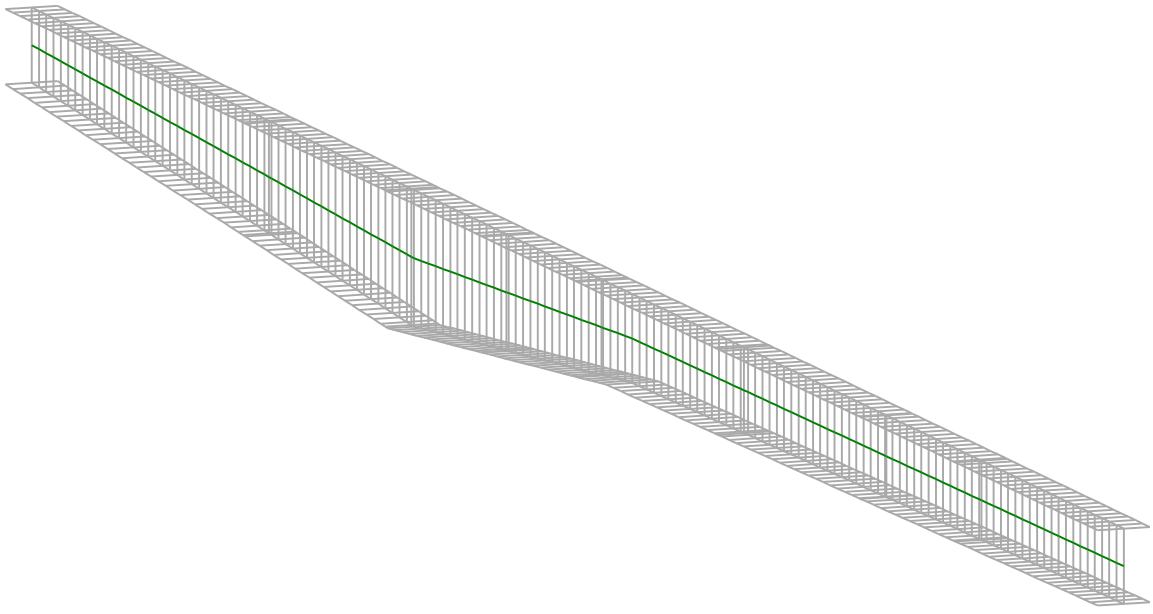
LTBeamN

v 1.0.3

CALCULATION SHEET



I - PARAMETERS

I.1 - General parameters

Projected total length :	L = 23 m
Initial discretization of the beam :	n_{el} = 150 elements

I.2 - Material

Name :	Steel
Young modulus :	E = 210000 MPa
Shear modulus :	G = 80769 MPa
Poisson factor :	ν = 0,3
Density :	ρ = 7850 kg/m^3

I.3 - Sections

Alignment of sections :	Top

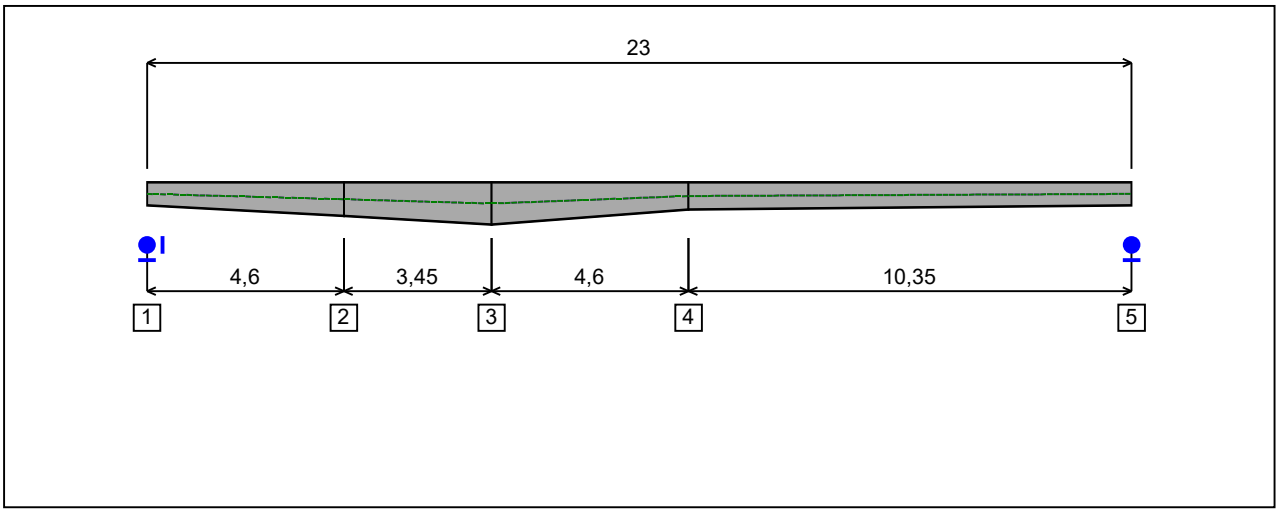


Figure 1 : Profile in long with section numbers.

- Section No. 1 : DIM 550x400

Abscissa from the left end of the beam : x = 0 m

Type : In catalogue (User)

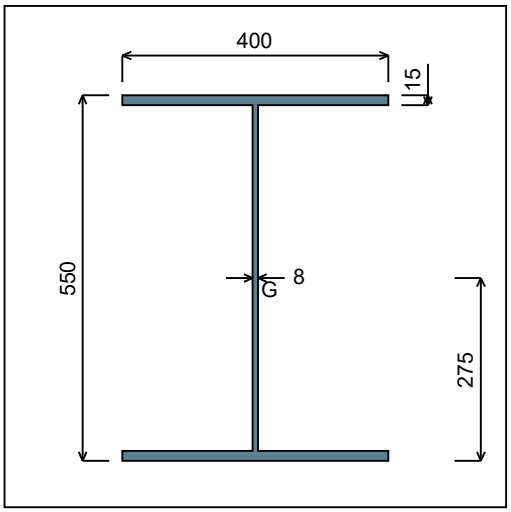


Figure 2 : Section No. 1 (DIM 550x400).

