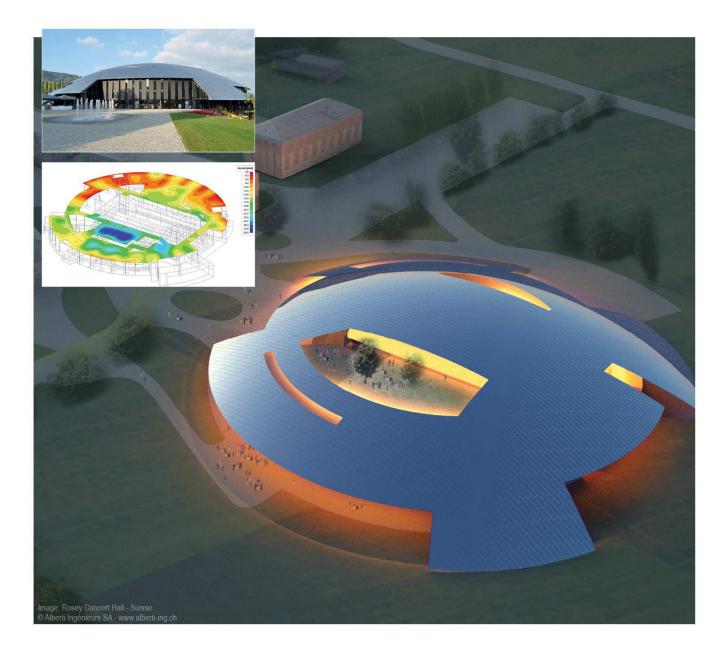
SCIAENGINEER



Advanced Professional Training Mobile Loads

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Introduction

The examples in this manual can be made in a full licensed as well as in a tryout or student version of SCIA Engineer.

Here follows an overview of the re - Mobile loads	quired SCIA Engineer modules / editions, per subject:
esas.02 (1D members)	Professional edition
esas.35 (2D members)	
- Advanced mobile loads	
esas.03 (1D members)	Expert edition
esas.36 (2D members)	

In this course the 'Mobile loads' functionality will be examined in detail. With this functionality, mobile load systems, connected to a track, can be placed and calculated on a structure.

These load systems represent e.g. the following physical systems:

- A crane on a crane track
- A train on a bridge
- A vehicle on a viaduct
- People on a bridge

There can also be multiple load systems:

- Trains with various types of wagons
- Trains on parallel tracks or one after the other
- Different vehicles on a bridge in combination with pedestrians

Through SCIA Engineer it is possible to look for extreme design components such as extreme moments, reaction forces, and deformations ... for these load systems.

In the first part of the course, the principles are explained, in the second part they are illustrated by means of projects.

Principle

The principle of the module Mobile Loads is based on the theory of the influence lines.

An influence line represents a diagram that shows the effect of a unit load on a variable position in a given point of the structure.

This is illustrated on the picture below:

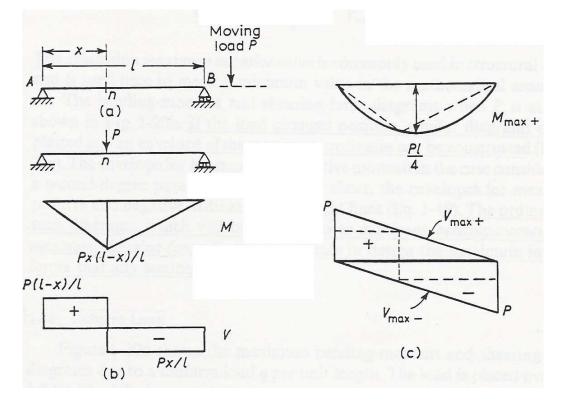


Figure (a) represents a simple beam on 2 supports, across which a concentrated load P can move.

In every section "n" the moment and the shear force are maximal if the load P is exactly above "n". This is shown on figure (b).

When the position of the load is changed, similar diagrams can be made. Finally the envelopes can be drawn as shown on figure (c). As expected, the maximal moment appears in the middle of the beam and the extreme shear forces in the supports.

Using these influence lines, the effect of more loads on the structures, the so-called load system, can be determined.

The goal is to find the position of the load system, for which the effect on the structure in a certain point is maximal.

This is illustrated on the following figure.

Principle

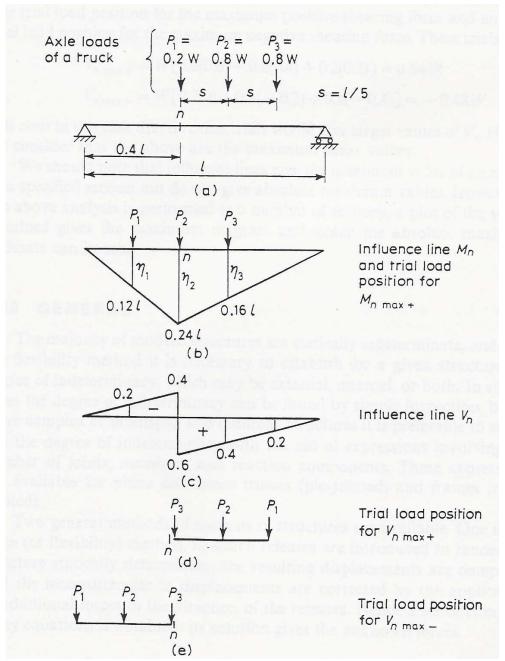


Figure (a) represents a simple beam on two supports again. Across the beam, a system of three point loads can move which represent e.g. the axis loads of a lorry. We look for the position of the load system for which the moment and the shear force are maximal in the section "n".

The influence line for M_n , the moment in n, is shown on figure (b). The moment resulting from the load system can now be determined as follows:

$$M_n = \sum_{i=1}^3 P_i \eta_i$$

At which η_i represents the location of the influence line exactly below $\mathsf{P}_i.$ The maximum of M_n is found by trial and error so the sum of the products of an axis load and the influence location below is as large as possible.

This maximum is shown on figure (b) at which the moment M_n can be determined as follows:

$$M_n = Wl[0,2(0,12) + 0,8(0,24) + 0,8(0,16)] = 0,344Wl$$

For every other position of the load system, a lower maximum in n is obtained.

In an analogous way this is illustrated for V_n , the shear force at the place of the section "n". Figure (c) shows the influence line for the shear force V_n .

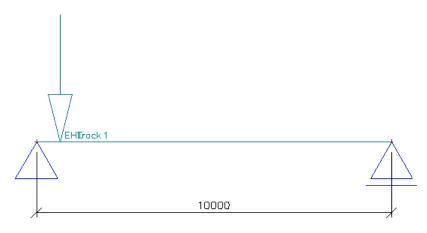
Figures (d) and (e) show the positions of the load system for the maximal positive shear force and the maximal negative shear force.

In SCIA Engineer these various steps appear as follows:

- Input Track across which a Unit load can move
- Input Unit load
- Representation Influence lines
- Input Load system
- Exploitation in a point at which the Load system is linked to the Unit load
- Generation load case for exploitation in a point
- Generation enveloping load cases to gain insight in the global behaviour of the structure.

Project M1: Influence lines

In this first project a simple beam is modelled on 2 supports. By means of the module Mobile Loads, a track and a unit load are defined on this beam so the influence lines of the various design components can be reviewed.

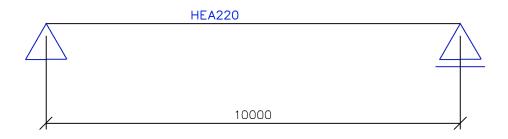


a) Project data

Dynar	nics	E	Steel	
Initial s	stress		Fire resistance	C
Subsc	ál -		Connection modeller	0
Nonlin	earity		Frame rigid connections	1
Stabili	ty		Frame pinned connections	[
Climat	ic loads		Grid pinned connections	1
Prestr	essing		Bolted diagonal connections	ſ
Pipelir	nes		Expert system	1
Structu	iral model		Connection monodrawings	
Param	neters		Scaffolding	
Mobile	e loads		LTB 2nd Order	
Overv	iew drawings		ArcelorMittal	1

b) Construction

The construction can be imported as ⁴⁵ Beam at which the begin node is imposed hinged and the end node rolled.



c) Load

To be able to calculate the construction one load case is made; the Self Weight.

d) Input track and unit load

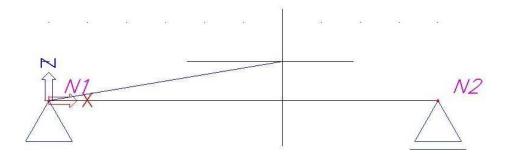
Subsequently the menu ^{# Mobile loads} can be opened.

As shown at the Principles, an influence line represents a diagram that shows the effect of a unit load on a variable position in a given point of the structure.

To be able to meet this definition, a track has to be defined first, across which a unit load can move.

You can import this track through New mobile load track .

The program defines the track as a polyline. As a starting point of the track, the node N1 is indicated, as an end point the node N2.



If the track moves across several members, it is important to indicate sufficient nodes.

The property window shows which nodes are used in the track. As a **Name** for the track **TR1** is entered.

	Name	TR1
	Use for calculation	
	Used nodes	2
Ξ	Track nodes	
	Node	N1 [81]
	Node	N2[B1]

The option **Use for calculation** shows that this track is taken into account in the calculation. If more tracks are defined, this is way can be used to show which tracks really have to be calculated The action **Update track definition** allows generating the imported track again if e.g. the coordinates of a node were adapted. That way the track doesn't have to be imported again after an adjustment of the geometry.

After defining the track, the unit load can be imported through the menu $\stackrel{\text{track}}{=}$ Unit loads.

