Canopy Calculation Report Structural Design NTI SE Zandvoort

Shell EPCM NLxxxx
NTI SE Zandvoort Circuit, Zandvoort, Nederland

Shell Station “NTI SE Zandvoort Circuit”
Burgemeester van Alphenstraat 108,
2041 KP Zandvoort,
The Netherlands

Shell Nederland Verkoopmaatschappij B.V.
"PERMIT PHASE"

Project reference: NLxxxx
Project number: xxxx-276503
NLxxxx-276503-FED-XX-RP-S-0001 Rev.B1

October 11, 2019

Shell Nederland Verkoopmaatschappij BV

Quality information

Prepared by	Checked by	Verified by	Approved by
C. Cretu Structural Engineer	W. Lia Project Design Specialist		

Revision History

Revisie	Revision date	Details	Geautoriseerd	Naam	Positie
A1	September 27, 2019	Vergunning		C. Cretu	Structural Engineer
B1	October 11, 2019	Vergunning – zonder portaal		C. Cretu	Structural Engineer

Prepared for:

Shell Nederland Verkoopmaatschappij B.V.
Weena 70
3012 CM Rotterdam
the Netherlands

Prepared by:

C. Cretu
Structural Engineer
M: +40 743 291 647
E: cezar.cretu@aecom.com

AECOM Netherlands B.V.
HNK Den Haag, Oude Middenweg 17
2491 AC Den Haag, The Netherlands

T: +31 (0) 702400898
aecom.com

INHOUD

Reference Documents

Document# and revision	Date of issue	Description
9019-0702-000	11 september 2019	Geotechnical Report

1. General

1.1 Introduction

This report contains the structural design of the new built Shell petrol station NTI SE Zandvoort Circuit, located in Zandvoort, Netherlands. Structural calculation has been made of the main steel structure and concrete foundations of the new canopy.

Detail calculations and drawings of the steel joints and piping shall be elaborated by the contractor during the execution phase. These documents shall be submitted for approval to the authorities at least 3 weeks before the start of the specific construction work.

1.2 Project scope of work

As part of the EPCM Shell Verkoopmaatschappij BV is intending to build a new Shell petrol station NTI SE Zandvoort Circuit, located in Zandvoort, Netherlands. The project scope of work includes construction of Shell Express (SE) site with canopy and liquid-tight pavement around dispensers/under canopy and around the filling point.

The footprint of canopy is approximately 7,2x9,0 meter with a total height of 5,5 meters from pavement level.

Fig. New location of Shell petrol station

The canopy will be constructed as a framed steel structure. Stability is obtained with moment connections in the steel structure and fixed connections between columns and foundations. The building will be founded on concrete isolated footings.

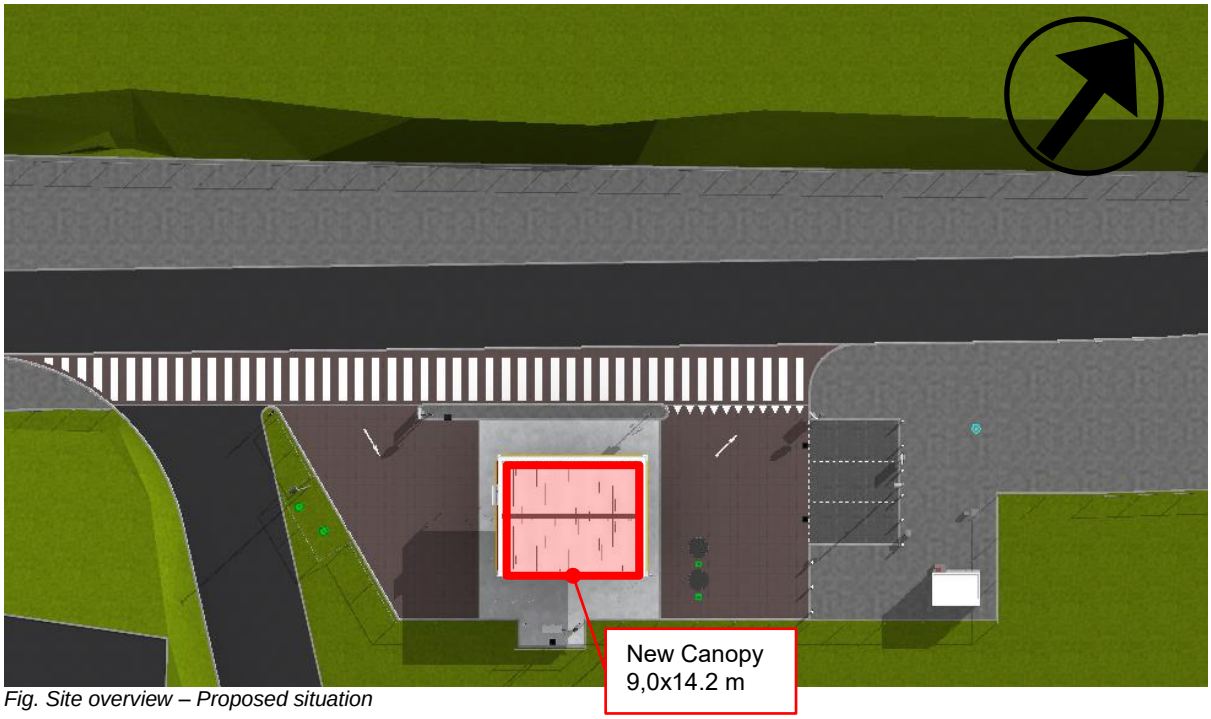


Fig. Site overview – Proposed situation

Fig. 3D view – Proposed situation

2. Codes & Regulations

This calculation has been based on the last expenditures of the European standards with applicable Dutch National Annexes:

- NEN-EN 1990 & NB Basis of structural design
- NEN-EN 1991 & NB Actions on structures
- NEN-EN 1992 & NB Design of concrete structures
- NEN-EN 1993 & NB Design of steel structures
- NEN-EN 1997 & NB Geotechnical design
- NEN-EN 206-1 Specification, performance, production and conformity
- NEN-EN 10080 Steel for the reinforcement of concrete
- NEN-EN 13670 Execution of concrete structures
- NEN-EN 1090-1 Execution of steel and aluminium structures
  Part 1: Requirements for conformity assessment of structural components
- NEN-EN 1090-2 Execution of steel and aluminium structures
  Part 2: Technical requirements for steel structures
- NEN-EN 10025-2 Hot rolled products of structural steel
- NEN-EN 10210-1 Hot finished structural hollow sections
- NEN-EN 10219-1 Cold formed welded structural hollow sections
- NEN-EN-ISO 898-1 Bolts, screws and studs with specified property classes
- NEN-EN-ISO 898-2 Nuts with specified proof load values

Other standards and regulations:

- NEN 9997-1 Geotechnical design of structures – part 1 – General rules
- Shell Global Innovation & Design Standards

3. Design Criteria

Indicative design working life

In accordance with Table NB.1 – 2.1 of NEN-EN 1990/NB

Category 3	50 years	Building structures and other common structures

Consequences classes (CC)

In accordance with Table NB.20 – B1 of NEN-EN 1990/NB

CC2	**Medium** consequence for loss of human life, *and/or* economic, social or environmental consequences **considerable**

Reliability classes (RC)

In accordance with Tables B2 and B3 of NEN-EN 1990

RC2	$\beta_{(1\ year)} = 4,7$	$\beta_{(50\ years)} = 3,8$	$K_{FI} = 1,0$

Design supervision levels (DSL)

In accordance with Table B4 of NEN-EN 1990

DSL 2 i.r.t. RC2	Normal supervision	Checking by different persons that those originally responsible and in accordance with the procedure of the organization

Inspection levels (IL)

In accordance with Table B5 of NEN-EN 1990

IL2 i.r.t. RC2	Normal inspection	Inspection in accordance with the procedures of organization

Execution classes (EXC)

In accordance with material treaties execution standards NEN-EN 13670 and NEN-EN 1090

EXC2	i.r.t. RC2 and RC1	Office, shopping, domestic and residential areas, industrial structures

Categories of use

In accordance with Art.6.3 of NEN-EN 1991-1-1/NB

		Values of Ψ factors *In accordance with Table NB.2 – A1.1 of NEN-EN 1990/NB*		
H	roofs (not accessible)	$\Psi_0 = 0,0$	$\Psi_1 = 0,0$	$\Psi_2 = 0,0$
	Snow loads	$\Psi_0 = 0,0$	$\Psi_1 = 0,2$	$\Psi_2 = 0,0$
	Loads by rainwater	$\Psi_0 = 0,0$	$\Psi_1 = 0,0$	$\Psi_2 = 0,0$
	Wind loads	$\Psi_0 = 0,0$	$\Psi_1 = 0,2$	$\Psi_2 = 0,0$

Vertical deflections and horizontal displacements

In accordance with Art.A1.4.3 of NEN-EN 1990/NB

Other roofs	w_{max}	≤ 1/250 × L
	w_2+w_3	≤ 1/250 × L

Horizontal displacements

In accordance with Art.A1.4.3 of NEN-EN 1990/NB

Other structures (one level)	u_{tot}	≤ 1/300 × H

3.1 Remarks

3.1.1 Requirements for the design

- New canopy will have an independent structure. Single column canopy will have drainage gutter placed on top of main beam, long direction. The drainage pipe for water is placed inside the column, starting just below the gutter, top of column. The additional stiffness plates placed inside column for beam-column connection will allow the drainage pipe to pass.

3.1.2 Environmental Factors

- Geotechnical influences on surroundings elements. Avoid influences on underground storage tanks. Take in consideration excavation impact during maintenance on underground tanks.

3.1.3 Type of geotechnical design

- Based on the soil condition in this area proposed foundations shall be considered as isolated footings

  A foundation advice shall be executed in a later stage by the geotechnical advisor to determine the soil capacity.

4. Material

4.1 Steel

4.1.1 Quality

Steel sections quality

Hot rolled products of structural steel	S235	f_y = 235 N/mm^2	f_u = 360 N/mm^2	*NEN-EN 10025-2*
Hot finished structural hollow sections	S275 H	f_y = 275 N/mm^2	f_u = 430 N/mm^2	*NEN-EN 10210-1*

Fasteners quality

Bolts, screws and studs with specified property classes	8.8	f_{yb} = 640 N/mm^2	f_{ub} = 800 N/mm^2	*NEN-EN-ISO 898-1*
Nuts with specified proof load values	8	corresponding bolt	8.8	*NEN-EN-ISO 898-2*

4.1.2 Partial factors

Partial factors of resistance in de sections *In accordance with Art.6.1 of NEN-EN 1993-1-1/NB*

γ_{M0} = 1,0 γ_{M1} = 1,0 γ_{M2} = 1,25

Partial factors of resistance of joints *In accordance with Art.2.2 of NEN-EN 1993-1-8/NB*

γ_{M2} = 1,25 γ_{M3} = 1,25 $\gamma_{M3;ser}$ = 1,1 γ_{M4} = 1,0 γ_{M5} = 1,0 $\gamma_{M6;ser}$ = 1,0 γ_{M7} = 1,1

Sustainability

Specific aspects related to sustainability such as conservation, etc. (if needed) mentioned in specifications and drawings.

Atmospheric corrosivity categories and examples of typical environments *In accordance with NEN-EN-ISO 12944-2*

Corrosivity category	Examples of typical environments (informative only)	
	Exterior	Interior
C1 very low	-	Heated buildings with clean atmospheres, e.g. offices, shops, schools, hotels
C2 low	**Atmospheres with low level of pollution: mostly rural areas**	**Unheated buildings where condensation can occur, e.g. depots, sports halls**
C3 medium	Urban and industrial atmospheres, moderate sulphur dioxide pollution; coastal area with low salinity	Production rooms with high humidity and some air pollution, e.g. food-processing plants, laundries, breweries, dairies
C4 high	Industrial areas and coastal areas with moderate salinity	Chemical plants, swimming pools, coastal ship and boatyards
C5 very high	Industrial areas with high humidity and aggressive atmosphere and coastal areas with high salinity	Buildings or areas with almost permanent condensation and high pollution

The period to first maintenance of applied coatings to steelwork is dependent of protection system specified but should be no less than 10 years according to Shell Specification.

4.2 Concrete

4.2.1 Quality

Concrete quality *In accordance with Table 3.1 of NEN-EN 1992-1-1/NB*

Blinding layer	C12/15	f_{ck} = 12 N/mm^2	$f_{ck;cube}$ = 15 N/mm^2
In situ concrete	C30/37	f_{ck} = 30 N/mm^2	$f_{ck;cube}$ = 37 N/mm^2

Quality of the reinforcement steel *In accordance with Annex C of NEN-EN 1992-1-1/NB and NEN-EN 10080*

B500B	f_{yk} = 500 N/mm^2	with dented or ribbed surface

4.2.2 Partial factors

Partial factors for materials *In accordance with Art.2.4.2.4 of NEN-EN 1992-1-1/NB*

Design situation	**γ_C for concrete**	**γ_S for reinforcing steel**
Persistent & Transient	1,5	1,15
Accidental	1,2	1,0
Fatigue	1,35	1,15
Serviceability	1,0	1,0

Partial factors for materials for foundation *In accordance with Art 2.4.2.5 of NEN-EN 1992-1-1/NB*

k_f = 1,1

4.2.3 Sustainability

Specific aspects related to sustainability such as environmental class, concrete cover, conservation, etc. (if needed) mentioned in specifications and drawings.

Environmental conditions *In accordance with Table 4.1 of NEN-EN 1992-1-1/NB*

Attack mechanism		**class**	**Environment**	**cover (c)**			
				Plate, wall	**Beam, pedestal, console**	**Column**	**Crack width (w)**
No Corrosion	**X0** (0= “zero risk”) No risk of corrosion or attack	X0	For concrete without reinforcement or embedded metal: all exposures except where there is freeze/thaw, abrasion of chemical attack				
Corrosion reinforcement	**XC** (C= “Carbonation”) Corrosion induced by carbonation	XC1	Dry or permanently wet	15	25	30	0,4
		XC2	Wet, rarely dry	**25**	**30**	**35**	**0,3**
		XC3	Moderate humidity				
		XC4	Cyclic wet and dry				
	XD (D= “Deicing salts”) Corrosion induced by chlorides not sea water	XD1	Moderate humidity	30	35	40	0,2
		XD2	Wet, rarely dry				
		XD3	Cyclic wet and dry				
	XS (S= “Seawater”) Corrosion induced by chlorides from sea water	XS1	Airborne salt (no contact with sea water)	30	35	40	0,2
		XS2	Permanently submerged				
		XS3	Tidal, splash and spray zones				
Corrosion concrete	**XF** (F= “Frost”) Freeze/Thaw attack	XF1	Moderate water saturation, without de-icing agent	25	30	35	0,3
		XF2	Moderate water saturation, with de-icing agent	30	35	40	0,2
		XF3	High water saturation, without de-icing agents	25	30	35	0,3
		XF4	High water saturation, with de-icing agents or sea water	30	35	40	0,2
	XA (A= “Aggressive”) Chemical attack	XA1	Slightly aggressive chemical environment	30	35	40	0,2
		XA2	Moderate aggressive chemical environment				
		XA3	Highly aggressive chemical environment				

5. Actions

5.1 Permanent actions

Dead loads of structural structures	*In accordance with Table A1 t/m A12 of NEN-EN 1991-1-1*
Steel structures	78,5 kN/m^3
Concrete structures	25,0 kN/m^3

Dead loads of non-structural structures	*In accordance with Table A1 t/m A12 of NEN-EN 1991-1-1*
Roof	
- Roof structure (steel plate, insulation, finishing)	0,30 kN/m^2
- Installation hanging in canopy (lighting, drains)	0,10 kN/m^2
- Suspended ceiling	0,10 kN/m^2

5.2 Imposed loads

Imposed loads for floors and roofs	*In accordance with Table NB.1 – 6.2 to NB.5 of NEN-EN 1991-1-1/NB*	
Roofs (not accessible), only maintenance	Category H	1,00 kN/m^2
Ground floor – Shopping areas	Category D1	4,00 kN/m^2

5.3 Snow loads

Snow load on roof	*In accordance with Art.5 of NEN-EN 1991-1-3 & NB*
Flat roof	0,56 kN/m^2

5.4 Loads by rainwater

Loads by rainwater	*In accordance with Art.7 of NEN-EN 1991-1-3/NB*
Rainwater not a decisive load case. Accumulating height of rainwater will not exceed snow load.	
Sufficient slope in roof plates and gutters, downspouts and emergency overflow are considered.	
Corrugated roof sheeting to gutters:	slope>20mm/m
Gutters 500x175mm to downspouts located at column:	slope>10mm/m.
Emergency overflow positioned at downspouts.	
Maximum capacity of gutters is 500x175mm/m. Accumulating height of rainwater will not exceed 175 mm in gutter.	

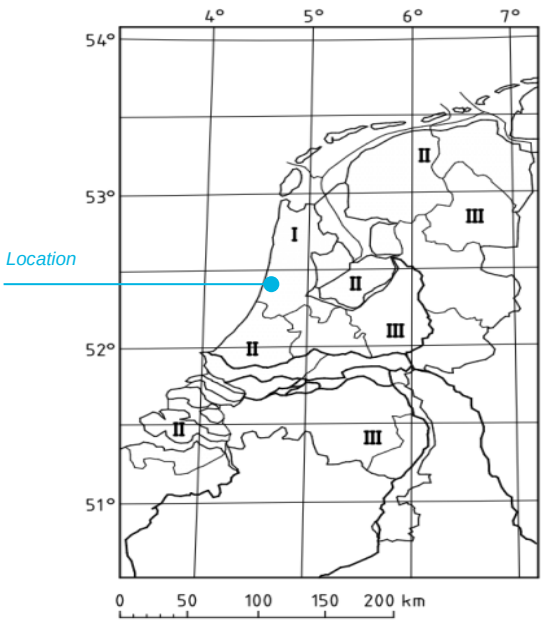
5.5 Wind load

Wind pressure $q_p(z)$

In accordance with Table NB.5 of NEN-EN 1991-1-4/NB

Wind category	II

Fig. NB.1 - Classification of the Netherlands in wind categories



Area	Coastal
Reference height z_e	5.5 meters

Extreme wind pressure $q_p(z)$

Table NB.5 - Wind velocity pressure in kN/m² in relation with the height

Height	Category I			Category II			Category III	
m	coastal	without obstacles	with buildings	coastal	without obstacles	with buildings	without obstacles	with buildings
1	0,93	0,71	0,69	0,78	0,60	0,58	0,49	0,48
2	1,11	0,71	0,69	0,93	0,60	0,58	0,49	0,48
3	1,22	0,71	0,69	1,02	0,60	0,58	0,49	0,48
4	1,30	0,71	0,69	1,09	0,60	0,58	0,49	0,48
5	1,37	0,78	0,69	1,14	0,66	0,58	0,54	0,48
5.5						1.165		
6	1,42	0,84	0,69	1,19	0,71	0,58	0,58	0,48
7	1,47	0,89	0,69	1,23	0,75	0,58	0,62	0,48
8	1,51	0,94	0,73	1,26	0,79	0,62	0,65	0,51
9	1,55	0,98	0,77	1,29	0,82	0,65	0,68	0,53
10	1,58	1,02	0,81	1,32	0,85	0,68	0,70	0,56
15	1,71	1,16	0,96	1,43	0,98	0,80	0,80	0,66

Structural factor $c_s c_e$

In accordance with Art.6 of NEN-EN 1991-1-4 & NB

Building height ≤ 15 m ($c_s c_d$ = 1,0)	*in accordance with Art.6.2(1)a*
Walls and roof elements with natural frequency > 5 Hz ($c_s c_d$ = 1,0)	*in accordance with Art.6.2(1)b*
Building with framework and stability walls H < 100m en H < 4 * building depth ($c_s c_d$ = 1,0)	*in accordance with Art.6.2(1)c*

Pressure, friction and force coefficients

In accordance with Art.7 of NEN-EN 1991-1-4 & NB

Canopy roofs, (c_{pe}) in accordance with Tables 7.6, 7.7 AND 7.8, with roof slope of -5° and +5°	Downwards	c_f = +0,3	
	Upwards	c_f = -1,3	
Friction coefficients (c_{fr}) in accordance with Table 7.10	Smooth	c_{fr} = 0,01	(e.g. steel, smooth concrete)
	Rough	c_{fr} = 0,02	(e.g. rough concrete, tar-boards)
	Very rough	c_{fr} = 0,04	(i.e. ripples, ribs, folds)
Structural elements with rectangular sections, (c_f) in accordance with Art.7.		c_f = 2,1	

5.6 Accidental actions

Impact

In accordance with art 4.3 of NEN-EN 1991-7/NB

Accidental actions caused by road vehicles shall not be considered. Where traffic is passing or parking along the structure provisions are taken into the design of the terrain to avoid impact on the structures.

Explosion

In accordance with NEN-EN 1991-7/NB

Accidental actions caused by fuel explosion shall not be considered in the design of structures.

6. Combinations of actions

6.1 ULS – Ultimate Limit States

Table NB.4 – A1.2 (B) – Design values of actions (STR/GEO) (Set B) in accordance with NEN-EN 1990/NB

Persistent and transient design situations	Permanent actions		Leading variable action	Accompanying variable actions	
	Unfavourable	Favourable		Main (if any)	Others
(Eq. 6.10a)	1,35 $G_{kj,sup}$	0,9 $G_{kj,inf}$		1,5 $\psi_{0,1}Q_{k,1}$	1,5 $\psi_{0,i}Q_{k,i}$ $i > 1$
(Eq. 6.10b)	1,2 $G_{kj,sup}$ $\zeta = 0,89$ is included	0,9 $G_{kj,inf}$	1,5 $Q_{k,1}$		1,5 $\psi_{0,i}Q_{k,i}$ $i > 1$

6.2 SLS – Serviceability Limit States

Table A1.4 – Design values of actions for use in the combination of actions in accordance with NEN-EN 1990

Combination	Permanent action G_d		Variable actions G_d	
	Unfavorable	Favorable	Leading	Others
Characteristic	1,0 $G_{kj,sup}$	1,0 $G_{kj,inf}$	1,0 $Q_{k,1}$	1,0 $\psi_{0,i}Q_{k,i}$
Frequent	1,0 $G_{kj,sup}$	1,0 $G_{kj,inf}$	1,0 $\Psi_{1,1}Q_{k,1}$	1,0 $\Psi_{2,i}Q_{k,i}$
Quasi-permanent	1,0 $G_{kj,sup}$	1,0 $G_{kj,inf}$	1,0 $\Psi_{2,1}Q_{k,1}$	1,0 $\Psi_{2,i}Q_{k,i}$

7. Schematic overview

7.1 Structural overview canopy

The structure is designed as an independent steel structure. Stability is be obtained placing the main beams diagonally in the roof and using fixed connection in the columns.