Main geometrical properties :

z_S	= 0 cm
z_G	= 27,5 cm
I_y	= 95264 cm^4
I_z	= 16002 cm^4
I_t	= 97,16 cm^4 (Villette)
I_w	= 1,145E+7 cm^6

Other geometrical properties :

A	= 161,6 cm^2		
$A_{v,y}$	= 120 cm^2	$A_{v,z}$	= 42,8 cm^2
$W_{el,y,sup}$	= 3464,1 cm^3		
$W_{el,y,inf}$	= 3464,1 cm^3	$W_{el,z}$	= 800,11 cm^3
$W_{pl,y}$	= 3750,8 cm^3	$W_{pl,z}$	= 1208,3 cm^3

Stiffness relaxations :

θ	: Continuous
v'	: Continuous
θ'	: Continuous
w'	: Continuous

- Section No. 2 : DIM 800x400

Abscissa from the left end of the beam : x = 4,6 m

Type : In catalogue (User)

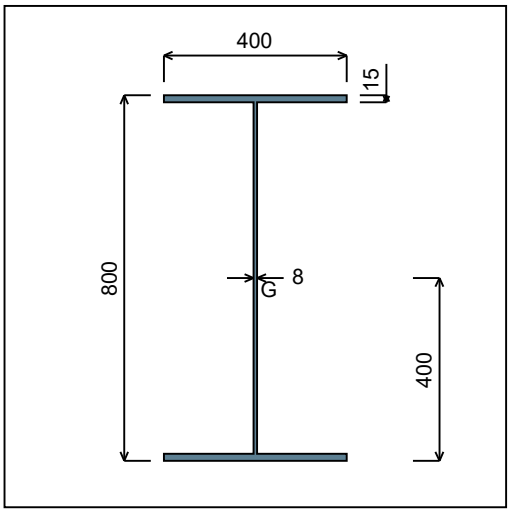


Figure 3 : Section No. 2 (DIM 800x400).

Main geometrical properties :

z_S	= 0 cm
z_G	= 40 cm
I_y	= 215326 cm^4
I_z	= 16003 cm^4
I_t	= 101,43 cm^4 (Villette)
I_w	= 2,465E+7 cm^6

Other geometrical properties :

A	= 181,6 cm^2		
$A_{v,y}$	= 120 cm^2	$A_{v,z}$	= 62,8 cm^2
$W_{el,y,sup}$	= 5383,1 cm^3		
$W_{el,y,inf}$	= 5383,1 cm^3	$W_{el,z}$	= 800,16 cm^3
$W_{pl,y}$	= 5895,8 cm^3	$W_{pl,z}$	= 1212,3 cm^3

Stiffness relaxations :

θ	: Continuous
v'	: Continuous
θ'	: Continuous
w'	: Continuous

- Section No. 3 : DIM 1000x400

Abscissa from the left end of the beam : x = 8,05 m

Type : In catalogue (User)

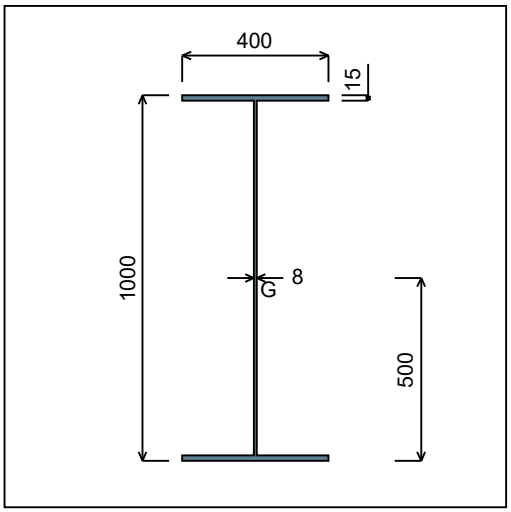


Figure 4 : Section No. 3 (DIM 1000x400).

Main geometrical properties :

z_S	= 0 cm
z_G	= 50 cm
I_y	= 351935 cm^4
I_z	= 16004 cm^4
I_t	= 104,84 cm^4 (Villette)
I_w	= 3,882E+7 cm^6

Other geometrical properties :

A	= 197,6 cm^2		
$A_{v,y}$	= 120 cm^2	$A_{v,z}$	= 78,8 cm^2
$W_{el,y,sup}$	= 7038,7 cm^3		
$W_{el,y,inf}$	= 7038,7 cm^3	$W_{el,z}$	= 800,21 cm^3
$W_{pl,y}$	= 7791,8 cm^3	$W_{pl,z}$	= 1215,5 cm^3

Stiffness relaxations :

θ	: Continuous
v'	: Continuous
θ'	: Continuous
w'	: Continuous

- Section No. 4 : DIM 650x400

Abscissa from the left end of the beam : x = 12,65 m

Type : In catalogue (User)

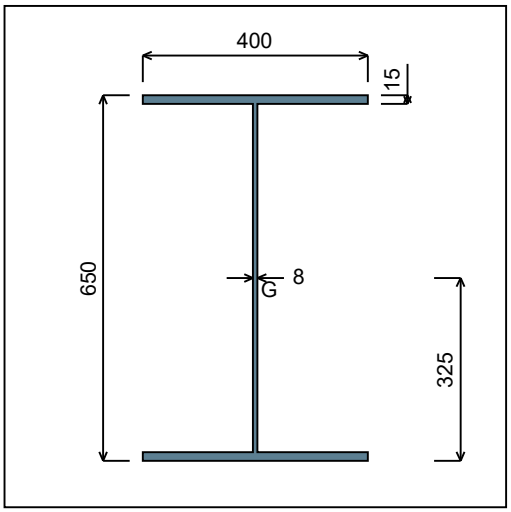


Figure 5 : Section No. 4 (DIM 650x400).

