RC slab bridge

Features:

1. Compact complete Input Receipt $\Rightarrow$ Less than 100 pages.
2. Traffic evaluation (VLO) both in longitudinal & transverse direction simultaneously.
3. The use of Search Area means loads can be defined as Discrete loads, thus can be defined in global X-Y-Z $\Rightarrow$ No need to keep track of nodes, element, point and lines.
4. Smart combinations that permit Permanent & Variable factors.
5. Smart combinations the permit number of Load cases to consider.
6. The use of Slice Resultant Beams/Shells $\Rightarrow$ Equivalent force associated to nodal forces in shells & beams can be integrated.
7. Location of nodes forces can be given in table format with coordinates X-Y-Z $\Rightarrow$ No need to keep track of nodal number or elements.
8. The use Slice Data when retrieving Force/Moment in shell structures $\Rightarrow$ Useful since reduces the amount of result lines need to be retrieved in result report.
9. The use of Wood-Armer that permits use of skewed reinforcement.

TABLE OF CONTENT

1. GENERAL / MEASUREMENTS

1.1 CONSTRUCTION TYPE

Superstructure:
Slab bridge in one spann with end-shields and bearings.

Superstructure is assumed constructed using continous schaffolding and cast in one stage.

Superstucture is assumed divided in two part with a longitidunal dilation joint at center of bridge.

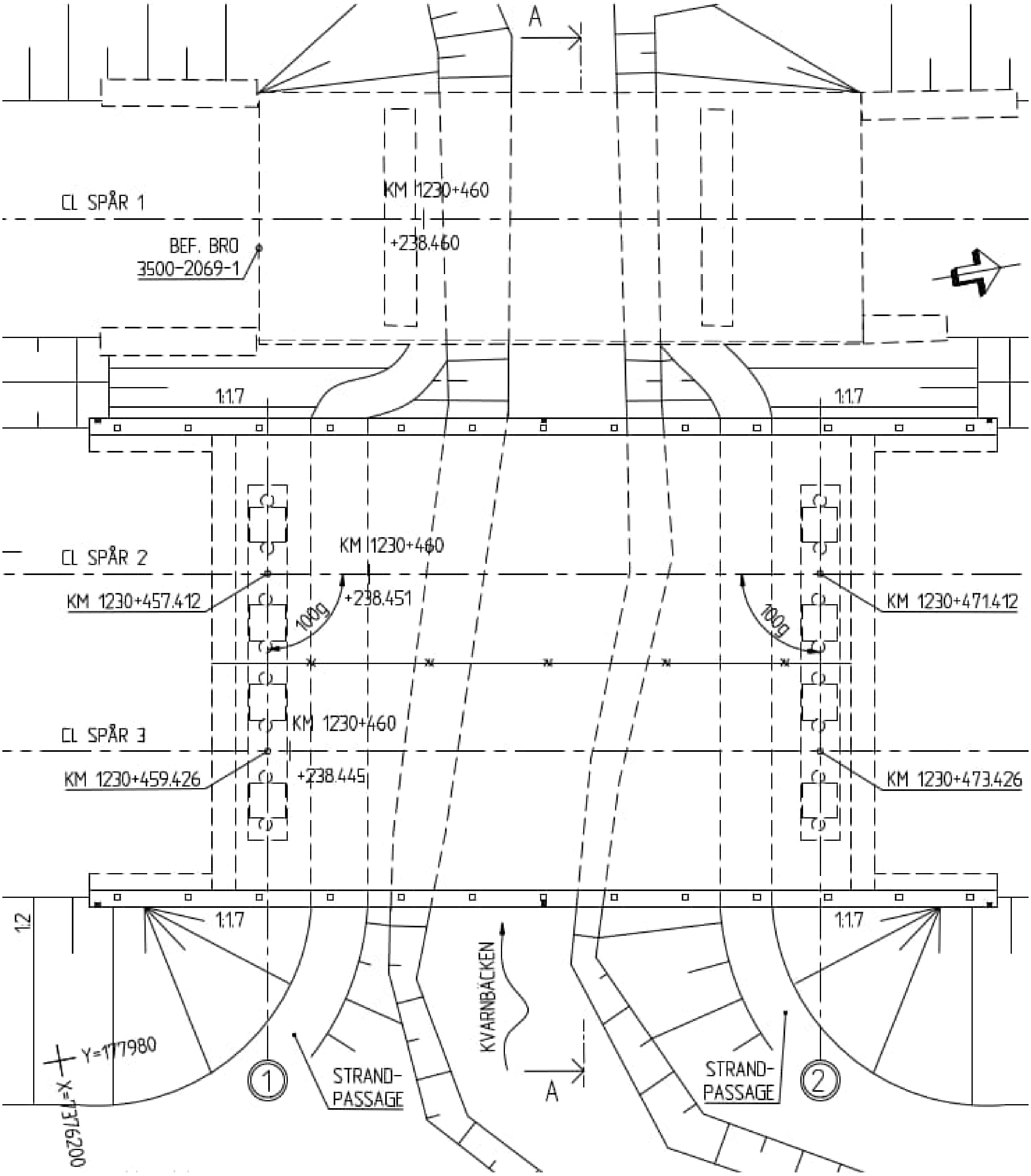
Future replacement of bearings is intended to be performed against temporary supports acting against transveral beams at location of supports.

Foundation:
Foundation is carried out with point bearing steel piles. The piles are drilled vertically.
at least 500 mm into crack-fri rock.

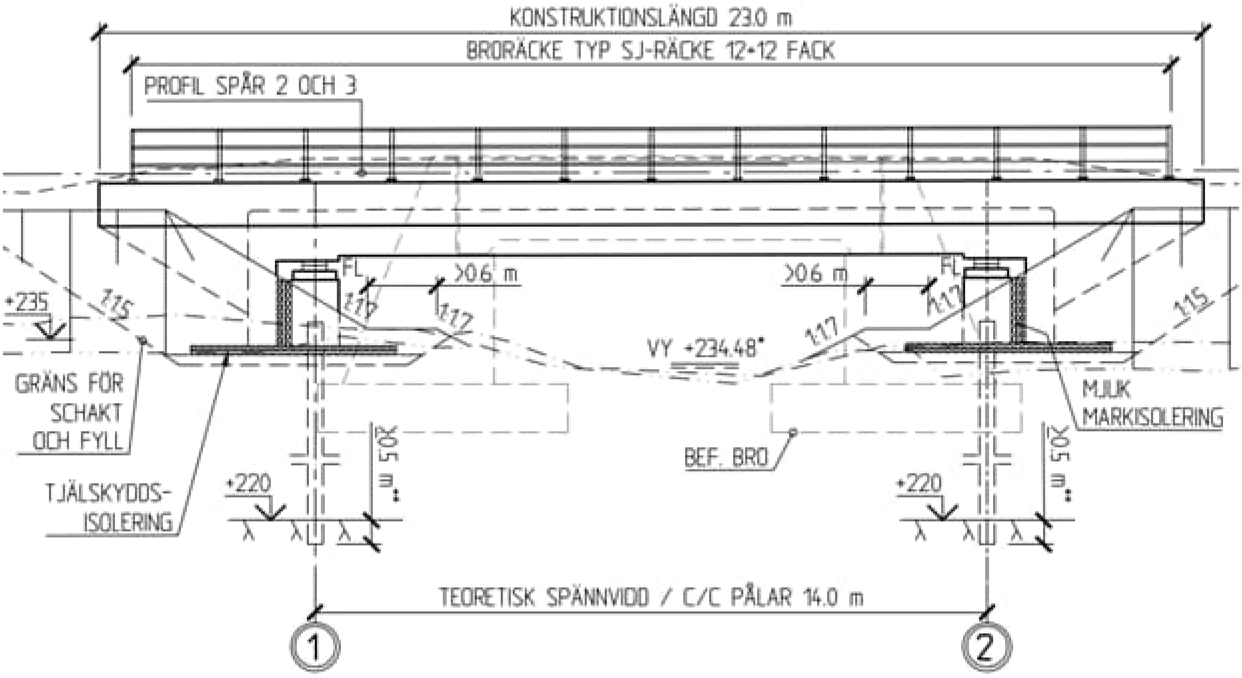
The piles are assumed to be executed as RD-piles (or equivalent) with welded joints.

1.2 MEASUREMENTS

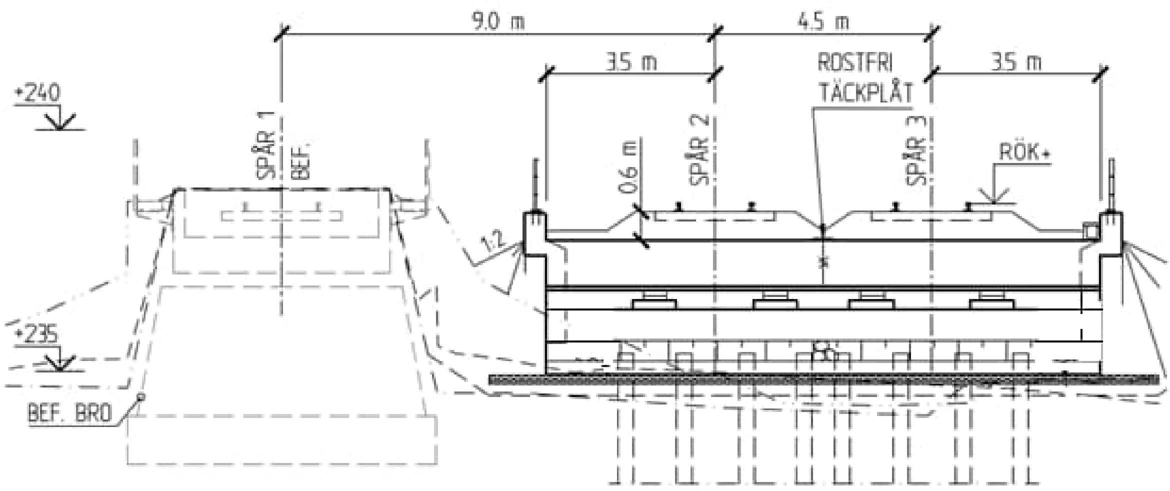
1.2.1 Theoretical geometry



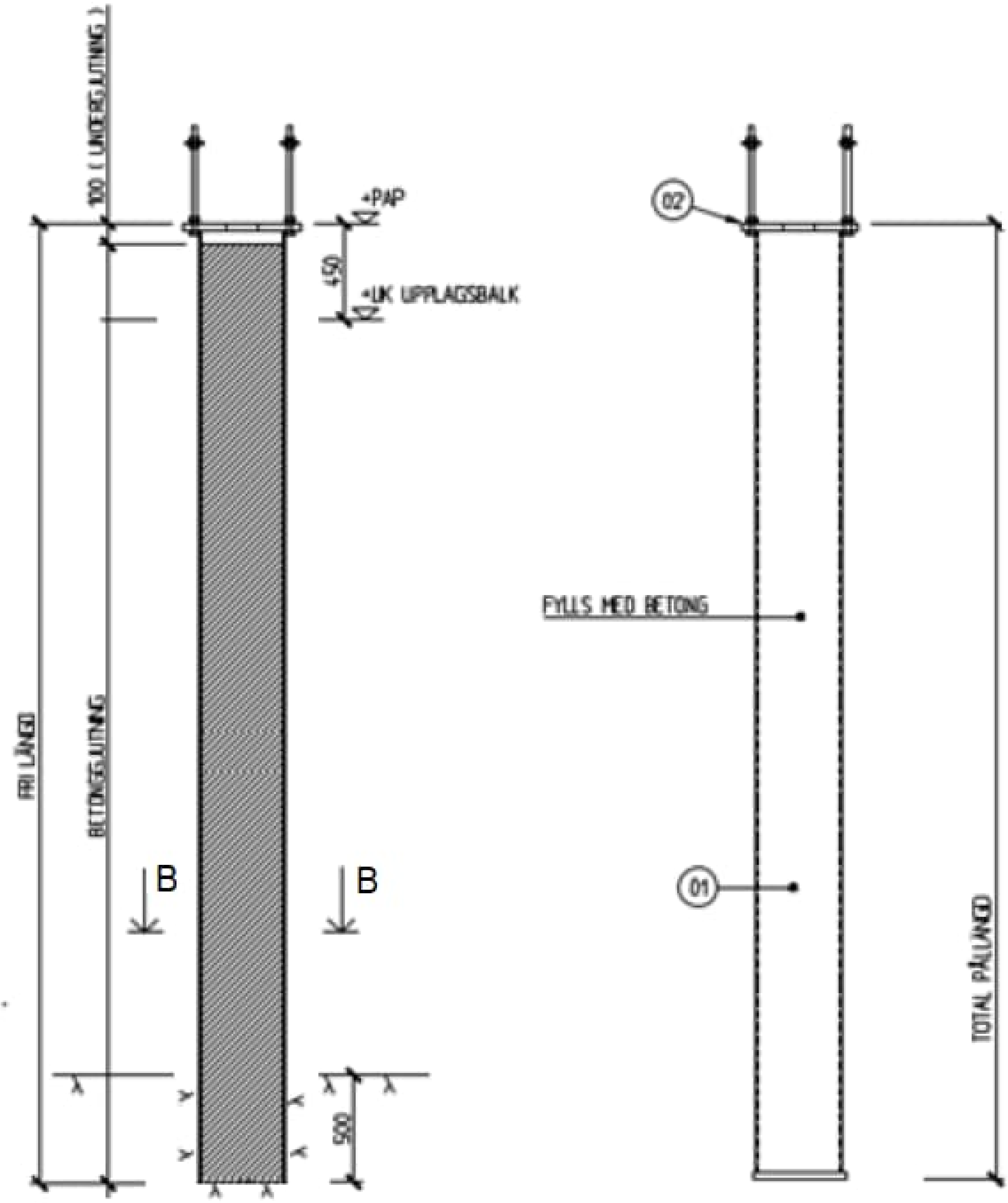
PLAN
Overview



ELEVATION



SECTION A-A

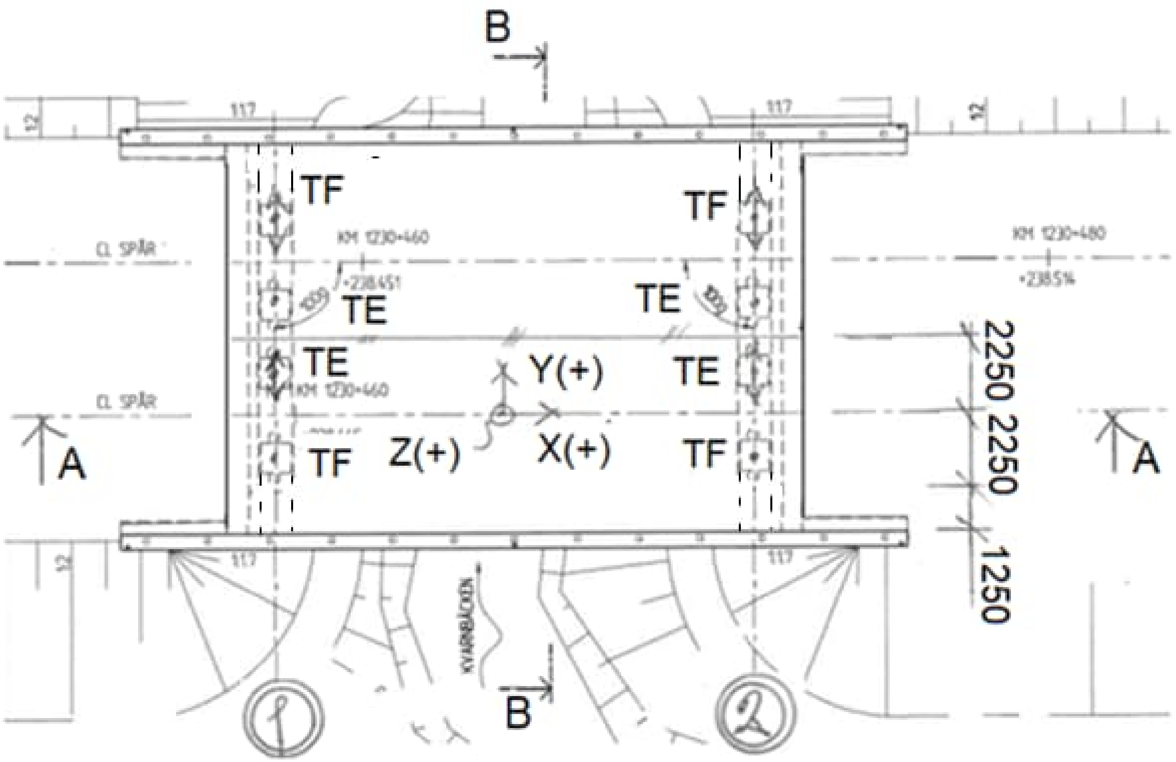


DETAIL 1

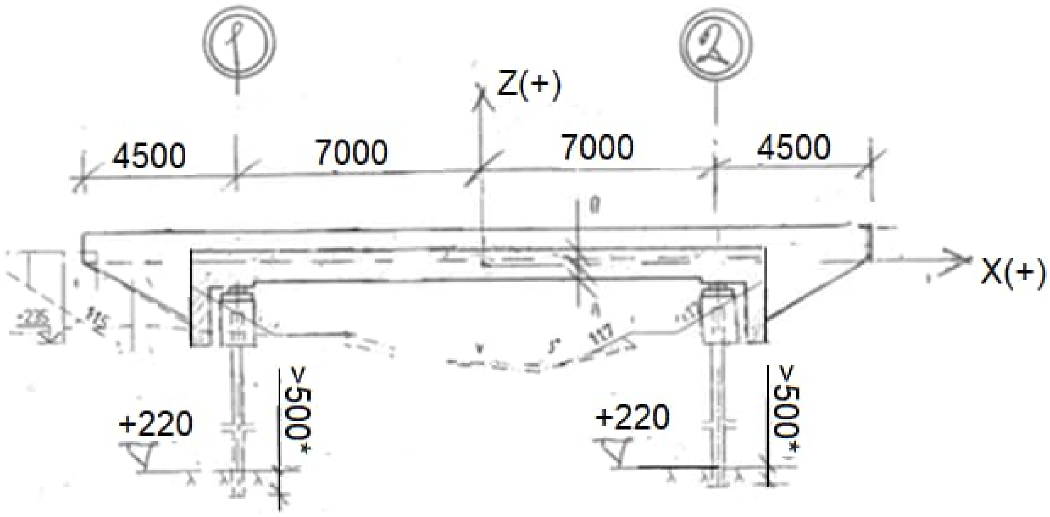
Pile assumed hinged againts rock.

SECTION B-B

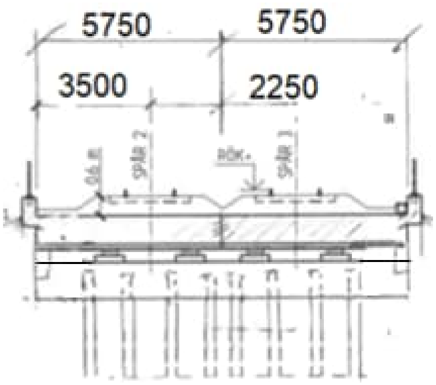
1.2.2 Simplified geometry calculations



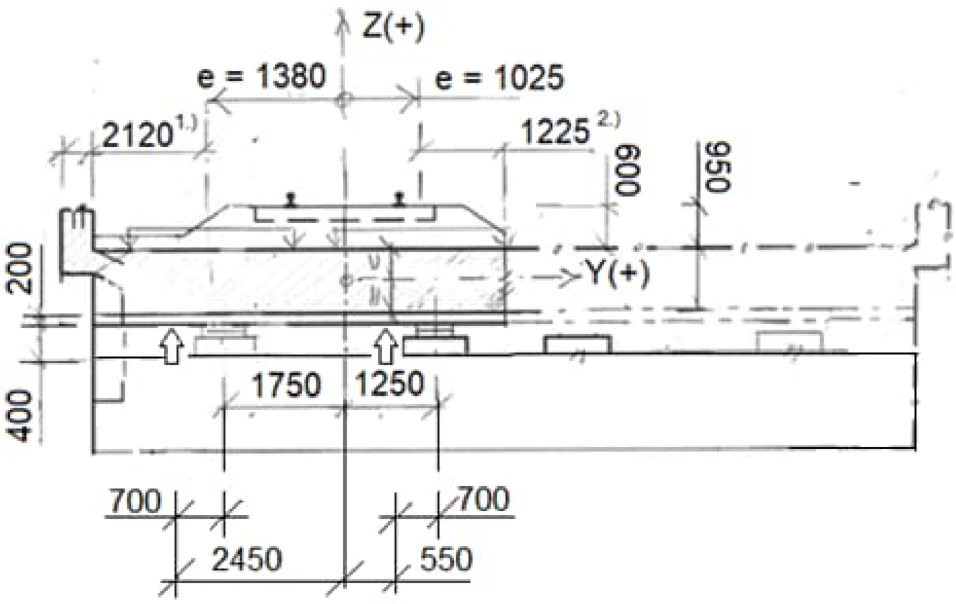
PLAN



SECTION A-A

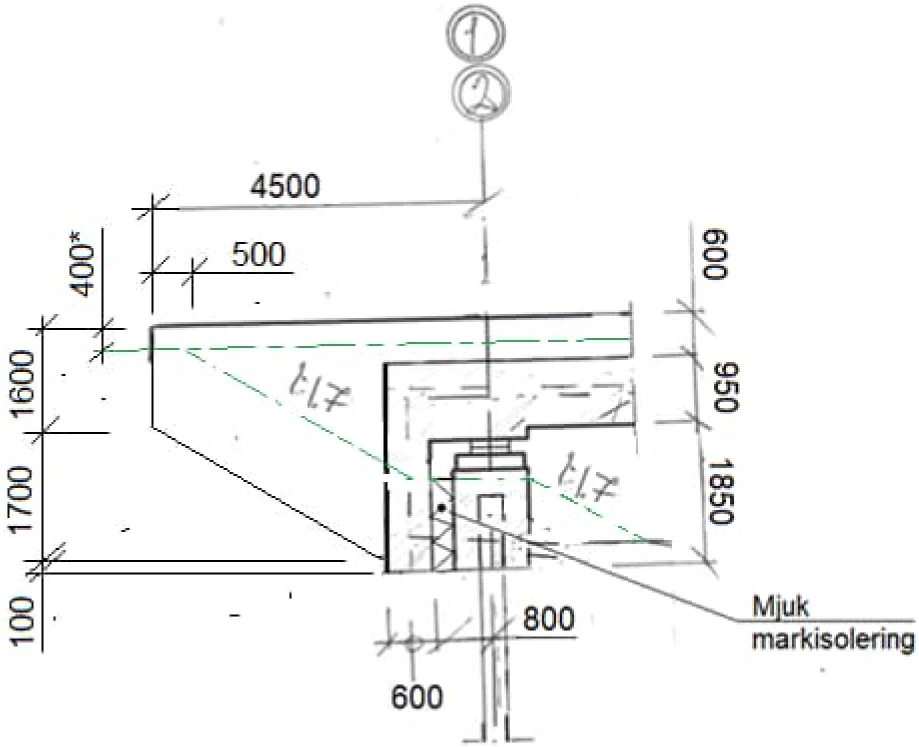


SECTION B-B



DETAIL 1
Cross section

* = applied with regard to possible tract adjustmenets.



DETAIL 2
Longitidinal

1.3 FOUNDATION

Foundation is performed using drilled point bearing steel piles RD ϕ270 x 12.5 with topp plate and permanently remaining drill bit (Symmetrix, DTH, ULTRA, MINICON or equvivalent).

	Support 1	Support 2
Section (track 22)	1230+457.4	1230+471.4
Level top of track	+238.44	+238.49
Level bottom of track	+238.24	+238.29
Level top of RC slab	+237.64	+237.69
Level bottom end-shield	+234.84	+234.89
Level bottom of bearing RC beam	+234.84	+234.89
Level top of pile	+235.44	+235.40
Level rock	+220.00	+220.00
Level bottom of pile	+219.50	+219.50
Pile length	~15	~15
-	m	m

1.4 CODE OCH TENDER DOCUMENTS

Document	Ver.	Name
TRVINFRA-00226	4.0	Bro och broliknande konstruktion, Allmänna krav
TRVINFRA-00227	4.0	Bro och broliknande konstruktion, Byggande
TRVINFRA-00229	2.0	Geokonstruktion, Administrativa regler
TRVINFRA-00230	2.0	Geokonstruktion, Dimensionering och utformning
TRVINFRA-00331	2.0	Bro och broliknande konstruktion, bärighetsberäkning
SS 137006:2015	-	Betongkonstruktioner – Utförande – Tillämpning av SS-EN 13670:2009
AMA 23	-	AMA Anläggning 23
TDOK 2023:0125	1.0	TRVAMA Anläggning 23

-

1.5 TECHNICAL SERVICE LIFE

Technical life span 20 years (L20) for railing.

Technical life span 120 years (L100) for all else.

1.6 MILJÖ

Exposure class accoring to TSFS 2018:57 section 5.3.2.3 and SS-EN 206-1. 1.

In TSFS 2021:57 figure 1.1 the road environment is defined, however does not act.

1.7 MATERIAL

1.7.1 Concrete

Concrete (see SS-EN 1992-1-1, Table 3.1):

C30/37 (f_{ck} = 30 MPa) - RC bearing beam

C35/45 (f_{ck} = 35 MPa) - all other parts

1.7.2 Reinforcement

Material coefficients see SS-EN 1992-1-1:

γ_s	1,15	[SS-EN 1992-1-1, 2.4.2.4]
$\gamma_{s,fat}$	1,15	[SS-EN 1992-1-1, 2.4.2.4]
$\gamma_{s,Exc}$	1,0	[SS-EN 1992-1-1, 2.4.2.4]

Reinforcement K500-CT:

f_{yk}	500 MPa	[SS-EN 10080:2005]
E_{sk}	200 GPa	[SS-EN 10080:2005]
$\Delta\sigma_{Rsk}$	162,5 MPa	[SS-EN 1992-1-1, Tabele 6.3N]

1.7.3 Steel pile

Steel pile RDTϕ320 x 12.5 with top plate and permanently remaining drill bit (Symmetrix, DTH, ULTRA, MINICON or equvialent) with properties seen below.

Steel pile: S550 J2H (f_{yk} = 550 MPa)

Top plate: S355 J2 (f_{yk} = 345 MPa)

Concrete (inside): C35/45

1.7.4 Soil material

Ballast:
Ballast of makadam according to AMA DCH.31 (requirements of material see TRVINFRA-00019) with thickness 0.6 m from bottom of track (minimum requirements see TDOK 2015:0198).
TRVINFRA-00230 tables A1-1 and A1-4 gives material properties ϕ_k = 45°, $\gamma = 17\frac{kN}{m^3}$,
$\gamma' = 11\frac{kN}{m^3}$ and E_k = 50 MPa.

Under ballast:
Under ballast of blasted rock according to AMA DCH.15 with thickness 1.0 m is assumed (minimum requirement 0.8 m according to TDOK 2015:0198).
TRVINFRA-00230 tables A1-1 and A1-4 gives material properties ϕ_k = 45°, $\gamma = 19\frac{kN}{m^3}$,
$\gamma' = 13\frac{kN}{m^3}$ and E_k = 50 MPa.

Backfill:
Coarse crushed blasted rock according to AMA CEB.524 is used to level of under ballast.
TRVINFRA-00230 tables A1-1 and A1-4 gives material properites ϕ_k = 45°, $\gamma = 20\frac{kN}{m^3}$,
$\gamma' = 13\frac{kN}{m^3}$ and E_k = 50 MPa.

1.8 GEOTECHNICAL CLASS

Geotechnical class GK2.

1.9 SAFETY CLASS

Safety class according to TSFS 2018:57 chapater 2 table 2.1 and TRVINFRA-00227 section 7.1.2.

Geotechnical resistance: SK 2

Wingwall: SK 2

Bridge structure: SK 3

1.10 TB OCH SPRICKKRITERIER

TRVINFRA-00227 section 5.3.2.1 states use SS-EN 206:2013+A1:2016.

Class identification bridge components :

Construction part	Exposure class[1.)]	Life span	max vct_{ekv}[2.)]	ζ[3.)]
Substructure				
▫ Wingwall towards filling	XC2/XF3	L100	0.50	1.0
▫ Wingwall from filling	XC4//XF3	L100	0.50	1.2
▫ Endshield towards filling	XC2/XF3	L100	0.50	1.0
▫ Endshield from filling	XC4/XF3	L100	0.50	1.2
▫ Bottom support beam	XC2/XF3	L100	0.50	1.0
▫ Other parts parts support beam	XC2/XF3	L100	0.50	1.0
Superstructure:				
▫ Edge beam	XC4/XF3	L100	0.50	1.2
▫ Bridge deck	XC4/XF3	L100	0.50	1.2

Footnotes:

1.) TRVINFRA-00227 section 5.3.2.3

2.) TSFS 2018:57 table 12.1

3.) TSFS 2018:57 table 12.3

Concrete strength classes :

Construction part	Concrete	vct_{ekv}
Support beam	C30/37	0.50
Other parts of bridge	C35/45	0.40

Design parameters low corrosion sensitive reinforcement (rebars):

$c_{min.dur}$: minimum cover with regard to environmental impact

$c_{min.b}$: minimum cover with regard to adhesion requirements
Δc_{dev} : execution tolerance
$c_{min} = \max(c_{min.b}; c_{min.dur}; 10mm)$: SS-EN 1992-1-1 eq. 4.2
$c_{nom} = c_{min} + \Delta c_{dev}$: SS-EN 1992-1-1 eq. 4.1, noted as BM on the drawing

Construction parts	$c_{min.dur}$ 1.)	$c_{min.b}$ 2.)	c_{min}	Δc_{dev} 3.)	c_{nom}	$w_{k,till}$ 4.)
Substructure						
▫ Wingwall towards filling	20	20	20	10	30	0.40
▫ Wingwall from filling	25	20	25	10	35	0.30
▫ Endshield towards filling	20	20	20	10	30	0.40
▫ Endshield from filling	25	20	25	10	35	0.30
▫ Bottom support beam	20	20	20	10	45 5.)	0.40
▫ Other parts parts support beam	20	20	20	10	30	0.40
Superstructure:						
▫ Edge beam	25	20	25	10	35	0.30
▫ Bridge deck	25	20	25	10	35	0.30
	mm	mm	mm	mm	mm	mm

Fotnotes:
1.) TSFS table 12.1
2.) SS-EN 1992-1-1 section 4.4.1.2 table 4.2
3.) SS-EN 1992-1-1 section 4.4.1.3
4.) TSFS table 12.2
5.) TSFS chapter 12 section 2§ $k_1 = c_{min}$ + 15 mm when casting against building foil.

2. SYSTEM ANALYSIS

2.1 GENERAL

Bron är en slakarmerad plattbro med ändskärm som tillverkas rak.

Bron grundläggs på borrade spetsburna vertikala stålrörspålar. Dessa förutsätts ledat anslutna i berg.

Två olika systemberäkningar ett betecknad primärt (överbyggnad) statiskt system och sekundär (pålelement).

The bridge is a reinforced concrete slab bridge with end abutments, constructed straight.

The bridge is founded on drilled steel piles. These are assumed to be hinged against rock.

Two different system calculations, one designated primary (superstructure) static system and secondary (pile element).

2.1.1 Primary analysis (superstructure)

The superstructure is divided by longitudinal expansion joint at centre. However, this does not apply to the substructure.

Edge beams are not considered to contribute any stiffness, but only as load.

Wingwalls are not modelled in the static model; they are considered statically inactive in the vertical plane. This is because stiffness in vertical direction is considered negligible due to cracking. Minimum reinforcement is used to limit the crack width. Wingwalls are replaced with line loads in the static model.

Traffic load evaluation is performed using the FEM-program function Moving Load Analysis.

The bridge deck and abutments consist of high-node shell elements (QTS8). These shell elements are modelled with isotropic material properties corresponding to uncracked concrete in all areas except for the bridge deck locally over each transverse beam. In this area, orthotropic shell elements without stiffness in the transverse direction are used. This is because the transverse beams replace this stiffness.

Transversal beams at supports are modelled as 3D beam elements (BMX21). These beam elements are modelled with isotropic material properties corresponding to uncracked concrete.

To achieve correct load distribution in the bridge deck, the fixed bearing (TF) at support 2 is replaced with a movable bearing (RX). The unilaterally movable bearing (TE) is also replaced with an all-sided movable bearing (TA).

Attachments:

Attachment	Name
1	Input receipt
2	Results bearing forces
3	Results bridge deck incl. end-shield
4	Results transversal beams at supports

2.1.2 Secondary analysis (steel piles)

See separate presentation, pile design.

2.2 SKETCH SYSTEM ANALYSIS

There are 2 static systems. The primary (superstructure) and secondary (pile elements).

The secondary static system is described in calculation section B (Foundation).

This section only describes the primary static system.

To describe geometry first POINTS are defined.

Beam elements are defined by applying attributes to LINES.

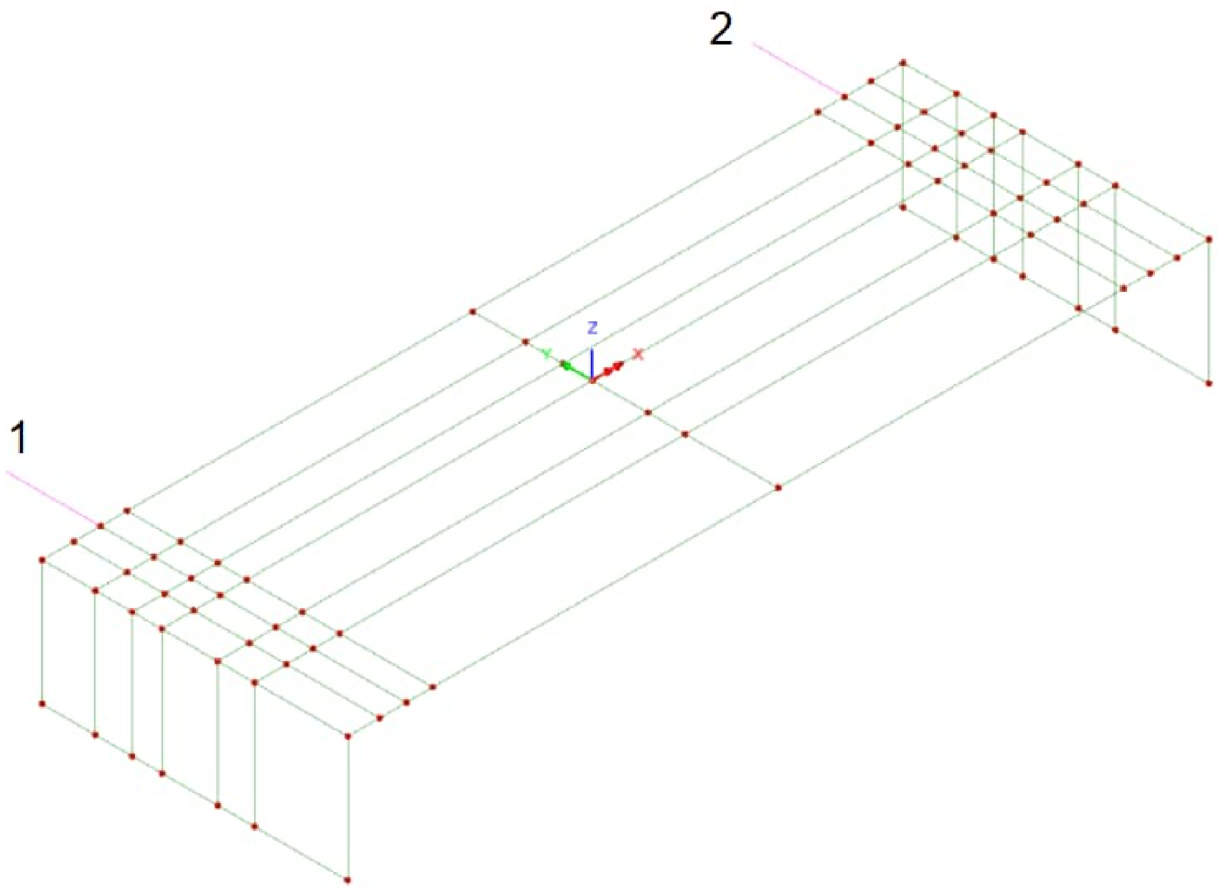
Shell elements are defined by applying attributes to SURFACES.

Attached pictures are retrieved from graphical sketches generated by FEM-programof POINTS, LINES and SURFACES.

All coordinates needed to describe POINTS are found in attachment 1.

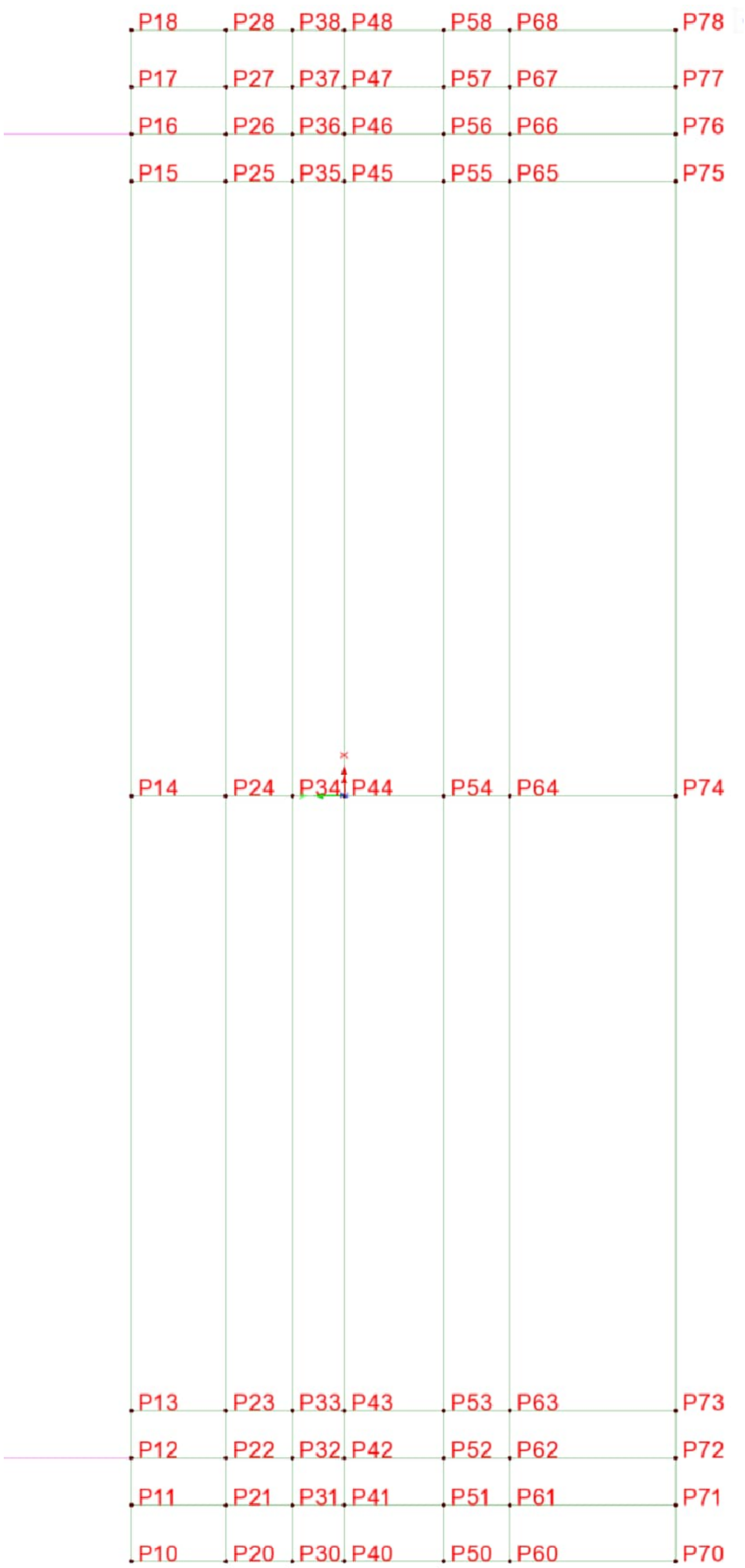
All POINTS needed to describe LINES are found in attachment 1.

All LINES need to describe SURFACE are found in attachment 1.

