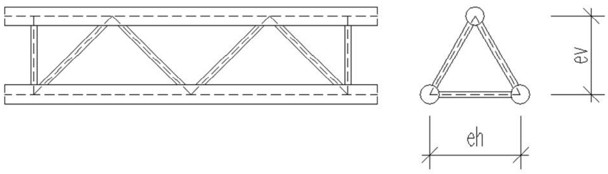
see annex

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
vertical Bracing	25	3	2,07	1,28	1,02	0,79
horizontal Bracing	25	3	2,07	1,28	1,02	0,79

Truss geometry



distance axes main chords	vertical	ev	30,3	[cm]
	horizontal	eh	35	[cm]
min. gradient bracing	vertical	α	34,5	[°]
	horizontal	α	34,5	[°]

Properties truss-Section

A	$= 3 \times A_G$	=	13,29	[cm²]
Iyy	$= 3 \times I_G + A_G \times [2 \times (ev/3)^2 + (ev \times 2/3)^2]$	=	2748,05	[cm⁴]
Izz	$= 3 \times I_G + 2 \times A_G \times (eh/2)^2$	=	2750,00	[cm⁴]
It	approximately	=	350,00	[cm⁴]
iy	$= (Iyy/A)^{1/2}$	=	14,38	[cm]
iz	$= (Izz/A)^{1/2}$	=	14,39	[cm]

Index G : section properties main chord

Material properties

Chords and bracing 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

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]

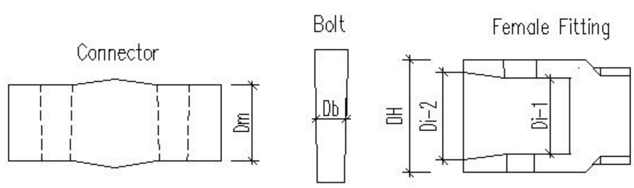
Female fitting EN AW 6082 T6

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

partial safety factors material

γ_{M1}=	1,10
γ_{M2}=	1,25

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



Section- and material properties of the chord 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-class	β=	12,25	[-]	$3 \cdot (D0 / t)^{0,5}$ nach 6.10
	ε=	1,00	[-]	$(250 / fo)^{0,5}$
	QS-Klasse=	2		acc. chapter 6.1.4.4
Coefficients for buckling	BC=	A	[-]	
	α=	0,20	[-]	
	λo=	0,10	[-]	
teff in heat affected zone	red-Faktor=	0,8	[-]	(WIG $_{TIG}$)
node with 1 bracing				
	D1=	25,00	[mm]	
	U_{WEZ}=	85,00	[mm]	$D1 + 2 \cdot 30$
	U_{Total}=	157,08	[mm]	
	teff,o/t=	0,68	[-]	$[1 - (1 - \text{red-Faktor} \cdot fo,haz / fo) \cdot U_{WEZ} / U_{Total}]$
	teff,u/t=	0,74	[-]	$[1 - (1 - \text{red-Faktor} \cdot fu,haz / fu) \cdot U_{WEZ} / U_{Total}]$
node with 2 bracing				
	D1=	25,00	[mm]	
	D2=	25,00	[mm]	
	U_{WEZ}=	111,18	[mm]	$\pi / \mathbf{6} \cdot D0 + D1 / 2 + D2 / 2 + 2 \cdot 30$
	U_{Total}=	157,08	[mm]	
	teff,o / t=	0,58	[-]	$[1 - (1 - \text{red-Faktor} \cdot fo,haz / fo) \cdot U_{WEZ} / U_{Total}]$
	teff,u / t=	0,65	[-]	$[1 - (1 - \text{red-Faktor} \cdot fu,haz / fu) \cdot U_{WEZ} / U_{Total}]$

Section- and material properties of the bracing

Material	E=	70000	[N/mm²]
	fo=	250,00	[N/mm²]
	fo/γ_{M1}=	227,27	[N/mm²]
	BC=	A	[-]
	α=	0,20	[-]
	λo=	0,1	[-]
cross section	Do=	25	[mm]
	A=	2,07	[cm²]
	I=	1,28	[cm^4]
	i=	0,79	[cm]

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

4 ALLOWABLE LOADING SINGLE COMPONENTS

main chord in heat affected zone at coupler			
N_{Rd} =A x 0,8* x fu,haz / γ_{M2}=	**52,45**	[kN]	*(WIG $_{TIG}$) local welding seam acc. chapter 6.2.9.3 (1)
main chord in heat affected zone			
node with 1 bracing			
N_{Rd} = Aeff x fo / γ_{M1}= (mit Aeff= teff,o / t x A)	**67,99**	[kN]	local welding seam acc. Chapter 6.2.9.3 (2)
node with 2 bracing			
N_{Rd} = Aeff x fo / γ_{M1}= (mit Aeff= teff,o / t x A)	**57,92**	[kN]	local welding seam acc. Chapter 6.2.9.3 (2)
buckling main chord bewteen nodes with 1 bracing in the middle sk=	84,00	[cm]	
Ncr=	120,25	[kN]	
λ^*=	0,79	[-]	
ϕ=	0,88	[-]	
X=	0,79	[-]	
κ=	1,00	[-]	verified by comparative calculation acc. Second Order Theory
N_{Rd} = X x κ x Aeff x fo / γ_{M1}=	**53,54**	[kN]	acc. equation 6.49a
buckling main chord between nodes without bracing in the middle sk=	84,00	[cm]	
Ncr=	120,25	[kN]	
λ^*=	0,96	[-]	
ϕ=	1,05	[-]	
X=	0,68	[-]	
N_{Rd} = X x A x fo / γ_{M1}=	**68,78**	[kN]	acc. equation 6.49a
welding seam between chord and female conical coupler			
fw=	190,00	[N/mm²]	
γ_{mw}=	1,25	[-]	
N_{Rd} = A x fw / γ_{M1}=	**67,33**	[kN]	acc. equation 8.29