Main geometrical properties :

z_S	= 0 cm
z_G	= 32,5 cm
I_y	= 136879 cm^4
I_z	= 16003 cm^4
I_t	= 98,87 cm^4 (Villette)
I_w	= 1,613E+7 cm^6

Other geometrical properties :

A	= 169,6 cm^2		
$A_{v,y}$	= 120 cm^2	$A_{v,z}$	= 50,8 cm^2
$W_{el,y,sup}$	= 4211,6 cm^3		
$W_{el,y,inf}$	= 4211,6 cm^3	$W_{el,z}$	= 800,13 cm^3
$W_{pl,y}$	= 4578,8 cm^3	$W_{pl,z}$	= 1209,9 cm^3

Stiffness relaxations :

θ	: Continuous
v'	: Continuous
θ'	: Continuous
w'	: Continuous

- Section No. 5 : DIM 550x400

Abscissa from the left end of the beam : x = 23 m

Type : In catalogue (User)

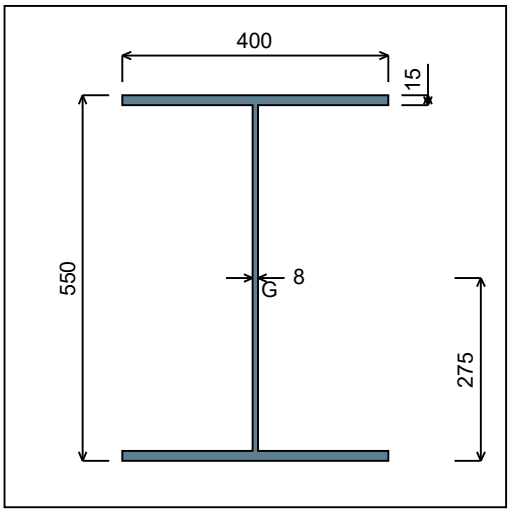


Figure 6 : Section No. 5 (DIM 550x400).

Main geometrical properties :

z_S	= 0 cm
z_G	= 27,5 cm
I_y	= 95264 cm^4
I_z	= 16002 cm^4
I_t	= 97,16 cm^4 (Villette)
I_w	= 1,145E+7 cm^6

Other geometrical properties :

A	= 161,6 cm^2		
$A_{v,y}$	= 120 cm^2	$A_{v,z}$	= 42,8 cm^2
$W_{el,y,sup}$	= 3464,1 cm^3		
$W_{el,y,inf}$	= 3464,1 cm^3	$W_{el,z}$	= 800,11 cm^3
$W_{pl,y}$	= 3750,8 cm^3	$W_{pl,z}$	= 1208,3 cm^3

Stiffness relaxations :

θ	: Continuous
v'	: Continuous
θ'	: Continuous
w'	: Continuous

I.4 - Lateral restraints

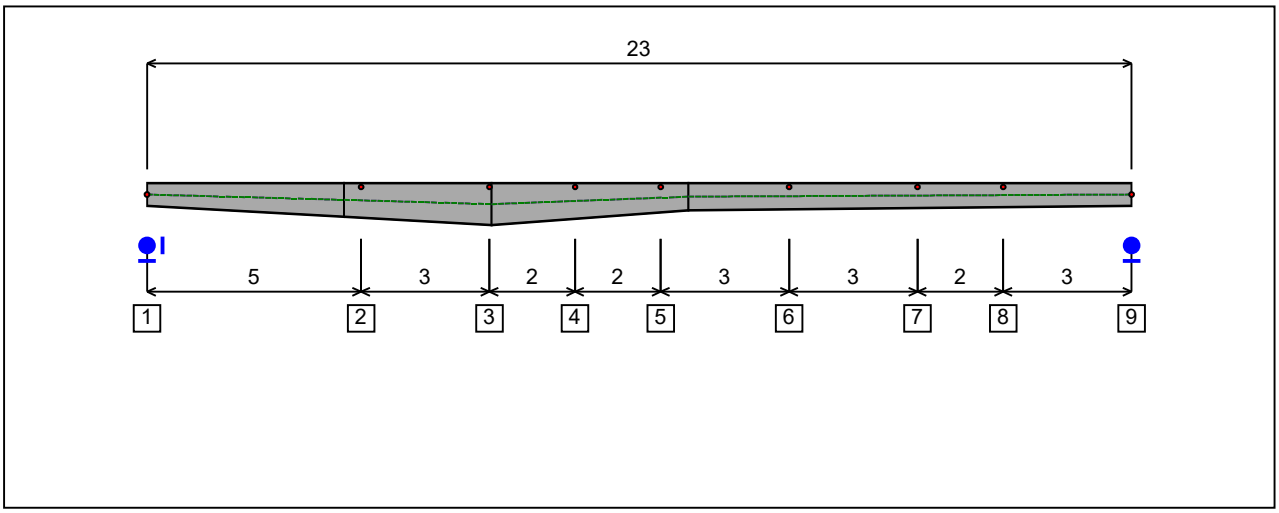


Figure 7 : Profile in long with restraint numbers.