	Name Track assignment Sections Step for 2D element [m] Generate section under Load system Add new Impulse Impulse 1 Type	EHL TR1 Use sections from results 1,000 ⊠	•
	Sections Step for 2D element [m] Generate section under Load system Add new Impulse Impulse 1	Use sections from results 1,000	•
Ð	Sections Step for 2D element [m] Generate section under Load system Add new Impulse Impulse 1	1,000	
B	Generate section under Load system Add new Impulse Impulse 1		
	Generate section under Load system Add new Impulse Impulse 1		
	Add new Impulse Impulse 1		
	Impulse 1	-	
	· 26 -	Concentrated	-
	Value	-1	
	Position [m]	0,000	
	ey [m]	0,000	
2	ez [m]	0,000	
	System	Local	•
		ī	
	Deleti		I (-1)

Through the option Track assignment you can indicate on which track the unit load needs to appear.

The option Sections determines the density of the used sections.

Use sections from results

The unit load is positioned in every section of the beam that lies in the area of the track. The number of sections on a member is indicated at -J+4 Solver setup.

Use step according 2D element

The unit load is positioned with the step entered of "*step for 2D element [m]*". If a 2D element has a length that is shorter than the adjusted step, it is not loaded by the unit load.

Generate at least one section on member

Analogously to the previous option; here the unit load is also positioned on 2D elements with a shorter length than the adjusted step.

Through the option **Generate section under Load system**, a section is made under every concentrated load of a load system when showing the results. This way the result can be exactly reviewed under the concentrated load.

By default 1 impulse is made. In other examples also more impulses are used. The distance between two impulses is always perpendicular to the track.

In this example the default settings are kept so the concentrated mobile unit load with value **-1** is defined.

The Name of the unit load is by default EHL, which is kept for this example.

e) Influence lines

After defining the track and the unit load, the linear calculation can be started. To do this it is not necessary to exit the menu Mobile Loads, but you can use the button Calculation in the project toolbar.

After the calculation a new group appears in the menu Mobile Loads:

🖻 🛗 Infuence lines

- ∽ Deformations on member
- → Internal forces on member
- ∼ → Displacement of nodes
- → Supports
- ↔ Member stresses

When choosing a result group, you have to indicate on which member and in which section the results have to be shown through the **Selection Tool**.

 B1 0.000 1.000 2.000 3.000 4.000 5.000 6.000 7.000 8.000 9.000 10.000 	
1.000 2.000 3.000 4.000 5.000 5.000 6.000 7.000 8.000 9.000	
3.000 4.000 5.000 6.000 7.000 8.000 9.000	
4.000 5.000 5.000 6.000 7.000 8.000 9.000	
5.000 5.000 6.000 7.000 8.000 9.000	
5.000 6.000 7.000 8.000 9.000	
6.000 7.000 8.000 9.000	
7.000 8.000 9.000	
8.000 9.000	
9.000	
10.000	D
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	1

The $\ensuremath{\text{Preview}}$ shows the results numerically.

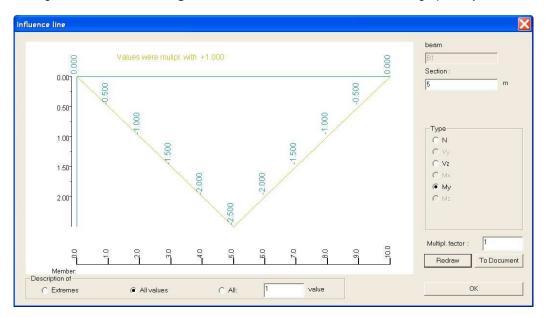
Influence lines - Internal forces on beam

Invloedslijne	en - intene	krachten	op staaf
---------------	-------------	----------	----------

Influence line for internal forces on beam EHL over TR1 - beam B1 - section x=5.0m Multiply factor : 1.00

poz	N	Vz	My
0.00	0.000	0.000	0.000
0.00	0.000	0.000	0.000
1.00	0.000	-0.100	+0.500
2.00	0.000	-0.200	+1.000
3.00	0.000	-0.300	+1.500
4.00	0.000	-0.400	+2.000
5.00	0.000	-0.500	+2.500
5.00	0.000	+0.417	+2.500
5.00	0.000	+0.417	+2.500
5.00	0.000	+0.500	+2.500
6.00	0.000	+0.400	+2.000
7.00	0.000	+0.300	+1.500
8.00	0.000	+0.200	+1.000
9.00	0.000	+0.100	+0.500
10.00	0.000	0.000	0.000
10.00	0.000	0.000	0.000

Through the action button Single Check the influence line can be shown graphically.

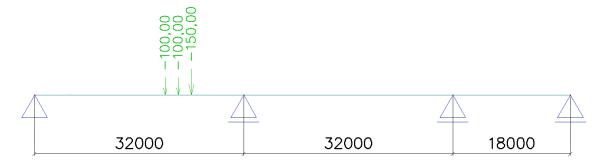


In the field **Multiplication factor**, a proportionality factor can be set. With the button **To document**, the numerical results are sent directly to the document.

Project M2: Load system

In this project a bridge deck is modelled on several supports. After defining a track and a mobile unit load, the various load systems are linked to the unit load.

Through a selective exploitation, the load cases are automatically generated for various positions of the load systems. In a last step, the envelope load cases are generated for various design components to gain insight in the global behaviour of the structure.



a) Project data

Dynamics	Concrete	
Initial stress	Fire resistance	
Subsoil		
Nonlinearity		
Stability		
Climatic loads		
Prestressing		
Pipelines		
Structural model		
Parameters		
Mobile loads		
Overview drawings		
LTA-load cases		

b) Construction

The construction is built from a "**Double T**" bridge girder with standard dimensions, given by SCIA Engineer.

		Name	CS1
		Туре	Double T
		Detailed	13000; 800; 100; 3000; 13
	E	Parameters	
		Material	C25/30
		b [mm]	13000
		b0 [mm]	800
		b1 [mm]	100 3000
		b2 [mm]	1300
D 13000 C 11 0 1 0 1 0 1 0 0 0 0 0 0 0 0 0 0		h1 [mm] h2 [mm]	150
b 13000		h3 [mm]	200
		h4 [mm]	1000
		s [mm]	150
p2 3000 o		d1 [mm]	0
	E		-
000 000 <u>b1 100</u> 000 <u>b0 800</u> <u>c1 11</u>		Draw color	Normal colour
		Colour	
E E E		Properties editable	
		Buckling editable	
		Buckling y-y	b
		Buckling z-z	b ·
		Fabrication	concrete
		FEM analysis	0
		Curve dividing	36
		_	
			Update Docume

The construction can be inserted as 3 horizontal beams through — Beam, at which the begin node is imposed hinged and the other nodes are rolled.



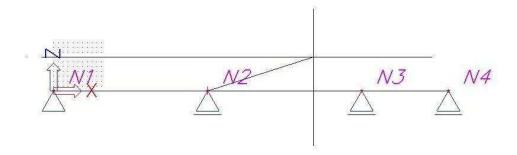
c) Load

To be able to calculate the construction, one load case is created; the Self Weight.

d) Input track and unit load

After entering the construction, the menu ^{def} Mobile loads</sup> can be opened.

Through New mobile load track a track can be defined from node N1 to node N4.



The property window shows the nodes that are recognized by the track:

As **Name** of the track **TR1** is entered.

	Name	TR1
	Use for calculation	
	Used nodes	4
Ξ	Track nodes	
	Node	N1 [81]
	Node	N2 [B1]
	Node	N3 [B2]
	Node	N4 [B3]

After defining the track, a unit load can be inserted through the menu ¹ Unit loads</sup>.

🛚 🤮 🗶 🛍 💺 🗠 😂 🧉	🗟 🗃 🖬 All	• 7
EHL	Name	EHL
	Track assignment	TR1
	Sections	Use sections from results
	Step for 2D element [m]	1,000
	Generate section under Load system	
	Add new Impulse	
	🗆 Impulse 1	
	Туре	Concentrated
	Value	-1
	Position [m]	0,000
	ey[m]	0,000
	ez [m]	0,000
	System	Local
	Direction	Z
	<u></u>	7
		L _y

e) Input load systems

By means of the unit load, the influence lines for the construction can already be generated. SCIA Engineer also allows linking this unit load to a load system.

The input of the load systems occurs through the option database.

Both Single and Multiple Load systems can be defined.

Possibilities with Single Load systems:

- A coherent combination of point loads (e.g. vehicle)
- Line loads of an indefinite length (e.g. pedestrians)
- A combination of both

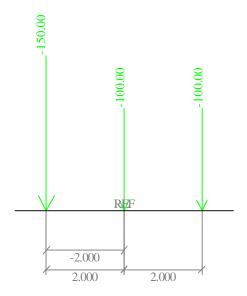
Possibilities with Multiple Load systems:

- A line load with a definite length in combination with a line load of an indefinite length.
- Two similar independent systems of point loads with variable interval in combination with a divided load of an indefinite length.
- Three or more independent systems of point loads with a fixed interval in combination with a divided load of an indefinite length.

In this project the following three load systems are considered:

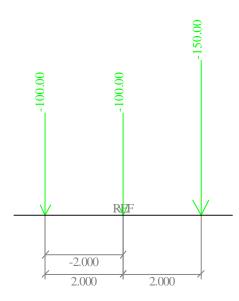
1) Single Load system P Loads left

This load system consists of a point load of 150 kN and 2 point loads of 100 kN with a mutual distance of 2m. The point load of 150 kN is at the front.



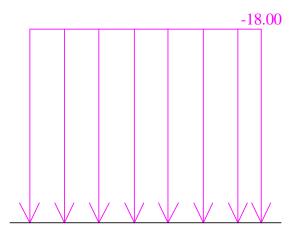
2) Single Load system P Loads right

This load system consists of a point load of 150 kN and 2 point loads of 100 kN with a mutual distance of 2m. The point load of 150 kN is at the back.



3) Single Load system Q Load

This load system consists of a line load of 18 kN/m with an indefinite length.