relevant for main chord tubes: **NRd_G = 52,45 kN**

bracing in heat affected zone				
	$N_{Rd} = A \times 0{,}8^* \times f_{u,haz} / \gamma_{M2}$=	**24,55**	[kN]	*(WIG $_{TIG}$) local welding seam acc. chapter 6.2.9.3 (1)
buckling bracing	sk=	47,00	[cm]	
		(buckling length = 0,75 x l)		
	Ncr=	39,96	[kN]	
	λ^*=	1,14	[-]	
	ϕ=	1,25	[-]	
	X=	0,56	[-]	
	$N_{Rd} = X \times A_G \times f_o / \gamma_{M1}$=	**26,57**	[kN]	acc. equation 6.49a
welding seam between chord and female conical coupler				
	fw=	190,00	[N/mm²]	
	γ_{mw}=	1,25	[-]	
	$N_{Rd} = A \times f_w / \gamma_{M1}$=	**31,52**	[kN]	acc. equation 8.29

relevant for bracing tubes: **NRd_D = 24,55 kN**

Allowable normal force at coupler:

Bolt		
material (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} = 2 x 0,60 x Ab x fub,k / 1,25=	**69,71** [kN]
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]
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=	18 [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}=	**80,04** [kN]

The allowable normal force of the coupler is not relevant compared to the allowable normal force of the tube. (NRd_G = 52,45 kN < 69,71 kN).

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

Interaction bending and normal force at coupler

Normal force and bending moments are transferred by the welding seam between coupler and chord.

Verification of interaction bending and normal force at coupler

=> $\mathbf{(Nsd_G / NRd_G)^{1,3} + (Msd_G / MRd_G) < 1,0}$

mit Nsd_G = Nsd / 3 + Msd / (0,303 m)
und Msd_G = 1 / 3 · Qsd · 6,75 cm = 2,25 cm · Qsd
=> a = factor for cantilever at the coupler = 2,25 cm

Nsd, Msd und Qsd: global internal forces in the truss (in kN resp. kNm)

The global internal forces include the following safety factors acc. Eurocode:

selfweight of the truss: y_F = 1,35

Net load on the truss: y_F = 1,50

NRd_G = allowable loading of the chord in the heat affected zone (see following table):

main chord in heat affected zone at coupler			
N_{Rd} =A x 0,8* x fu,haz / Y_{M2}=	**52,45**	[kN]	*(WIG $_{TIG}$) local welding seam acc. chapter 6.2.9.3 (1)

MRd_G = MuRd (see following table):

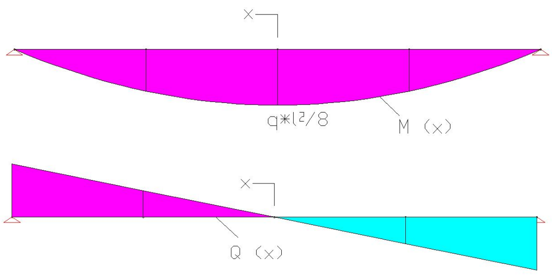
Local bending of chord completely in HAZ			
local welding seam acc. Chapter 6.2.9.3 (1)			
D=	50	[mm]	
red-Faktor=	0,8	[-]	(WIG $_{TIG}$)
ρu,haz=	0,64	[-]	fu,haz / fu
tu,eff=	1,53	[mm]	red-Faktor · ρu,haz · t
$W_{u,eff}$= π x R² x tu,eff=	2,66	[cm³]	with R = D / 2 - t / 2
MuRd = $W_{u,eff}$ · fu / yM2=	**61,63**	[kNcm]	acc. equation 6.24b

The following 3 cases are taken into account.

1. Loading with **uniformly distributed load (UDL)**

The coupler is always located at the theoretically worst point. This results from the following extremum-calculation:

Note: For the determination of the worst position of the coupler, the exponent 1,3 for the relation of actual load to the allowable load is not taken into account with sufficient accuracy.



