

Stabiliteitsberekening

Datum aanmaak 17-07-2024
Auteur 5.1, 2, e
Project No Art 2024 Circoloco
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Gebruiksperiode 08-09-2024 t/m 16-09-2024
Constructie/object 1160-Goodguyz-Circoloco Scaff Helling

Afmeting constructie

Breedte 6.88 m

Diepte 2.07 m

Hoogte 6.00 m

Normering

NEN-EN-1990 - Eurocode 0 Grondslag van het constructief ontwerp
NEN-EN-1991 - Eurocode 1 Belastingen op constructies
NEN-EN-1993 - Eurocode 3 Ontwerp en berekening van staalconstructies
NEN-EN 13814 Machines en constructies op kermisterreinen en amusementsparken
NEN-EN 12811-1 Steigers - Deel 1 - Prestatie-eisen en algemeen ontwerp
NPR-8020-51 Podiumconstructies - Belastingen en constructieve uitgangspunten

Veiligheidsfactoren in geval van omvallen, glijden en optillen [NEN-EN 13814 tabel 2]:

Veiligheidsfactor voor ongunstige permanente belasting (Y_{sg}) 1.10
Veiligheidsfactor voor ongunstige variabele belasting (Y_{so}) 1.20

Windbelasting

Terreinruwheid	Onbebouwd	Volheidsgraad scherm	100.00 %
10 min. gemidd. basiswindsnelheid	7 Bft 17,1 m/s	Volheidsgraad scaff	7.00 %
Max. windsnelheid +10.00m	23.42 m/s	Bouwwerkfactor¹ ($C_s C_d$)	1.00
Max. windsnelheid hoogste punt	21.17 m/s	Krachtcoefficient² (c_f)	1.30
Wrijving spindel-ondergrond	Staalhout-beton	Wrijvingsfactor³	0.40

¹ EN 1991-1-4

² EN 12811 par. 6.2.7.2

³ EN 13814 par. 5.1.1.2

Bepaling koppel uit wind

Hoogte (m)	Stram. breed	Stram. diep	Extreme stuwdruk (kN/m ²)	Ascher m (m ²)	Fw scherm (kN)	Ascaff projectie (m ²)	Fw scaff (kN)	Fw totaal (kN)	Aan-grijp punt Fw (m)	Kiep-moment (kNm)	Schoren rand stram.	Schoren midden stram.
0-2	4	4	0.28	4.53	1.65	0.00	0	1.65	1	1.65	1	1
2-4	4	2	0.28	0.77	0.28	0.00	0	0.28	3	0.84	1	1
4-6	4	2	0.28	7.87	2.86	0.00	0	2.86	5	14.3	1	1
								4.79		16.79		

Kiepzekerheid

Voorschrift EN 13814 par. 5.5.1	$\Sigma M_{stand} / \Sigma M_{kiep} \geq Y_{so}$
Eigen gewicht constructie (G)	700.00 kg => 7.0 kN
Standmoment Mstand	$G / Y_{sg} \times (\text{diepte} / 2) = 6.59 \text{ kNm}$
Cumulatief kiepmoment Mkiep	16.79 kNm
Arm ballast	1.04 m
Benodigde ballast	$(\Sigma M_{kiep} \times Y_{so} - \Sigma M_{stand}) / \text{arm ballast} \times 100 = 1304 \text{ kg}$

Glijzekerheid

Voorschrift EN 13814 par. 5.5.1	$\Sigma F_v \times \mu / \Sigma F_h \geq Y_{so}$
Som verticale krachten	$\Sigma F_v = G / Y_{sg} / 100 = 7.00 \text{ kN}$
Som horizontale krachten	$\Sigma F_h = F_w = 4.79 \text{ kN}$
Wrijving	Staal-hout-beton
Wrijvingscoëfficiënt (μ)	0.40
Benodigde ballast	800 kg

Bepaling benodigde ballast

Benodigde ballast constructie/object (B) 1304 kg

Opmerkingen

Controle truss met: [twee kolommen dus vandaar /2]

$$N = 1.2 \times 5.0 / 2 = 3.0 \text{ kN}$$

$$V_y = 1.35 \times 4.8 / 2 = 3.24 \text{ kN}$$

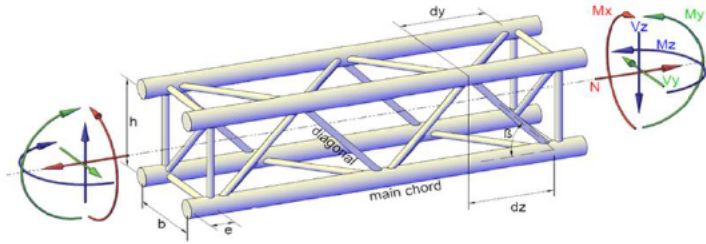
$$M_z = 1.35 \times 16.8 / 2 = 11.33 \text{ kNm}$$

zie controle truss op volgende pagina.