When entering a Single Load system, you have the possibility to mark the option **Neglect point load** with opposite influence. If this option is activated, the complete concentrated load, which lies in the negative area of the influence line, will be taken in account in the calculation. By activating this option, the found maximum will be reduced.

In this project, the option is not activated.

f) Exploitation of load systems

After defining the mobile unit load and the load systems, the linear calculation can be started through the button Electron in the project toolbar. After the calculation a new group appears in the menu Mobile Loads: ➡ Detail analysis
 ➡ Member force, deformation
 ♣ Reaction
 ➡ Member stress

With the **Detailed Analysis**, the load systems can be linked to the unit load. For every desired position on the structure, between all the selected tracks, SCIA Engineer determines the system that is most adverse for the chosen design parameter.

This is illustrated for 2 different cases.

Case 1

An exploitation is performed for the moment **My** on a position **24m** on the first beam **B1**. The exploitation is performed for the load systems **P Loads Left** and **P Loads Right**.

In the Property window these options can be adjusted:

	Name	Exploitatie van invloedslijnen - Staven
	Unit loads	EHL
	Load systems	[P Loads left] [P Loads right]
Ŧ	Limited run	
Ŧ	Additional	
Ŧ	Load case	
	Setup report	
	Selected members	[B1]
	Values	More comp
	N	
	Vz	
	Му	
	ux	
	uz	
	fiy	
	uz fiy	

The advanced options Limited run, Additional and Load case are discussed further in this course.

Through the action **Preview** the result of the required exploitation can be called up:

1. Description of the influence line + The selected load systems for which the exploitation is done: Influence line: Member B1, Position : 24.00[m], Type : My Considered load systems: P Loads left P Loads left Unit Load : EHL

Node	Х	Y	Z
	[m]	[m]	[m]
1	0.000	0.000	0.000
2	32.000	0.000	0.000
3	64.000	0.000	0.000

4	82.000	0.000	0.000

3. Areas of the fields of the influence line:

Area Nr	Area
1	43.527
2	-34.564
3	2.722

4. Co-ordinates at the points where the sign of the influence line changes:

Sign Nr	X	Y	Z
-	[m]	[m]	[m]
0	0.000	0.000	0.000
1	32.000	0.000	0.000
2	64.000	0.000	0.000

5. Additional factors:

Mult. factor results except deformations : 1.000 Mobile factor: 1.000

6. The data of load system which gives the maximum / minimum values: Negative maximum position : P Loads left

Sum P	Sum Q	X1	X2		
[kNm]	[kNm]	[m]	[m]		
-621.408	0.000	44.667	44.667		

Positive maximum position : P Loads right

Sum P	Sum Q	X1	X2
[kNm]	[kNm]	[m]	[m]
1149.982	0.000	22.000	22.000

7. Results:

Negative maximum position : P Loads left

Description	Due to P	Due to	P + Q	Unit s
My negative	-	0.000	-	[kN
	621.40 8		621.40 8	m]

Positive maximum position : P Loads right

Description	Due to P	Due to Q	P + Q	Unit s
My positive	1149.9 82	0.000	1149.9 82	[kN m]

The parts that should be displayed in the report can be indicated through the options Setup report.

Under *Title 1.* you can see that the position for which the design parameter My is extreme on a position **24m** on member **B1**.

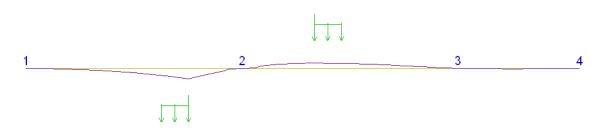
Under Title 6. and 7., is indicated that two extremes have been found.

My is minimal (-621,408 kNm) on 24m if the reference point of the load system P Loads left is located at 44,667m from the begin point of the track.

My is maximal (1149,983 kNm) on 24m if the reference point of the load system P Loads right is located at 22m from the begin point of the track.

The values X1 and X2 are the same since a single load system is used.

This result is also displayed graphically:



Through the action **Single Check** the results are shown in a window, at which the position for the exploitation can be simply changed.

Case 2

An exploitation is performed for the moment **My** on a position **24m** on the first beam **B1**. The exploitation is performed for the load systems **P Loads left**, **P Loads right** and **Q Load**.

In the Property window these options can be set:

1	Jame	Exploitatie van invloedslijnen - Staven
ι	Unit loads	EHL
L	.oad systems	[P Loads left] [P Loads right] [Q Load]
ÐL	imited run	
Ð	Additional	
ÐL	.oad case	
S	Setup report	
S	Selected members	[B1]
V	/alues	More comp
N	4	
V	/z	
N	Лу	
u	X	
u	Z	D
fi	У	

Through the action **Preview** the result of the required exploitation can be called up:

1. Description of the influence line +

The selected load systems for which the exploitation is done: Influence line: Member B1, Position : 24.00[m], Type : My Considered load systems: P Loads left P Loads right Q Load Unit Load : EHL

2. Co-ordinates of the nodes of the load track and their ordinates:

Node	Х	Y	Z
	[m]	[m]	[m]
1	0.000	0.000	0.000
2	32.000	0.000	0.000

3	64.000	0.000	0.000
4	82.000	0.000	0.000

3. Areas of the fields of the influence line:

Area Nr	Area
1	43.527
2	-34.564
3	2.722

4. Co-ordinates at the points where the sign of the influence line changes:

Sign Nr	Х	Y	Z
	[m]	[m]	[m]
0	0.000	0.000	0.000
1	32.000	0.000	0.000
2	64.000	0.000	0.000

5. Additional factors:

Mult. factor results except deformations : 1.000 Mobile factor: 1.000

6. The data of load system which gives the maximum / minimum values: Negative maximum position : Q Load

Sum P	Sum Q	X1	X2
[kNm]	[kNm]	[m]	[m]
0.000	-622.150	0.000	0.000

Positive maximum position : P Loads right

Sum P	Sum Q	X1	X2
[kNm]	[kNm]	[m]	[m]
1149.982	0.000	22.000	22.000

7. Results:

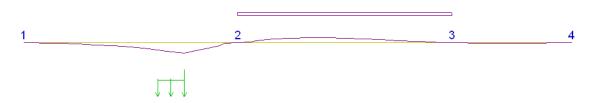
Negative maximum position : Q Load

Descriptio	Due	Due	P + Q	Uni
n	to P	to Q		ts
My negative	0.000	- 622.1 50	- 622.1 50	[kN m]

Positive maximum position : P Loads right

Descriptio	Due	Due	P+Q	Uni
n	to P	to Q		ts
My	1149.	0.000	1149.	[kN
positive	982		982	m]

This result is also displayed graphically:



An influence line for a point of the construction is the representation of the amplitude of the design parameter in the point, if the unit load is moving across the structure. By placing the divided load on the places where the influence line has the same sign, an extreme result is obtained. In this example the moment My on 24m reaches a minimal value **-622.15 kNm** if the divided load is placed in the second field.

Remarks:

With an exploitation calculation various load systems can be selected. In the calculation, SCIA Engineer considers these load systems as individual.

To obtain an exploitation at which various systems are loading the structure at the same time, multiple systems have to be used.

In this project only one track is defined. Of course it also possible to define several tracks. With a calculation, at which various tracks and several load systems have been selected, the program considers every system on every track separately. The resulting extreme component comes from one of the systems on one of the tracks.

Mobile load systems AII 🧎 🛃 📸 🗽 🕰 😫 🖌 AII - 7 P Loads left P Loads right Q Load SB 150 50 50 50 VOSB 150 80.00 -80.00 -10 00 New Insert Edit Delete Close

In the system database various load systems have already been pre-programmed.

g) Generation Load cases – Enveloping Load cases

SCIA Engineer allows making both single and enveloping load cases.

Generation Load cases

With the exploitation of a design parameter in a section you have the possibility to generate several exclusive variable load cases.

First of all the option Load case - generate has to be marked at the Detailed Analysis.

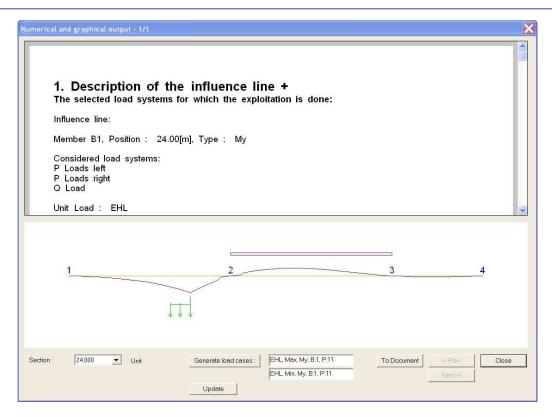
If no variable load group is found, the program asks whether a new group has to be made.

In this example it is applied on case 2, mentioned above:

	Name	Exploitatie van invloedslijnen - Staven
	Unit loads	EHL
	Load systems	[P Loads left] [P Loads right] [Q Load]
Ŧ	Limited run	
Ŧ	Additional	
Ξ	Load case	
	Generate	
	Load group	Mobile
	Setup report	
	Selected members	[B1]
	Values	More comp
	N	
	Vz	
	Му	
	ux	
	uz	
	fiy	

A load case Mobile is made.

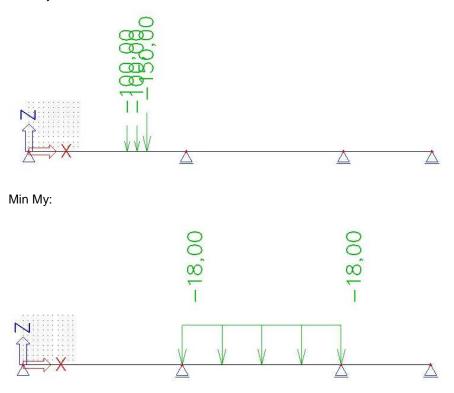
After activating this option, a Single check is performed on the member B1 through the action Single check.