$Msd\ (x) = qsd \cdot L^2 / 8 - qsd \cdot x^2 / 2$
$Qsd\ (x) = qsd \cdot x$

$NRd_G = 52{,}45$ kN
$MRd_G = 61{,}63$ kNcm

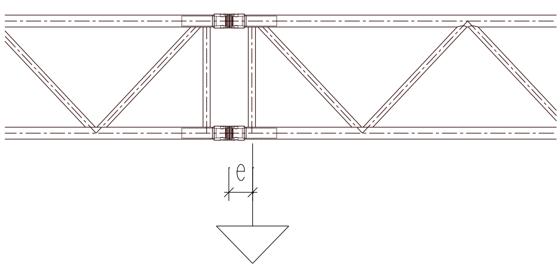
M-Q Interaction $Msd(x) / (0{,}303 \cdot 52{,}45) + Qsd(x) \cdot 2{,}25 / 61{,}63$

Extremum: $d/dx\ \sigma\ (x) = 0$

$\Rightarrow x = 0{,}303 \cdot 52{,}45 \cdot 2{,}25 / 61{,}63 = 0{,}58$ m
(from middle of span)

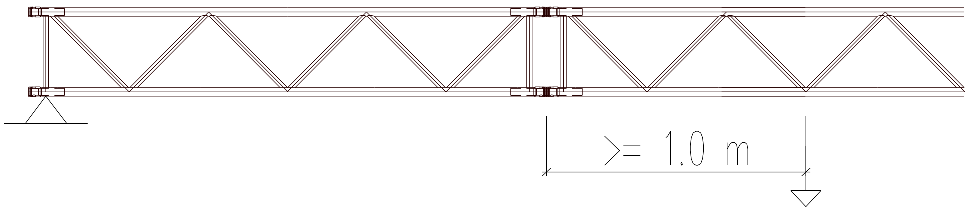
2. Loading with **single-point loads** without requirements for position of couplers

No requirements for position of coupler (Distance between load and coupler is e, see below). The allowable loads of this case have to be regarded, if the distance between coupler and load is <1,0 m.



3. Alternative to (2): Loading with **single-point loads with requirements for position of couplers**

In this case it is assumed, that the coupler is located >1,0m from the loading-point. The coupler has to be located in a manner, so that the distance is >1,0m into the direction of the support-point.



Summary

Following points are relevant for the determination of the allowable loads:

1. Allowable normal force in main chord (NRd_G)

   Main chord in heat affected zone at coupler is relevant => $NRd_G = 52{,}45$ kN

2. Global shear force in truss (Q)

   Allowable normal force in diagonals at nodes (HAZ) is relevant => $NRd_D = 24{,}55$ kN

   allowable shear force: $Q_{Rd} / (2 \cdot \sin 34{,}5° \cdot \cos 60°) < 0{,}9 \cdot N_{RdD}$

   (10% reduction because of minor stresses)

   => all. QRd = $0{,}9 \cdot 24{,}55 \cdot 2 \cdot \sin 34{,}5° \cdot \cos 60°$ => QRd = 12,49 kN

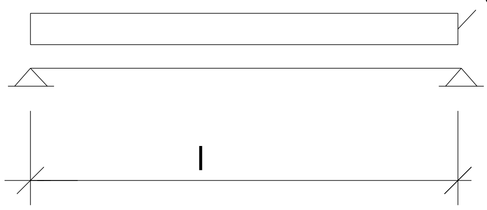
3. Interaction bending and normal force at coupler see pg. 13

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:



qsd = psd + gsd (payload + selfweight, including safety)

Normal force in chord:

$NRd \geq qsd \cdot L^2 / 8 / (n \cdot b)$ => $qsd \leq NRd \cdot (n \cdot b) \cdot 8 / L^2$

=> $zul\ p = (NRd \cdot (n \cdot b) \cdot 8 / L^2 - gsd) / yF$

Normal force in diagonals:

$QRd \geq qsd \cdot L / 2$ => $qsd \leq QRd \cdot 2 / L$

=> $zul\ p = (QRd \cdot 2 / L - gsd) / yF$

Interaction at coupler:

Verification of interaction bending and normal force at coupler by an iterative method.

=> $(Nsd_G / NRd_G)^{1,3} + (Msd_G / MRd_G) < 1,0$

applied: The coupler is located at e = 0,58 m from the middle of the span (theoretically worst point, see extremum-calculation in chapter 4)

Loading-table: see next page

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

Loading table:

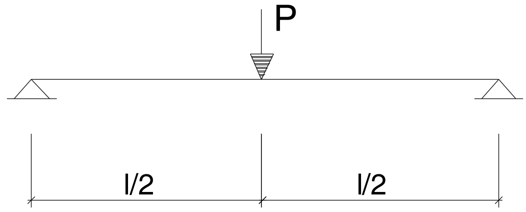
The coupler is located at e = 0,580 from the middle of the span
(theoretically worst point, see extremum-calculation in chapter 4)

