

## 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 1140-Goodguyz-Circoloco Standalone Licht (2x)

### Afmeting constructie

Breedte 2.07 m      Diepte 2.07 m      Hoogte 12.00 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<sub>sg</sub>)** 1.10  
**Veiligheidsfactor voor ongunstige variabele belasting (Y<sub>so</sub>)** 1.20

### Windbelasting

<b>Terreinruwheid</b>	Onbebouwd	<b>Volheidsgraad scherm</b>	100.00 %
<b>10 min. gemidd. basiswindsnelheid</b>	7 Bft   17,1 m/s	<b>Volheidsgraad scaff</b>	7.00 %
<b>Max. windsnelheid +10.00m</b>	24.98 m/s	<b>Bouwwerkfactor<sup>1</sup> (CsCd)</b>	1.00
<b>Max. windsnelheid hoogste punt</b>	24.98 m/s	<b>Krachtcoefficient<sup>2</sup> (cf)</b>	1.30
<b>Wrijving spindel-ondergrond</b>	Staalhout-beton	<b>Wrijvingsfactor<sup>3</sup></b>	0.40

<sup>1</sup> EN 1991-1-4

<sup>2</sup> EN 12811 par. 6.2.7.2

<sup>3</sup> EN 13814 par. 5.1.1.2

## Bepaling koppel uit wind

Hoogte (m)	Stram. breed	Stram. diep	Extreme stuwdruk (kN/m <sup>2</sup> )	Ascher m (m <sup>2</sup> )	Fw scherm (kN)	Ascaff projectie (m <sup>2</sup> )	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	3.45	1.08	0.00	0	1.08	1	1.08	1	0
2-4	2	2	0.24	0.67	0.21	0.00	0	0.21	3	0.63	1	0
4-6	2	2	0.28	2.00	0.73	0.00	0	0.73	5	3.65	1	0
6-8	2	2	0.32	2.45	1.02	0.00	0	1.02	7	7.14	1	0
8-10	2	2	0.39	3.75	1.9	0.00	0	1.9	9	17.1	1	0
10-12	2	2	0.39	4.90	2.48	0.00	0	2.48	11	27.28	1	0
								<b>7.42</b>		<b>56.88</b>		

## Kiepzekeerheid

Voorschrift EN 13814 par. 5.5.1

Eigen gewicht constructie (G)

Standmoment Mstand

Cumulatief kiepmoment Mkiep

Arm ballast

Benodigde ballast

$$\Sigma M_{stand} / \Sigma M_{kiep} \geq Y_{so}$$

$$1400.00 \text{ kg} \Rightarrow 14.0 \text{ kN}$$

$$G / Y_{sg} \times (\text{diepte} / 2) = 13.17 \text{ kNm}$$

$$56.88 \text{ kNm}$$

$$1.04 \text{ m}$$

$$(\Sigma M_{kiep} \times Y_{so} - \Sigma M_{stand}) / \text{arm ballast} \times 100 = 5296 \text{ kg}$$

## Glijzekeerheid

Voorschrift EN 13814 par. 5.5.1

Som verticale krachten

Som horizontale krachten

Wrijving

Wrijvingscoefficient ( $\mu$ )

Benodigde ballast

$$\Sigma F_v \times \mu / \Sigma F_h \geq Y_{so}$$

$$\Sigma F_v = G / Y_{sg} / 100 = 14.00 \text{ kN}$$

$$\Sigma F_h = F_w = 7.42 \text{ kN}$$

Staal-hout-beton

$$0.40$$

$$953 \text{ kg}$$

## Bepaling benodigde ballast

Benodigde ballast constructie/object (B) 5296 kg

## Opmerkingen

Controle truss met:

$$N = 1.2 \times 14.0 = 16.8 \text{ kN}$$

$$V_y = 1.35 \times (7.42 - 1.08) = 8.56 \text{ kN}$$

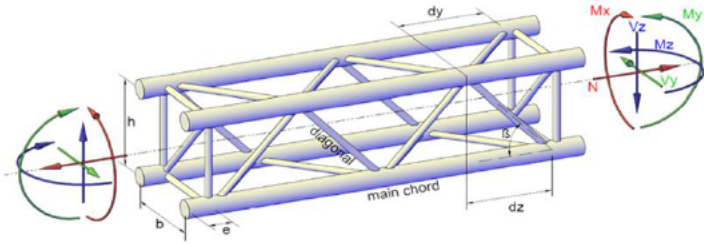
$$M_z = 1.35 \times (56.88 - 1.08) = 75.33 \text{ kNm}$$

zie controle truss op volgende pagina.