Through the button **Generate Load Cases** two load cases are generated, one for the minimal My on 24m and one for the maximal My on 24m. The parameter B indicates the member, parameter P the position on the member.

Since this option is used to make real load cases, the content of these load cases can be seen.

Max My:



After a linear calculation these load cases can be combined with other load cases and e.g. used for a steel check.

Generation Envelope Load cases

During the exploitation of the influence line, the individual sections of the track are evaluated for the design components (e.g. My). During this exploitation the critical position of the load system is determined. This position causes a maximal value of the design component in the appropriate section. This value is saved together with the corresponding values of this design component in other sections and the procedure is repeated for the following section.

As soon as the calculation is performed for every section, the envelope can be created. Subsequently the system can create envelopes for other design components (e.g. Vy, Vz, etc.). It is important to see that the envelope doesn't represent a realistic load case, so it is not possible to show the content.

The envelope represents a fictive load case that shows the found extremes (envelopes). For this reason it is not useful to use this envelope e.g. for a steel check. This envelope can be combined with other load cases to obtain insight in the global behaviour of the structure.

To be able to generate such enveloping load cases, the option the menu Mobile Loads.

🗖 Stel gegeneerde bela:	stinggevallen in		X
🔎 🤮 🖋 🔛 🕰	🗠 😂 🖙 🔚 🛛 Alles	• 7	
CA	Naam	CA	^
	Gebruik voor berekening		
	Selecteer eenheidslast	[EHL]	
	Selecteer lastsystemen	[P Lasten Links] [P Lasten Rechts] [Q Last]	
E	Eenheidslast: EHL		
	Naam	EHL	
	Belastingsgeval		
	Groep van belastinggevallen		
	Genereer namen		
E	Beperkte looplengte		
E	Extra		
E	Selectie van staven		≣
	Alle staven		
E	Componenten		
	Selecteer componenten		
1	3 Staven		
	N		
	٧٧		
	Vz	⊠	
	Mx		
	Му		
	Mz		
	ux		
	uy		
	uz		
	fix		
	fiy		
	fiz		~
Nieuw Invoegen Bew	erken Verwijder	Sluite	n

First of all you have to indicate which unit loads and which load systems have to be taken into account. In this example three imported load systems are selected.

In the window **Load case** you can enter a name for the load cases you have to make. In this example the names of the load cases are automatically generated by the program by leaving the window blank and the name **Mobile** is selected for the load group.

With **Selection of member** the option **All members** is marked, so all the members are taken into account in the calculation.

Through **Select Components** you can indicate for which components a envelope has to be generated. In this example all components are considered.

V N	□ ∨y	▼ ∨z	Mx Mx	🔽 My	I ™ Mz		Select All
🔽 ux	Γ uy	🔽 uz	Г fix	🔽 fiy	Г fiz		Unselect All
utput of	componen	s on suppo	orts				/
🔽 Rx	☐ Ry	🔽 Rz	∏ Mx	🔽 My	∏ Mz		Select All
							Unselect All
utput of	componen	ts on 2D ele	ements				
M mx	₩ my	₩ mxy	$\overline{ \nabla } = \nabla (\nabla ($	I₹ vy – I	₹ nx 🛛 🕅 ny	🕅 dxà	Select All
₩ UX	🗹 uy	🗹 uz	I fix	IV fiy ■	₹ fiz		Unselect All

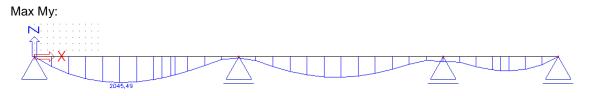
After importing these data a linear calculation can be performed, so the envelope load cases are made.

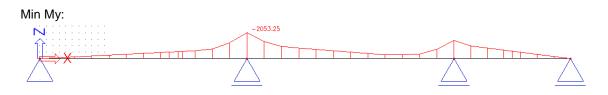
After the calculation the Load cases manager shows the following:

LC1 - Eigengewicht	Name	EHL-P Loads left, P Loads right-Min
EHL-P Loads left, P Loads right-Min Vz	Description	
EHL-P Loads left, P Loads right-Min My	Action type	Variable
EHL-P Loads left, P Loads right-Min uz EHL-P Loads left, P Loads right-Min fiy EHL-P Loads left, P Loads right-Max Vz EHL-P Loads left, P Loads right-Max My EHL-P Loads left, P Loads right-Max uz	LoadGroup	Mobile
	Load type	Static
	Specification	Mobile envelope
	Master load case	None
EHL-P Loads left, P Loads right-Max fiy EHL-P Loads left, P Loads right-Min Rz EHL-P Loads left, P Loads right-Max Rz		

The load cases have 'Mobile envelope' as a description and are in an exclusive load group. If required, the load group can be adjusted to set a Load type according to EC1991.

Subsequently the results of this envelope can be reviewed, e.g. the moment My:





Remarks:

When performing a Detailed analysis or generating the enveloping load cases, a number of advanced options is available:

Limited run:

During the exploitation the critical position of the load system is determined. However, it may happen that the extreme is reached if the mobile load is partially outside the structure. With this option you can indicate whether the mobile load can only appear on a restricted interval of the track so you can avoid that a part of the load system falls partially outside the structure.

The restriction of the track will be executed in such a way that the values of the influence lines will be zero outside the given interval.

Additional multiplication factor results except deformations:

The VOSB code (NEN code) shows that every internal force and reaction for the position of a mobile load has to be multiplied by this coefficient. The results of influence lines for deformations are not multiplied with this factor.

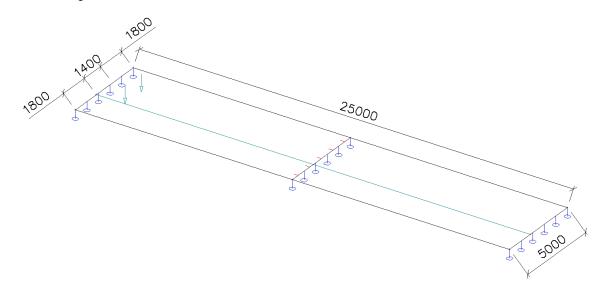
It is possible that a deformation of a load case, associated with internal forces such as Max My, has a larger deformation than e.g. the load case Min uz.

Additional Mobile factor:

The mobile factor is used e.g. to consider a single or double traffic lane. All results are multiplied with this factor, also the deformations.

Project M3: Train loads

In this project a bridge deck is modelled as a concrete plate on three supports. Analogously to the previous projects, a track with a unit load is defined on the bridge deck so the influence lines can be determined. However, in this project a unit load with two impulses is defined to simulate both rails of a train track. In a next step, a VOSB 150 load system is linked to this unit load and the enveloping load cases are generated.



a) Project data

Project data							X
Basic data Fun	ctionality Loads	Combinations	Protection Nation	nal Annexes			
	Data				Structure :		
MILL OF THE OWNER	20.0				Plate XY	•	
A COMPANY OF					Material :		
	Name	Project M3			Concrete		
	Part	r			Material	C25/30 🔽	
	r un	17			Steel		
And the second second	Description	Treinloads			Timber		
a contra	A 11	-			Other Aluminium		
Exclusion in the	Author	PVT			Aiuminium		
1	Date	14.10.2005					
		1					
100							
					10		
	Project Level :		Model :				
	Advanced	•	One				
		-	Jone				
	National Code						
		EC-EN	l .				
-							
						OK Cance	1 1
					7		

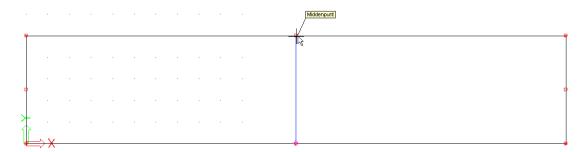
Dynamics	Concrete	
Initial stress	Fire resistance	
Subsoil		
Nonlinearity		
Stability		
Climatic loads		
Prestressing		
Pipelines		
Structural model		
Parameters		
Mobile loads		
Overview drawings		
LTA - load cases		

b) Construction

The bridge deck can be entered as \checkmark Plate with thickness **500mm**. The length of the bridge deck is **25m**, the width **5m**.



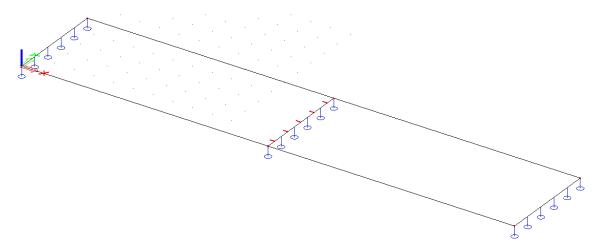
In the middle of the bridge deck an internal edge is created. Using the **Cursor Snap Settings** you can snap on midpoints of the long edges so the edge can be imported through the option



Using $\Rightarrow \Delta D = \Delta D$ support $\Rightarrow D = D D$ member edge, the translation in the Z-direction can be prevented for the three short edges. They can be simply selected by drawing a rectangle:

R		
>	· · · · · · · · · · · · · · · · · · ·	

Then we have the following structure:



c) Load

To be able to calculate the construction, one load case is made; the Self Weight.

d) Input track and unit load

The train track consists in this project of two rails with a distance of **1.4m** between them. To make sure that the train drives on two rails at the same time, 1 mobile load track is entered with a unit and two impulses on it.

The track has to be entered on **1.8m** from the edge to be able to place the train track in the middle of the bridge.

Through New mobile load track the track can be defined. The coordinates can be entered in the Command line:



As Name of the track, TR1 is entered.

	Name	TR1
	Use for calculation	
	Used nodes	2
Ξ	Track nodes	
	Node	K7 [-]
	Node	K8 [-]
	Node	NO [-]

After defining the track, the unit load can be entered through the menu 2 Unit loads.