Uniformly distributed load UDL

	allowable load as a function of			
	Nrd	Qrd	Interaction at coupler	
L [m]	**zul q [kN/m]**	**zul q [kN/m]**	**zul q [kN/m]**	**min zul q [kN/m]**
4,00	5,23	4,10	4,98	4,10
5,00	3,32	3,26	3,22	3,22
6,00	2,29	2,71	2,24	2,24
7,00	1,66	2,31	1,64	1,64
8,00	1,26	2,01	1,24	1,24
9,00	0,98	1,78	0,97	0,97
10,00	0,78	1,60	0,77	0,77
11,00	0,63	1,45	0,63	0,63
12,00	0,52	1,32	0,52	0,52
13,00	0,43	1,21	0,43	0,43
14,00	0,36	1,12	0,36	0,36
15,00	0,31	1,04	0,31	0,31
16,00	0,26	0,97	0,26	0,26
17,00	0,23	0,91	0,23	0,23
18,00	0,19	0,86	0,19	0,19
19,00	0,17	0,81	0,17	0,17
20,00	0,14	0,77	0,14	0,14

5.2 Single-load in 1/2 point

System



Normal force in chord:

$NRd \geq (Psd \cdot L / 4 + gsd \cdot L^2 / 8) / (n \cdot b)$

=> $Psd \leq [NRd \cdot (n \cdot b) - gsd \cdot L^2 / 8] \cdot 4 / L$

=> $zul\ P = [NRd \cdot (n \cdot b) - gsd \cdot L^2 / 8] \cdot 4 / L / yF$

Normal force in diagonals:

$QRd \geq Psd / 2 + gsd \cdot L / 2$

=> $Psd \leq (QRd - gsd \cdot L / 2) \cdot 2$

=> $zul\ P = (QRd - gsd \cdot L / 2) \cdot 2 / yF$

Interaction at coupler:

Verification of interaction bending and normal force at coupler by an iterative method.

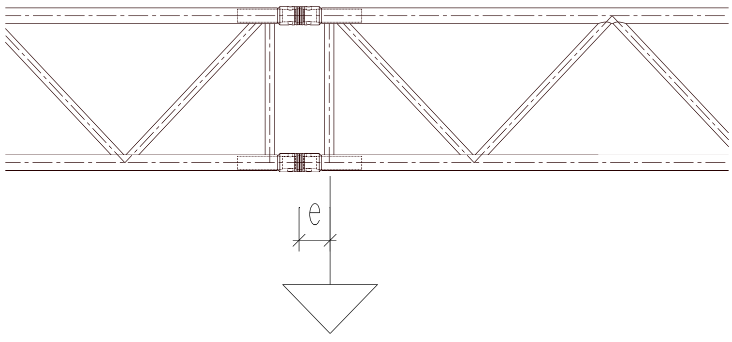
=> $(Nsd_G / NRd_G)^{1,3} + (Msd_G / MRd_G) < 1,0$

applied: Loading point at coupler e = 0,08 m

Alternatively: Location of coupler from loading point >= 1,0 m

Loading-tables: see next pages

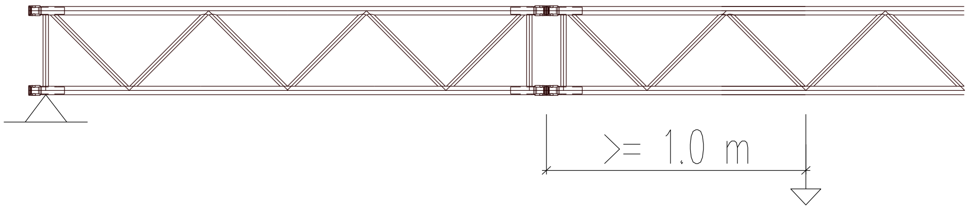
Loading point at coupler e = 0,08 m



Single-load in 1/2point

	allowable load as a function of			
	Nrd	Qrd	Interaction at coupler	
			0,08	= e [m]
L [m]	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**min zul P [kN]**
4,00	10,46	16,38	8,77	8,77
5,00	8,31	16,32	7,21	7,21
6,00	6,86	16,25	6,09	6,09
7,00	5,82	16,18	5,25	5,25
8,00	5,03	16,11	4,59	4,59
9,00	4,41	16,05	4,07	4,07
10,00	3,90	15,98	3,63	3,63
11,00	3,48	15,91	3,26	3,26
12,00	3,13	15,84	2,94	2,94
13,00	2,82	15,78	2,67	2,67
14,00	2,55	15,71	2,43	2,43
15,00	2,32	15,64	2,21	2,21
16,00	2,11	15,57	2,02	2,02
17,00	1,92	15,51	1,84	1,84
18,00	1,75	15,44	1,68	1,68
19,00	1,59	15,37	1,53	1,53
20,00	1,44	15,30	1,39	1,39