- Restraint No. 1 :

Type : Ponctual

Abscissa from the left end of the beam : x = 0 m

Vertical position from the shear centre : z = 0 cm

Restraint conditions :

v : Fixed
θ : Fixed
v' : Free
θ' : Fixed

- Restraint No. 2 :

Type : Ponctual

Abscissa from the left end of the beam : x = 5 m

Vertical position from the shear centre : z = 31,16 cm

Restraint conditions :

v : Fixed
θ : Free
v' : Free
θ' : Free

- Restraint No. 3 :

Type : Ponctual

Abscissa from the left end of the beam : x = 8 m

Vertical position from the shear centre : z = 39,86 cm

Restraint conditions :

v : Fixed
θ : Free
v' : Free
θ' : Free

- Restraint No. 4 :

Type : Ponctual

Abscissa from the left end of the beam : x = 10 m

Vertical position from the shear centre : z = 32,58 cm

Restraint conditions :

v : Fixed
θ : Free
v' : Free
θ' : Free

- Restraint No. 5 :

Type : Ponctual

Abscissa from the left end of the beam : x = 12 m

Vertical position from the shear centre : z = 24,97 cm

Restraint conditions :

v : Fixed
θ : Free
v' : Free
θ' : Free

- Restraint No. 6 :

Type : Ponctual

Abscissa from the left end of the beam : x = 15 m

Vertical position from the shear centre : z = 21,36 cm

Restraint conditions :

v : Fixed
θ : Free
v' : Free
θ' : Free

- Restraint No. 7 :

Type : Ponctual

Abscissa from the left end of the beam : x = 18 m

Vertical position from the shear centre : z = 19,92 cm

Restraint conditions :

v : Fixed
θ : Free
v' : Free
θ' : Free

- Restraint No. 8 :

Type : Ponctual

Abscissa from the left end of the beam : x = 20 m

Vertical position from the shear centre : z = 18,95 cm

Restraint conditions :

v : Fixed
θ : Free
v' : Free
θ' : Free

- Restraint No. 9 :

Type : Ponctual

Abscissa from the left end of the beam : x = 23 m

Vertical position from the shear centre : z = 0 cm

Restraint conditions :

v : Fixed
θ : Fixed
v' : Free
θ' : Fixed

I.5 - Supports

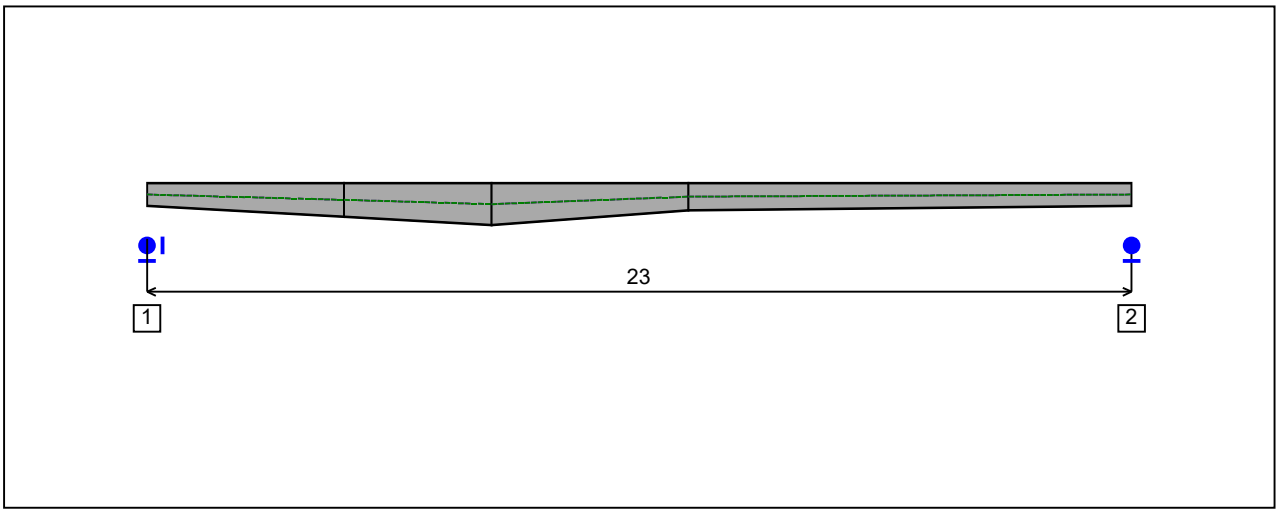


Figure 8 : Profile in long with support numbers.

- Support No. 1 :

Abscissa from the left end of the beam : x = 0 m

Support conditions :

u : Fixed
w : Fixed
w' : Free

- Support No. 2 :

Abscissa from the left end of the beam : x = 23 m

Support conditions :

u : Free
w : Fixed
w' : Free

I.6 - Loads

Type of loading : Internal

- Moment diagram :