As a **Name** of the unit load, **Train** is entered for a simple reference. With **Sections** the option **Use step according 2D element** can be chosen and as step, **0.25m** is entered.

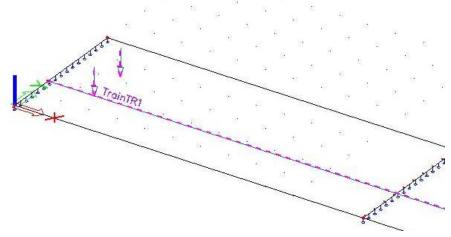
旭 달 🏒 📸 🔛 🖄 Train		Name	Train	1
IIdiii		Track assignment	TR1	-
		Sections	Use Step according 2D element	-
	0	Step for 2D element [m]	0,250	
		Generate section under Load system	H 시작 / 가장 ·	
		Add new Impulse		
		Impulse 1		
		Type	Concentrated	-
		Value	-1	_
		Position [m]	0,000	
		ey [m]	0,000	
		ez [m]	0,000	
		System	Local	•
		7		

Now the unit load consists of 1 concentrated load. To show both rails of the train track, a second impulse is added through the option **Add new impulse**

	🚔 🔂 日 All	• 8	
Train	Delete impulse		54
	🗆 Impulse 1		
	Туре	Concentrated	•
	Value	-1	
	Position [m]	0,000	
	ey[m]	0,000	
	ez [m]	0,000	
	System	Local	-
	Direction	Z	•
	🗆 Impulse 2		
	Туре	Concentrated	•
	Value	-1	
	Position [m]	1,400	
	ey [m]	0,000	
	ez [m]	0,000	
	System	Local	
	Direction	Z	•
	- Weight	1,400	

Subsequently the Position [m] of Impulse 2 can be adjusted to 1.4m.

Both impulses are displayed on the bridge deck:



e) Influence lines

After defining the train track and the unit load that represent both rails, the linear calculation can be started. To do this it is not necessary to exit the menu Mobile Loads, but you can use the button Calculation in the project toolbar. Through Hesh setup the Average size of 2D element/curved element can be set to 0.5m.

After the calculation a new group appears in the menu Mobile Loads:

Infuence lines
→ Displacement of nodes
→ Deformation on slab

∽ Internal forces on slab

When choosing a result group, you have to indicate on which 2D element in which point the results have to be displayed through the **Selection tool**.

	-	S1	
		Pt.1 [m]	5,000, 2,500, 0,000
		Add new point	
	> >> << <		
	Group sele		Deselect all
1			

The results are e.g. asked for the Deformation on slab in the point (5; 2,5; 0).

The **Preview** shows the following results:

Influence lines - Deformation on member 2D

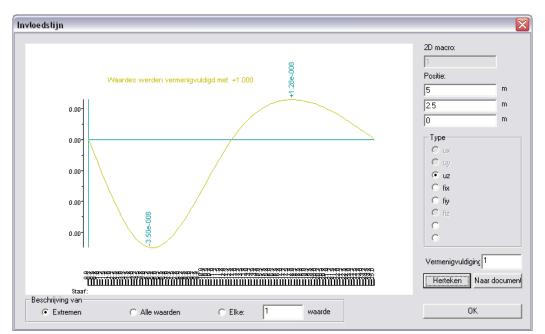
Invloedslijnen - Vervormingen op 2D elementen

Influence line for deformation in member 2D

Train over TR1 - 2D macro 1 - Position: x=5.0,y=2.5,z=0.0m Multiply factor : 1.00

poz	uz	fix	fiy
0.00	0.000	0.000	0.000
0.00	0.000	0.000	0.000
0.25	0.000	0.000	0.000
0.50	0.000	0.000	0.000
0.75	0.000	0.000	0.000
1.00	-1.01e-010	0.000	0.000
1.25	-1.11e-010	0.000	0.000
1.50	-1.20e-010	0.000	0.000
1.75	-1.11e-010	0.000	0.000
2.00	-1.02e-010	0.000	0.000
2.25	0.000	0.000	0.000
2.50	0.000	0.000	0.000
2.75	0.000	0.000	0.000
3.00	0.000	0.000	0.000
3.25	+2.00e-010	0.000	0.000
3.50	+3.04e-010	0.000	0.000

The result table clearly shows the step of 0.25m. Through **Single Check** the result can be viewed graphically.



f) Input Load systems

Through the option de Load System Database a load system can be entered in the project.

In this project a predefined load system is used; namely VOSB 150. That is why the window Load system is cancelled so the Load system Manager is displayed.

Mobile load systems			
⊅ ∄ ∠ ≊⊾ <u>≏</u> ≃ 4	5 🔁 😂 🖬 🛛 All	- 7	
	System database		

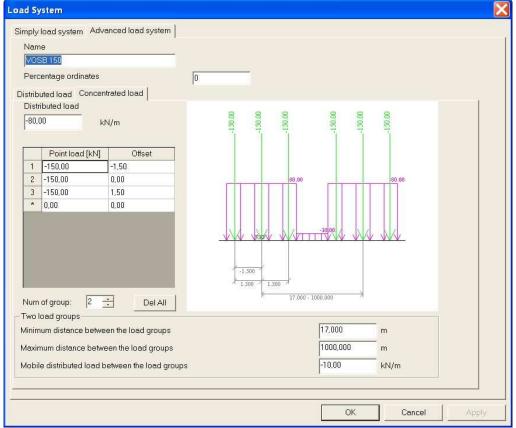
Through the button System database 🔎 a predefined load system can be added to the project:

Read from database		
Project database	System database	
VOSB 150	KLAS 45R KLAS 60L KLAS 60R Load model 1 Lane 1 Load model 1 Lane 2 Load model 1 Lane 3 Load model 1 Other lane Model 71 Model SW/0 Model SW/2 UIC 71 Unloaded train VBS 170 VBS 270	
	VOSB 150 VOSB 1938 VOSB 250 VOSB 270 UIC 71 - HSL 600 E CSN UIC 71 CSN CSD Z CSN CSD T CSN TRM NS CSN TRM 4N	
Close	Copy to project	

With the button <u>Copy to project</u> a load system **VOSB 150** can be copied to the Project. By pressing the button Close this system is displayed in the Load system Manager.

🗖 Mobiele laststelsels	
Alles 🕰 📑 🛃 🗠 😂 😂 🖨 🖬 🛛 Alles	• 7
Noam VOSB 150 Naam VOSB 150	
Nieuw Invoegen Bewerken Verwijder	Sluiten

Through the button **Properties** sthe properties of this load system can be viewed.



The load system consists of 2 groups of three point loads and a divided load. The point loads have a value of 150 kN and a mutual distance 1.5m. The divided load has a value of 80 kN/m.

The **Minimum distance between the load groups** is 17m, the **Maximum distance** is 1000m. SCIA Engineer will let the distances of the load groups between these two boundaries vary to obtain the maximal effect on the bridge deck.

The **Mobile distributed load between the load groups** is 10 kN/m. This value will reduce the found maximum.

g) Exploitation of the load systems

After defining the mobile Unit load and the load systems, the linear calculation can be started by pressing the button 🛱 Calculation in the project toolbar.

After the calculation a new group appears in the menu Mobile Loads:

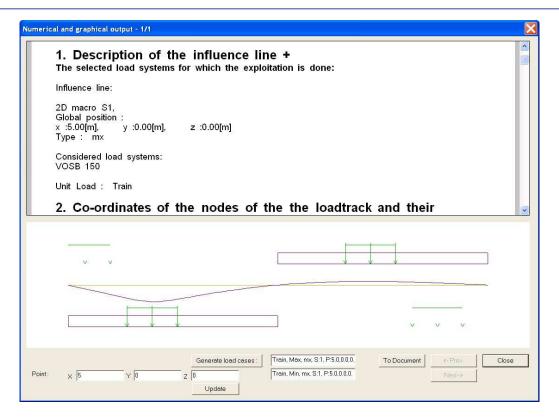
With the Detailed Analysis the load system can be linked to the Unit load. For every desired position on the structure, between all the selected tracks, SCIA Engineer determines the system that is most adverse for the chosen design parameter.

E.g. an exploitation is performed for the moment **mx**. The parameters can be set in the Property window and through **Selected 2D members** is indicated that results are called up for 2D element S1.

The option **Load case - generate** has to marked at the Detailed Analysis. If no variable load group was found, the program asks if a new group had to be made. The **Load group - Train** is selected/made.

	Name	Exploitatie van invloedslijnen - 2D el.
	Unit loads	Train
	Load systems	[VOSB 150]
Ŧ	Limited run	
Ð	Additional	
Ξ	Load case	
	Generate	
	Load group	Train 💌
	Setup report	
	Selected 2D members	[S1]
	Values	mx

Subsequently through **Single Check** the bridge deck can be indicated. The exploitation is performed e.g. in the point (5;0;0).



Under *Title 6. and 7.* is indicated that two extremes have been found. **6. The data of load system which gives the maximum / minimum values:** Negative maximum position : VOSB 150

Sum P	Sum Q	X1	X2
[kNm/m]	[kNm/m]	[m]	[m]
-83.093	-125.154	1.000	18.000

Positive maximum position : VOSB 150

Sum P	Sum Q	X1	X2
[kNm/m]	[kNm/m]	[m]	[m]
365.018	475.258	5.000	22.000

7. Results:

Negative maximum position : VOSB 150

Description	Due to P	Due to Q	P+Q	Units
mx negative	- 83.093	- 125.15 4	- 208.24 7	[kNm/ m]

Positive maximum position : VOSB 150

Description	Due to P	Due to Q	P + Q	Units
mx positive	365.01	475.25	840.27	[kNm/
	8	8	7	m]

mx is minimal (-208,247 kNm/m) in point (5;0;0) if the reference point of the first group of point loads is on 1m from the begin point of the track and the reference point of the second group of point loads that is on 18m.

mx is maximal (840,277 kNm/m) in point (5;0;0) if the reference point of the first group of point loads is on 5m from the begin point of the track and the reference point of the second group of point load is on 22m.