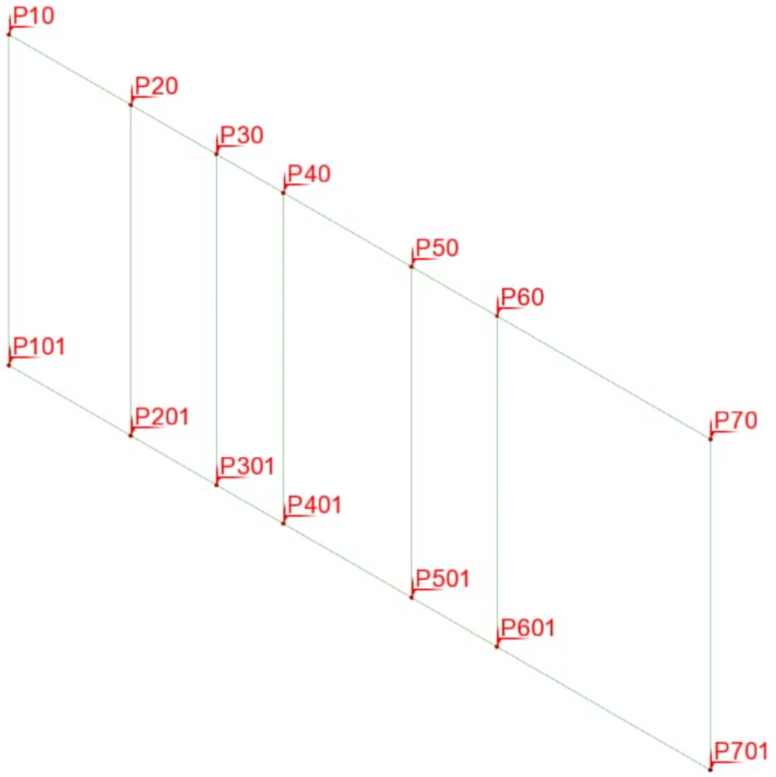


<u>Overview 3D</u>
Geometry

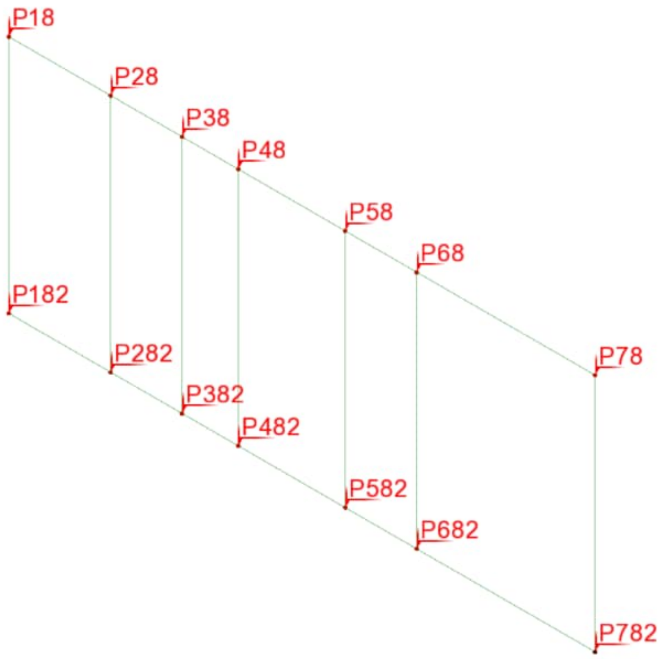
2.2.1 Geometry : POINTS



Bridge deck

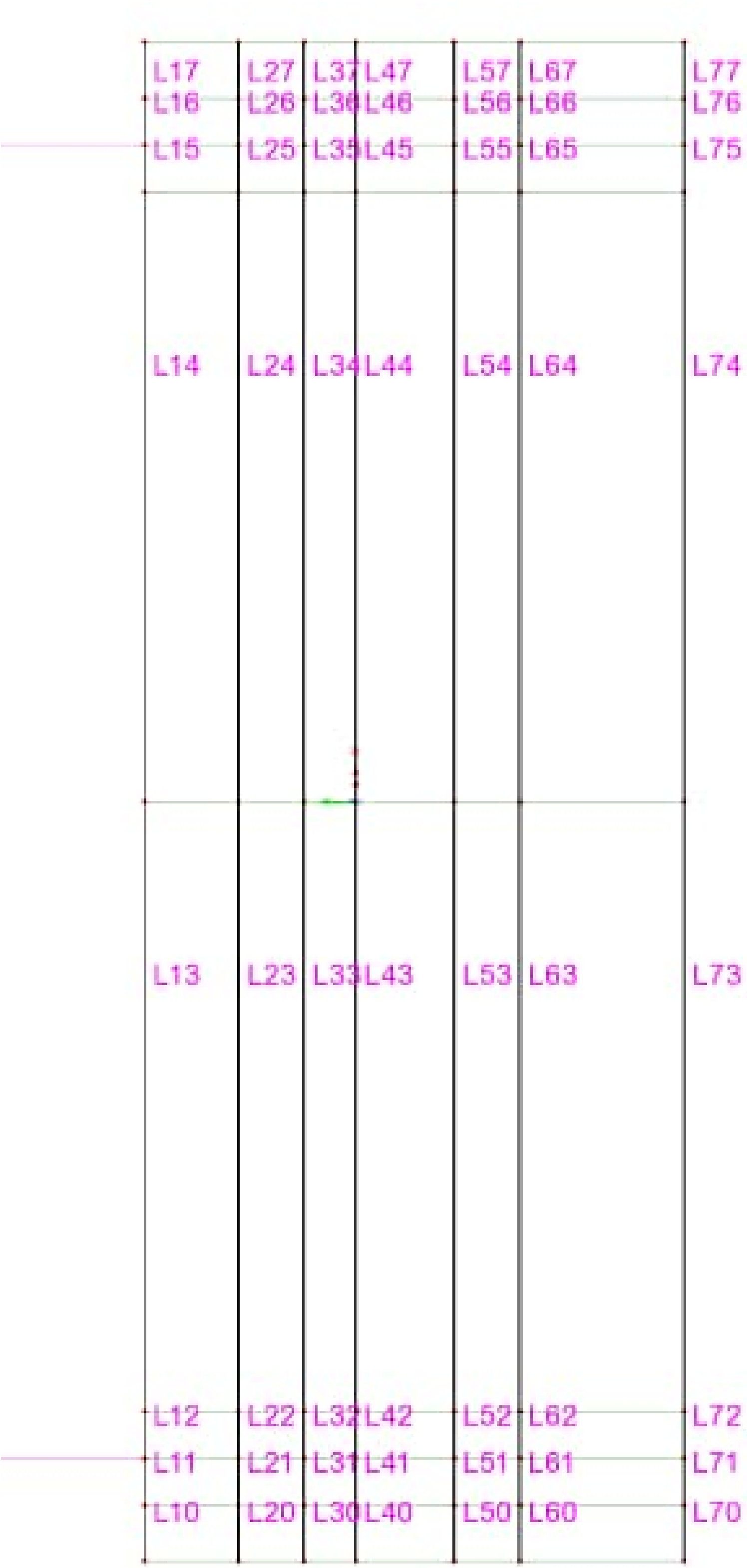


End shield – support 1

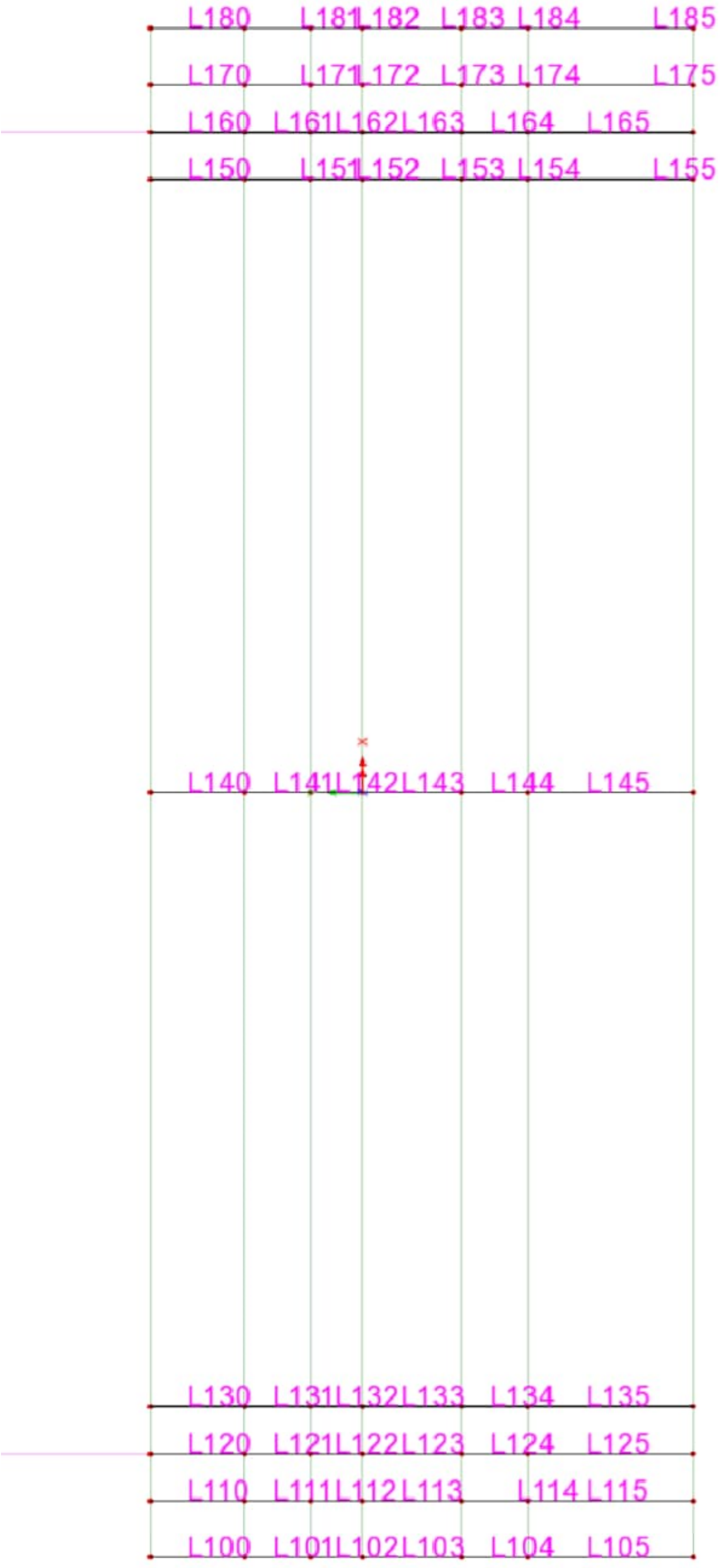


End shield - support 2

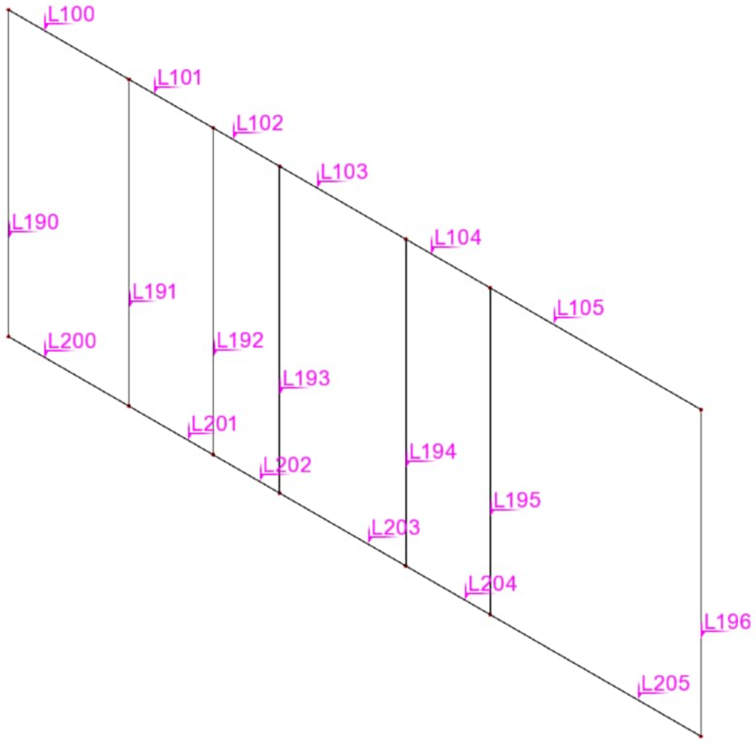
2.2.2 Geometry : LINES



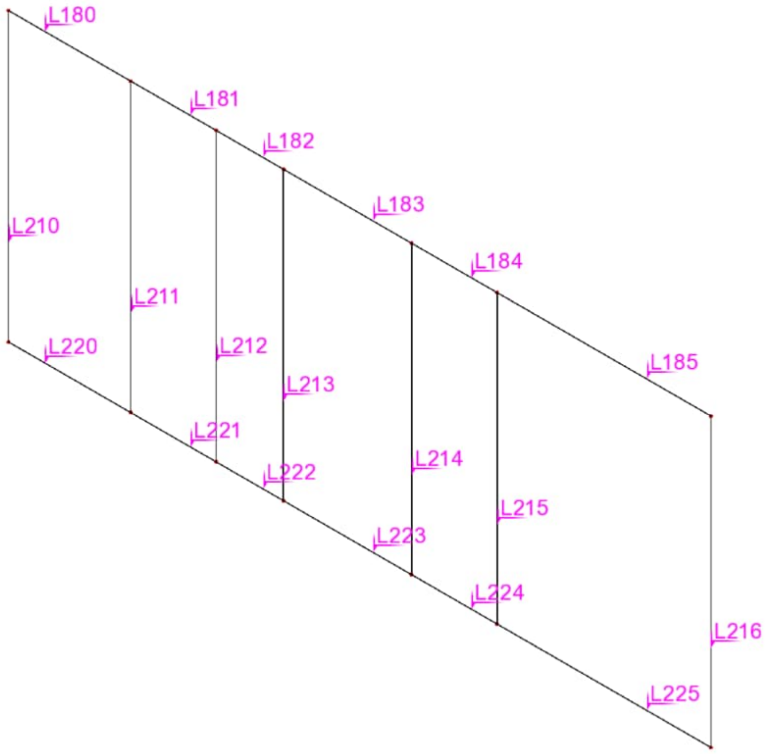
Bridge deck
Longitudinal lines



<u>Bridge deck</u>
Transversal lines

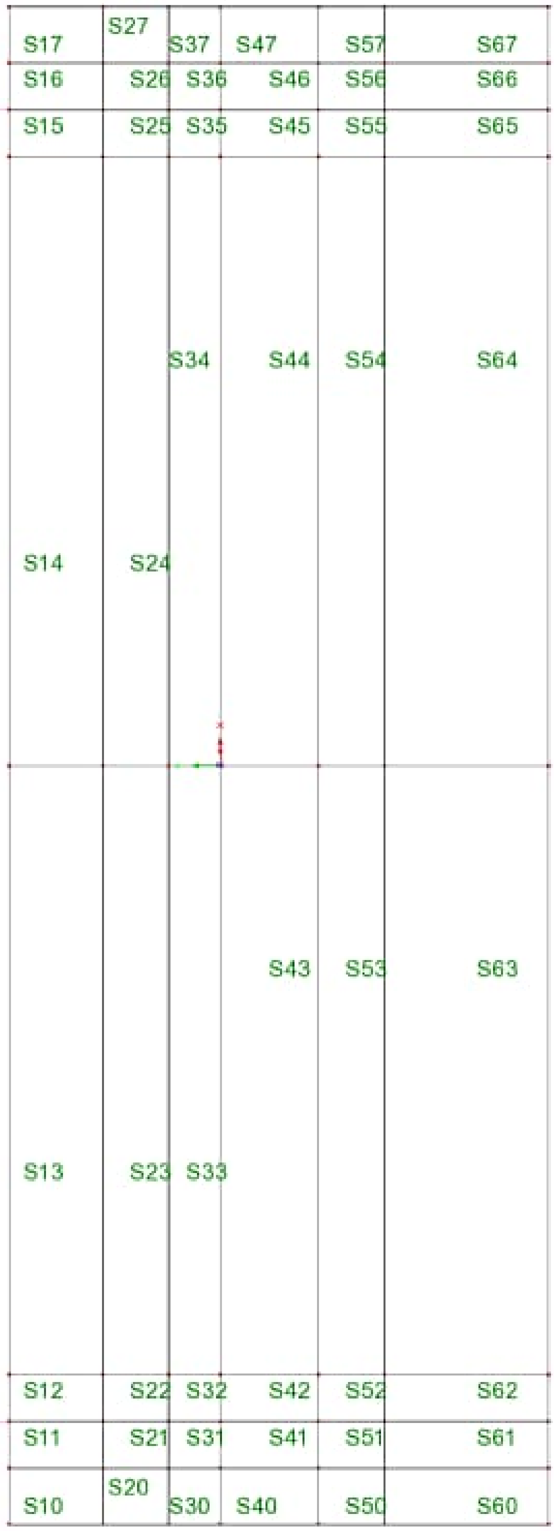


End shield - support 1

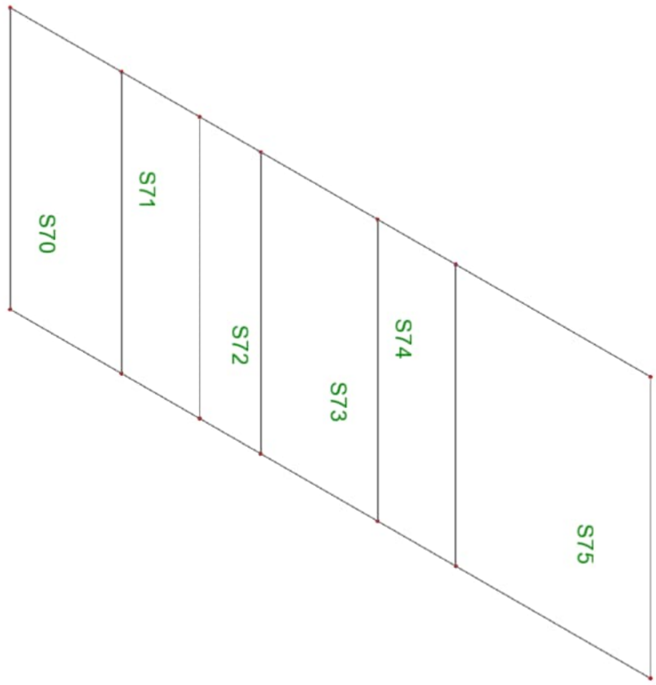


End shield – support 2

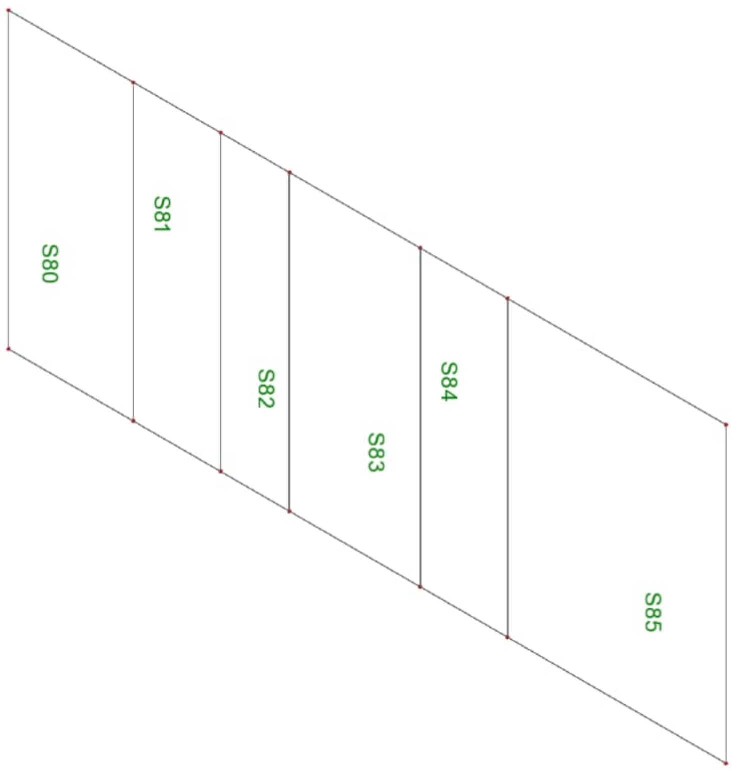
2.2.3 Geometry : SURFACES



Bridge deck



End shield – support 1



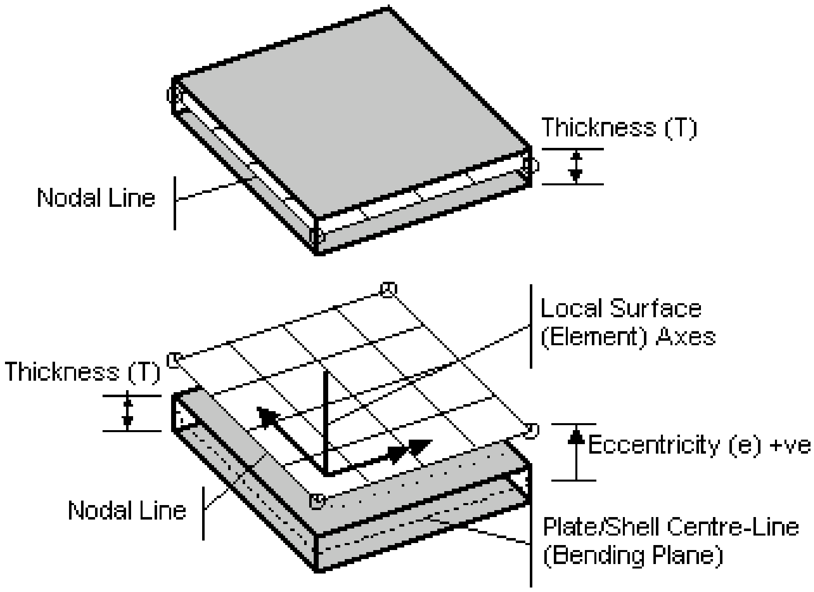
End shield – support 2

2.3 CROSS SECTION PROPERTIES

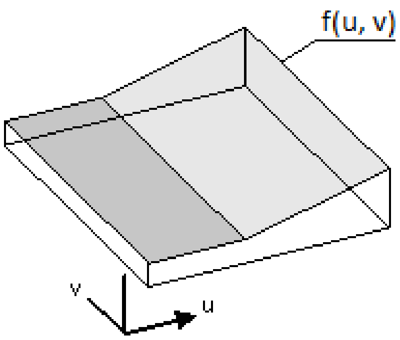
There are 2 different types of constructions – shell elements and beam elements. Geometric properties are applied to these.

2.3.1 Shell element

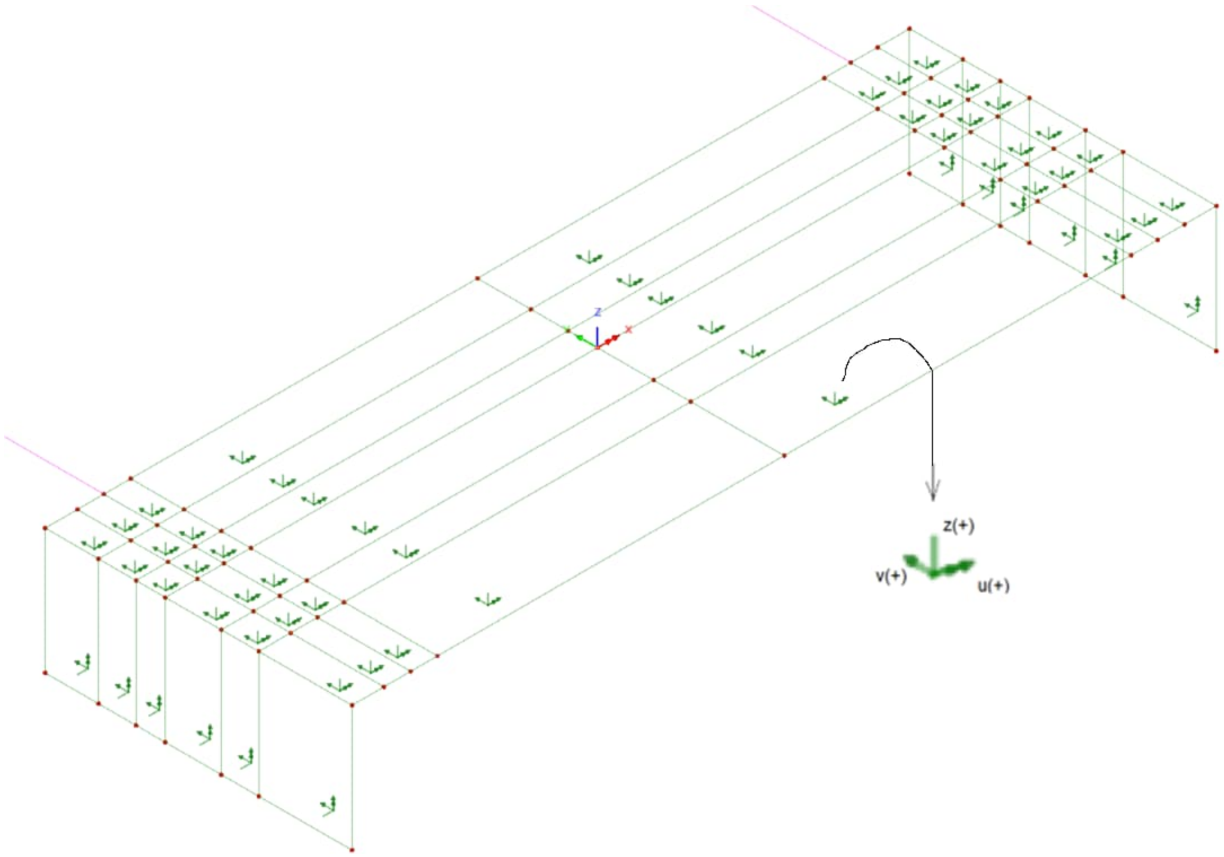
Principle figures of geometry associated to shell elements (”Thick shell” / QTS4) are seen below.



Varying thickness in shell element is handled using ”Function variation”. This makes it possible to create a function f(u,v) as seen below.



Local coordinate system (u,v) according to sketch below:

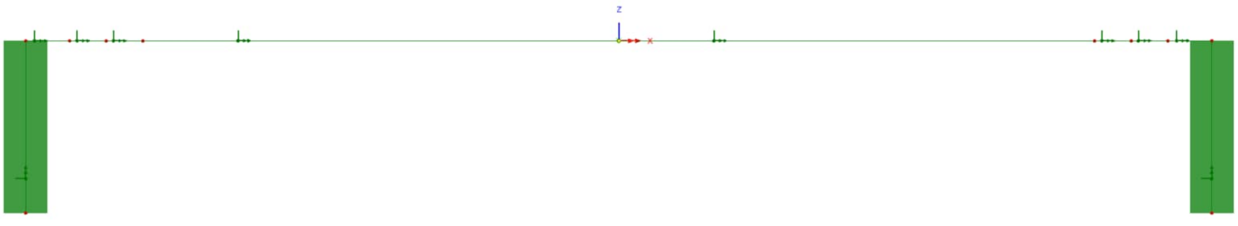


Surface geometry :

Attribute	t	ez	Remark
t = 0.95 m	0.95	0	Bridge deck
t = 0.60 m	0.60	0	End shield
-	m	m	-

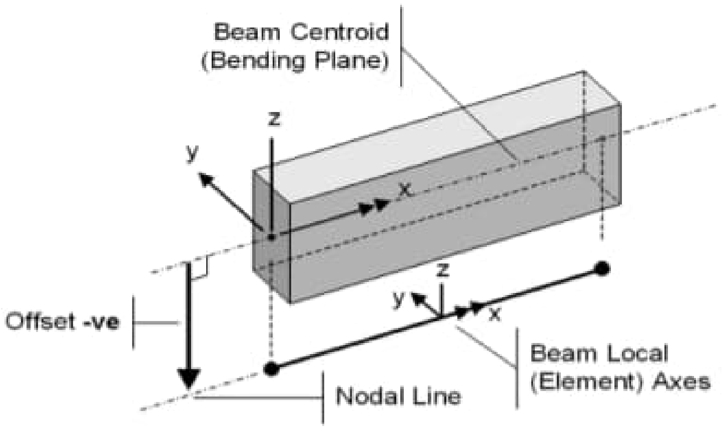
Bridge deck:

End shields:

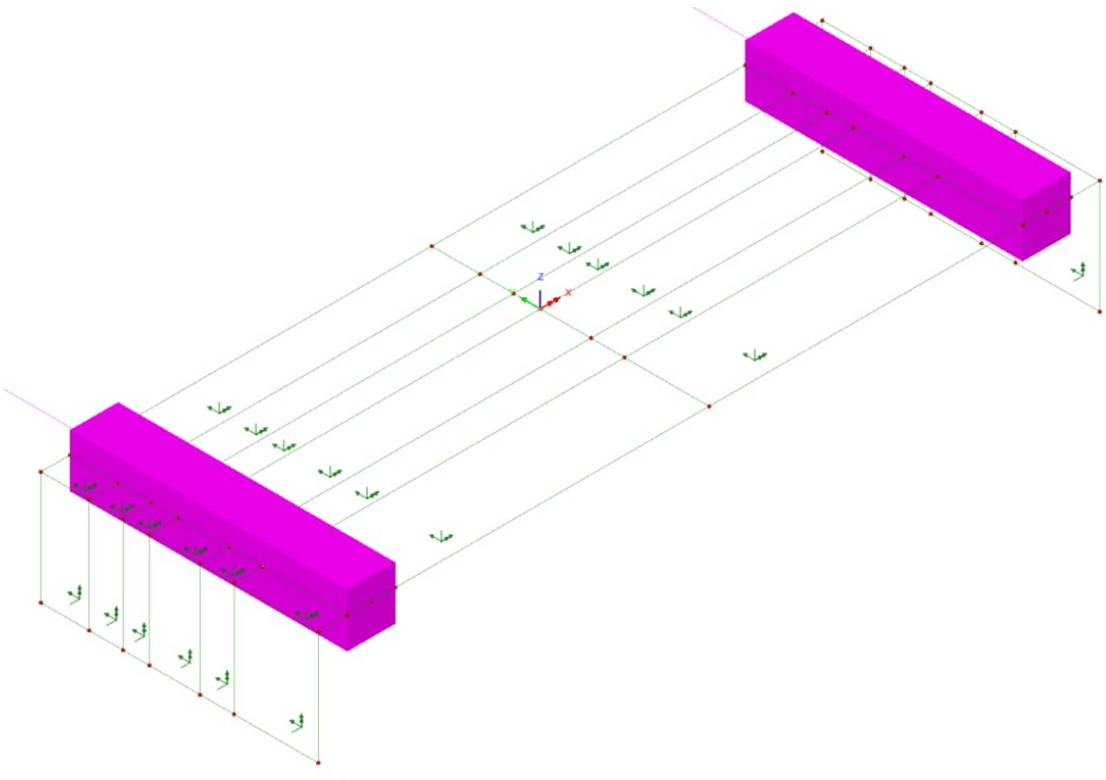


2.3.2 Beam elememts

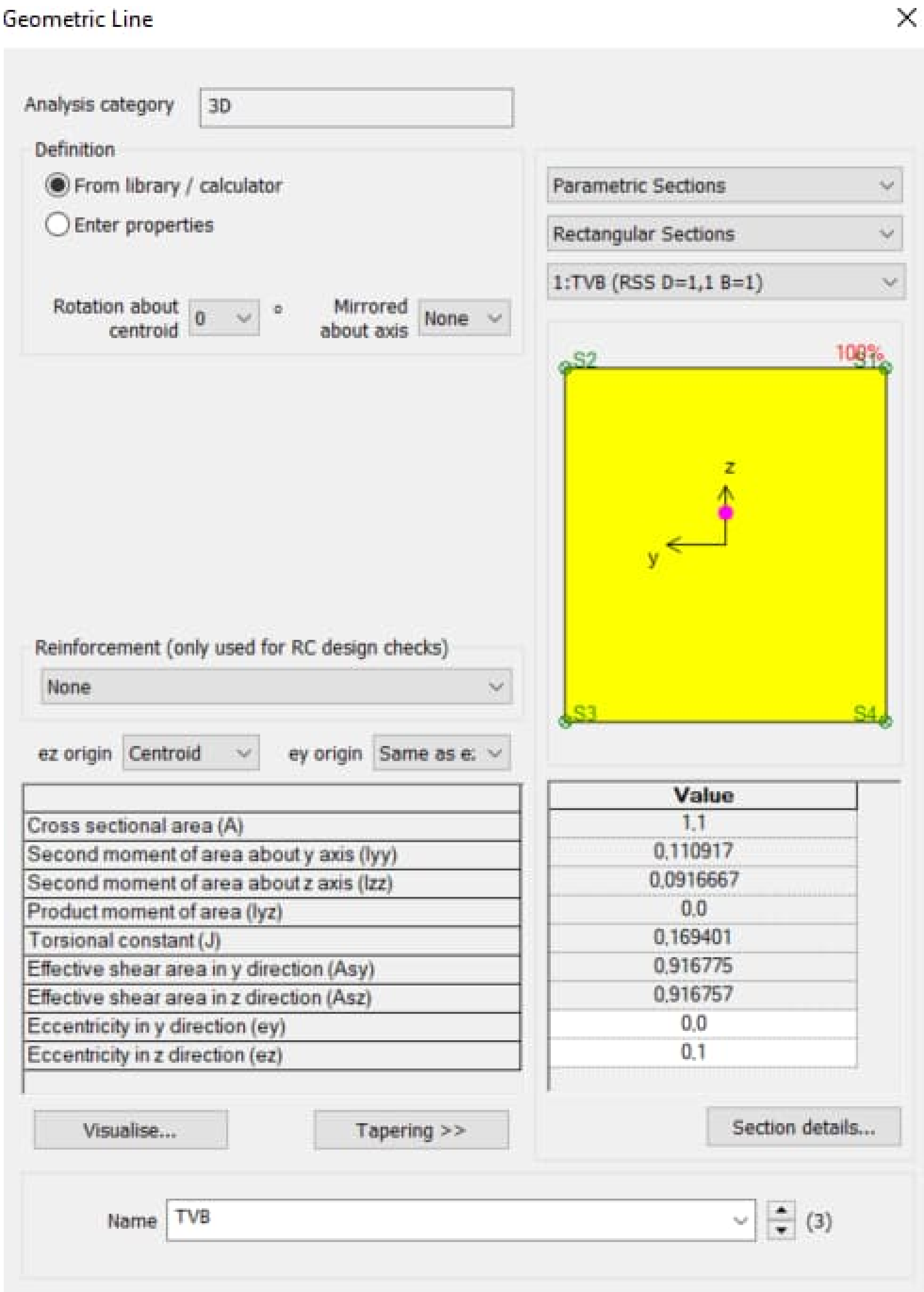
Principal sketch of geometry associated to 3D beam elements (”Thick beam” BMX21) are seen below.



Transversal beam (TVB) is added at both supports .



Overview
Transversal beams



Geometric Line
Analysis category
3D
Definition
From library / calculator
Enter properties
Rotation about centroid
0
Mirrored about axis
None
Parametric Sections
Rectangular Sections
1:TVB (RSS D=1,1 B=1)
S2
100%
S1
z
y
S3
S4
Reinforcement (only used for RC design checks)
None
ez origin
Centroid
ey origin
Same as e:
Value
Cross sectional area (A)
1,1
Second moment of area about y axis (Iyy)
0,110917
Second moment of area about z axis (Izz)
0,0916667
Product moment of area (Iyz)
0,0
Torsional constant (J)
0,169401
Effective shear area in y direction (Asy)
0,916775
Effective shear area in z direction (Asz)
0,916757
Eccentricity in y direction (ey)
0,0
Eccentricity in z direction (ez)
0,1
Visualise...
Tapering >>
Section details...
Name
TVB
(3)

2.4 MATERIAL

Material properties seen below are to be used for all parts.

Concrete C35/45 : E_{cm} = 34 GPa

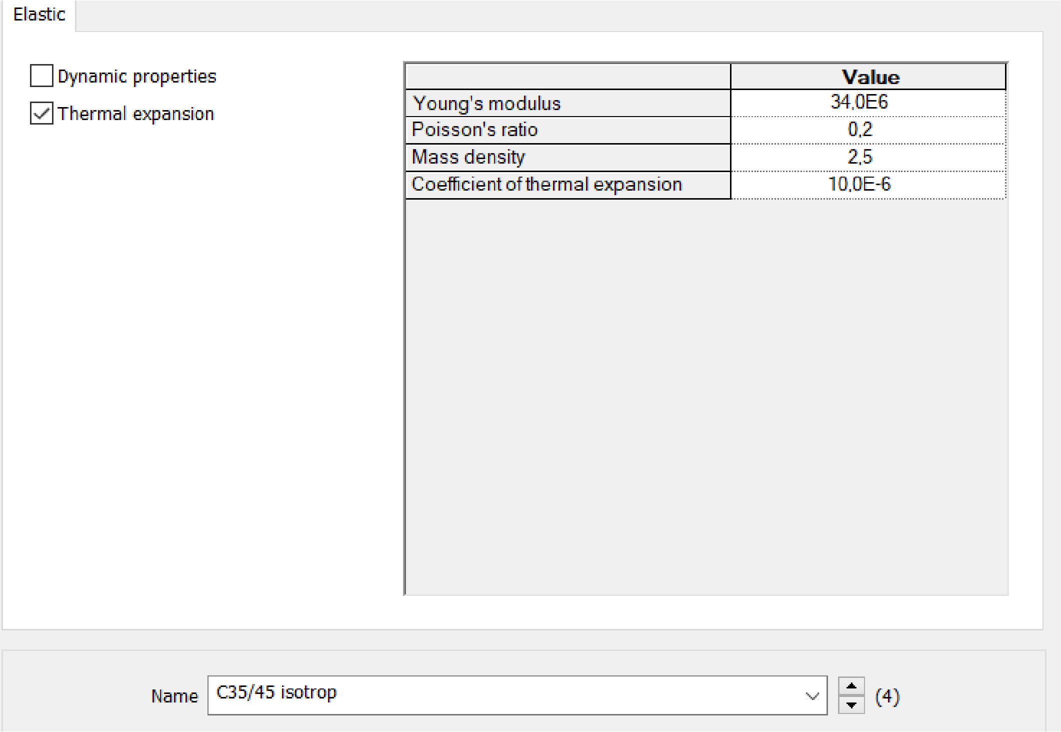
- Shell element a location of transversal beam at supports (TVB) → orthotropic weightless concrete C35/45
- All other shell elements → isotropic concrete C35/45
- Transversal beams (TVB) → isotropic concrete C35/C45

Remark

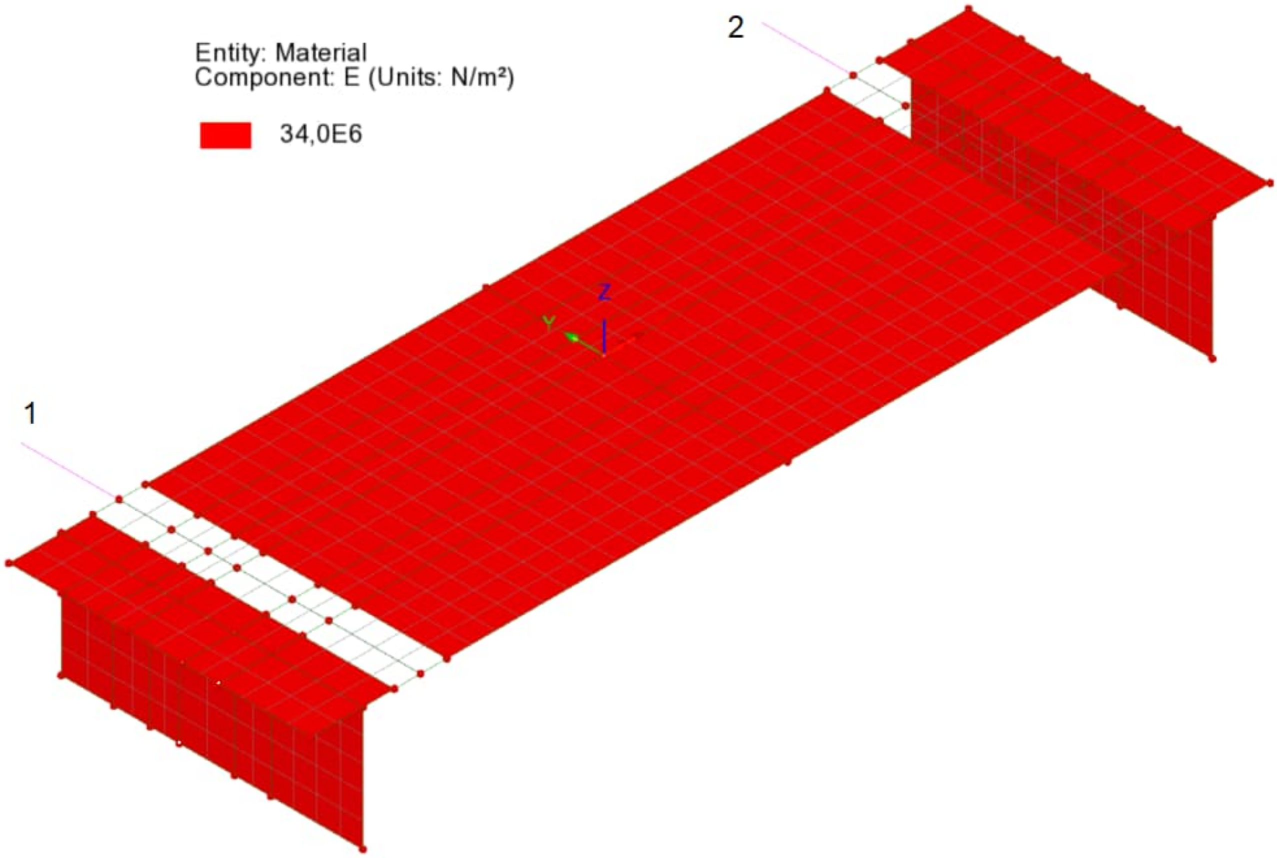
The orthotropic shell elements are used to avoid considering stiffness and weight in the transverse direction when already included in the transversal beams.

2.4.1 Material: Isotropic concrete C35/45

$E = 34 \cdot 10^3$ MPa



	Value
Young's modulus	34,0E6
Poisson's ratio	0,2
Mass density	2,5
Coefficient of thermal expansion	10,0E-6



<u>Overview</u>
Material *C35/45 Isotropic*

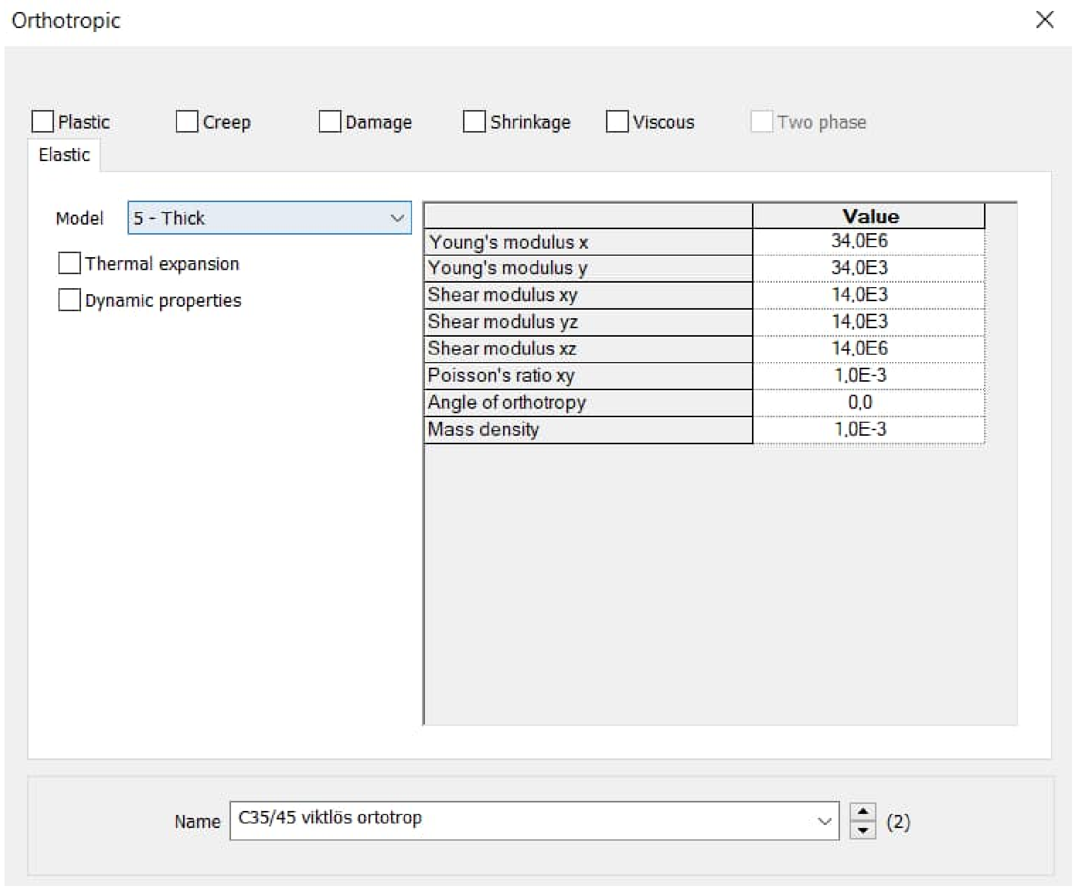
2.4.2 Material: Orthotropic concrete C35/45

The orthotropic concrete has negligible stiffness in the transverse direction (Y-direction). The negligible stiffness is modelled as $E_{cm}/1000$. The material is also modelled as weightless. The material is used locally over the transverse beams (TVB) in order to ensure that the weight and stiffness of the bridge deck are not considered for either shell elements or beam elements.

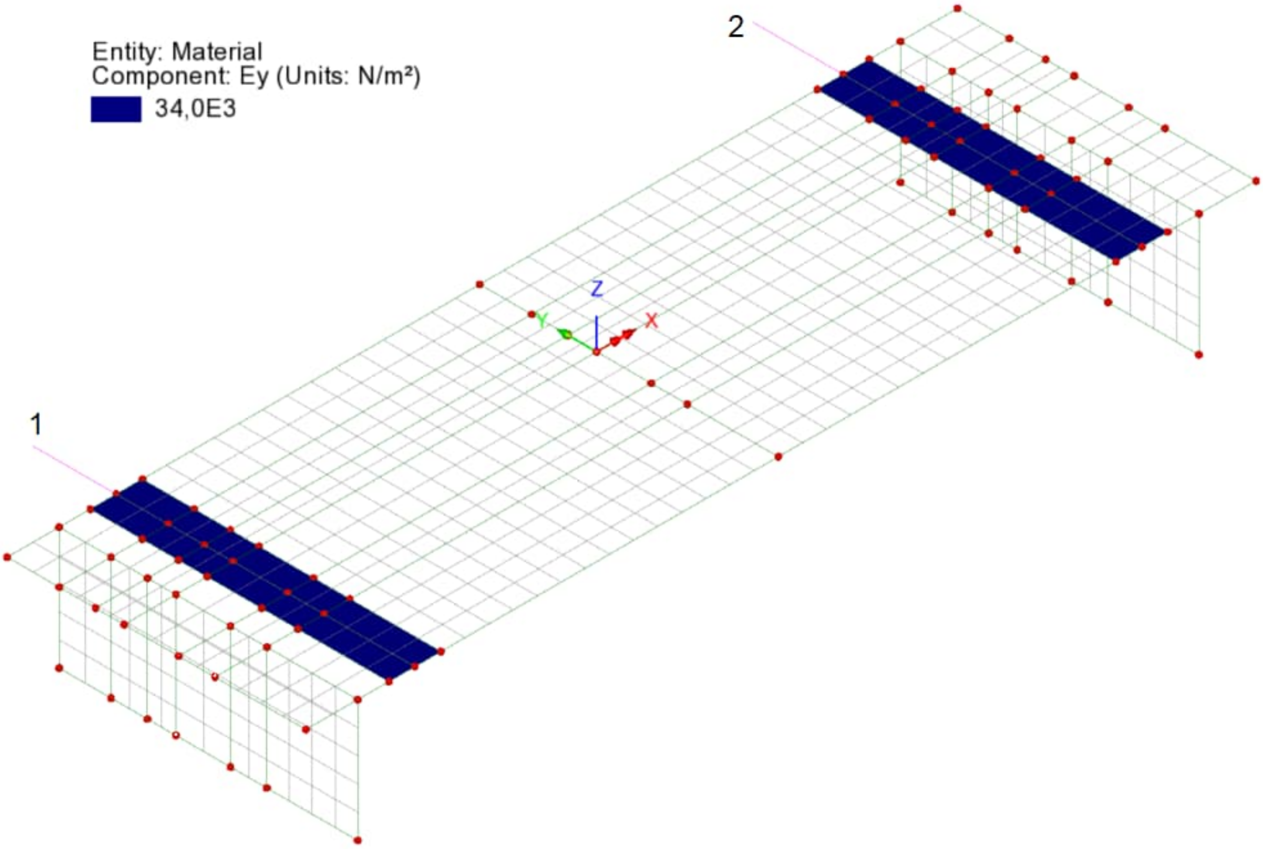
The material is applied only to shell elements within an area of 1.0 m at each support line.

$E_x = 34 \cdot 10^6$ kPa

$E_y = 34 \cdot 10^3$ kPa



	Value
Young's modulus x	34,0E6
Young's modulus y	34,0E3
Shear modulus xy	14,0E3
Shear modulus yz	14,0E3
Shear modulus xz	14,0E6
Poisson's ratio xy	1,0E-3
Angle of orthotropy	0,0
Mass density	1,0E-3



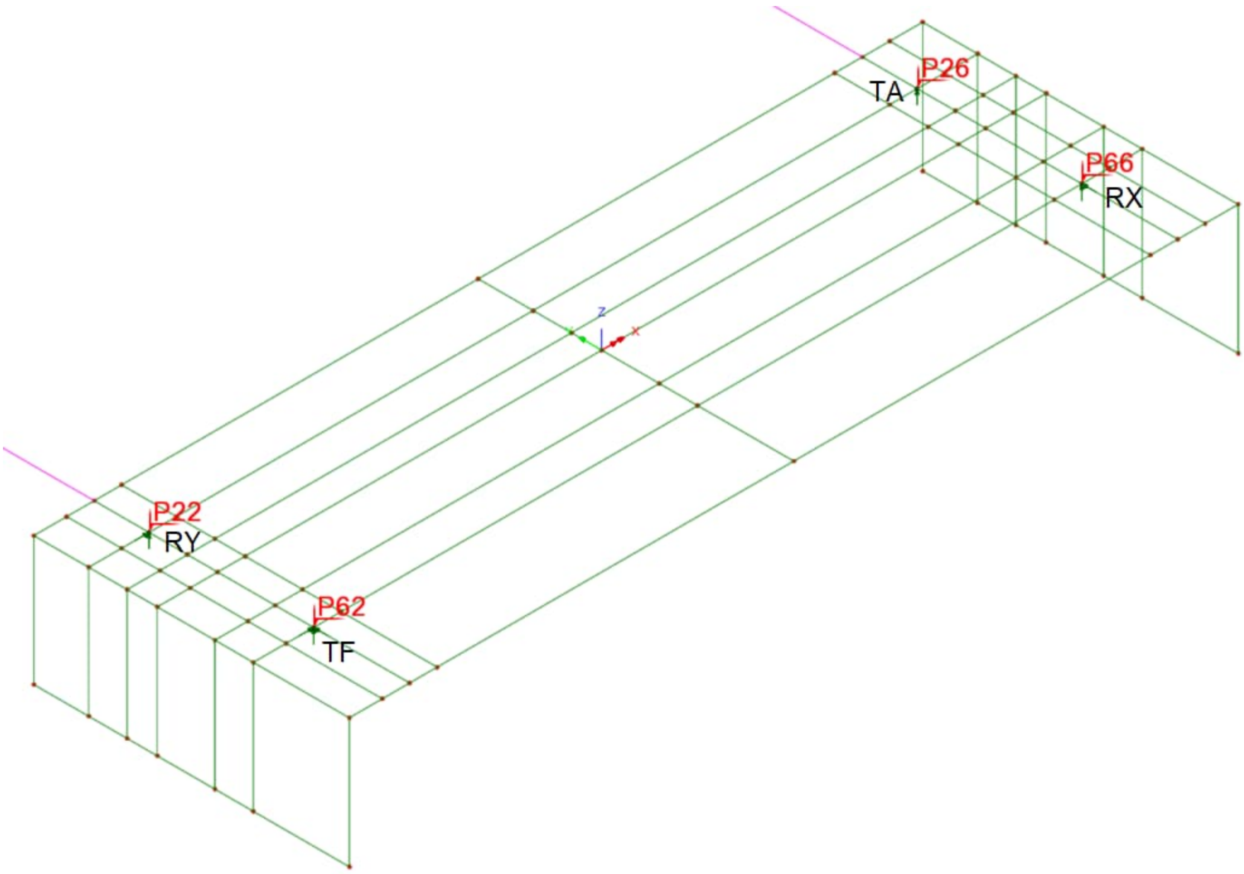
<u>Overview</u>
Material *C35/45 Orthotropic*

2.5 BOUNDARY CONDITIONS

In the static model, the following boundary conditions are applied at the position for each layer. The selection of boundary conditions provides correct load effects when determining load effects in the superstructure.

Bearing	X:movement	Y:movment	Z:movement
TA	Free	Free	Fixed
TF	Fixed	Fixed	Fixed
RX	Free	Fixed	Fixed
RY	Fixed	Free	Fixed

Table
Definition bearings.



2.6 MESH

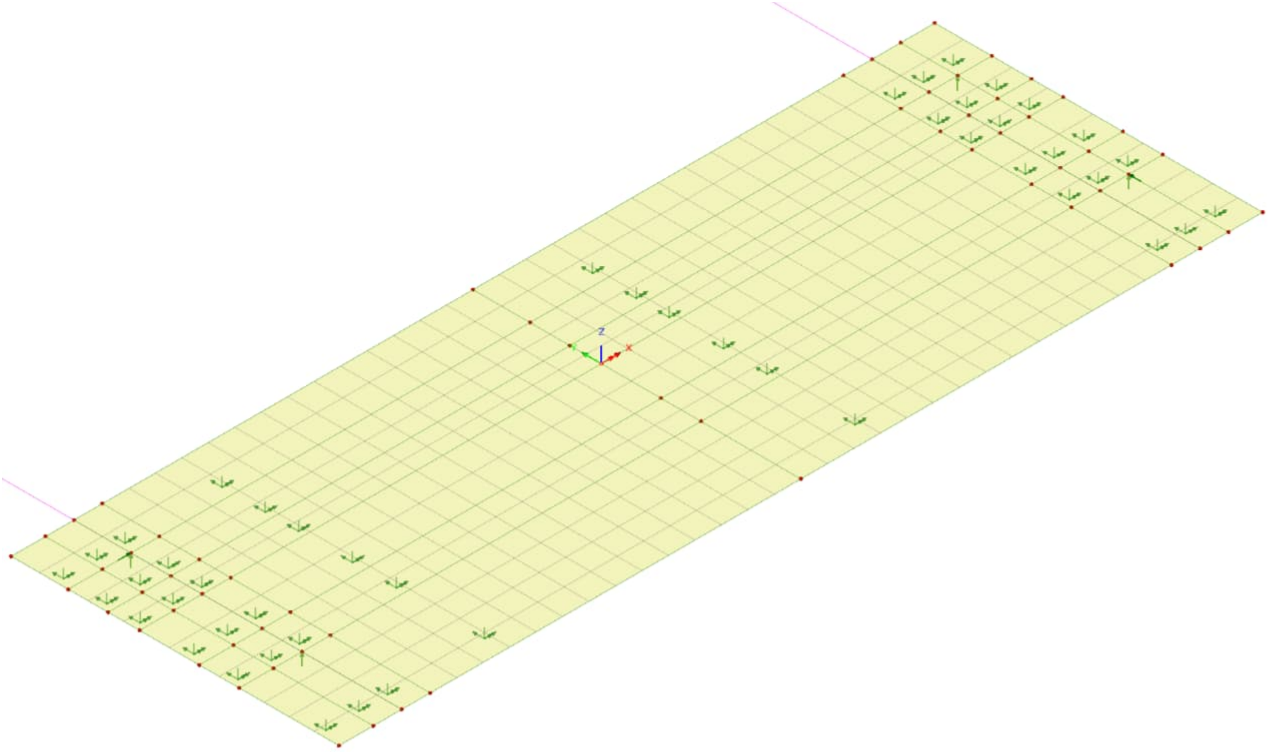
2.6.1 Shell element (QTS8): linear

Bridge is modelled using shell elements.

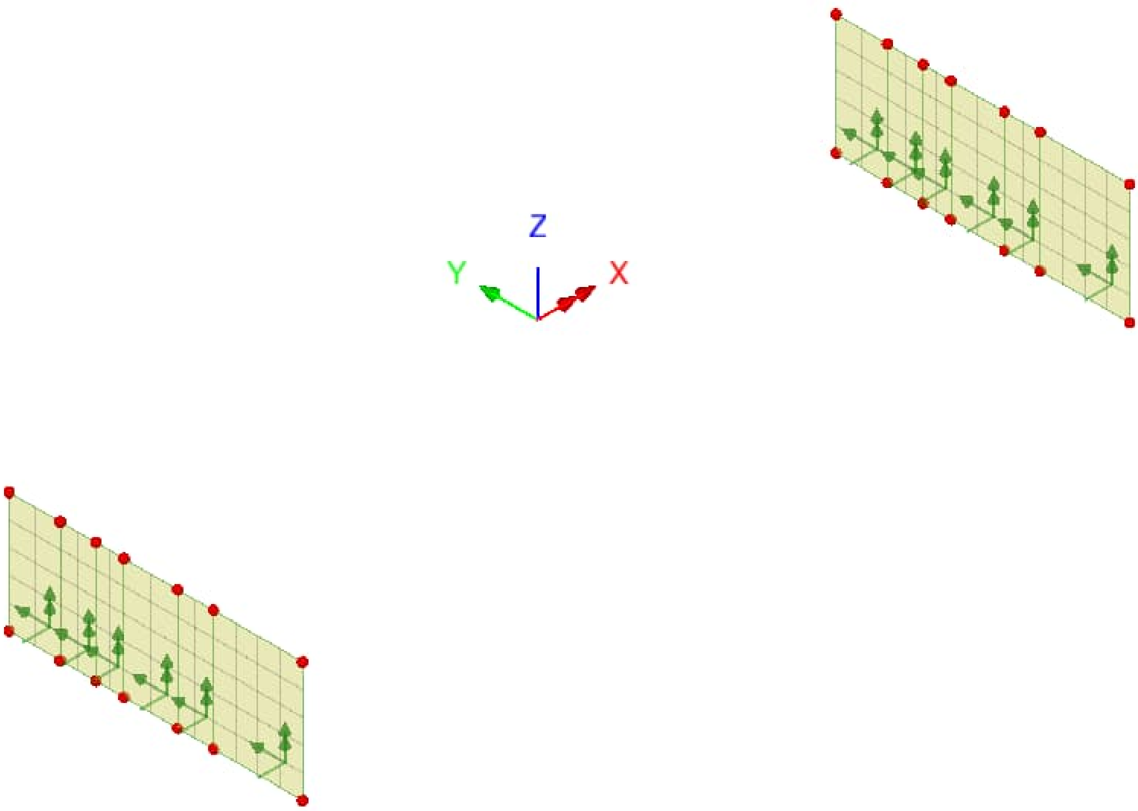
High node elements are chosen (”Thick shell” / QTS8) to limit the number of elements while maintaining accuracy.

Type	x-divisions	y-divisions
Element 1 x 2	1	2
Element 1 x 4	1	4
Element 5 x 2	5	2
Element 5 x 4	5	4
Element 14 x 1	14	1
Element 14 x 2	14	2
Element 14 x 4	14	4

Bridge deck:



End shields:

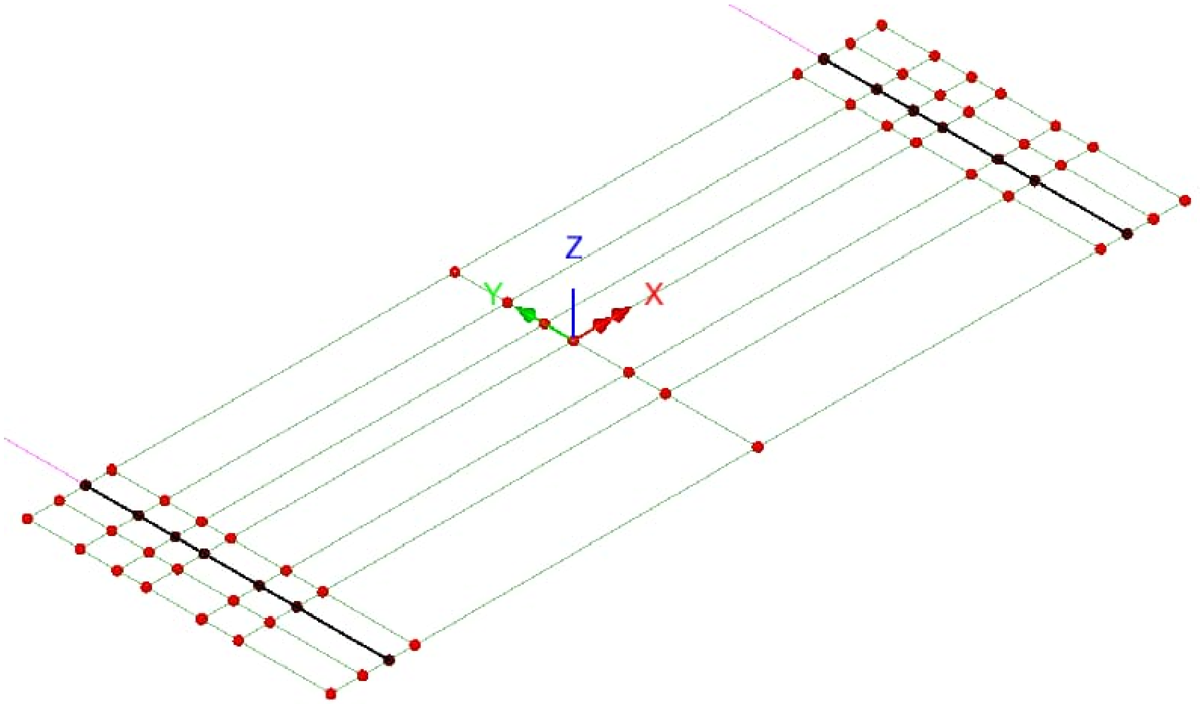


2.6.2 Beam element (BMX21) : linear

Studied bridge uses beam elements (” Beam element” / BMX21) for support beam.