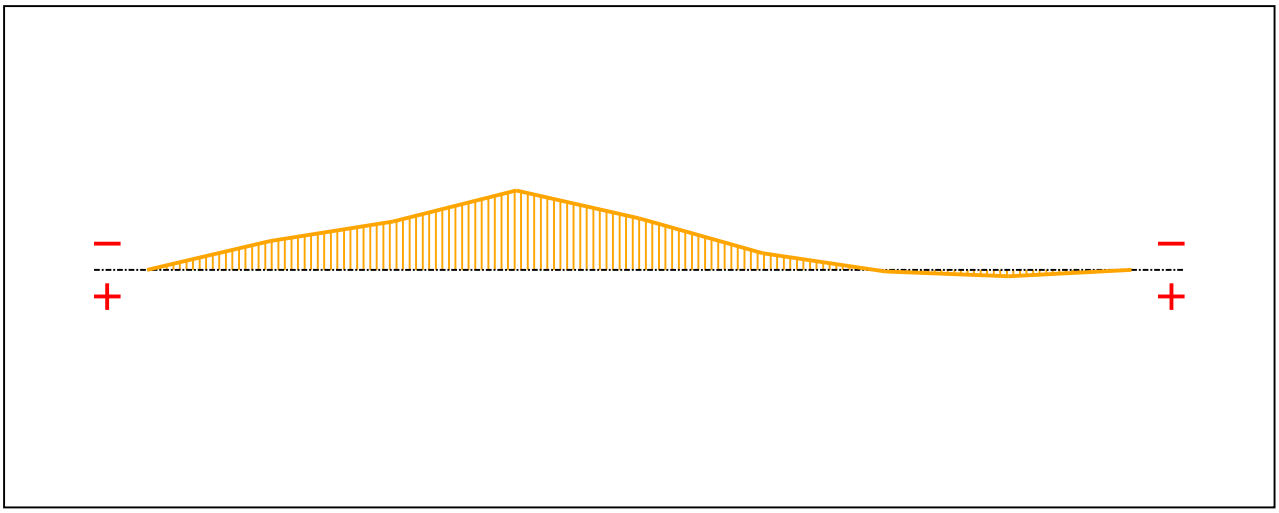


Figure 9 : Moment diagram.

Active : Yes

Table 1 : Moment diagram.

x(m)	M(kN.m)
0	0
2,875	-89,96
5,75	-150,24
8,625	-247,31
11,5	-160,8
14,38	-52,17
17,25	4,97
20,13	19,74
23	0

- Axial force diagram :

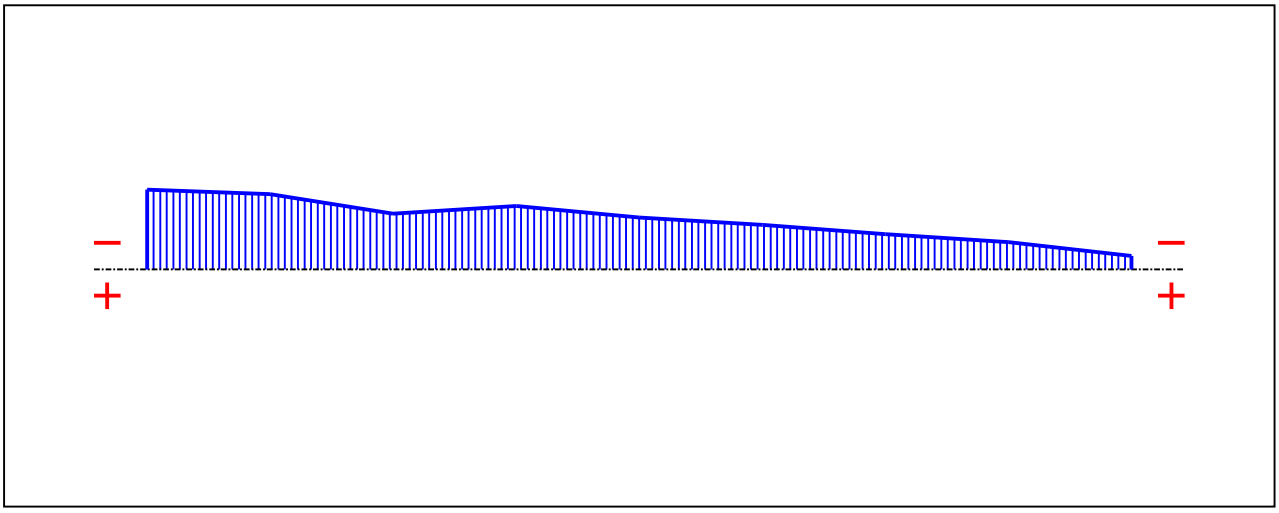


Figure 10 : Axial force diagram.

Active : Yes

Table 2 : Axial force diagram.

x(m)	N(kN)
0	-148,51
2,875	-140,4
5,75	-103,62
8,625	-118,21
11,5	-96,5
14,38	-82,82
17,25	-65,79
20,13	-50,76
23	-24,74

- Eccentric concentrated loads :

No load has been defined.

- Eccentric distributed loads :

No load has been defined.

II - LTB CALCULATION

Requested number of modes : 1

Blocked moment diagram : No

Blocked axial force diagram : Yes

The TAPER effect is taken into account

II.1 - LTB modes

Table 3 : LTB modes.

Mode	μ_{cr}	$M_{max,cr}$ [kN.m]	$x(M_{max})$ [m]	$N_{max,cr}$ [kN]	$x(N_{max})$ [m]
1	3,241	-797,73	8,663	-148,51	0

II.2 - Mode shapes

- Mode 1

Table 4 : Mode 1.

Mode	μ_{cr}	$M_{max,cr}$ [kN.m]	$x(M_{max})$ [m]	$N_{max,cr}$ [kN]	$x(N_{max})$ [m]
1	3,241	-797,73	8,663	-148,51	0