Based on soil condition in this area it is expected that the foundation shall be carried out on a single reinforced concrete foundation. A foundation advice shall be executed in a later stage by the geotechnical advisor to determine the soil capacity.

7.1.1 Steel structure

Below the schematic overview of the steel structure.

For canopy steel frames calculations see **appendix A**

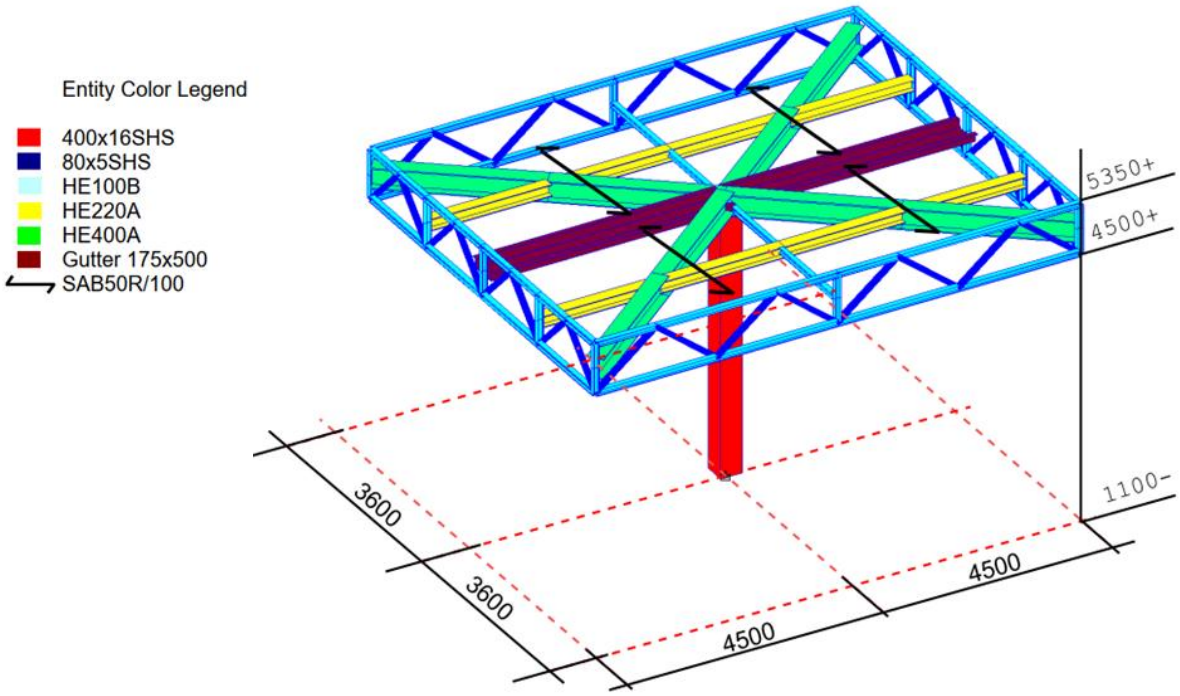


Fig. Overview steel structure canopy

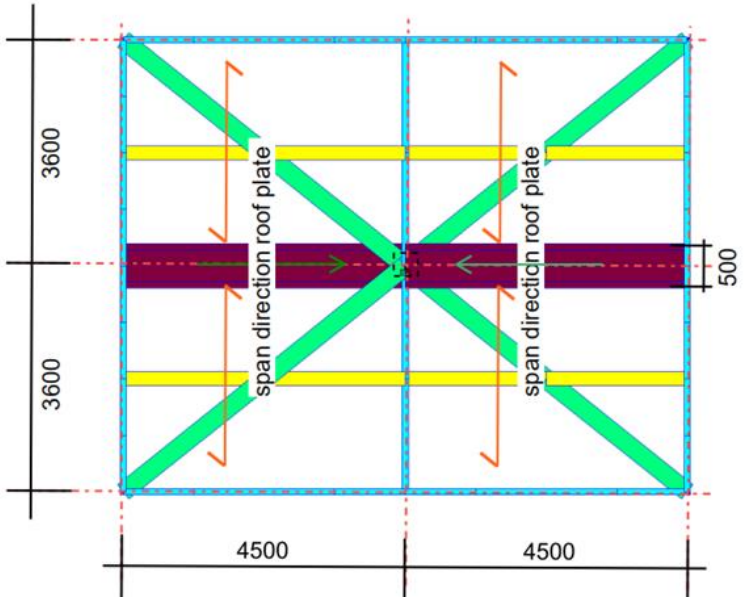


Fig. Spans direction for roof plates

7.1.2 Concrete foundations for canopy

Below the schematic overview of the canopy foundation.

Design requirements for the isolated footing:
- Concrete quality: C30/37
- Steel quality for reinforcing steel: B500B
- Minimum concrete cover: 40mm

For foundation calculation sees **Appendix B**.

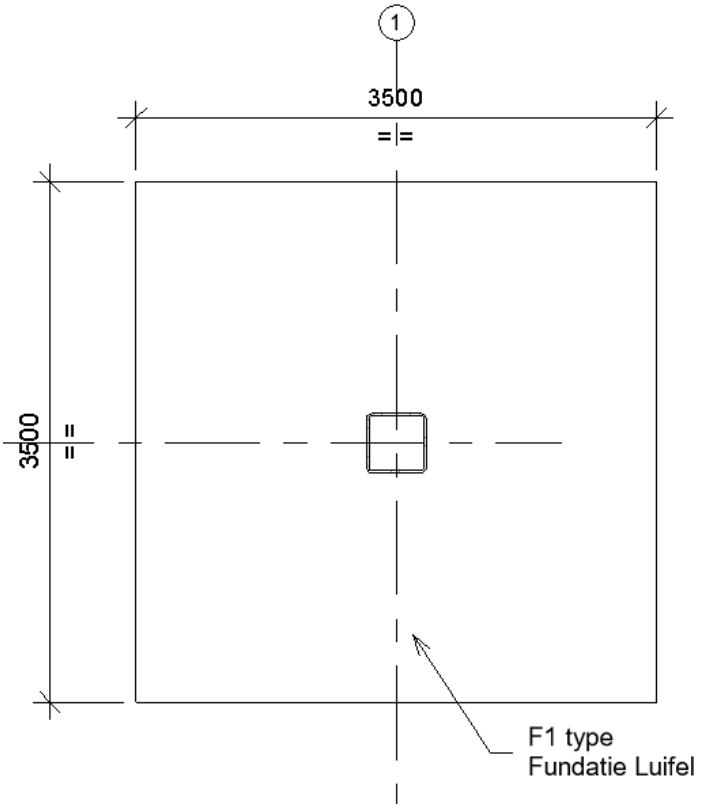


Fig. Top view for canopy foundation

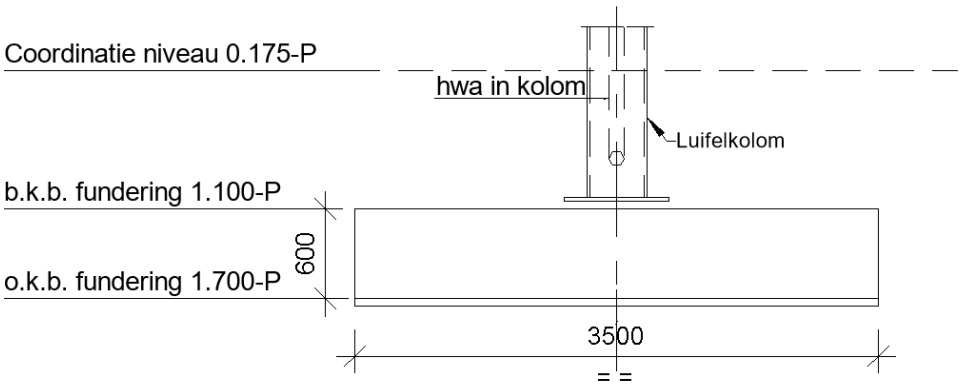


Fig. Side view for canopy foundation

Loads from steel columns are transferred to foundation trough the base plate and anchoring assembly. Connection type is fixed.

See base plate calculation in **Appendix C.**

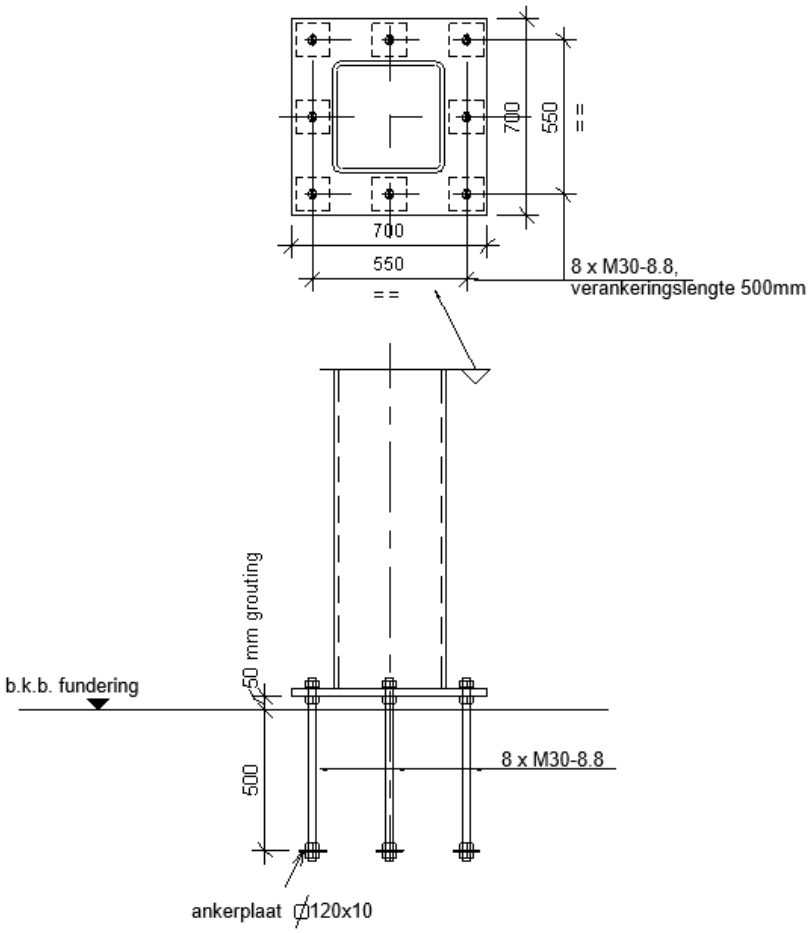
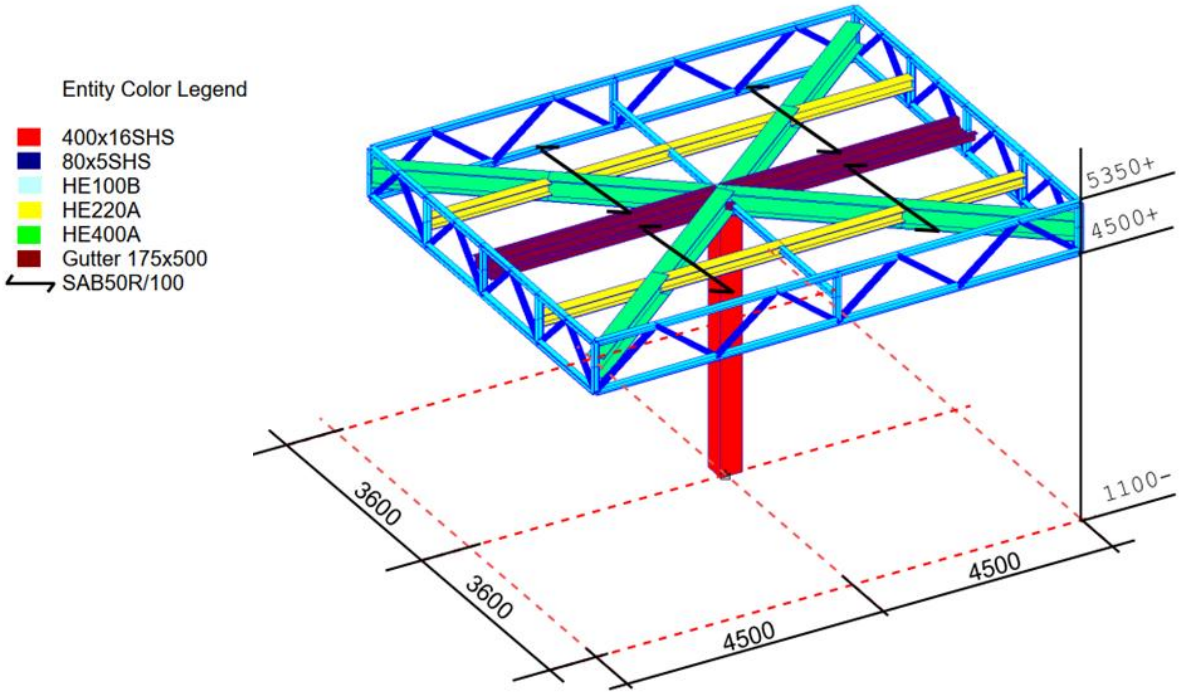


Fig. Base plate details

Appendix A – Canopy steel frames calculation

A.1 Schematic overview and steel sections

Overview structural model and used steel section with parameters



Materials

S235 – hot rolled sections
S275H – hollow sections

Prop	Section	Area (cm^2)	I_{yy} (cm^4)	I_{zz} (cm^4)	J (cm^4)	Material
1	400X16SHS	243.00	59.3E 3	59.3E 3	90.6E 3	STEEL275
2	80X5SHS	14.70	137.00	137.00	210.94	STEEL275
3	HE100B	26.00	167.00	450.00	9.30	STEEL235
4	HE220A	64.30	1955.00	5410.00	28.50	STEEL235
5	HE400A	159.00	8564.00	45.1E 3	189.00	STEEL235
6	GUTTER175X500	52.00	24.7E 3	2647.83	5.79	STEEL235

A.2 Supports

Connection between canopy column and foundation is fixed.

Support node restraints:

Node	X (kN/mm)	Y (kN/mm)	Z (kN/mm)	rX (kN·m/deg)	rY (kN·m/deg)	rZ (kN·m/deg)
1	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed

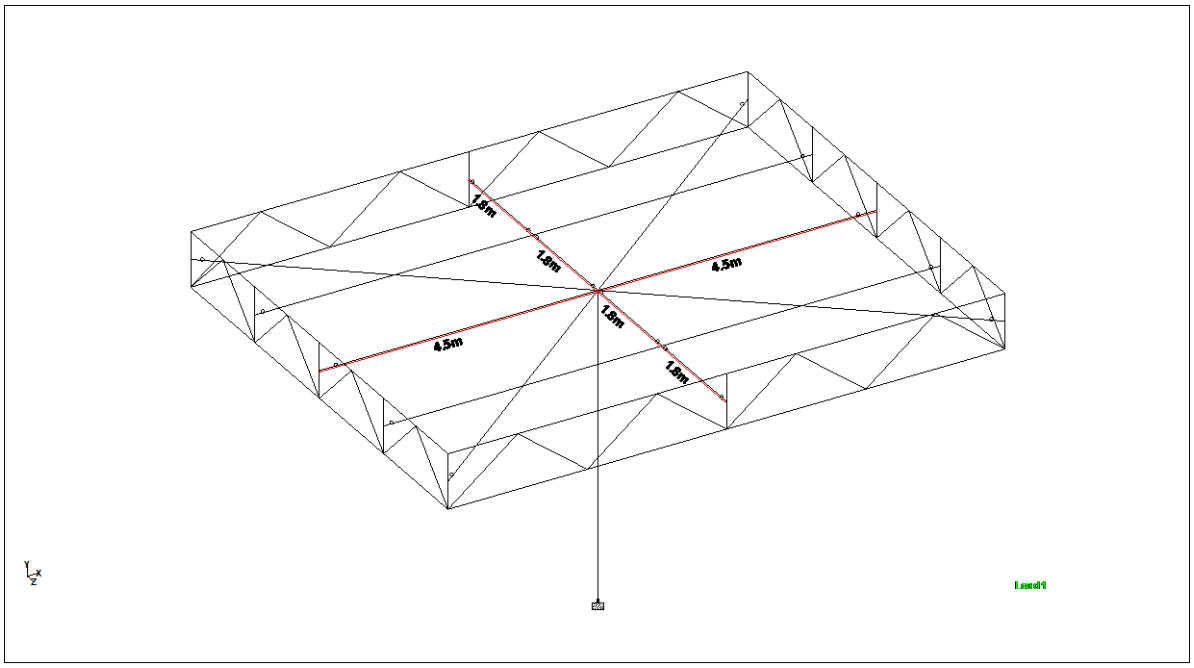
A.3 Loads

a. Load cases

Overview structural model with loads per load cases

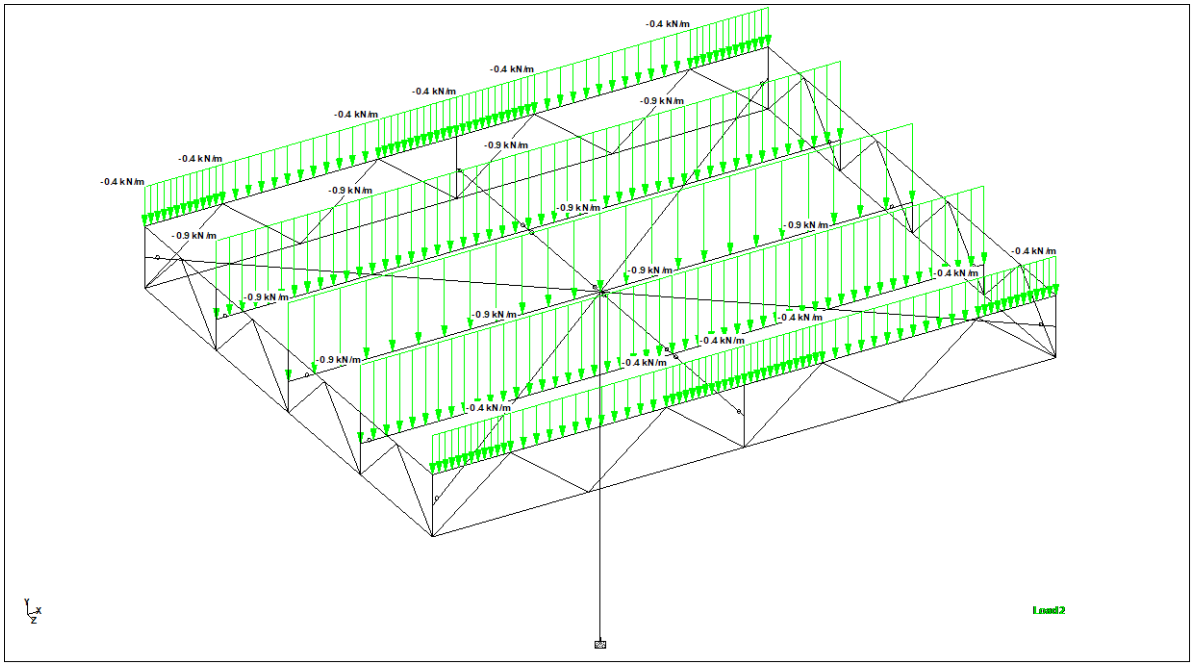
Permanent loads:

1. SW – Dead load due to selfweight of structure.



1 SELFWEIGHT (SW)

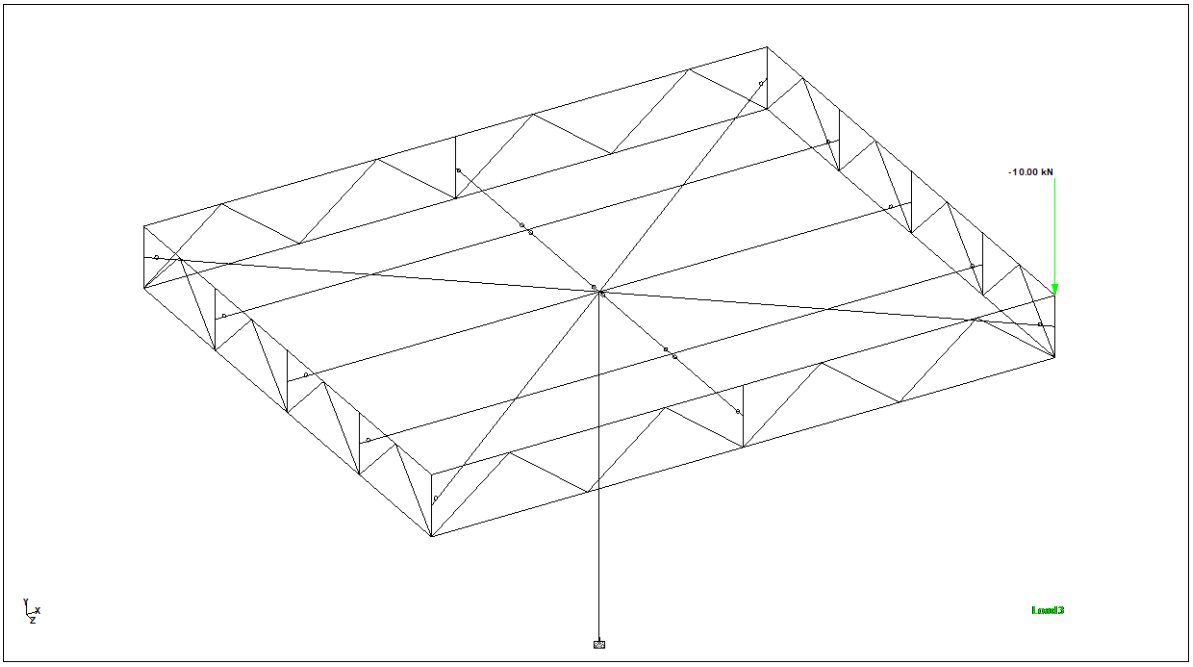
2. DL – structure dead load, weight of materials for additional elements
   Canopy: DL =0,50 [kN/m^2];
   Load on beam [kN/m] = DL * (beam_$_{\text{left spam}}$ [m] + beam_$_{\text{right spam}}$ [m]) / 2 [kN/m]