Typ	Divisions	End release: Start	End release: End	Structure
Element 2	2	None	None	TVB
Element 4	4	None	None	TVB

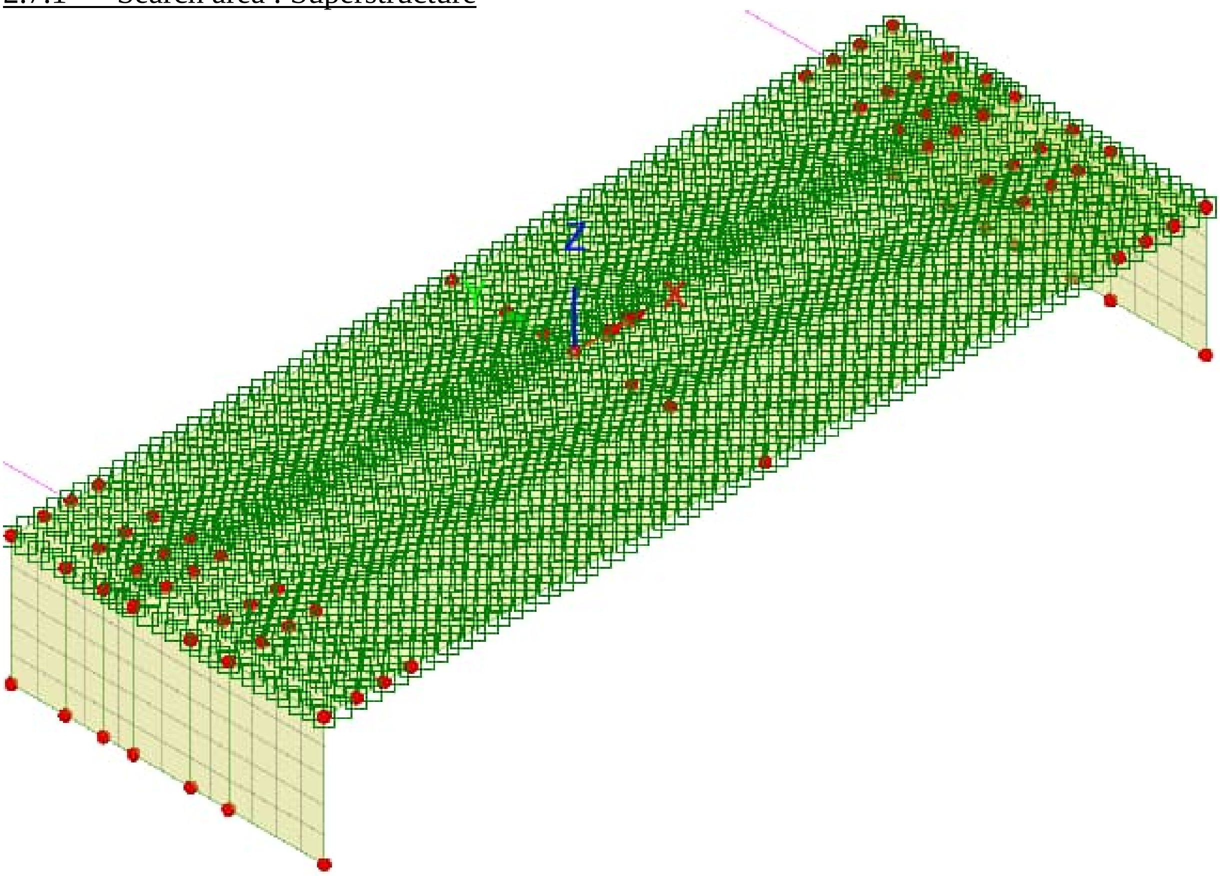
Tvärbalkar (TVB) :



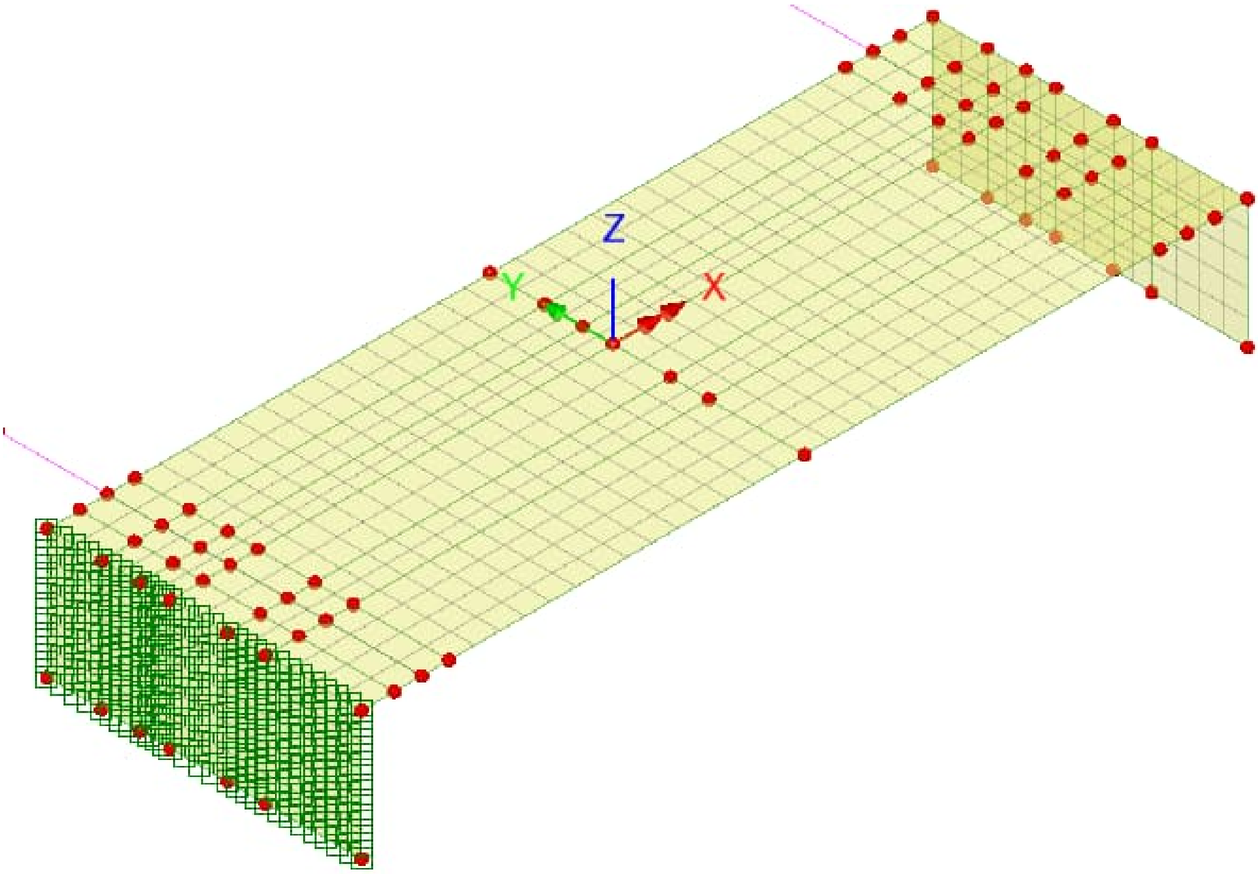
2.7 SEARCH AREA

Discrete load can be applied to structure as geometrical load areas, termed *Search Area*.

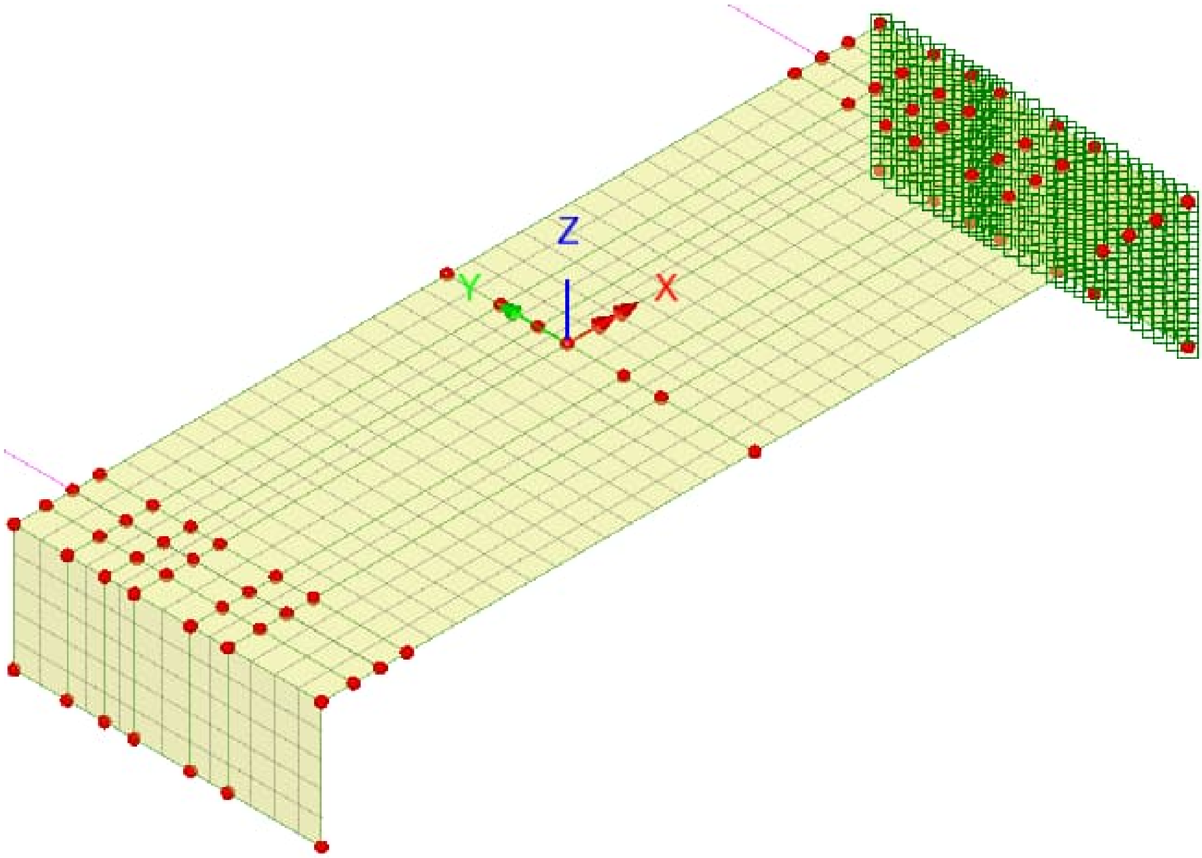
2.7.1 Search area : Superstructure



2.7.2 Search area : End shield 1



2.7.3 Search area : End shield 2



3. LOADS

3.1 DEAD WEIGHT

$\gamma_c = 25 \cdot \frac{kN}{m^3}$: concrete

3.1.1 End shield

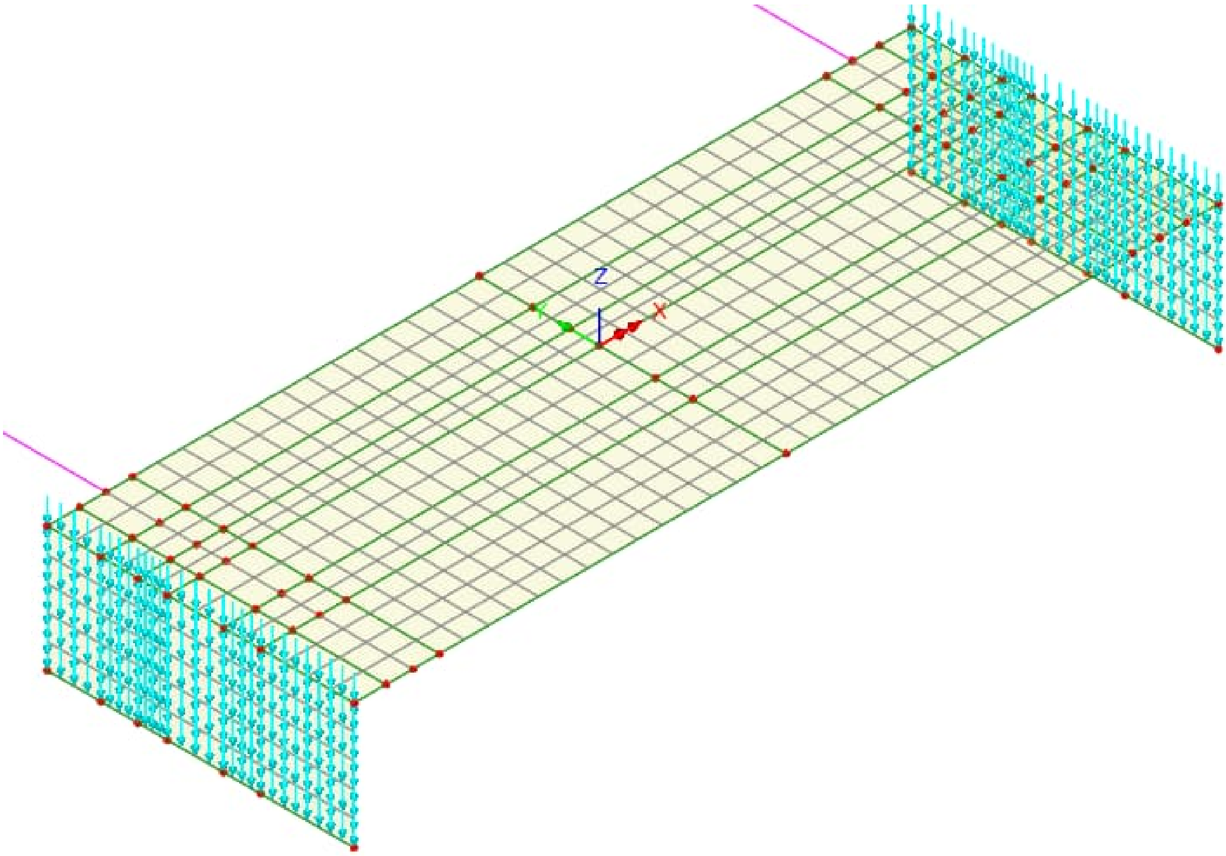
Load case : EGEN 1

Structural loading : Body ovforce

Linear acceleration in Z (a_z) : -10 $\frac{m}{s^2}$

Component	Value
Linear acceleration in X	0,0
Linear acceleration in Y	0,0
Linear acceleration in Z	-10,0
Angular velocity about X axis	0,0
Angular velocity about Y axis	0,0
Angular velocity about Z axis	0,0
Angular acceleration about X axis	0,0
Angular acceleration about Y axis	0,0
Angular acceleration about Z axis	0,0

Name EGEN 1 (2)



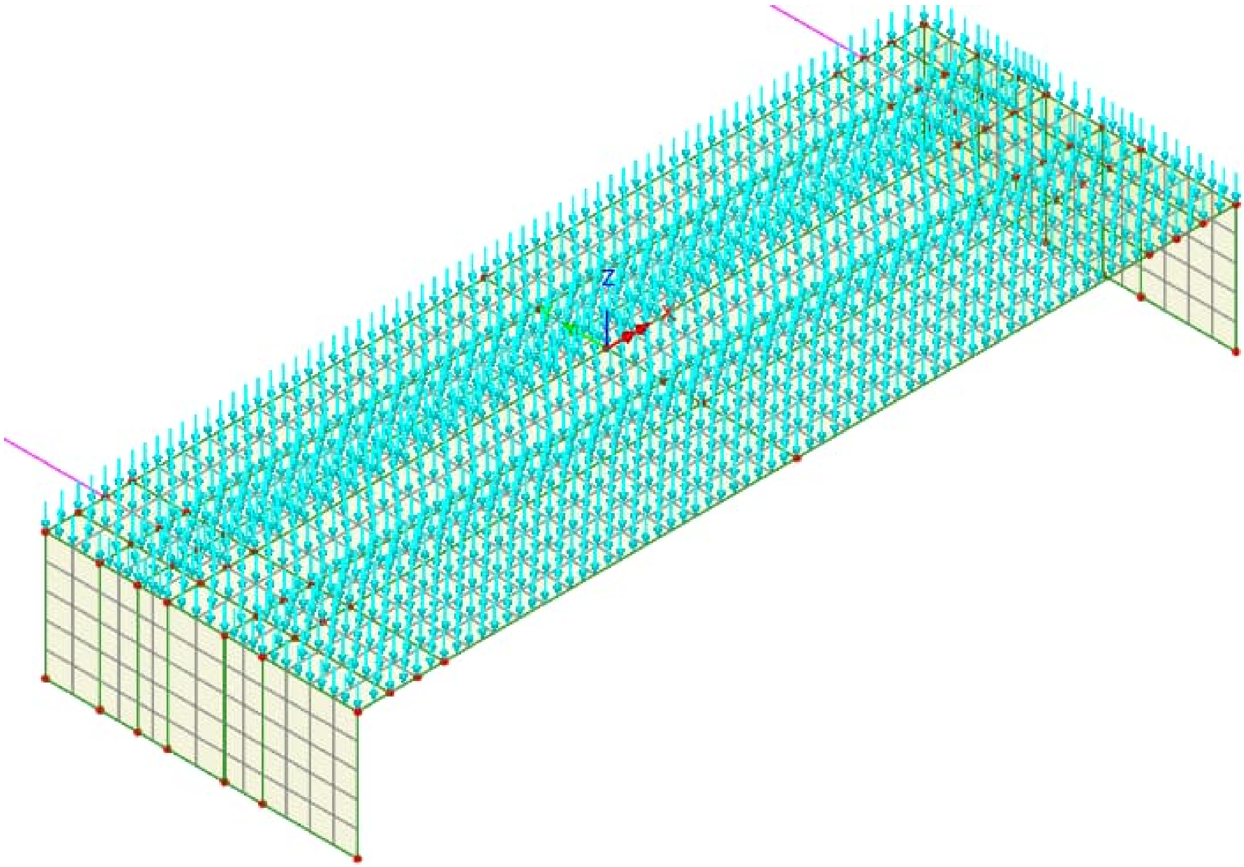
Overview 3D

3.1.2 Bridge deck

Load case : EGEN 2

Structural loading : Body force

Linear acceleration in Z (a_z) : -10 $\frac{m}{s^2}$



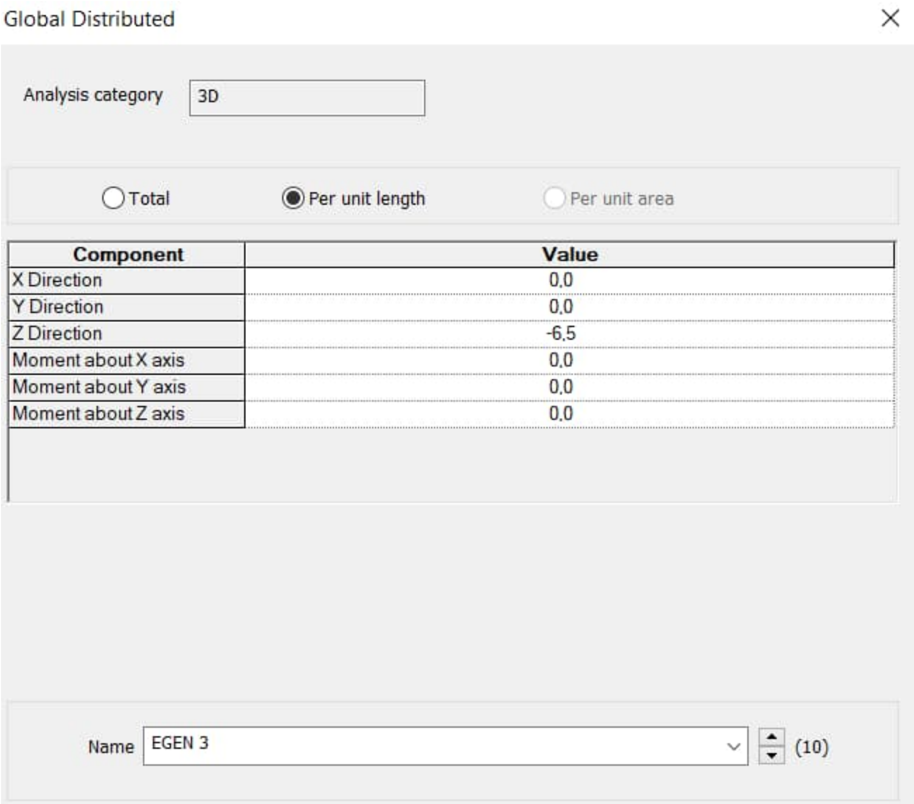
Overview 3D

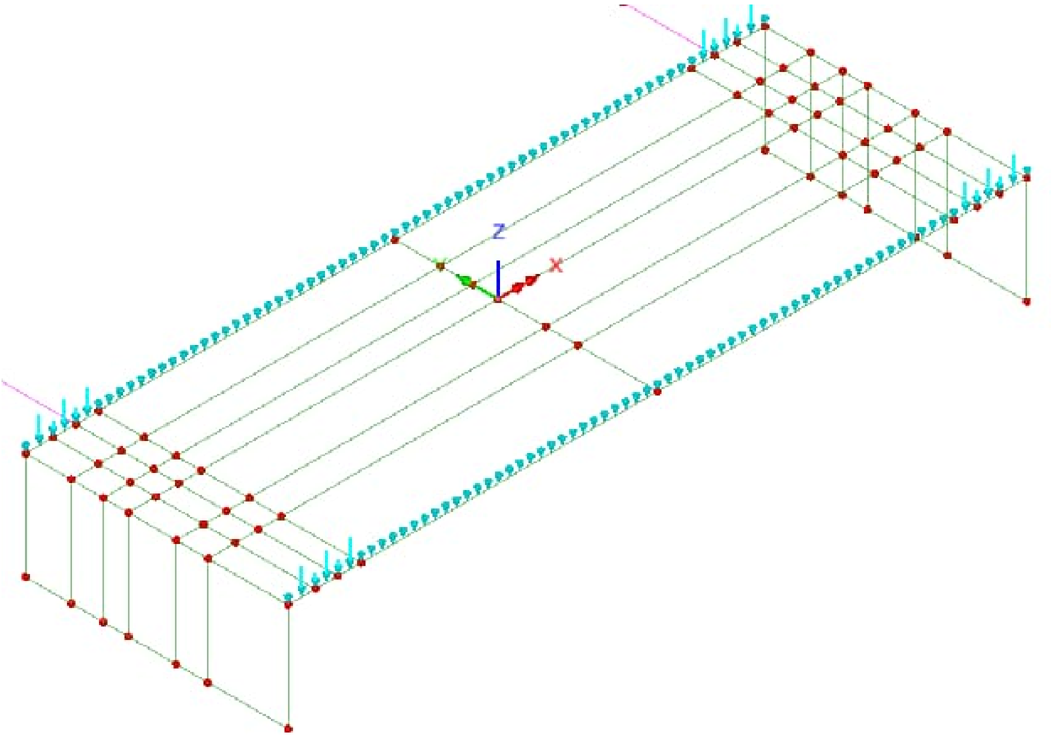
3.1.3 Edge beam incl. railing

On each edge beam a fictive line load is applied as seen below. The load includes railing.

$p_{räcke} = 0.5\frac{kN}{m}$: railing

$\rightarrow p_z = p_{räcke} + p_{KB} = 0.5\frac{kN}{m} + 0.40m \cdot 0.60m \cdot 25\frac{kN}{m^3} = -6.5\frac{kN}{m}$





Overview 3D

Remark

The effect of eccentricity (x_{tp} = 1.35 m) according to page A3:35 is not considered. Considered negligible.

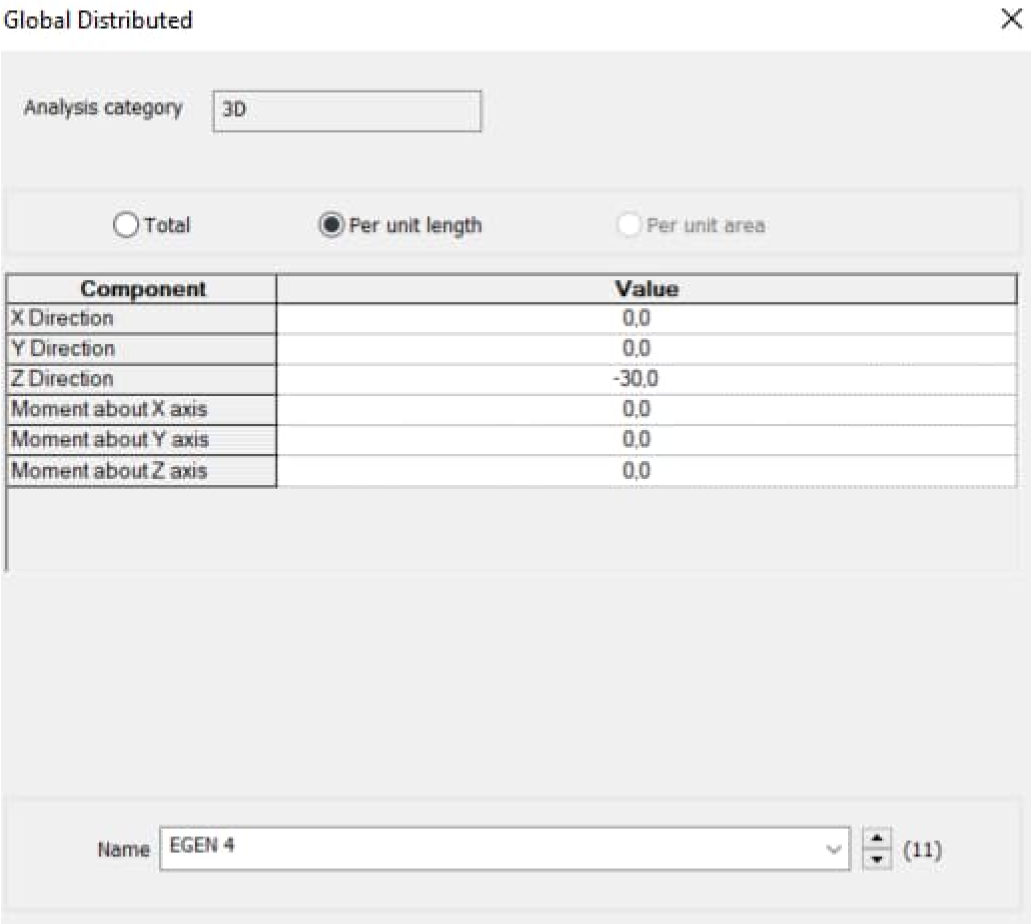
3.1.4 Wingwalls

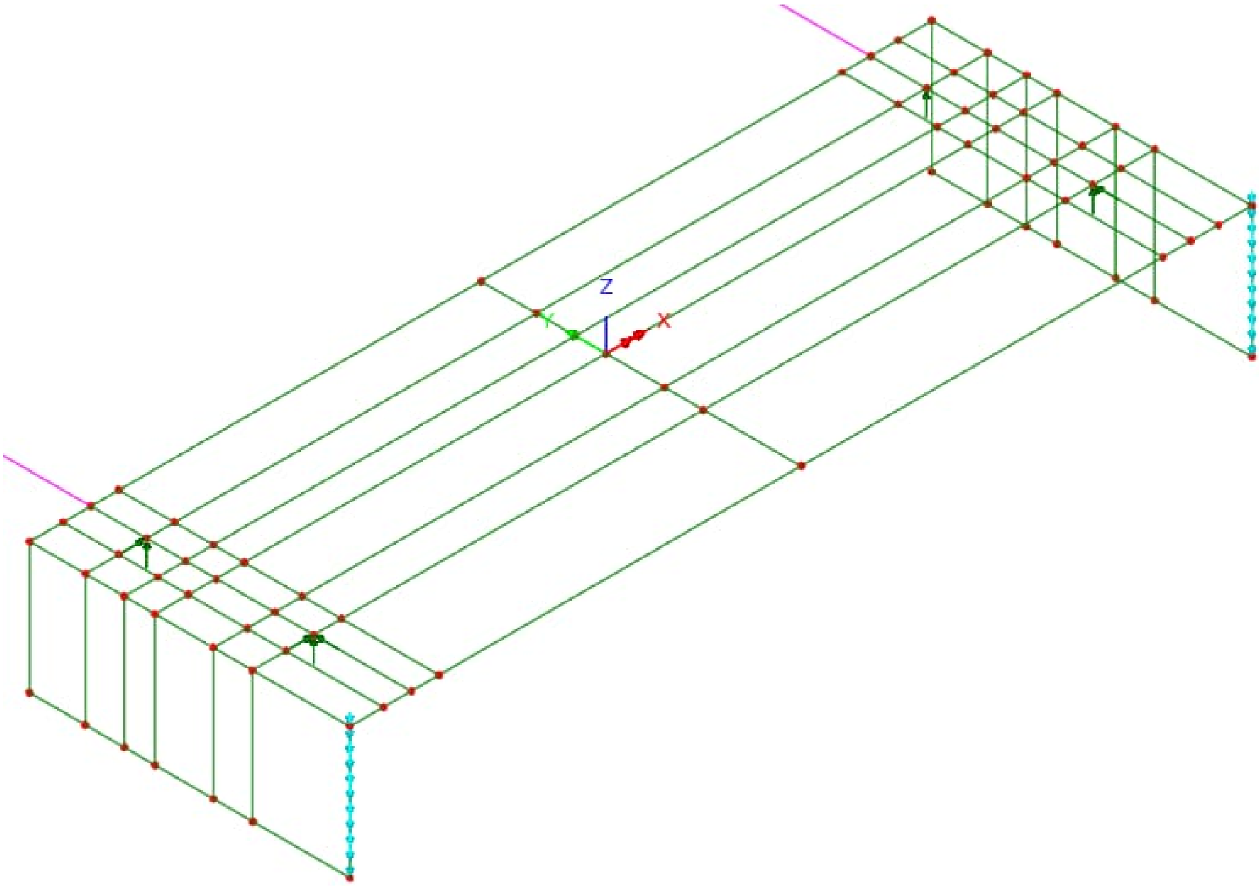
All wingwalls are considered identical (∴ L = 3.1 m).

$P_z = -71kN$: page A3:35

Load is distributed along height of end shield (∴ h_s = 2.4 m).

$$p_z = \frac{P_z}{h_s} = -\frac{71kN}{2.4m} = -30\frac{kN}{m}$$





Overview 3D

3.1.6 Summary dead weight (EGEN)

Basic load combination EGEN :

Load case	Factor
EGEN 1	1.00
EGEN 2	1.00
EGEN 3	1.00
EGEN 4	1.00

3.2 BALLAST

Minimum thickness ballast 600 mm. Track longitudinal inclination 0.3% and deck 1.0% to dewater deck, will result in varying ballast thickness as seen below.

L = 1.4 m + 14.0 m + 1.4 m = 16 m $\rightarrow (1.0\% - 0.3\%) \cdot L = 0.12\,m$

$\gamma = 20\frac{kN}{m^3}$

$q_{ballast.1} = 20\frac{kN}{m^3} \cdot 0.60m = 12kPa$

$q_{ballast.2} = 20\frac{kN}{m^3} \cdot 0.72m = 14kPa$

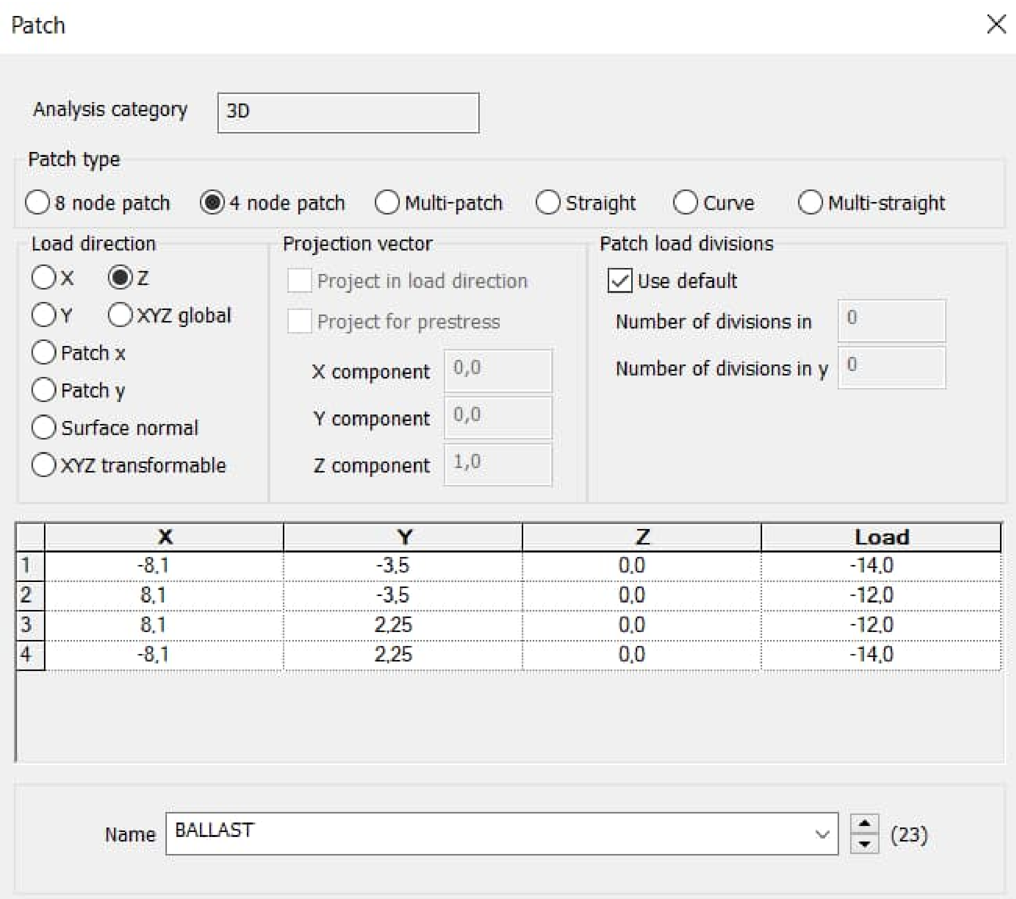
Load case : BALLAST

Structural loading : Discrete 4 node patch

Surface load (q_z) : -14 kPa → -12 kPa

Search Area : Brobana

Loads outside search area : Include full load


Patch

Analysis category: 3D

Patch type: 8 node patch / (●) 4 node patch / Multi-patch / Straight / Curve / Multi-straight

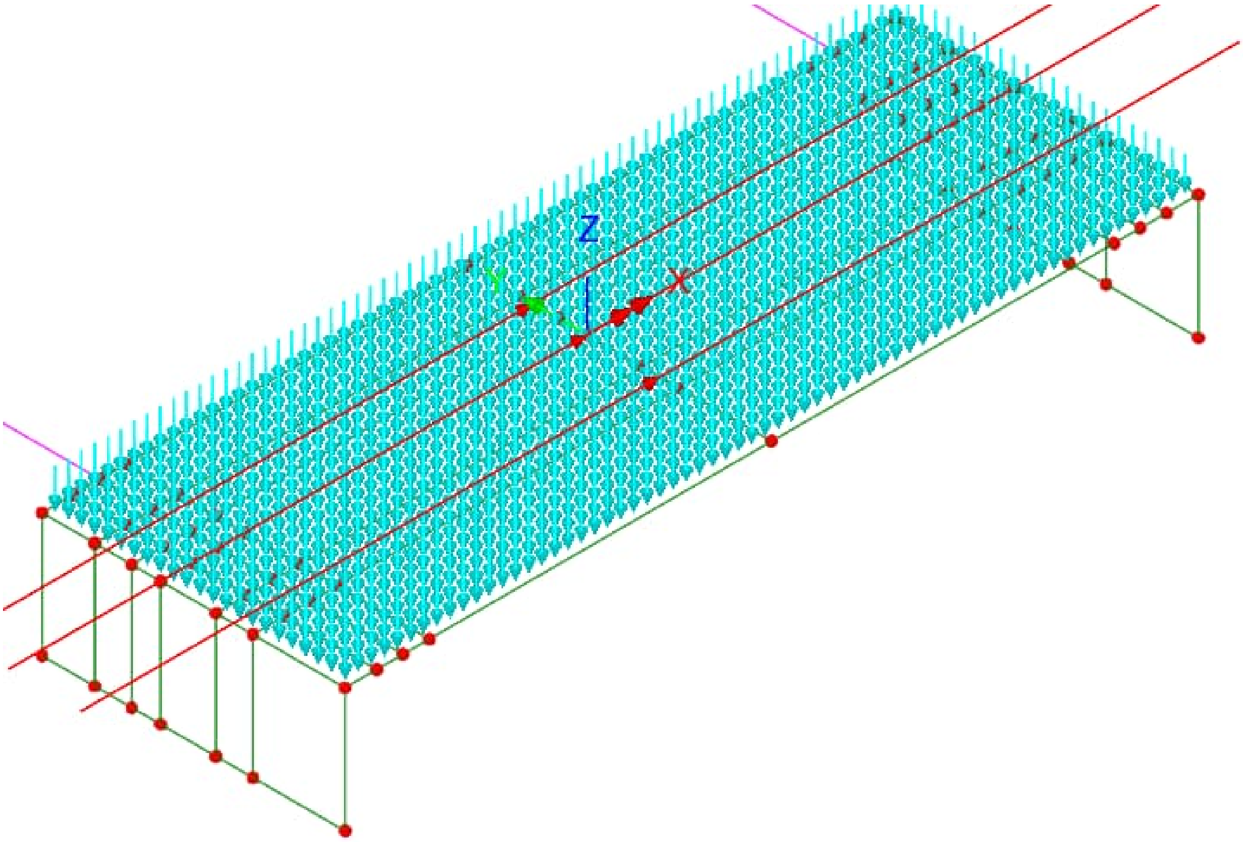
Load direction: X / (●) Z / Y / XYZ global / Patch x / Patch y / Surface normal / XYZ transformable

Projection vector: Project in load direction / Project for prestress; X component 0,0; Y component 0,0; Z component 1,0

Patch load divisions: [✓] Use default; Number of divisions in 0; Number of divisions in y 0

	X	Y	Z	Load
1	-8,1	-3,5	0,0	-14,0
2	8,1	-3,5	0,0	-12,0
3	8,1	2,25	0,0	-12,0
4	-8,1	2,25	0,0	-14,0

Name: BALLAST (23)



Overview 3D

3.3 EARTH PRESSURE

Earth pressure in filling corresponds to coarse crushed blasted rock (AMA CEB.524).

φ_k = 45°

$\gamma = 20\frac{kN}{m^3}$

$\gamma' = 10\frac{kN}{m^3}$

$$X_d = \frac{1}{\gamma_m} \cdot \eta \cdot \overline{X} \equiv \frac{1}{\gamma_m} \cdot X_k$$

Earth pressure coefficient for design method 2 (D2) :
Design coefficients associated to *A1 + M1 + R2* according to SS-EN 1997-1 section 2.4.7.3.4.3 is applied.

$\gamma_{m.D2}$ = 1.0 : see TSFS chapter 38 table 38.3 for M1

$\rightarrow \varphi_d = artctan\left(\frac{tan\varphi_k}{\gamma_{m.D2}}\right) = arctan\left(\frac{tan45°}{1.0}\right) = 45°$

$K_0 = 1 - \sin(\varphi_d) = 0.29$

$K_a = tan^2\left(45° - \frac{\varphi_d}{2}\right) = 0.17$

$K_p = tan^2\left(45° + \frac{\varphi_d}{2}\right) = 5.82$

Earth pressure for design method 3 (D3) :
Design coefficients associated to *A1(design loads) + A2(geotechnical loads) + M2 + R3* according to SS-EN 1997-1 section 2.4.7.3.4.4 is applied.

$\gamma_{m.D3}$ = 1.3 : see TSFS chapter 8 table 38.3 för M2

$\rightarrow \varphi_d = artctan\left(\frac{tan\varphi_k}{\gamma_m}\right) = arctan\left(\frac{tan45°}{1.3}\right) = 38°$

$K_0 = 1 - \sin(\varphi_d) = 0.38$

$K_a = tan^2\left(45° - \frac{\varphi_d}{2}\right) = 0.24$

$K_p = tan^2\left(45° + \frac{\varphi_d}{2}\right) = 4.20$

Earth pressure in FEM-analysis:

$$K_o = 1 - sin(\varphi_d)$$

$$K_a = tan^2(45° - \frac{\varphi_d}{2})$$

$$K_p = tan^2(45° + \frac{\varphi_d}{2})$$

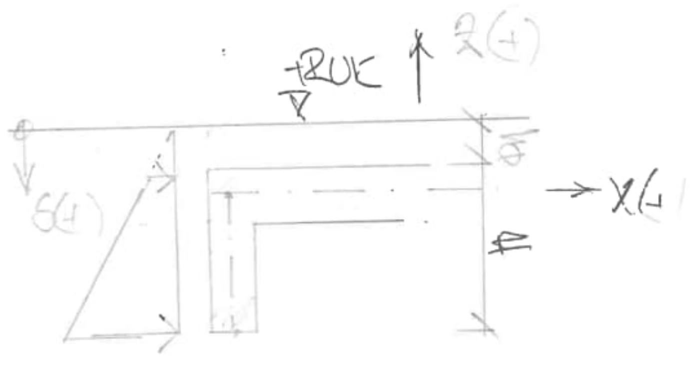
φ_d	K_a	K_0	K_p	Metod
(38°)	(0.24)	(0.38)	(4.20)	D3
45°	0.17	0.29	5.82	D2

During design earth press coefficients associated to method D2 will used applied, however the load coefficients are adjusted according to verification, see section 3.13.1.

$$h_b = 0.60m$$

$$H = 2.80m$$

$$q_{vilo}(s) = K_0 \cdot \gamma \cdot s = 0.29 \cdot 20 \frac{kN}{m^3} \cdot s(+) = s(+) \cdot 5.8kPa$$



3.3.1 Load against abutment 1

$q_{vilo}\ (0m) = 0kPa$: level bottom of track

$q_{vilo}\ (0.6m) = 3.4m \cdot 5.8\frac{kN}{m^3} = 4kPa$: level top of end shield

$q_{vilo}\ (3.4m) = 3.4m \cdot 5.8\frac{kN}{m^3} = 20kPa$: level bottom of end shield

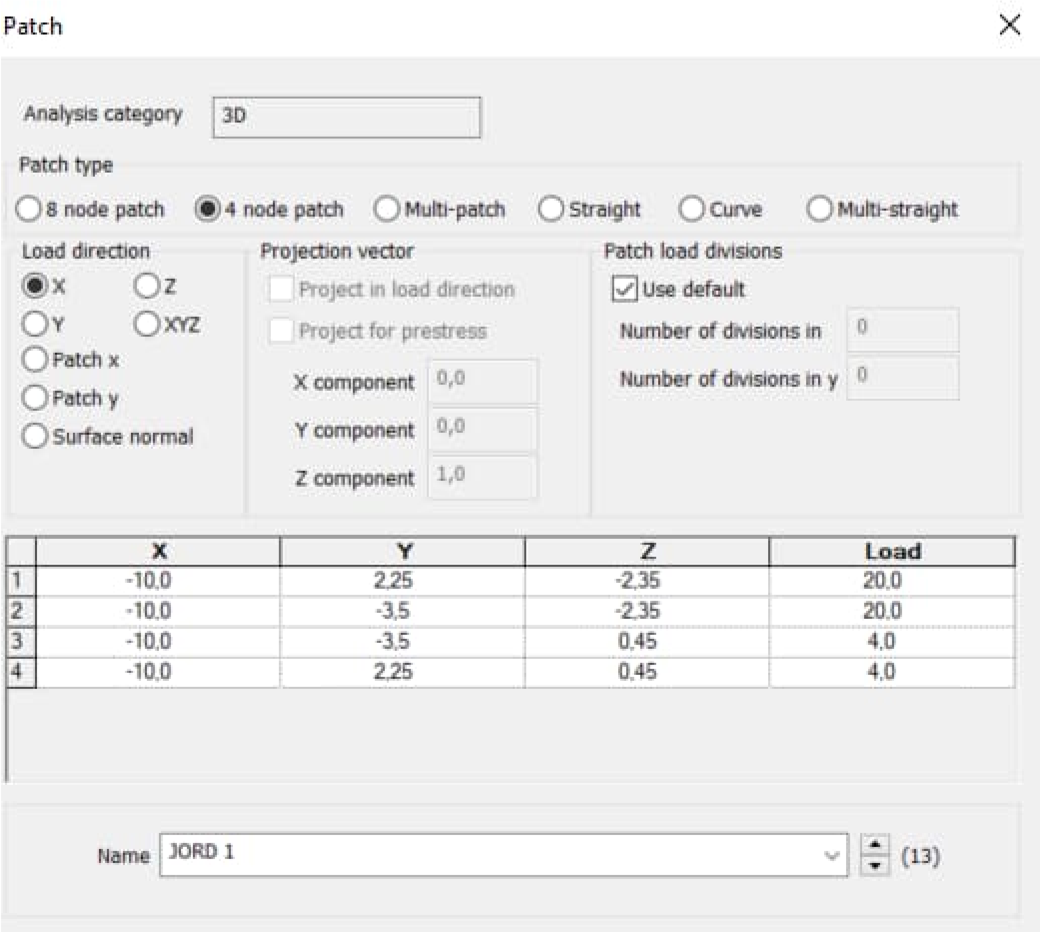
Load case : JORD 1

Structural loading : Discrete 4 node patch

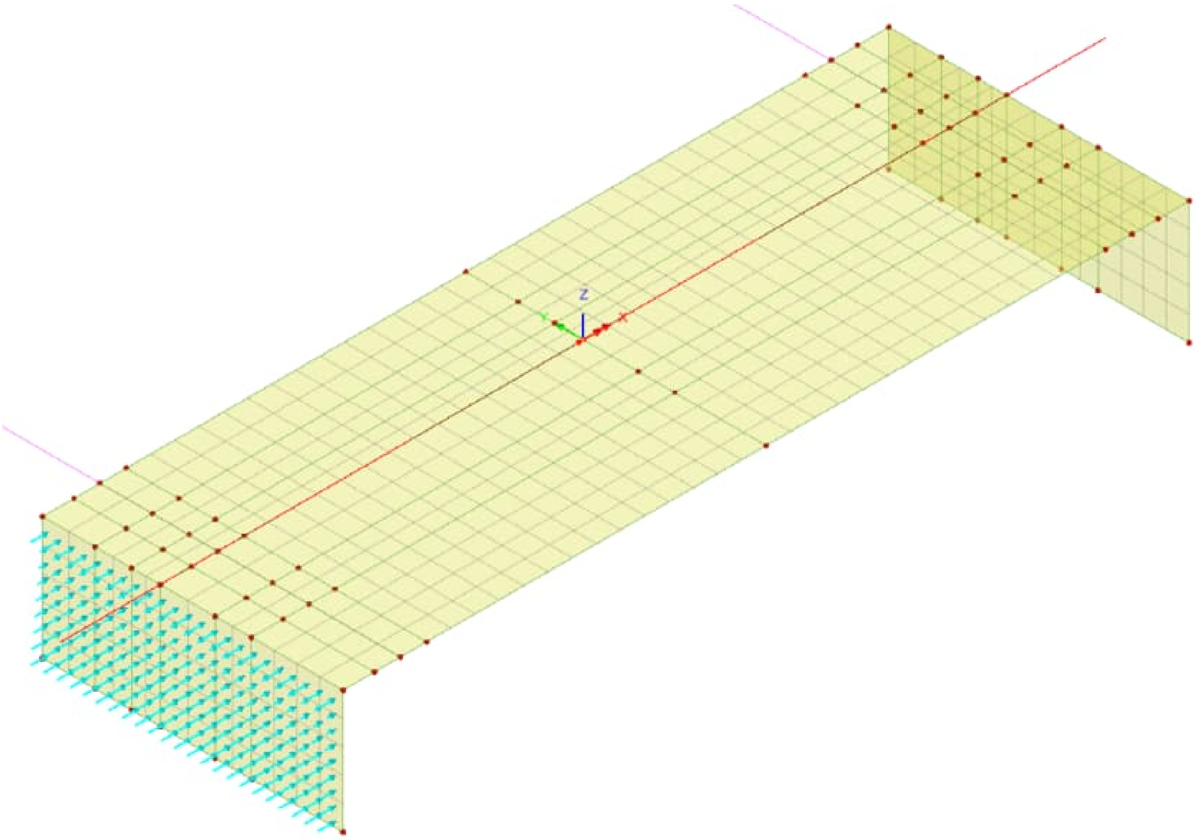
Surface load (q_x) : +4 kPa → +20 kPa

Search Area : End shield 1

Loads outside search area : Include full load



	X	Y	Z	Load
1	-10,0	2,25	-2,35	20,0
2	-10,0	-3,5	-2,35	20,0
3	-10,0	-3,5	0,45	4,0
4	-10,0	2,25	0,45	4,0



Overview 3D

3.3.2 Load against abutment 2

$q_{vilo}\ (0m) = 0kPa$: level bottom of track

$q_{vilo}\ (0.6m) = 3.4m \cdot 5.8\frac{kN}{m^3} = 4kPa$: level top of end shield

$q_{vilo}\ (3.4m) = 3.4m \cdot 5.8\frac{kN}{m^3} = 20kPa$: level bottom of end shield

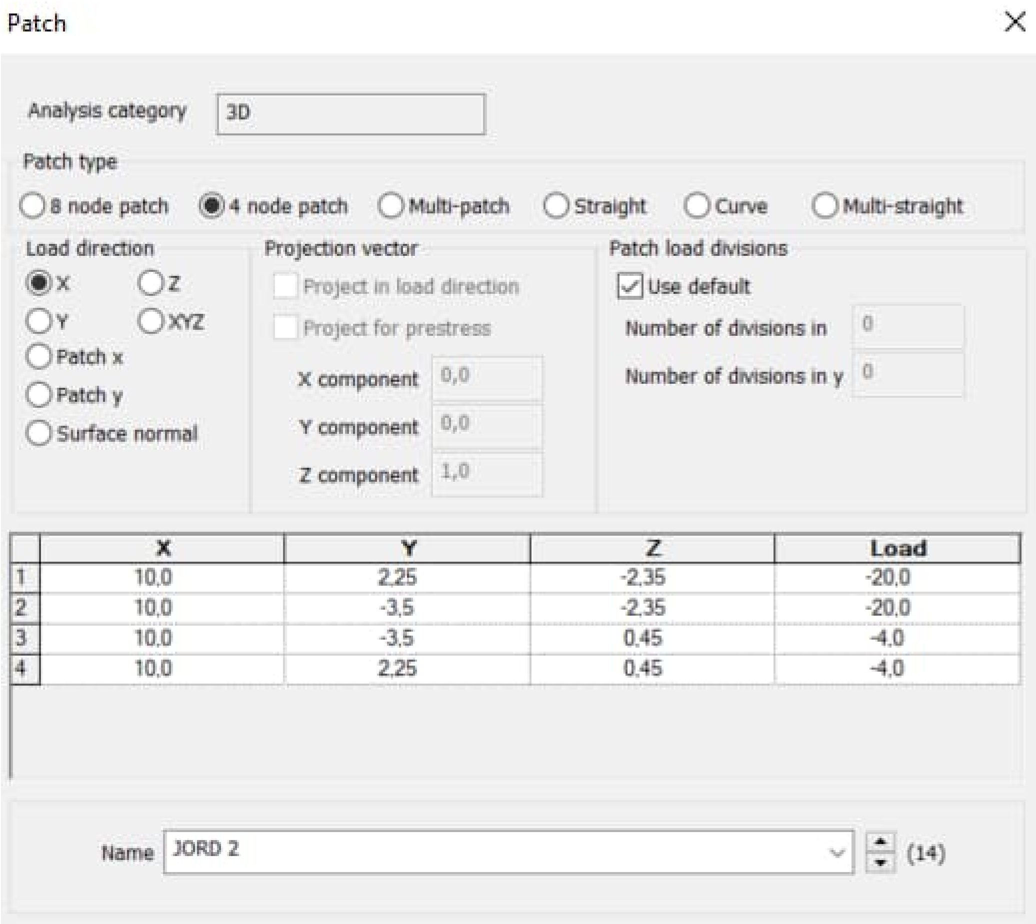
Load case : JORD 2

Structural loading : Discrete 4 node patch

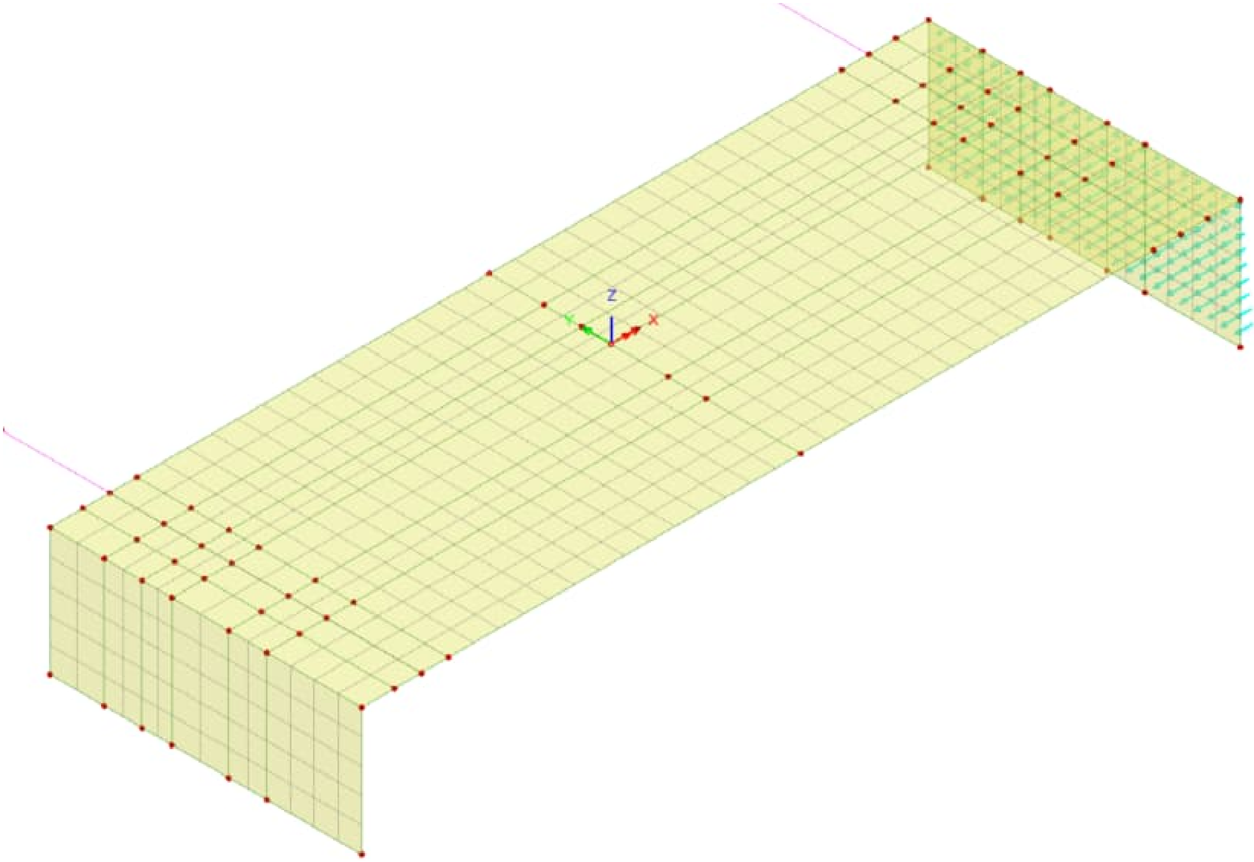
Surface load (q_x) : -4 kPa → -20 kPa

Search Area : End shield 2

Loads outside search area : Include full load



	X	Y	Z	Load
1	10,0	2,25	-2,35	-20,0
2	10,0	-3,5	-2,35	-20,0
3	10,0	-3,5	0,45	-4,0
4	10,0	2,25	0,45	-4,0

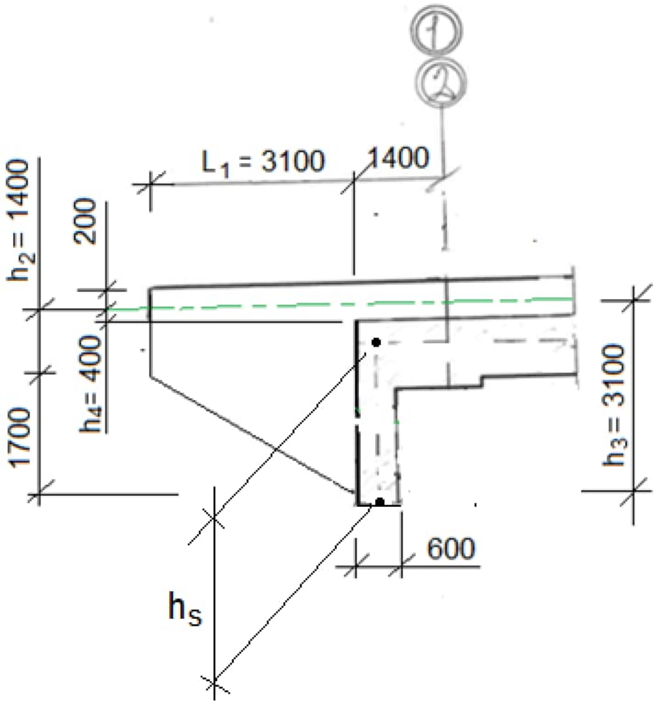


Overview 3D

3.3.3 Load against wingwalls

Design software K2.002 is used to determine earth pressure against wingwalls according to Cullman's theory. All wingwalls are assumed to have same length (L = 3.1 m).