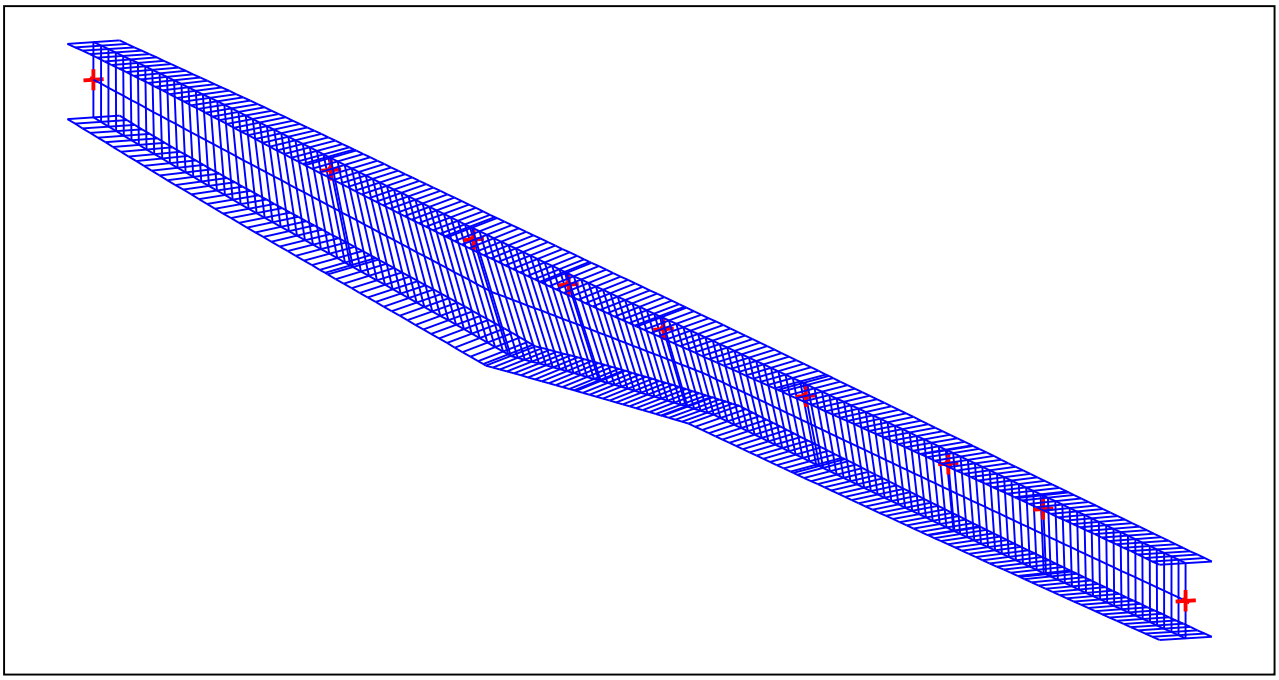


Figure 11 : Mode shape in 3D (Mode 1).

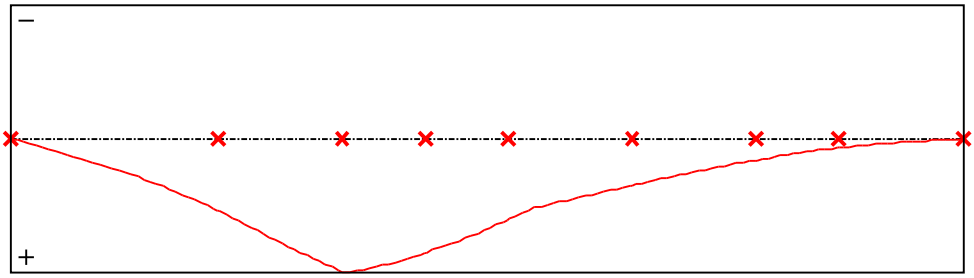


Figure 12 : Lateral displacement compopent of the shear centre (Mode 1).

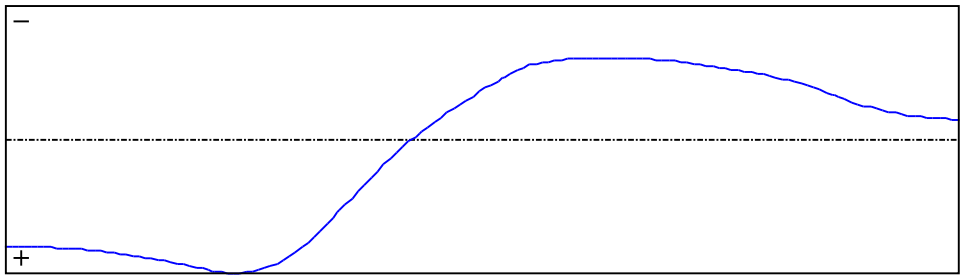


Figure 13 : Rotation in lateral flexure component of the shear centre (Mode 1).

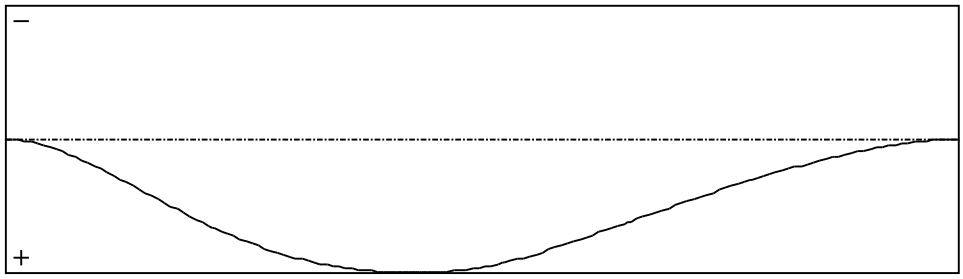


Figure 14 : Longitudinal rotation (torsion) component of the shear centre (Mode 1).

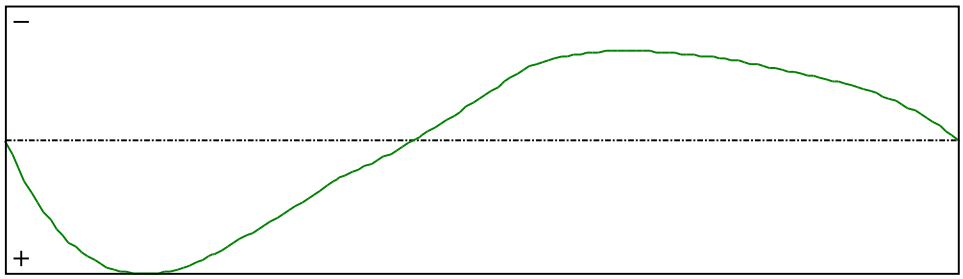


Figure 15 : Warping compopent of the shear centre (Mode 1).