2 DEAD LOAD (DL)

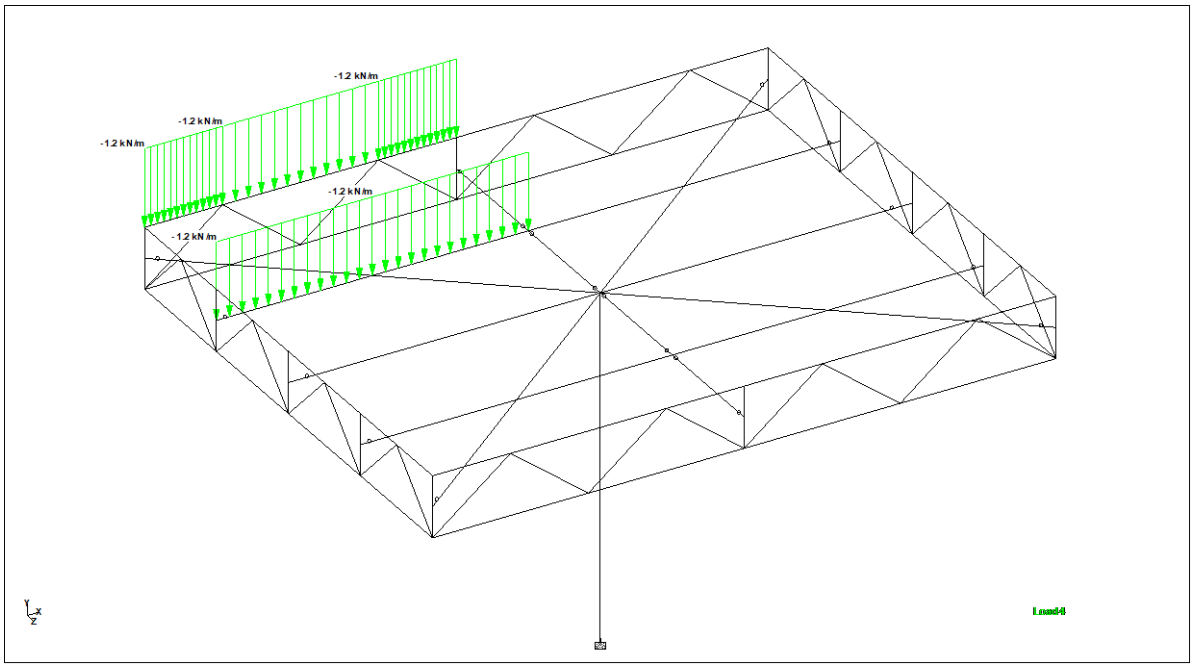
Live loads:

3. LL – roof live load – 1st pitch
   LL =1.0 [kN/m^2] on 10 m^2
   Load on beam [kN/m]= DL*(beam_left spam+beam_right spam)/2 [kN/m]



3 IMPOSED LOAD (LLR) - 1ST PITCH

4. LLR – roof live load – 2nd pitch



4 IMPOSED LOAD (LLR) - 2ND PITCH

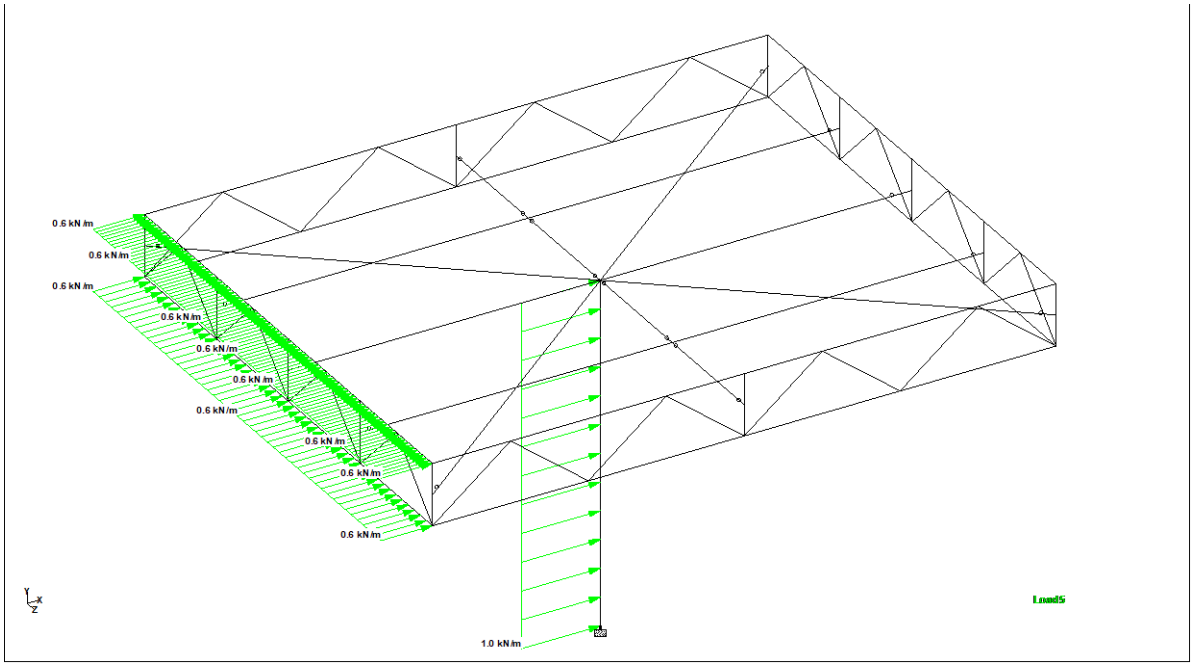
Wind load:

5. WL+X – Wind on X direction

q_{pz}=1.165 [kN/m^2]

c_{pe1} = 1.3 → q_{pza}= q_{pz}* c_{pe1}*h_{truss}/2=0.65 [kN/m] (canopy)

c_{f0} = 2.1 → q_{pzb}= q_{pz}* c_{f0}*b_{column}=1.00 [kN/m] (columns)



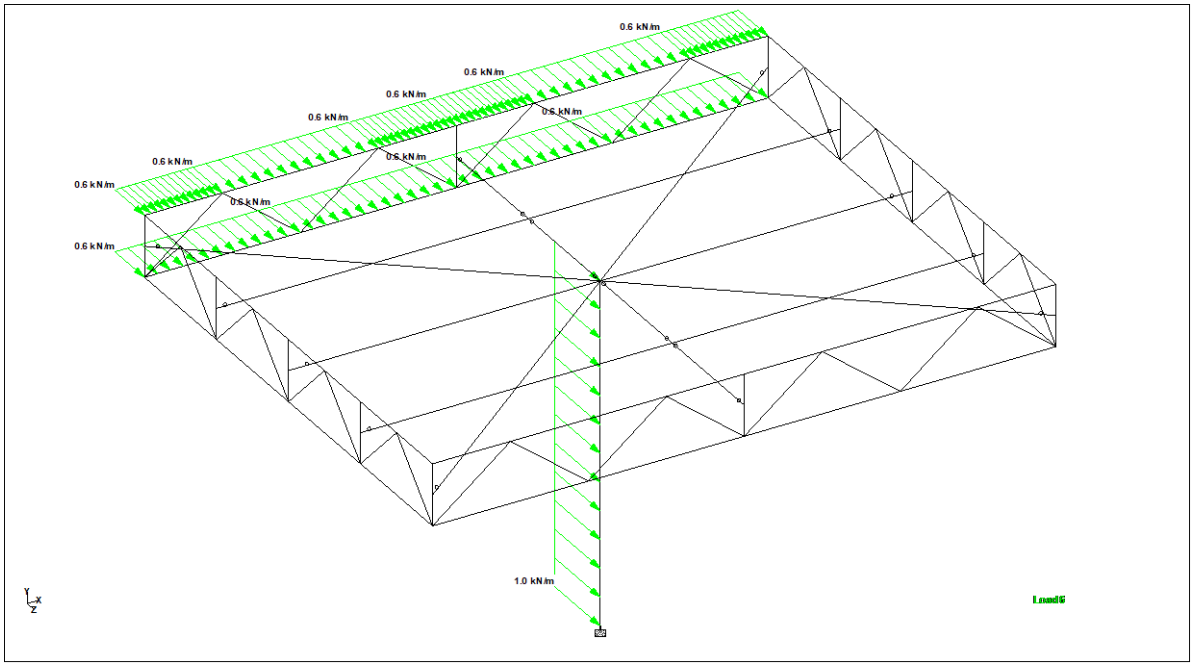
5 WIND LOAD X DIR POS (WL)

6. WL+Z – Wind on Z direction

q_{pz}=1.165 [kN/m^2]

c_{pe1} = 1.3 → q_{pza}= q_{pz}* c_{pe1}*h_{truss}/2=0.65 [kN/m] (canopy)

c_{f0} = 2.1 → q_{pzb}= q_{pz}* c_{f0}*h_{column}=1.00 [kN/m] (columns)

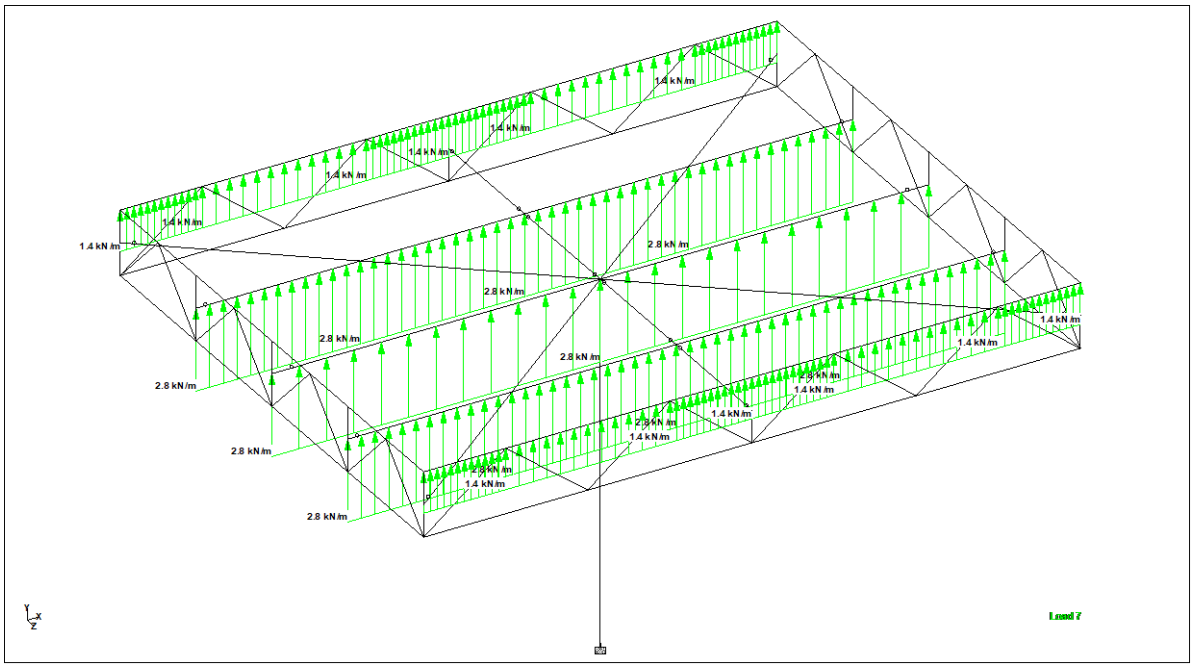


6 WIND LOAD Z DIR POS (WL)

7. WL_Y DIR –uplift both pitches

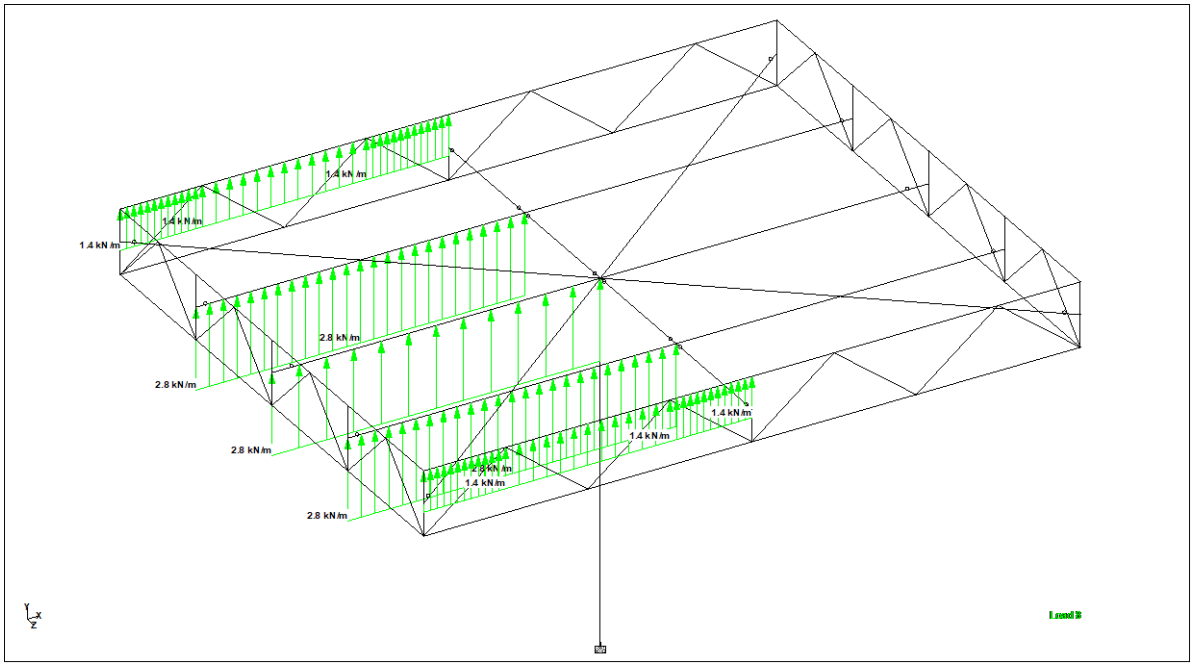
q_{pz}=1.165 [kN/m^2]

c_f = -1.3 → q_{pza}= q_{pz} * c_f * (beam_left spam [m] + beam_right spam [m]) / 2 [kN/m] (canopy)



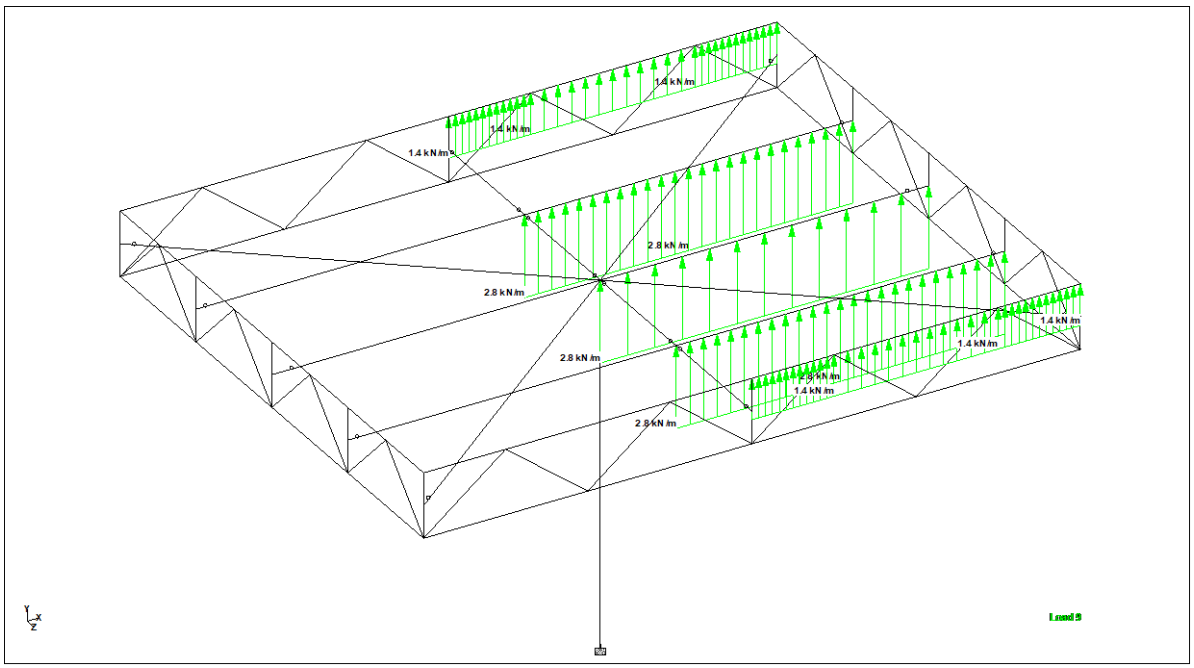
7 WIND LOAD Y DIR POS (WL) - BOTH PITCH

8. WL_Y DIR–uplift 1st pitch_X



8 WIND LOAD Y DIR POS (WL) - 1ST PITCH_X

9. WL_Y DIR POS – uplift 2nd pitch_X

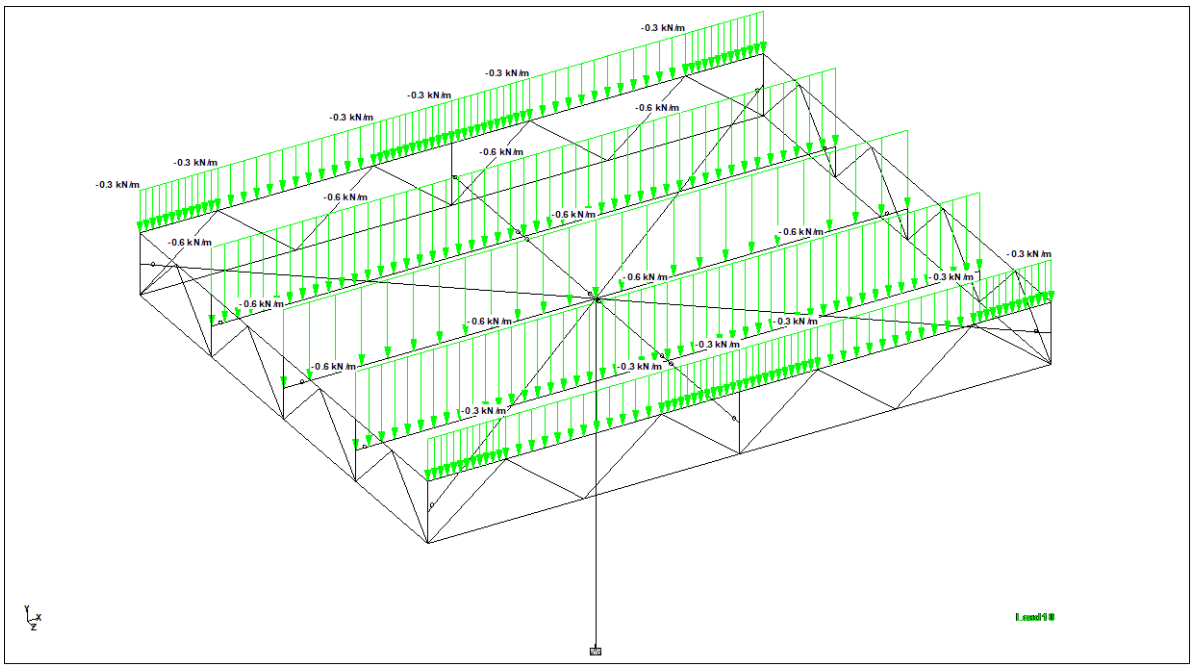


9 WIND LOAD Y DIR POS (WL) - 2ND PITCH_X

10. WL_Y DIR NEG – pressure both pitches

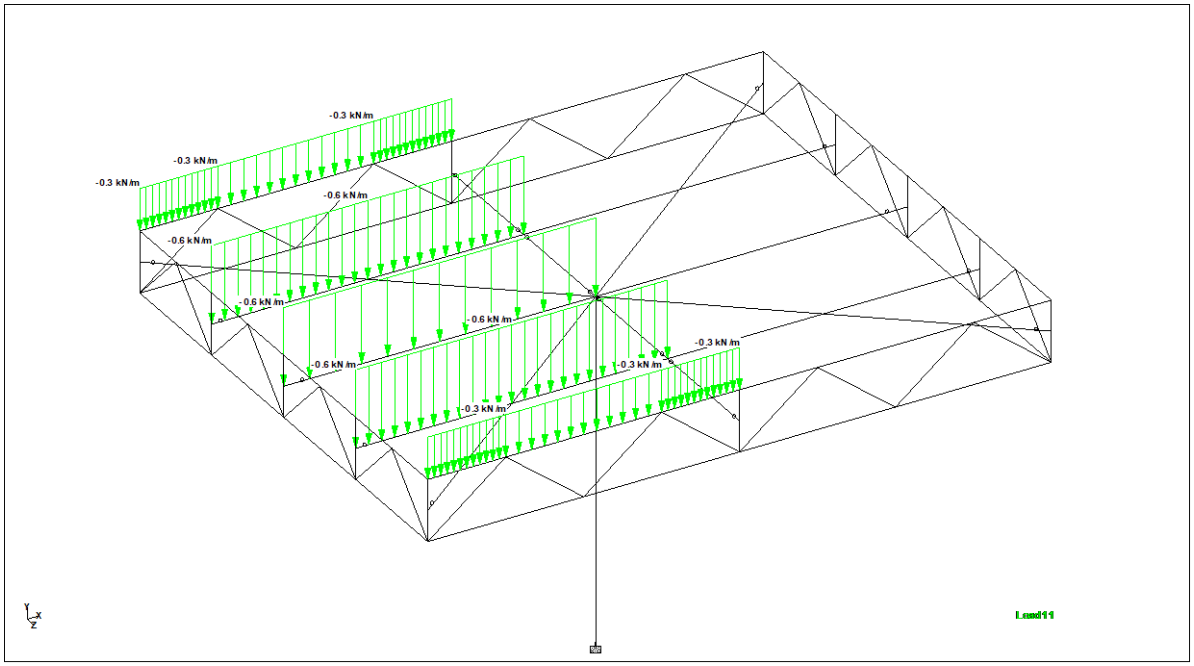
q_{pz}=1.165 [kN/m^2]

c_f = 0.3 → q_{pza}= q_{pz} * c_f * (beam_left spam [m] + beam_right spam [m]) / 2 [kN/m] (canopy)