In this example it is clear that the distance between both load groups is always 17m, as set at the VOSB 150 load system.

h) Generate load cases – Envelope load cases

In this project the enveloping load cases are generated for the moment mx and the shear force vx. After drawing up the envelopes, a selective exploitation is performed in a point from the bridge deck.

Generation Envelope Load Cases

To be able to generate the enveloping load cases, the option ¹⁺⁴ Setup generated load cases</sup> is used.

6	All	• 8	
	Name	CA	
	Use for calculation		
	Select unit loads	[Train]	
	Select load systems	[VOSB 150]	3
E	Unit Load: Train		
	Name	Train	
	Load case		
	Group of load cases	Train	-
E	Limited running length		
	Enable		
	Start [m]	0,000	
	Finish [m]	0.000	
E	Additional		
	Mult. factor results except deformatio	1	
	Mobile factor	1	
E	Selection of members		
	All members		
E	Components		
	Select components		
	🗆 Members		
	N		
	Vy		
	Vz		
	Mx		
	Му		
	Mz		
	ux		
	uy		
	uz		
	fix		
	fiy		

First of all you have to indicate which Unit load and which Load system have to be taken into account.

Subsequently the option **Name Load case** can be used to enter the names. This is not necessary. Nothing is filled in so the program generates the names automatically based on *Train* and *VOSB 150*.

Through **Select components** you can indicate for which components an envelope has to be generated. In this example the design parameters vx and mx are considered.

uipui oi c	component	s on membe	ers				
		∏ ∨z	∏ M×	Г Му	∏ Mz		Select All
ux 🗌	Г uy	☐ uz	☐ fix	∏ fiy	☐ fiz		Unselect All
utput of c	component	s on suppor	ts				·
∏ Rx	☐ Ry	∏ Rz	∏ Mx	∏ Му	☐ Mz		Select All
							Unselect All
utput of c	component	s on 2D eler	nents				
🔽 mx	∏ my	∏ mxy	VX F	Tw F	nx 🗌 ny	∏ qxy	Select All
∏ ux	Г чу	🕅 uz	∏ fix ∏	fiy 🗌	fiz	1	Unselect All

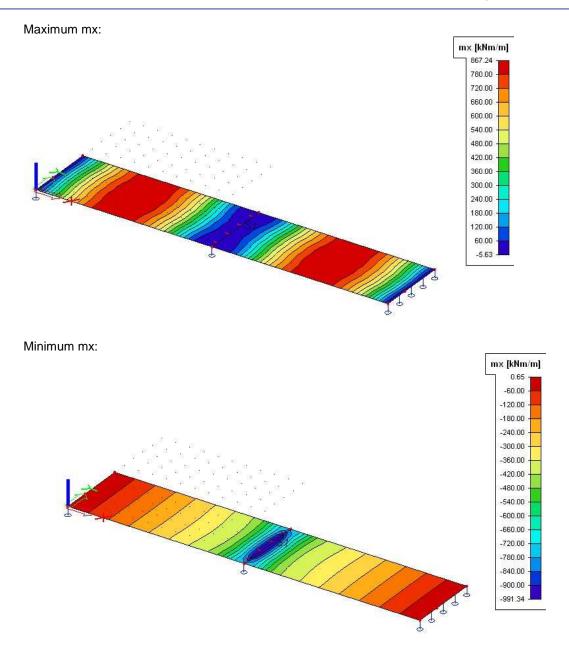
After entering these data, a linear calculation can be performed so the enveloping load cases are made.

After the calculation the Load cases manager shows the following:

🗄 🖌 🛍 💽 🎦 🛛	🔁 🚭 🖼 🛛 Ali	• 7
.C1 - Self weight	Name	Train-VOSB 150-max mx
rain-VOSB 150-max mx	Description	
Train-VOSB 150-min m×	Action type	Variable
Frain-VOSB 150-max vx	LoadGroup	Train
rain-VOSB 150-min vx	Load type	Static
	Specification	Mobile envelope
	Master load case	None

The load cases have Mobile envelope as a description and are in an exclusive load group. The load group can be adjusted if required to set a Load type according to EC1991.

Subsequently the results of these envelopes can be viewed for e.g. the moment mx:



Generation of load cases

After setting the envelopes, a selective exploitation is performed for the moment, indicated on position (**10**; **2**,**5**; **0**).

First of all the option Load case - Generate has to be marked at the Detailed Analysis.

▼.

The load cases will be placed in the variable load group **Train** that has already been made.

After activating this option, a Single check is performed on the bridge deck through the option **Single check** and the desired position is set.

nerical and graphical output - 1/1		
1. Description of the The selected load systems fo	e influence line + or which the exploitation is done:	
Influence line:		
2D macro S1, Global position : x :10.00[m], y :2.50[m], Type : mx	z :0.00[m]	
Considered load systems: VOSB 150		
V V		
int: × 10 Y 2.5	Generate load cases : Train, Max. mx. S:1, P:10.0.2.5, To Document <- Prev Close Z 0 Train, Min, mx. S:1, P:10.0.2.5,0 Next->	e
I I I I I I I I I I I I I I I I I I I	Update	

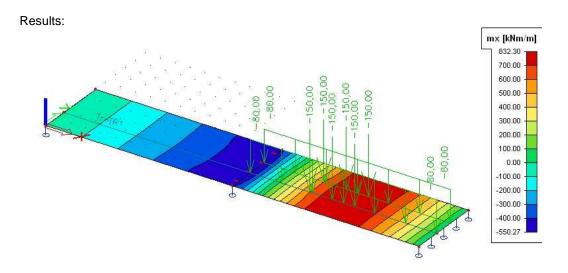
Through Generate Load Cases the load cases are generated.

In the Load cases manager a description can be added to these load cases:

l 🤮 🗶 🛍 🖳 😫	2 🚭 😂 🖬 🛛 All	• 8
LC1 - Self weight	Name	Train, Max, mx, S:1, P:10.0,2.5,0.0
Train-VOSB 150-max mx	Description	
Train-VOSB 150-min mx Train-VOSB 150-max vx Train-VOSB 150-min vx Train, Min, mx, S:1, P:1 Train, Max, mx, S:1, P:	Action type	Variable
	LoadGroup	
	Load type	Static
	Specification	Standard
	Duration	Short
	Master load case	None
	Master load case	None

After re-running the linear calculation, the results for these generated load cases can be viewed.

Load case Max, mx:

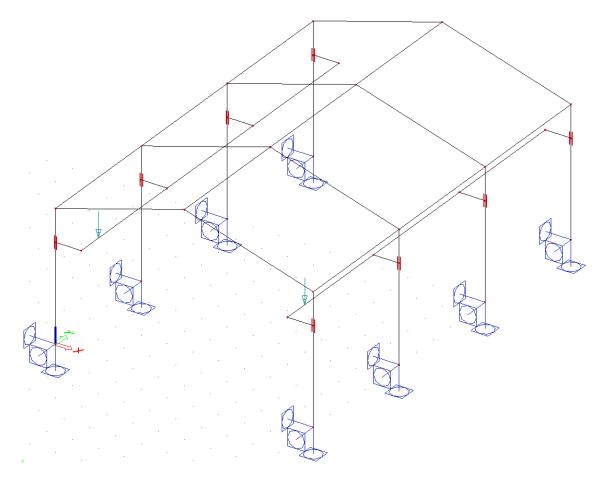


Project M4: Crane track

This last project shows how the position of a load system on the structure can be adapted through various unit loads. That way e.g. a crane track, which moves from left to right in a hall, can be modelled.

After entering a simple hall, the track of the crane track is defined. Using the Unit load with two impulses, both rails of the crane track are simulated. More Unit loads with various factors are entered to show that the crane track can also move in the transversal direction, perpendicular on the rails.

In a next step the load system is defined which represents the wheels of the crane track and this load system is linked to various unit loads so the enveloping load cases can be generated.



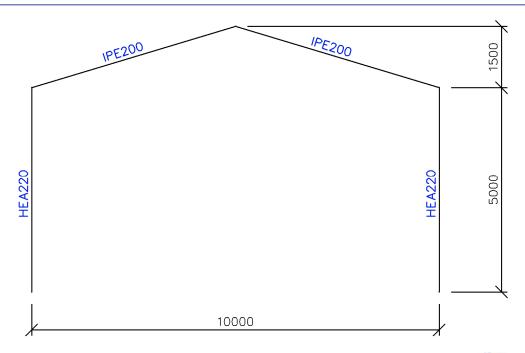
a) Project data

Project data Basic data Funct	ionality Loads	Combinations	Protection Nation	al Annexes		
	Data				Structure : Frame XYZ	•
	Name Part Description Author Date	Project M4 - Crane track PVT 15. 10. 2005			Concrete Steel Material Timber Other Aluminium	□ S 235 ▼ □ □ □
	Project Level : Advanced National Code	EC-EN	Madel : One			OK Cancel

Dynamics	Steel	
Initial stress	Fire resistance	
Subsoil	Connection modeller	
Nonlinearity	Frame rigid connections	
Stability	Frame pinned connections	
Climatic loads	Grid pinned connections	
Prestressing	Bolted diagonal connections	
Pipelines	Expert system	
Structural model	Connection monodrawings	
Parameters	Scaffolding	
Mobile loads	LTB 2nd Order	
Overview drawings	ArcelorMittal	

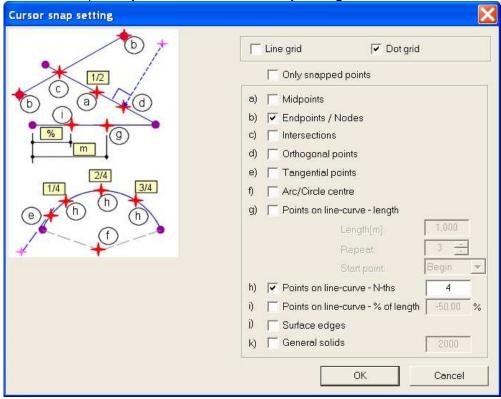
b) Construction

The first portal of the hall can be entered through $-\frac{2}{3}$ Catalogue blocks .