Table 5 : Mode 1.

x [m]	v [cm]	v' [rd]	θ [rd]	θ' [rd/m]
0	-2,604E-28	8,164E-4	2,701E-26	7,918E-22
0,1533	0,0125	8,166E-4	3,75E-5	4,844E-4
0,3067	0,0251	8,169E-4	1,463E-4	9,295E-4
0,46	0,0377	8,172E-4	3,206E-4	0,0013
0,6133	0,0504	8,177E-4	5,548E-4	0,0017
0,7667	0,0633	8,184E-4	8,44E-4	0,0021
0,92	0,0762	8,196E-4	0,0012	0,0024
1,073	0,0894	8,211E-4	0,0016	0,0026
1,227	0,1027	8,232E-4	0,002	0,0029
1,38	0,1163	8,256E-4	0,0025	0,0031
1,533	0,1301	8,286E-4	0,003	0,0033
1,687	0,1442	8,321E-4	0,0035	0,0035
1,84	0,1585	8,361E-4	0,004	0,0037
1,993	0,1732	8,405E-4	0,0046	0,0038
2,147	0,1882	8,454E-4	0,0052	0,004
2,3	0,2035	8,507E-4	0,0058	0,0041
2,453	0,2191	8,564E-4	0,0065	0,0042
2,607	0,2351	8,624E-4	0,0071	0,0042
2,76	0,2515	8,688E-4	0,0078	0,0043
2,913	0,2682	8,754E-4	0,0084	0,0043
3,067	0,2854	8,824E-4	0,0091	0,0044
3,22	0,3029	8,898E-4	0,0098	0,0044
3,373	0,3208	8,975E-4	0,0104	0,0044
3,527	0,3391	9,057E-4	0,0111	0,0044
3,68	0,3578	9,142E-4	0,0118	0,0044
3,833	0,377	9,231E-4	0,0125	0,0043
3,987	0,3965	9,323E-4	0,0131	0,0043
4,14	0,4165	9,419E-4	0,0138	0,0042
4,293	0,4369	9,517E-4	0,0144	0,0042
4,447	0,4577	9,619E-4	0,0151	0,0041
4,6	0,479	9,725E-4	0,0157	0,004
4,75	0,5006	9,82E-4	0,0163	0,0039
4,9	0,5226	9,919E-4	0,0169	0,0038
5	0,5375	9,987E-4	0,0172	0,0038
5,05	0,545	0,001	0,0174	0,0037

Table 5 (Next) : Mode 1.

x [m]	v [cm]	v' [rd]	θ [rd]	θ' [rd/m]
5,2	0,5678	0,001	0,018	0,0036
5,35	0,5909	0,001	0,0185	0,0035
5,5	0,6143	0,001	0,019	0,0034
5,65	0,6379	0,001	0,0195	0,0033
5,8	0,6618	0,001	0,02	0,0031
5,95	0,6857	0,001	0,0205	0,003
6,1	0,7097	9,942E-4	0,0209	0,0029
6,25	0,7337	9,801E-4	0,0214	0,0028
6,4	0,7576	9,625E-4	0,0218	0,0027
6,55	0,7815	9,414E-4	0,0222	0,0025
6,7	0,8051	9,168E-4	0,0225	0,0024
6,85	0,8285	8,886E-4	0,0229	0,0023
7	0,8517	8,57E-4	0,0232	0,0022
7,15	0,8744	8,219E-4	0,0235	0,002
7,3	0,8967	7,832E-4	0,0238	0,0019
7,45	0,9186	7,411E-4	0,0241	0,0018
7,6	0,9399	6,956E-4	0,0243	0,0016
7,75	0,9606	6,466E-4	0,0246	0,0015
7,9	0,9807	5,943E-4	0,0248	0,0014
8	0,9936	5,576E-4	0,0249	0,0013
8,05	1	5,388E-4	0,025	0,0012
8,203	0,9933	4,924E-4	0,0252	0,0012
8,357	0,9857	4,439E-4	0,0254	0,0011
8,51	0,9773	3,933E-4	0,0255	9,652E-4
8,663	0,968	3,411E-4	0,0257	8,677E-4
8,817	0,9578	2,892E-4	0,0258	7,671E-4
8,97	0,9468	2,389E-4	0,0259	6,633E-4
9,123	0,935	1,904E-4	0,026	5,564E-4
9,277	0,9224	1,437E-4	0,0261	4,462E-4
9,43	0,909	9,891E-5	0,0261	3,327E-4
9,583	0,8949	5,601E-5	0,0262	2,158E-4
9,737	0,8802	1,509E-5	0,0262	9,543E-5
9,89	0,8648	-2,383E-5	0,0262	-2,854E-5
10	0,8535	-5,049E-5	0,0262	-1,197E-4
10,04	0,8489	-6,073E-5	0,0262	-1,561E-4

Table 5 (Next) : Mode 1.