A load increase due to wind and lateral load is considered.



Load is distributed over height of end shield (∴ h_s = 2.4 m).

Resulting earth pressure:

H_{jord} = 55kN : see page A3:34
M_{jord} = 70kNm : see page A3:34

Earth pressure is distributed along height of end shield (h_s):

$$N_{jord} = \frac{55kN}{2.4m} = 23\frac{kN}{m}$$

$$M_{jord} = \frac{70kNm}{2.4m} = 30\frac{kNm}{m}$$

Objekt : L = 3.1 m

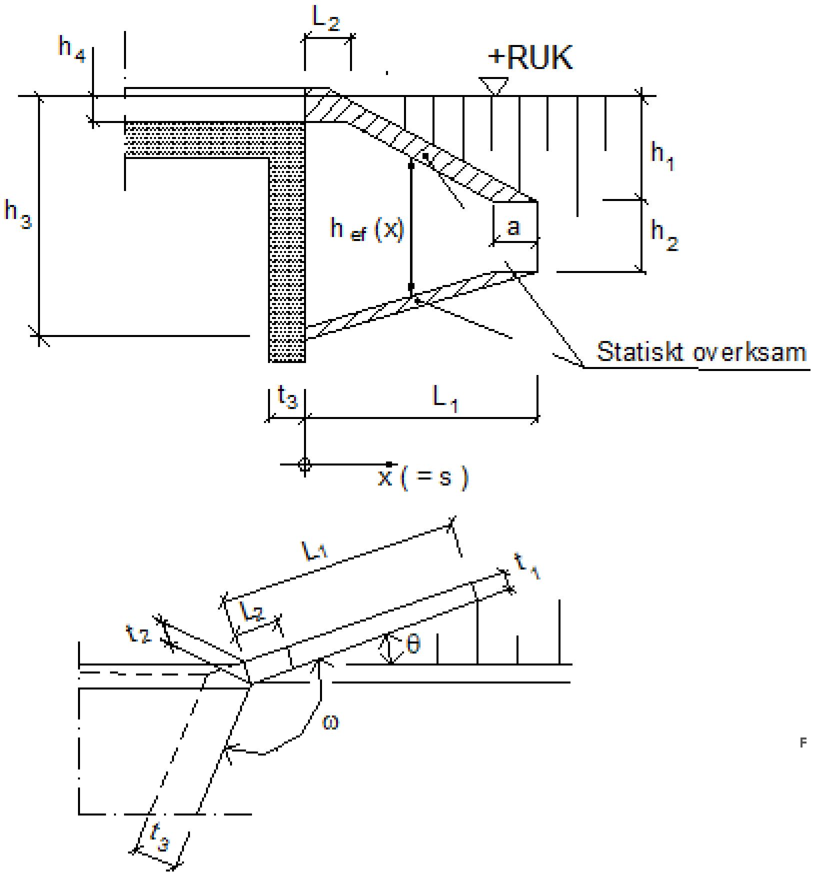
TEORI

Vid bestämning av dimensionerande lasteffekt i vingmur tillämpas Culmans metod för bestämning av lasteffekt av jordfyllning. Detta sker då Rankine´s metod inte är fungerar i brunten slänt.

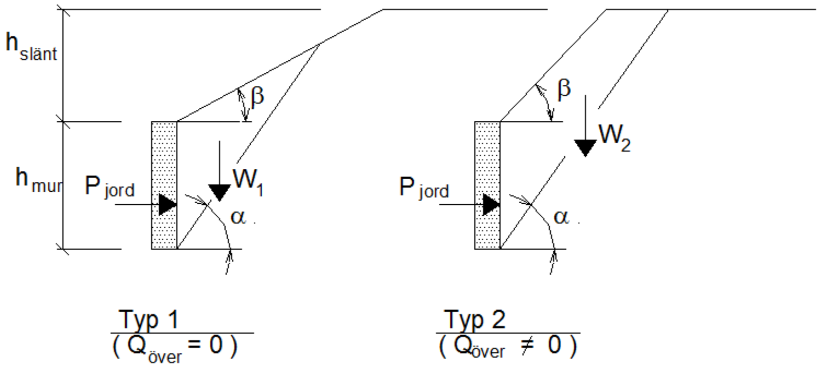
Vid bestämning av överlastens bidrag tillämpas dock Rankine´s metod. Vid kontroll tillämpas lastspridning (1:N) genom fyllning. Vanligen är N = 1 dimensionerande för låga vingmurar men bör kontrolleras.

Lasteffekten från jordfyllning och överlast adderas trots att brottvinkel (α) kan variera mellan dem. Denna förenkling anses dock på säker sida.

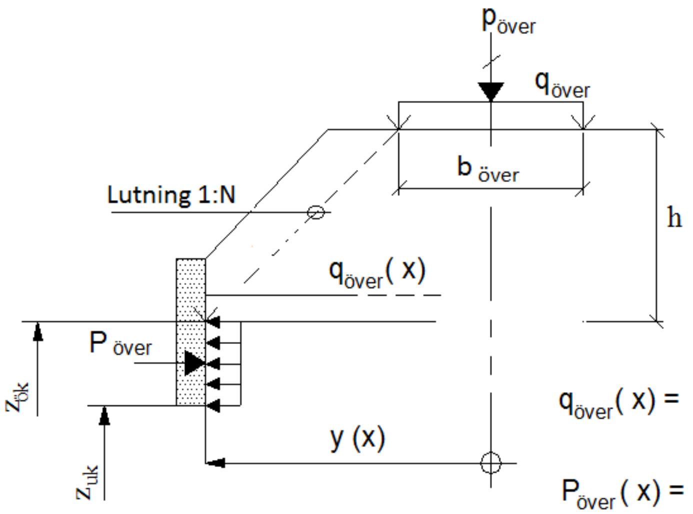
PRINCIPFIGUR



F



Culmansmetod
(Tillämpas för bestämning av jordtryck.)



$$q_{över}(x) = \frac{p_{över}}{b_{över} + 2h/N}$$

$$P_{över}(x) = K_o \cdot q_{över}(x) \cdot (z_{ök} - z_{uk})$$

Överlast i friktionsmaterial enligt Rankine
(Tillämpas för bestämings av överslast.)

INDATA

Geometri :

$L_1 = 3.1m$ $L_2 = 0.5m$

$h_1 = 0.4m$ $h_2 = 1.4m$ $h_3 = 3.1m$ $h_4 = 0.4m$

$t_1 = 0.40m$ $t_2 = 0.40m$ $t_3 = 0.60m$

Vinkel vinge-ramben på baksidan : $\omega = 90°$

Vinkel vinge-vägbankskrön på baksidan : $\theta = 1°$

Avstånd till brytpunkt för effektiv höjd : $a = 0.80m$

Material :

Jordmaterial : $\gamma_{jord} = 20\frac{kN}{m^3}$ $K_o = 0.29$ $K_a = 0.17$

$\gamma\psi_{jord.ULS} = 1.31$ $\gamma\psi_{jord.SLS} = 1.0$

Betong : $\gamma_{btg} = 25\frac{kN}{m^3}$

Laster :

Överlast :

$$p_{över} = 1.6\frac{4 \cdot 250kN}{6.4m} = 250 \cdot \frac{kN}{m}$$

$$b_{över} = 3.0m - (0.7m - 0.2m) = 2.5\,m$$

$y_{start} = 2.12m$

$N = 1$

$\gamma\psi_{över.ULS} = 1.67$

$\gamma\psi_{över.SLS} = 0$

BERÄKNING

Lastintensitet av jordtryck enligt Culmans metod :

Nivå överkant vingmur : $mur_{ök}(x) = \mathrm{linterp}\left[\begin{pmatrix} 0 \\ L_2 \\ L_1 \end{pmatrix}, \begin{pmatrix} h_3 \\ h_3 \\ h_3 - h_1 \end{pmatrix}, x\right]$

Nivå underkant vingmur : $mur_{uk}(x) = \mathrm{linterp}\left[\begin{pmatrix} 0 \\ L_1 \end{pmatrix}, \begin{pmatrix} 0 \\ h_3 - h_1 - h_2 \end{pmatrix}, x\right]$

Vingmurens höjd : $h_{mur}(x) = mur_{ök}(x) - mur_{uk}(x)$

Släntens höjd : $h_{slänt}(x) = \mathrm{linterp}\left[\begin{pmatrix} 0 \\ L_2 \\ L_1 \end{pmatrix}, \begin{pmatrix} 0 \\ 0 \\ h_1 \end{pmatrix}, x\right]$

Friktionsvinkel: $\varphi = \mathrm{asin}\left(1 - K_o\right)$

Lutning hos slänten ned till överkant vingmur mätt vinkelrätt mot vingen :

$$\beta = \mathrm{atan}\left[\frac{h_1}{\left(L_1 - L_2\right)\tan(\theta)}\right]$$

Vertikallast för brottfigur typ 1 (= brottlinje i slänt) :

$$W_1 = h_{mur}(x)\cdot\sin\left(\frac{\pi}{2} - \alpha\right)\cdot\left(h_{mur}(x)\cdot\cos\left(\frac{\pi}{2} - \alpha\right) + \frac{h_{mur}(x)\cdot\sin\left(\frac{\pi}{2} - \alpha\right)}{\tan(\alpha - \beta)}\right)\cdot\frac{\gamma_{jord}}{2}$$

Vertikallaster för brottfigur typ 2 (= brottlinje hamnar ovanför slänt) :

$$W_2 = \left[\left(h_{mur}(x) + h_{slänt}(x)\right)^2\cdot\tan\left(\frac{\pi}{2} - \alpha\right) - \frac{h_{slänt}(x)^2}{\tan(\beta)}\right]\cdot\frac{\gamma_{jord}}{2}$$

Vilojordtrycksresultant enligt Culmann under inverkan av jordlast :

$$P_o = \left| \begin{array}{l} W_{jord} \leftarrow W_1 \;\; \text{if} \;\; \left(h_{mur}(x) + h_{slänt}(x)\right) \cdot \tan(90° - \alpha) < \dfrac{h_{slänt}(x)}{\tan(\beta)} \\ W_{jord} \leftarrow W_2 \;\; \text{otherwise} \\ P_{aktiv} \leftarrow W_{jord} \cdot \tan(\alpha - \varphi) \\ P_{vilo} \leftarrow P_{aktiv} \cdot \dfrac{K_o}{K_a} \end{array} \right.$$

Utvärdera största last av jordtryck genom att kontrollera N_a antal vinklar mellan φ och 90 °.

$$P_{jord} = \left| \begin{array}{l} N_\alpha \leftarrow 20st \\ \Delta\alpha \leftarrow \dfrac{90° - \varphi}{N_\alpha - 1} \\ \alpha \leftarrow \varphi \\ P_{max} \leftarrow P_o(s, \alpha) \\ \text{for } \; i \in 2 .. N_\alpha \\ \quad \left| \begin{array}{l} \alpha \leftarrow \alpha + \Delta\alpha \\ P_{vilo} \leftarrow P_o \\ \text{if } \; P_{vilo} > P_{max} \\ \quad \left| \begin{array}{l} P_{max} \leftarrow P_{vilo} \\ \alpha_{max} \leftarrow \alpha \end{array} \right. \end{array} \right. \end{array} \right.$$

Snitt där jordlast bestäms (totalt 10 st)

$$\Delta_x = \frac{L_1 - L_2}{6}$$

$$x = \begin{pmatrix} 0 & \frac{1}{3}L_2 & \frac{2}{3}L_2 & L_2 & L_2 + \Delta_x & L_2 + 2 \cdot \Delta_x & L_2 + 3 \cdot \Delta_x & L_2 + 4 \cdot \Delta_x & L_2 + 5\Delta_x & L_1 \end{pmatrix}$$

Skapa funktion för resultatet av de 10 st beräknade snitten :

$$p_{vilo}(x) = \text{lspline}\left(P_{jord}, x\right)$$

Lastintensitet för överlast i friktionsmaterial enligt Rankine :

Nivå överkant belastningshöjd mot vingmur :

$$y_{slut} = y_{start} + L_1 \cdot \sin(\theta)$$

$$y_{mitt} = \frac{y_{start} + y_{slut}}{2}$$

$$z_{start} = h_3 - N \cdot \left(y_{start} - 0.5b_{över}\right)$$

$$z_{slut} = h_3 - N \cdot \left(y_{slut} - 0.5b_{över}\right)$$

$$z_{ök}(x) = \text{linterp}\left[\begin{pmatrix} 0 \\ L_1 \end{pmatrix}, \begin{pmatrix} z_{start} \\ z_{slut} \end{pmatrix}, x\right]$$

Nivå underkant vingmur :

$$z_{uk}(x) = \text{linterp}\left[\begin{pmatrix} 0 \\ L_1 \end{pmatrix}, \begin{pmatrix} 0 \\ h_3 - h_1 - h_2 \end{pmatrix}, x\right]$$

Effektiv bealstningshöjd mot vingmur : $h_{över}(x) = z_{ök}(x) - z_{uk}(x)$

Skärningspunkt mellan $z_{ök}(x)$ och $z_{uk}(x)$:

$$x_{skär} = 0.5L_1$$

Given

$$z_{ök}\left(x_{skär}\right) = z_{uk}\left(x_{skär}\right)$$

$$x_{skär} = \text{Find}\left(x_{skär}\right)$$

Belastninglängd mot vingmur :

$$L_{över} = \text{if}\left(x_{skär} > L_1, L_1, x_{skär}\right)$$

$x_{start} = 0\text{m}$ $\qquad x_{mitt} = \frac{L_{över}}{2}$ $\qquad x_{slut} = L_{över}$

Vertikal lastintensitet på nivå där lastspridning 1:1 belastar vingmur :

$$q_{över}(s) = \begin{vmatrix} 0\text{kPa} \quad \text{if } s > L_{över} \\ \dfrac{p_{över}}{2 \cdot \left[y_{start} + \left(y_{slut} - y_{start}\right) \cdot \dfrac{x}{L_1}\right]} \quad \text{otherwise} \end{vmatrix}$$

Lastintensitet mot vingmur :

$$P_{över} = K_o \cdot q_{över}(x) \cdot h_{över}(x)$$

Snittkrafter jordtryck + överlast :

$$H'_{jord} = \int_{x}^{L_1} p_{vilo}(s)\,ds \qquad M'_{jord} = \int_{x}^{L_1} (s-x)\cdot p_{vilo}(s)\,ds$$

$$H'_{över} = \begin{cases} 0kN & \text{if } x > L_{över} \\ \int_{x}^{L_{över}} P_{över}\,ds & \end{cases} \qquad M'_{över} = \begin{cases} 0kNm & \text{if } x > L_{över} \\ \int_{x}^{L_{över}} (s-x)\cdot P_{över}\,ds & \text{otherwise} \end{cases}$$

Lastkombinering - Lk ULS och Lk SLS :

Snittkraft i frontmur för inspänningssnitt

$$N'_{ULS.front} = \left(\gamma\psi_{jord.ULS}\cdot H'_{jord}(x=0m) + \gamma\psi_{över.ULS}\cdot H'_{över}(x=0m)\right)\cdot \sin(\omega)$$

$$M'_{ULS.front} = \gamma\psi_{jord.ULS}\cdot M'_{jord}(x=0m) + \gamma\psi_{över.ULS}\cdot M'_{över}(x=0m) + N'_{ULS.front}\cdot\frac{t_3}{2}$$

$$N'_{SLS.front} = \left(\gamma\psi_{jord.SLS}\cdot H'_{jord}(x=0m) + \gamma\psi_{över.SLS}\cdot H'_{över}(x=0m)\right)\cdot \sin(\omega)$$

$$M'_{SLS.front} = \gamma\psi_{jord.SLS}\cdot M'_{jord}(x=0m) + \gamma\psi_{över.SLS}\cdot M'_{över}(x=0m) + N'_{SLS.front}\cdot\frac{t_3}{2}$$

Snittkrafter i vingmur :

$$Q'_{ULS} = \gamma\Psi_{jord.ULS}\cdot H'_{jord} + \gamma\Psi_{över.ULS}\cdot H'_{över}$$

$$M'_{ULS} = \gamma\Psi_{jord.ULS}\cdot M'_{jord} + \gamma\Psi_{över.ULS}\cdot M'_{över}$$

$$M'_{SLS} = \gamma\Psi_{jord.SLS}\cdot M'_{jord} + \gamma\Psi_{över.ULS}\cdot M'_{över}$$

Beräkning av effektiv höjd :

$\Delta h = h_3 - h_2 - h_1$

Nivå överkant effektiv vingmur :

$$\text{Nivå}_{\text{ök}}(x) = \text{linterp}\left[\begin{pmatrix} 0m \\ L_2 \\ L_1 - a \\ L_1 \end{pmatrix}, \begin{pmatrix} h_3 - h_4 \\ h_3 - h_4 \\ h_3 - h_1 \\ h_3 - h_1 \end{pmatrix}, x\right]$$

Nivå underkant effektiv vingmur :

$$\text{Nivå}_{\text{uk}}(x) = \text{linterp}\left[\begin{pmatrix} 0 \\ L_1 - L_2 \\ L_1 \end{pmatrix}, \begin{pmatrix} \frac{a}{L_1} \cdot \Delta h \\ \Delta h \\ \Delta h \end{pmatrix}, x\right]$$

Effektiv höjd vingmur : $h_{ef}(x) = \text{Nivå}_{\text{ök}}(x) - \text{Nivå}_{\text{uk}}(x)$

Dimensionerande snittrafter (Lk ULS och Lk SLS) fördelade på effektiv höjd :

Snittkraft i frontmur för inspänningssnitt :

$$H_{ef} = h_{ef}(0m)$$

$$N_{ULS.front} = \frac{N'_{ULS.front}}{H_{ef}}$$

$$M_{ULS.front} = \frac{M'_{ULS.front}}{H_{ef}}$$

$$N_{SLS.front} = \frac{N'_{SLS.front}}{H_{ef}}$$

$$M_{SLS.front} = \frac{M'_{SLS.front}}{H_{ef}}$$

Snittkrafter i vingmur :

$$Q_{ULS}(x) = \frac{Q'_{ULS}}{h_{ef}(x)} \qquad M_{ULS}(x) = \frac{M'_{ULS}}{h_{ef}(x)} \qquad M_{SLS}(s) = \frac{M'_{SLS}}{h_{ef}(x)}$$

Egenvikt vingmur :

$$t(x) = t_2 - \frac{t_2 - t_1}{L_1} \cdot x$$

$$A(x) = h_{mur}(x) \cdot t(x)$$

$$V_{egen} = \gamma_{btg} \cdot \int_0^{L_1} A(x)\, dx$$

$$M_{egen} = \gamma_{btg} \cdot \int_0^{L_1} A(x) \cdot s\, dx$$

RESULTAT

Mellansresultat :

Dimensionerande friktionsvinkel tillhörande K_o: $\varphi = 45 \cdot°$

Lutning hos slänten ned till överkant vingmur mätt vinkelrätt mot vingen : $\beta = 84 \cdot°$

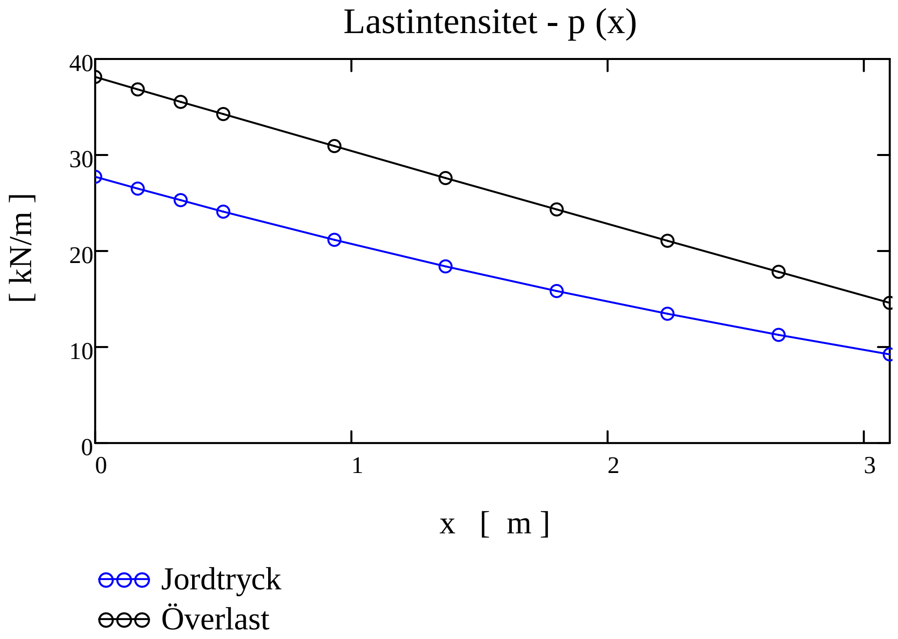
Belastningsyta för överlast :

x	$z_{ök}(x)$	$z_{uk}(x)$	y (x)	Snitt
0	2,230	0	2,120	Vingrot
1,550	2,203	0,650	2,147	$0.5L_{över}$
3,100	2,176	1,300	2,174	$L_{över}$
m	m	m	m	-

Utvärdering av jordtryck + överlast samt tilhörande farligaste brottvinkel redovisad i tabellform :

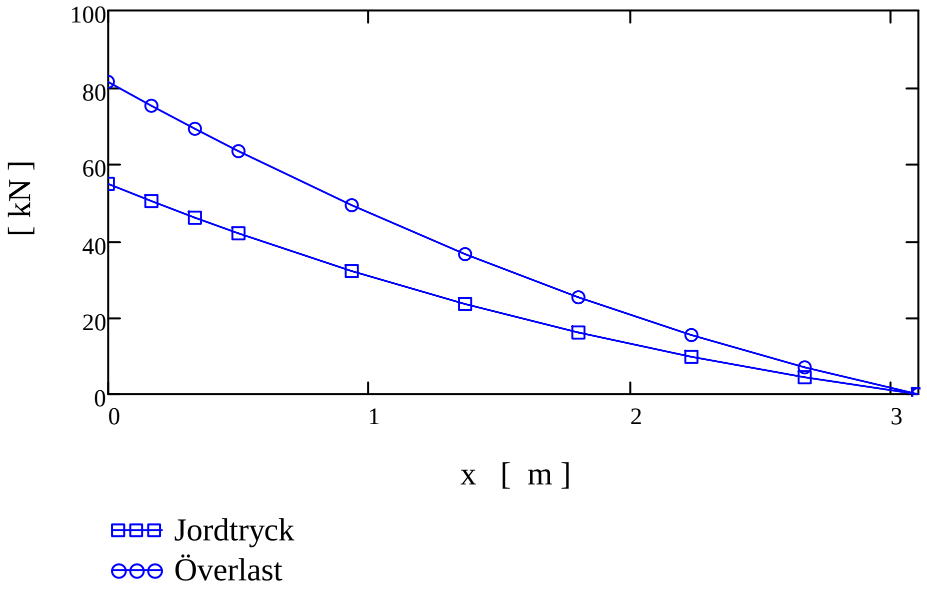
x	P_{jord}	α_{tillh}	$P_{över}$
0	28	66	38
0,17	26	66	37
0,33	25	66	36
0,50	24	66	34
0,93	21	66	31
1,37	18	66	28
1,80	16	66	24
2,23	13	66	21
2,67	11	66	18
3,10	9	66	15
m	kN/m	grader	kN/m

Utvärdering av jordtryck + överlast i diagramform :

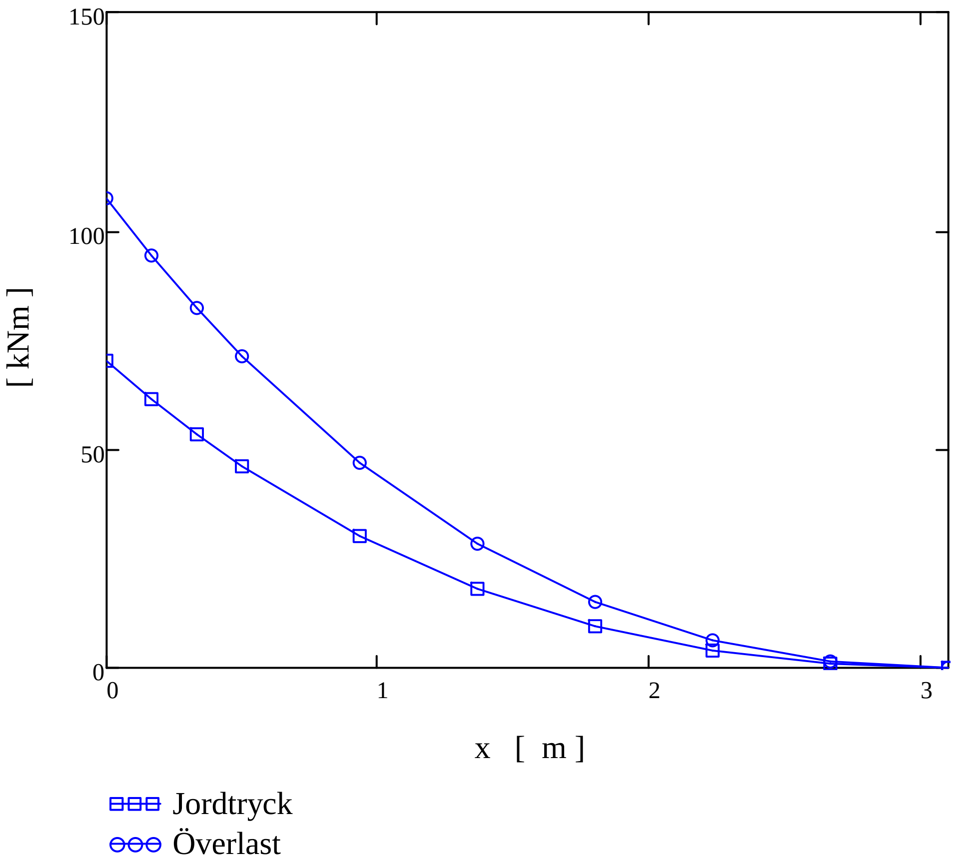


Uvärdering av snittkrafter tillhörande jordtryck + överlast i diagramform :

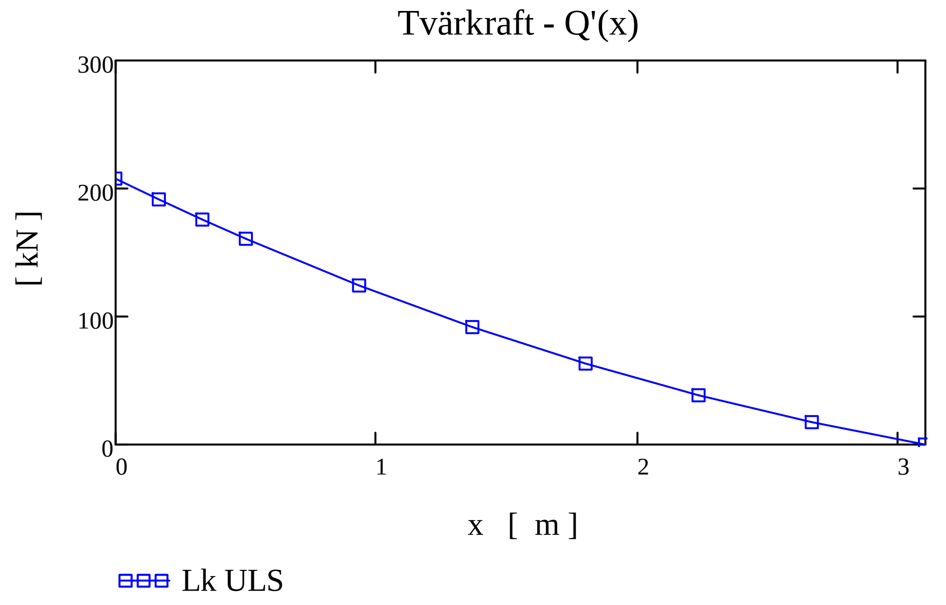
Tvärkraft - H'(x)

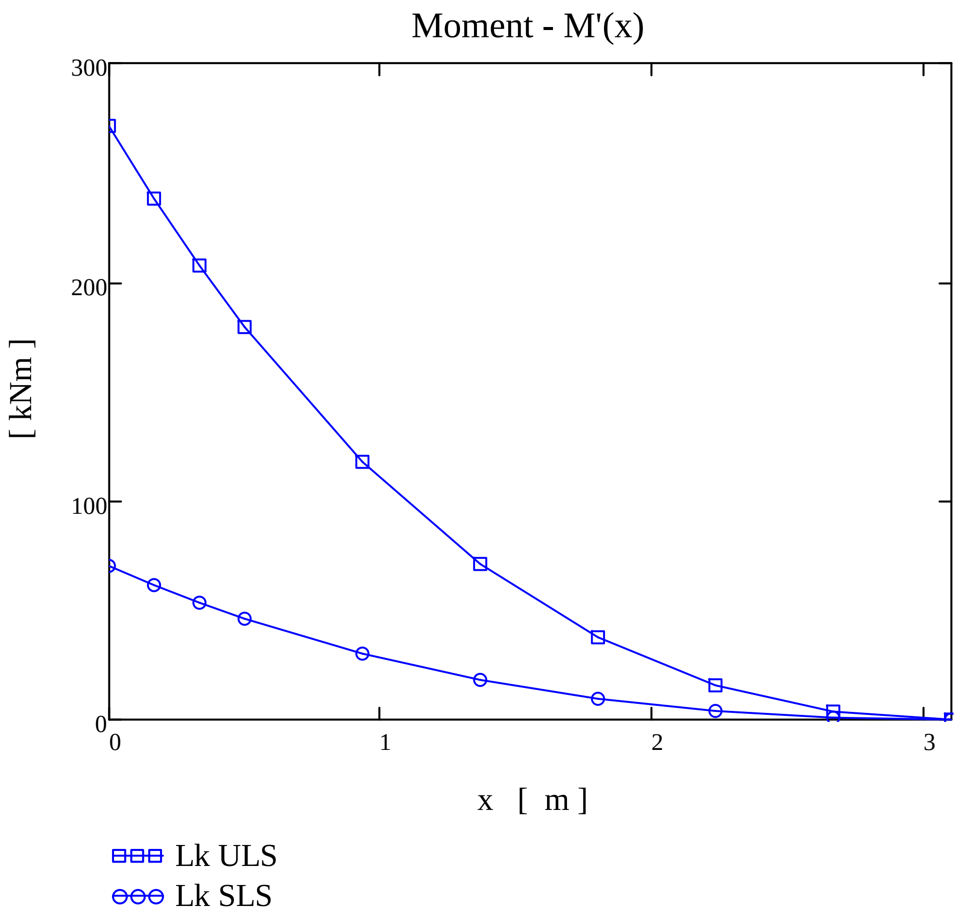


Moment - M'(x)

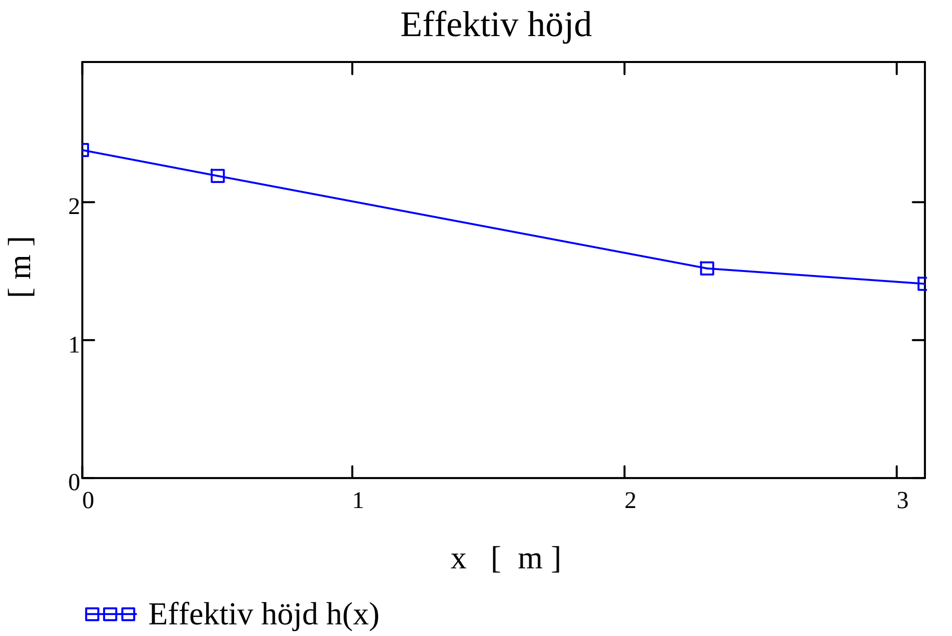


Uvärdering av dimensionerande snittkrafter för Lk ULS och Lk SLS i diagramform :





Uvärdering av effektivhöjd i diagramform :



Resultat :

Resulterande snittkrafter för vingmur inspänningssnitt :

$H'_{jord}(0\cdot m) = 55\cdot kN$

$M'_{jord}(0\cdot m) = 70\cdot kNm$

$H'_{över}(0\cdot m) = 81\cdot kN$

$M'_{över}(0\cdot m) = 107\cdot kNm$

Dimensionerande snittkrafter i frontmur för inspänningssnitt för delade på höjden $H_{ef} = 2.365m$:

N_{ULS}	M_{ULS}	N_{SLS}	M_{SLS}
88	141	23	37
kN/m	kNm/m	kN/m	kNm/m

Dimensionerande snittkrafter i vingmur :

x	Q_{ULS}	M_{ULS}	M_{SLS}	t (x)
0	88	115	30	0,400
0,17	83	103	27	0,400
0,33	78	93	24	0,400
0,50	74	82	21	0,400
0,93	62	58	15	0,400
1,37	49	38	10	0,400
1,80	37	22	6	0,400
2,23	25	10	3	0,400
2,67	13	3	1	0,400
3,10	0	0	0	0,400
m	kN/m	kNm/m	kNm/m	m

Egenvikt vingmur :

Egenvikt ger upphov till en triangulär linjelast med största intensiteten enligt nedan :

$V_{egen} = 71 \cdot kN$

$M_{egen} = 96 \cdot kNm$

$$x_{tp} = \frac{M_{egen}}{V_{egen}}$$

$x_{tp} = 1.35\,m$

Last vinkelrätt mot frontmur / ramben av egentyngd + jordtryck + överlast :

Egenvikt ger upphov till en triangulär linjelast med största intensiteten enligt nedan :

$$p_{egen} = M_{egen} \cdot \frac{6}{H_{ef}^{2}} \cdot \sin(\omega)$$

$p_{egen} = 103 \cdot \frac{kN}{m}$

Jordtryck + överlast ger upphov till en reaktangulär linjelast med intensiteten enligt nedan :

$$p_{jord} = -\frac{H'_{jord}(0m)}{H_{ef}} \cdot \cos(\omega)$$

$p_{jord} = -0 \cdot \frac{kN}{m}$

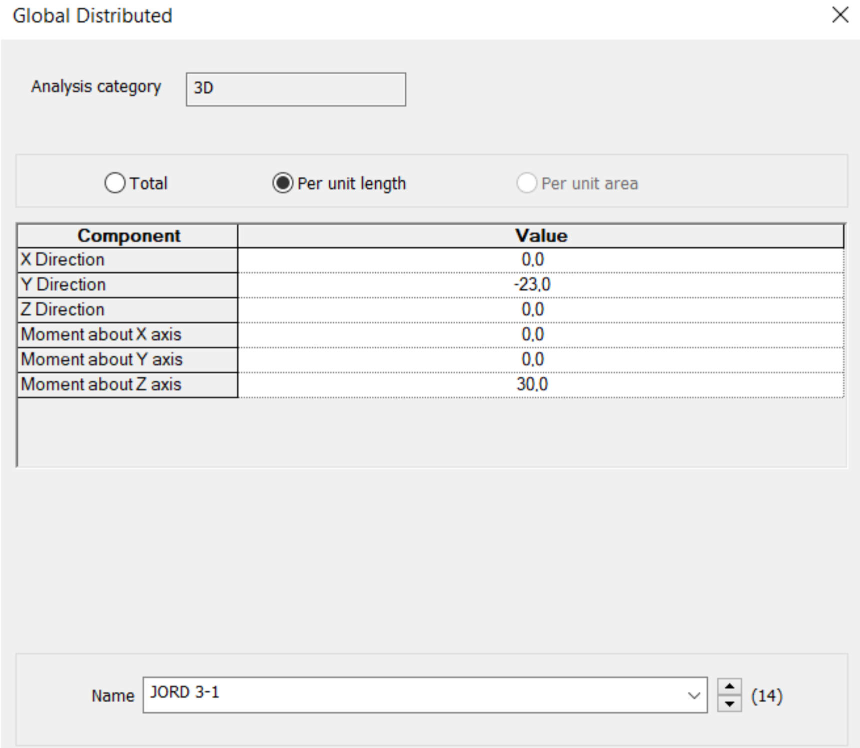
$$p_{över} = -\frac{H'_{över}(0m)}{H_{ef}} \cdot \cos(\omega)$$

$p_{över} = -0 \cdot \frac{kN}{m}$

Load case : JORD 3-1

$$p_y = -23\frac{kN}{m}$$

$$m_z = +30\frac{kNm}{m}$$

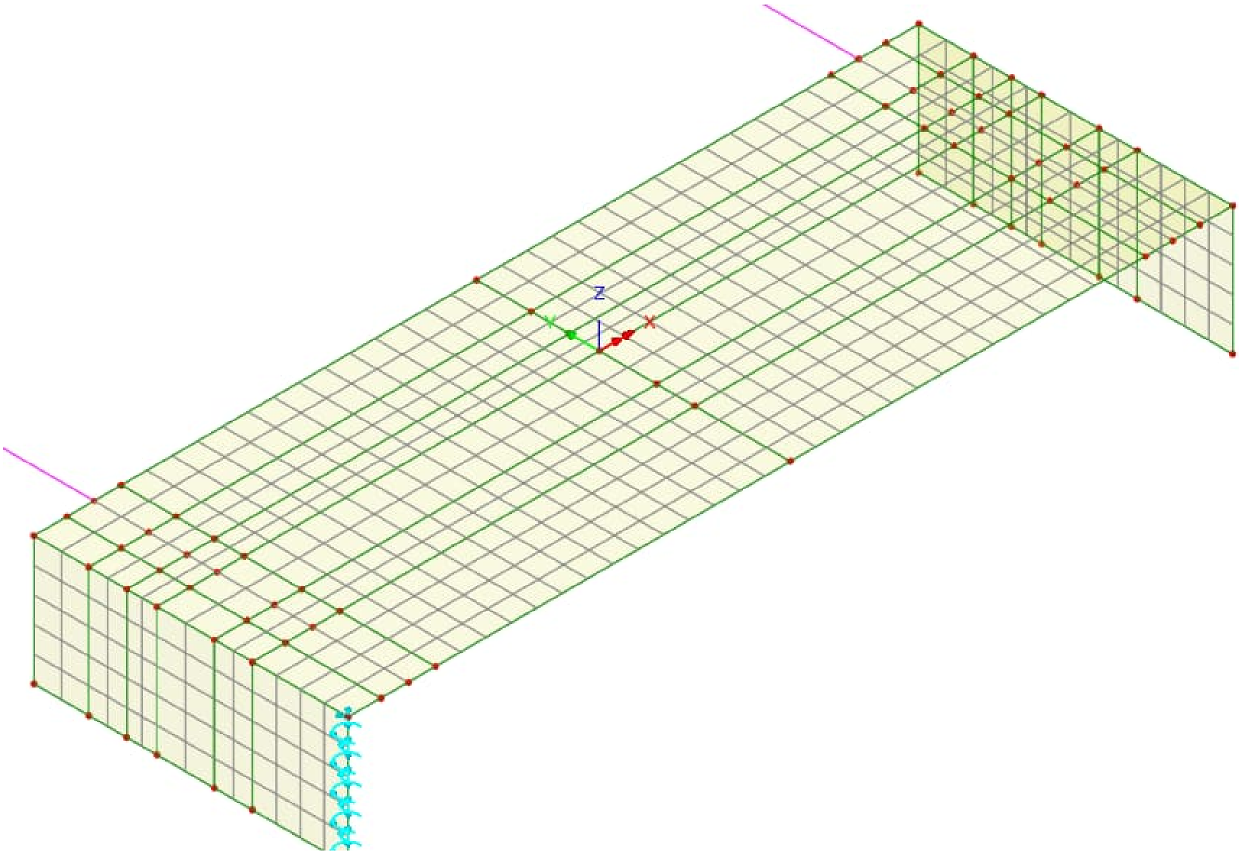

Global Distributed

Analysis category: 3D

Total / Per unit length (selected) / Per unit area

Component	Value
X Direction	0,0
Y Direction	-23,0
Z Direction	0,0
Moment about X axis	0,0
Moment about Y axis	0,0
Moment about Z axis	30,0

Name: JORD 3-1 (14)

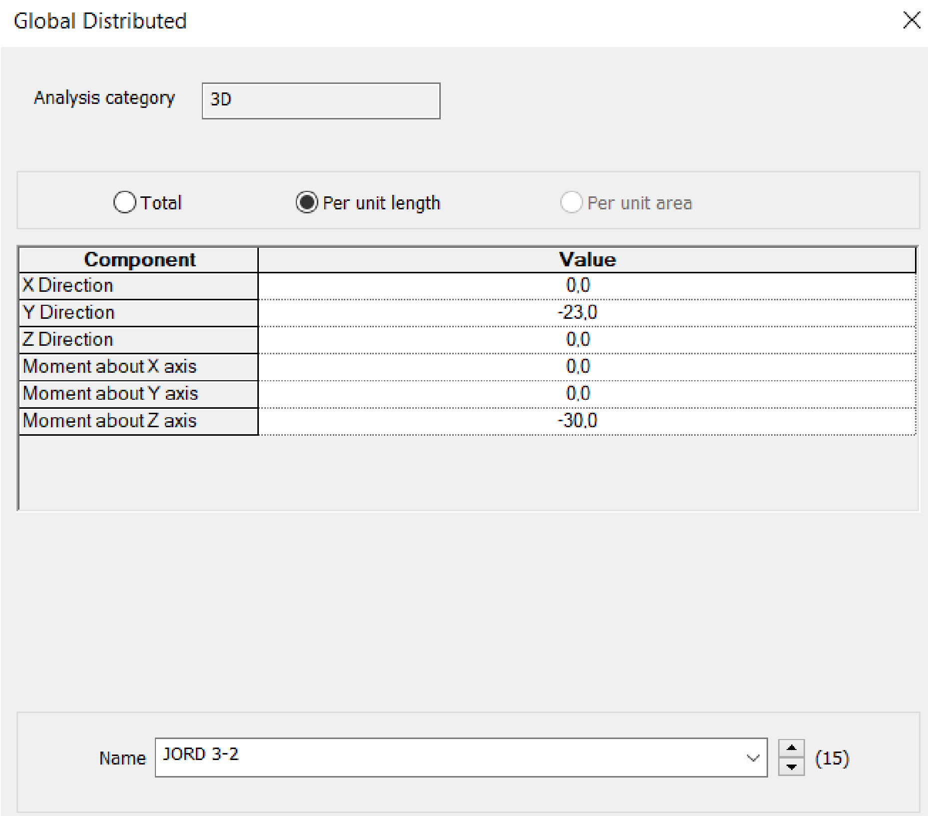


Overview 3D

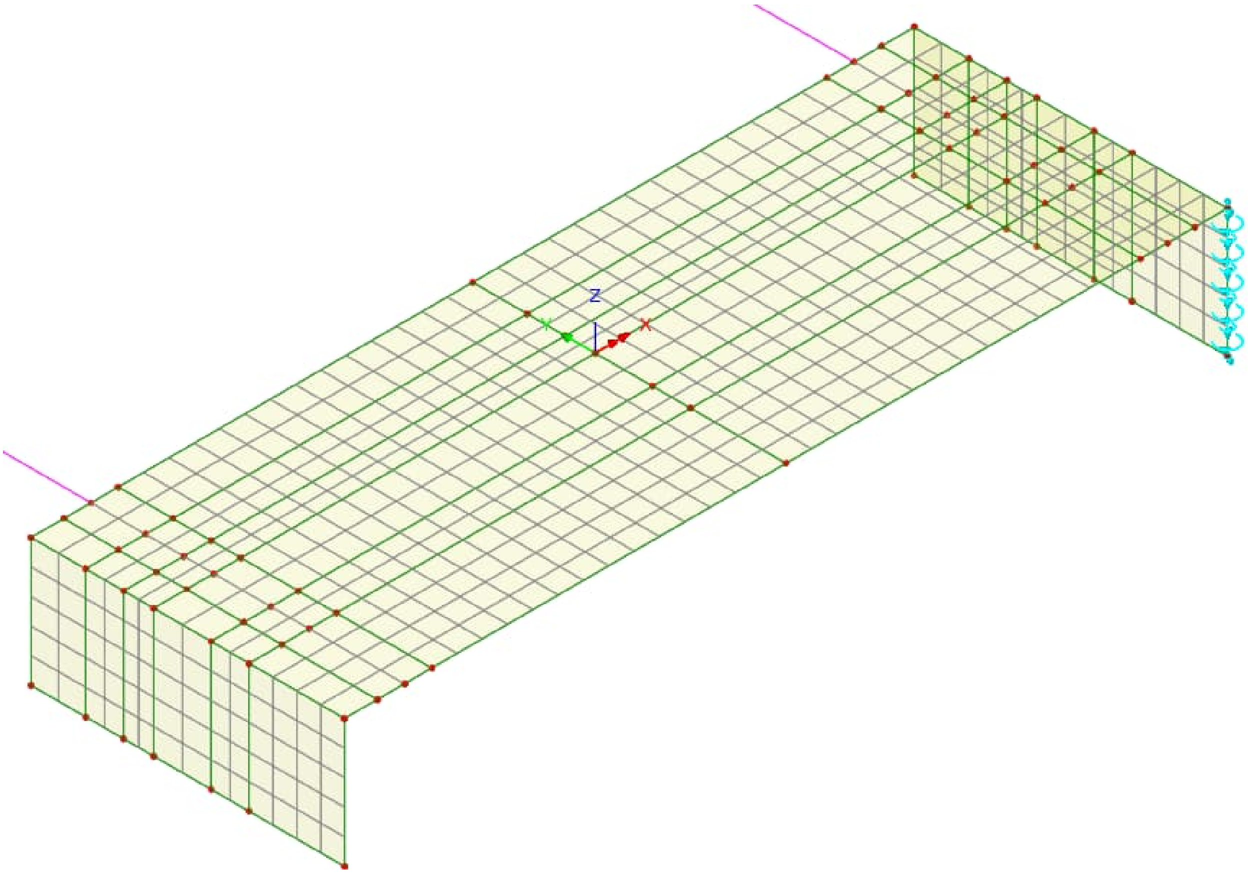
Load case : JORD 3-2

$$p_y = -23\frac{kN}{m}$$

$$m_z = -30\frac{kNm}{m}$$



Component	Value
X Direction	0,0
Y Direction	-23,0
Z Direction	0,0
Moment about X axis	0,0
Moment about Y axis	0,0
Moment about Z axis	-30,0



Overview 3D

3.3.4 Load combination earth pressure: JORD

Basic load combination JORD :

Load case	Factor
JORD 1	1
JORD 2	1
JORD 3-1	1
JORD 3-2	1

3.4 SUPPORT SETTLEMENT

Load effect of support settlement shall be considered in TRVINFRA-00227 section 7.2.1.1.1.1.

Only horizontal support displacement in the longitudinal direction of the bridge needs to be considered. Additionally, it is stated that horizontal and vertical support displacements do not need to be combined.

When designing superstructure, the effect of support settlement is not considered.

Not when designing piles support settlement is movement occurs. No associtating load effect arises in piles.

3.5 CREEP

Total creep is determined according to SS-EN 1992-1-1 §3.1.4 and TRVINFRA-00227 section 7.1.6.4 for RH 80% at time t_1.

Time for first loading (= time when formwork was removed) is termed t_0.

The effect should be considered in the serviceability limit state according to SS-EN 1992-1-1 §2.3.2.2(1).
If this is done, a gradual crack development may be applied according to SS-EN 1992-1-1 §5.4(3).

The effect does not need to be considered in the ultimate limit state according to SS-EN 1992-1-1 §2.3.2.2(2).
If this is done, a reduced stiffness may be applied according to SS-EN 1992-1-1 §5.4(3).

$t_0 = 5\ days$

$t_1 = 120\ years$

Creep is determined using program PROG A001.

For b = 5.75 m and t = 0.95 m → $\phi(t_1, t_0) = 1.94$ according to page A3:45.

Creep value $\phi(t_1, t_0) = 1.9$ is used on all structural parts on safe side.

$$\varepsilon_{cc}(t_1, t_0) = \varphi(t_1, t_0) \cdot \frac{\sigma_c}{E_c}$$

The effect of reducted stiffness according SS-EN 1992-1-1 5.8.7 is considered as see in table below.

$$E^{system} = \frac{E_{cm}}{1 + \phi} = f \cdot E_{cm}$$

Last	φ	f
Permanent	1.9	0.34
Variable excl. Temperature	0	1.00
Temperature	0.3*	0.77

* = According to swedish praxis.

Remark.
TRVINFRA-00227 section 7.2.1.1.2.4 states no reduction is permissible for uneven temperature variation over height of cross section is permissible. This since variation has very short duration (only over a day).