Truss Type: **Prolyte C52T** Self-Weight Truss 15 kg/m

Truss geometry:

Height	h	470 mm
Width	b	470 mm
Length vert. dia.	d <sub>z</sub>	470 mm
Angle vert. dia.	β <sub>z</sub>	45,00°
Length hor. dia.	d <sub>y</sub>	470 mm
Angle hor. dia.	β <sub>y</sub>	45,00°
Coupler offset	e	80 mm



Tube Cross Sections:

	D [mm]	t [mm]	A [mm <sup>2</sup> ]	W [mm <sup>3</sup> ]	I [mm <sup>4</sup> ]	i [mm]
Main Chord	60	5	863,9	10979,2	329376,4	19,5256
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 x A <sub>chord</sub>	3455,752	mm <sup>2</sup>
I <sub>y</sub> = 0,85 x (4 x I <sub>chord</sub> + 4 x A <sub>chord</sub> x (h / 2) <sup>2</sup> )	1,63E+08	mm <sup>4</sup>
I <sub>z</sub> = 0,85 x (4 x I <sub>chord</sub> + 4 x A <sub>chord</sub> x (b / 2) <sup>2</sup> )	1,63E+08	mm <sup>4</sup>
i <sub>y</sub> = (I <sub>y</sub> / A) <sup>0,5</sup>	217,4059	mm
i <sub>z</sub> = (I <sub>z</sub> / A) <sup>0,5</sup>	217,4059	mm
I <sub>T</sub> (according to calculation supplier)	3200	cm <sup>4</sup>

Tube Material:

	f <sub>o</sub>	f <sub>u</sub>	f <sub>u,haz</sub>	α	λ <sub>0</sub>	E
EN AW-6082-T6	250	290	185	0,2	0,1	70000

Factors:

Y <sub>M1</sub>	Y <sub>M2</sub>	factor <sub>f<sub>u,haz</sub></sub>
1,1	1,25	0,8

Buckling data:

	K	k	L <sub>cr</sub> [mm]	λ	φ	χ
Chords	1	1	940	0,92	1,001	0,71
Diagonals z	1	0,75	498,5	0,99	1,076	0,66
Diagonals y	1	0,75	498,5	0,99	1,076	0,66
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<sub>b,Rd</sub> = N<sub>b,Rd</sub> = K x A<sub>eff</sub> x f<sub>o</sub> / γ<sub>M1</sub>

Chords	N <sub>b,Rd chord</sub> =	139,8 kN
Diagonals z	N <sub>b,Rd dia,z</sub> =	38,45 kN
Diagonals y	N <sub>b,Rd dia,y</sub> =	38,45 kN
End frame z	N <sub>b,Rd end,z</sub> =	48,14 kN
End frame y	N <sub>b,Rd end,y</sub> =	48,14 kN

Max. normal force @ node:

with N<sub>R,d</sub> = N<sub>o,Rd</sub> = A<sub>g</sub> x f<sub>o</sub> / γ<sub>M1</sub>  
N<sub>u,Rd</sub> = A<sub>eff</sub> x f<sub>u</sub> / γ<sub>M2</sub>

Chords	N <sub>R,d</sub>	102,29 kN
Diagonals z	N <sub>R,d</sub>	30,13 kN
Diagonals y	N <sub>R,d</sub>	30,13 kN
End frame	N <sub>R,d</sub>	30,13 kN

Max. normal force @ Coupler:

(according to calculation supplier)

Truss pin	147,7 kN
male coupler	126,7 kN
Female coupler	101,3 kN

Decisive N<sub>R,d</sub>

N <sub>R,d main</sub>	101,3 kN
N <sub>R,d dia,z</sub>	30,1 kN
N <sub>R,d dia,y</sub>	30,1 kN
N <sub>R,d end,z</sub>	30,1 kN
N <sub>R,d end,y</sub>	30,1 kN