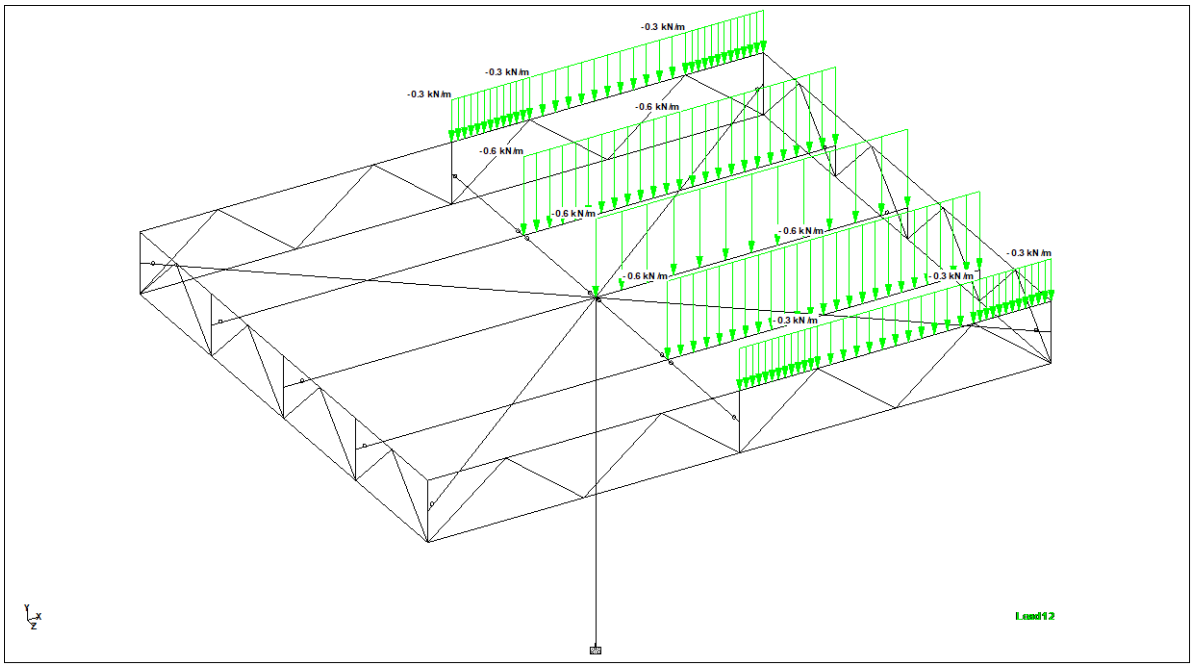
10 WIND LOAD Y DIR NEG (WL) - BOTH PITCH

11. WL_Y– pressure 1st pitch_X



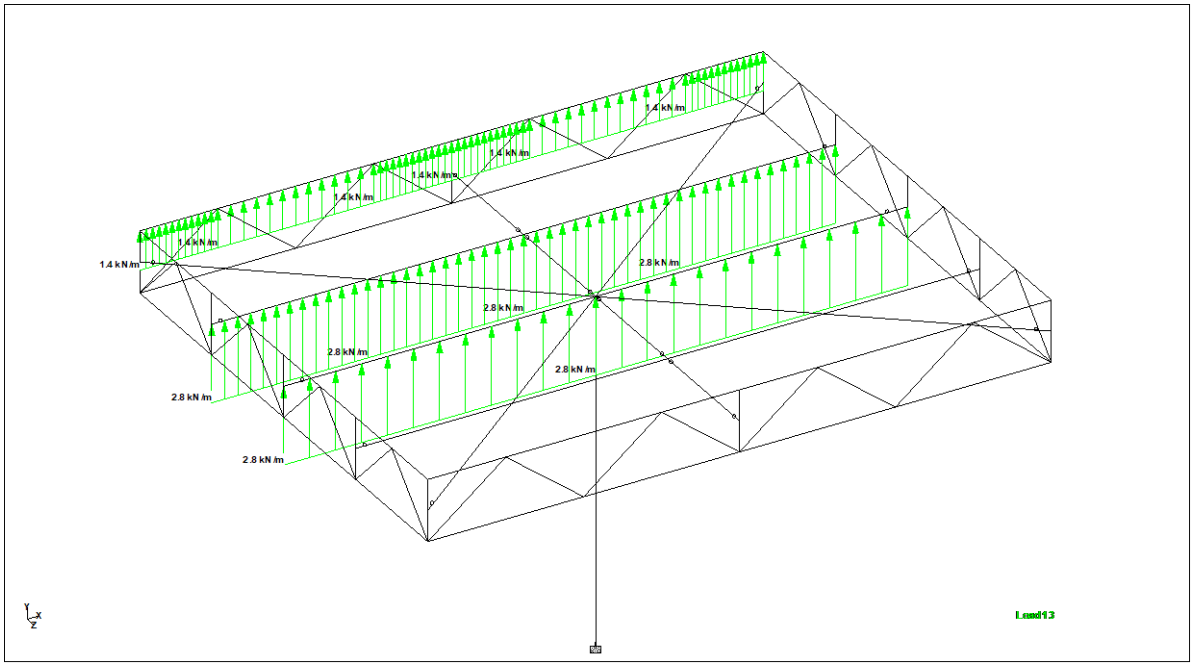
11 WIND LOAD Y DIR NEG (WL) - 1ST PITCH_X

12. WL_Y– pressure 2nd pitch_X



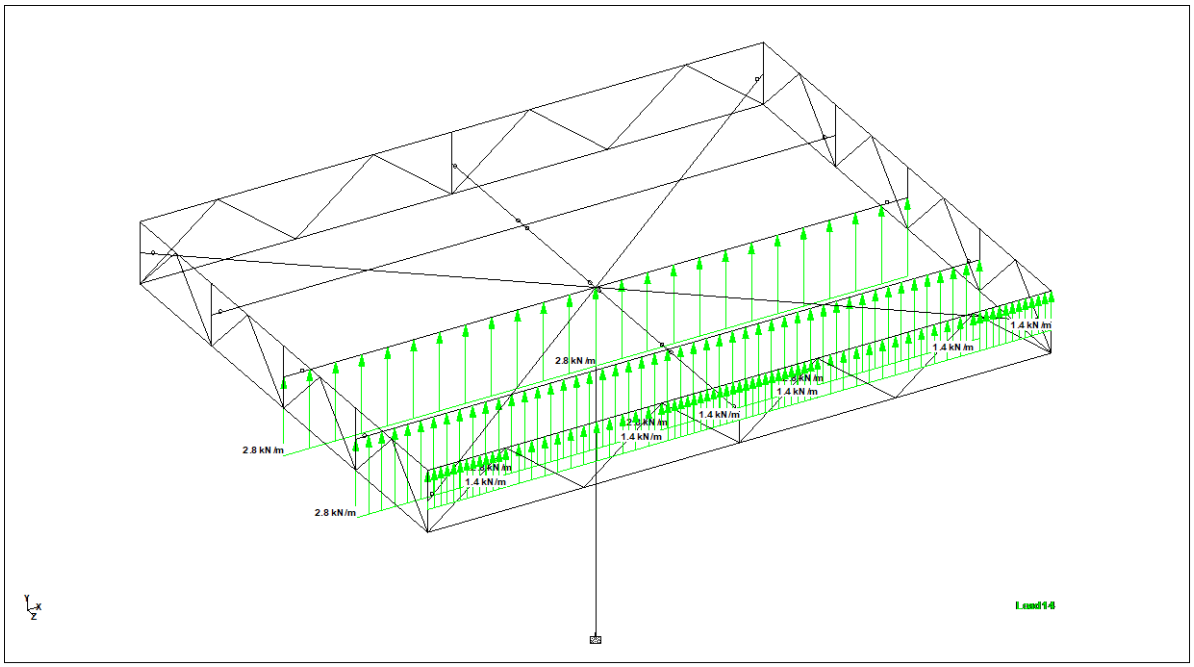
12 WIND LOAD Y DIR NEG (WL) - 2ND PITCH_X

13. WL_Y– pressure 2nd pitch_Z



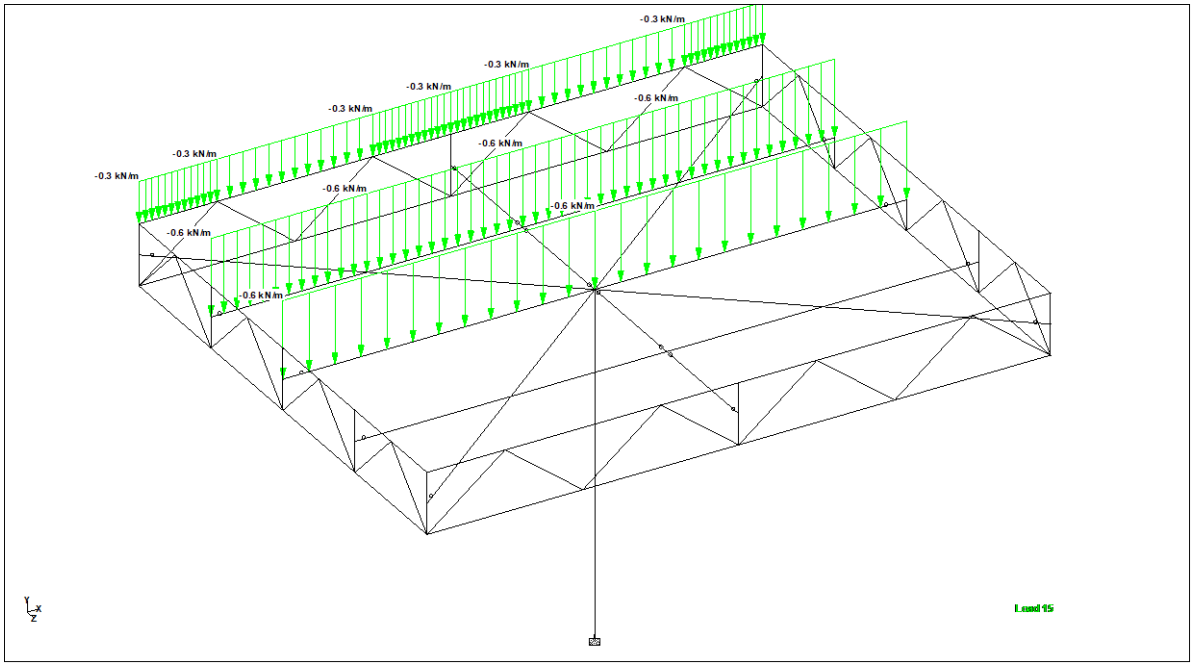
13 WIND LOAD Y DIR NEG (WL) - 2ND PITCH_Z

14. WL_Y– pressure 2nd pitch_Z



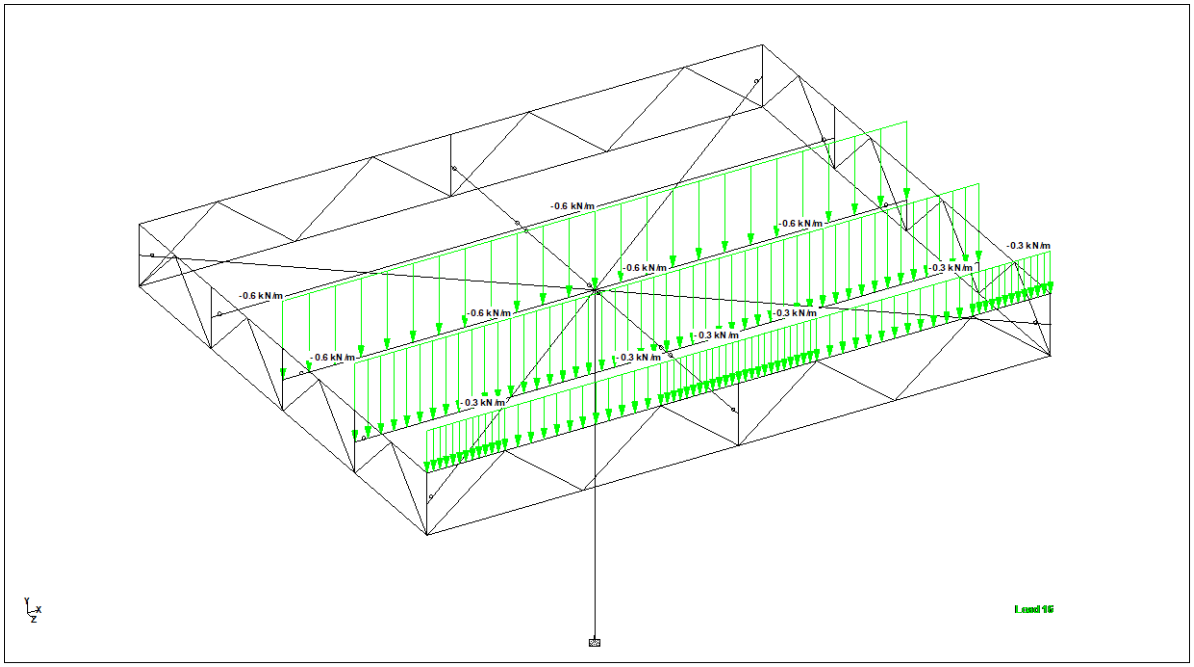
14 WIND LOAD Y DIR NEG (WL) - 2ND PITCH_Z

15. WL_Y DIR POS – uplift 1st pitch_Z



15 WIND LOAD Y DIR NEG (WL) – 1ST PITCH_Z

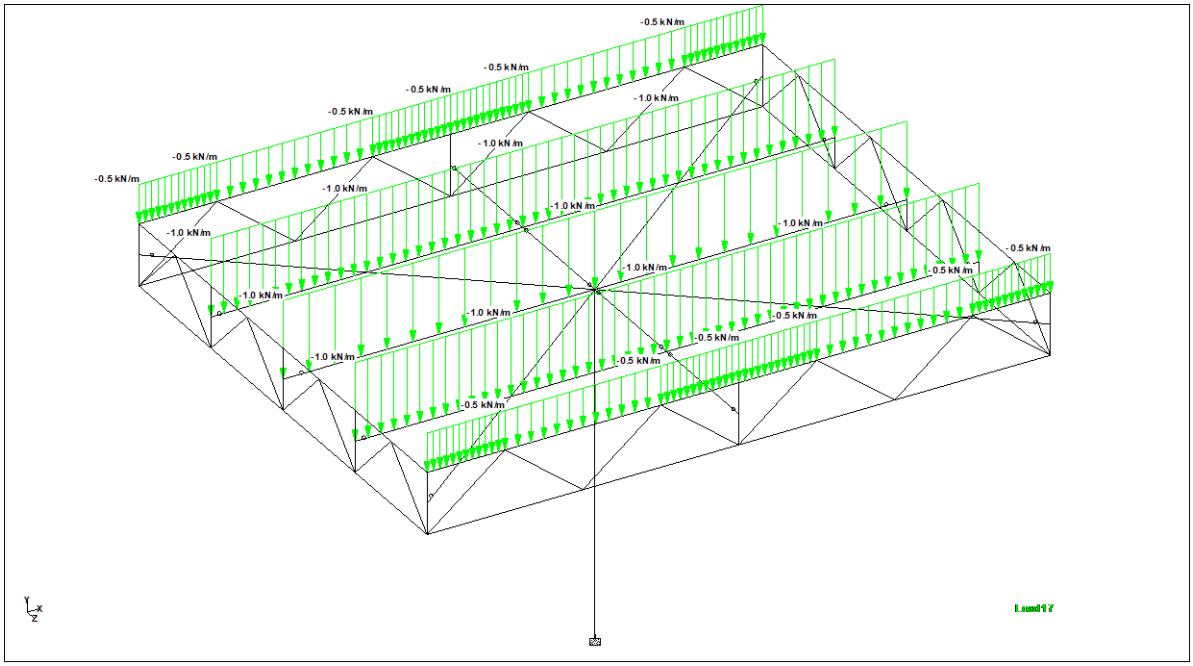
16. WL_Y DIR POS – uplift 2nd pitch_Z



16 WIND LOAD Y DIR NEG (WL) - 2ND PITCH_Z

Snow:

17. SL – snow load
    SL =0.56 [kN/m^2]
    Load on beam [kN/m] = SL * (beam_left spam [m] + beam_right spam [m]) / 2 [kN/m]



17 SNOW LOAD (SW)

b. Load combination

			LOAD																
			SELFWEIGHT	DEAD LOAD	IMPOSED LOAD (LL) 1st PITCH_X	IMPOSED LOAD (LL) 2nd PITCH_Z	WIND LOAD X DIR POS (WL)	WIND LOAD Z DIR POS (WL)	WIND LOAD Y DIR POS (WL) BOTH PITCH	WIND LOAD Y DIR POS (WL) 1st PITCH_X	WIND LOAD Y DIR POS (WL) 2nd PITCH_X	WIND LOAD Y DIR NEG (WL) BOTH PITCH	WIND LOAD Y DIR NEG (WL) 1st PITCH_X	WIND LOAD Y DIR NEG (WL) 2nd PITCH_X	WIND LOAD Y DIR POS (WL) 1st PITCH_Z	WIND LOAD Y DIR POS (WL) 2nd PITCH_Z	WIND LOAD Y DIR NEG (WL) 1st PITCH_Z	WIND LOAD Y DIR NEG (WL) 2nd PITCH_Z	SNOW LOAD (SW)
		No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
COMBINATION			Load factors																
	1.35SW+1.35DL+1.5LLR_1STPITCH	101	1.35	1.35	1.5														
	1.35SW+1.35DL+1.5LLR_2NDPITCH	102	1.35	1.35		1.5													
	1.35SW+1.35DL+1.5WL XDIR	103	1.35	1.35			1.5												
	1.35SW+1.35DL+1.5WL X+YDIR_POS_BP	104	1.35	1.35			1.5		1.5										
	1.35SW+1.35DL+1.5WL X+YDIR_POS_1P	105	1.35	1.35			1.5			1.5									
	1.35SW+1.35DL+1.5WL X+YDIR_POS_2P	106	1.35	1.35			1.5				1.5								
	1.35SW+1.35DL+1.5WL X+YDIR_NEG_BP	107	1.35	1.35			1.5					1.5							
	1.35SW+1.35DL+1.5WL X+YDIR_NEG_1P	108	1.35	1.35			1.5						1.5						
	1.35SW+1.35DL+1.5WL X+YDIR_NEG_2P	109	1.35	1.35			1.5							1.5					
	1.35SW+1.35DL+1.5WL ZDIR	110	1.35	1.35				1.5											
	1.35SW+1.35DL+1.5WL Z+YDIR_POS_BP	111	1.35	1.35				1.5	1.5										
	1.35SW+1.35DL+1.5WL Z+YDIR_POS_1P	112	1.35	1.35				1.5							1.5				
	1.35SW+1.35DL+1.5WL Z+YDIR_POS_2P	113	1.35	1.35				1.5								1.5			
	1.35SW+1.35DL+1.5WL Z+YDIR_NEG_BP	114	1.35	1.35				1.5				1.5							
	1.35SW+1.35DL+1.5WL Z+YDIR_NEG_1P	115	1.35	1.35				1.5									1.5		
	1.35SW+1.35DL+1.5WL Z+YDIR_NEG_2P	116	1.35	1.35				1.5										1.5	
	1.35SW+1.35DL+1.5SL	117	1.35	1.35															1.5
	0.9SW+0.9DL+1.5LLR_1STPITCH	118	1.35	1.35	1.5														
	0.9SW+0.9DL+1.5LLR_2NDPITCH	119	1.35	1.35		1.5													
	0.9SW+0.9DL+1.5WL XDIR	120	1.35	1.35			1.5												
	0.9SW+0.9DL+1.5WL X+YDIR_POS_BP	121	1.35	1.35			1.5		1.5										
	0.9SW+0.9DL+1.5WL X+YDIR_POS_1P	122	1.35	1.35			1.5			1.5									
	0.9SW+0.9DL+1.5WL X+YDIR_POS_2P	123	1.35	1.35			1.5				1.5								
	0.9SW+0.9DL+1.5WL X+YDIR_NEG_BP	124	1.35	1.35			1.5					1.5							
	0.9SW+0.9DL+1.5WL X+YDIR_NEG_1P	125	1.35	1.35			1.5						1.5						
	0.9SW+0.9DL+1.5WL X+YDIR_NEG_2P	126	1.35	1.35			1.5							1.5					
	0.9SW+0.9DL+1.5WL ZDIR	127	1.35	1.35				1.5											
	0.9SW+0.9DL+1.5WL Z+YDIR_POS_BP	128	1.35	1.35				1.5	1.5										
	0.9SW+0.9DL+1.5WL Z+YDIR_POS_1P	129	1.35	1.35				1.5							1.5				
	0.9SW+0.9DL+1.5WL Z+YDIR_POS_2P	130	1.35	1.35				1.5								1.5			
	0.9SW+0.9DL+1.5WL Z+YDIR_NEG_BP	131	1.35	1.35				1.5				1.5							
	0.9SW+0.9DL+1.5WL Z+YDIR_NEG_1P	132	1.35	1.35				1.5									1.5		
	0.9SW+0.9DL+1.5WL Z+YDIR_NEG_2P	133	1.35	1.35				1.5										1.5	
			Load factors																
	SW+DL+LLR_1ST_P	1001	1	1	1														
	SW+DL+LLR_2ND_P	1002	1	1		1													
	SW+DL+WL XDIR	1003	1	1			1												
	SW+DL+WL X+YDIR_POS_BP	1004	1	1			1		1										
	SW+DL+WL X+YDIR_POS_1P	1005	1	1			1			1									
	SW+DL+WL X+YDIR_POS_2P	1006	1	1			1				1								
	SW+DL+WL X+YDIR_NEG_BP	1007	1	1			1					1							
	SW+DL+WL X+YDIR_NEG_1P	1008	1	1			1						1						
	SW+DL+WL X+YDIR_NEG_2P	1009	1	1			1							1					
	SW+DL+WL ZDIR	1010	1	1				1											
	SW+DL+WL Z+YDIR_POS_BP	1011						1	1										
	SW+DL+WL Z+YDIR_POS_1P	1012						1							1				
	SW+DL+WL Z+YDIR_POS_2P	1013						1								1			
	SW+DL+WL Z+YDIR_NEG_BP	1014						1				1							
	SW+DL+WL Z+YDIR_NEG_1P	1015						1									1		
	SW+DL+WL Z+YDIR_NEG_2P	1016						1										1	
	SW+DL+SL	1017	1	1															1