Location of coupler from loading point e >= 1,0 m

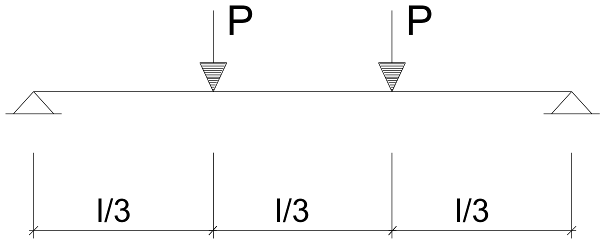


Single-load in 1/2point

	allowable load as a function of			
	Nrd	Qrd	Interaction at coupler	
			1	= e [m]
L [m]	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**min zul P [kN]**
4,00	10,46	16,38	14,11	10,46
5,00	8,31	16,32	10,49	8,31
6,00	6,86	16,25	8,31	6,86
7,00	5,82	16,18	6,85	5,82
8,00	5,03	16,11	5,79	5,03
9,00	4,41	16,05	5,00	4,41
10,00	3,90	15,98	4,37	3,90
11,00	3,48	15,91	3,86	3,48
12,00	3,13	15,84	3,44	3,13
13,00	2,82	15,78	3,08	2,82
14,00	2,55	15,71	2,77	2,55
15,00	2,32	15,64	2,50	2,32
16,00	2,11	15,57	2,27	2,11
17,00	1,92	15,51	2,05	1,92
18,00	1,75	15,44	1,86	1,75
19,00	1,59	15,37	1,69	1,59
20,00	1,44	15,30	1,53	1,44

5.3 Single-loads in 1/3 points

System



Normal force in chord:

NRd ≥ (Psd · L / 3 + gsd · L² / 8) / (n · b)

=> Psd ≤ [NRd · (n · b) - gsd · L² / 8] · 3 / L

=> zul P = [NRd · (n · b) - gsd · L² / 8] · 3 / L / yF

Normal force in diagonals

QRd ≥ Psd / 2 gsd · L / 2

=> Psd ≤ (QRd – gsd · L / 2)

=> zul P = (QRd – gsd · L / 2) / yF

Interaction at coupler

Verification of interaction bending and normal force at coupler by an iterative method.

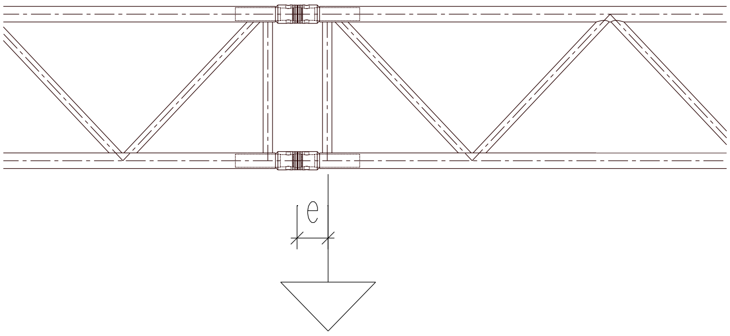
=> $(Nsd_G / NRd_G)^{1,3} + (Msd_G / MRd_G) < 1,0$

applied: Loading point at coupler e = 0,08 m

Alternatively: Location of coupler from loading point >= 1,0 m

Loading-tables: see next pages

Loading point at coupler e = 0,08 m

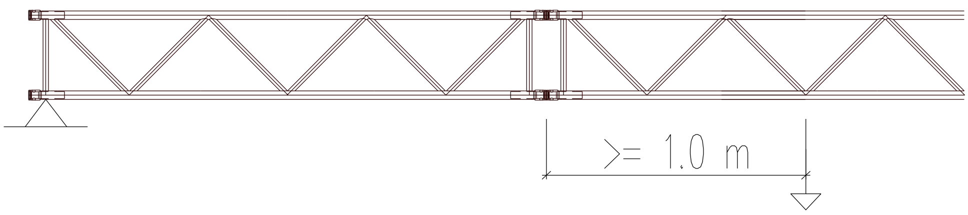


Single-load in 1/3points

	allowable load as a function of			
	Nrd	Qrd	Interaction at coupler	
			0,08	= e [m]
L [m]	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**min zul P [kN]**
4,00	7,84	8,19	6,07	6,07
5,00	6,23	8,16	5,06	5,06
6,00	5,15	8,12	4,32	4,32
7,00	4,36	8,09	3,76	3,76
8,00	3,77	8,06	3,31	3,31
9,00	3,30	8,02	2,94	2,94
10,00	2,93	7,99	2,64	2,64
11,00	2,61	7,96	2,38	2,38
12,00	2,34	7,92	2,16	2,16
13,00	2,12	7,89	1,97	1,97
14,00	1,92	7,85	1,80	1,80
15,00	1,74	7,82	1,65	1,65
16,00	1,58	7,79	1,51	1,51
17,00	1,44	7,75	1,38	1,38
18,00	1,31	7,72	1,27	1,27
19,00	1,19	7,69	1,16	1,16
20,00	1,08	7,65	1,07	1,07