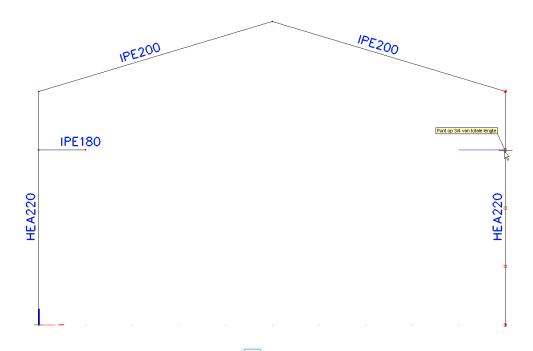


Subsequently the haunch beams on which the rail support, can be entered through $\stackrel{2}{\longrightarrow} Beam$. The beams have a length **1m**, type **IPE 180** and move across $\frac{3}{4}$ of the length of the column.

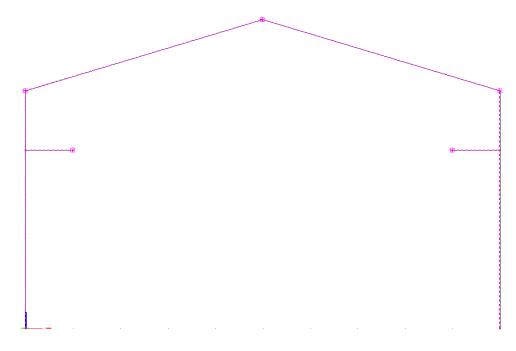
Æ



To find this Snap Point you can use the Cursor Snap settings



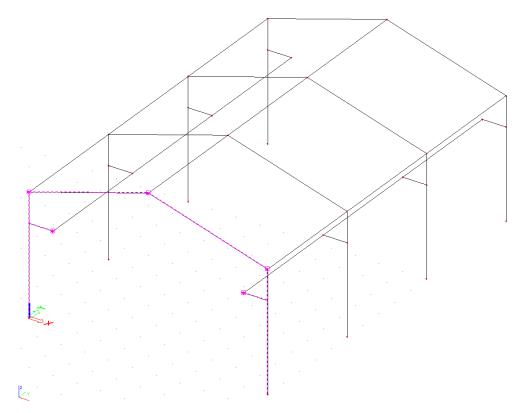
To be able to get the full hall, the option Multiple copy is used. All members, the three nodes of the roof and the two nodes of the IPE180 beams are selected:



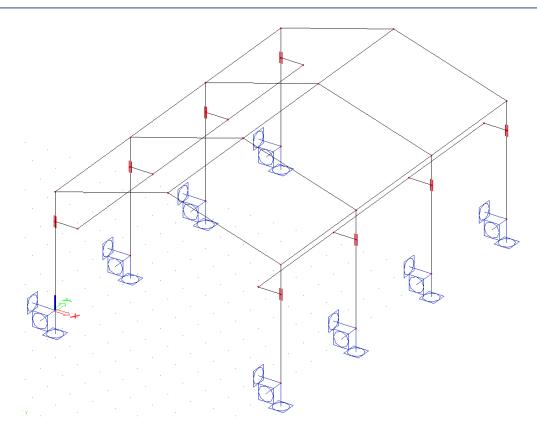
The window More copies can be set:

Numbe	er of copies	÷	Connect selected nodes with new beams	~
🔽 Inse	ert the very last copy	6	Copy additional data	•
Distanc	e vector		How to define the distance ?	
Define	distance by cursor		between two copies	
x	0,000	m	C from original to the last co	ру
y	5,000	- m	-How to define the rotation ?	
7	0.000	- m	between two copies	
-	1	111-	C from original to the last co	ру
Rotatio		-	Rotation around	
ix 👘	0,00	deg	current UCS	
ry	0,00	_ deg	C distance vector	
rz	0,00	_ deg	ОКО	Cancel

As a profile type for the connection beam between the various trusses, **IPE 180** is chosen. Than we have the following structure:



The geometry input is ended by entering the rigid supports to the column bases and by executing the Check structure data and Connect members/nodes to connect the various members.



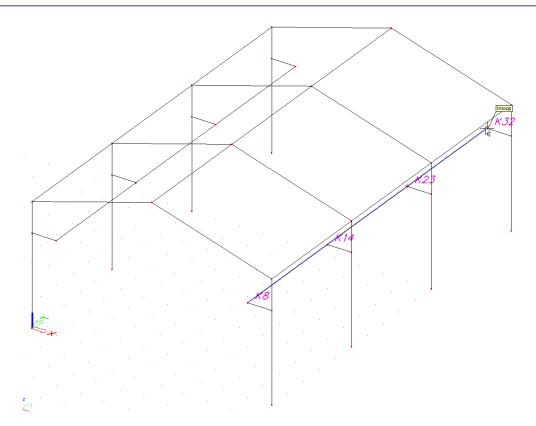
c) Load

To be able to calculate the structure, one load case is created; the Self Weight.

d) Input track and unit load

After entering the construction, the menu - Mobile loads can be opened.

Through New mobile load track a track can be defined from node **K8** to **K14** to **K23** to **K32**.



The Property window shows the nodes that are recognized by the track:

	Name	TR1
	Use for calculation	
	Used nodes	4
Ξ	Track nodes	
	Node	K8 [B36]
	Node	K14 [B36]
	Node	K23 [B37]
	Node	K32 [B38]
	Node	K23 [B37]
tions		
J	pdate track definition	>>>
	able edit geometry	>>>

As a Name for the track TR1 is entered.

After defining the track, the Unit loads can be entered through the menu ^{Unit loads}. In this project three unit loads are entered:

Centre: a Unit load consisting of two impulses of **0**,**5** simulating that the crane track is in the middle of both rails.

Left: a Unit load consisting of an impulse of **0,8** and an impulse of **0,2** simulating that the crane track is on the left hand side of the hall.

Right: a Unit load consisting of an impulse of **0**,**2** and an impulse of **0**,**8** simulating that the crane track is on the right hand side of the hall.

The distance between both impulses is the distance between both rails: 8m.

<mark>@ ≩‡ </mark>			
Left		Name	Midpoint
		Track assignment	TRI
Right	- D,	Sections	Use sections from results
	3	Step for 2D element [m]	1,000
		Generate section under Load system	
	1	Add new Impulse	
		Delete impulse	
	B	Impulse 1	
	323	Туре	Concentrated
	1	Value	-0,5
		Position [m]	0,000
	3	ey[m]	0,000
		ez [m]	0,000
	3	System	Local
		Direction	Z
	E	Impulse 2	
	373	Туре	Concentrated
	9	Value	-0,5
		Position [m]	8,000
	0	ey [m]	0,000
		ez [m]	0,000
	0	System	Local
	1	Direction	Z
		I1 (-0.5)	I2 (-0.5)

Nidpoint Name Right Right Track assignment TR1 Left Sections Use sections from result Step for 2D element [m] 1,000 Generate section under Load system Add new Impulse Delete impulse Delete impulse Impulse 1 Type Concentrated Value Value -0.8 Position [m] 0,000 ez [m] 0,000 System Local Direction Z Type Concentrated Value -0.2 Position [m] 8,000	ults
Right Track assignment TR1 Left Sections Use sections from result Step for 2D element [m] 1,000 Generate section under Load system Add new Impulse Add new Impulse Delete impulse Delete impulse Concentrated Value -0.8 Position [m] 0,000 ez [m] 0,000 system Local Direction Z Type Concentrated Value -0,8 Position [m] 0,000 ez [m] 0,000 gate Type Value -0.2 Position [m] 8,000	ults
Left Sections Use sections from result Step for 2D element [m] 1,000 Generate section under Load system Add new Impulse Add new Impulse Delete impulse Delete impulse Concentrated Value -0.8 Position [m] 0,000 ez [m] 0,000 system Local Direction Z Type Concentrated Value -0,8 Position [m] 0,000 ez [m] 0,000 Type Concentrated Value -0,2 Position [m] 8,000	ults
Step for 2D element [m]1,000Generate section under Load systemImplandAdd new ImpulseImplandDelete impulseImplandTypeConcentratedValue-0,8Position [m]0,000ey [m]0,000ez [m]0,000SystemLocalDirectionZTypeConcentratedValue-0,2Position [m]0,000ez [m]0,000SystemLocalDirectionZPosition [m]0,000SystemLocalDirectionZPosition [m]6,000	
Generate section under Load systemØAdd new Impulse-Delete impulse-Impulse 1-TypeConcentratedValue-0,8Position [m]0,000ey [m]0,000ez [m]0,000SystemLocalDirectionZImpulse 2-TypeConcentratedValue-0,2Position [m]8,000	
Add new ImpulseDelete impulseImpulse 1TypeValuePosition [m]0,000ey [m]0,000ez [m]0,000SystemLocalDirectionZImpulse 2TypeValue-0.2Position [m]8,000	
Delete impulseImpulse 1TypeValuePosition [m]0,000ey [m]0,000ez [m]0,000SystemLocalDirectionZImpulse 2TypeValueValue-0,2Position [m]8,000	
Impulse 1ConcentratedTypeConcentratedValue-0,8Position [m]0,000ey [m]0,000ez [m]0,000SystemLocalDirectionZImpulse 2Impulse 2TypeConcentratedValue-0,2Position [m]8,000	
TypeConcentratedValue-0,8Position [m]0.000ey [m]0,000ez [m]0,000SystemLocalDirectionZImpulse 2ConcentratedValue-0,2Position [m]8,000	
Value -0,8 Position [m] 0,000 ey [m] 0,000 ez [m] 0,000 System Local Direction Z Impulse 2 Concentrated Value -0,2 Position [m] 8,000	
Position [m] 0.000 ey [m] 0.000 ez [m] 0.000 System Local Direction Z Impulse 2 Type Value -0.2 Position [m] 8,000	
ey [m] 0,000 ez [m] 0,000 System Local Direction Z Impulse 2 Type Type Concentrated Value -0,2 Position [m] 8,000	
ez [m]0,000SystemLocalDirectionZImpulse 2ConcentratedTypeConcentratedValue-0,2Position [m]8,000	
System Local Direction Z Impulse 2 Concentrated Type Concentrated Value -0,2 Position [m] 8,000	
Direction Z Impulse 2 Type Concentrated Value -0,2 Position [m] 8,000	
Impulse 2 Concentrated Type Concentrated Value -0,2 Position [m] 8,000	
Type Concentrated Value -0.2 Position [m] 8,000	
Value-0.2Position [m]8,000	
ey [m] 0,000	
ez [m] 0,000	
System Local	
Direction Z	
I1 (-0.8)	