A.4 Results

a. Member forces

Overview structural model with summary efforts and moment/shear/axial diagrams

HE400A beams member forces:

Sign convention as diagrams: - positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A

HE400A				Axial	Shear		Torsion	Bending	
	Beam	L/C	d (m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)
Max	189	128:0.9SW+0.9DL+1.5WL	0.0	**4.02**	-11.64	0.12	0.00	-0.06	-46.82
Min	267	114:1.35SW+1.35DL+1.5WL	0.0	**-3.37**	-31.25	-0.18	-0.01	0.38	32.35
Max	189	117:1.35SW+1.35DL+1.5SL	0.0	-0.18	**39.80**	0.01	-0.01	-0.01	142.94
Min	268	101:1.35SW+1.35DL+1.5LLR_1STPITCH	2.9	-0.05	**-43.69**	-0.00	0.01	-0.00	182.05
Max	267	107:1.35SW+1.35DL+1.5WL	0.0	2.75	-31.25	**0.75**	-0.01	-0.97	32.35
Min	266	107:1.35SW+1.35DL+1.5WL	0.0	2.75	-31.25	**-0.75**	0.01	0.97	32.35
Max	266	112:1.35SW+1.35DL+1.5WL	0.0	3.81	7.03	-0.11	**0.02**	0.27	-4.83
Min	189	101:1.35SW+1.35DL+1.5LLR_1STPITCH	0.0	-0.04	29.69	0.00	**-0.02**	-0.00	98.18
Max	267	107:1.35SW+1.35DL+1.5WL	2.9	2.75	-36.10	0.75	-0.01	**1.18**	129.39
Min	266	107:1.35SW+1.35DL+1.5WL	2.9	2.75	-36.10	-0.75	0.01	**-1.18**	129.39
Max	268	101:1.35SW+1.35DL+1.5LLR_1STPITCH	2.9	-0.05	-43.69	-0.00	0.01	-0.00	**182.05**
Min	267	130:0.9SW+0.9DL+1.5WL	2.9	-3.11	11.77	-0.21	-0.02	-0.16	**-52.07**

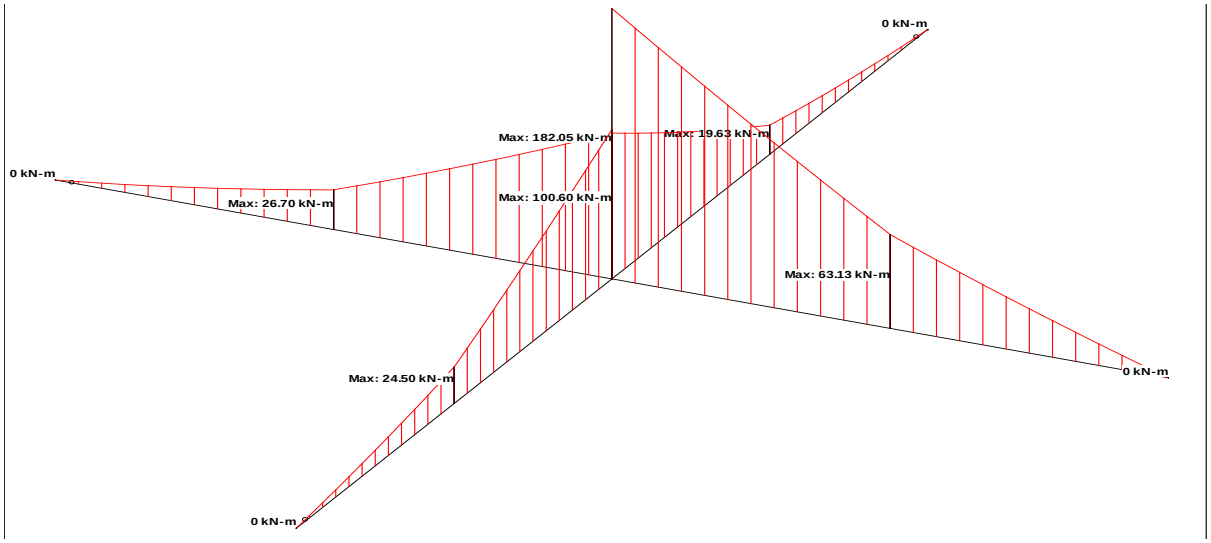
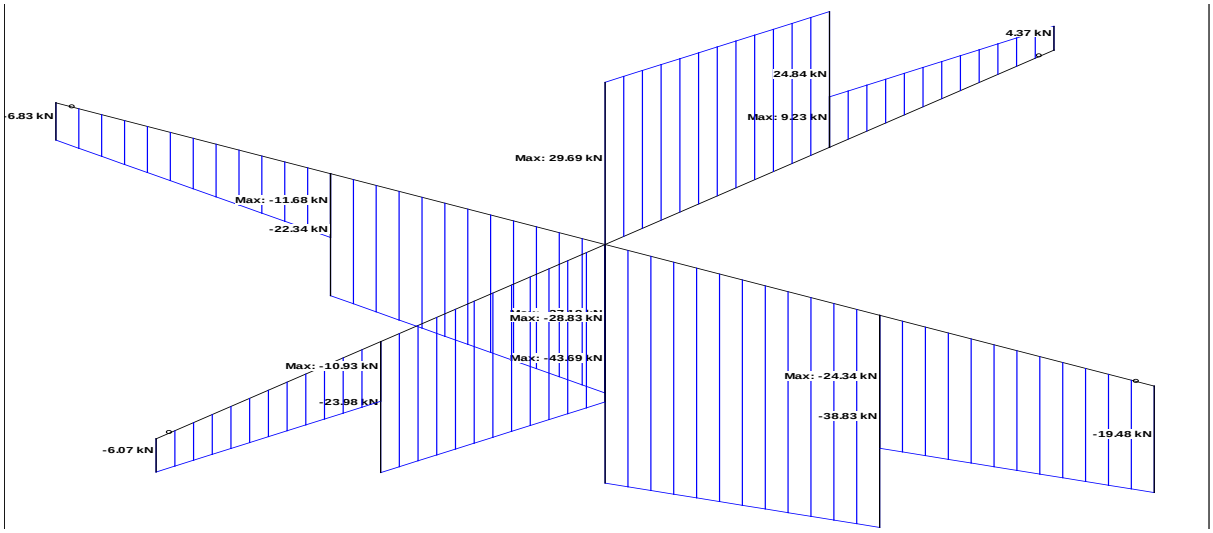


Fig. Moment diagram HE400A (Mz) C 101 1.35SW+1.35DL+1.5LLR_1STPITCH



Shear diagram HE400A (Fy) C 101 1.35SW+1.35DL+1.5LLR_1STPITCH

HE220A purlins member forces:

Sign convention as diagrams: - positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

HE220A				Axial	Shear		Torsion	Bending	
	Beam	L/C	d (m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)
Max	259	121:0.9SW+0.9DL+1.5WL	0.0	**3.66**	0.46	-0.13	0.00	0.00	0.00
Min	265	113:1.35SW+1.35DL+1.5WL	0.0	**-2.65**	-0.25	0.16	0.00	-0.14	1.94
Max	271	117:1.35SW+1.35DL+1.5SL	0.0	-0.01	**12.40**	-0.00	0.00	0.00	19.30
Min	259	117:1.35SW+1.35DL+1.5SL	2.3	-0.01	**-12.40**	0.00	-0.00	0.00	19.30
Max	265	113:1.35SW+1.35DL+1.5WL	0.0	-2.65	-0.25	**0.16**	0.00	-0.14	1.94
Min	272	113:1.35SW+1.35DL+1.5WL	0.0	-2.65	4.51	**-0.16**	0.00	0.22	7.30
Max	263	117:1.35SW+1.35DL+1.5SL	0.0	-0.01	-4.76	-0.00	**0.00**	0.00	0.00
Min	273	101:1.35SW+1.35DL+1.5LLR_1STPITCH	0.0	-0.00	9.86	0.00	**-0.00**	-0.00	17.38
Max	263	121:0.9SW+0.9DL+1.5WL	2.3	3.66	7.07	0.13	-0.00	**0.30**	-8.47
Min	259	121:0.9SW+0.9DL+1.5WL	2.3	3.66	7.07	-0.13	0.00	**-0.30**	-8.47
Max	259	117:1.35SW+1.35DL+1.5SL	2.3	-0.01	-12.40	0.00	-0.00	0.00	**19.30**
Min	271	121:0.9SW+0.9DL+1.5WL	0.0	0.08	-7.07	-0.12	-0.00	0.27	**-8.47**

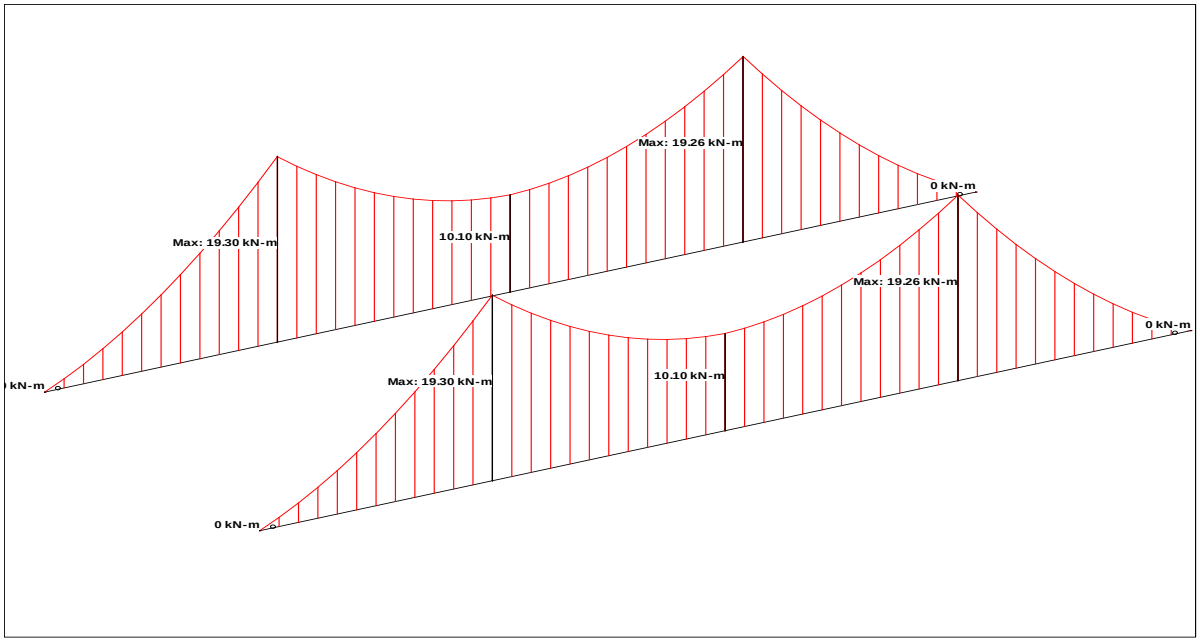


Fig. Moment diagram HE220A (Mz) C 117 1.35SW+1.35DL+1.5SL

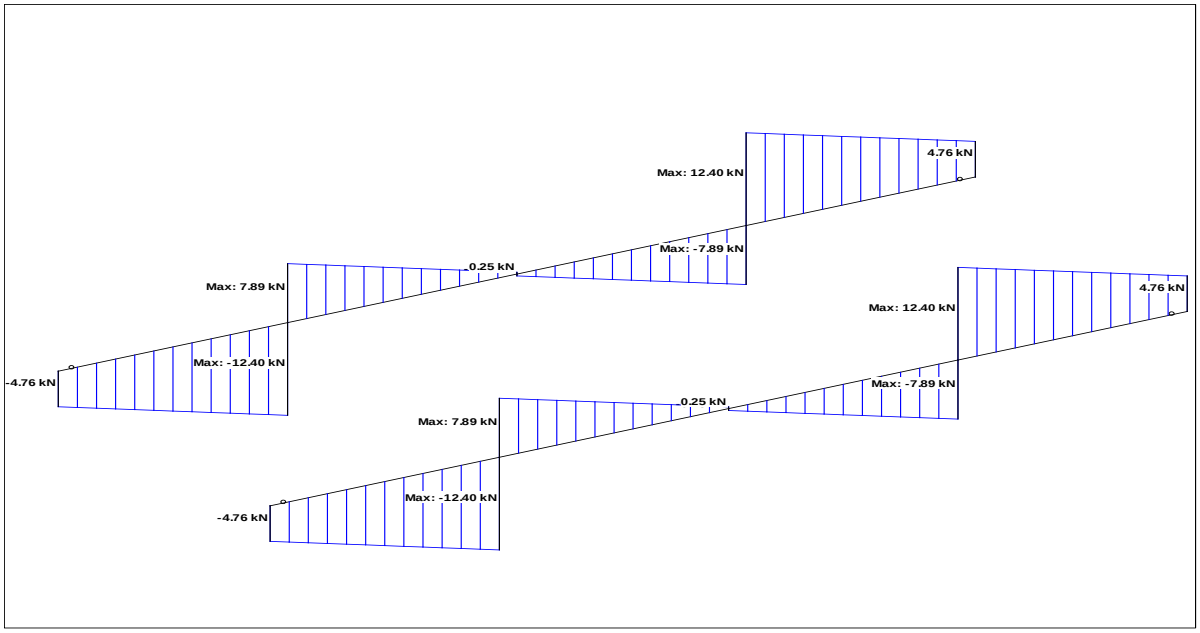


Fig. Shear diagram HE220A (Fy) C 117 1.35SW+1.35DL+1.5SL

Gutter 175x500 mm member forces:

Sign convention as diagrams: - positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

Gutter 175x500				Axial	Shear		Torsion	Bending	
	Beam	L/C	d (m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)
Max Fx	36	107:1.35SW+1.35DL+1.5WL	0.0	**3.57**	2.21	0.00	0.00	0.00	0.00
Min Fx	37	121:0.9SW+0.9DL+1.5WL	0.0	**-0.12**	-9.35	-0.00	0.00	0.00	-11.49
Max Fy	37	117:1.35SW+1.35DL+1.5SL	0.0	0.00	**11.85**	0.00	-0.00	-0.00	20.25
Min Fy	36	117:1.35SW+1.35DL+1.5SL	4.5	0.00	**-11.85**	0.00	-0.00	0.00	20.25
Max Fz	36	113:1.35SW+1.35DL+1.5WL	0.0	0.41	-4.77	**0.19**	-0.00	0.00	0.00
Min Fz	37	113:1.35SW+1.35DL+1.5WL	0.0	0.41	-6.19	**-0.19**	0.00	0.85	-3.19
Max Mx	36	112:1.35SW+1.35DL+1.5WL	0.0	0.41	-4.77	0.17	**0.00**	0.00	0.00
Min Mx	37	112:1.35SW+1.35DL+1.5WL	0.0	0.41	-6.19	-0.17	**-0.00**	0.75	-3.19
Max My	37	113:1.35SW+1.35DL+1.5WL	0.0	0.41	-6.19	-0.19	0.00	**0.85**	-3.19
Min My	37	109:1.35SW+1.35DL+1.5WL	0.0	-0.11	10.09	0.00	0.00	**-0.00**	17.65
Max Mz	36	117:1.35SW+1.35DL+1.5SL	4.5	0.00	-11.85	0.00	-0.00	0.00	**20.25**
Min Mz	37	121:0.9SW+0.9DL+1.5WL	0.0	-0.12	-9.35	-0.00	0.00	0.00	**-11.49**

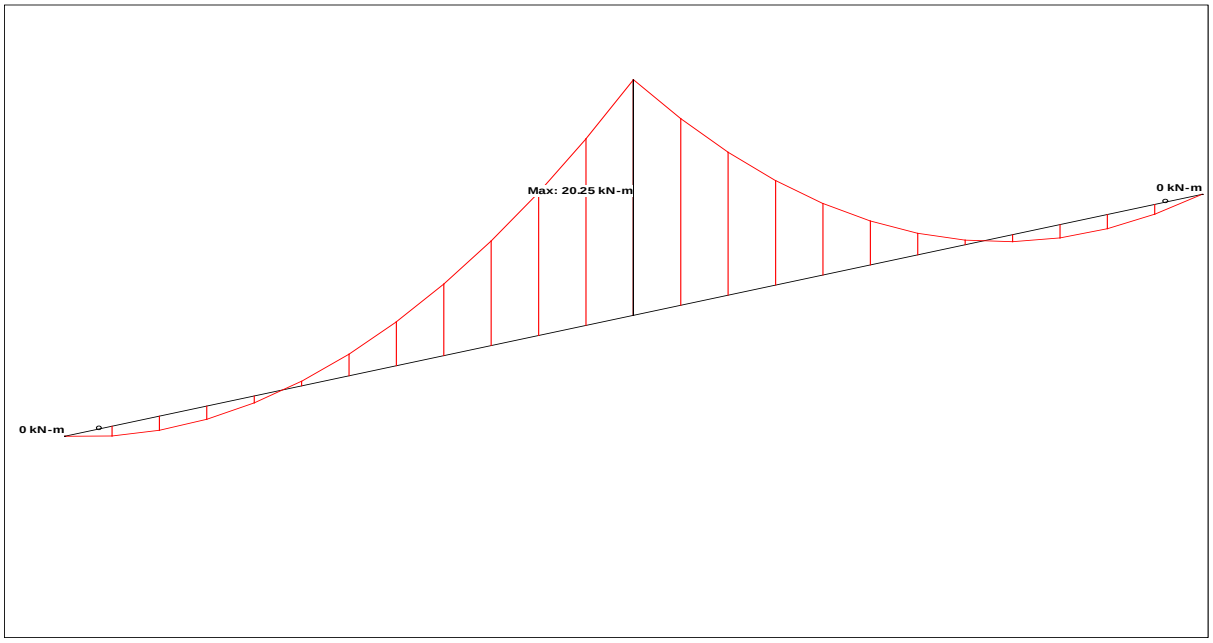
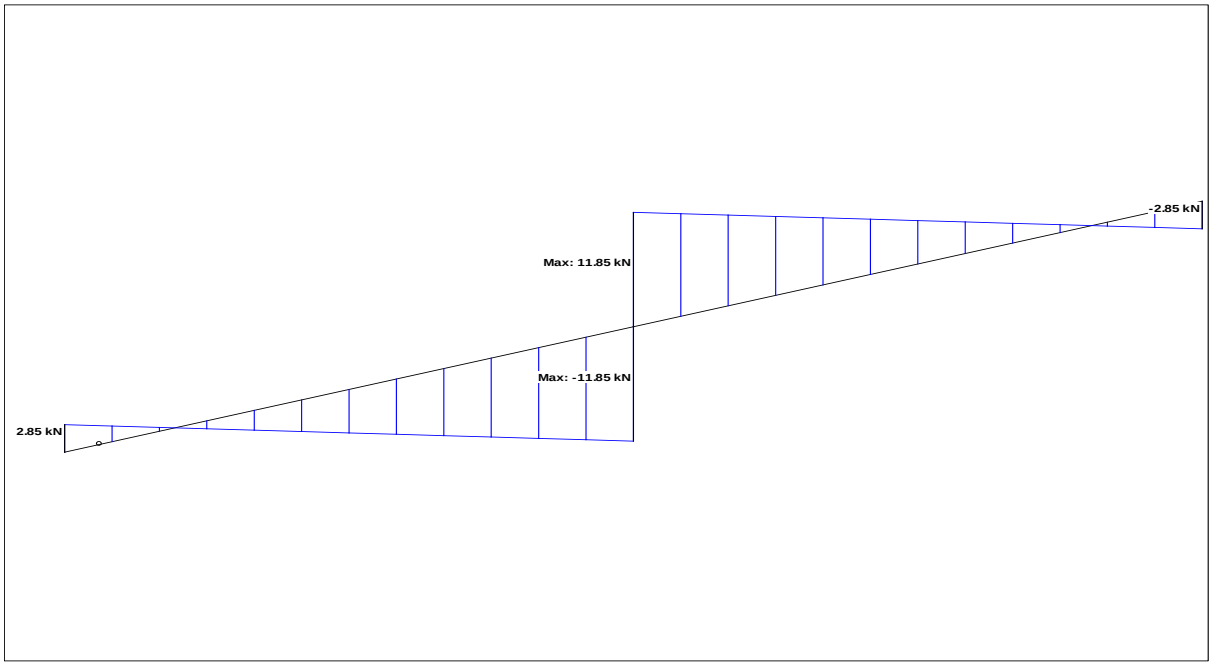


Fig. Moment diagram Gutter 175x500 (Mz) C 117 1.35SW+1.35DL+1.5SL



Shear diagram Gutter 175x500 (Fy) C 117 1.35SW+1.35DL+1.5SL

HE100B truss member forces:

HE100B				Axial	Shear		Torsion	Bending	
	Beam	L/C	d (m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)
Max	64	102:1.35SW+1.35DL+1.5LLR_2NDPITCH	0.0	**26.67**	2.22	-0.00	-0.00	0.00	0.77
Min	51	102:1.35SW+1.35DL+1.5LLR_2NDPITCH	0.0	**-27.21**	0.30	0.00	-0.00	-0.00	-0.02