Objekt: Överbyggnad

Betong (C30/37, C35/45, C40/50 och C45/55): $BTG = \text{"C35/45"}$

Relativ fuktighet : $RH = 80\%$

Tvärsnittetsbredd : $b = 7.5m$

Tvärsnittetshöjd : $h = 1.0m$

Tvärsnittsarea : $A_c = b \cdot h = 7.5 \cdot m^2$

Omkrets i kontakt med "luft" : $u = 2 \cdot b = 15\,m$

Bärverkets ekvivalenta tjocklek : $h_0 = \dfrac{2 \cdot A_c}{u} = 1\,m$

Studerad tidpunkt för bestämning av krypning : $t_1 = 70\text{år}$ $t_1 = 25550 \cdot \text{dag}$ (60 dag)

Tidpunkt för pålastning (= formrivning): $t_0 = 30\text{dag}$

Indatakvitto

$f_{cm} = 43 \cdot MPa$

BERÄKNING

Uttryck för bestämning av kryptalet är hämtat från SS-EN 1992-1-1 Bilaga B.1.

$$\alpha_1 = \left(\frac{35MPa}{f_{cm}}\right)^{0.7} = 0.87$$

$$\alpha_2 = \left(\frac{35MPa}{f_{cm}}\right)^{0.2} = 0.96$$

$$\alpha_3 = \left(\frac{35MPa}{f_{cm}}\right)^{0.5} = 0.9$$

$$\varphi_{RH} = \begin{cases} 1 + \dfrac{1 - RH}{0.1\sqrt[3]{\dfrac{h_0}{mm}}} & \text{if } f_{cm} \le 35MPa \\ \left(1 + \dfrac{1 - RH}{0.1\sqrt[3]{\dfrac{h_0}{mm}}}\cdot\alpha_1\right)\cdot\alpha_2 & \text{otherwise} \end{cases} = 1.13$$

$$\beta_0 = \frac{1}{0.1 + t_0^{0.20}} = 0.48$$

$$\beta_{fcm} = \frac{16.8}{\sqrt{\dfrac{f_{cm}}{MPa}}} = 2.56$$

$$\beta_H = \begin{array}{|l} \text{if } f_{cm} \le 35MPa \\ \quad \begin{array}{|l} \beta_{H.max} \leftarrow 1500 \\ \beta_H \leftarrow \beta_{H.max} \text{ if } 1.5 \cdot \left[1 + (0.012 \cdot 100RH)^{18}\right] \cdot \frac{h_0}{mm} + 250 > \beta_{H.max} \\ \beta_H \leftarrow 1.5 \cdot \left[1 + (0.012 \cdot 100RH)^{18}\right] \cdot \frac{h_0}{mm} + 250 \text{ otherwise} \end{array} \\ \text{if } f_{cm} > 35MPa \\ \quad \begin{array}{|l} \beta_{H.max} \leftarrow 1500 \cdot \alpha_3 \\ \beta_H \leftarrow \beta_{H.max} \text{ if } 1.5 \cdot \left[1 + (0.012 \cdot 100RH)^{18}\right] \cdot \frac{h_0}{mm} + 250 > \beta_{H.max} \\ \beta_H \leftarrow 1.5 \cdot \left[1 + (0.012 \cdot 100RH)^{18}\right] \cdot \frac{h_0}{mm} + 250 \cdot \alpha_3 \text{ otherwise} \end{array} \\ \beta_H \end{array}$$

$\beta_H = 1353$

$$\beta_c = \left(\frac{t_1 - t_0}{\beta_H + t_1 - t_0}\right)^{0.3} = 0.98$$ (0.3)

$\varphi_{t0} = \varphi_{RH} \cdot \beta_{fcm} \cdot \beta_0 = 1.39$ (1.4)

$\varphi_{t1} = \varphi_{t0} \cdot \beta_c = 1.4$ (0.4)

3.6 SHRINKAGE

Total shrinkage according to SS-EN 1992-1-1 §3.1.4 and TRVINFRA-00227 section 7.1.6.4 for RH 80% at time t_1.

Determination of load effect from shrinkage should consider the reduced concrete stiffness from creep.

$t_s = 0\ days$

$t_1 = 120\ years$

Shrinkage is determined using program PROG A002 after time t_1.

In studied bridge different thickness varies, but geometry seen below is used on safe side.

For b = 5.75 m and t = 0.95 m → $\varepsilon_{cs}\ (t_1) = 0.024\%$ according to page A3:49.

Shrinkage ε_cs=0.024% is applied to all construction parts for safety. The movement corresponds to that which occurs due to an imaginary temperature load ∴ T = -24°C.

The load effect is used when designing piles but is not considered when designing superstructure since generated only movement.

Remark

The effect of support is considered in the serviceability limit state (SLS) according to SS-EN 1992-1-1 §2.3.2.2(1). If this occurs, a gradual crack development may be applied according to SS-EN 1992-1-1 §5.4(3).

Reduction due to cracking is not credited on the safe side; however, the effect of creep is considered.

The effect of support is not considered in the ultimate limit state (ULS) according to SS-EN 1992-1-1 §2.3.2.2(2).

Objekt: Plattbro

Betong (C30/37, C35/45, C40/50 och C45/55): $BTG = "C35/45"$

Relativ fuktighet (se KBB avsnitt B.3.3.6): $RH = 80\%$

Tvärsnittetsbredd : $b = 5.75m$

Tvärsnittetshöjd : $h = 0.95m$

Tvärsnittsarea : $A_c = b \cdot h = 5.46 \cdot m^2$

Omkrets i kontakt med "luft" : $u = 2 \cdot b = 11.5\, m$

Bärverkets ekvivalenta tjocklek : $h_0 = \frac{2 \cdot A_c}{u} = 0.95\, m$

Studerad tidpunkt för bestämning av krympning : $t_1 = 120år$ $t_1 = 43800 \cdot dag$

Tidpunkt för pålastning (= formrivning): $t_0 = 5dag$

Cementklass (S, N, R) : $Klass = "N"$

Betongens ålder då uttorkningskrympning påbörjas : $t_s = 0dag$

Indatakvitto

$f_{cm} = 43 \cdot MPa$ $f_{ck} = 35 \cdot MPa$ $f_{ck.kub} = 45 \cdot MPa$

BERÄKNING

Grundvärdet för krympning från uttorkning (SS-EN 1992-1-1 Bilaga B.2)

$$\alpha_{ds1} = \begin{vmatrix} 3.0 \text{ if Klass} = \text{"S"} \\ 4.0 \text{ if Klass} = \text{"N"} \\ 6.0 \text{ if Klass} = \text{"R"} \end{vmatrix} = 4.00$$

$$\alpha_{ds2} = \begin{vmatrix} 0.13 \text{ if Klass} = \text{"S"} \\ 0.12 \text{ if Klass} = \text{"N"} \\ 0.11 \text{ if Klass} = \text{"R"} \end{vmatrix} = 0.12$$

$$RH_o = 100 \cdot \%$$

$$\beta_{RH} = 1.55 \cdot \left[1 - \left(\frac{RH}{RH_o}\right)^3\right] = 0.76$$

$$\varepsilon_{cd.0} = 0.85 \left[\left(220 + 110 \cdot \alpha_{ds1}\right) \cdot e^{-\alpha_{ds2} \cdot \frac{f_{cm}}{f_{cmo}}}\right] \cdot 10^{-6} \cdot \beta_{RH} = 0.025 \cdot \%$$

Grundvärdet för krympning från uttorkning (SS-EN 1992-1-1 avsnitt 3.1.4 ekv. 3.9 och 3.10)

$$k_h = \text{linterp}\left[\left(0 \quad 100 \quad 200 \quad 300 \quad 500 \quad 10^4\right) mm^T, \left(1.00 \quad 1.00 \quad 0.85 \quad 0.75 \quad 0.70 \quad 0.70\right)^T, h_0\right] = 0.70$$

$$\beta_{ds} = \frac{t_1 - t_s}{t_1 - t_s + 0.04 \sqrt{\left(\frac{h_0}{mm}\right)^3}} = 0.97$$

$$\varepsilon_{cd} = \beta_{ds} \cdot k_h \cdot \varepsilon_{cd.0} = 0.017 \cdot \%$$

Autogen krympning (SS-EN 1992-1-1 avsnitt 3.1.4 ekv. 3.11, 3.12 och 3.13)

$$k_h = \text{linterp}\left[\left(0 \quad 100 \quad 200 \quad 300 \quad 500 \quad 10^4\right)\text{mm}^{T}, \left(1.00 \quad 1.00 \quad 0.85 \quad 0.75 \quad 0.70 \quad 0.70\right)^{T}, h_0\right] = 0.70$$

$$\beta_{as} = 1 - e^{-0.2\cdot\sqrt{t_1}} = 1.00$$

$$\varepsilon_{ca.\infty} = 2.5\cdot\left(\frac{f_{ck}}{\text{MPa}} - 10\right)\cdot 10^{-6} = 0.006\cdot\%$$

$$\varepsilon_{ca} = \beta_{as}\cdot\varepsilon_{ca.\infty} = 0.006\cdot\%$$

Total krympning (SS-EN 1992-1-1 avsnitt 3.1.4 ekv. 3.8)

$$\varepsilon_{cs} = \varepsilon_{cd} + \varepsilon_{ca} = 0.024\cdot\%$$

3.7 TRAIN LOAD

3.7.1 Track location

According to TRVINFRA-00227, 7.1.6.2.1.3 t), consideration must be given to future track adjustments. The bridge is therefore designed for alternative track layouts. The minimum distance between obstacles laterally must be able to be 2.12 m at the level top of track and meet the clearance requirements according to “Infrastrukturprofiler” TRVINFRA-00004 with a reduction of 0.3 m according to TRVINFRA-00227.

According to SS-EN 1991-2, 6.3.5, an effect of lateral displacement of vertical loads shall be considered by setting the ratio between wheel loads for all axles to 1.25 m for any track. This is achieved by using different load panels that are eccentrically placed in relation to the actual track centreline.

According to SS-EN 1991-2, 6.8.1 (1), the superstructure shall be designed for the number of tracks required and the track placement according to the track positions and tolerances specified.

According to SS-EN 1991-2, 6.8.1 (2), the superstructure shall also be designed for the greatest number of tracks that is geometrically and structurally possible.

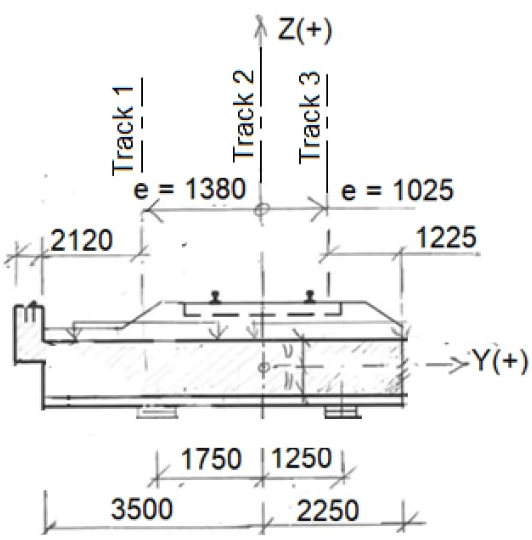
Width bridge deck (2 pcs) 5.75 m

Free distance between centre of tracks: 4.50 m

Minimum distance to edge: 2.25 m respective 3.50 m

System analysis is performed using 3 different track loactions.

e	Location
+1380	Track 1
0	Track 2
-1025	Track 3
mm	-



3.7.2 Dynamic contribution

Dynamic contribution is determined according to SS EN 1991-2 section 6.4.5.2 with the condition of careful maintenance (TSFS 2018:57).

$L_\Phi = 14m$

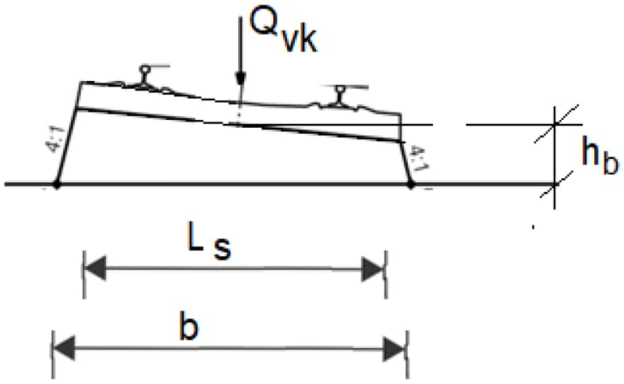
$$\frac{1.44}{\sqrt{L_\Phi} - 0.2} + 0.82 = \frac{1.44}{\sqrt{14} - 0.2} + 0.82 = 1.23 < 1.67 \rightarrow \Phi_2 = 1.23$$

According to SS-EN 1991-2 section 6.4.5.4 (2), dynamic contribution does not need to be considered for foundations. For this bridge, the pile load capacity and geotechnical capacity will be checked without dynamic contribution.

3.7.3 Transverse load distribution

A very conservative load distribution for distribution length (b) through sleepers and ballast is carried out according to SS-EN 1991-2 section 6.3.6.3, see the presentation below.

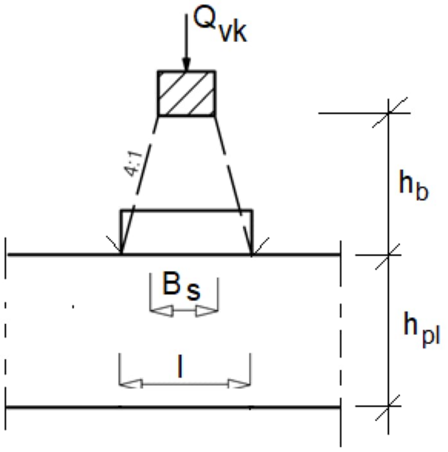
$$b = L_s + 2 \cdot \frac{h_b}{4} = 2250mm + 2 \cdot \frac{400mm}{4} = 2450mm$$



3.7.4 Longitudinal load distribution

A very conservative load distribution length (l) through sleepers and ballast occurs according to SS-EN 1991-2 section 6.3.6.3, see the presentation below.

$$l = B_s + 2 \cdot \frac{h_b}{4} = 320mm + 2 \cdot \frac{400mm}{4} = 520mm$$



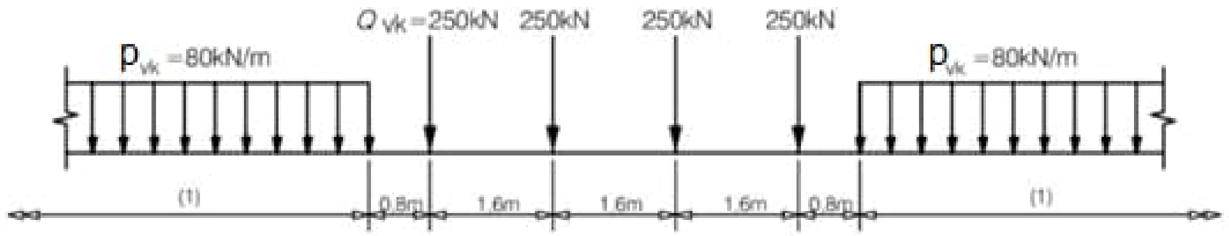
When determining the design load capacity corresponding to LM 71, however, the point load (Q_{vk}) is distributed over a distribution length of 1.60 m according to common calculation practice.

This is considered possible because the load is also spread in the bridge deck slab. For a load distribution of 1:1.7, a distribution width corresponding to 1.6 m is obtained, as shown below.

$$l' = l + 2 \cdot \frac{h_{pl}}{1.7} = 520mm + 2 \cdot \frac{900mm}{1.7} = 1.6m$$

3.7.5 Load modell LM 71

Characteristic values of vertical loads according to EN 1991-2 section 6.3.2.



Adaption factor for" malmbanan": α = 1,60

Design speed: v = 120 km/h

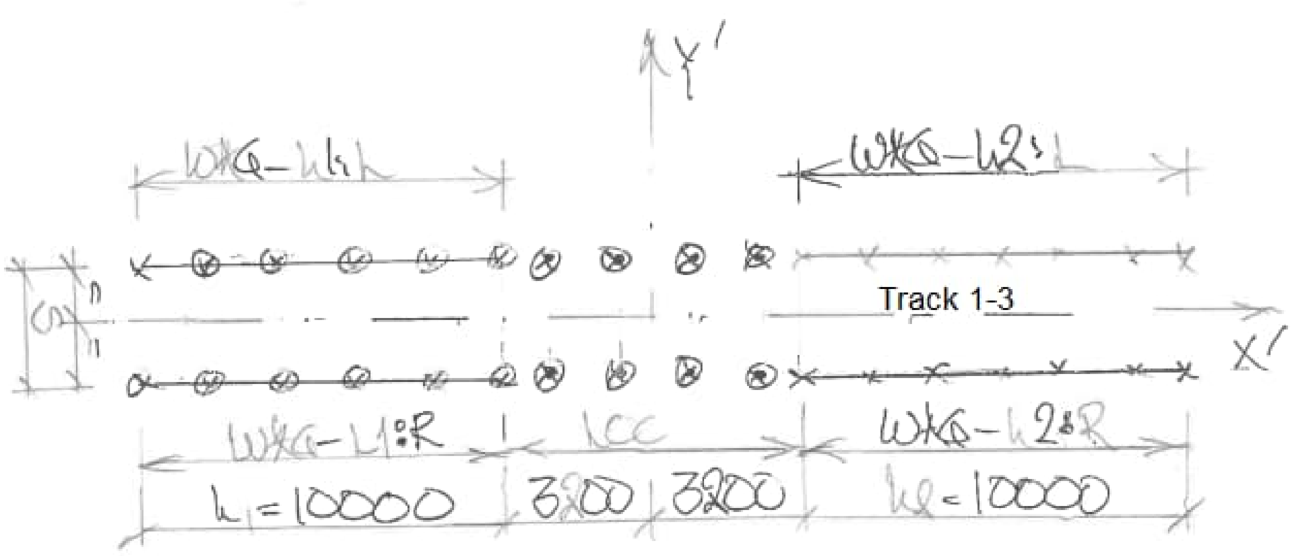
Train load is modelled as line loads and point loads in the system calculation according to the presentation below.

This is done by creating 4 line loads (∴ wagon) and 8 point loads (∴ locomotive).

In these loads, neither the impact of dynamic addition (Φ_2) nor the adaptation factor (α) is considered. These are instead considered when determining load coefficients.

Line loads apply the distance of 1435 mm between the rails (s) on the safe side.

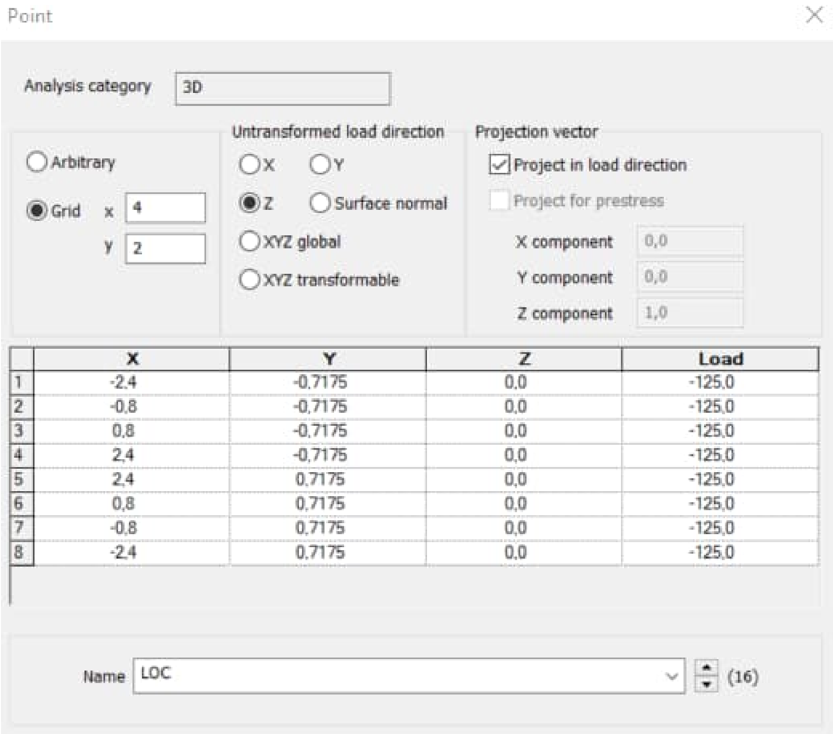
The most dangerous load condition is obtained by applying these loads along the track lines (track 1-3). This is done with the function "Moving Load Analysis." All loads are "Discrete load" (loads tied to the coordinate system) which are combined into a "Compound load" as shown below.



PLAN

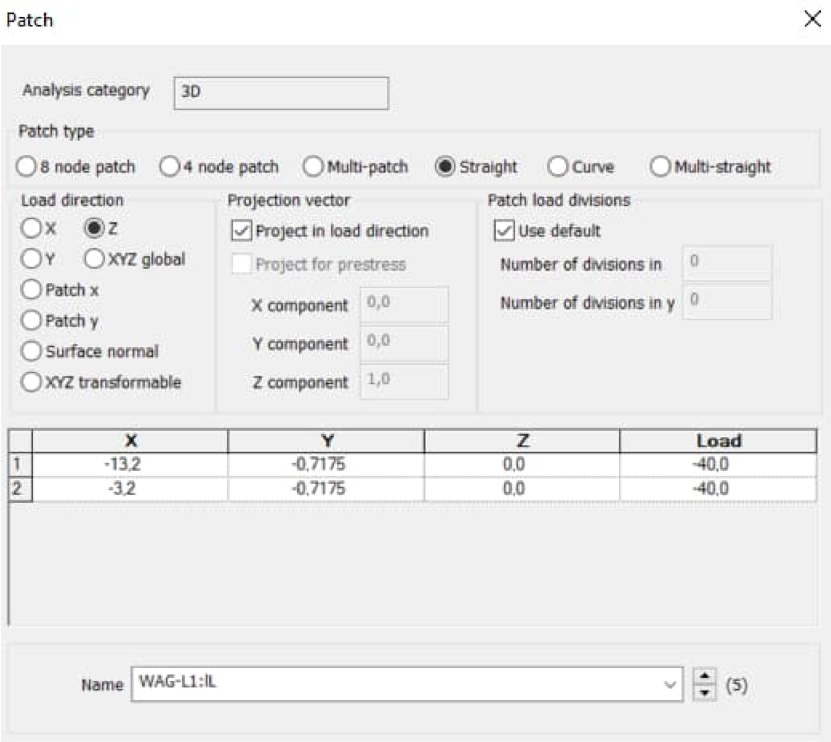
Discrete loads

Discrete point load - LOC :

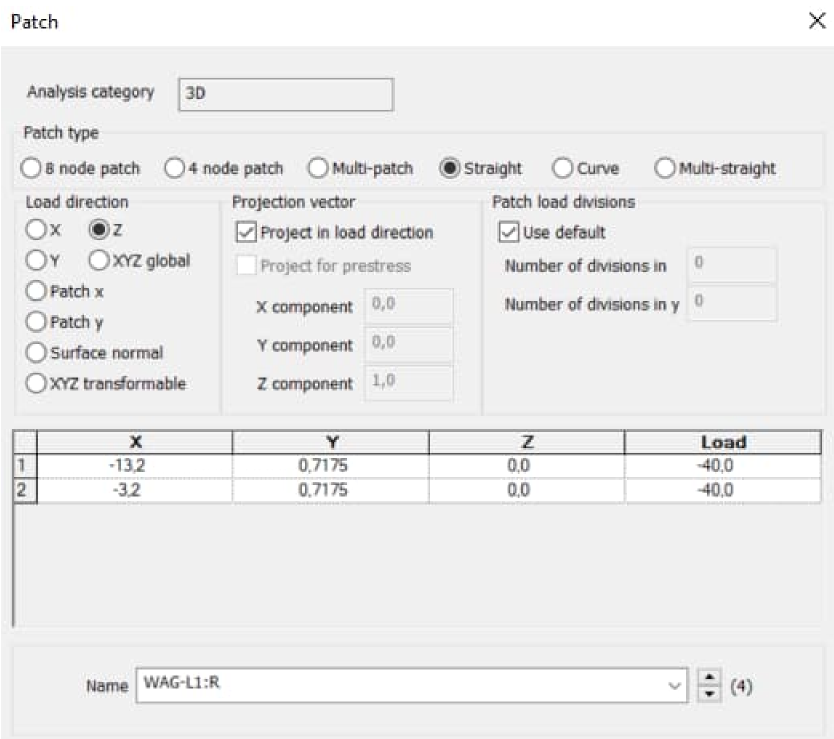


	X	Y	Z	Load
1	-2,4	-0,7175	0,0	-125,0
2	-0,8	-0,7175	0,0	-125,0
3	0,8	-0,7175	0,0	-125,0
4	2,4	-0,7175	0,0	-125,0
5	2,4	0,7175	0,0	-125,0
6	0,8	0,7175	0,0	-125,0
7	-0,8	0,7175	0,0	-125,0
8	-2,4	0,7175	0,0	-125,0

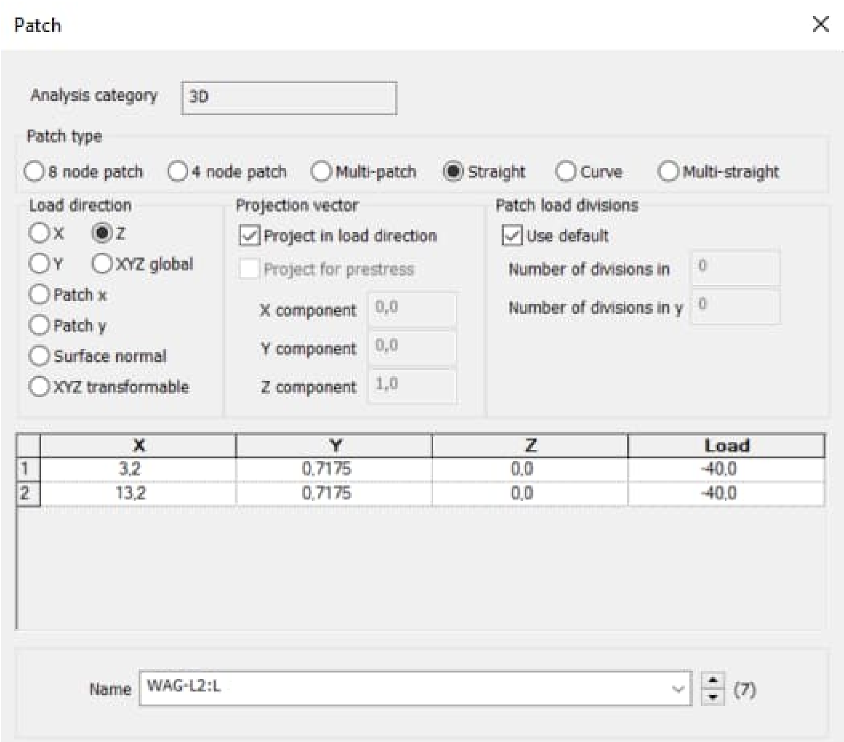
Discrete patch load - WAG-L1:L :



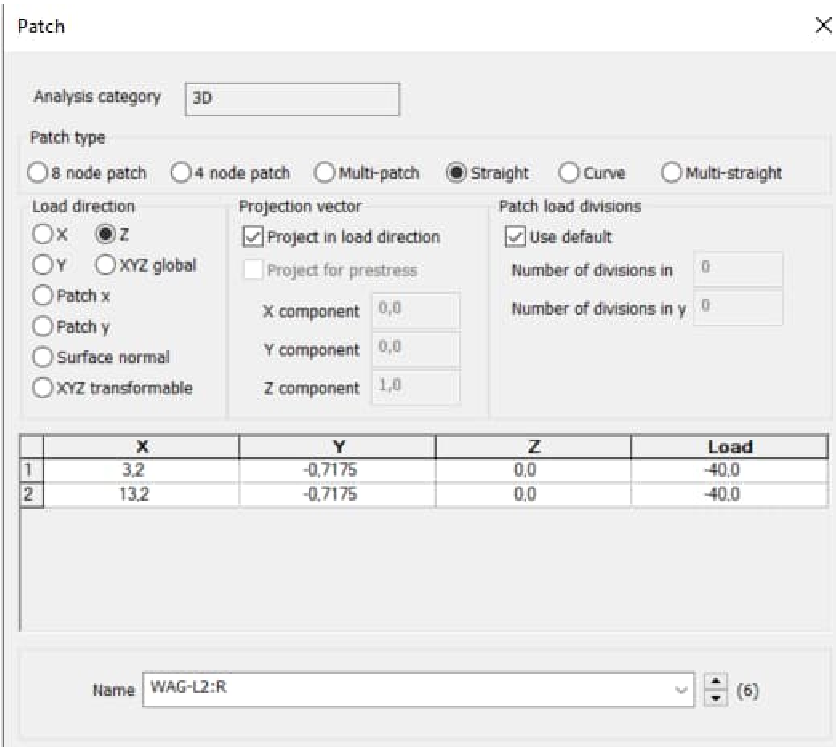
Discrete patch load - WAG-L1:R :



Discrete patch load - WAG-L2:L :



Discrete patch load - WAG-L2:R :



Compound load – LM 71:

Compound

Analysis category: 3D

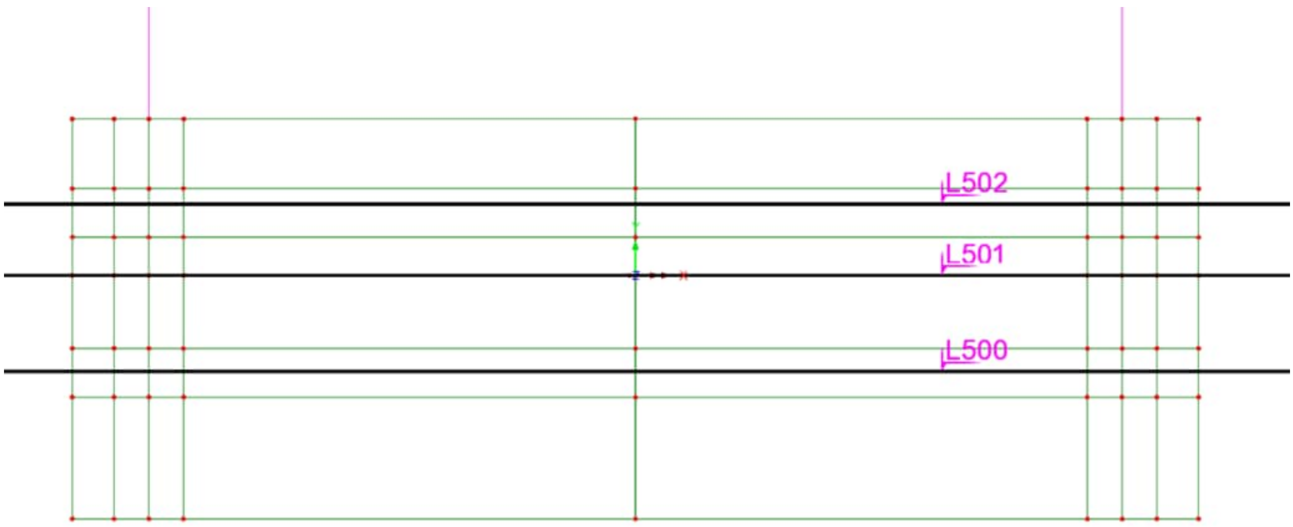
Included

Component	x offse	y offse	z offse	Factor	Transformati
16:LOC	0,0	0,0	0,0	1,0	None
4:WAG-L1:R	0,0	0,0	0,0	1,0	None
5:WAG-L1:IL	0,0	0,0	0,0	1,0	None
6:WAG-L2:R	0,0	0,0	0,0	1,0	None
7:WAG-L2:L	0,0	0,0	0,0	1,0	None

Name: LM71 (8)

Track location (Track 1-3):

Track	e	Line
1	+1.380	L500
2	0	L501
3	-1.025	L502
-	m	m



PLAN
Track 1-3

Load attribute :

Load attribute nr	Load attribute	Type
8	LM 71	Compound load

Load cases :

Loadcase	Line	Track
LM 71 -T1	500	FB1
LM 71 - T2	501	FB2
LM 71 - T3	502	FB3

Envelope LM71... :

Envelope
LM71 - T1
LM71 - T2
LM71 - T3

3.7.6 Load model SW/0

Train load SW/0 according to SS-EN 1991-2 section 6.3.3.

Load model SW/0 only applies to continuous beams according to SS-EN 1991-2 section 6.3.3(1), which is why the train load is omitted.

3.7.7 Load model SW/2

Train load SW/2 according to SS-EN 1991-2 section 6.3.3.

According to TSFS 2018:57 chapter 1 §12 load model SW/2 does not need to be considered on tracks where adaptation factor $\alpha \geq 1.33$, thus this load model is neglected.

3.7.8 Empty wagons

Empty wagons according to SS-EN 1991-2 section 6.3.4.

Consists of a uniformly distributed vertical load with a characteristic value of 10 kN/m. Used only for the verification of lateral stability for wind load. This load is not considered governing for this type of bridge, which is why the train load is omitted.

3.7.9 Track replacement machine

According to TRVINFRA-00227, 7.1.6.2.1.3-r, bridges with tracks in ballast shall be designed for track replacement machine.

Total weight track replacement machine: Q_{vk} = 900 kN

Dynamic contribution: D = 1.2

Distance from top of track to concrete deck: H = 0.80 m

Longitudinal distribution length (l) through ballast:

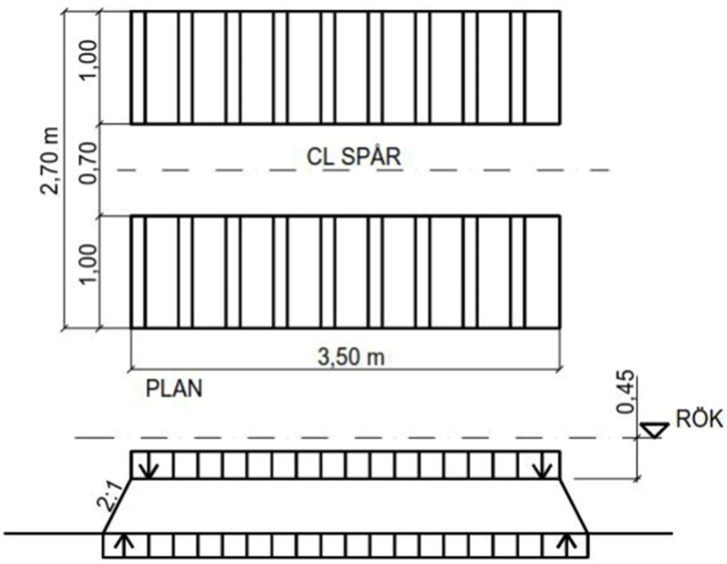
l = 3.5 m + 0.8 m – 0.45 m = 3.85 m

Transversal distribution width (b) through ballast:

b = 2 · (1.0 m + 0.8 m – 0.45 m) = 2 · 1.35 m = 2.7 m

Equivalent load in system analysis:

$$q_{spår} = D \cdot \frac{Q_{vk}}{b \cdot l} = 1.2 \cdot \frac{900kN}{3.85m \cdot 2.7m} = 104kPa$$



3.7.10 Fatigue model

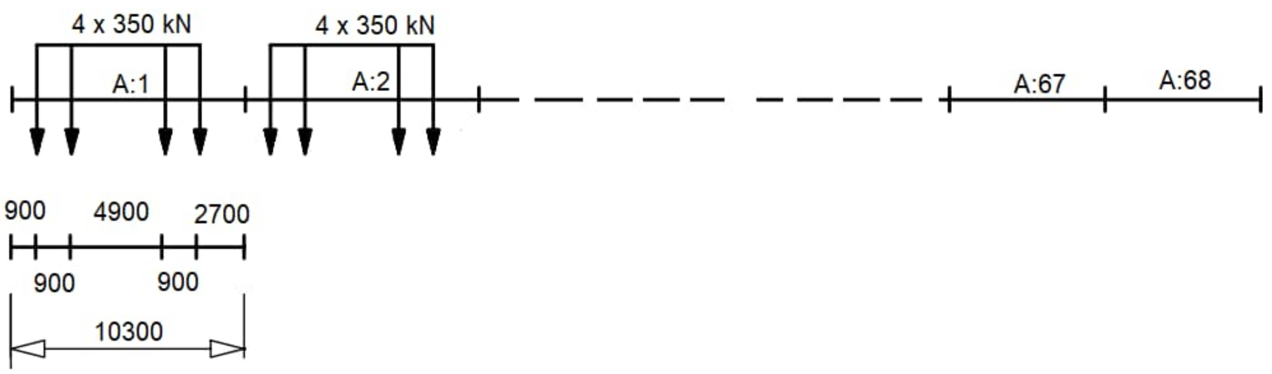
Bridge is designed with fatigue assumptions seen below.

Design conditions:

- Training: type 13S
- Traffic volume: Vol = $59.8 \cdot 10^6 \frac{ton}{year}$
- Equivalent load cycles λ-method: $N = 10^6$
- Train speed (v): $60 \frac{km}{h} \therefore 17 \frac{m}{s}$
- Magnification factor (K): $\frac{v}{160 m/s} = \frac{17}{160} = 0.11$
- Dynamic factor :

$$\Phi_2 = 1 + \frac{1}{2} \cdot \left(\frac{K}{1-K+K^4} + \frac{1}{2} \cdot 0.56 e^{\frac{L}{100}^2} \right) = 1 + \frac{1}{2} \cdot \left(\frac{0.11}{1-0.11+0.11^4} + \frac{1}{2} \cdot 0.56 e^{-\frac{14}{100}^2} \right) = 1.08$$

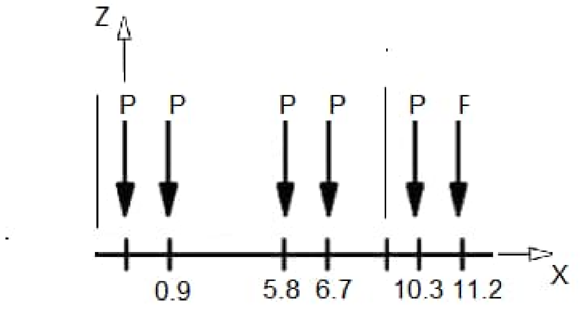
∑ Q = 95200 kN L = 68 x 10.3 m = 700.4 m v = 60 km/h



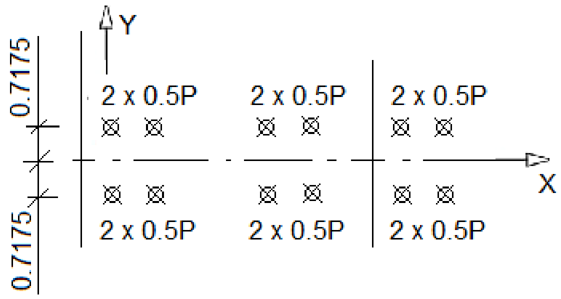
Train type 3S
”Malmbanan”

The most dangerous loading condition is obtained by applying the normal track position (track 2) for train type 13S with the function *"Moving Load Analysis"*.

Train loads are modelled as "*Discrete point load*" (loads tied to the coordinate system).



ELEVATION



PLAN

Discrete point load – TAG 13S :

Point

Analysis category: 3D

- Arbitrary
- Grid (selected) x: 2, y: 6

Untransformed load direction
- X
- Y
- Z (selected)
- Surface normal
- XYZ global
- XYZ transformable

Projection vector
- [x] Project in load direction
- [ ] Project for prestress

X component: 0,0
Y component: 0,0
Z component: 1,0

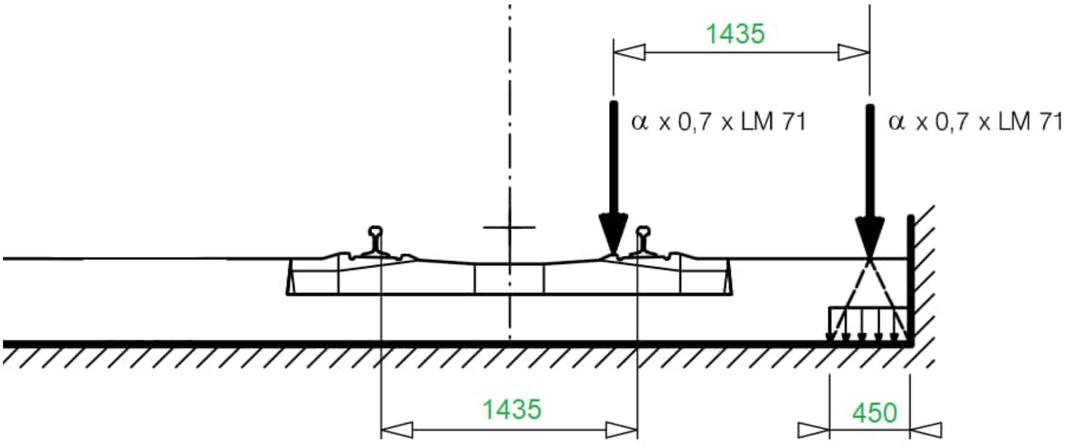
	X	Y	Z	Load
1	0,0	0,7175	0,0	-175,0
2	0,9	0,7175	0,0	-175,0
3	5,8	0,7175	0,0	-175,0
4	6,7	0,7175	0,0	-175,0
5	10,3	0,7175	0,0	-175,0
6	11,2	0,7175	0,0	-175,0
7	0,0	-0,7175	0,0	-175,0
8	0,9	-0,7175	0,0	-175,0
9	5,8	-0,7175	0,0	-175,0
10	6,7	-0,7175	0,0	-175,0
11	10,3	-0,7175	0,0	-175,0
12	11,2	-0,7175	0,0	-175,0

Name: TAG 13S (30)

3.7.11 Derailment load (accident load)

Design situations according to SS-EN 1991-2 section 6.7.1(2).

3.7.11.1 Design situation I (ACC_I)



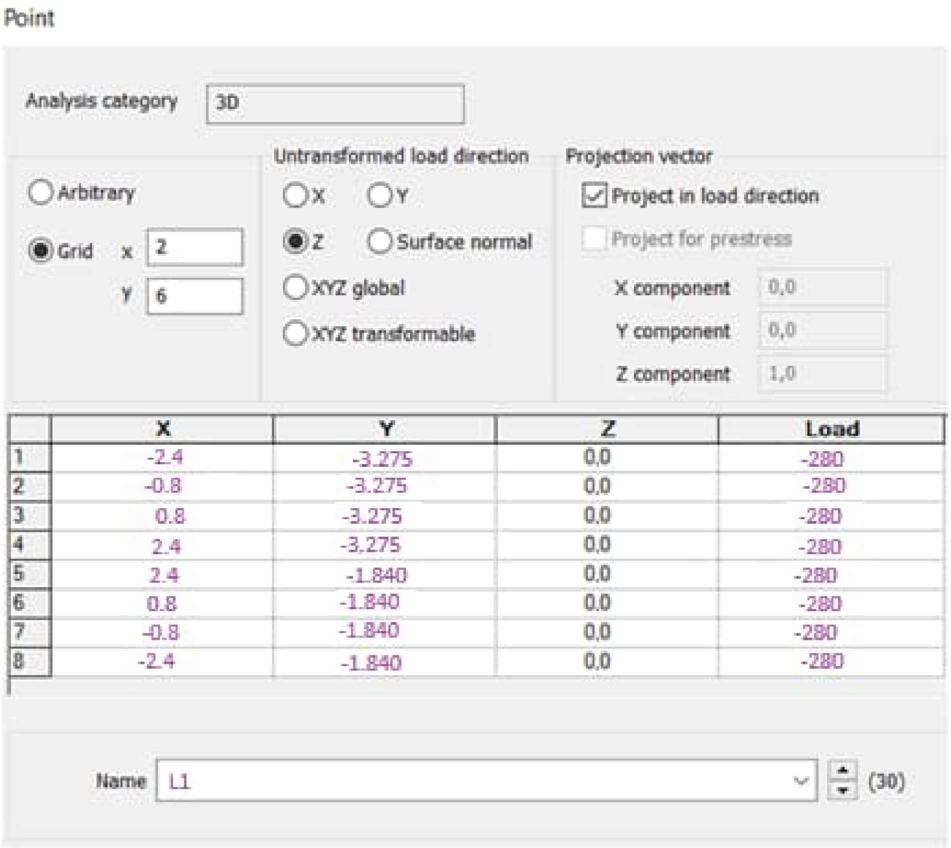
Line load (W1 → W4):

$$p_{OLYCK} = \alpha \cdot 0.7 \cdot p_{vk} = 1.6 \cdot 0.7 \cdot 80 \frac{kN}{m} = 89 \frac{kN}{m}$$

Point load (L1):

$$P_{OLYCK} = \alpha \cdot 0.7 \cdot P_{vk} = 1.6 \cdot 0.7 \cdot 250 kN = 280 kN$$

Discrete point load – L1 :


Point

Analysis category: 3D

Arbitrary / Grid (selected) x: 2, y: 6

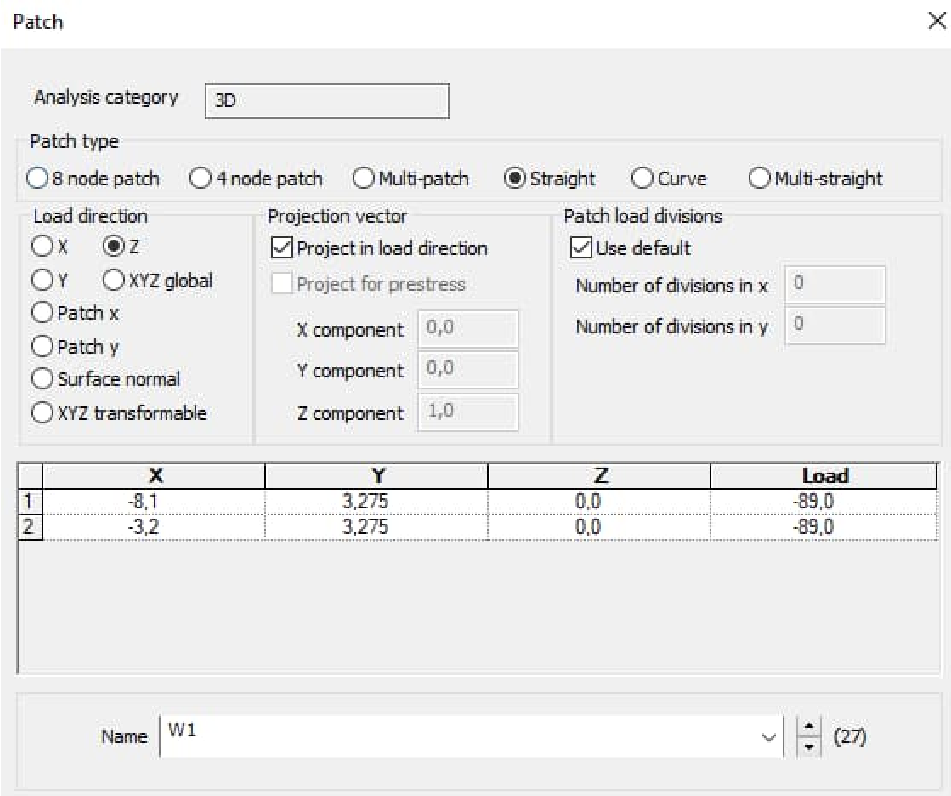
Untransformed load direction: X / Y / Z (selected) / Surface normal / XYZ global / XYZ transformable

Projection vector: Project in load direction (checked); Project for prestress; X component 0,0; Y component 0,0; Z component 1,0

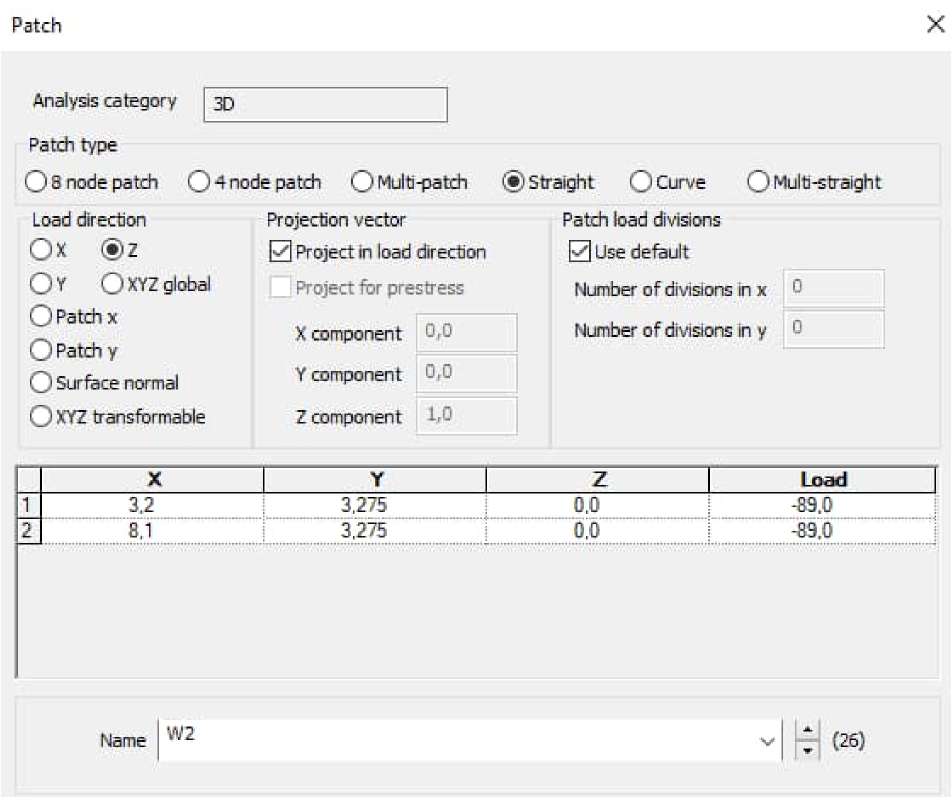
	X	Y	Z	Load
1	-2.4	-3.275	0,0	-280
2	-0.8	-3.275	0,0	-280
3	0.8	-3.275	0,0	-280
4	2.4	-3.275	0,0	-280
5	2.4	-1.840	0,0	-280
6	0.8	-1.840	0,0	-280
7	-0.8	-1.840	0,0	-280
8	-2.4	-1.840	0,0	-280

Name: L1 (30)

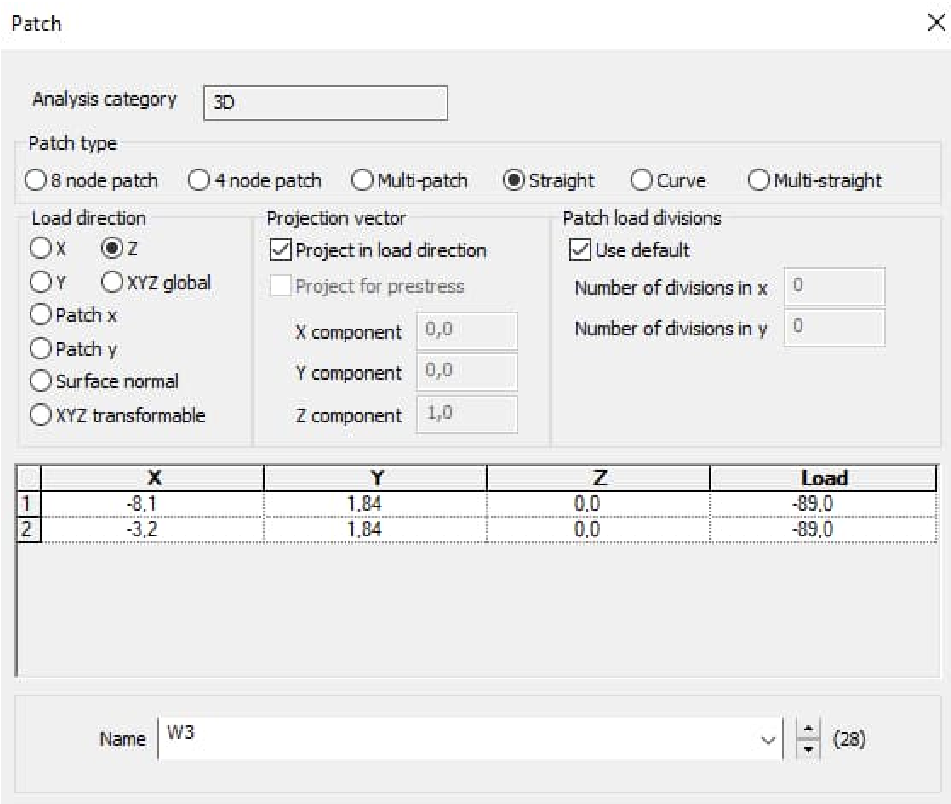
Discrete patch load – W1 :