Truss Type: **Interal T.C. S41** Self-Weight Truss 6,9 kg/m

Truss geometry:

Height	h	339 mm
Width	b	339 mm
Length vert. dia.	d _z	339 mm
Angle vert. dia.	β _z	45,00°
Length hor. dia.	d _y	339 mm
Angle hor. dia.	β _y	45,00°
Coupler offset	e	50 mm



Tube Cross Sections:

	D [mm]	t [mm]	A [mm ²]	W [mm ³]	I [mm ⁴]	i [mm]
Main Chord	48	3	424,1	4493,0	107831,2	15,9452
Diagonals z	20	2	113,1	463,7	4637,0	6,40312
Diagonals y	20	2	113,1	463,7	4637,0	6,40312
End frame	20	2	113,1	463,7	4637,0	6,40312

total Truss cross section parameters

A = 4 x A _{chord}	1696,46	mm ²
I _y = 0,85 x (4 x I _{chord} + 4 x A _{chord} x (h / 2) ²)	41795389	mm ⁴
I _z = 0,85 x (4 x I _{chord} + 4 x A _{chord} x (b / 2) ²)	41795389	mm ⁴
i _y = (I _y / A) ^{0,5}	156,9612	mm
i _z = (I _z / A) ^{0,5}	156,9612	mm
I _T (according to calculation supplier)	900	cm ⁴

Tube Material:

	f _o	f _u	f _{u,haz}	α	λ ₀	E
EN AW-6082-T6	250	290	185	0,2	0,1	70000

Factors:

Y _{M1}	Y _{M2}	factor _{f_{u,haz}}
1,1	1,25	0,8

Buckling data:

	K	k	L _{cr} [mm]	λ	φ	χ
Chords	1	1	678	0,81	0,898	0,78
Diagonals z	1	0,75	359,6	1,07	1,167	0,61
Diagonals y	1	0,75	359,6	1,07	1,167	0,61
End frame z	1	0,75	254,25	0,76	0,851	0,80
End frame y	1	0,75	254,25	0,76	0,851	0,80

Max. Normal force in tube (buckling)

with N_{b,Rd} = N_{b,Rd} = κ × A_{eff} × f_o / γ_{M1}

Chords	N _{b,Rd chord}	74,8 kN
Diagonals z	N _{b,Rd dia,z}	15,69 kN
Diagonals y	N _{b,Rd dia,y}	15,69 kN
End frame z	N _{b,Rd end,z}	20,69 kN
End frame y	N _{b,Rd end,y}	20,69 kN

Max. normal force @ node:

with N_{R,d} = N_{o,Rd} = A_g × f_o / γ_{M1}
N_{u,Rd} = A_{eff} × f_u / γ_{M2}

Chords	N _{R,d}	50,22 kN
Diagonals z	N _{R,d}	13,39 kN
Diagonals y	N _{R,d}	13,39 kN
End frame	N _{R,d}	13,39 kN

Max. normal force @ Coupler:

(according to calculation supplier)

Truss pin	70,98 kN
male coupler	60,3 kN
Female coupler	93,39 kN

Decisive N_{R,d}

N _{R,d main}	50,2 kN
N _{R,d dia,z}	13,4 kN
N _{R,d dia,y}	13,4 kN
N _{R,d end,z}	13,4 kN
N _{R,d end,y}	13,4 kN

Design forces Complete Truss assembly

M _{y,R,d}	34,05 kNm	2 x N _{R,d main} x h
M _{z,R,d}	34,05 kNm	2 x N _{R,d main} x b
N _{R,d}	200,86 kN	4 x N _{R,d main}
V _{z,R,d}	18,94 kN	2 x N _{R,d dia,z} x sin β _z
V _{y,R,d}	18,94 kN	2 x N _{R,d dia,y} x sin β _y
M _{x,R,d} *	6,42 kNm	V _{y,R,d} x h

*the assumed max. torsion in the complete truss assembly is limited by the max. normal force of the diagonals in the horizontal plane.

Check design values of complete Truss assembly

M _{y,E,d} ≤ M _{y,R,d}	1,00 kNm	in member	B1	Combi1
M _{z,E,d} ≤ M _{z,R,d}	11,33 kNm	in member	B1	Combi1
N _{E,d} ≤ N _{R,d}	3,00 kN	in member	B1	Combi1
V _{z,E,d} ≤ V _{z,R,d}	3,24 kN	in member	B1	Combi1
V _{y,E,d} ≤ V _{y,R,d}	1,00 kN	in member	B1	Combi1
M _{x,E,d} ≤ M _{x,R,d}	0,50 kNm	in member	B1	Combi1

Max. bending moment in main chord

with M_{R,d main} = W_{chord} x (f_{u,haz} x factor_{f_{u,haz}} / Y_{M2})

M_{R,d main} = 0,532 kNm

Check normal force in main chord

N_{E,d main} ≤ N_{R,d main} **18,94 kN** in member B1 Combi1

N_{d,n} + N_{d,my} + N_{d,mz}

With:

N _{Ed,N}	0,750 kN	N _{Ed} / 4
N _{Ed,my}	1,475 kN	M _{y,E,d} / 2h
N _{Ed,mz}	16,711 kN	M _{z,E,d} / 2b

Check bending moment in main chord

M_{E,d main} ≤ M_{R,d main} **0,04239 kNm** in member B1 Combi1

√ (V_{z,E,d}² + V_{y,E,d}²) x e / 4

Check Interaction of bending moment en normal force in main chord

U.C. max ≤ 1,0 **0,35718** (N_{E,d main} / N_{R,d main})^{1,3} + ((M_{E,d main} / M_{R,d main})^{1,7})^{0,6}

in member B1 Combi1

With:

N _{E,d main}	18,936 kN	N _{d,n} + N _{d,my} + N _{d,mz}
M _{E,d main}	0,042 kN	√ (V _{z,E,d} ² + V _{y,E,d} ²) x e / 4

Check Buckling (member with max. U.C. on interaction)

Length of span	L =	3810,00 mm	Zwaartepunt N
Buckling factor	K =	2	
Buckling length	L _{cr} =	7620 mm	
	λ =	0,9234932	
	φ =	1,0087692	
	χ =	0,7068663	
	(N / (X ₂ * N _{RD})) ^{0,8} + ((M _y / M _{y,RD}) ^{1,7} + (M _z / M _{z,RD}) ^{1,7}) ^{0,6} < 1		
U.C.	Check U.C.	0,37	
in member	B1	Combi1	dx [mm] 0