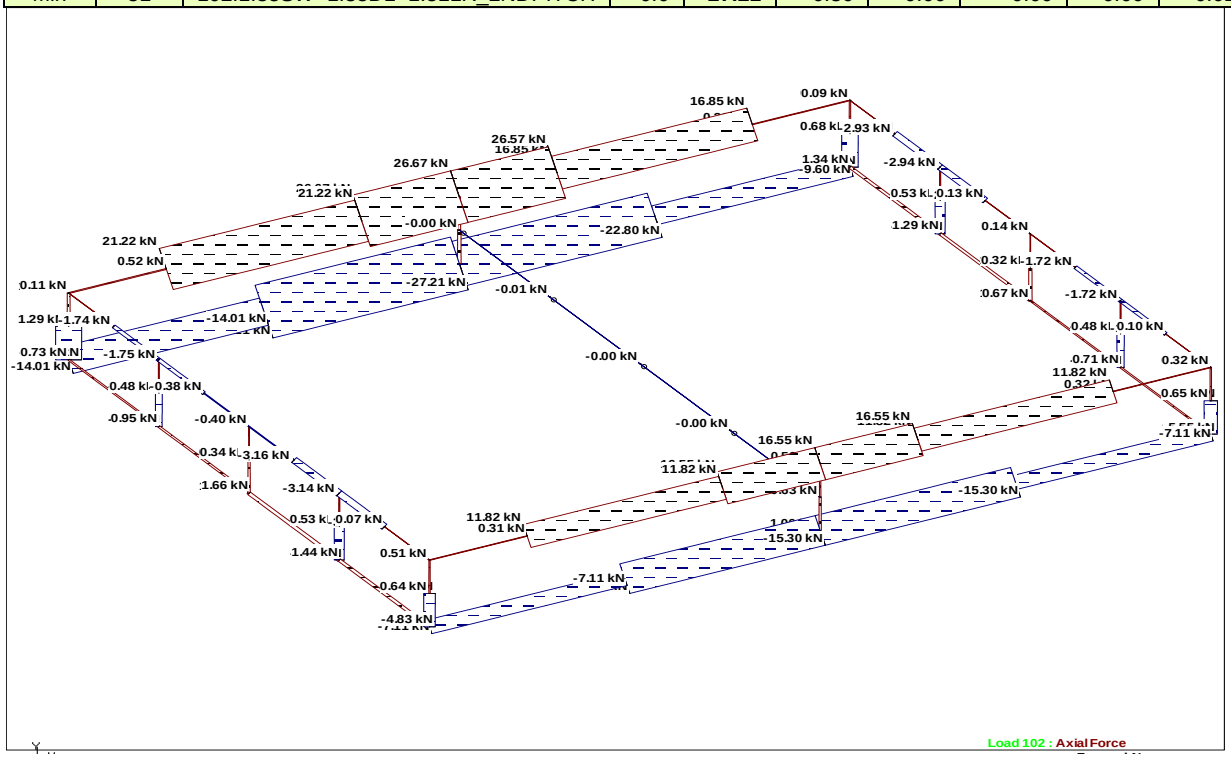


Fig. Axial diagram HE100B (Fx) C 102 1.35SW+1.35DL+1.5LLR_2NDPITCH

80X5SHS tension member forces:

80x5SHS				Axial	Shear		Torsion	Bending	
	Beam	L/C	d (m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)
Max	113	102:1.35SW+1.35DL+1.5LLR_2NDPITCH	1.4	**17.53**	-0.09	-0.00	-0.00	-0.00	-0.00
Min	107	102:1.35SW+1.35DL+1.5LLR_2NDPITCH	0.0	**-9.18**	0.09	0.00	0.00	0.00	0.00

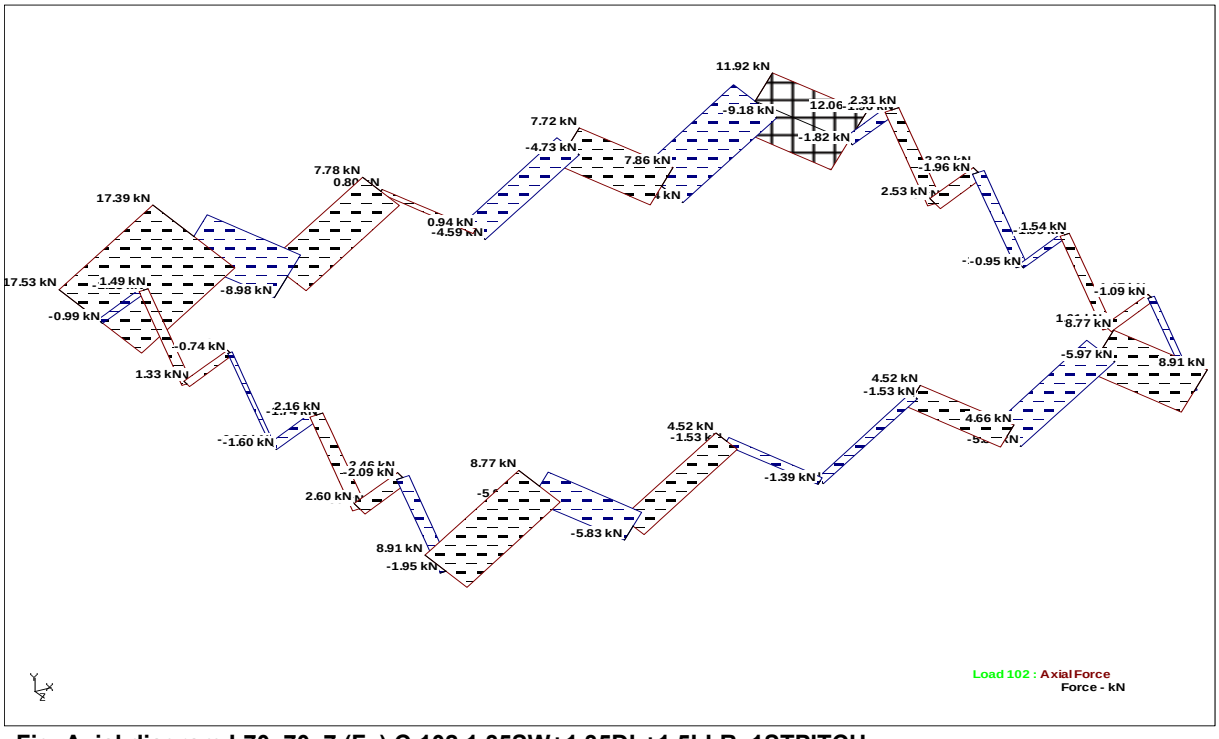


Fig. Axial diagram L70x70x7 (Fx) C 102 1.35SW+1.35DL+1.5LLR_1STPITCH

400X16SHS columns member forces:

Sign convention as diagrams: - positive above line, negative below line except Fx where positive is compression. Distance d is given from beam end A.

400x16SHS				Axial	Shear		Torsion	Bending	
	Beam	L/C	d (m)	Fx (kN)	Fy (kN)	Fz (kN)	Mx (kN-m)	My (kN-m)	Mz (kN-m)
Max Fx	1	117:1.35SW+1.35DL+1.5SL	0.0	**196.26**	0.00	-0.00	-0.00	-0.00	0.00
Min Fx	1	121:0.9SW+0.9DL+1.5WL	5.0	**-64.94**	14.04	0.00	-0.00	0.00	-0.00
Max Fy	1	103:1.35SW+1.35DL+1.5WL	0.0	142.26	**21.54**	0.00	-0.00	-0.00	88.95
Min Fy	1	129:0.9SW+0.9DL+1.5WL	0.0	0.34	**-0.00**	-25.05	0.00	242.58	0.00
Max Fz	1	122:0.9SW+0.9DL+1.5WL	0.0	19.24	21.54	**0.00**	-0.00	0.00	259.05
Min Fz	1	110:1.35SW+1.35DL+1.5WL	0.0	142.26	-0.00	**-25.05**	0.00	106.50	-0.00
Max Mx	1	129:0.9SW+0.9DL+1.5WL	0.0	0.34	-0.00	-25.05	**0.00**	242.58	0.00
Min Mx	1	105:1.35SW+1.35DL+1.5WL	0.0	66.66	21.54	0.00	**-0.00**	-0.00	259.05
Max My	1	112:1.35SW+1.35DL+1.5WL	0.0	47.76	-0.00	-25.05	0.00	**242.58**	-0.00
Min My	1	113:1.35SW+1.35DL+1.5WL	5.0	34.88	0.00	-17.55	0.00	**-136.08**	-0.00
Max Mz	1	105:1.35SW+1.35DL+1.5WL	0.0	66.66	21.54	0.00	-0.00	-0.00	**259.05**
Min Mz	1	106:1.35SW+1.35DL+1.5WL	5.0	53.78	14.04	-0.00	0.00	-0.00	**-170.10**

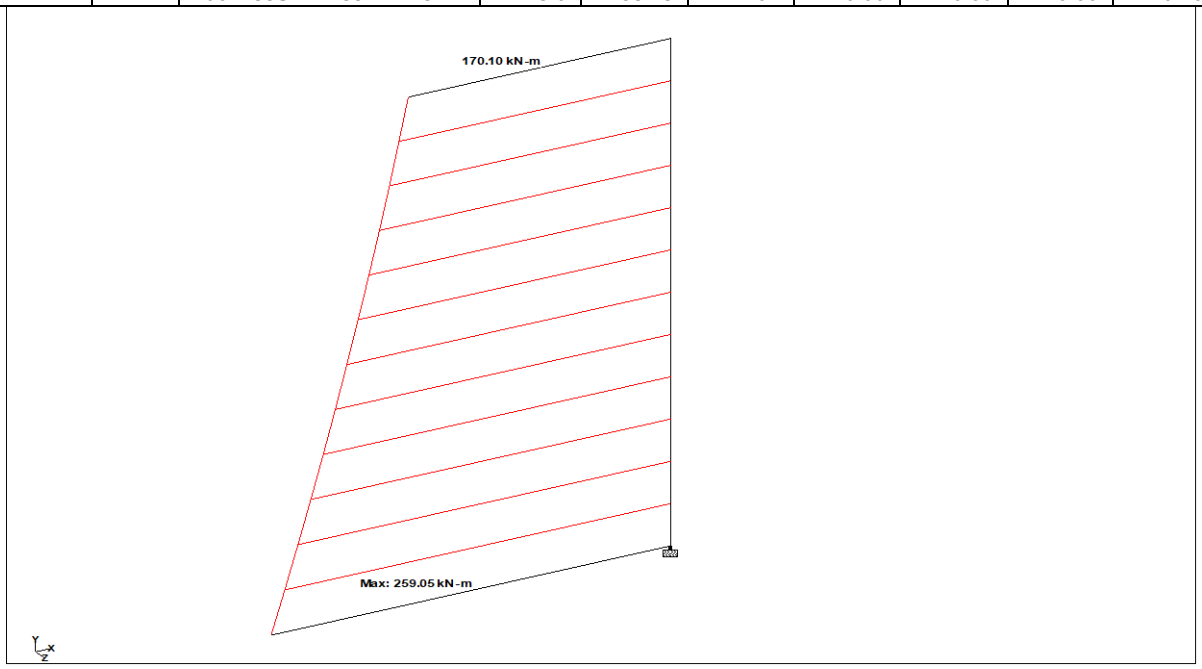


Fig. Moment diagram 400X16SHS (Mz) C 105 1.35SW+1.35DL+1.5WL X+YDIR_POS_1P

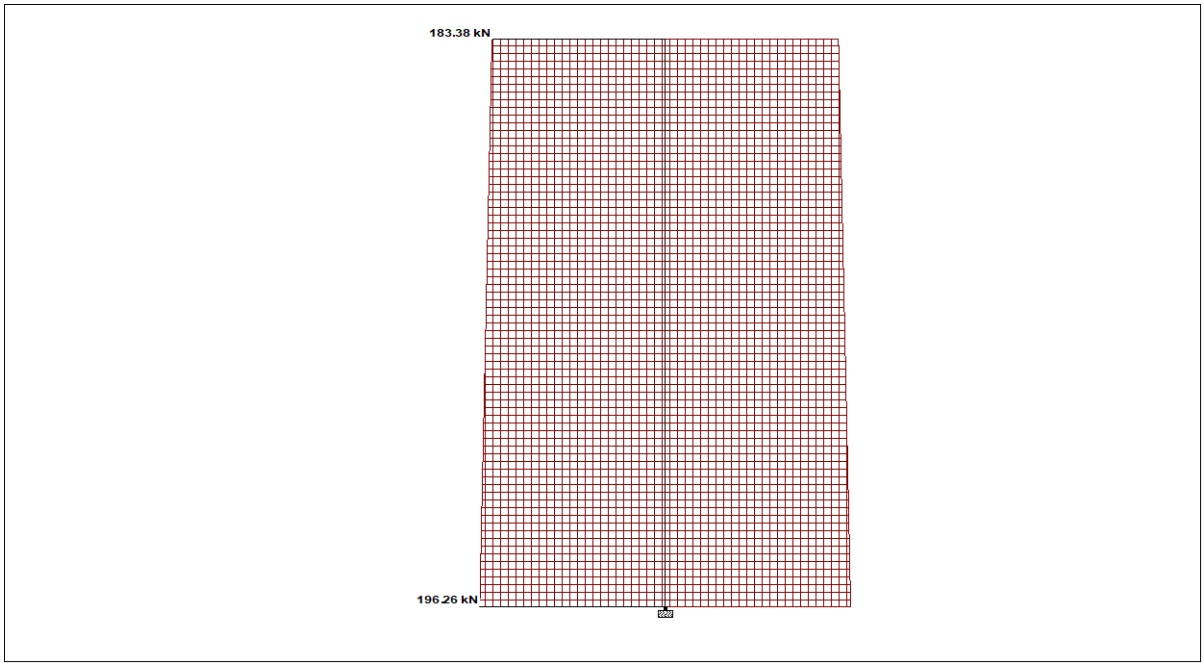


Fig. Axial diagram 400X16SHS (Fx) C 117 1.35SW+1.35DL+1.5SL

b. Unity checks

Beams design - Canopy

HE400A

Utilization Ratio

Beam	Analysis Property	Actual Ratio	Allowable Ratio	Ratio (Act./Allow.)	Clause	L/C	Ax (cm^2)	Iz (cm^4)	Iy (cm^4)	Ix (cm^4)
186	HE400A	0.071	0.800	0.089	EC-6.2.9.1	102	159.00	45.1E 3	8564.00	189.00
187	HE400A	0.059	0.800	0.073	EC-6.2.9.1	117	159.00	45.1E 3	8564.00	189.00
188	HE400A	0.105	0.800	0.131	EC-6.2.9.1	101	159.00	45.1E 3	8564.00	189.00
189	HE400A	0.237	0.800	0.297	EC-6.2.9.1	117	159.00	45.1E 3	8564.00	189.00
266	HE400A	0.258	0.800	0.323	EC-6.2.9.1	102	159.00	45.1E 3	8564.00	189.00
267	HE400A	0.237	0.800	0.297	EC-6.2.9.1	117	159.00	45.1E 3	8564.00	189.00
268	HE400A	0.302	0.800	0.378	EC-6.2.9.1	101	159.00	45.1E 3	8564.00	189.00
269	HE400A	0.059	0.800	0.073	EC-6.2.9.1	117	159.00	45.1E 3	8564.00	189.00

HE220A

Utilization Ratio

Beam	Analysis Property	Actual Ratio	Allowable Ratio	Ratio (Act./Allow.)	Clause	L/C	Ax (cm^2)	Iz (cm^4)	Iy (cm^4)	Ix (cm^4)
259	HE220A	0.145	0.800	0.181	EC-6.2.9.1	117	64.30	5410.00	1955.00	28.50
261	HE220A	0.144	0.800	0.180	EC-6.2.9.1	117	64.30	5410.00	1955.00	28.50
263	HE220A	0.145	0.800	0.181	EC-6.2.9.1	117	64.30	5410.00	1955.00	28.50
265	HE220A	0.144	0.800	0.180	EC-6.2.9.1	117	64.30	5410.00	1955.00	28.50
270	HE220A	0.144	0.800	0.180	EC-6.2.9.1	117	64.30	5410.00	1955.00	28.50
271	HE220A	0.145	0.800	0.181	EC-6.2.9.1	117	64.30	5410.00	1955.00	28.50
272	HE220A	0.144	0.800	0.180	EC-6.2.9.1	117	64.30	5410.00	1955.00	28.50
273	HE220A	0.145	0.800	0.181	EC-6.2.9.1	117	64.30	5410.00	1955.00	28.50

GUTTER 175x500

Utilization Ratio

Beam	Analysis Property	Actual Ratio	Allowable Ratio	Ratio (Act./Allow.)	Clause	L/C	Ax (cm^2)	Iz (cm^4)	Iy (cm^4)	Ix (cm^4)
36	GUTTER175X500	0.458	0.800	0.572	EC-6.2.5	117	52.00	2647.83	24.7E	5.79
37	GUTTER175X500	0.458	0.800	0.572	EC-6.2.5	117	52.00	2647.83	24.7E	5.79

HE100B

Utilization Ratio, maximum values

Beam	Analysis Property	Allowable Ratio	Ratio (Act./Allow.)	Clause	L/C	Ax (cm^2)	Iz (cm^4)	Iy (cm^4)	Ix (cm^4)
38	HE100B	0.800	0.218	EC-6.2.9.1	110	26.00	450.00	167.00	9.30
39	HE100B	0.800	0.218	EC-6.2.9.1	110	26.00	450.00	167.00	9.30
14	HE100B	0.800	0.190	EC-6.2.9.1	110	26.00	450.00	167.00	9.30
22	HE100B	0.800	0.190	EC-6.2.9.1	110	26.00	450.00	167.00	9.30
51	HE100B	0.800	0.190	EC-6.2.9.1	110	26.00	450.00	167.00	9.30
64	HE100B	0.800	0.190	EC-6.2.9.1	110	26.00	450.00	167.00	9.30
62	HE100B	0.800	0.163	EC-6.3.3-662	114	26.00	450.00	167.00	9.30
68	HE100B	0.800	0.163	EC-6.3.3-662	114	26.00	450.00	167.00	9.30
11	HE100B	0.800	0.130	EC-6.2.9.1	110	26.00	450.00	167.00	9.30
12	HE100B	0.800	0.129	EC-6.2.9.1	110	26.00	450.00	167.00	9.30
19	HE100B	0.800	0.129	EC-6.2.9.1	110	26.00	450.00	167.00	9.30
20	HE100B	0.800	0.129	EC-6.2.9.1	110	26.00	450.00	167.00	9.30

80X5SHS

Utilization Ratio

113	80X5SHS	0.051	0.800	0.063	EC-6.3.1.1	102	14.70	137.00	137.00
138	80X5SHS	0.038	0.800	0.048	EC-6.3.1.1	101	14.70	137.00	137.00
139	80X5SHS	0.038	0.800	0.048	EC-6.3.1.1	101	14.70	137.00	137.00
137	80X5SHS	0.037	0.800	0.047	EC-6.2.3 (T)	101	14.70	137.00	137.00
140	80X5SHS	0.037	0.800	0.047	EC-6.2.3 (T)	101	14.70	137.00	137.00
98	80X5SHS	0.034	0.800	0.043	EC-6.3.1.1	117	14.70	137.00	137.00
105	80X5SHS	0.034	0.800	0.043	EC-6.3.1.1	117	14.70	137.00	137.00

Columns design - Canopy

400x16 SHS

Utilization Ratio

Beam	**Analysis** Property	**Actual** Ratio	**Allowable** Ratio	**Ratio** (Act./Allow.)	**Clause**	**L/C**	**Ax** (cm^2)	**Iz** (cm^4)	**Iy** (cm^4)	**Ix** (cm^4)
1	400X16SHS	0.316	0.800	0.396	EC-6.2.9.1	105	243.00	59.3E 3	59.3E 3	92.4E 3

c. Displacements/deflections

3D view

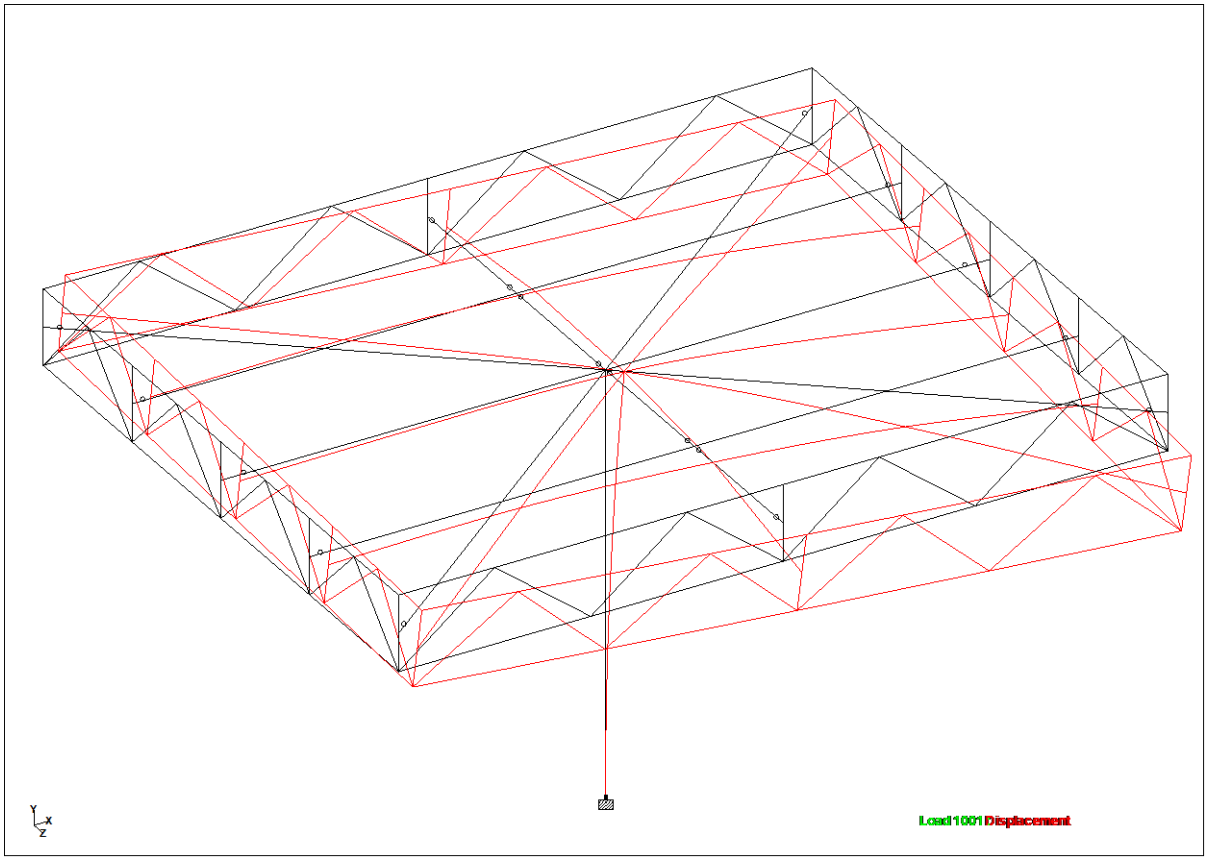


Fig. Structure Displacement C 1001 SW+DL+LLR_1ST_P

Node displacement summary

400x16SHS – Column Horizontal Displacement

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	1	1005:SW+DL+WL	5.0	**15.2**	-0.0	0.0	15.2
Min X	1	1006:SW+DL+WL	5.0	**-7.6**	-0.0	0.0	7.6
Max Y	1	1004:SW+DL+WL	4.5	3.3	**0.0**	0.0	3.3
Min Y	1	1017:SW+DL+SL	5.0	0.0	**-0.1**	0.0	0.1
Max Z	1	1012:SW+DL+WL	5.0	0.0	-0.0	**13.7**	13.7
Min Z	1	1013:SW+DL+WL	5.0	0.0	-0.0	**-4.5**	4.5
Max Rst	1	1005:SW+DL+WL	5.0	15.2	-0.0	0.0	**15.2**