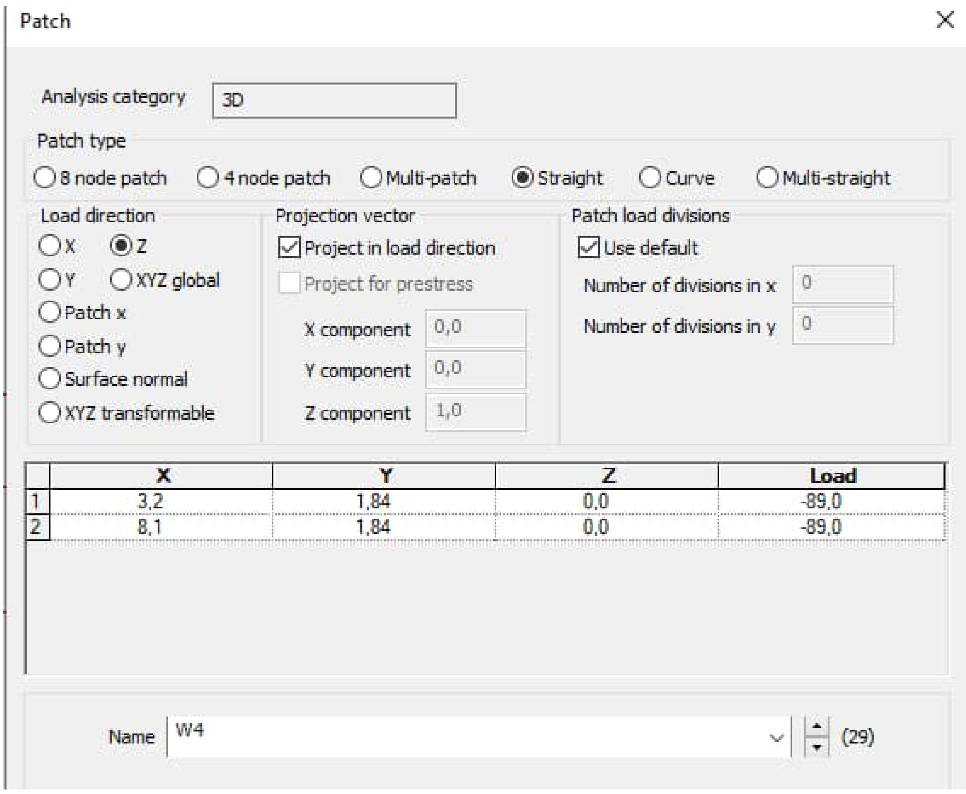
Discrete patch load – W2:



Discrete patch load – W3 :



Discrete patch load – W4:



Compound load:

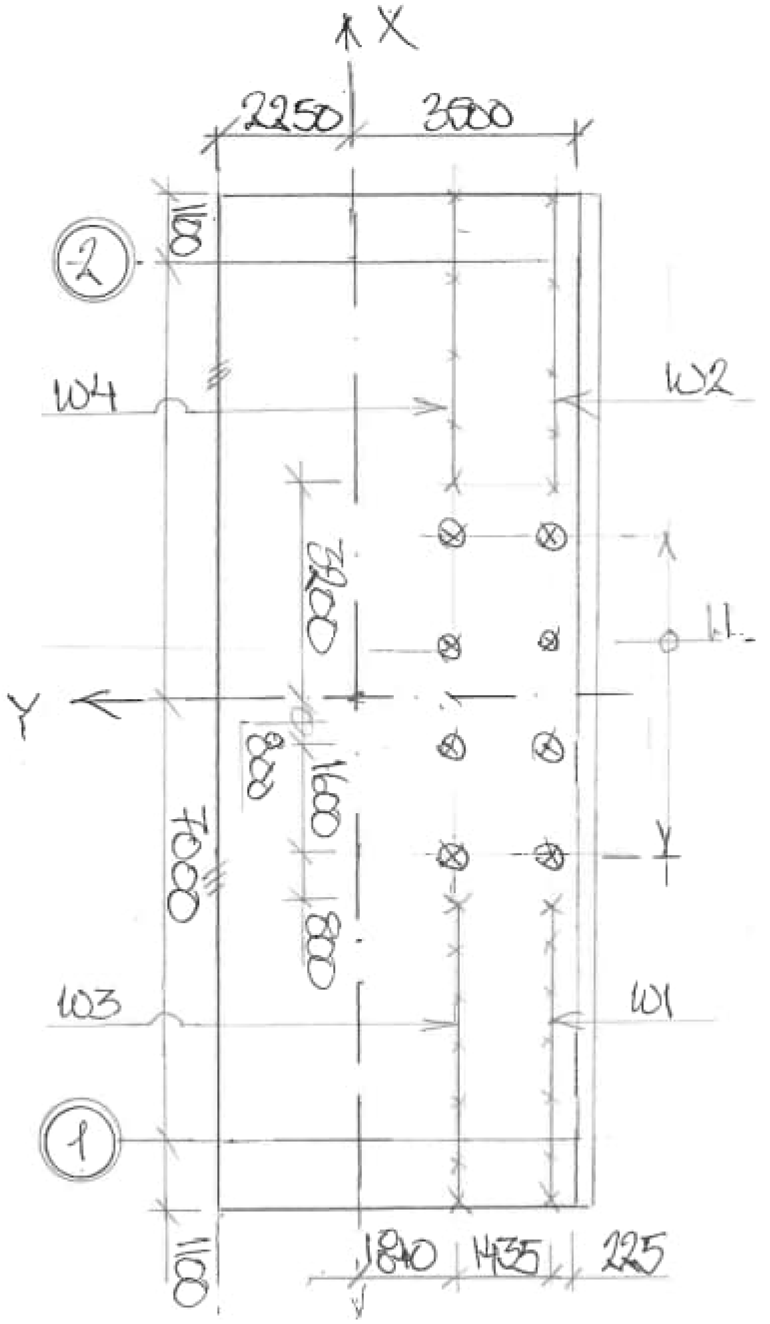
Compound

Analysis category: 3D

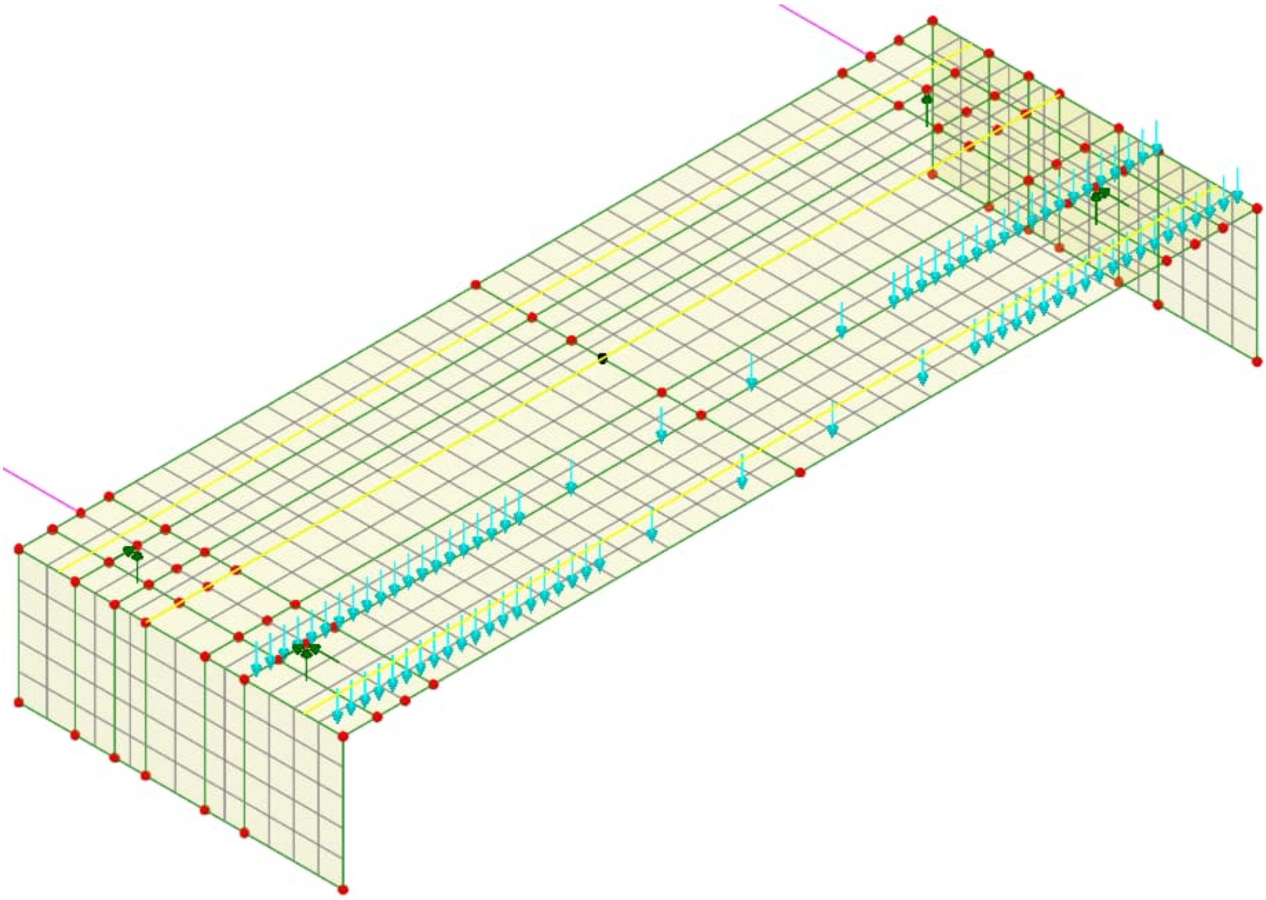
Included

Component	x offset	y offset	z offset	Factor	Transformation
27:W1	0,0	0,0	0,0	1,0	None
26:W2	0,0	0,0	0,0	1,0	None
28:W3	0,0	0,0	0,0	1,0	None
29:W4	0,0	0,0	0,0	1,0	None
31:L1	0,0	0,0	0,0	1,0	None

Name: ACC_1 (new)

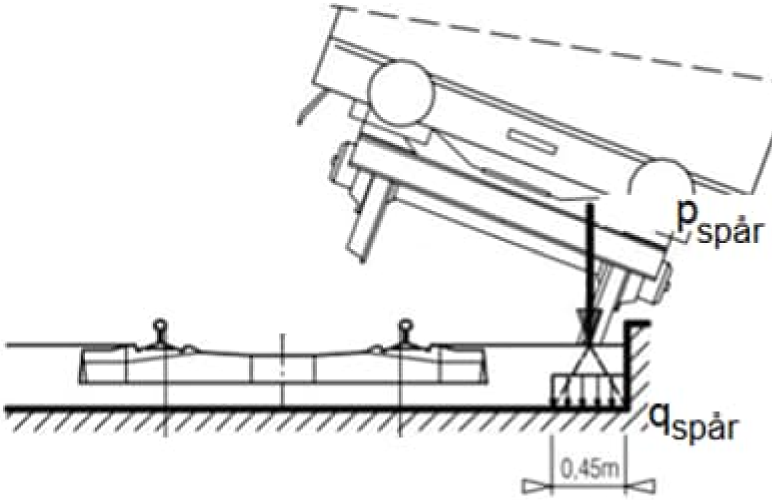


PLAN
Studied load position.



Overview 3D
Visualization loads.

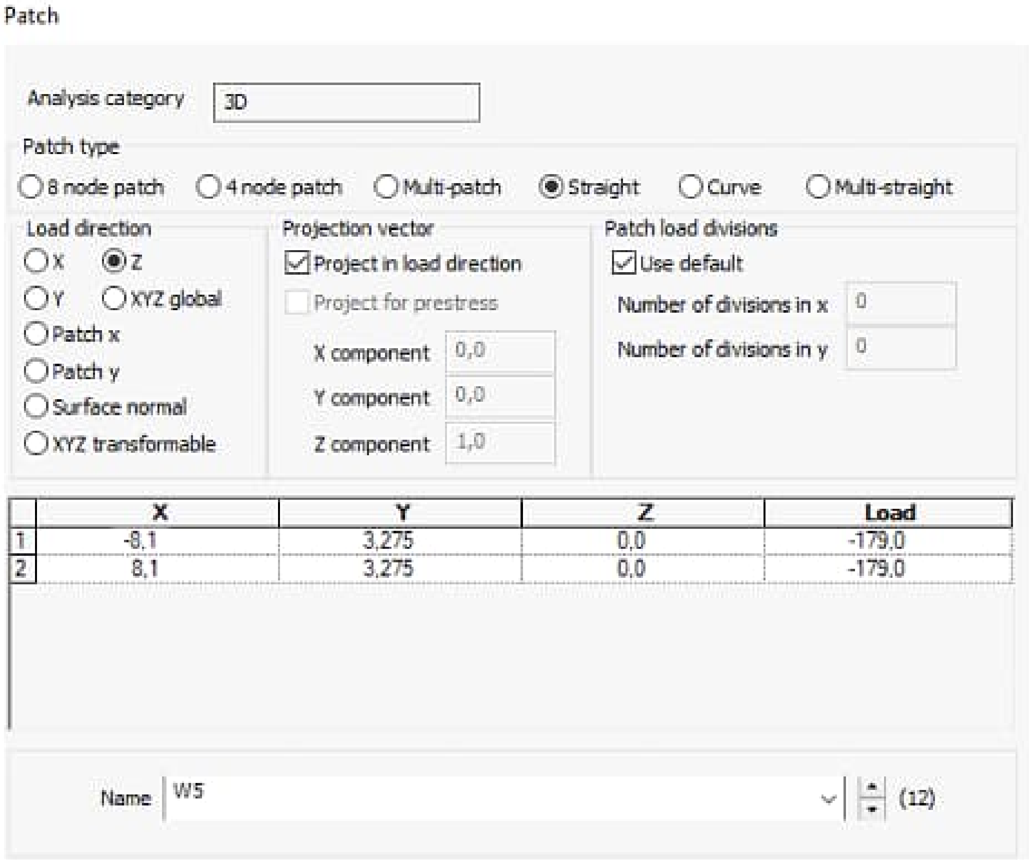
3.7.11.2 Design situation II (ACC_II)



Line load (W5 och W6):

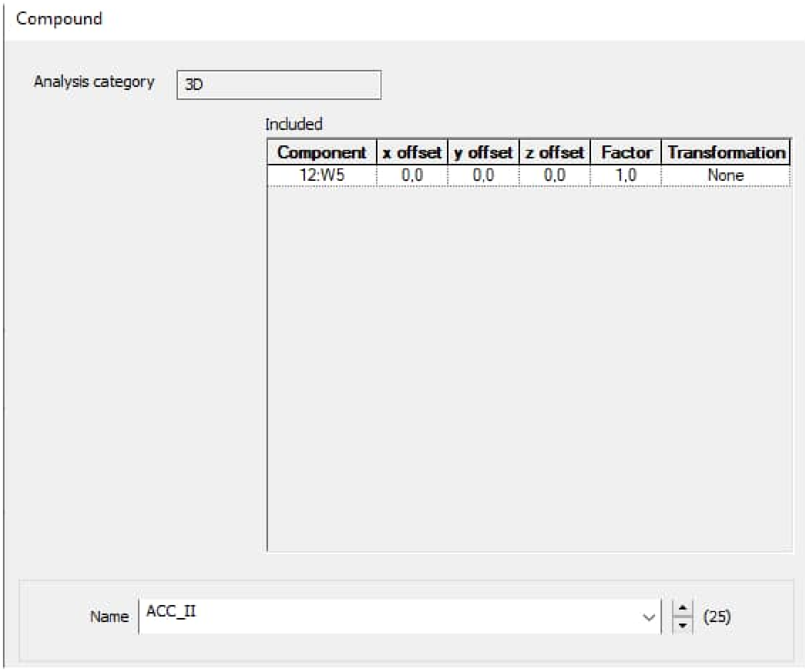
$$p_{OLYCK} = \alpha \cdot 1.4 \cdot p_{vk} = 1.6 \cdot 1.4 \cdot 80 \frac{kN}{m} = 179 \frac{kN}{m}$$

Discrete patch load – W5 :

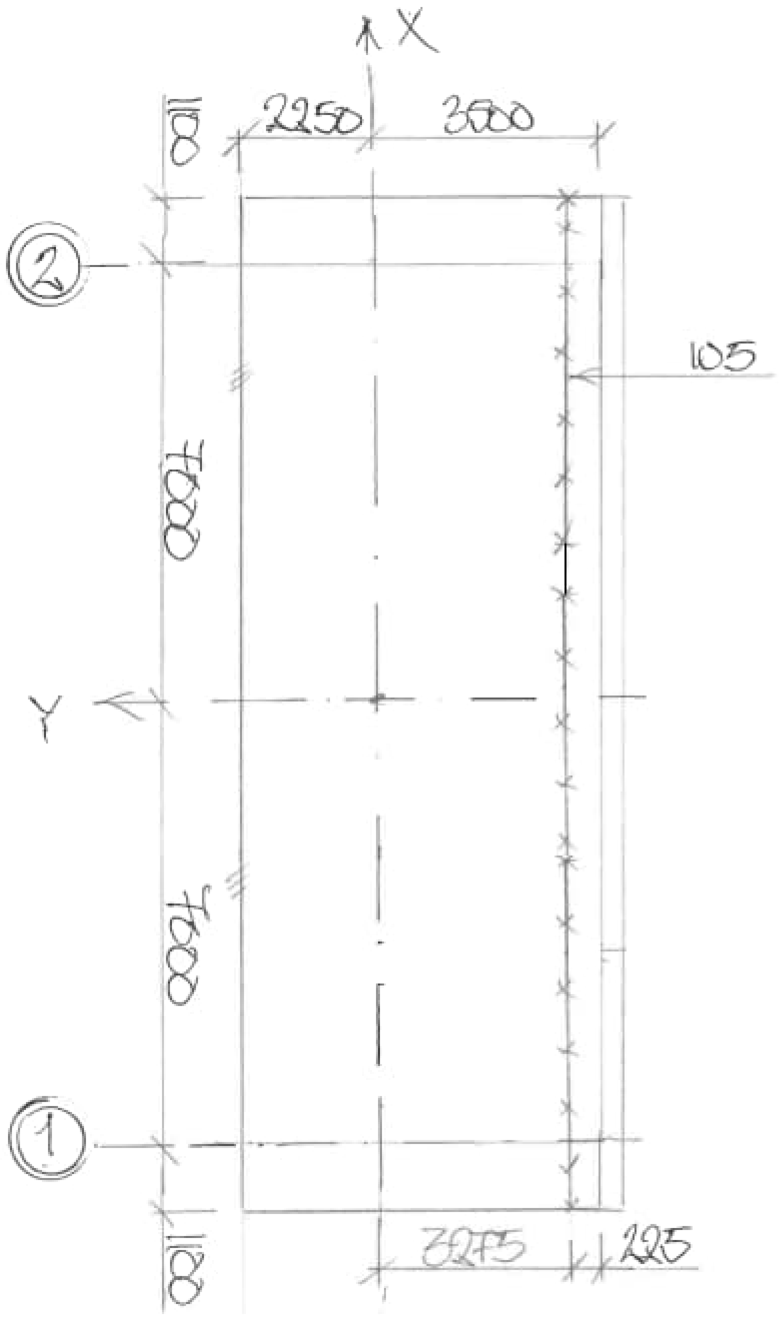


	X	Y	Z	Load
1	-8,1	3,275	0,0	-179,0
2	8,1	3,275	0,0	-179,0

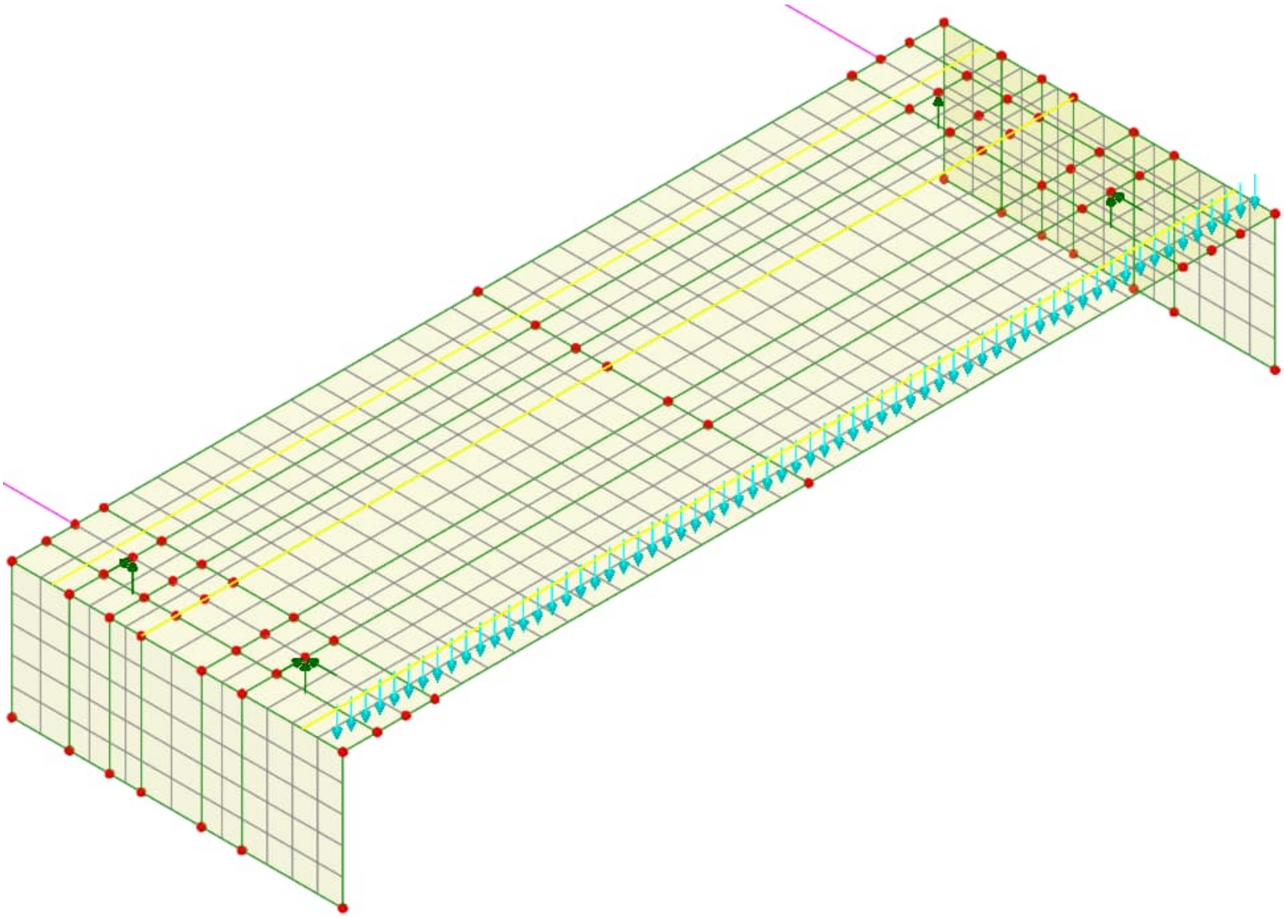
Compound load – ACC_II:



Component	x offset	y offset	z offset	Factor	Transformation
12:W5	0,0	0,0	0,0	1,0	None



PLAN
Studied load position.



Overview 3D
Visualization loads.

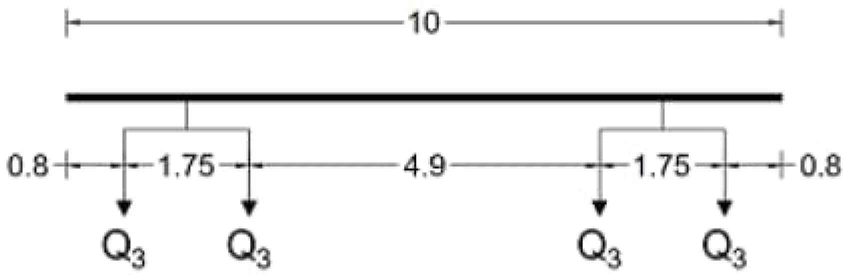
<u>3.7.12 Load resistance calculation</u>

TRVINFRA-00227 section 7.1.5.3 states that a load resistance calculation shall be performed for the superstructure as a load effect comparison of only vertical traffic loads according to TRVINFRA-0331 section 7.1.5.3.

The track is designated track segment 117 according to TRVINFRA-00331 table 8-4.

Verification is carried out only for train load TLM3 at the speed v = 60 km/h with dynamic supplement according to TRVINFRA-00331 section 8.3.3.2.5.

In the calculation report, the maximum permissible axle load Q_3 is determined according to the figure below.



3.8 BRAKING LOAD

Braking and acceleration load according to SS-EN 1991-2 section 6.5.3.

Load act at level top of track.

Max braking load: 6000 kN

Max acceleration load: 1000 kN

Bridge length: L_{bro} = 1.4 m + 14 m + 1.4 m = 16.8 m

Load length: $L_{broms} = L_{bro} =$ 16.8 m

Load effect excluding interaction between track and bridge deck :

Braking load : Q_b = 20 kN/m · α ·L_{broms} = 538 kN

Acceleration load: Q_a = 33 kN/m · α · L_{broms} = 887 kN

$\rightarrow Q_{broms}^{ored} = 887kN$

Load effect including interaction between track and brodge deck :

The impact of continuous ballast and fully welded rails provides a reduction (η). Requirements for a simplified calculation method according to SS-EN 1991-2, section 6.5.4.6.1. The determination of the reduced braking force is performed with calculation program L1_010, where all formulas and partial results are presented.

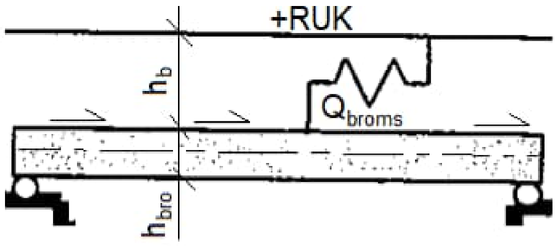
Reduktionsfaktor:

η = 66% : see page A3:75

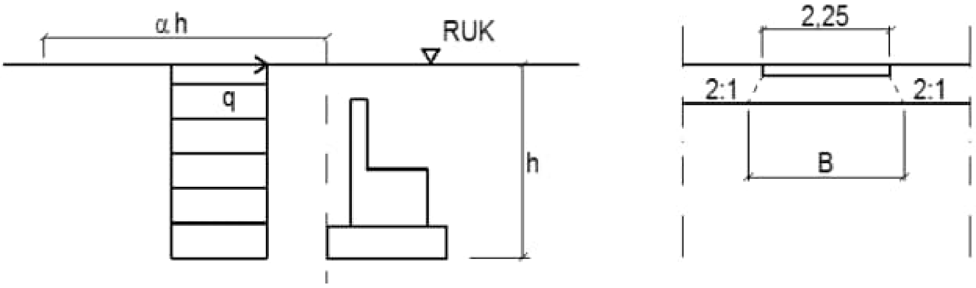
→ According to common technical calculation practice, 50% is applied.

Reduced braking load t:

Q_{broms} = 0.50 x 887 kN = 444 kN



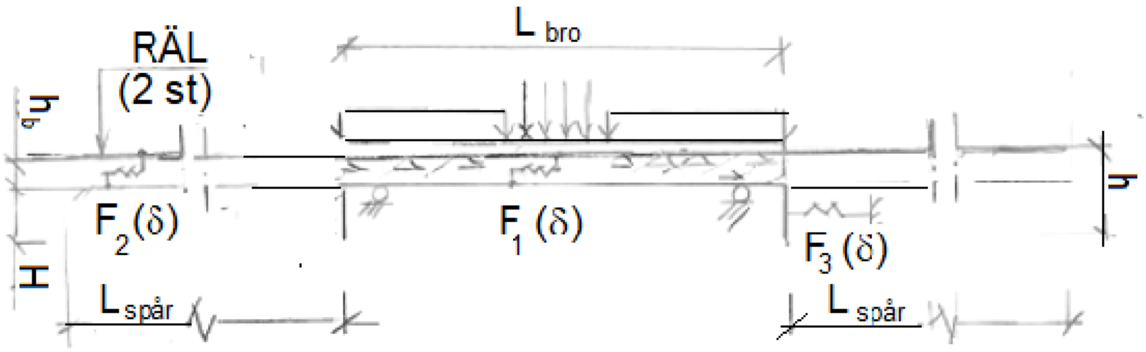
Remark
Load is assumed to act at level top of bridge deck.



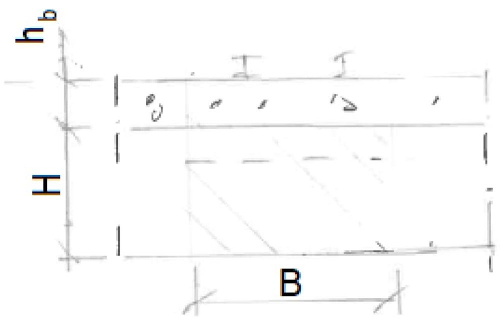
Remark
According to TRVINFRA-00227 section 7.1.6.2.1.3 (1a), it states that the bridge superstructure does not need to be designed for the addition of braking load behind the support.

Objekt: Bro Murjek

PRINCIPFIGUR



Längdsektion



Tvärsektion

TEORI

Samverkan mellan bro och spårkonstruktion gör att en del av bromskraften upptas av spårkonstruktions utanför bron, se även SS-EN 1991-2 avsnitt 6.5.3 och avsnitt 6.5.4.

Spårkonstruktionen bärförmåga beror på faktorer nedan:

(1) Bärförmåga mellan slipers och räl. Denna beror på infästningsanordningens effektivitet.

(2) Bärförmåga mellan slipers och ballast. Denna beror på bärförmågan i de förekommande horisontella brottytorna. Inuti ballast eller mellan ballast och brobana. Skillnaden i bärförmågan är således mycket stor mellan belastat och obelastat spår.

SS-EN 1991-2 avsnitt 6.5.4.6.1 anger att en förenklad beräkningsmetod är möjlig om kraven för metoden är uppfyllda. Metoden medger att rälsspäning inte behöver beaktas.
Då bärförmågan mellan slipers och räl är relativt liten och dessutom beror på effektiviteten hos infästningsanordning så försummas dess bidrag vid bestämning av hur stor bromslast som belastar bron.

TRVINFRA-00227 tabell 7.1-6 (p) anger att den förenklade metoden får användas för samtliga järnvägsbroar kortare än 36 m.

"UIC Code 774-3 R: Track/bridge interaction" avsnitt 3.3 "Simplified rules" anger att bärförmågan i spårkonstruktion ($L_{spår}$) motsvarande minst 100 m får användas om angiva krav är uppfyllda.

TRVINFRA-00227 tabell 7.1-6 (o) anger att största bärförmåga mellan slipers och räl sker för förskjutning u_o = 0.5 mm.

TRVINFRA-00227 tabell 7.1-6 (o) anger att största bärförmåga mellan slipers och ballast sker för förskjutning u_o = 2.0 mm.

TSFS:2018:57 kapitel 11 §15 anger att största bärförmåga mellan slipers/ballast/bro varierar från 20 kN/m till 40 kN/m för obelastat spår. Denn stora variation beror på effektivtet i infästningsanordningar. På säker sida tillämpas 20 kN/m vilket överensstämmer med förenklad metod enligt SS-EN 1992-1 avsnitt 6.5.4.6.1 (2).

TSFS:2018:57 kapitel 11 §15 anger att största bärförmåga mellan slipers/ballast/bro varierar från 50 kN/m till 60 kN/m för belastat spår. Vid bestämning av bromslast på bro tillämpas 60 kN/m vilket överensstämmer med förenklad metod enligt SS-EN 1992-1 avsnitt 6.5.4.6.1 (2).

Största mothållande jordtryck mot bank uppträder vid förskjutning (δ) motsvarande H/200 enligt TRVINFRA-00227 avsnitt 7.2.1.1.2.1.

I denna beräkningsmodell har inverkan av axiell deformation i räl försummats. Detta då inte entydligt angivits i gällande regelverk om detta är beaktad i den bärförmåga gällande regelverk anger.
Om inverkan önskas måste dock noggrann FEM-analys utföras. Eller så väljs ett lägre värd på $L_{spår}$ än 100 m.

Observera att om $L_{spår}$ = 0 m väljs behövs ingen FEM-analys dock bör aldrig reduktion överstiga mera än 50 % enligt äldre gängse teknisk beräkningspraxis.

INDATA

Geometri

$L_{spår} = 0m$

$h_b = 0.60m$

$H = 2.80m$

$B = 5.75m$

$L_{bro} = 16.8m$

Jordmaterial:

$K_p = 5.82$

$K_0 = 0.29$

$\gamma_b = 20 \frac{kN}{m^3}$

Fjäder belastad ballast på bro (fjäder:1)

$\Delta_{p.1} = 2mm$

$p_1 = 60 \frac{kN}{m}$

Fjäder ballast utanför bro (fjäder:2)

$\Delta_{p.2} = 2mm$

$p_2 = 20 \frac{kN}{m}$

Laster:
(Accelerationslast är dimensionerande)

$\alpha = 1.6$

$p_{broms} = \alpha \cdot 33 \frac{kN}{m} = 53 \cdot \frac{kN}{m}$

BERÄKNING

Total belastningslängd:

$$h = \begin{cases} 0m & \text{if } L_{spår} = 0m \\ H + h_b & \text{otherwise} \end{cases} \qquad h = 0 \cdot m$$

$$L_{broms} = L_{bro} + 1.5 \cdot h = 16.8\,m$$

Total bromslast:

$$P_{broms.tot} = p_{broms} \cdot L_{broms} = 887 \cdot kN$$

Funktion - fjäder 1 (belastad räl):

$$P_{1.max} = p_1 \cdot L_{broms} = 1008 \cdot kN$$

$$F_1 = \begin{cases} F_1 \leftarrow 0kN & \text{if } \delta < 0mm \\ F_1 \leftarrow P_{1.max} & \text{if } \delta > \Delta_{p.1} \\ F_1 \leftarrow P_{1.max} \cdot \dfrac{\delta}{\Delta_{p.1}} & \text{otherwise} \end{cases}$$

Funktion - fjäder 2 (obelastad räl):

$$P_{2.max} = \begin{cases} 0kN & \text{if } \left(2L_{spår} - 1.5h\right) < 0m \\ p_2 \cdot \left(2L_{spår} - 1.5h\right) & \text{otherwise} \end{cases} \qquad P_{2.max} = 0 \cdot kN$$

$$F_2 = \begin{cases} F_2 \leftarrow 0kN & \text{if } \delta < 0mm \\ F_2 \leftarrow P_{2.max} & \text{if } \delta > \Delta_{p.2} \\ F_2 \leftarrow P_{2.max} \cdot \dfrac{\delta}{\Delta_{p.2}} & \text{otherwise} \end{cases}$$

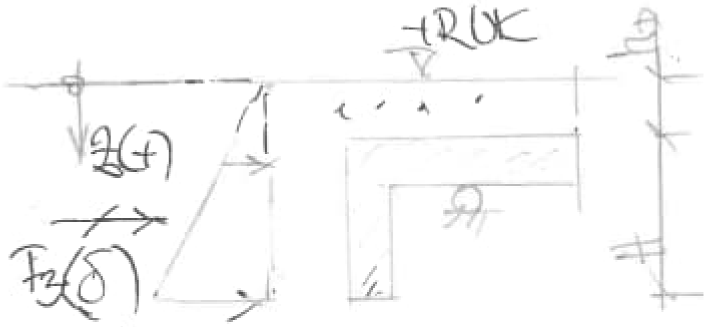
Funktion - fjäder 3 (ändskärm):

$$\Delta_{p.3} = \frac{H}{200} = 14 \cdot mm$$

$$K_3 = \begin{array}{|l} K_3 \leftarrow 0 \quad \text{if} \quad \delta < 0mm \\ K_3 \leftarrow 0 \quad \text{if} \quad \delta > \Delta_{p.3} \\ K_3 \leftarrow \left(K_p - K_0\right) \cdot \dfrac{\delta}{\Delta_{p.3}} \quad \text{otherwise} \end{array}$$

$$F_3(\delta) = \int_{h_b}^{\left(h_b + H\right)} B \cdot \gamma_b \cdot K_3 \cdot z \, dz$$

$$F_3\left(\Delta_{p.3}\right) = 3561 \cdot kN$$



Total bromslast:
(Tillhörande belastningslängd L_{bro})

$P_{broms.tot} = 887 \cdot kN$

Fördelning av total bromslast:

Given

$$P_{broms.tot} = F_1(u) + F_2(u) + F_3(u)$$

$$u_1 = Find(\delta)$$

$u_1 = 1.2 \cdot mm$:förskjutning vid jämvikt

$F_1(u_1) = 590 \cdot kN$: last ballast på belastat spår

$F_2(u_1) = 0 \cdot kN$: last ballast på obelastat spår

$F_3(u_1) = 298 \cdot kN$: last ändskärm

$P_{broms.tot} - F_1(u_1) - F_2(u_1) - F_3(u_1) = 0 \cdot kN$

RESULTAT

Oreducerad bromslast utan samverkan:

$P_{broms.ored} = P_{broms.tot} = 887 \cdot kN$

Reducerad bromslast med samverkan:
(Motsvarar last mot ändskärm)

$P_{broms.red} = F_3(u_1) = 298 \cdot kN$

$$\eta_{red} = 1 - \frac{P_{broms.red}}{P_{broms.ored}} = 66 \cdot \%$$

Studied load cases:

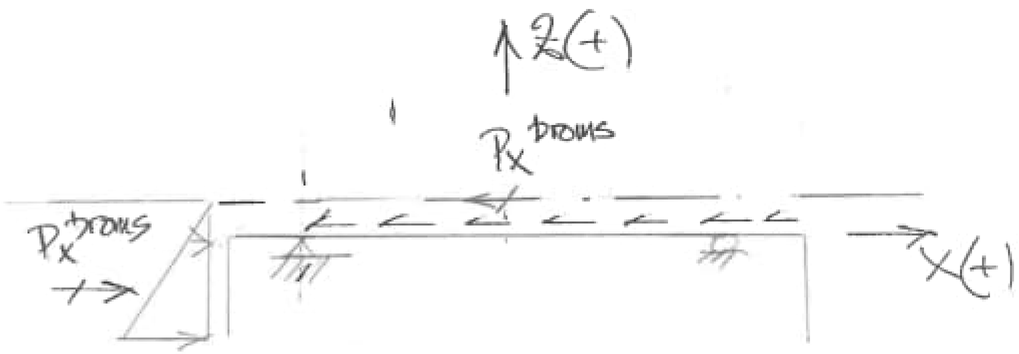
Two load cases are studied, designated "BROMS 1" and "BROMS 2," depending on the direction of the braking load.

The braking load on the bridge is applied as a fictitious line load in the brake in the position of its system line. When determining this load, it is distributed over the width (B).

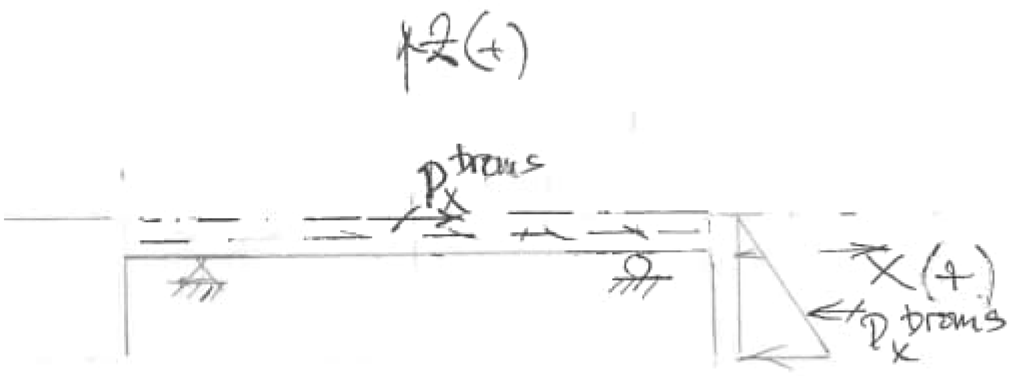
$$p_x = \frac{Q_{broms}}{B} = \frac{444kN}{5.75m} = 77\frac{kN}{m}$$

$$m_y = p_x \cdot \frac{h_{bro}}{2} = 77\frac{kN}{m} \cdot \frac{0.95m}{2} = 37\frac{kNm}{m}$$

The resisting load at each end screen corresponds to weighted values (f) of earth pressure at rest "JORD 1" and "JORD 2," respectively.

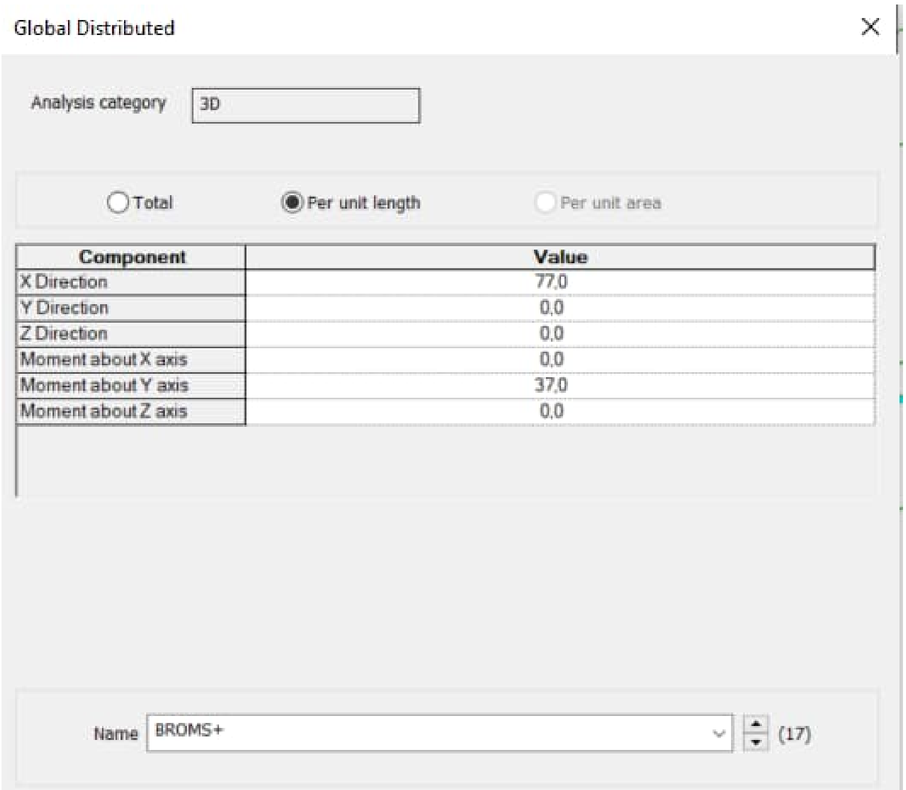


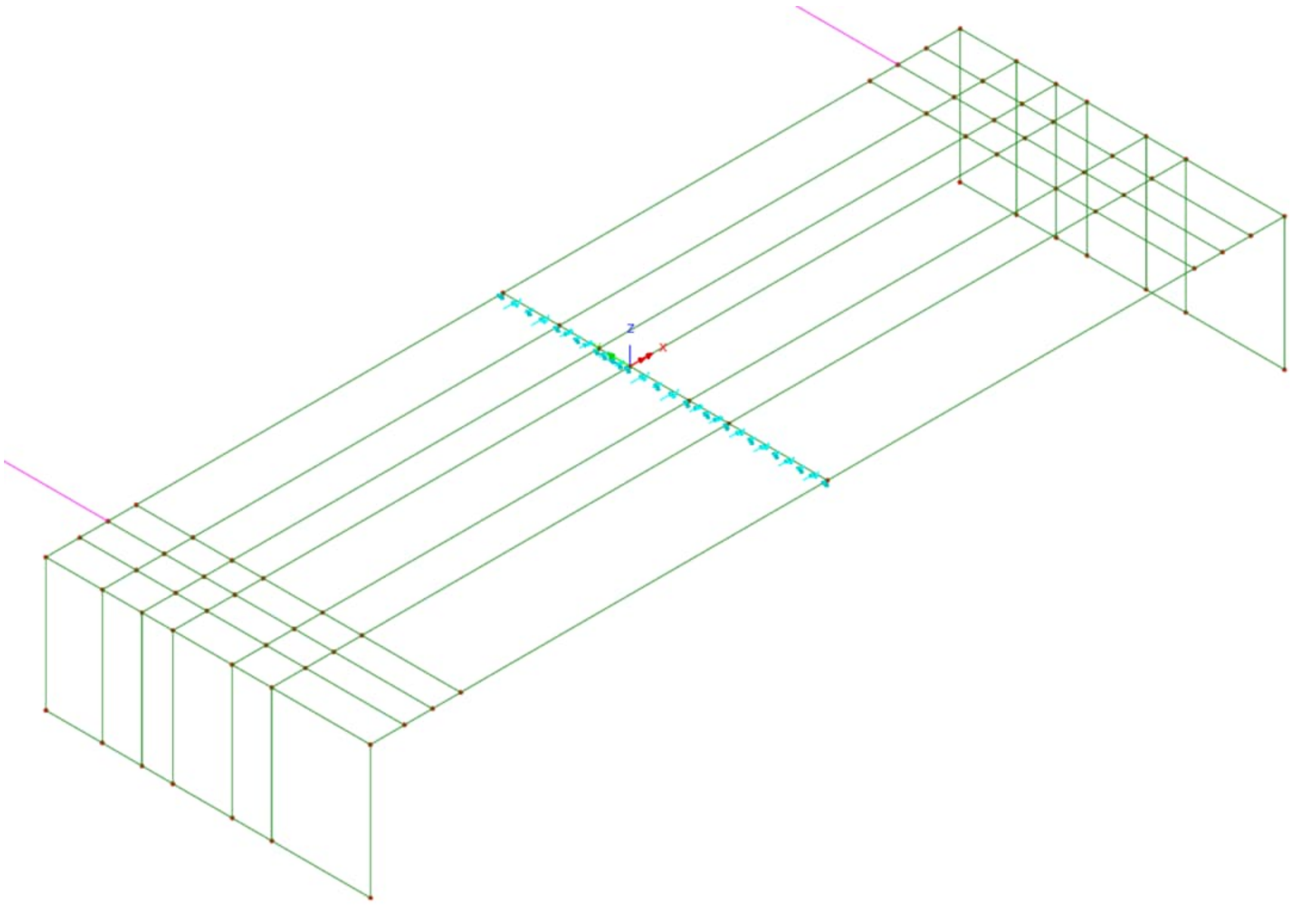
BROMS 1
(Load case: f ·”JORD 1” och ”BROMS –”)



BROMS 2
(Load case: f ·”JORD 2” och ”BROMS +”)

Load case : BROMS +





Overview 3D

Loadcase : BROMS-

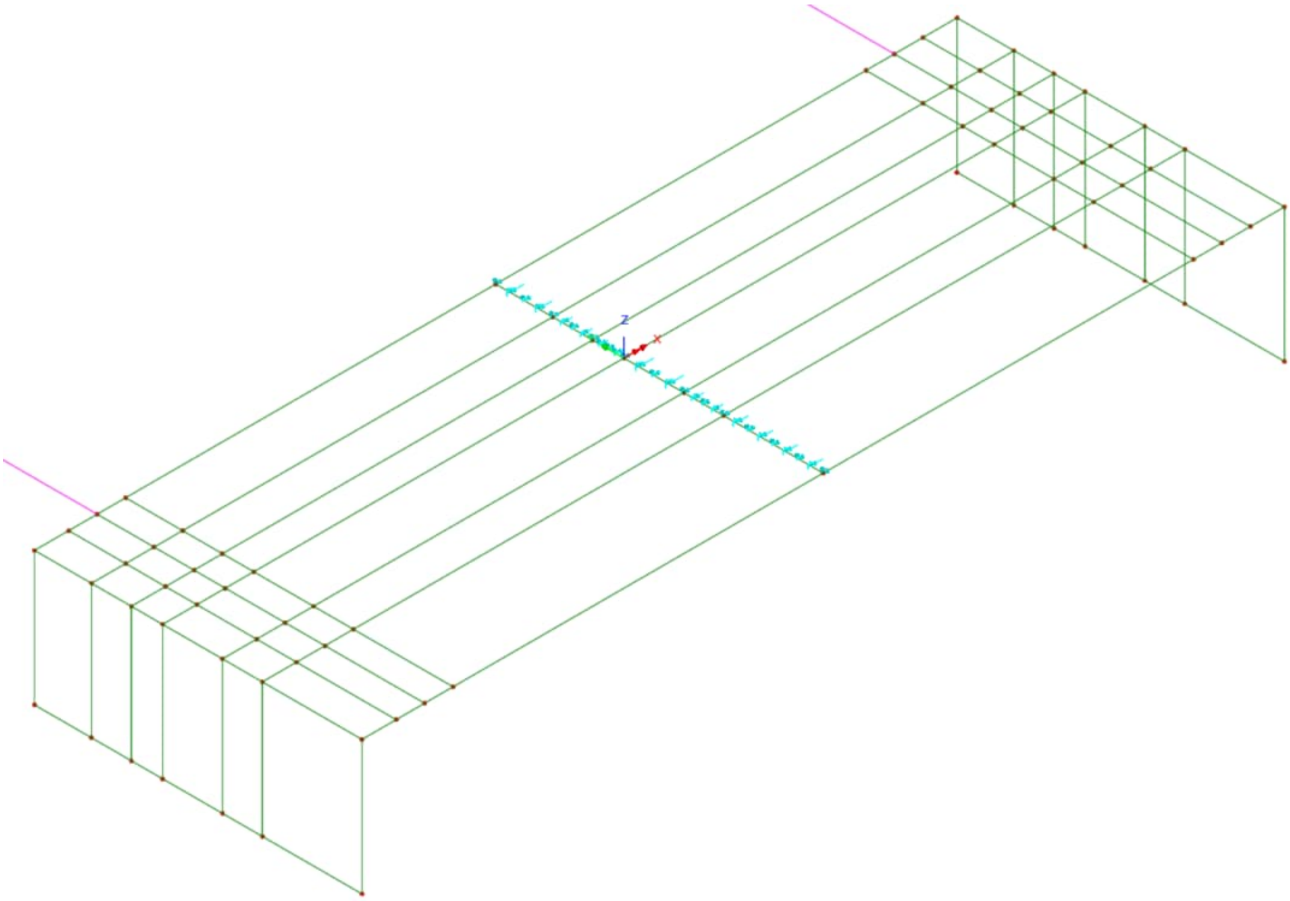
Global Distributed

Analysis category: 3D

○ Total ◉ Per unit length ○ Per unit area

Component	Value
X Direction	-77,0
Y Direction	0,0
Z Direction	0,0
Moment about X axis	0,0
Moment about Y axis	-37,0
Moment about Z axis	0,0

Name: BROMS- (3)



Overview 3D

3.8.2.2 Load combinations

Basic load combination BROMS 1 :

Load case	Factor
JORD 1	2.30[1.)]
BROMS-	1.0

Fotnote:

[1.)] Effect of reaktions force (Fx) for load case BROMS- and JORD .

$$\frac{Fx(BROMS-)}{Fx(JORD\ 1)} = \frac{444kN}{193kN} = 2.30$$

Basic loadcombination BROMS 2 :

Load case	Factor
JORD 2	2.30[2.)]
BROMS-	1.0

Fotnot2:

[2.)] Effect of reaktions force (Fx) for load case BROMS+ and JORD .

$$\frac{Fx(BROMS+)}{Fx(JORD\ 2)} = \frac{444kN}{193kN} = 2.30$$

Envelope BROMS:

Load case
BROMS 1
BROMS 2

3.9 LATERAL LOAD

Lateral load according to SS-EN 1991-2 section 6.5.2.

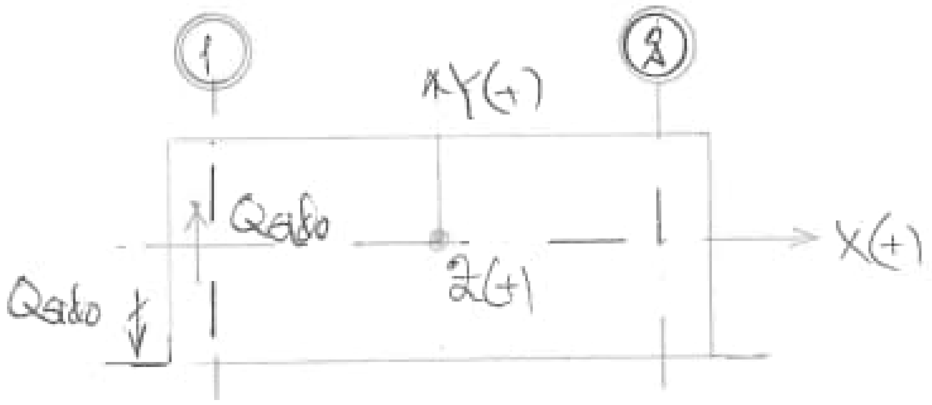
Load acts at top of track.