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

Location of coupler from loading point e >= 1,0 m



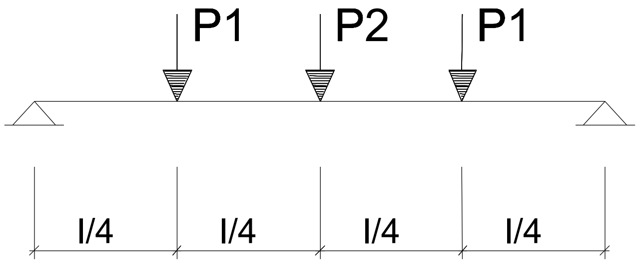
Single-load in 1/3points

	allowable load as a function of			
	Nrd	Qrd	Interaction at coupler	
			1	= e [m]
L [m]	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**min zul P [kN]**
4,00	7,84	8,19	12,56	7,84
5,00	6,23	8,16	9,05	6,23
6,00	5,15	8,12	6,99	5,15
7,00	4,36	8,09	5,67	4,36
8,00	3,77	8,06	4,74	3,77
9,00	3,30	8,02	4,06	3,30
10,00	2,93	7,99	3,53	2,93
11,00	2,61	7,96	3,11	2,61
12,00	2,34	7,92	2,77	2,34
13,00	2,12	7,89	2,48	2,12
14,00	1,92	7,85	2,23	1,92
15,00	1,74	7,82	2,02	1,74
16,00	1,58	7,79	1,83	1,58
17,00	1,44	7,75	1,67	1,44
18,00	1,31	7,72	1,52	1,31
19,00	1,19	7,69	1,38	1,19
20,00	1,08	7,65	1,26	1,08

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

5.4 Single-loads in 1/4 points

System



Normal force in chord:

$NRd \geq (Psd \cdot L / 4 + gsd \cdot L^2 / 8) / (n \cdot b)$

$\Rightarrow Psd \leq [NRd \cdot (n \cdot b) - gsd \cdot L^2 / 8] \cdot 2 / L$

$\Rightarrow zul\ P = [NRd \cdot (n \cdot b) - gsd \cdot L^2 / 8] \cdot 2 / L / yF$

Normal force in diagonals:

$QRd \geq 3 / 2 \cdot Psd + gsd \cdot L / 2$ $\Rightarrow Psd \leq (QRd - gsd \cdot L / 2) \cdot 2 / 3$

$\Rightarrow zul\ P = (QRd - gsd \cdot L / 2) \cdot 2 / 3 / yF$

Interaction at coupler

Verification of interaction bending and normal force at coupler by an iterative method.

$\Rightarrow (Nsd_G / NRd_G)^{1,3} + (Msd_G / MRd_G) < 1,0$

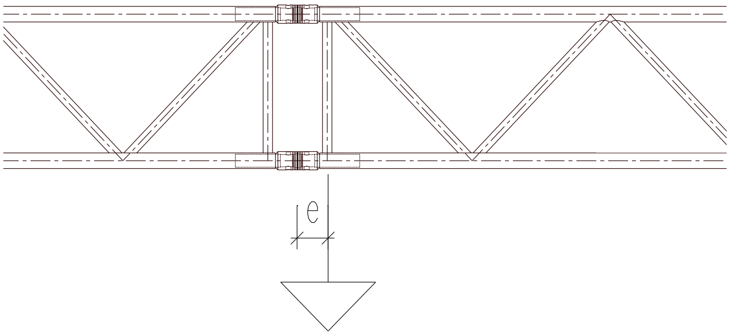
applied: Loading point at coupler e = 0,08 m

Alternatively: Location of coupler from loading point >= 1,0 m

Loading-tables: see next pages

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

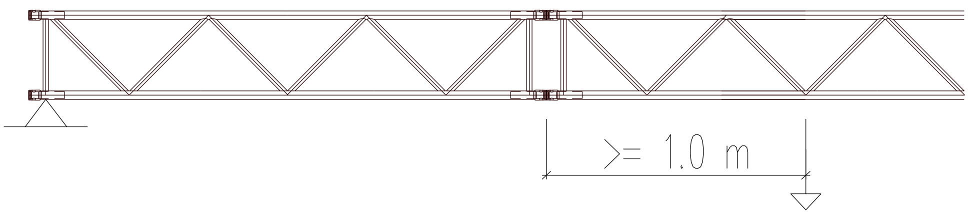
Loading point at coupler e = 0,08 m



Single-load in 1/4points

	allowable load as a function of				
	Nrd	Qrd	Interaction at coupler 1	Interaction at coupler 2	
			0,08	0,08	= e [m]
L [m]	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**min zul P [kN]**
4,00	5,23	5,46	4,98	4,78	4,78
5,00	4,15	5,44	4,25	3,86	3,86
6,00	3,43	5,42	3,69	3,23	3,23
7,00	2,91	5,39	3,26	2,76	2,76
8,00	2,51	5,37	2,90	2,40	2,40
9,00	2,20	5,35	2,60	2,11	2,11
10,00	1,95	5,33	2,35	1,88	1,88
11,00	1,74	5,30	2,13	1,68	1,68
12,00	1,56	5,28	1,94	1,52	1,52
13,00	1,41	5,26	1,77	1,37	1,37
14,00	1,28	5,24	1,62	1,24	1,24
15,00	1,16	5,21	1,49	1,13	1,13
16,00	1,05	5,19	1,36	1,03	1,03
17,00	0,96	5,17	1,25	0,94	0,94
18,00	0,87	5,15	1,15	0,86	0,86
19,00	0,79	5,12	1,05	0,78	0,78
20,00	0,72	5,10	0,96	0,71	0,71