Design forces Complete Truss assembly

M <sub>y,R,d</sub>	95,25 kNm	2 x N <sub>R,d main</sub> x h
M <sub>z,R,d</sub>	95,25 kNm	2 x N <sub>R,d main</sub> x b
N <sub>R,d</sub>	405,32 kN	4 x N <sub>R,d main</sub>
V <sub>z,R,d</sub>	42,61 kN	2 x N <sub>R,d dia,z</sub> x sin β <sub>z</sub>
V <sub>y,R,d</sub>	42,61 kN	2 x N <sub>R,d dia,y</sub> x sin β <sub>y</sub>
M <sub>x,R,d</sub> *	20,03 kNm	V <sub>y,R,d</sub> 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 <sub>y,E,d</sub> ≤ M <sub>y,R,d</sub>	1,00 kNm	in member	B1	Combi1
M <sub>z,E,d</sub> ≤ M <sub>z,R,d</sub>	76,79 kNm	in member	B1	Combi1
N <sub>E,d</sub> ≤ N <sub>R,d</sub>	16,80 kN	in member	B1	Combi1
V <sub>z,E,d</sub> ≤ V <sub>z,R,d</sub>	8,98 kN	in member	B1	Combi1
V <sub>y,E,d</sub> ≤ V <sub>y,R,d</sub>	1,00 kN	in member	B1	Combi1
M <sub>x,E,d</sub> ≤ M <sub>x,R,d</sub>	0,50 kNm	in member	B1	Combi1

Max. bending moment in main chord

with M<sub>R,d main</sub> = W<sub>chord</sub> x (f<sub>u,haz</sub> x factor<sub>f<sub>u,haz</sub></sub> / γ<sub>M2</sub>)

M<sub>R,d main</sub> = 1,2999 kNm

Check normal force in main chord

N<sub>E,d main</sub> ≤ N<sub>R,d main</sub> **86,95 kN** N<sub>d,n</sub> + N<sub>d,my</sub> + N<sub>d,mz</sub>

in member B1 Combi1

With:

N <sub>Ed,N</sub>	4,200 kN	N <sub>Ed</sub>   / 4
N <sub>Ed,my</sub>	1,064 kN	M <sub>y,E,d</sub>   / 2h
N <sub>Ed,mz</sub>	81,689 kN	M <sub>z,E,d</sub>   / 2b

Check bending moment in main chord

M<sub>E,d main</sub> ≤ M<sub>R,d main</sub> **0,18071 kNm** √ (V<sub>z,E,d</sub><sup>2</sup> + V<sub>y,E,d</sub><sup>2</sup>) x e / 4

in member B1 Combi1

Check Interaction of bending moment en normal force in main chord

U.C. max ≤ 1,0 **0,95325** (N<sub>E,d main</sub> / N<sub>R,d main</sub>)<sup>1,3</sup> + ((M<sub>E,d main</sub> / M<sub>R,d main</sub>)<sup>1,7</sup>)<sup>0,6</sup>

in member B1 Combi1

With:

N <sub>E,d main</sub>	86,953 kN	N <sub>d,n</sub> + N <sub>d,my</sub> + N <sub>d,mz</sub>
M <sub>E,d main</sub>	0,181 kN	√ (V <sub>z,E,d</sub> <sup>2</sup> + V <sub>y,E,d</sub> <sup>2</sup> ) x e / 4

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

Length of span	L =	8000,00 mm	Zwaartepunt N
Buckling factor	K =	2	
Buckling length	L <sub>cr</sub> =	16000 mm	
	λ	1,3999735	
	φ	1,6099603	
	χ	0,415805	
	(N / (X <sub>2</sub> * N <sub>RD</sub> )) <sup>0,8</sup> + ((M <sub>y</sub> / M <sub>y,RD</sub> ) <sup>1,7</sup> + (M <sub>z</sub> / M <sub>z,RD</sub> ) <sup>1,7</sup> ) <sup>0,6</sup>	< 1	
U.C.	Check U.C.	<b>0,96</b>	
in member	B1	Combi1	dx [mm] 0