$\rightarrow Q_{sido} = 100kN \cdot \alpha = 100kN \cdot 1.6 = 160\ kN$

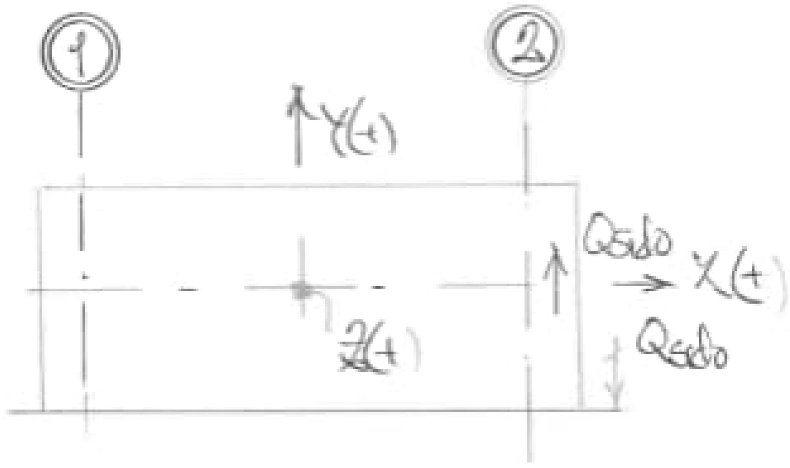
Two loadcase are studied. The are termed ”SIDO 1” and ”SIDO 2”. They are used depending on where lateral load acts. The lateral load is transfered to wingwall using incread earthpressure (Δp) due to movement.

The lateral force is introduced into static modell using weighted value (f) of earthpressure ”JORD 3-1” respektive ”JORD 3-2”.

$$f = \frac{Q_{sido}}{H_{jord}} = \frac{160kN}{55kN} = 2{,}9$$



SIDO 1
(Load case : f ·”JORD 3-1”)



SIDO 2
(Load case: f ·”JORD 3-2”)

Basic load combination SIDO 1:

Loadcase	Factor
JORD 3-1	2,9

Basic load combination SIDO 2 :

Load case	Factor
JORD 3-2	2,9

Envelope SIDO :

Load case
SIDO 1
SIDO 2

3.10 CENTRIFUGAL FORCE

Centrifugal force according to SS-EN 1991-2 section 6.5.1, however track is not constructed with radius thus load case is not considered.

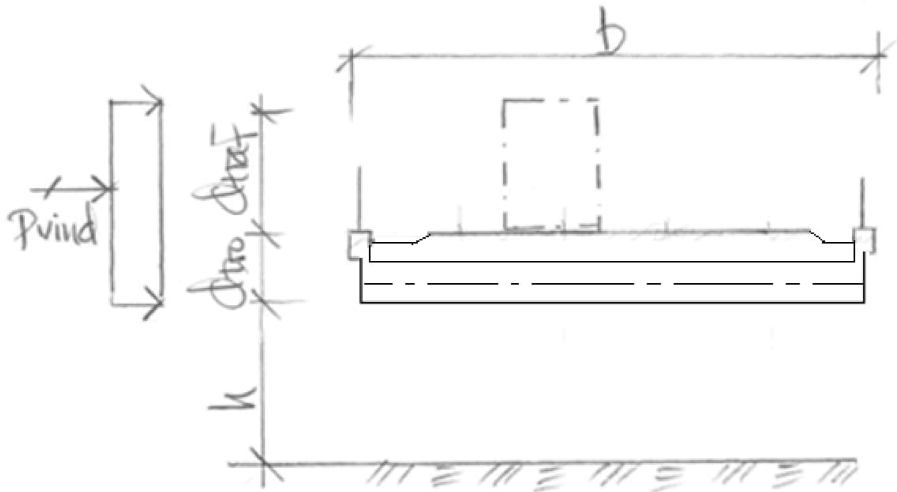
3.11 WIND LOAD

Wind load according to EN 1991-1-4 chapter 8.

Duration coefficients (see SS-EN 1990 appendix A2 table A2.1):

ψ_k = 1.00
ψ_0 = 0.30
ψ_1 = 0.20
ψ_2 = 0

Load intensity:



Terrain type II according to SS-EN 1991-1-4 table 4.1 is applied on sate side.

h = 3 m but 4 m is used on safe side.

$v_b(\text{"}Location\text{"}; z = 10m; z_0 = 0.05m) = 23\frac{m}{s}$: TSFS chapter 7 sketch 7.1

$q_p\left(h = 4m, Terrain\ type\ II, v_b = 23\frac{m}{s}\right) = 0.54kPa$: TSFS chapter 7 sketch 7.1

$q_b = \frac{1}{2} \cdot \rho \cdot v_b^2 = \frac{1}{2} \cdot 1.25\frac{kg}{m^3} \cdot \left(23\frac{m}{s}\right)^2 = 0.33\frac{kN}{m^2}$: SS-EN 1991-1-4 chapter 4.5

$c_e = \frac{q_p}{q_b} = \frac{0.54kPa}{0.33kPa} = 1.64$: SS-EN 1991-1-4 section 4.5

$d_{bro} = 0.95m + 0.60\ m = 1.55m$: construction height

$d_{traf} = 4.0m + 0.2 = 4.2m$: train height above level bottom of track see SS-EN 1991-4 section 8.3.1 (3)

$d_{tot} = 1.5m + 4.2m = 5.75m$

$$\rightarrow \frac{b_{bro}}{d_{tot}} = \frac{11.5m}{5.75m} = 1.91$$

$c_{f.x}\left(\frac{b_{bro}}{d_{tot}} = 1.91\right) = 1.9$: SS-EN 1991-1-4 sketech 8.3

$$C = c_e \cdot c_{f.x} = 1.64 \cdot 1.9 = 3.1$$

$$\frac{A_{ref.x}}{L} = d_{tot}$$

Wind load against bridge :

$$\frac{A_{ref.x}^{bro}}{L} \equiv d_{bro}$$

$$p_{vind}^{bro} = \frac{F_w}{L} = \frac{1}{2} \cdot \rho \cdot v_b^2 \cdot C \cdot \frac{A_{ref.x}^{bro}}{L} = \frac{1}{2} \cdot 1.25 \frac{kg}{m^3} \cdot \left(23 \frac{m}{s}\right)^2 \cdot 3.1 \cdot 1.55m = 1.6 \frac{kN}{m}$$

Wind load aginst train :

$$\frac{A_{ref.x}^{traf}}{L} \equiv d_{traf}$$

$$p_{vind}^{traf} = \frac{F_w}{L} = \frac{1}{2} \cdot \rho \cdot v_b^2 \cdot C \cdot \frac{A_{ref.x}^{bro}}{L} = \frac{1}{2} \cdot 1.25 \frac{kg}{m^3} \cdot \left(23 \frac{m}{s}\right)^2 \cdot 3.1 \cdot 4.2m = 4.3 \frac{kN}{m}$$

Studied load case:

Studied load cases is termed ”VIND” and acts in transversal direction.

Wind load consist of forces against both bridge and train on safe side.

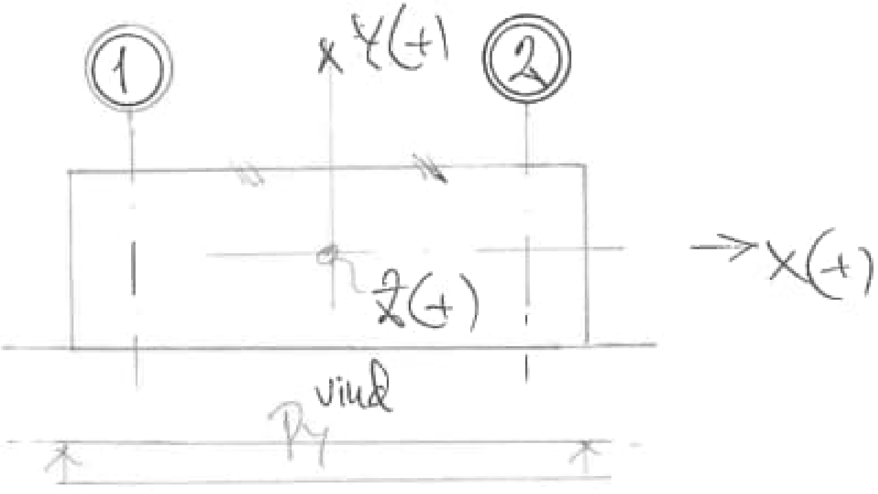
Load is applied at center of track (e = 0 m) which is reasonable simplication.

$$p_y = p_{vind}^{bro} + p_{vind}^{traf} = 1.6\frac{kN}{m} + 4.3\frac{kN}{m} = 6\frac{kN}{m}$$

$$m_{vind}^{bro} = 1.6\frac{kN}{m} \cdot (1.55m - \frac{0.95m}{2}) = 2\frac{kNm}{m}$$

$$m_{vind}^{traf} = 4.3\frac{kN}{m} \cdot (\frac{4.2m}{2} + 0.60m + \frac{0.95mm}{2}) = 14\frac{kNm}{m}$$

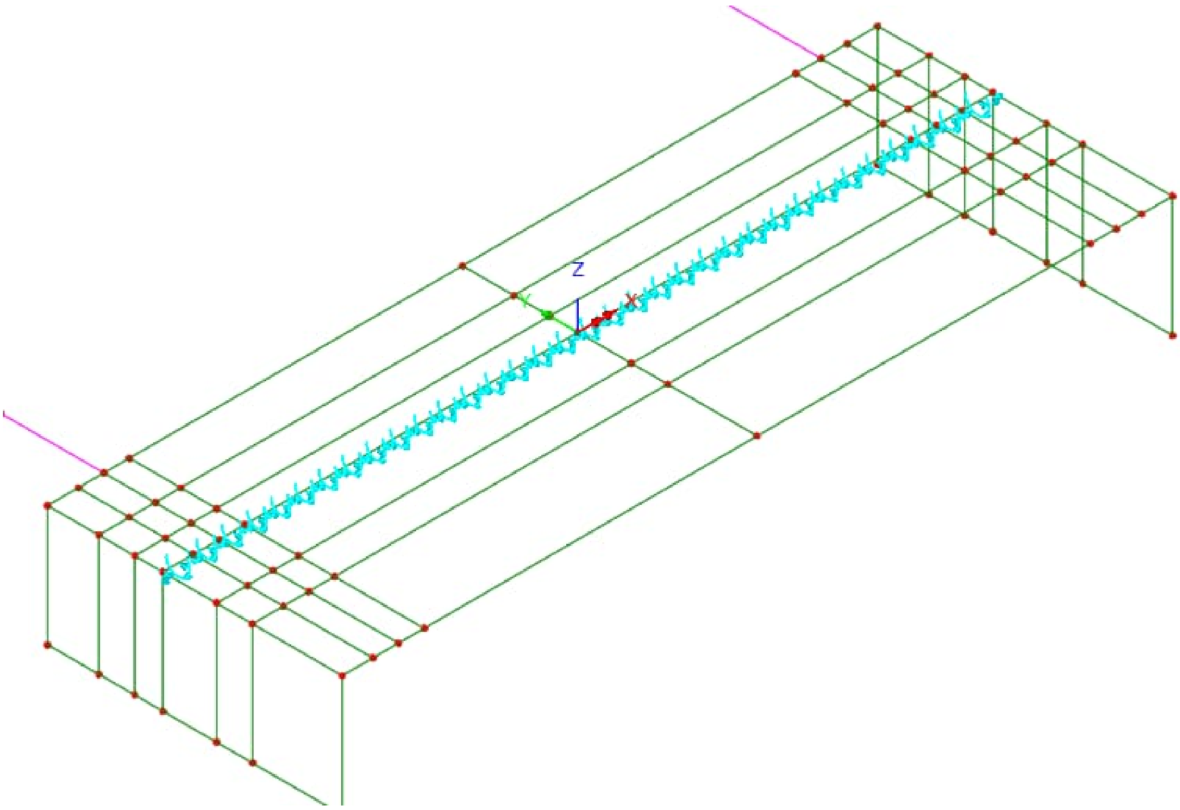
$$m_x = -m_{vind}^{bro} - m_{vind}^{traf} = -2\frac{kNm}{m} - 14\frac{kNm}{m} = -16\frac{kN}{m}$$



Load : VIND
Structural loading : Global distributed

Load per unit length in Y direction (p_y) : 6 $\frac{kN}{m}$

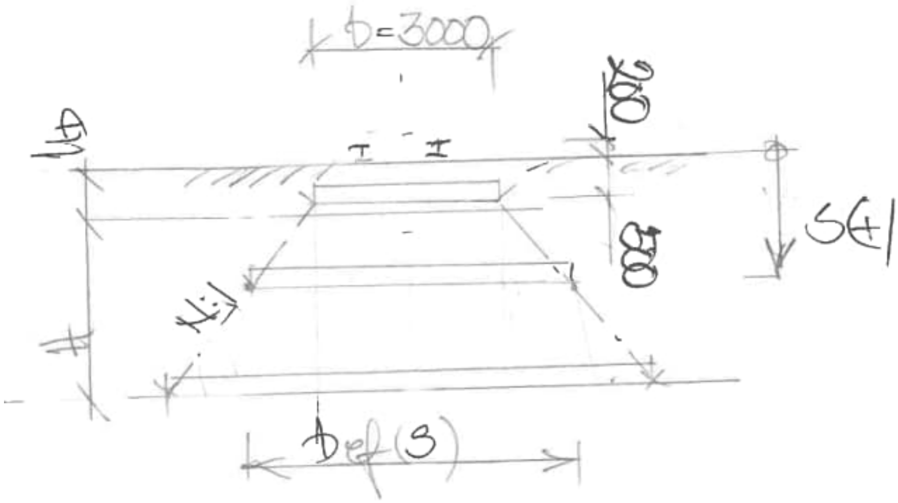
Moment about X axis (m_x) : -16 $\frac{kNm}{m}$



Overview 3D

3.12 SURCHARGE

Surharge according to SS-EN 1991-2 section 6.3.6.4 with even distribution of train load associated to LM71 (axles c/c 1.6 m) in longitudinal direction and width (b) 3.0 m in transversal direction a distance of 0.7 m from leverl top of track.



3.12.1 Load effect on end shields

Load effect on endshield assumes load distrubtion 2:1 (∴ N = 2) in ballast.

$$q_{över}(s) = \alpha \cdot \frac{Q_{vk}}{(b+s-0.50m)\cdot l} = 1.6 \cdot \frac{250kN}{(2.5m+s)\cdot 1.6m}$$

$$q_{över}(0.6m) = 1.6 \cdot \frac{250kN}{(2.5m+0.6m)\cdot 1.6m} = 81kPa$$: level top endhield $b_{över}$ = 3.1 m

$$q_{över}(3.4m) = 1.6 \cdot \frac{250kN}{(2.5m+3.4m)\cdot 1.6m} = 43kPa$$: level bottom of endshield $b_{över}$ = 5.9 m

$$q_{över}^{med} = \frac{43kPa+81kPa}{2} = 62kPa$$: avarage width $b_{över}$ = 4.5 m

In the static model the avarage value of load is applied ($q_{över}^{med}$) on load width ($b_{över}$) corresponding to width of end shields (B = 5.75 m) on safe side.

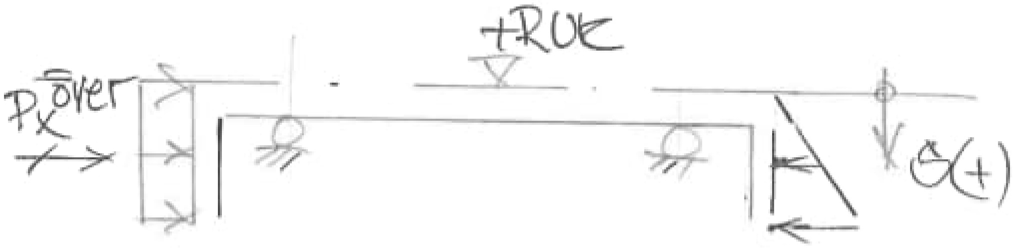
$$q_x^{över} = K_0 \cdot q_{över}^{med} = 0.29 \cdot 62kPa = 18kPa$$

Surcharge is introduced into static model as weigthed (f) earth pressure ”JORD 1” and ”JORD 2”.

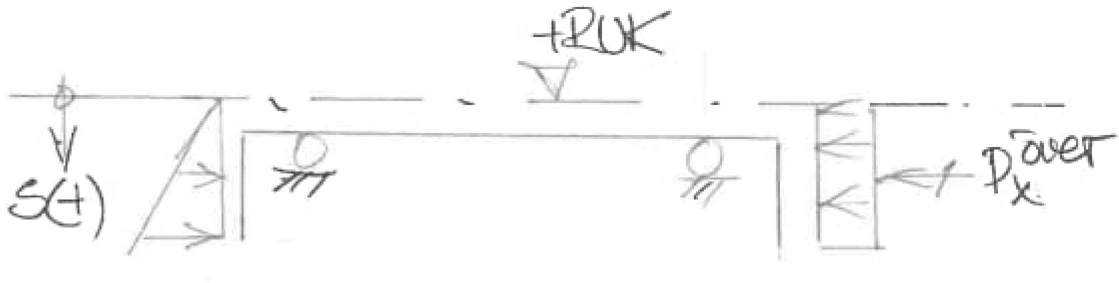
$$f = \frac{Fx_{over}}{Fx_{jord}} = \frac{289kN}{193kN} = 1.50$$

Studied load cases:

Two load cases are studied, termed ”OVER 1” and ”OVER 2”. Used depending on direction of surcharge.



OVER 1
(Load case: f ·”JORD 2” och ”OVER +”)



OVER 2
(Load case: f ·”JORD 1” och ”OVER -”)

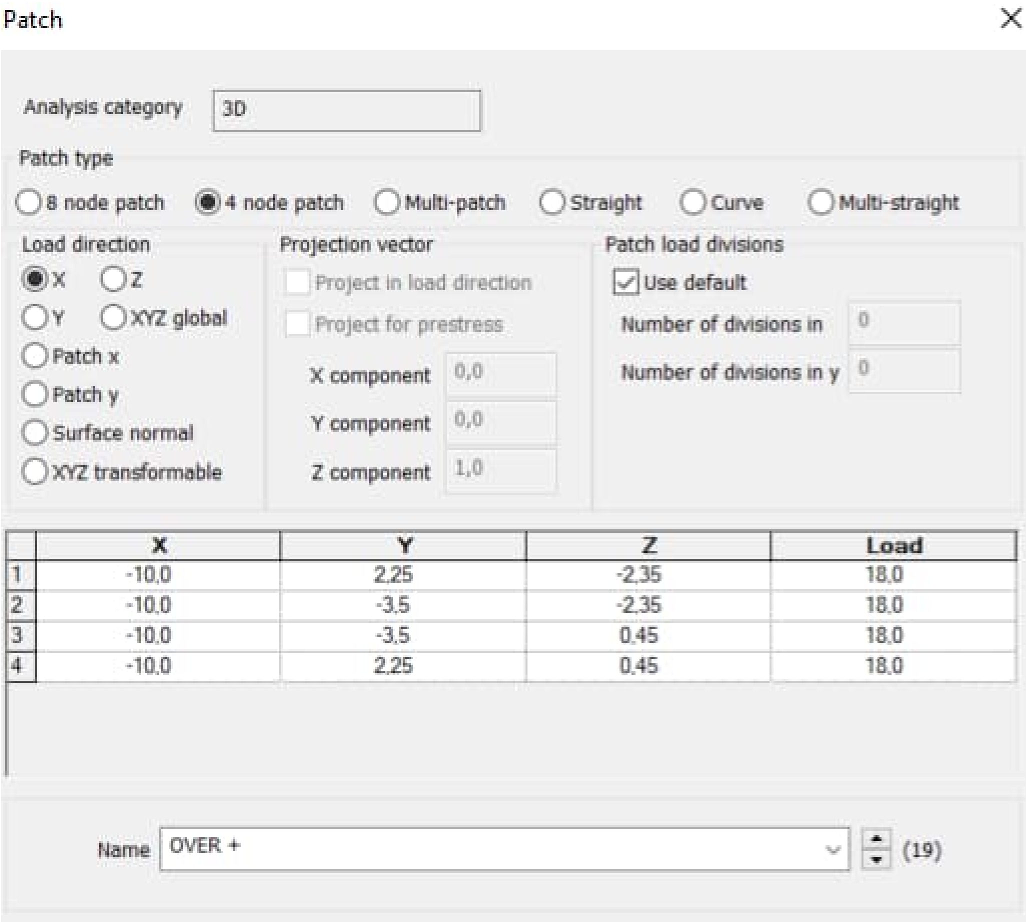
Load case : OVER+

Structural loading : Discrete 4 node patch

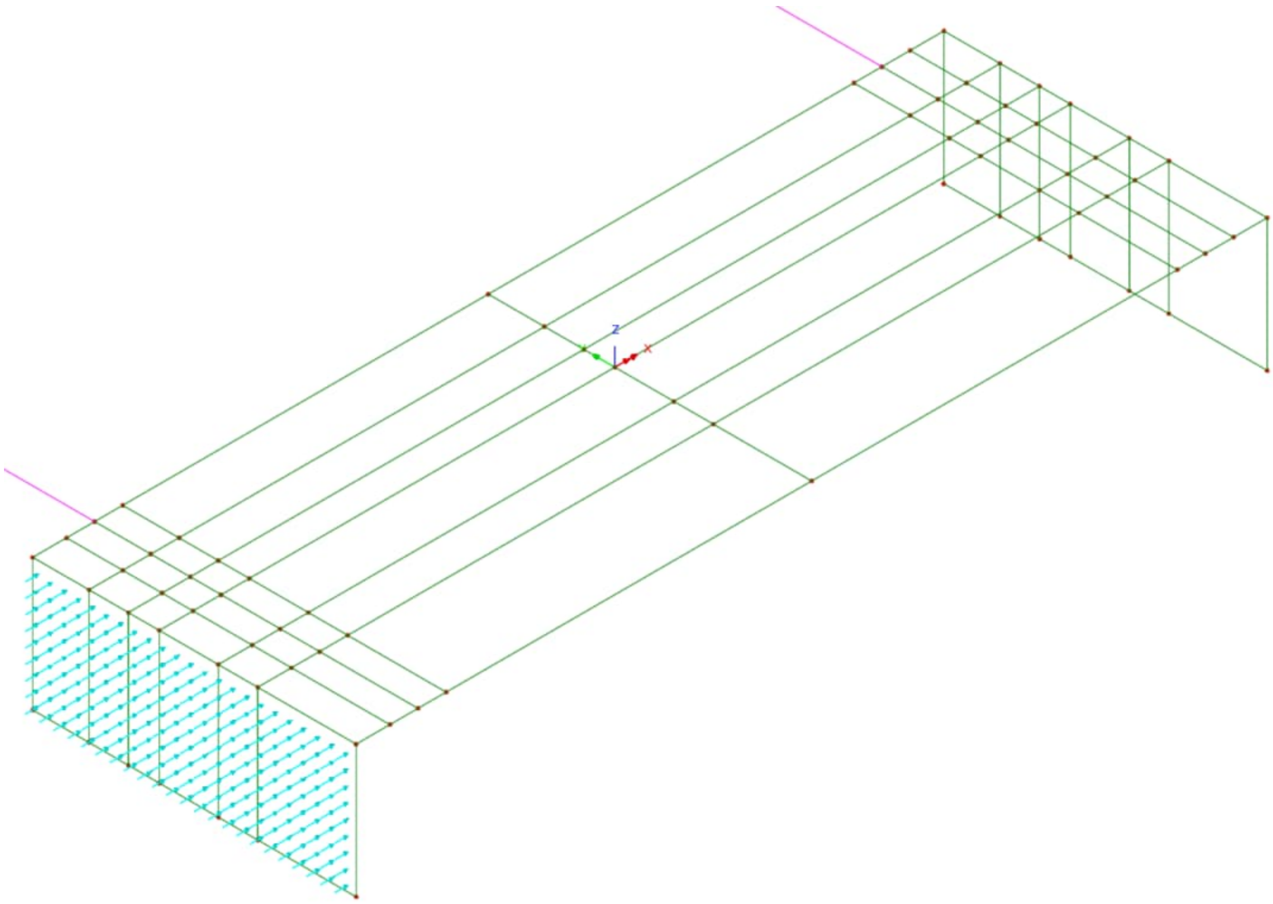
Surface load (q_x) : +18 kPa

Search Area : End shield 1

Loads outside search area : Include full load



	X	Y	Z	Load
1	-10,0	2,25	-2,35	18,0
2	-10,0	-3,5	-2,35	18,0
3	-10,0	-3,5	0,45	18,0
4	-10,0	2,25	0,45	18,0



Overview 3D

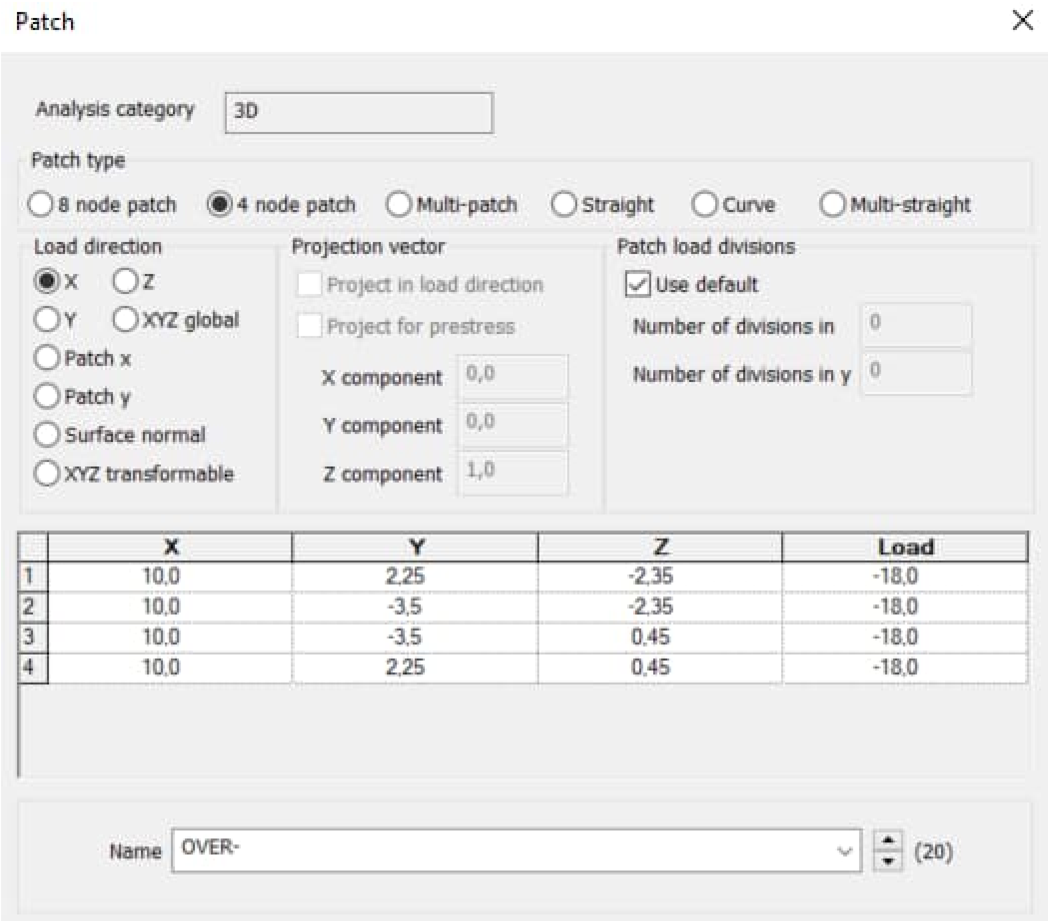
Load case : OVER-

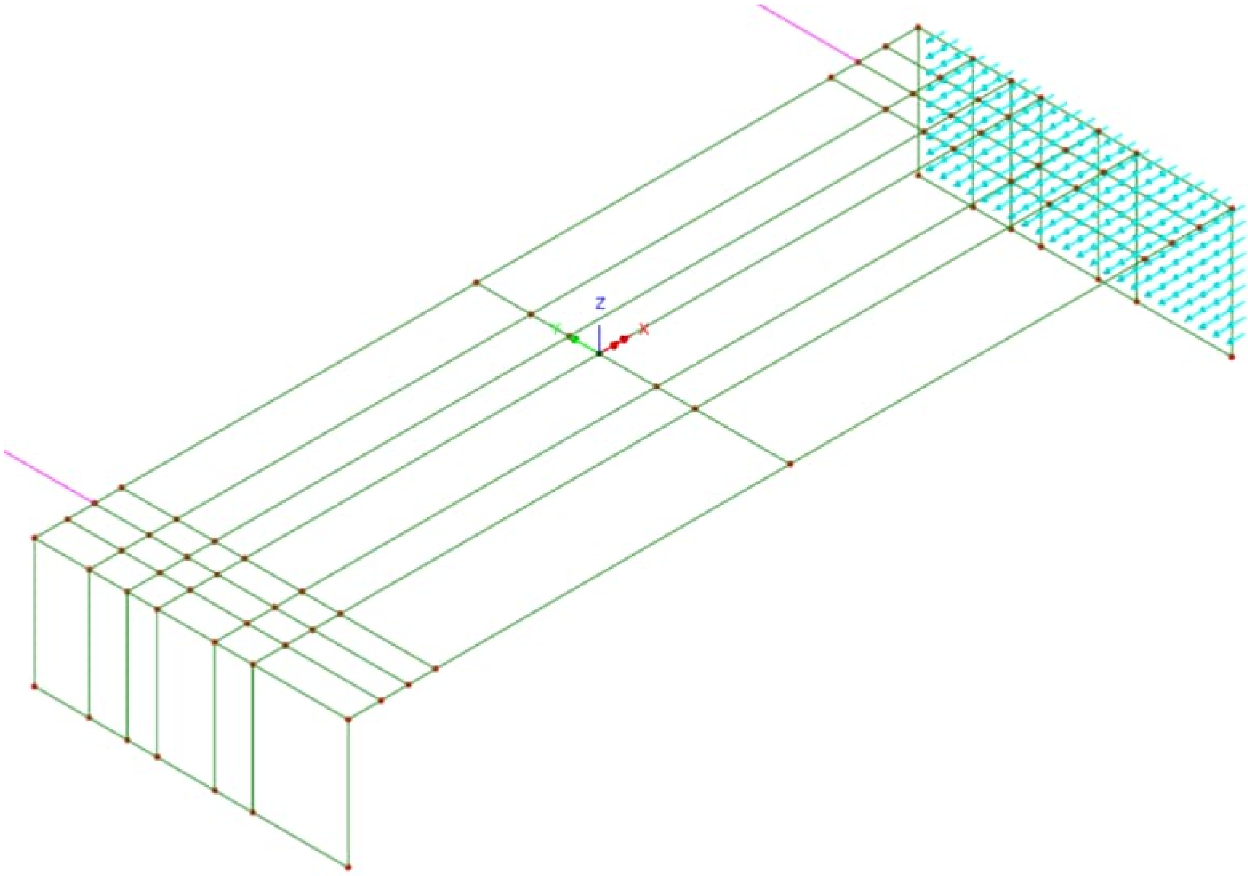
Structural loading : Discrete 4 node patch

Surface load (q_x) : -18 kPa

Search Area : End shield 2

Loads outside search area : Include full load





Overview 3D

Basic load combination OVER 1 :

Load case	Factor
JORD 2	1.50
OVER+	1.0

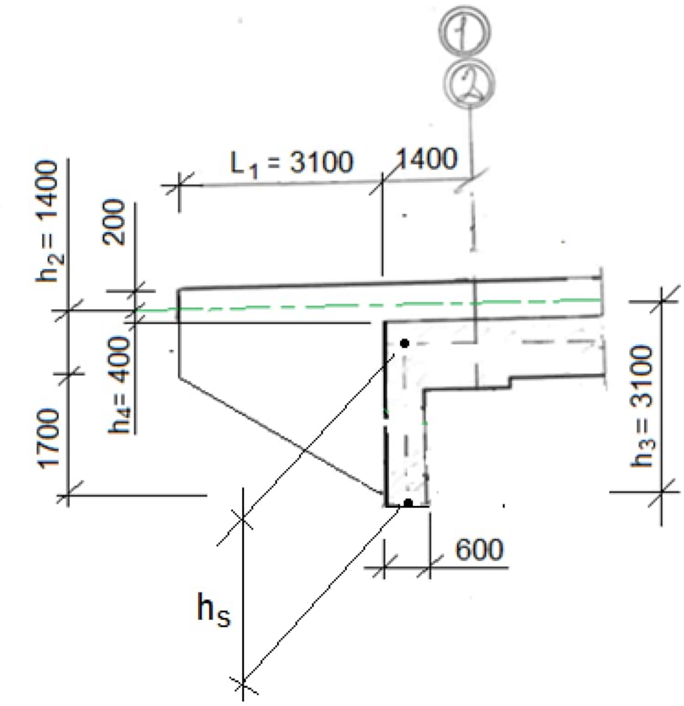
Basic load combination OVER 2 :

Load case	Factor
JORD 1	1.50
OVER-	1.0

3.12.2 Load effect on wingwalls

Program K2.003 is used to determine earthpressure againts wingwalls ordtryck mot vingmurar according to Culmans´s method. All wingwalls are assumed to have the same length (L = 3.1 m).

The low height of the wing wall and the large side distance in relation to the track center have shown that the design load effect on wing walls occurs for load distribution 1:1.



Last fördelas längs inspänningssnitt mot ändskärm (∴ h_s = 2.4 m).

Total load:

$H_{över} = 81kN$: see page A3:34

$M_{över} = 107kNm$: see page A3:34

Load distributed over height of end shield (h_s):

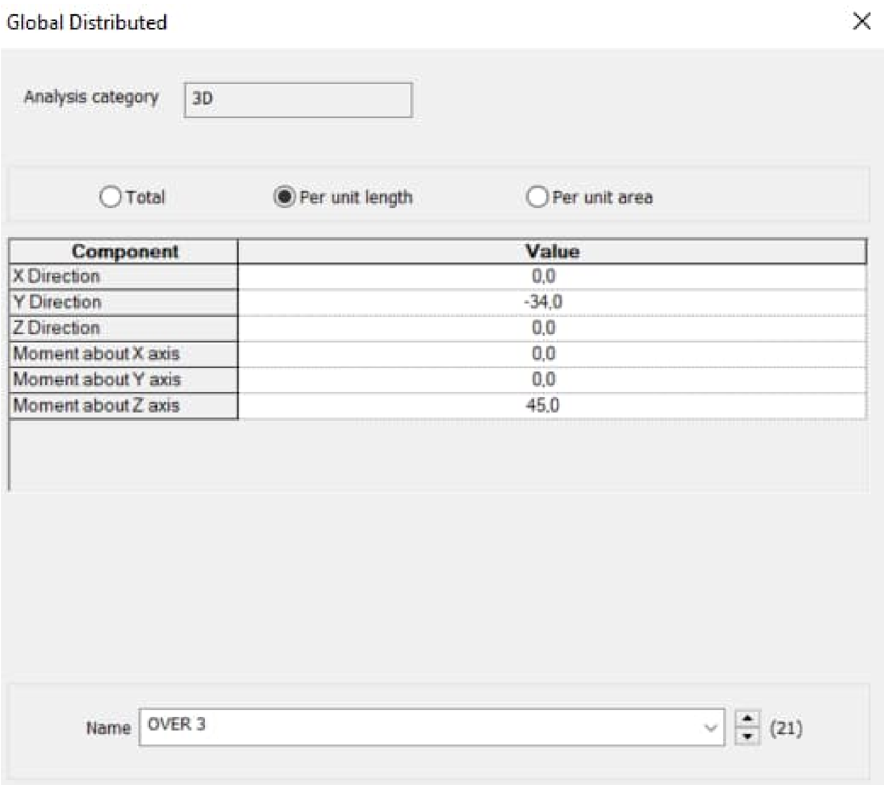
$$N_{över} = \frac{81kN}{2.4m} = 34\frac{kN}{m}$$

$$M_{över} = \frac{107kNm}{2.4m} = 45\frac{kNm}{m}$$

Load case : OVER 3

$$p_y = -34\frac{kN}{m}$$

$$m_z = +45\frac{kNm}{m}$$

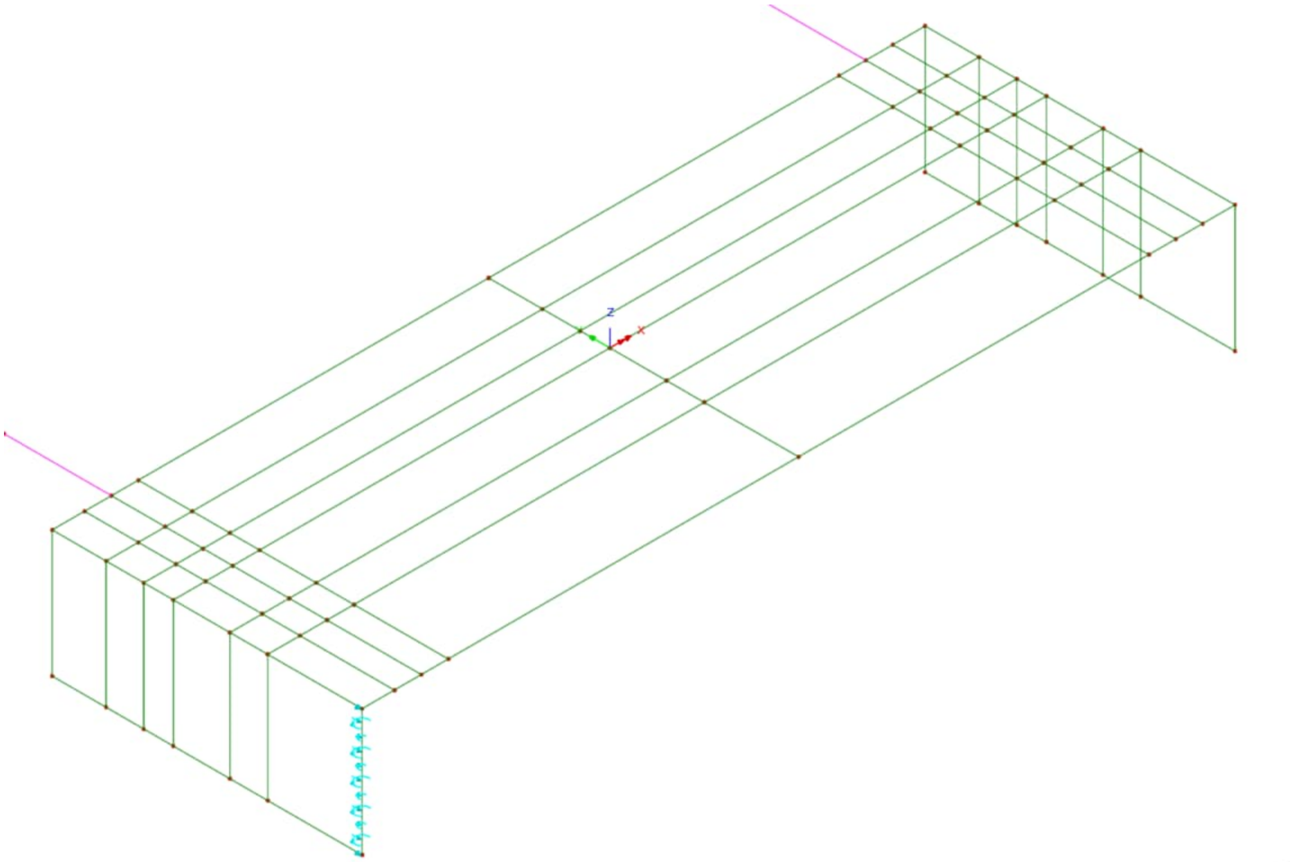

Global Distributed

Analysis category: 3D

○ Total ◉ Per unit length ○ Per unit area

Component	Value
X Direction	0,0
Y Direction	-34,0
Z Direction	0,0
Moment about X axis	0,0
Moment about Y axis	0,0
Moment about Z axis	45,0

Name: OVER 3 (21)

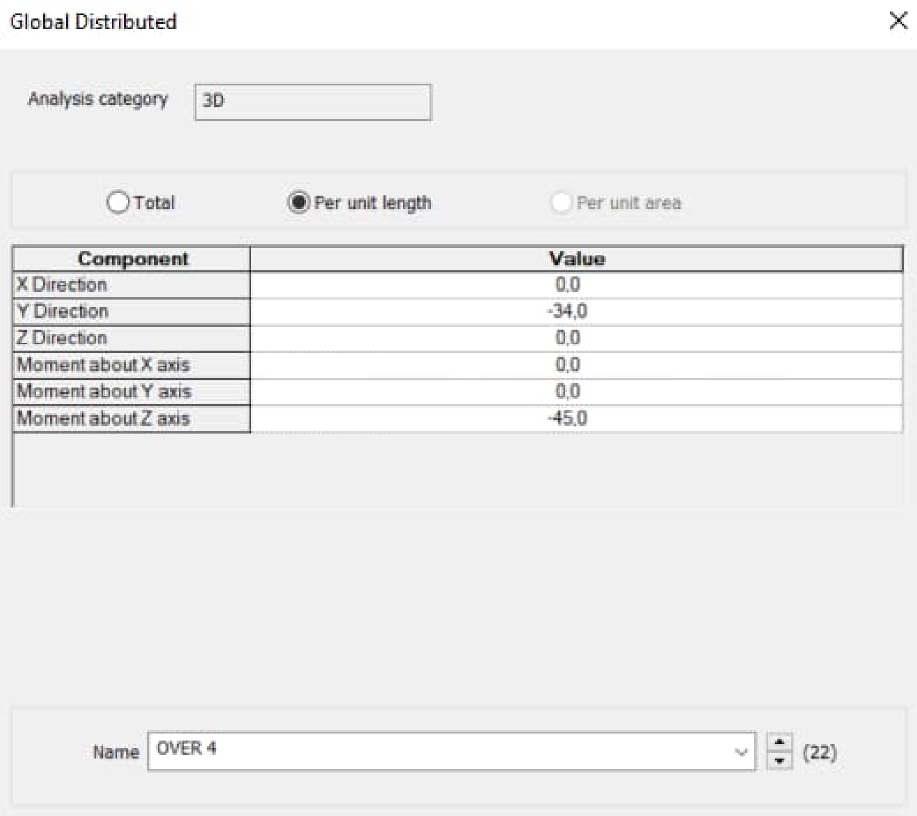


Overview 3D

Load case : OVER 4

$$p_y = -34\frac{kN}{m}$$

$$m_z = -45\frac{kNm}{m}$$

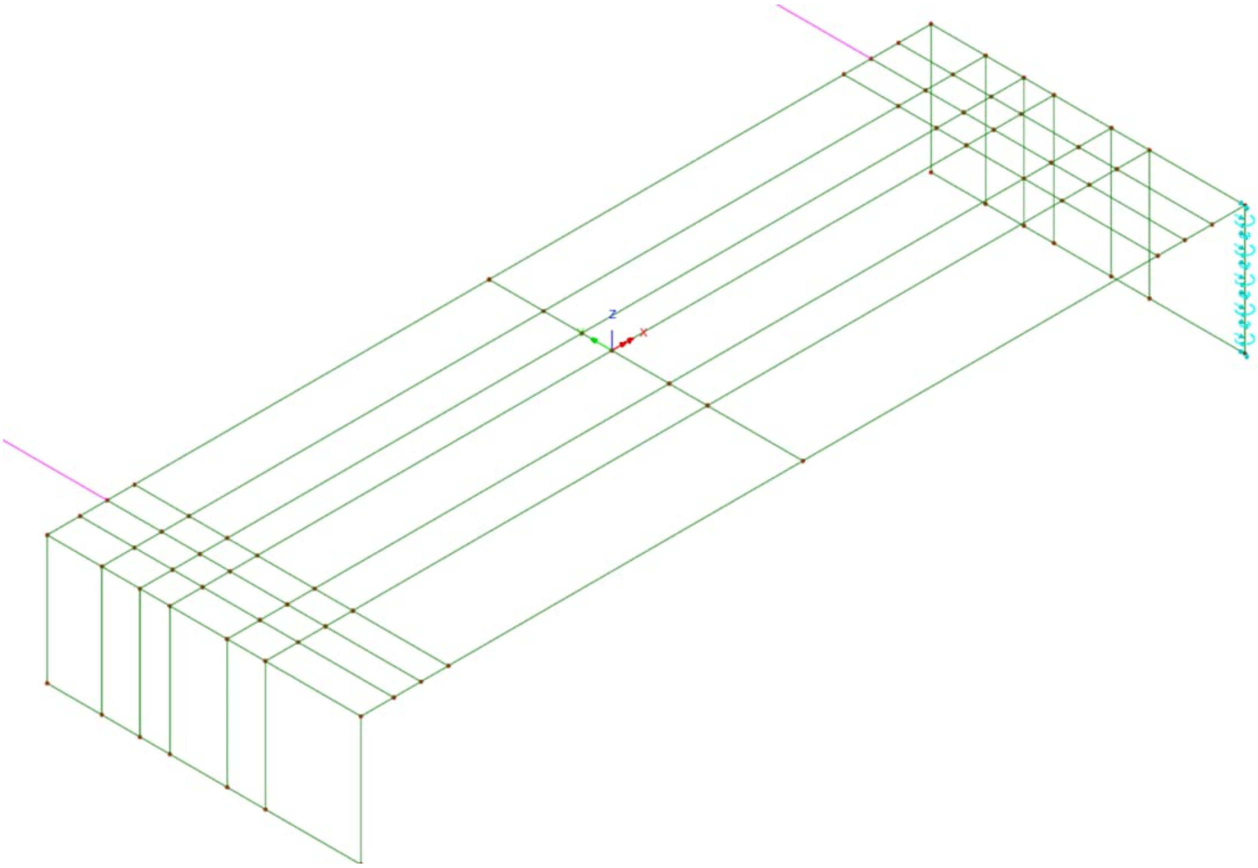

Global Distributed

Analysis category: 3D

○ Total ◉ Per unit length ○ Per unit area

Component	Value
X Direction	0,0
Y Direction	-34,0
Z Direction	0,0
Moment about X axis	0,0
Moment about Y axis	0,0
Moment about Z axis	-45,0

Name: OVER 4 (22)



Overview 3D

3.12.3 Load combination

Load combination smart OVER :

Load case	Permanent factor	Variable factor
OVER 1	0	1
OVER 2	0	1
OVER 3	0	1
OVER 4	0	1

3.13 TEMPERATURE

Temperature effects on bridges are specified in TSFS 2018:57 section B.3.2.5 and EN 1991-1-5 chapter 6.

The effect of gradual crack development is allowed according to SS-EN 1992-1-1 §5.4(3) when determining load effects. This is managed by applying reduced stiffness.

Assembly temperature: $T_0 = +10°C$: EN 1991-1-5A.1(3)

Linear expansion coefficient: $\alpha = 12 \cdot 10^{-6}$

Concrete bridge (concrete slab) ⇒ type 3

Location : ”Location”

$T_{max} = +32℃$: TSFS chapter 8 sketch 8.1
$T_{min} = -44℃$: TSFS chapter 8 sketch 8.2

Duration coefficents :

Coefficents see SS-EN 1990/A1 table A2.3.

$\psi_0 = 0.60$
$\psi_1 = 0.60$
$\psi_2 = 0.50$

3.13.1 Uniform temperature over entire bridge (JTEMP)

Uniform temperature change across the entire bridge is given by EN 1991-1-5 section 6.1.3.3. This temperature change is seasonal and mainly causes translation with movement from the bridge's center of motion towards the respective end abutments. Only movements occur from these loads, which means that the temperature load is not included in the static model.

Function according to SS-EN 1991-1-5 sketch 6.1 (type 3):

$$T_e(T) = \text{linterp}\left[(-50\ \ 0\ \ 30\ \ 50)^T \cdot °C, (-42\ \ 7\ \ 32\ \ 52)^T \cdot °C, T\right]$$

$$T_{e.max} = T_e(T_{max}) = 34\,°C$$

$$T_{e.min} = T_e(T_{min}) = -36\,°C$$

$$T^+ = T_{e.max} - T_0 = +34℃ - 10℃ = +24℃$$

$$T^- = T_{e.min} - T_0 = -36℃ - 10℃ = -46℃$$

3.13.2 Uneven temperature difference between different structural parts

Temperature difference between different structural parts is considered according to TRVINFRA-00227 section 7.2.1.1.2.4.

This load case is disregarded as it is not considered that there are different structural parts with different temperatures that give rise to constraint loads.

3.13.3 Uneven temperature difference across the cross-section

Uneven temperature difference across the cross-section is considered according to SS-EN 1991-1-5 section 6.1.4.

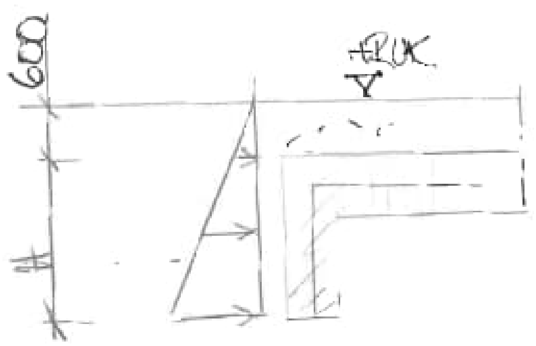
This load case is disregarded as it only causes translation but no constraint loads.

3.13.4 Increased earth pressure due to movement

Increased earth pressure caused by the horizontal movement of the frame legs against the fill is calculated according to TRVINFRA-00227, 7.2.1.1.2.1 and according to SS-EN 1997-1 appendix C, Table C.2 and Figure C.4.

Passive earth pressure associated movement v_p = H/200 = 2800 mm/200 = 14 mm.

$$\Delta p = (p_p - p_0) \cdot v \cdot \frac{200}{H}$$



$$v_t = \Delta T \cdot \alpha \cdot \frac{L}{2} = (24^oC + 46^oC) \cdot 1.2 \cdot 10^{-5} \cdot \frac{16800}{2} = 7mm$$

$$\frac{v_t}{v_p} = \frac{7mm}{14mm} = 0.50 \rightarrow \Delta p = 0.50 \cdot (p_p - p_0)$$

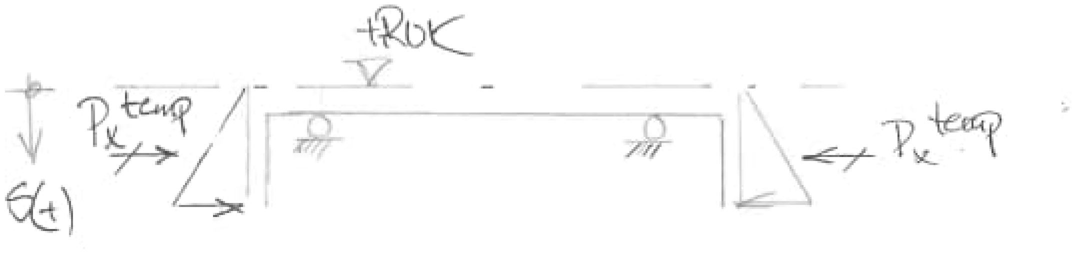
$Fx_{vilo} = 193kN$: see page A3:16

$$\rightarrow Fx_{passiv} = \frac{K_p}{K_0} \cdot Fx_{vilo} = \frac{5.82}{0.29} \cdot 193kN = 3873kN$$

$$P_x^{temp} = 0.5 \cdot (Fx_{passiv} - Fx_{vilo}) = 0.5 \cdot (3873kN - 193kN) = 1840kN$$

Increased earth pressure is introduced in the static model as weighted values (f) of the at-rest earth pressure ”JORD 1” and ”JORD 2”.

$$f = \frac{P_x^{temp}}{Fx_{jord}} = \frac{1840kN}{193kN} = 9.5$$



Basic load combination TEMP :

Load case	Factor
JORD 1	9.5
JORD 2	9.5

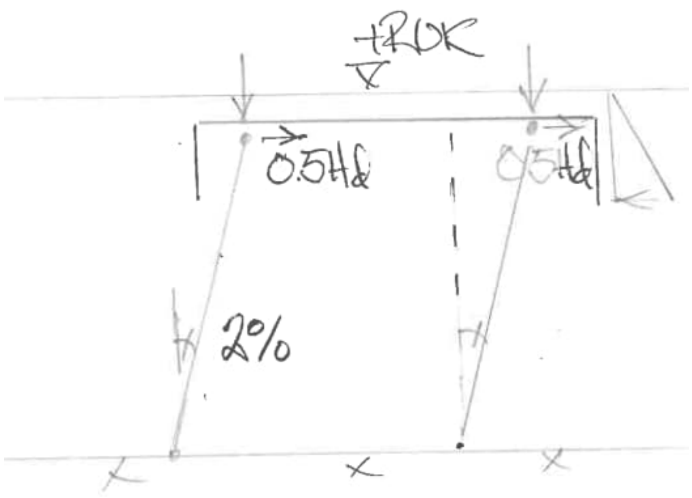
3.14 IMPACT MISS ALIGNMENT OF PILES

The studied bridge assumes that end shields can maintaion global stability.