x [m]	v [cm]	v' [rd]	θ [rd]	θ' [rd/m]
10,2	0,8324	-9,663E-5	0,0262	-2,853E-4
10,35	0,8154	-1,32E-4	0,0261	-4,152E-4
10,5	0,7979	-1,668E-4	0,026	-5,46E-4
10,66	0,78	-2,009E-4	0,0259	-6,776E-4
10,81	0,7615	-2,344E-4	0,0258	-8,1E-4
10,96	0,7426	-2,672E-4	0,0257	-9,432E-4
11,12	0,7234	-2,992E-4	0,0255	-0,0011
11,27	0,7037	-3,305E-4	0,0254	-0,0012
11,42	0,6836	-3,61E-4	0,0252	-0,0013
11,58	0,6633	-3,906E-4	0,025	-0,0015
11,73	0,6426	-4,19E-4	0,0247	-0,0016
11,88	0,6216	-4,462E-4	0,0245	-0,0018
12	0,6054	-4,66E-4	0,0242	-0,0019
12,04	0,6004	-4,721E-4	0,0242	-0,0019
12,19	0,5789	-4,972E-4	0,0239	-0,002
12,34	0,5573	-5,217E-4	0,0235	-0,0022
12,5	0,5354	-5,455E-4	0,0232	-0,0023
12,65	0,5135	-5,688E-4	0,0228	-0,0025
12,8	0,5031	-5,786E-4	0,0225	-0,0025
12,95	0,4926	-5,871E-4	0,0221	-0,0026
13,11	0,482	-5,944E-4	0,0217	-0,0026
13,26	0,4713	-6,006E-4	0,0213	-0,0027
13,41	0,4605	-6,057E-4	0,0209	-0,0027
13,56	0,4498	-6,098E-4	0,0204	-0,0028
13,72	0,439	-6,129E-4	0,02	-0,0028
13,87	0,4282	-6,152E-4	0,0196	-0,0028
14,02	0,4174	-6,165E-4	0,0192	-0,0029
14,17	0,4066	-6,171E-4	0,0187	-0,0029
14,32	0,3958	-6,17E-4	0,0183	-0,0029
14,48	0,3851	-6,165E-4	0,0178	-0,0029
14,63	0,3745	-6,16E-4	0,0174	-0,0029
14,78	0,3638	-6,156E-4	0,017	-0,0029
14,93	0,3532	-6,155E-4	0,0165	-0,0029
15	0,3486	-6,155E-4	0,0163	-0,0029
15,09	0,3427	-6,154E-4	0,0161	-0,0029

Table 5 (Next) : Mode 1.

x [m]	v [cm]	v' [rd]	θ [rd]	θ' [rd/m]
15,24	0,3321	-6,146E-4	0,0156	-0,0029
15,39	0,3217	-6,131E-4	0,0152	-0,0029
15,54	0,3112	-6,108E-4	0,0147	-0,0029
15,69	0,3009	-6,078E-4	0,0143	-0,0029
15,85	0,2906	-6,042E-4	0,0139	-0,0029
16	0,2805	-6E-4	0,0134	-0,0029
16,15	0,2704	-5,952E-4	0,013	-0,0029
16,3	0,2604	-5,899E-4	0,0125	-0,0028
16,46	0,2506	-5,841E-4	0,0121	-0,0028
16,61	0,2409	-5,778E-4	0,0117	-0,0028
16,76	0,2313	-5,711E-4	0,0113	-0,0028
16,91	0,2218	-5,641E-4	0,0108	-0,0028
17,06	0,2125	-5,567E-4	0,0104	-0,0027
17,22	0,2034	-5,49E-4	0,01	-0,0027
17,37	0,1943	-5,411E-4	0,0096	-0,0027
17,52	0,1855	-5,333E-4	0,0092	-0,0026
17,67	0,1768	-5,255E-4	0,0088	-0,0026
17,83	0,1682	-5,179E-4	0,0084	-0,0026
17,98	0,1598	-5,103E-4	0,008	-0,0025
18	0,1585	-5,092E-4	0,008	-0,0025
18,13	0,1515	-5,025E-4	0,0076	-0,0025
18,28	0,1433	-4,938E-4	0,0073	-0,0024
18,43	0,1354	-4,842E-4	0,0069	-0,0024
18,59	0,1276	-4,737E-4	0,0065	-0,0024
18,74	0,12	-4,623E-4	0,0062	-0,0023
18,89	0,1126	-4,5E-4	0,0058	-0,0023
19,04	0,1055	-4,369E-4	0,0055	-0,0022
19,19	0,0985	-4,229E-4	0,0052	-0,0022
19,35	0,0918	-4,081E-4	0,0048	-0,0021
19,5	0,0854	-3,924E-4	0,0045	-0,0021
19,65	0,0792	-3,759E-4	0,0042	-0,002
19,8	0,0733	-3,586E-4	0,0039	-0,002
19,96	0,0677	-3,404E-4	0,0036	-0,002
20	0,0662	-3,35E-4	0,0035	-0,0019
20,11	0,0624	-3,219E-4	0,0033	-0,0019

Table 5 (Next) : Mode 1.

x [m]	v [cm]	v' [rd]	θ [rd]	θ' [rd/m]
20,26	0,0575	-3,043E-4	0,003	-0,0019
20,41	0,0527	-2,877E-4	0,0027	-0,0018
20,56	0,0483	-2,722E-4	0,0024	-0,0017
20,72	0,0441	-2,577E-4	0,0022	-0,0017
20,87	0,0401	-2,443E-4	0,0019	-0,0016
21,02	0,0364	-2,318E-4	0,0017	-0,0015
21,17	0,0328	-2,203E-4	0,0015	-0,0015
21,33	0,0294	-2,099E-4	0,0013	-0,0014
21,48	0,0262	-2,003E-4	0,0011	-0,0013
21,63	0,0232	-1,918E-4	8,652E-4	-0,0012
21,78	0,0203	-1,842E-4	6,944E-4	-0,0011
21,93	0,0175	-1,775E-4	5,4E-4	-9,582E-4
22,09	0,0148	-1,717E-4	4,03E-4	-8,413E-4
22,24	0,0122	-1,668E-4	2,842E-4	-7,179E-4
22,39	0,0096	-1,629E-4	1,847E-4	-5,881E-4
22,54	0,0072	-1,598E-4	1,055E-4	-4,515E-4
22,7	0,0048	-1,576E-4	4,762E-5	-3,081E-4
22,85	0,0024	-1,563E-4	1,208E-5	-1,577E-4
23	-1,397E-28	-1,558E-4	6,772E-27	-2,549E-22

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WARNING !

The following software may be used for working out technical solutions during preparatory engineering studies.

Because of the complexity of the calculations involved, the software is only for users who are able to make themselve an accurate idea of its possibilities, its limitations and adequacy to the various practical applications. The user will use it under his own responsibilities at his own risk.

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