Steel Structure Maximum Global Horizontal Displacement
Δstr.all =H/300(5500/300=18.3mm; 20mm)=18.3mm
Δstr.z.eff = 13.7 mm ≤ Δ str.all → OK
Δstr.x.eff = 15.2 mm ≤ Δ str.all → OK

HE400A - Beam Displacement

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	186	1005:SW+DL+WL	2.6	**15.2**	13.7	-0.1	20.5
Min X	189	1006:SW+DL+WL	0.0	**-7.6**	-0.0	0.0	7.6
Max Y	186	1005:SW+DL+WL	0.0	15.2	**24.9**	-0.0	29.2
Min Y	188	1005:SW+DL+WL	0.0	15.2	**-32.8**	-0.0	36.2
Max Z	186	1012:SW+DL+WL	0.0	-0.0	18.5	**13.8**	23.1
Min Z	267	1013:SW+DL+WL	1.2	-0.0	2.5	**-4.5**	5.2
Max Rst	188	1005:SW+DL+WL	0.0	15.2	-32.8	-0.0	**36.2**

Beam Maximum Vertical Displacement
Beam checking:
Δcantiliver.all = 2*(4500/250) =36mm
$\Delta_{cant.HE400A}$ = 32.8 mm → OK

HE220A - Beam Displacement

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	270	1005:SW+DL+WL	0.0	**15.2**	12.5	0.1	19.7
Min X	261	1006:SW+DL+WL	2.3	**-7.5**	7.5	-0.1	10.6
Max Y	270	1005:SW+DL+WL	0.0	15.2	**12.5**	0.1	19.7
Min Y	261	1005:SW+DL+WL	2.3	15.2	**-15.6**	-0.1	21.8
Max Z	265	1012:SW+DL+WL	0.0	0.0	10.0	**13.7**	17.0
Min Z	261	1013:SW+DL+WL	1.1	-0.0	4.9	**-4.5**	6.6
Max Rst	261	1005:SW+DL+WL	2.3	15.2	-15.6	-0.1	**21.8**

Beam Maximum Vertical Displacement
Beam checking:
Δbeam.all = 4500/250 =18mm
$\Delta_{beam.IPE220}$ = 15.6 mm → OK

GUTTER 175x500 – Beam Displacement

	Beam	L/C	d (m)	X (mm)	Y (mm)	Z (mm)	Resultant (mm)
Max X	36	1005:SW+DL+WL	0.0	**15.2**	25.0	0.0	29.3
Min X	37	1006:SW+DL+WL	2.3	**-7.6**	8.2	0.0	11.1
Max Y	36	1005:SW+DL+WL	0.0	15.2	**25.0**	0.0	29.3
Min Y	37	1005:SW+DL+WL	4.5	15.2	**-32.9**	0.0	36.2
Max Z	36	1012:SW+DL+WL	0.0	0.0	-3.2	**13.8**	14.2
Min Z	36	1013:SW+DL+WL	4.5	0.0	-0.0	**-4.5**	4.5
Max Rst	37	1005:SW+DL+WL	4.5	15.2	-32.9	0.0	**36.2**

Beam Maximum Vertical Displacement
Beam checking:
Δcantiliver.all = 2*(4500/250) =36mm
$\Delta_{cant.GUTTER}$ = 32.9 mm → OK

d. Support reaction

Overview structural model with support assigned number

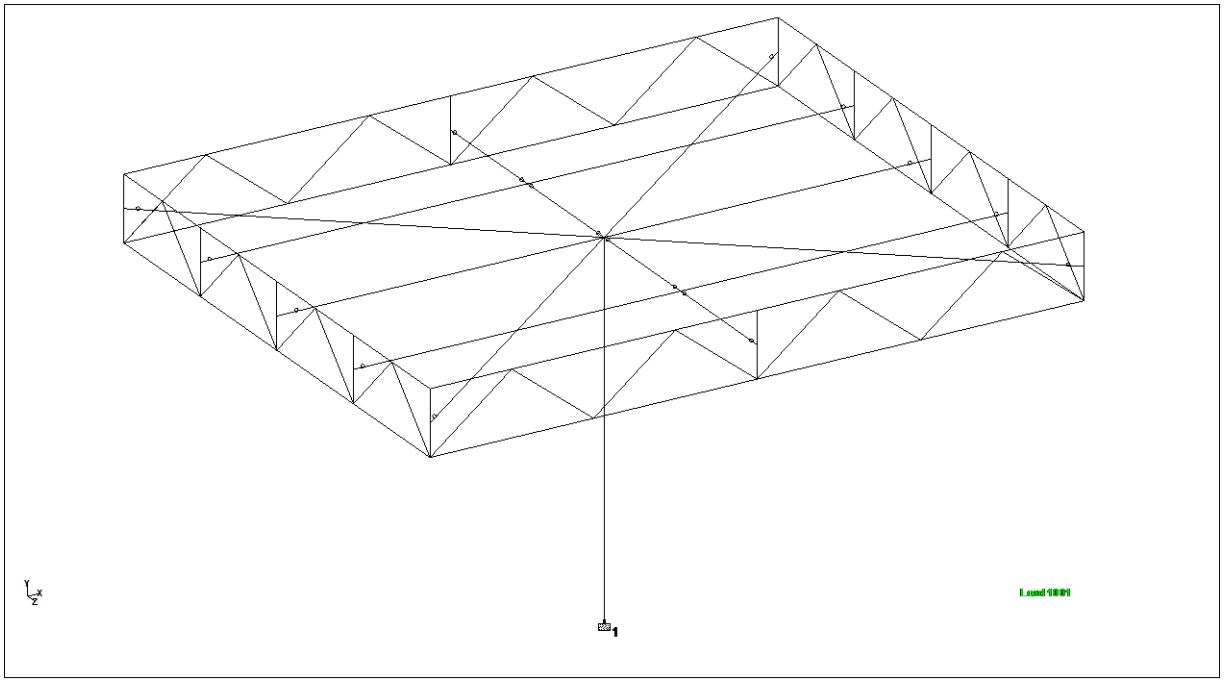


Fig. 3D VIEW SUPPORT REACTIONS

Support nodes restraints:

Node	X (kN/mm)	Y (kN/mm)	Z (kN/mm)	rX (kN-m/deg)	rY (kN-m/deg)	rZ (kN-m/deg)
1	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed

Reaction Summary

			Horizontal	Vertical	Horizontal	Moment		
	Node	L/C	FX (kN)	FY (kN)	FZ (kN)	MX (kN-m)	MY (kN-m)	MZ (kN-m)
Max	1	129:0.9SW+0.9DL+1.5WL	**0.00**	0.34	-25.05	-242.58	0.00	0.00
Min	1	103:1.35SW+1.35DL+1.5WL XDIR	**-21.54**	142.26	0.00	0.00	-0.00	88.95
Max	1	117:1.35SW+1.35DL+1.5SL	-0.00	**196.26**	-0.00	0.00	-0.00	0.00
Min	1	121:0.9SW+0.9DL+1.5WL	-21.54	**-56.36**	0.00	-0.00	-0.00	88.95
Max	1	122:0.9SW+0.9DL+1.5WL	-21.54	19.24	**0.00**	-0.00	-0.00	259.05
Min	1	110:1.35SW+1.35DL+1.5WL ZDIR	0.00	142.26	**-25.05**	-106.50	0.00	-0.00
Max	1	102:1.35SW+1.35DL+1.5LLR_2NDPITCH	-0.00	158.46	0.00	**43.74**	0.00	-36.45
Min	1	112:1.35SW+1.35DL+1.5WL	0.00	47.76	-25.05	**-242.58**	0.00	-0.00
Max	1	129:0.9SW+0.9DL+1.5WL	0.00	0.34	-25.05	-242.58	**0.00**	0.00
Min	1	105:1.35SW+1.35DL+1.5WL	-21.54	66.66	0.00	0.00	**-0.00**	259.05
Max	1	105:1.35SW+1.35DL+1.5WL	-21.54	66.66	0.00	0.00	-0.00	**259.05**
Min	1	106:1.35SW+1.35DL+1.5WL	-21.54	66.66	-0.00	0.00	0.00	**-81.15**

*vertical Y axis

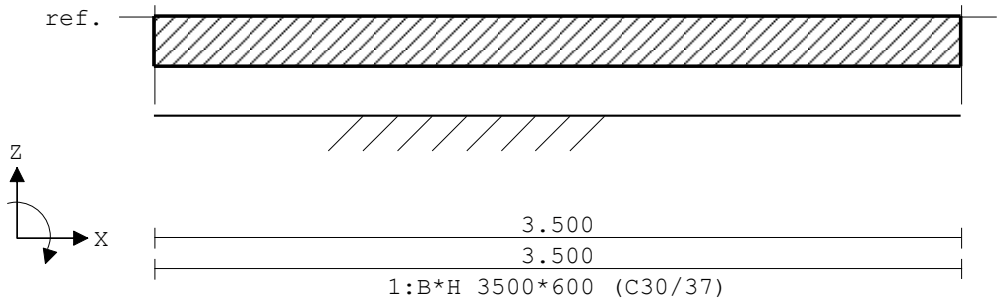
Appendix B – Canopy foundation calculation

Applied standards according to Eurocode with Dutch NA

Loads	NEN-EN 1990:2002	C2:2010	NB:2011(nl)
	NEN-EN 1991-1-1:2002	C1:2009	NB:2011(nl)
Concrete	NEN-EN 1992-1-1:2011(nl)	C2/A1:2015(nl)	NB:2016(nl)

K82509

GEOMETRY Beam:1



FIELD LENGTHS Beam:1

Field	From	To	Length
1	0.000	3.500	3.500

MATERIALS

Mt	Description	E-modulus[N/mm2]	S.W.	Pois.	Exp. coeff.
1	C30/37	9465	25.0	0.20	1.0000e-05

MATERIALS contd.

Mt	Description	Cement	Creep coeff.
1	C30/37	N	2.47

SECTIONS [mm]

Sect.	Description	Material	Area	Inertia	Formf.
1	B*H 3500*600	1:C30/37	2.1000e+06	6.3000e+10	0.00

CROSS-SECTIONS Beam:1

sector	From	To	Length	Section begin	z-begin	Section end	z-end
1	0.000	3.500	3.500	1:B*H 3500*600	0.000	1:B*H 3500*600	0.000

sector	From	To	Length	End code	Elast.f	Bw.[mm]
1	0.000	3.500	3.500	1:Fixed	10000	3500

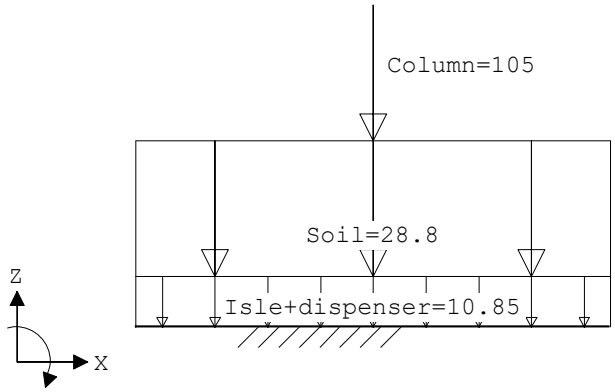
LOAD CASES

L.C.	Description	Loaded/unloaded	ψ_0	ψ_1	ψ_2	s.w.
1	DL	2:Permanent EN1991				-1.00
2	LL	0:All at once	0.70	0.70	0.60	0.00
3	WL	0:All at once	0.00	0.20	0.00	0.00
4	SL	0:All at once	1.00	1.00	1.00	0.00

LOAD CASES

LCa	Description	Type
1	DL	1 Permanent load
2	LL	3 Var. load pers. etc. (F-rep)
3	WL	17 Wind on canopy roof upward
4	SL	22 Snow A

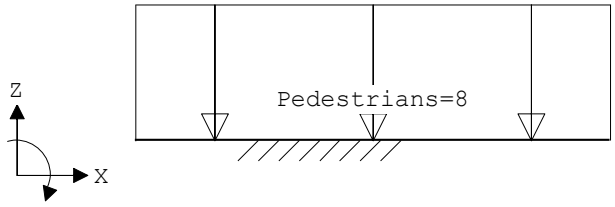
FIELD LOADS Beam:1 LCa:1 DL



FIELD LOADS Beam:1 LCa:1 DL

Load Ref.	Type	Description	q1/p/m	q2	psi	Dist.	Length
1	1:q-load	Isle+dispenser	-10.850	-10.850		0.000	3.500
2	1:q-load	Soil	-28.800	-28.800		0.000	3.500
3	8:Point load	Column	-105.000			1.750	

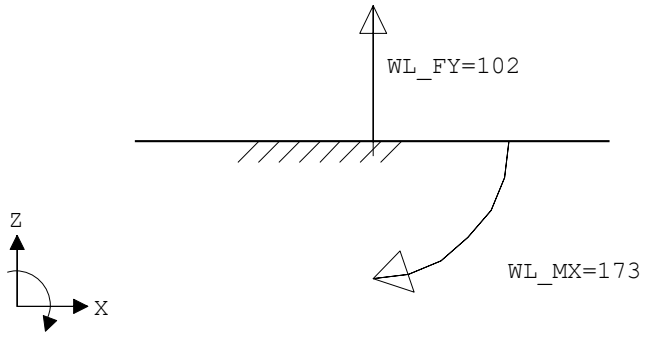
FIELD LOADS Beam:1 LCa:2 LL



FIELD LOADS Beam:1 LCa:2 LL

Load Ref.	Type	Description	q1/p/m	q2	psi	Dist.	Length
1	1:q-load	Pedestrians	-8.000	-8.000		0.000	3.500

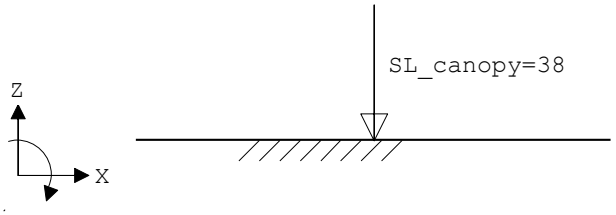
FIELD LOADS Beam:1 LCa:3 WL



FIELD LOADS Beam:1 LCa:3 WL

Load Ref.	Type	Description	q1/p/m	q2	psi	Dist.	Length
1	8:Point load	WL_FY	102.000			1.750	
2	12:Moment	WL_MX	173.000			1.750	

FIELD LOADS Beam:1 LCa:4 SL



FIELD LOADS Beam:1 LCa:4 SL

Load Ref.	Type	Description	q1/p/m	q2 psi	Dist.	Length
1	8:Point load	SL_canopy	-38.000		1.750	

LOAD COMBINATIONS

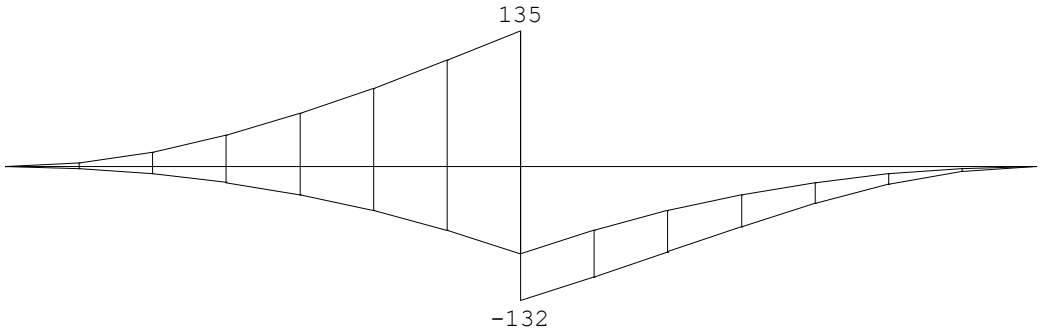
LCo	Type	LCa	Gen.	Factor	LCa	Gen.	Factor	LCa	Gen.	Factor	LCa	Gen.	Factor
1	Fund.	1	Perm	1.35	2	Extr	1.50	4	Extr	1.50			
2	Fund.	1	Perm	1.35	2	Extr	1.50	3	Extr	1.50			
3	Fund.	1	Perm	0.90	3	Extr	1.50						
4	Char.	1	Perm	1.00	2	Extr	1.00	3	Extr	1.00			
5	Char.	1	Perm	1.00	3	Extr	1.00						
6	Char.	1	Perm	1.00	2	Extr	1.00	4	Extr	1.00			
7	Quas.	1	Perm	1.00	2	psi2	1.00	4	psi2	1.00			
8	Freq.	1	Perm	1.00	2	Extr	0.60						
9	Perm.	1	Perm	1.00									

FAVOURABLE PARTS OF PERMANENT ACTION

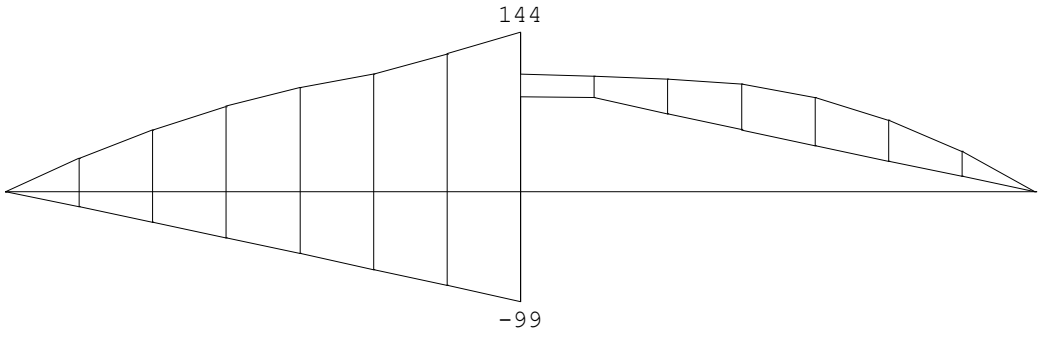
LCo	Fields with favourable parts of permanent action
1	No beams
2	No beams
3	All fields the factor:0.90

CONTOUR OF THE FUNDAMENTAL COMBINATIONS

MOMENTS Phys. linear model Beam:1 Fundamental combination



SHEAR FORCES Phys. linear model Beam:1 Fundamental combination

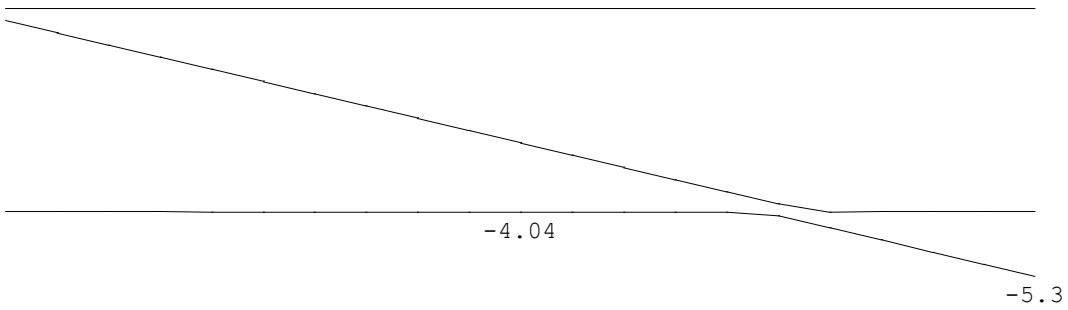


FIELD VALUES Phys. linear model Beam:1 Fundamental combination

		Earth stress[kN/m2]		Shear force		Moment	
Field	Pos.	min.	max.	min.	max.	min.	max.
1	0.000		54.539	0.00	0.00	0.00	0.00
1	1.750		55.636	-99.38	143.97	-85.91	134.61
1	1.750		55.636	85.47	105.98	-132.56	-85.91
1	2.500		55.335				
1	3.250	54.747					
1	3.500	54.539	74.145	0.00	0.00	0.00	0.00

CONTOUR OF THE CHARACTERISTIC COMBINATIONS

TRANSLATIONS [mm] Phy.NLE.short Beam:1 Characteristic combination



The displacements are without creep (w2)!