Location of coupler from loading point e >= 1,0 m

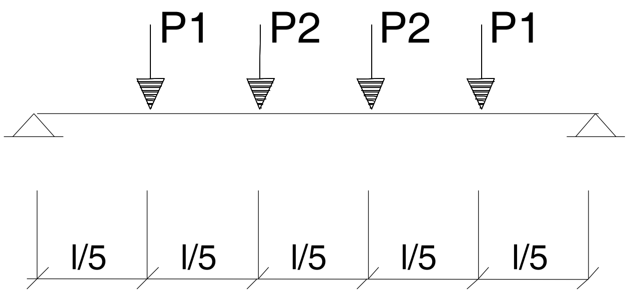


Single-load in 1/4points

	allowable load as a function of				
	Nrd	Qrd	Interaction at coupler 1	Interaction at coupler 2	
			1	1	= e [m]
L [m]	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**min zul P [kN]**
4,00	5,23	5,46	11,97	6,07	5,23
5,00	4,15	5,44	9,55	4,67	4,15
6,00	3,43	5,42	7,50	3,78	3,43
7,00	2,91	5,39	6,06	3,16	2,91
8,00	2,51	5,37	5,03	2,70	2,51
9,00	2,20	5,35	4,26	2,35	2,20
10,00	1,95	5,33	3,66	2,07	1,95
11,00	1,74	5,30	3,19	1,83	1,74
12,00	1,56	5,28	2,81	1,64	1,56
13,00	1,41	5,26	2,49	1,47	1,41
14,00	1,28	5,24	2,22	1,33	1,28
15,00	1,16	5,21	1,99	1,20	1,16
16,00	1,05	5,19	1,79	1,09	1,05
17,00	0,96	5,17	1,61	0,99	0,96
18,00	0,87	5,15	1,45	0,90	0,87
19,00	0,79	5,12	1,31	0,82	0,79
20,00	0,72	5,10	1,18	0,74	0,72

5.5 Single-loads in 1/5 points

System



Normal force in chord:

$NRd \geq (Psd \cdot 3/5 \cdot L + gsd \cdot L^2/8) / (n \cdot b)$

$\Rightarrow Psd \leq [NRd \cdot (n \cdot b) - gsd \cdot L^2/8] \cdot 5/3$

$\Rightarrow zul\ P = [NRd \cdot (n \cdot b) - gsd \cdot L^2/8] \cdot 5/3 / L / yF$

Normal force in diagonals:

$QRd \geq 2 \cdot Psd + gsd \cdot L/2$ $\Rightarrow Psd \leq (QRd - gsd \cdot L/2)/2$

$\Rightarrow zul\ P = (QRd - gsd \cdot L/2)/2/yF$

Interaction at coupler:

Verification of interaction bending and normal force at coupler by an iterative method.

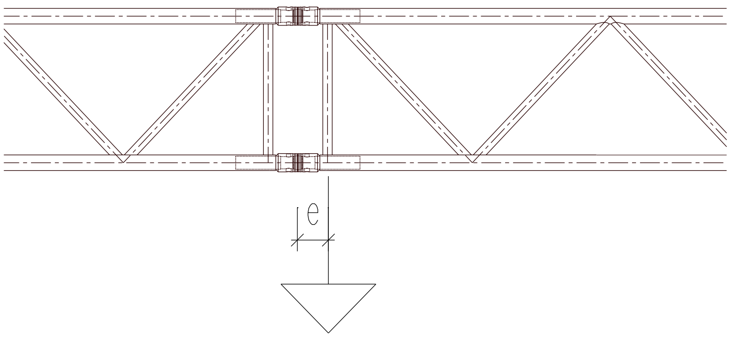
$\Rightarrow (Nsd_G / NRd_G)^{1,3} + (Msd_G / MRd_G) < 1{,}0$

applied: Loading point at coupler e = 0,08 m

Alternatively: Location of coupler from loading point >= 1,0 m

Loading-tables: see next pages

Loading point at coupler e = 0,08 m

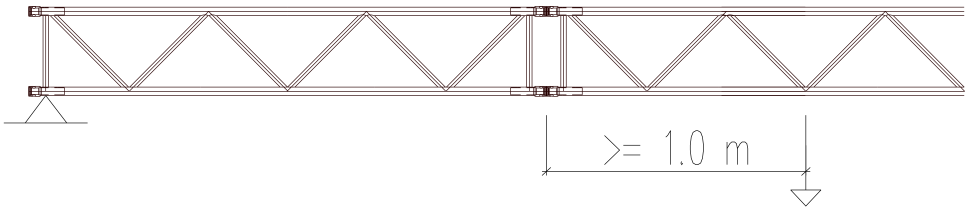


Single-load in 1/5points

	allowable load as a function of				
	Nrd	Qrd	Interaction at coupler 1	Interaction at coupler 2	
			0,08	0,08	= e [m]
L [m]	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**min zul P [kN]**
4,00	4,36	4,10	4,41	3,76	3,76
5,00	3,46	4,08	3,79	3,07	3,07
6,00	2,86	4,06	3,33	2,59	2,59
7,00	2,42	4,05	2,96	2,22	2,22
8,00	2,09	4,03	2,65	1,94	1,94
9,00	1,84	4,01	2,40	1,72	1,72
10,00	1,63	3,99	2,17	1,53	1,53
11,00	1,45	3,98	1,98	1,37	1,37
12,00	1,30	3,96	1,81	1,24	1,24
13,00	1,18	3,94	1,66	1,12	1,12
14,00	1,06	3,93	1,53	1,02	1,02
15,00	0,97	3,91	1,40	0,93	0,93
16,00	0,88	3,89	1,29	0,85	0,85
17,00	0,80	3,88	1,19	0,78	0,78
18,00	0,73	3,86	1,09	0,71	0,71
19,00	0,66	3,84	1,00	0,65	0,65
20,00	0,60	3,83	0,92	0,59	0,59