ctions from results trated trated
trated
12 (-0.8)
J2 (-0.8)
12 (-0.8)
12 (-0.8)
I2 (-0.8)
12 (-0.8)
12 (-0.8)
7

e) Input load system

The input of the load system for the crane track happens through the option - database .

For the crane track a total weight of **40 kN** is taken. If the crane track is in the middle, it means **20 kN** per rail. On every rail there are two wheels so a weight of **10 kN** is calculated. The interval between the wheels is **0,8m**.

However, the defined Unit loads are entered with a factor lower than 1. For the unit load Centre a factor of **0,5** is entered per rail. Because of this the loads of the load system have to be doubled to come to the total weight of **40kN**.

The single load system can be entered as two point loads of **20kN** with a mutual distance of **0,8m**.

Load System Simply load system Advanced load system Name Crane Track Neglect point load whit opposite influence Distributed load 0.00 kN/m	-20.00
Point load [kN] Offset 1 -20,00 -0,40 2 -20,00 0,40 * 0,00 0,00	-0.400 0.800
Del All	OK Cancel Apply

As a Name for the load system, Crane Track is entered.

f) Exploitation of the load system

After defining the mobile unit loads and the load system, the linear calculation can be started through the button Equation in the project toolbar.

After the calculation a new group appears in the menu Mobile Loads:

開 Detail analysis が Member force, deformation 希 Reaction L Member stress

With the Detailed Analysis the load system can be linked to various unit loads.

An exploitation is performed for the moment **My** on a position **2.5m** on the first beam **B33**. The exploitation is performed for the three Unit loads together.

In the Property window these loads can be set:

•
-

Through Generate a Load group Mobile is made. Through the action **Preview** the result of the asked exploitation can be asked for.

1. Description of the influence line +

The selected load systems for which the exploitation is done: Influence line: Member B33, Position : 2.50[m], Type : My Considered load systems: Crane Track Unit Load : Left

2. Co-ordinates of the nodes of the load track and their ordinates:

Node	X [m]	Y [m]	Z [m]
9	9.000	0.000	3.750
18	9.000	5.000	3.750
27	9.000	10.000	3.750
36	9.000	15.000	3.750

3. Areas of the fields of the influence line:

Area Nr	Area
1	-0.000
2	1.940
3	-0.471
4	0.088

4. Co-ordinates at the points where the sign of the influence line changes:

Sign Nr	Х	Y	Z
_	[m]	[m]	[m]
0	9.000	0.000	3.750
1	9.000	0.049	3.750
2	9.000	5.197	3.750
3	9.000	10.418	3.750
0	9.000	0.000	3.750
1	9.000	0.049	3.750
2	9.000	5.197	3.750

3	9.000	10.418	3.750

5. Additional factors:

Mult. factor results except deformations : 1.000 Mobile factor: 1.000

6. The data of load system which gives the maximum / minimum values:

Negative maximum position : Crane Track

Sum P	Sum Q	X1	X2
[kNm]	[kNm]	[m]	[m]
-5.590	0.000	7.275	7.275

Positive maximum position : Crane Track

Sum P	Sum Q	X1	X2
[kNm]	[kNm]	[m]	[m]
27.074	0.000	2.100	2.100

7. Results:

Negative maximum position : Crane Track

Description	Due to P	Due to Q	P + Q	Units
My negative	-5.590	0.000	-	[kNm
			5.590]

Positive maximum position : Crane Track

Description	Due to P	Due to Q	P + Q	Units
My positive	27.074	0.000	27.07 4	[kNm]

As expected the maximal moment **My** on the position **2.5m** arises when the crane track is on the left hand side of the hall:

Under *Title 6. and 7.* is indicated that two extremes have been found.

My is minimal **(-5.590 kNm)** on **2.5m** if the reference point of the crane track is on **7.275m** from the begin point of the track.

My is maximal (27.074 kNm) on 2.5m if the reference point of the crane track is on 2.1m from the begin point of the track.

The values X1 and X2 are the same since a single load system was used.

This result is also shown graphically:

		\neg	
9	18	27	36
\downarrow \downarrow			

g) Generation Enveloping Load Cases

For the component My the enveloping load cases are generated through the option – J+4 Setup generated load cases

0 😳 🖋 😼	🕰 😂 😂 🖬 🛛 All	• 8	
CA	Name	CA	
	Use for calculation		
	Select unit loads	[Midpoint] [Right] [Left]	
	Select load systems	[Crane Track]	
	🛛 🖾 Unit Load: Midpoint		
	Name	Midpoint	
	Load case		
	Group of load cases	Mobile	×
	🗉 Unit Load: Right		
	Name	Right	
	Load case		
	Group of load cases	Mobile	×
	🗉 Unit Load: Left		
	Name	Left	
	Load case		
	Group of load cases	Mobile	•
	Limited running length		
	Additional		
	Selection of members		
	All members		
	Selection		
	Components		
	Select components		
	Members		
	N		
	Vy		
	Vz		
	Mx		
	Му		
	Mz		

First of all you have to indicate which unit loads and which load systems have to be taken into account. In this example all unit loads are selected.

Subsequently you can enter the name through the option **Name Load case.** This is not necessary. For a load group the name **Mobile** is chosen, this load group has been created before in the Detailed analysis.

With **Selection of members** the option **All members** is deselected and the member **B33** is indicated. Through **Select components** you can indicate for which components an envelope has to be generated. In this example, only the component **My** is considered.

ΓN	Γvy	∏ ∨z	Г м:	× 🔽	му Г	Mz		Select All
□ ux	∏ uy	∏ uz	∏ fix	Г	fiy 🗆	fiz		Unselect All
utput of	component	ts on suppo	orts					
∏ Rx	∏ Ry	∏ Rz	∏ M:	×Г	му П	Mz		Select All
								Unselect All
utput of	component	ts on 2D ele	ements					
M mx	₩ my	M mxy	₩ vx	₩ vy	l₩ nx	🗹 ny	🔽 dxà	Select All
M IIX	🗹 uy	I√ uz	I ∕ fix	🗹 fiy	🗹 fiz			Unselect All

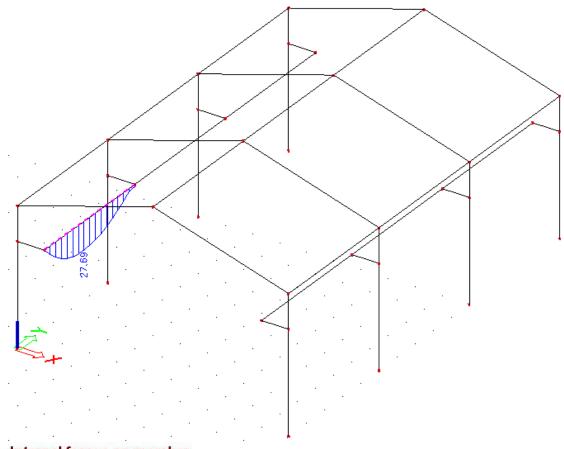
After entering these data, a linear calculation can be performed so the enveloping load cases are made.

After the calculation the Load cases manager displays the following:

LC1 - Eigengewicht	Name	Left-Crane Track-Max My
Midpoint-Crane Track-Min My	Description	
Midpoint-Crane Track-Max My	Action type	Variable
Left-Crane Track-Min My	LoadGroup	Mobile
Left-Crane Track-Max My Right-Crane Track-Min My	Load type	Static
	Specification	Mobile envelope
Right-Crane Track-Max My	Master load case	None

The load cases have Mobile envelope as a description and are in an exclusive load group. If required, the load group can be adjusted, e.g. to set a moment factor according to NEN or a Load Type according to EC1991.

Subsequently, the results of these envelopes can be viewed. The moment course **My** on member **B33** for load case Left – Crane track – Max My shows the following:



Internal forces on member

Linear calculation, Extreme : Global, System : Principal Selection : B33 Load cases : Left-Crane Track-Max My

Load cases	: Left-Crane	Track-Max My
	-	

Member	Case	dx [m]	N [kN]	Vy [kN]	Vz [kN]	Mx [kNm]	My [kNm]	Mz [kNm]
B33	Left-Crane Track-Max My	0,313	-0,05	-0,02	24,89	0,00	8,17	0,04
B33	Left-Crane Track-Max My	4,688	0,14	0,05	-28,75	-0,01	2,77	0,12
B33	Left-Crane Track-Max My	0,000	0,11	0,04	-2,22	0,00	0,01	-0,10
B33	Left-Crane Track-Max My	2,188	0,07	0,03	11,35	0,00	27,69	0,00