FIELD VALUES Phys. linear model Beam:1 Characteristic combination

		Earth stress[kN/m2]		Shear force		Moment	
Field	Pos.	min.	max.	min.	max.	min.	max.
1	0.000			0.00	0.00	0.00	0.00
1	1.750			-71.50	72.90	-61.81	85.20
1	1.750			71.50	75.90	-87.80	-61.81
1	3.500			0.00	0.00	0.00	0.00

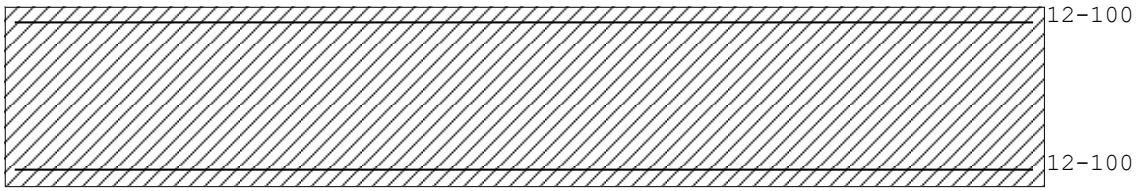
SECTION DATA Floor **[N][mm]** rel. to section:1 B*H 3500*600

General

Material : C30/37
Area : 2.100000e+06 Inertia : 6.3000e+10
Bar type : 0:normal Shape fact.: 0.00

Cross section

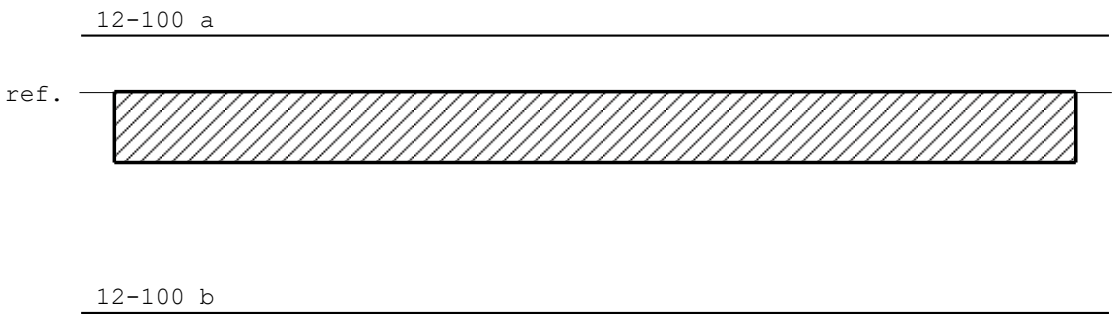
width : 3500 height : 600 center of gravity bott.side : 300
Reference : Top



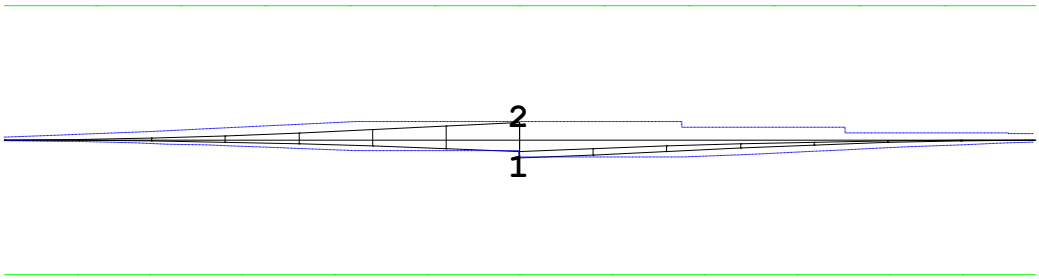
Nominal size : 512.2
Bearing width a_b 6.1(10) : 0

Concrete quality element : C30/37 Creep coeff. : 2.5
Tensile str. $f_{ct,eff}$ art. 7.1(2): $f_{ctm,fl}$ (2.90 N/mm²)
Type of stress-straindiagram : Parabolic - rectangular diagram
Deflection according to 7.3.4(3): Yes
Longterm cracking moment limited: Yes
Steel quality main reinforcement: 500 ε_{uk} : 5.00
Type of stress-straindiagram : Bi-linear diagram with inclined branch
Prefabricated element : No

Main reinforcement Phys. linear modelBeam:1Fundamental combination



MEd covering Phys. linear model Beam:1 Fundamental combination



Main reinforcement Beam:1

Sect.	Pos. [mm]	M_{Ed} [kNm]	M_{Rd} [kNm]	z [mm]	T/B	A_r [mm²]	A_d [mm²]	Main reinforcement +Aux. reinforcement	Rem.
1	1750	134.61	1003.43	443	T	1923*	3960	12-100	54
2	1750	-132.56	-1003.43	443	B	1923*	3960	12-100	54

Remarks
[54] * = Demands for minimum reinforcement due to the control of cracking are applied according to 7.3.2.

Crack formation according to article 7.3.4 Beam:1

Geb.	Pos. [mm]	Side	$M_{E;freq}$ [kNm]	$s_{r,max}$ [mm]	$\varepsilon_{sm}-\varepsilon_{cm}$ [‰]	w_k [mm]	k_x	w_{max} [mm]	U.C.	Opm.
1	1750	Bot	-45.24	312	0.065	0.020	1.33	0.400	0.05	

Course of main reinforcement Beam:1

Mark	T/B	Reinforcement	From [mm]	To [mm]	Length [mm]	$L_{bd;begin}$ [mm]	$L_{bd;eind}$ [mm]
a	Top	12-100	-120	3620	3740	120	120
b	Btm.	12-100	-120	3620	3740	120	120

Remarks
All measurements include translation of the M-line and anchorage

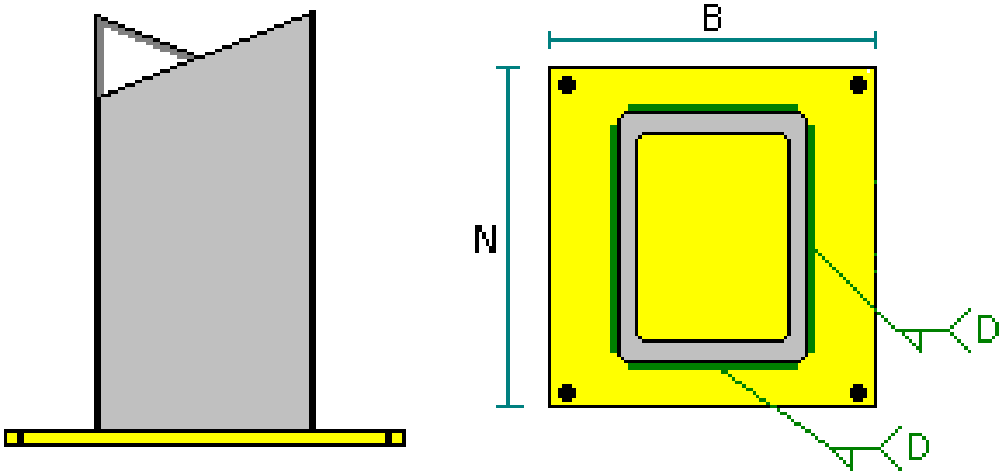
Appendix C – Canopy base plate calculation

Steel connections
Detailed report

Bentley

GENERAL INFORMATION

Connector



MEMBERS

Column

Section	:	SHS400X16
Material	:	S 275

CONNECTOR

Base plate

Connection type	:	Unstiffened
Position on the support	:	Center
N: Depth	:	700 mm
D: Gross width	:	700 mm
tp: Thickness	:	60 mm
Material	:	S 275
Column weld	:	E_42
s: Column weld size	:	10 mm
Override Ac1/Ac0 ratio	:	No
Shear key type	:	None

Support

With pedestal	:	No
Longitudinal dimension	:	3500 mm
Transversal dimension	:	3500 mm
Thickness	:	600 mm
Material	:	C30-37
Include grouting	:	Yes
Grout thickness	:	50 mm
Cover	:	50 mm

Anchor

Anchor position	:	Customized

Anchor coordinates:

Coordinate

Transverse [mm]	Longitudinal [mm]
300.00	300.00
300.00	-300.00
-300.00	300.00
-300.00	-300.00
-300.00	0.00
300.00	0.00
0.00	-300.00
0.00	300.00

Head type	:	Hexagonal
Include lock nut	:	No
Anchor	:	M_30
Effective embedment depth	:	500 mm
Total length	:	649.6 mm
Material	:	Class 8.8
Fy	:	640 N/mm2
Fu	:	800 N/mm2
Splitting Failure	:	No
Cracked concrete	:	No
Non-ductile steel	:	No
Fasteners welded to base plate	:	No
Lever arm	:	No

Anchor supplementary reinforcement

Tension reinforcement	:	No
Shear reinforcement	:	No

Design code: Standard NA EN 1993-1-8 (2005) : Eurocode 3

DEMANDS

Description	Pu [KN]	Mu22 [KN*m]	Mu33 [KN*m]	Vu2 [KN]	Vu3 [KN]
DL	-185.00	-262.00	-245.00	21.00	25.00

Design for major axis
Base plate (Standard NA EN 1993-1-8 (2005) : Eurocode 3)

Dimensions

Dimensions References	Unit	Value	Min. value	Max. value	Sta.
Base plate					
Longitudinal dimension	[mm]	700.00	420.00	--	✔
Transversal dimension	[mm]	700.00	420.00	--	✔
Distance from fasteners to edge	[mm]	50.00	6.35	--	✔

DESIGN CHECK

Verification References	Unit	Capacity	Demand	Ctrl EQ	Ratio
Concrete base					
Concrete base bearing of the effective area DG1 Sec 3.1.1;	[KN]	56666.67	56666.67	DL	1.00
Base plate					
Yielding at bearing interface SCI P358 p.231	[KN*m/m]	153.00	111.56	DL	0.73
Yielding at tension interface DG1 Eq. 3.3.13	[KN*m/m]	229.50	54.21	DL	0.24
Column					
Weld resistance Eq. 4.3	[KN/m]	2003.61	620.87	DL	0.31

Ratio	**1.00**				

Design for minor axis
Base plate (Standard NA EN 1993-1-8 (2005) : Eurocode 3)

Dimensions

Dimensions **References**	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**
Base plate					
Longitudinal dimension	[mm]	700.00	420.00	--	✓
Transversal dimension	[mm]	700.00	420.00	--	✓
Distance from fasteners to edge	[mm]	50.00	6.35	--	✓

DESIGN CHECK

Verification **References**	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**
Concrete base					
Concrete base bearing of the effective area DG1 Sec 3.1.1;	[KN]	56666.67	56666.67	DL	1.00
Base plate					
Yielding at bearing interface SCI P358 p.231	[KN*m/m]	153.00	117.96	DL	0.77
Yielding at tension interface DG1 Eq. 3.3.13	[KN*m/m]	229.50	59.37	DL	0.26
Column					
Weld resistance Eq. 4.3	[KN/m]	2003.61	679.94	DL	0.34
Ratio	**1.00**				

Major axis
Fasteners

Dimensions

Dimensions **References**	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**
Fasteners					
Spacing EN 1992-4: 2013, Sec. 7.2.2.5	[mm]	300.00	120.00	--	✓
Concrete cover EN 1991-1: 2004, Table 4.4N	[mm]	50.00	35.00	--	✓
Effective length	[mm]	500.00	--	580.50	✓

DESIGN CHECK

Verification **References**	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**
Steel failure of fastener in tension 7, EN 1992-4: 2013, Table 7.1	[KN]	293.37	78.85	DL	0.27
Pull-out failure of single fastener EN 1992-4: 2013, Eq. 7.1,	[KN]	200.56	78.85	DL	0.39

EN 1992-4: 2013, Table 7.1 Concrete cone failure of single fastener EN 1992-4: 2013, Eq. 7.13,	[KN]	518.48	78.85	DL	0.15
EN 1992-4: 2013, Table 7.1 Concrete cone failure of group of fasteners EN 1992-4: 2013, Eq. 7.13,	[KN]	1016.21	333.69	DL	0.33
EN 1992-4: 2013, Table 7.1 Steel failure of fastener in shear EN 1992-4: 2013, Sec. 7.2.2.3.1	[KN]	176.02	2.63	DL	0.01
Pry-out failure of single fastener EN 1992-4: 2013, Eq. 7.13,	[KN]	1036.95	2.63	DL	0.00
EN 1992-4: 2013, Table 7.1 Pry-out failure of group of fasteners EN 1992-4: 2013, Eq. 7.13,	[KN]	2032.42	21.00	DL	0.01
EN 1992-4: 2013, Table 7.1 Concrete edge failure of single fastener EN 1992-4: 2013, Eq. 7.39,	[KN]	306.08	2.63	DL	0.01
EN 1992-4: 2013, Table 7.2 Concrete edge failure of group of fasteners EN 1992-4: 2013, Eq. 7.39,	[KN]	475.83	21.00	DL	0.04
EN 1992-4: 2013, Table 7.2 Combined tension and shear interaction for steel failure			1.00	0.07	DL
0.07	EN 1992-4: 2013,				
Eq. 7.53 Combined tension and shear interaction for other modes			1.00	0.26	DL
0.26	EN 1992-4: 2013,				
Eq. 7.54 Combined tension and shear interaction for other modes			1.20	0.44	DL
0.36	EN 1992-4: 2013,				

Eq. 7.55

Ratio	**0.39**					

Minor axis Fasteners

Dimensions

Dimensions References	**Unit**	**Value**	**Min. value**	**Max. value**	**Sta.**
Fasteners					
Spacing EN 1992-4: 2013, Sec. 7.2.2.5	[mm]	300.00	120.00	--	✔
Concrete cover EN 1991-1: 2004, Table 4.4N	[mm]	50.00	35.00	--	✔
Effective length	[mm]	500.00	--	580.50	✔

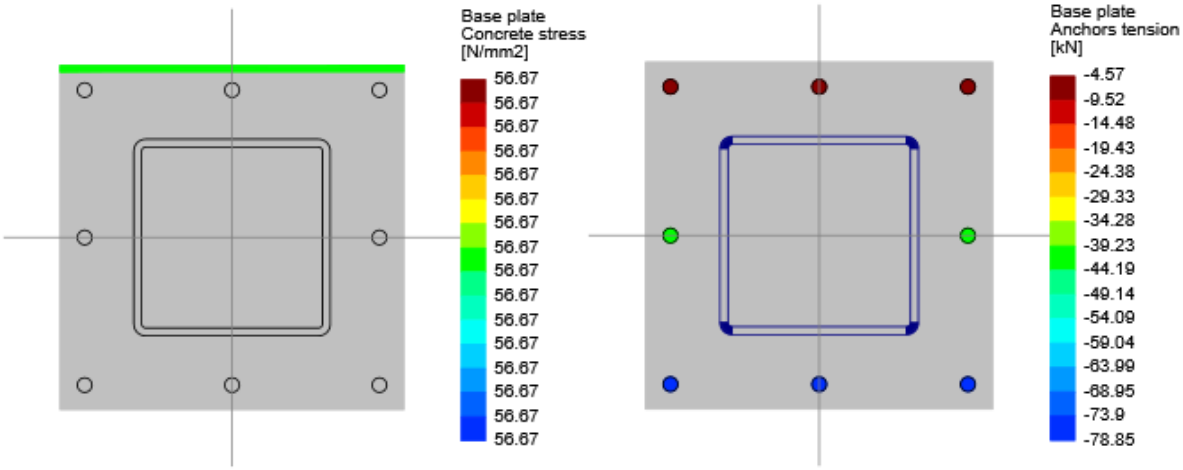
DESIGN CHECK

Verification References	**Unit**	**Capacity**	**Demand**	**Ctrl EQ**	**Ratio**
Steel failure of fastener in tension 7, EN 1992-4: 2013, Table 7.1	[KN]	293.37	86.35	DL	0.29
Pull-out failure of single fastener EN 1992-4: 2013, Eq. 7.1, EN 1992-4: 2013, Table 7.1	[KN]	200.56	86.35	DL	0.43
Concrete cone failure of single fastener EN 1992-4: 2013, Eq. 7.13, EN 1992-4: 2013, Table 7.1	[KN]	518.48	86.35	DL	0.17
Concrete cone failure of group of fasteners EN 1992-4: 2013, Eq. 7.13, EN 1992-4: 2013, Table 7.1	[KN]	1016.21	365.03	DL	0.36
Steel failure of fastener in shear EN 1992-4: 2013, Sec. 7.2.2.3.1	[KN]	176.02	3.13	DL	0.02
Pry-out failure of single fastener EN 1992-4: 2013,	[KN]	1036.95	3.13	DL	0.00

Eq. 7.13,
EN 1992-4: 2013,
Table 7.1

Pry-out failure of group of fasteners EN 1992-4: 2013,	[KN]	2032.42	25.00	DL	0.01 Eq. 7.13, EN 1992-4: 2013, Table 7.1
Concrete edge failure of single fastener EN 1992-4: 2013,	[KN]	306.08	3.13	DL	0.01 Eq. 7.39, EN 1992-4: 2013, Table 7.2
Concrete edge failure of group of fasteners EN 1992-4: 2013,	[KN]	428.86	25.00	DL	0.06 Eq. 7.39, EN 1992-4: 2013, Table 7.2
Combined tension and shear interaction for steel failure			1.00	0.09	DL 0.09 EN 1992-4: 2013, Eq. 7.53
Combined tension and shear interaction for other modes			1.00	0.30	DL 0.30 EN 1992-4: 2013, Eq. 7.54
Combined tension and shear interaction for other modes			1.20	0.49	DL 0.41 EN 1992-4: 2013, Eq. 7.55
Ratio	**0.43**				
Global critical strength ratio	**1.00**				

Major axis
Maximum compression and tension (DL)



Maximum bearing pressure	56.67	[N/mm2]
Minimum bearing pressure	56.67	[N/mm2]
Maximum anchor tension	78.85	[KN]
Minimum anchor tension	4.57	[KN]
Neutral axis angle	0.00	
Bearing length	13.08	[mm]

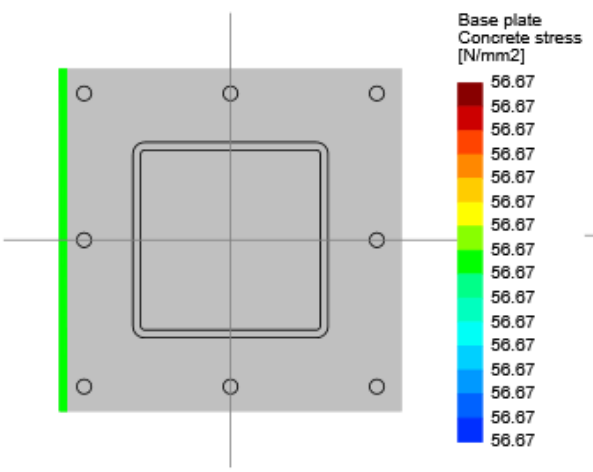
Anchors tensions

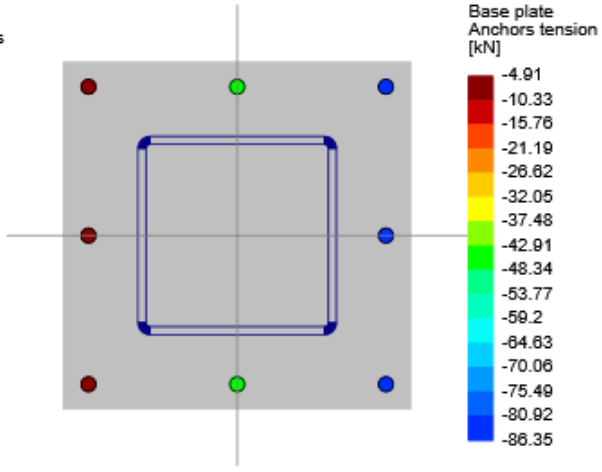
Anchor	Transverse [mm]	Longitudinal [mm]	Shear [KN]	Tension [KN]
1	300.00	300.00	2.63	4.57
2	300.00	-300.00	2.63	78.85
3	-300.00	300.00	2.63	4.57
4	-300.00	-300.00	2.63	78.85
5	-300.00	0.00	2.63	41.71
6	300.00	0.00	2.63	41.71
7	0.00	-300.00	2.63	78.85

8	0.00	300.00	2.63	4.57

Minor axis

Maximum compression and tension (DL)





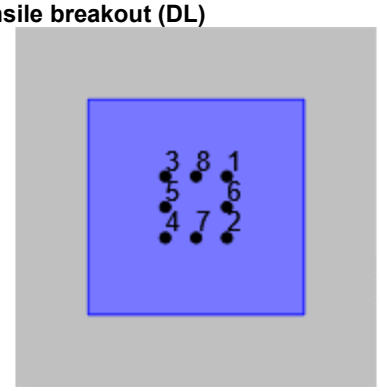
Maximum bearing pressure	56.67	[N/mm2]
Minimum bearing pressure	56.67	[N/mm2]
Maximum anchor tension	86.35	[KN]
Minimum anchor tension	4.91	[KN]
Neutral axis angle	0.00	
Bearing length	13.87	[mm]

Anchors tensions

Anchor	Transverse [mm]	Longitudinal [mm]	Shear [KN]	Tension [KN]
1	300.00	300.00	3.13	86.35
2	300.00	-300.00	3.13	86.35
3	-300.00	300.00	3.13	4.91
4	-300.00	-300.00	3.13	4.91
5	-300.00	0.00	3.13	4.91
6	300.00	0.00	3.13	86.35
7	0.00	-300.00	3.13	45.63
8	0.00	300.00	3.13	45.63

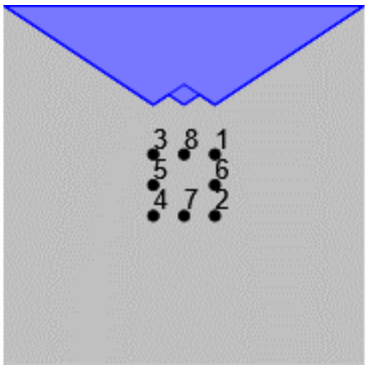
Major axis

Results for tensile breakout (DL)



Group	Area [mm2]	Tension [KN]	Fasteners
1	4410000.00	333.69	1, 2, 3, 4, 5, 6, 7, 8

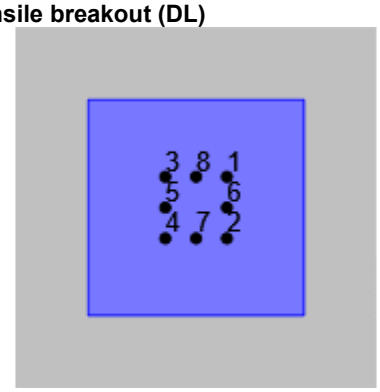
Results for shear breakout (DL)



Group	Area [mm2]	Shear [KN]	Fasteners
1	2100000.00	13.13	1, 3, 5, 6, 8
2	2100000.00	21.00	1, 2, 3, 4, 5, 6, 7, 8
3	2100000.00	7.88	1, 3, 8

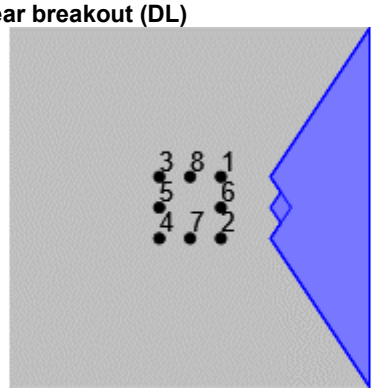
Minor axis

Results for tensile breakout (DL)



Group	Area [mm2]	Tension [KN]	Fasteners
1	4410000.00	365.03	1, 2, 3, 4, 5, 6, 7, 8

Results for shear breakout (DL)



Group	Area [mm2]	Shear [KN]	Fasteners
1	2100000.00	25.00	1, 2, 3, 4, 5, 6, 7, 8
2	2100000.00	9.38	1, 2, 6
3	2100000.00	15.63	1, 2, 6, 7, 8

C. Cretu
Structural Engineer
M: +40 743 291 647
E: cezar.cretu@aecom.com

AECOM Netherlands B.V.
HNK Den Haag, Oude Middenweg 17
2491 AC Den Haag, The Netherlands

T: +31 (0) 702400898
aecom.com