

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 1150-Goodguyz-Circoloco Standalone Rookmachines

Afmeting constructie

Breedte 2.07 m Diepte 2.07 m Hoogte 7.50 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	22.63 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	2	2	0.24	2.59	0.81	0.00	0	0.81	1	0.81	1	0
2-4	2	2	0.24	1.04	0.32	0.00	0	0.32	3	0.96	1	0
4-6	2	2	0.32	1.04	0.43	0.00	0	0.43	5	2.15	1	0
6-8	2	2	0.32	0.59	0.25	0.00	0	0.25	7	1.75	1	0
								1.81		5.67		

Kiepzekerheid

Voorschrift EN 13814 par. 5.5.1	$\Sigma M_{stand} / \Sigma M_{kiep} \geq Y_{so}$
Eigen gewicht constructie (G)	350.00 kg => 3.5 kN
Standmoment Mstand	$G / Y_{sg} \times (\text{diepte} / 2) = 3.29 \text{ kNm}$
Cumulatief kiepmoment Mkiep	5.67 kNm
Arm ballast	1.04 m
Benodigde ballast	$(\Sigma M_{kiep} \times Y_{so} - \Sigma M_{stand}) / \text{arm ballast} \times 100 = 337 \text{ kg}$

Glijzekerheid

Voorschrift EN 13814 par. 5.5.1	$\Sigma F_v \times \mu / \Sigma F_h \geq Y_{so}$
Som verticale krachten	$\Sigma F_v = G / Y_{sg} / 100 = 3.50 \text{ kN}$
Som horizontale krachten	$\Sigma F_h = F_w = 1.81 \text{ kN}$
Wrijving	Staal-hout-beton
Wrijvingscoëfficiënt (μ)	0.40
Benodigde ballast	224 kg

Bepaling benodigde ballast

Benodigde ballast constructie/object (B) 337 kg

Opmerkingen

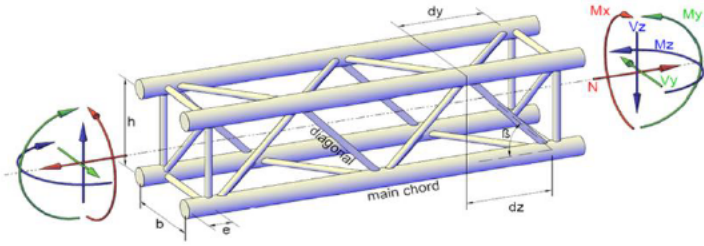
Controle truss met:
 $N = 1.2 \times 3.5 = 4.2 \text{ kN}$
 $V_y = 1.35 \times 1.81 = 2.45 \text{ kN}$
 $M_z = 1.35 \times 5.67 = 7.66 \text{ kNm}$

zie controle truss op volgende pagina.

Truss Type: **Interal T.C. P50SV** Self-Weight Truss 15 kg/m

Truss geometry:

Height	h	470 mm
Width	b	470 mm
Length vert. dia.	d _z	317 mm
Angle vert. dia.	β _z	56,00°
Length hor. dia.	d _y	317 mm
Angle hor. dia.	β _y	56,00°
Coupler offset	e	80 mm



Tube Cross Sections:

	D [mm]	t [mm]	A [mm ²]	W [mm ³]	I [mm ⁴]	i [mm]
Main Chord	50	4	578,1	6162,0	154051,1	16,3248
Diagonals z	30	3	254,5	1565,0	23474,8	9,60469
Diagonals y	30	3	254,5	1565,0	23474,8	9,60469
End frame	30	3	254,5	1565,0	23474,8	9,60469

total Truss cross section parameters

A = 4 × A _{chord}	2312,212	mm ²
I _y = 0,85 × (4 × I _{chord} + 4 × A _{chord} × (h / 2) ²)	1,09E+08	mm ⁴
I _z = 0,85 × (4 × I _{chord} + 4 × A _{chord} × (b / 2) ²)	1,09E+08	mm ⁴
i _y = (I _y / A) ^{0,5}	217,1814	mm
i _z = (I _z / A) ^{0,5}	217,1814	mm
I _T (according to calculation supplier)	3300	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	634	0,74	0,837	0,81
Diagonals z	1	0,75	425,2	0,84	0,929	0,76
Diagonals y	1	0,75	425,2	0,84	0,929	0,76
End frame z	1	0,75	352,5	0,70	0,804	0,83
End frame y	1	0,75	352,5	0,70	0,804	0,83

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} =	106,8 kN
Diagonals z	N _{b,Rd dia,z} =	43,79 kN
Diagonals y	N _{b,Rd dia,y} =	43,79 kN
End frame z	N _{b,Rd end,z} =	48,14 kN
End frame y	N _{b,Rd end,y} =	48,14 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}	68,44 kN
Diagonals z	N _{R,d}	30,13 kN
Diagonals y	N _{R,d}	30,13 kN
End frame	N _{R,d}	30,13 kN

Max. normal force @ Coupler:

(according to calculation supplier)

Truss pin	162,4 kN
male coupler	125,2 kN
Female coupler	108,9 kN

Decisive N_{R,d}

N _{R,d main}	68,4 kN
N _{R,d dia,z}	30,1 kN
N _{R,d dia,y}	30,1 kN
N _{R,d end,z}	30,1 kN
N _{R,d end,y}	30,1 kN

Design forces Complete Truss assembly

M _{y,R,d}	64,33 kNm	2 × N _{R,d main} × h
M _{z,R,d}	64,33 kNm	2 × N _{R,d main} × b
N _{R,d}	273,77 kN	4 × N _{R,d main}
V _{z,R,d}	49,96 kN	2 × N _{R,d dia,z} × sin β _z
V _{y,R,d}	49,96 kN	2 × N _{R,d dia,y} × sin β _y
M _{x,R,d} *	23,48 kNm	V _{y,R,d} × h

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

Max. bending moment in main chord

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

M_{R,d main} = 0,7296 kNm

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}	7,66 kNm	in member	B1	Combi1
N _{E,d} ≤ N _{R,d}	4,20 kN	in member	B1	Combi1
V _{z,E,d} ≤ V _{z,R,d}	2,45 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

Check normal force in main chord

N _{E,d main} ≤ N _{R,d main}	10,26 kN	in member	B1	Combi1	N _{d,n} + N _{d,my} + N _{d,mz}
With:					
N _{Ed,N}	1,050 kN	N _{E,d} / 4			
N _{Ed,my}	1,064 kN	M _{y,E,d} / 2h			
N _{Ed,mz}	8,149 kN	M _{z,E,d} / 2b			

Check bending moment in main chord

M _{E,d main} ≤ M _{R,d main}	0,05292 kNm	in member	B1	Combi1	√ (V _{z,E,d} ² + V _{y,E,d} ²) × e / 4
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Check Interaction of bending moment en normal force in main chord

U.C. max ≤ 1,0

0,1537	(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}	10,263 kN	N _{d,n} + N _{d,my} + N _{d,mz}		
M _{E,d main}	0,053 kN	√ (V _{z,E,d} ² + V _{y,E,d} ²) × e / 4		

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

Length of span	L =	6000,00 mm	Zwaartepunt N
Buckling factor	K =	2	
Buckling length	L _{cr} =	12000 mm	
	λ	1,0510652	
	φ	1,1474756	
	χ	0,6219412	
	(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.	0,17	
in member	B1	Combi1	dx [mm] 0