If piles are installed with eccentricity, the load on the end diaphragms increases.

To account for the effect of inclined pile installation, 2% in the same direction is assumed with a design load effect of 1500 kN in each pile (a total of 8 piles is assumed). At a late stage of design, a deviation on the safe side was encountered, as a detailed check showed that 1363 kN was obtained in each pile.

This fictitious load is considered only in the ultimate limit state (ULS).



Detailed verifical of vertical load (ULS):

Load	Support 1	Support 2	ψγULS	Remark.
EGEN	1506	1496	1,20	Appendix 3 page 5
BALLAST	624	587	1,56	Appendi 3 page 5
LM71	1804	1804	1,50	See below
-	kN	kN	-	-

$\Rightarrow \Sigma$ 10904 kN $\therefore$ 8 x 1363 kN

$$\Sigma Fz_{LM\,71} = \alpha \cdot \Phi_2 \cdot \left[4x250kN + 80\frac{kN}{m} \cdot (16.8m - 6.4m)\right] = 1.6 \cdot 1.23 \cdot 1832kN = 3608kN$$

The load effect on the end walls arises from the applied load effect (H_d) as shown below.

$$H_d = 8\,x\,1500\,kN \cdot 2\% = 240kN$$

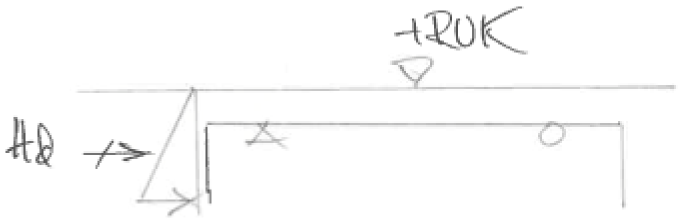
Two load cases are studied, designated “SNED+” and “SNED-”, depending on the direction of the slope.

These load cases give rise to an increased earth pressure against the respective end wall. This is handled through weighted values (f) of the at-rest earth pressure “JORD 1” and “JORD 2”.

$$f = \frac{H_d}{Fx_{jord}} = \frac{240kN}{193kN} = 1.24$$

SNED-

(Load case: f ·”JORD 2”)



SNED+

(Load case: f ·”JORD 1”)

Basic load combination SNED- :

Load case	Factor
JORD 2	1.24

Basic load combination SNED+ :

Load case	Factor
JORD 1	1.24

Envelope SNED :

Load case
SNED+
SNED-

3.15 LOAD COEFFICIENTS

A derivation of applied load factor tables, see RKFM section 7.3 LOAD COMBINATIONS.

3.15.1 Ultimate state ULS

When designing loads both on the bridge and on piles, D2 and Sk3 apply.

In the static model, these load factors are applied in the design of the load combination ULS.

Permanent loads:

Nr	Loads		$\psi\gamma_{ULS}$
1	Deadweight	max	1.20
		min	1.00
2	Ballast	max	1.56
		min	0.70
3	Filling	max	1.20
		min	1.00
4	Earthpressure	max	1.20
		min	1.00
5	Water pressure	max	1.20
		min	1.00
6	Support settlement	max	1.20
		min	0
7	Shrinkage	max	1.20
		min	0
8	Pretension	max	1.20
		min	1.00
*	Effect inclined piles [1.)]		-

Footnote:

1.) Fictive load, see page A3:153-155.

Variable loads:

The least favorable variable load is given the higher value. The others are given the lower value.

Nr	Loads	$\psi\gamma_{ULS-B}$
	Load model LM71:a	
9	Vertikallast LM71	1.50/0.75
9	Bromskraft	1.50/0.75
9	Sidokraft	0.75/0.75
9	Centrifugalkraft	0.75/0.75
	Load model LM71:b	
10	Vertikallast LM71	1.50/0.75
10	Bromskraft	0.75/0.75
10	Sidokraft	1.50/0.75
10	Centrifugalkraft	1.50/0.75
	Load modell empty wagon	
11	Vertikallast tomvagn	1.50/1.50
11	Sidokraft	1.50/1.50
11	Centrifugalkraft	1.50/1.20
	Load model machine track replacement	
12	Machine track replacement	1.50/1.20
13	Surcharge (LM71)	1.50/1.20
	Temperature	
14	Temperature load	1.50/0.90
	Wind loads	
15	Wind load bridge	1.50/0.45
16	Wind load train	1.50/0.45

Loadcombination smart *ULS-PERM :*

Load case	Permanent factor	Variable factor
EGEN	1.00	0.20
BALLAST	0.70	0.86
JORD	1.00	0.20
SNED	1.00	0

Load combination smart LM 71:a*:*
(Load cases to consider :3 / Variable load cases : all)

Load case	Permanent factor	Variable factor
LM 71	1.97 = 1.0·1.97[2.)]	0
BROMS	1.0	0
SIDO	0.50	0

Load combination smart LM 71:b*:*
(Load cases to consider :3 / Variable load cases : all)

Load case	Permanent factor	Variable factor
LM 71	1.97 = 1.0·1.97[2.)]	0
BROMS	0.50	0
SIDO	1.0	0

Envelope LM 71-ULS:

Load case
LM 71:a
LM 71:b

Footnote:
[2.)] Factor dynamics and adaption factor $f = \Phi_2 \cdot \alpha = 1.23 \cdot 1.6 = 1.97$

Load combination smart ULS-VAR:
(Load cases to consider : 4 / Variable load cases : 1)

Load case	Permanent factor	Variable factor
LM 71-ULS	0.75	0.75
OVER	1.20	0.30
TEMP	0.90	0.60
VIND	0.45	1.05

Load combination smart *ULS :*

Load case	Permanent factor	Variable factor
ULS-PERM	1	0
ULS-VAR	0	1

3.15.2 Service state (SLS)

Two load combinations studied in the serviceability limit state. They have different load factors depending on their duration. The load combinations are presented below.

Load combinations	Description
SLS:K	Characteristic
SLS:F	Frequent
SLS:Q	Quasi permanent

Permanent loads:

Nr	Loads		$\psi\gamma_{SLS-Q}$	$\psi\gamma_{SLS-F}$
1	Deadweight	max	1.00	1.00
		min	1.00	1.00
2	Ballast	max	1.30	1.30
		min	0.70	0.70
3	Filling	max	1.00	1.00
		min	1.00	1.00
4	Earthpressure	max	1.00	1.00
		min	1.00	1.00
5	Water pressure	max	1.00	1,00
		min	0	0
6	Support settlement	max	1.00	1.00
		min	0	0
7	Shrinkage	max	1.00	1.00
		min	1.00	0
8	Pretension	max	1.00	1.10
		min	1.00	0.90

Variable loads:

Nr	Loads	$\psi\gamma_{SLS-Q}$	$\psi\gamma_{SLS-F}$
	Load model LM71:a		
9	Vertikallast LM71	-	0.80
9	Bromskraft	-	0.80
9	Sidokraft	-	0.40
9	Centrifugalkraft	-	0.40
	Load model LM71:b		
10	Vertikallast LM71	-	0.80
10	Bromskraft	-	0.40
10	Sidokraft	-	0.80
10	Centrifugalkraft	-	0.80
	Load modell empty wagon		
11	Vertikallast tomvagn	-	0.80
11	Sidokraft	-	0.80
11	Centrifugalkraft	-	0.80
	Load model machine track replacement		
12	Machine track replacement	-	0.80
13	Surcharge (LM71)	-	0.80
	Temperature		
14	Temperature load	0.50	0.60
	Wind loads		
15	Wind load bridge	-	0.20
16	Wind load train	-	0.20

Load combination smart SLS-PERM :

Load case	Permanent factor	Variable factor
EGEN	1.00	0
BALLAST	0.70	0.60
JORD	1.00	0

Load combination smart *SLS-F-VAR :*

Load case	Permanent factor	Variable factor
LM 71	1.58 = 0.80·1.97 [3)]	0
BROMS	0.80	0
SIDO	0.40	0
TEMP	0.60	0
OVER	0.80	0
VIND	0.20	0

Footnote:

[1.)] Factor due to dynamics and adapation of vertical load $f = \Phi_2 \cdot \alpha = 1.23 \cdot 1.6 = 1.97$

Load combination smart *SLS-F :*

Load case	Permanent factor	Variable factor
SLS-PERM	1	0
SLS-F-VAR	0	1

Load combination smart *SLS-Q :*

Load case	Permanent factor	Variable factor
SLS-PERM	1	0
TEMP	0	0.50

3.15.3 Accident load combinbation

Accident load is termed A_d and acts during derrailing of train.

Permanent loads:

Nr	Loads		$\psi\gamma_{EXC}$
1	Deadweight	max	1.00
		min	1.00
2	Ballast	max	1.30
		min	0.70
3	Filling	max	1.00
		min	1.00
4	Earthpressure	max	1.00
		min	1.00
5	Water pressure	max	1,00
		min	1.00
6	Support settlement	max	1.00
		min	0
7	Shrinkage	max	1.00
		min	0
8	Pretension	max	1.10
		min	0.90

Variable loads:

Nr	Loads	$\psi\gamma_{EXC}$
	Load model LM71:a	
9	Vertikallast LM71	0.80
9	Bromskraft	0.80
9	Sidokraft	0.40
9	Centrifugalkraft	0.40
	Load model LM71:b	
10	Vertikallast LM71	0.80
10	Bromskraft	0.40
10	Sidokraft	0.80
10	Centrifugalkraft	0.80
	Load modell empty wagon:	
11	Vertikallast tomvagn	0.80
11	Sidokraft	0.80
11	Centrifugalkraft	0.80
	Load model machine track replacement :	
12	Machine track replacement	0.80
13	Surcharge (LM71)	0.80
	Temperature :	
14	Temperature load	0.60
	Wind loads:	
15	Wind load bridge	0.20
16	Wind load train	0.20
17	Accident load	1.00

3.14.4 Fatigue state (UTM)

Permanent loads:

Nr	Load	$\psi\gamma_{UTM}$
1	Deadweight	1.00
2	Ballast	1.00
3	Filling	1.00
4	Earthpressure	1.00
5	Water pressure	1,00
6	Support settlement	-
7	Shrinkage	-
8	Pretension	1.00

Variable loads:

Nr	Load	$\psi\gamma_{UTM}$
13	Surcharge (LM71)	0.80
	Wind loads :	
15	Wind load bridge	0.20
16	Wind load train	0.20
18	Train type 13S	1.00

Load combination smart FAT :

Loadcase	Permanent factor	Variable factor
EGEN	1.00	0
BALLAST	1.00	0
JORD	1.00	0
TAG 13	1.08 [4.)]	-
OVER	- [5.)]	-
VIND	- [5.)]	-

Fotnotes

[4.)] Dynamic factor $\Phi_2 = 1.08$

[5.)] Not considered as fatigue loads. Reasonable simplification.

Title: Indatakvitto

Model Units: kN,m,t,s,C
Report Units: kN,m,t,s,C

Model Title: System 001

I samband med intern kontroll framkom önskemål om förtydligande nedan.

I rapport används bokstaven “T” för att beskriva ett interval. Bokstaven är en förkortning av “to”.

Se exempel av tilldelning nedan.

Assignment to Lines:
105T110;114T119

Detta uttryck betyder av tilldelning sker till linjerna L105 → L110 och L114 → L119.

Assignment to Surfaces:
3T17;19T24
Detta uttryck betyder av tilldelning sker till ytorna S3 → S17 och S19 → S24.

I samband med intern kontroll framkom önskemål om förtydligande nedan.

Loadcase ID: 500 Title: “Lastkombination 1”
Sub Type: Smart Combination
Loadcases to consider: 3 ← Endast 3 st laster betecknad ”Permanent” skall beaktas
Variable Loadcases: 1 ← Endast 1 st last betecknad ”Variable” skall beaktas

Loadcase	Title	Permanent Factor	Variable Factor	Title
414	0	1,0	0,2	EGEN
179	0	0,7	0,86	BALLAST
415	0	1,0	0,31	JORD
420	0	0,0	1,0	SNED (Max)
421	0	0,0	1,0	SNED (Min)

Loadcase ID: 416 Title: “Lastkombination 2” ← Betyder välj farligaste lastfall av de förekommande (4 st i detta fall)
Sub Type: Envelope
Loadcase Results

File	Title	Type
201	0	LOAD 1
202	0	LOAD 2
203	0	LOAD 3
204	0	LOAD 4

Table of Contents

1. Points

Point	X coordinate	Y coordinate	Z coordinate
10	-8,1	2,3	0,0
11	-7,5	2,3	0,0
12	-7,0	2,3	0,0
13	-6,5	2,3	0,0
14	0,0	2,3	0,0
15	6,5	2,3	0,0
16	7,0	2,3	0,0
17	7,5	2,3	0,0
18	8,1	2,3	0,0
20	-8,1	1,3	0,0
21	-7,5	1,3	0,0
22	-7,0	1,3	0,0
23	-6,5	1,3	0,0
24	0,0	1,3	0,0
25	6,5	1,3	0,0
26	7,0	1,3	0,0
27	7,5	1,3	0,0
28	8,1	1,3	0,0
30	-8,1	0,6	0,0
31	-7,5	0,6	0,0
32	-7,0	0,6	0,0
33	-6,5	0,6	0,0
34	0,0	0,6	0,0
35	6,5	0,6	0,0
36	7,0	0,6	0,0
37	7,5	0,6	0,0
38	8,1	0,6	0,0
40	-8,1	0,0	0,0
41	-7,5	0,0	0,0
42	-7,0	0,0	0,0
43	-6,5	0,0	0,0
44	0,0	0,0	0,0
45	6,5	0,0	0,0
46	7,0	0,0	0,0
47	7,5	0,0	0,0
48	8,1	0,0	0,0
50	-8,1	-1,1	0,0
51	-7,5	-1,1	0,0
52	-7,0	-1,1	0,0
53	-6,5	-1,1	0,0
54	0,0	-1,1	0,0
55	6,5	-1,1	0,0
56	7,0	-1,1	0,0
57	7,5	-1,1	0,0
58	8,1	-1,1	0,0
60	-8,1	-1,8	0,0
61	-7,5	-1,8	0,0
62	-7,0	-1,8	0,0
63	-6,5	-1,8	0,0
64	0,0	-1,8	0,0
65	6,5	-1,8	0,0
66	7,0	-1,8	0,0
67	7,5	-1,8	0,0
68	8,1	-1,8	0,0
70	-8,1	-3,5	0,0
71	-7,5	-3,5	0,0
72	-7,0	-3,5	0,0
73	-6,5	-3,5	0,0
74	0,0	-3,5	0,0
75	6,5	-3,5	0,0
76	7,0	-3,5	0,0
77	7,5	-3,5	0,0
78	8,1	-3,5	0,0

101	-8,1	2,3	-2,4
182	8,1	2,3	-2,4
201	-8,1	1,3	-2,4
282	8,1	1,3	-2,4
301	-8,1	0,6	-2,4
382	8,1	0,6	-2,4
401	-8,1	0,0	-2,4
482	8,1	0,0	-2,4
501	-8,1	-1,1	-2,4
582	8,1	-1,1	-2,4
587	7,0	4,3	0,0
601	-8,1	-1,8	-2,4
682	8,1	-1,8	-2,4
701	-8,1	-3,5	-2,4
782	8,1	-3,5	-2,4
1283	-7,0	4,3	0,0

1297	-11,0	-1,38	0,0
1301	11,0	-1,38	0,0

1302	-11,0	0,0	0,0
1303	11,0	0,0	0,0

1304	-11,0	1,025	0,0
1305	11,0	1,025	0,0

2. Lines

Line	Points	Line	Points
10	10;11	11	11;12
12	12;13	13	13;14
14	14;15	15	15;16
16	16;17	17	18;17
20	20;21	21	21;22
22	22;23	23	23;24
24	24;25	25	25;26
26	26;27	27	28;27
30	30;31	31	31;32
32	32;33	33	33;34
34	34;35	35	35;36
36	36;37	37	38;37
40	40;41	41	41;42
42	42;43	43	43;44
44	44;45	45	45;46
46	46;47	47	48;47
50	50;51	51	51;52
52	52;53	53	53;54
54	54;55	55	55;56
56	56;57	57	58;57
60	60;61	61	61;62
62	62;63	63	63;64
64	64;65	65	65;66
66	66;67	67	68;67
70	70;71	71	71;72
72	72;73	73	73;74
74	74;75	75	75;76
76	76;77	77	78;77
100	20;10	101	30;20
102	40;30	103	50;40
104	60;50	105	70;60
110	21;11	111	31;21
112	41;31	113	51;41
114	51;61	115	71;61
120	22;12	121	32;22
122	42;32	123	52;42
124	62;52	125	72;62
130	23;13	131	33;23
132	43;33	133	53;43
134	63;53	135	73;63
140	24;14	141	34;24
144	64;54	145	74;64
150	25;15	151	25;35
152	35;45	153	45;55
154	55;65	155	65;75
160	26;16	161	36;26
162	46;36	163	56;46
164	66;56	165	76;66
170	27;17	171	27;37
172	37;47	173	47;57
174	57;67	175	67;77
180	28;18	181	28;38
182	38;48	183	48;58
184	58;68	185	68;78
190	10;101	191	20;201
192	30;301	193	40;401
194	50;501	195	60;601
196	70;701	200	201;101
201	201;301	202	301;401
203	401;501	204	501;601
205	601;701	210	18;182
211	28;282	212	38;382
213	48;482	214	58;582

215	68;682	216	78;782
220	282;182	221	282;382
222	382;482	223	482;582
224	582;682	225	682;782
500	1297;1301	501	1302;1303
502	1304:1305		

3. Surfaces

Surface	Lines	Surface	Lines
10	20;110;10;100	11	21;120;11;110
12	22;130;12;120	13	23;140;13;130
14	24;150;14;140	15	25;160;15;150
16	26;170;16;160	17	27;180;17;170
20	30;111;20;101	21	31;121;21;111
22	32;131;22;121	23	33;141;23;131
24	34;151;24;141	25	35;161;25;151
26	36;171;26;161	27	37;181;27;171
30	40;112;30;102	31	41;122;31;112
32	42;132;32;122	33	43;142;33;132
34	44;152;34;142	35	45;162;35;152
36	46;172;36;162	37	47;182;37;172
40	50;113;40;103	41	51;123;41;113
42	52;133;42;123	43	53;143;43;133
44	54;153;44;143	45	55;163;45;153
46	56;173;46;163	47	57;183;47;173
50	60;114;50;104	51	61;124;51;114
52	62;134;52;124	53	63;144;53;134
54	64;154;54;144	55	65;164;55;154
56	66;174;56;164	57	67;184;57;174
60	70;115;60;105	61	71;125;61;115
62	72;135;62;125	63	73;145;63;135
64	74;155;64;145	65	75;165;65;155
66	76;175;66;165	67	77;185;67;175
70	191;100;190;200	71	192;101;191;201
72	193;102;192;202	73	194;103;193;203
74	195;104;194;204	75	196;105;195;205
80	211;180;210;220	81	212;181;211;221
82	213;182;212;222	83	214;183;213;223
84	215;184;214;224	85	216;185;215;225

4. MESH:Line

Attribute: 16 Title: Element 2
Sub Type = Line Mesh Element Type = BMX21

Mesh spacing	Nr. of elements	Start node end releases:	End node end releases:
Uniform	2	None	None

Assignment to Lines: Beta angle = 0,0
120T124;160T164

Attribute: 17 Title: Element 4
Sub Type = Line Mesh Element Type = BMX21

Mesh spacing	Nr. of elements	Start node end releases:	End node end releases:
Uniform	4	None	None

Assignment to Lines: Beta angle = 0,0
125;165

5. MESH:Surface

Attribute: 7 Title: Element 14 x 2
Sub Type = Surface Mesh Element Type = QTS8

Property	Symbol	Value
Element size	size	0,0
Number of divisions in x	xDivisions	14
Number of divisions in y	yDivisions	2
Transition mesh	transition	true
Allow irregular mesh	allowIrregular	true
Element defined by name	DefinedByName	false
Single feature joint	isSingleFtrJnt	false

Assignment to Surfaces:
13;14;23;24;34;43;44;53;54

Attribute: 8 Title: Element 14 x 1
Sub Type = Surface Mesh Element Type = QTS8

Property	Symbol	Value
Element size	size	0,0
Number of divisions in x	xDivisions	14
Number of divisions in y	yDivisions	2
Transition mesh	transition	true
Allow irregular mesh	allowIrregular	true
Element defined by name	DefinedByName	false
Single feature joint	isSingleFtrJnt	false

Assignment to Surfaces:
33

Attribute: 9 Title: Element 14 x 4
Sub Type = Surface Mesh Element Type = QTS8

Property	Symbol	Value
Element size	size	0,0
Number of divisions in x	xDivisions	14
Number of divisions in y	yDivisions	4
Transition mesh	transition	true
Allow irregular mesh	allowIrregular	true
Element defined by name	DefinedByName	false
Single feature joint	isSingleFtrJnt	false

Assignment to Surfaces:
63;64

Attribute: 11 Title: Element 1 x 2
Sub Type = Surface Mesh Element Type = QTS8

Property	Symbol	Value
Element size	size	0,0
Number of divisions in x	xDivisions	1
Number of divisions in y	yDivisions	2
Transition mesh	transition	true
Allow irregular mesh	allowIrregular	true
Element defined by name	DefinedByName	false
Single feature joint	isSingleFtrJnt	false

Assignment to Surfaces:
10T12;15T17;20T22;25T27;30T32;35T37;40T42;45T47;50T52;55T57

Attribute: 13 Title: Element 1 x 4
Sub Type = Surface Mesh Element Type = QTS8

Property	Symbol	Value
Element size	size	0,0
Number of divisions in x	xDivisions	1
Number of divisions in y	yDivisions	4
Transition mesh	transition	true
Allow irregular mesh	allowIrregular	true
Element defined by name	DefinedByName	false
Single feature joint	isSingleFtrJnt	false

Assignment to Surfaces:
60T62;65T67

Attribute: 14 Title: Element 5 x 4
Sub Type = Surface Mesh Element Type = QTS8

Property	Symbol	Value
Element size	size	0,0
Number of divisions in x	xDivisions	5
Number of divisions in y	yDivisions	4
Transition mesh	transition	true
Allow irregular mesh	allowIrregular	true
Element defined by name	DefinedByName	false
Single feature joint	isSingleFtrJnt	false

Assignment to Surfaces:
75;85

Attribute: 15 Title: Element 5 x 2
Sub Type = Surface Mesh Element Type = QTS8

Property	Symbol	Value
Element size	size	0,0
Number of divisions in x	xDivisions	5
Number of divisions in y	yDivisions	2
Transition mesh	transition	true
Allow irregular mesh	allowIrregular	true
Element defined by name	DefinedByName	false
Single feature joint	isSingleFtrJnt	false

Assignment to Surfaces:
70T74;80T84

6. Geometric : Line

Attribute: 3 Title: TVB (TVB (RSS D=1,1 B=1))
Sub Type = Line Geometric
Assigned in: Analysis 1

Property	Symbol	Value
Cross sectional area	A	1,1
Second moment of area about y axis	Iyy	0,1
Second moment of area about z axis	Izz	0,1
Product moment of area	Iyz	0,0
Torsional constant	J	0,2
Eccentricity in local z direction, relative to specified origin	ez0	0,1
Eccentricity in local y direction, relative to specified origin	ey0	0,0
Eccentricity in local z direction, relative to beam centroid	ez	0,1
Eccentricity in local y direction, relative to beam centroid	ey	0,0
Wagner constant 1st moment of square radius about y (Iyr)	Iyr	0,0
Wagner constant 1st moment of square radius about z (Izr)	Izr	0,0
Wagner constant 4th moment of area about origin (Irr)	Irr	0,1
Wagner constant 2nd moment of warping about origin (Iwr)	Iwr	0,0
Effective shear area in local z direction	Asz	0,9
Effective shear area in local y direction	Asy	0,9
Plastic area	Ap	1,1
Plastic modulus for bending about y	Zpy	0,3
Plastic modulus for bending about z	Zpz	0,3
Plastic neutral axis, distance from centroid along y axis	yp	0,0
Plastic neutral axis, distance from centroid along z axis	zp	0,0
Plastic torsional section modulus	Zpt	0,4
Warping torsional constant about shear centre	Cw	0,0
Shear centre about y axis	yo	0,0
Shear centre about z axis	zo	0,0
Monosymmetry constant about y	betay	0,0
Monosymmetry constant about z	betaz	0,0
Radius of gyration about y axis	ky	0,3
Radius of gyration about z axis	kz	0,3
y axis extreme fibre, top	yt	0,5
y axis extreme fibre, bottom	yb	-0,5
z axis extreme fibre, top	zt	0,6
z axis extreme fibre, bottom	zb	-0,6
Shape code identifier	Type	1
Breadth of this section	B	1,0
Depth of this section	D	1,1
Element type	elementType	"3D Thick Beam"
Reinforcement	reinforcement	None

Assignment to Lines:
120T125;160T165

7. Geometric: Surface

Attribute: 1 Title: t = 0,95 m
Sub Type = Surface Geometric
Assigned in: Analysis 1

Property	**Symbol**	**Value**
Thickness	t	0,95
Eccentricity in local z direction, relative to beam centroid	ez	0,0

Assignment to Surfaces:
10T17;20T27;30T37;40T47;50T57;60T67

Attribute: 6 Title: t = 0,6 m
Sub Type = Surface Geometric
Assigned in: Analysis 1

Property	**Symbol**	**Value**
Thickness	t	0,6
Eccentricity in local z direction, relative to beam centroid	ez	0,0

Assignment to Surfaces:
70T75;80T85

8. Isotropic material

Attribute: 1 Title: C35/45 Isotrop
Sub Type = Isotropic Material
Assigned in: Analysis 1

Property	Symbol	Value
Young's modulus	E	34000000,0
Poisson's ratio	nu	0,2
Density	rho	2,5
Coefficient of thermal expansion	alpha	0,0

Assignment to Lines:
120T125;160T165

Assignment to Surfaces:
10;13;14T23I3;24T33I3;34T43I3;44T53I3;54T63I3;64T70I3;71T75;80T85

9. Orthotropic material

Attribute: 2 Title: C35/45 viktlös ortotrop
Sub Type = Orthotropic Material
Assigned in: Analysis 1

Property	Symbol	Value
Shear modulus in yz	Gyz	14000,0
Shear modulus in xz	Gzx	14000000,0
Coefficient of thermal expansion in yz	ayz	0,0
Coefficient of thermal expansion in xz	azx	0,0
Shear modulus in xy	Gxy	14000,0
Coefficient of thermal expansion in xy	axy	0,0
Young's modulus in x	Ex	34000000,0
Young's modulus in y	Ey	34000,0
Poisson's ration in xy	nuxy	0,0
Angle of othotropy	angle	0,0
Density	rho	0,0
Coefficient of thermal expansion in x	ax	0,0
Coefficient of thermal expansion in y	ay	0,0
Mass Rayleigh damping constant	ar	0,0
Stiffness Rayleigh damping constant	br	0,0

Loadcase ID: 1 Title: EGEN 1
Assignment to Surfaces:
11;12;15;16;21;22;25;26;31;32;35;36;41;42;45;46;51;52;55;56;61;62;65;66

10. Support

Attribute: 1 Title: TF
Sub Type = Structural Support
Assigned in: Analysis 1

Property	Symbol	Value
Translation in X	U	"R"
Translation in Y	V	"R"
Translation in Z	W	"R"
Rotation about X	THX	"F"
Rotation about Y	THY	"F"
Rotation about Z	THZ	"F"
Torsional warping	Torsion	"F"
Moment about hinge	L1	"F"

Assignment to Points:
62

Attribute: 2 Title: RY
Sub Type = Structural Support
Assigned in: Analysis 1

Property	Symbol	Value
Translation in X	U	"R"
Translation in Y	V	"F"
Translation in Z	W	"R"
Rotation about X	THX	"F"
Rotation about Y	THY	"F"
Rotation about Z	THZ	"F"
Torsional warping	Torsion	"F"
Moment about hinge	L1	"F"

Assignment to Points:
22

Attribute: 3 Title: TA
Sub Type = Structural Support
Assigned in: Analysis 1

Property	Symbol	Value
Translation in X	U	"F"
Translation in Y	V	"F"
Translation in Z	W	"R"
Rotation about X	THX	"F"
Rotation about Y	THY	"F"
Rotation about Z	THZ	"F"
Torsional warping	Torsion	"F"
Moment about hinge	L1	"F"

Assignment to Points:
26

Attribute: 4 Title: RX
Sub Type = Structural Support
Assigned in: Analysis 1

Property	Symbol	Value
Translation in X	U	"F"
Translation in Y	V	"R"
Translation in Z	W	"R"
Rotation about X	THX	"F"
Rotation about Y	THY	"F"
Rotation about Z	THZ	"F"
Torsional warping	Torsion	"F"
Moment about hinge	L1	"F"

Assignment to Points:
66

11. Search Area

Attribute: 1 Title: Brobana
Sub Type = Search Area

Assignment to Surfaces:
10T17;20T27;30T37;40T47;50T57;60T67

Attribute: 2 Title: Andskarm 1
Sub Type = Search Area

Assignment to Surfaces:
70T75

Attribute: 3 Title: Andskarm 2
Sub Type = Search Area

Assignment to Surfaces:
80T85

12. Global distributed load

I samband med intern kontroll framkom önskemål om förtydligande av uttryck nedan.

Property	**Symbol**	**Value**
Attribute type	type	"Length"

Tilldelning **Attribute type** används för laster av typen **Global Distributed Load** för att beskriva hurvida det är en ytlast eller linjelast. En linjelast betecknas ”Per unit length” som i result rapport anges som ”Length”.

Attribute: 3 Title: BROMS-
Sub Type = Global Distributed Load

Property	**Symbol**	**Value**
Attribute type	type	"Length"
X Direction	WX	-77,0
Y Direction	WY	0,0
Z Direction	WZ	0,0
Moment about X axis	MX	0,0
Moment about Y axis	MY	-37,0
Moment about Z axis	MZ	0,0
Moment about hinge nodes	Hinge	0,0
Pore pressure flux	pwp	0,0
Keep global	keepGlobal	false

Loadcase ID: 206 Title: BROMS- Factor = 1
Assignment to Lines:
140T145

Attribute: 10 Title: EGEN 3
Sub Type = Global Distributed Load

Property	**Symbol**	**Value**
Attribute type	type	"Length"
X Direction	WX	0,0
Y Direction	WY	0,0
Z Direction	WZ	-6,5
Moment about X axis	MX	0,0
Moment about Y axis	MY	0,0
Moment about Z axis	MZ	0,0
Moment about hinge nodes	Hinge	0,0
Pore pressure flux	pwp	0,0
Keep global	keepGlobal	false

Loadcase ID: 177 Title: EGEN 3 Factor = 1
Assignment to Lines:
10T17;70T77

Attribute: 11 Title: EGEN 4
Sub Type = Global Distributed Load

Property	Symbol	Value
Attribute type	type	"Length"
X Direction	WX	0,0
Y Direction	WY	0,0
Z Direction	WZ	-30,0
Moment about X axis	MX	0,0
Moment about Y axis	MY	0,0
Moment about Z axis	MZ	0,0
Moment about hinge nodes	Hinge	0,0
Pore pressure flux	pwp	0,0
Keep global	keepGlobal	false

Loadcase ID: 178 Title: EGEN 4 Factor = 1
Assignment to Lines:
196;216

Attribute: 14 Title: JORD 3-1
Sub Type = Global Distributed Load

Property	Symbol	Value
Attribute type	type	"Length"
X Direction	WX	0,0
Y Direction	WY	-23
Z Direction	WZ	0,0
Moment about X axis	MX	0,0
Moment about Y axis	MY	0,0
Moment about Z axis	MZ	30
Moment about hinge nodes	Hinge	0,0
Pore pressure flux	pwp	0,0
Keep global	keepGlobal	false

Loadcase ID: 202 Title: JORD 3-1 Factor = 1
Assignment to Lines:
196

Attribute: 15 Title: JORD 3-2
Sub Type = Global Distributed Load

Property	**Symbol**	**Value**
Attribute type	type	"Length"
X Direction	WX	0,0
Y Direction	WY	-23
Z Direction	WZ	0,0
Moment about X axis	MX	0,0
Moment about Y axis	MY	0,0
Moment about Z axis	MZ	-30
Moment about hinge nodes	Hinge	0,0
Pore pressure flux	pwp	0,0
Keep global	keepGlobal	false

Loadcase ID: 203 Title: JORD 3-2 Factor = 1
Assignment to Lines:
216

Attribute: 17 Title: BROMS+
Sub Type = Global Distributed Load

Property	**Symbol**	**Value**
Attribute type	type	"Length"
X Direction	WX	77,0
Y Direction	WY	0,0
Z Direction	WZ	0,0
Moment about X axis	MX	0,0
Moment about Y axis	MY	37,0
Moment about Z axis	MZ	0,0
Moment about hinge nodes	Hinge	0,0
Pore pressure flux	pwp	0,0
Keep global	keepGlobal	false

Loadcase ID: 207 Title: BROMS+ Factor = 1
Assignment to Lines:
140T145

Attribute: 18 Title: VIND
Sub Type = Global Distributed Load

Property	**Symbol**	**Value**
Attribute type	type	"Length"
X Direction	WX	0,0
Y Direction	WY	6,0
Z Direction	WZ	0,0
Moment about X axis	MX	-16,0
Moment about Y axis	MY	0,0
Moment about Z axis	MZ	0,0
Moment about hinge nodes	Hinge	0,0
Pore pressure flux	pwp	0,0
Keep global	keepGlobal	false

Loadcase ID: 214 Title: VIND Factor = 1
Assignment to Lines:
40T47

Attribute: 21 Title: OVER 3
Sub Type = Global Distributed Load

Property	**Symbol**	**Value**
Attribute type	type	"Length"
X Direction	WX	0,0
Y Direction	WY	-34,0
Z Direction	WZ	0,0
Moment about X axis	MX	0,0
Moment about Y axis	MY	0,0
Moment about Z axis	MZ	45,0
Moment about hinge nodes	Hinge	0,0
Pore pressure flux	pwp	0,0
Keep global	keepGlobal	false

Loadcase ID: 217 Title: OVER 3 Factor = 1
Assignment to Lines:
196

Attribute: 22 Title: OVER 4
Sub Type = Global Distributed Load

Property	**Symbol**	**Value**
Attribute type	type	"Length"
X Direction	WX	0,0
Y Direction	WY	-34,0
Z Direction	WZ	0,0
Moment about X axis	MX	0,0
Moment about Y axis	MY	0,0
Moment about Z axis	MZ	-45,0
Moment about hinge nodes	Hinge	0,0
Pore pressure flux	pwp	0,0
Keep global	keepGlobal	false

Loadcase ID: 218 Title: OVER 4 Factor = 1
Assignment to Lines:
216

13. Body load

Attribute: 1 Title: EGEN 1

Sub Type = Body Force Load

Property	Symbol	Value
Linear acceleration in X	AccX	0,0
Linear acceleration in Y	AccY	0,0
Linear acceleration in Z	AccZ	-10,0
Angular velocity about X axis	AngVelX	0,0
Angular velocity about Y axis	AngVelY	0,0
Angular velocity about Z axis	AngVelZ	0,0
Angular acceleration about X axis	AngAccX	0,0
Angular acceleration about Y axis	AngAccY	0,0
Angular acceleration about Z axis	AngAccZ	0,0
Linear acceleration In X fluid phase	lnFlAccX	0,0
Linear acceleration In Y fluid phase	lnFlAccY	0,0
Linear acceleration In Z fluid phase	lnFlAccZ	-10,0

Loadcase ID: 1 Title: EGEN 1 Factor = 1
Assignment to Surfaces:
70T75;80T85

Attribute: 2 Title: EGEN 2

Sub Type = Body Force Load

Property	Symbol	Value
Linear acceleration in X	AccX	0,0
Linear acceleration in Y	AccY	0,0
Linear acceleration in Z	AccZ	-10,0
Angular velocity about X axis	AngVelX	0,0
Angular velocity about Y axis	AngVelY	0,0
Angular velocity about Z axis	AngVelZ	0,0
Angular acceleration about X axis	AngAccX	0,0
Angular acceleration about Y axis	AngAccY	0,0
Angular acceleration about Z axis	AngAccZ	0,0
Linear acceleration In X fluid phase	lnFlAccX	0,0
Linear acceleration In Y fluid phase	lnFlAccY	0,0
Linear acceleration In Z fluid phase	lnFlAccZ	-10,0

Loadcase ID: 2 Title: EGEN 2 Factor = 1
Assignment to Surfaces:
10T17;20T27;30T37;40T47;50T57;60T67

14. Discrete point load

Symbol	Property
dirType	Load direction
pDir	Projection vector
nGridX	X Grid size
nGridY	Y Grid size
pos	Coordinates
P	Load

Attribute: 16 Title: LOC
Sub Type = Discrete Point Load

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	4	2

pos_x	pos_y	pos_z	Pz
-2,4	-0,7175	0,0	-125,0
-0,8	-0,7175	0,0	-125,0
0,8	-0,7175	0,0	-125,0
2,4	-0,7175	0,0	-125,0
2,4	0,7175	0,0	-125,0
0,8	0,7175	0,0	-125,0
-0,8	0,7175	0,0	-125,0
-2,4	0,7175	0,0	-125,0

Attribute: 30 Title: TAG 13S
Sub Type = Discrete Point Load

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	2	6

pos_x	pos_y	pos_z	Pz
0,0	0,7175	0,0	-175,0
0,9	0,7175	0,0	-175,0
5,8	0,7175	0,0	-175,0
6,7	0,7175	0,0	-175,0
10,3	0,7175	0,0	-175,0
11,2	0,7175	0,0	-175,0
0,0	-0,7175	0,0	-175,0
0,9	-0,7175	0,0	-175,0
5,8	-0,7175	0,0	-175,0
6,7	-0,7175	0,0	-175,0
10,3	-0,7175	0,0	-175,0
11,2	-0,7175	0,0	-175,0

Attribute: 31 Title: L1

Sub Type = Discrete Point Load

dirType	**pDir_x**	**pDir_y**	**pDir_z**	**nGridX**	**nGridY**
Z	0,0	0,0	1,0	4	2

pos_x	**pos_y**	**pos_z**	**Pz**
-2,4	-3,275	0,0	-280,0
-0,8	-3,275	0,0	-280,0
0,8	-3,275	0,0	-280,0
2,4	-3,275	0,0	-280,0
2,4	-1,84	0,0	-280,0
0,8	-1,84	0,0	-280,0
-0,8	-1,84	0,0	-280,0
-2,4	-1,84	0,0	-280,0

15. Discrete patch load

Symbol	Property
patchType	Patch type
sweptAngle	Swept angle
xDivisions	Number of local x divisions
yDivisions	Number of local y divisions
dirType	Load direction
pDir	Projection vector
nGridX	X Grid size
nGridY	Y Grid size
pos	Coordinates
P	Load

Attribute: 4 Title: WAG-L1:R
Sub Type = Discrete Patch Load
Patch type: 2-noded edge

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
-13,2	0,7175	0,0	-40,0
-3,2	0,7175	0,0	-40,0

Attribute: 5 Title: WAG-L1:lL
Sub Type = Discrete Patch Load
Patch type: 2-noded edge

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
-13,2	-0,7175	0,0	-40,0
-3,2	-0,7175	0,0	-40,0

Attribute: 6 Title: WAG-L2:R
Sub Type = Discrete Patch Load
Patch type: 2-noded edge

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
3,2	-0,7175	0,0	-40,0
13,2	-0,7175	0,0	-40,0

Attribute: 7 Title: WAG-L2:L
Sub Type = Discrete Patch Load
Patch type: 2-noded edge

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
3,2	0,7175	0,0	-40,0
13,2	0,7175	0,0	-40,0

Attribute: 9 Title: JORD 1
Sub Type = Discrete Patch Load
Patch type: 4-noded quadrilateral

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
X	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Px
-10,0	2,25	-2,35	20,0
-10,0	-3,5	-2,35	20,0
-10,0	-3,5	0,45	4,0
-10,0	2,25	0,45	4,0

Loadcase ID: 204 Title: JORD 1 Factor = 1
Patch transformation = None Load transformation = None
Search area=Andskarm 1
Moving status = Include Full Local X Load Assign type = area
Include moments All
Assignment to Points:
44

Attribute: 13 Title: JORD 2
Sub Type = Discrete Patch Load
Patch type: 4-noded quadrilateral

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
X	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Px
10,0	2,25	-2,35	-20,0
10,0	-3,5	-2,35	-20,0
10,0	-3,5	0,45	-4,0
10,0	2,25	0,45	-4,0

Loadcase ID: 205 Title: JORD 2 Factor = 1
Patch transformation = None Load transformation = None
Search area=Andskarm 2
Moving status = Include Local X Projected Load Assign type = area
Include moments All
Assignment to Points:
44

Attribute: 23 Title: BALLAST
Sub Type = Discrete Patch Load
Patch type: 4-noded quadrilateral

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
-8,1	-3,5	0,0	-14,0
8,1	-3,5	0,0	-12,0
8,1	2,25	0,0	-12,0
-8,1	2,25	0,0	-14,0

Loadcase ID: 179 Title: BALLAST Factor = 1
Patch transformation = None Load transformation = None
Search area=Brobana
Moving status = Exclude All Load Assign type = area
Include moments None
Assignment to Points:
44

Attribute: 19 Title: OVER+
Sub Type = Discrete Patch Load
Patch type: 4-noded quadrilateral

dirType	**pDir_x**	**pDir_y**	**pDir_z**	**nGridX**	**nGridY**
X	0,0	0,0	1,0	0	0

pos_x	**pos_y**	**pos_z**	**Px**
-10,0	2,25	-2,35	18,0
-10,0	-3,5	-2,35	18,0
-10,0	-3,5	0,45	18,0
-10,0	2,25	0,45	18,0

Loadcase ID: 215 Title: OVER + Factor = 1
Patch transformation = None Load transformation = None
Search area=Andskarm 1
Moving status = Include Local X Projected Load Assign type = area
Include moments All
Assignment to Points:
44

Attribute: 20 Title: OVER-
Sub Type = Discrete Patch Load
Patch type: 4-noded quadrilateral

dirType	**pDir_x**	**pDir_y**	**pDir_z**	**nGridX**	**nGridY**
X	0,0	0,0	1,0	0	0

pos_x	**pos_y**	**pos_z**	**Px**
10,0	2,25	-2,35	-18,0
10,0	-3,5	-2,35	-18,0
10,0	-3,5	0,45	-18,0
10,0	2,25	0,45	-18,0

Loadcase ID: 216 Title: OVER - Factor = 1
Patch transformation = None Load transformation = None
Search area=Andskarm 2
Moving status = Include Local X Projected Load Assign type = area
Include moments All
Assignment to Points:
44

Attribute: 27 Title: W1
Sub Type = Discrete Patch Load
Patch type: 2-noded edge

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
-8,1	-3,275	0,0	-89,0
-3,2	-3,275	0,0	-89,0

Attribute: 26 Title: W2
Sub Type = Discrete Patch Load
Patch type: 2-noded edge

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
3,2	-3,275	0,0	-89,0
8,1	-3,275	0,0	-89,0

Attribute: 28 Title: W3
Sub Type = Discrete Patch Load
Patch type: 2-noded edge

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
-8,1	-1,84	0,0	-89,0
-3,2	-1,84	0,0	-89,0

Attribute: 29 Title: W4
Sub Type = Discrete Patch Load
Patch type: 2-noded edge

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
3,2	-1,84	0,0	-89,0
8,1	-1,84	0,0	-89,0

Attribute: 12 Title: W5
Sub Type = Discrete Patch Load
Patch type: 2-noded edge

dirType	pDir_x	pDir_y	pDir_z	nGridX	nGridY
Z	0,0	0,0	1,0	0	0

pos_x	pos_y	pos_z	Pz
-8,1	-3,275	0,0	-179,0
8,1	-3,275	0,0	-179,0

16. Discrete compound load

component	Component name
xOffset	x offset
yOffset	y offset
zOffset	z offset
factor	load factor
transformation	transformation name

Attribute: 8 Title: LM71
Sub Type = Discrete Compound Load

component	xOffset transformation	yOffset	zOffset	factor
LOC	0,0 None	0,0	0,0	1,0
WAG-L1:R	0,0 None	0,0	0,0	1,0
WAG-L1:lL	0,0 None	0,0	0,0	1,0
WAG-L2:R	0,0 None	0,0	0,0	1,0
WAG-L2:L	0,0 None	0,0	0,0	1,0

Attribute: 32 Title: ACC_I
Sub Type = Discrete Compound Load

component	xOffset transformation	yOffset	zOffset	factor
W1	0,0 None	0,0	0,0	1,0
W2	0,0 None	0,0	0,0	1,0
W3	0,0 None	0,0	0,0	1,0
W4	0,0 None	0,0	0,0	1,0
L1	0,0 None	0,0	0,0	1,0

Attribute: 25 Title: ACC_II
Sub Type = Discrete Compound Load

component	xOffset transformation	yOffset	zOffset	factor
W5	0,0 None	0,0	0,0	1,0

17. Reference path

Reference Path "Track 1"
Assignment to Lines: 500

Reference Path "Track 2"
Assignment to Lines: 501

Reference Path "Track 3"
Assignment to Lines: 502

18. Moving load analysis

Type: Moving load analysis ~ LM 71-T1

Moving load: LM71
Longitudinal increment : 0.50 m
Vehicule direction : Both
Patch transformation = None   Load transformation = None
Search area=Brobana
Moving status = Exclude All Load   Assign type = area
Include moments All
path - Reference Path "Track 1"

Type: Moving load analysis ~ LM 71-T2

Moving load: LM71
Longitudinal increment : 0.50 m
Vehicule direction : Both
Patch transformation = None   Load transformation = None
Search area=Brobana
Moving status = Exclude All Load   Assign type = area
Include moments All
path - Reference Path "Track 2"

Type: Moving load analysis ~ LM 71-T3

Moving load: LM71
Longitudinal increment : 0.50 m
Vehicule direction : Both
Patch transformation = None   Load transformation = None
Search area=Brobana
Moving status = Exclude All Load   Assign type = area
Include moments All
path - Reference Path "Track 3"

Type: Moving load analysis ~ TAG 13S

Moving load: TAG 13S
Longitudinal increment : 0.50 m
Vehicule direction : Both
Patch transformation = None   Load transformation = None
Search area=Brobana
Moving status = Exclude All Load   Assign type = area
Include moments All
path - Reference Path "Track 2"

19. Basic combination

Loadcase ID: 208 Title: BROMS 1
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
204	0	2,30	JORD 1
206	0	1,0	BROMS-

Loadcase ID: 209 Title: BROMS 2
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
207	0	1,0	BROMS+
205	0	2,30	JORD 2

Loadcase ID: 212 Title: SIDO 1
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
202	0	2,9	JORD 3-1

Loadcase ID: 213 Title: SIDO 2
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
203	0	2,9	JORD 3-2

Loadcase ID: 219 Title: OVER 1
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
205	0	1,50	JORD 2
215	0	1,0	OVER +

Loadcase ID: 220 Title: OVER 2
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
216	0	1,0	OVER -
204	0	1,50	JORD 1

Loadcase ID: 414 Title: EGEN
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
1	0	1,0	EGEN 1
2	0	1,0	EGEN 2
177	0	1,0	EGEN 3
178	0	1,0	EGEN 4

Loadcase ID: 415 Title: JORD
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
204	0	1,0	JORD 1
205	0	1,0	JORD 2
202	0	1,0	JORD 3-1
203	0	1,0	JORD 3-2

Loadcase ID: 418 Title: SNED-
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
205	0	1,24	JORD 2

Loadcase ID: 419 Title: SNED+
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
204	0	1,24	JORD 1

Loadcase ID: 430 Title: TEMP
Sub Type: Basic Combination

Loadcase File	Results Factor	Title	Type
204	0	9,5	JORD 1
205	0	9,5	JORD 2

20. Smart combination

Loadcase ID: 221 Title: OVER
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
219	0	0,0	1,0	OVER 1
220	0	0,0	1,0	OVER 2
217	0	0,0	1,0	OVER 3
218	0	0,0	1,0	OVER 4

Loadcase ID: 412 Title: ULS-PERM
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
414	0	1,0	0,2	EGEN
179	0	0,7	0,86	BALLAST
415	0	1,0	0,2	JORD
420	0	0,0	1,0	SNED (Max)
421	0	0,0	1,0	SNED (Min)

Loadcase ID: 422 Title: LM 71a
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
410	0	0,0	1,97	LM71 (Max)
411	0	0,0	1,97	LM71 (Min)
210	0	0,0	1,0	BROMS (Max)
211	0	0,0	1,0	BROMS (Min)
416	0	0,0	0,5	SIDO (Max)
417	0	0,0	0,5	SIDO (Min)

Loadcase ID: 424 Title: LM 71b
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
410	0	0,0	1,97	LM71 (Max)
411	0	0,0	1,97	LM71 (Min)
210	0	0,0	0,5	BROMS (Max)
211	0	0,0	0,5	BROMS (Min)
416	0	0,0	1,0	SIDO (Max)
417	0	0,0	1,0	SIDO (Min)

Loadcase ID: 428 Title: ULS-VAR
Sub Type: Smart Combination
Loadcases to consider: 4
Variable Loadcases: 1

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
426	0	0,75	0,75	LM 71-ULS (Max)
427	0	0,75	0,75	LM 71-ULS (Min)
221	0	1,2	0,3	OVER (Max)
222	0	1,2	0,3	OVER (Min)
430	0	0,9	0,6	TEMP
214	0	0,45	1,05	VIND

Loadcase ID: 431 Title: ULS
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
412	0	1,0	0,0	ULS-PERM (Max)
413	0	1,0	0,0	ULS-PERM (Min)
428	0	0,0	1,0	ULS-VAR (Max)
429	0	0,0	1,0	ULS-VAR (Min)

Loadcase ID: 433 Title: SLS-PERM
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
414	0	1,0	0,0	EGEN
179	0	0,7	0,6	BALLAST
415	0	1,0	0,0	JORD

Loadcase ID: 435   Title: SLS-F-VAR
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
410	0	0,0	1,58	LM71 (Max)
411	0	0,0	1,58	LM71 (Min)
210	0	0,0	0,8	BROMS (Max)
211	0	0,0	0,8	BROMS (Min)
416	0	0,0	0,4	SIDO (Max)
417	0	0,0	0,4	SIDO (Min)
430	0	0,0	0,6	TEMP
221	0	0,0	0,8	OVER (Max)
222	0	0,0	0,8	OVER (Min)
214	0	0,0	0,2	VIND

Loadcase ID: 437   Title: SLS-F
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
433	0	1,0	0,0	SLS-PERM (Max)
434	0	1,0	0,0	SLS-PERM (Min)
435	0	0,0	1,0	SLS-F-VAR (Max)
436	0	0,0	1,0	SLS-F-VAR (Min)

Loadcase ID: 573   Title: FAT
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
414	0	1,0	0,0	EGEN
179	0	1,0	0,0	BALLAST
415	0	1,0	0,0	JORD
620	0	0,0	1,08	Envelope (TAG 13S) (Max)
621	0	0,0	1,08	Envelope (TAG 13S) (Min)

Loadcase ID: 439 Title: SLS-Q
Sub Type: Smart Combination
Loadcases to consider: All
Variable Loadcases: All

Loadcase File Factor Factor	Results Permanent Variable Title	Type		
433	0	1,0	0,0	SLS-PERM (Max)
434	0	1,0	0,0	SLS-PERM (Min)
430	0	0,0	0,5	TEMP

21. Envelopes

Loadcase ID: 210 Title: BROMS
Sub Type: Envelope

Loadcase File	Results Title	Type
208	0	BROMS 1
209	0	BROMS 2

Loadcase ID: 410 Title: LM71
Sub Type: Envelope

Loadcase File	Results Title	Type
270	0	Envelope (LM71 - T1) (Max)
271	0	Envelope (LM71 - T1) (Min)
317	0	Envelope (LM71 - T2) (Max)
318	0	Envelope (LM71 - T2) (Min)
408	0	Envelope (LM71 - T3) (Max)
409	0	Envelope (LM71 - T3) (Min)

Loadcase ID: 416 Title: SIDO
Sub Type: Envelope

Loadcase File	Results Title	Type
212	0	SIDO 1
213	0	SIDO 2

Loadcase ID: 420 Title: SNED
Sub Type: Envelope

Loadcase File	Results Title	Type
418	0	SNED-
419	0	SNED+

Loadcase ID: 426 Title: LM 71-ULS
Sub Type: Envelope

Loadcase File	Results Title	Type
422	0	LM 71a (Max)
423	0	LM 71a (Min)
424	0	LM 71b (Max)
425	0	LM 71b (Min)