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

Location of coupler from loading point e >= 1,0 m



Single-load in 1/5points

	allowable load as a function of				
	Nrd	Qrd	Interaction at coupler 1	Interaction at coupler 2	
			1	1	= e [m]
L [m]	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**zul P [kN]**	**min zul P [kN]**
4,00	4,36	4,10	not relevant	not relevant	4,10
5,00	3,46	4,08	8,91	4,24	3,46
6,00	2,86	4,06	7,50	3,38	2,86
7,00	2,42	4,05	6,16	2,80	2,42
8,00	2,09	4,03	5,13	2,38	2,09
9,00	1,84	4,01	4,35	2,06	1,84
10,00	1,63	3,99	3,74	1,80	1,63
11,00	1,45	3,98	3,26	1,60	1,45
12,00	1,30	3,96	2,86	1,43	1,30
13,00	1,18	3,94	2,53	1,28	1,18
14,00	1,06	3,93	2,26	1,15	1,06
15,00	0,97	3,91	2,02	1,05	0,97
16,00	0,88	3,89	1,82	0,95	0,88
17,00	0,80	3,88	1,64	0,86	0,80
18,00	0,73	3,86	1,47	0,78	0,73
19,00	0,66	3,84	1,33	0,71	0,66
20,00	0,60	3,83	1,20	0,65	0,60

6 SUMMARY OF THE RESULTS

6.1 Allowable loadings

Allowable Load F43P

single-span beam

		Single point loads			
Span	UDL	in 1/2 Point	in 1/3 Points	in 1/4 Points	in 1/5 Points
[m]	[kN/m]	[kN]	[kN]	[kN]	[kN]
4	4,10	8,77	6,07	4,78	3,76
5	3,22	7,21	5,06	3,86	3,07
6	2,24	6,09	4,32	3,23	2,59
7	1,64	5,25	3,76	2,76	2,22
8	1,24	4,59	3,31	2,40	1,94
9	0,97	4,07	2,94	2,11	1,72
10	0,77	3,63	2,64	1,88	1,53
11	0,63	3,26	2,38	1,68	1,37
12	0,52	2,94	2,16	1,52	1,24
13	0,43	2,67	1,97	1,37	1,12
14	0,36	2,43	1,80	1,24	1,02
15	0,31	2,21	1,65	1,13	0,93
16	0,26	2,02	1,51	1,03	0,85
17	0,23	1,84	1,38	0,94	0,78
18	0,19	1,68	1,27	0,86	0,71
19	0,17	1,53	1,16	0,78	0,65
20	0,14	1,39	1,07	0,71	0,59

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

The truss-elements have to be braced with diagonals.

Large loads have to be applied at the nodes or have to be distributed by appropriate constructions.

Loads at the middle of the couplers are not allowed.

All loads have to be distributed equally to both chords.

The specified values include partial safety coefficients on the loadings side acc. EN 1990 of y_F = 1.50 for payloads and y_G = 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, y_F = 1.35 for payloads).

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

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

The values are calculated with no requirements for the location o the couplers. In case that the distance from the couplers to the loadingpoints of the single-point loads is ≥ 1,0 m into the direction of the support, the values of the calculations for the different loadcases can be used (see chapter 5).

6.2 Deflections at max. allowable loadings

Deflections [cm] for F43P at max. allowable loads

[cm]

		Single point loads			
Span	UDL	in 1/2 Point	in 1/3 Points	in 1/4 Points	in 1/5 Points
[m]	[cm]	[cm]	[cm]	[cm]	[cm]
4	0,72	0,62	0,73	0,80	0,80
5	1,39	1,01	1,20	1,27	1,29
6	2,03	1,49	1,79	1,86	1,90
7	2,78	2,07	2,50	2,56	2,62
8	3,65	2,76	3,33	3,37	3,47
9	4,64	3,54	4,29	4,30	4,43
10	5,75	4,44	5,38	5,34	5,52
11	6,97	5,44	6,60	6,51	6,74
12	8,32	6,56	7,95	7,79	8,08
13	9,80	7,80	9,44	9,20	9,55
14	11,40	9,16	11,06	10,73	11,14
15	13,12	10,65	12,82	12,39	12,87
16	14,98	12,27	14,73	14,18	14,74
17	16,96	14,02	16,78	16,11	16,74
18	19,08	15,93	18,99	18,17	18,88
19	21,33	17,98	21,35	20,37	21,17
20	23,72	20,19	23,88	22,71	23,60

= Deflection ≥ L/100