Certificate of Compliance for Proposed Building Work

Building Act 1993 – Victoria | Section 238(1)(a) | Building Regulations 2018 | Regulation 126

This certificate is issued to Relevant Building Surveyor

Location of proposed building work N/A

Nature of proposed building work

Prescribed class *Structural
Description of work Steel deck framing design
BCA classification Class 1a

Documents setting out the design

Document(s) Steel deck framing member capacities
Prepared by Tingmore Structures *Dated* 26.07.2022

Reference documents relating to the design

Document(s) Evolution steel framing technical data sheet (TDS) *Type* Documents
Prepared by Fortress Building Products (10 pages) *Dated* N/A

Document(s) 220088 comps *Type* Computation
Prepared by Tingmore Structures (58 pages) *Dated* 26.07.2022

Compliance provisions relating to the design

The design certified by this certificate complies with the following provisions of Building Act 1993, Building Regulations 2018 or National Construction Code:

AS1170.0 Structural Design Actions – Part 0: General principles
AS1170.1 Structural Design Actions – Part 1: Permanent, imposed and other actions
AS1170.2 Structural Design Actions – Part 2: Wind actions
AS/NZS 4600:2018 Cold-formed steel structures

Certification and signature of authorized person

I prepared the design, or part of the design, set out in the documents listed above. I certify that the design set out in the documents listed above complies with the provisions set out above. I believe that I hold the required skills, experience and knowledge to issue this certificate and can demonstrate this if requested to do so.

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Engineering type Civil and structural engineering
Registration details PE0003412
Signature  *Date* 26.07.2022

Tingmore Structures was engaged by Fortress Framing LLC to evaluate the Evolution Steel Deck framing members. The purpose of this structural assessment is to determine the maximum span lengths for the Joist, Single beam, Double beam at different types of loading conditions.

Note that connection capacities are outside the scope of this structural assessment and these calculation do not account for any lateral loading and overall stability, which are outside the scope of this structural assessment.

Section properties (Gross and effective) of the members are given in the below. Evaluation of section properties was undertaken in accordance with AS/NZS 4600

Member (FF- EVOLUTION)	D (mm)	W (mm)	T (mm)	I_{gross_xX} (mm^4)	Z_{gross_xX} (mm^4)	A_{gross_XX} (mm^4)
2'x6'-16' JOIST	150	50	1.6	1.68 E^6	22.52E^3	629
2'x11'-16' S.BEAM	280	50	1.6	12.35 E^6	88.24E^3	1254
4'X11'-16' D.BEAM	280	100	1.6	35.75 E^6	252.36 E^3	3172

Table 1.1: Gross section properties

	Strength		Serviceability	
Member (FF- EVOLUTION)	I_{eff_xx} (mm^4)	Z_{eff_xx} (mm^4)	I_{eff_xx} (mm^4)	Z_{eff_xx} (mm^4)
2'x6'-16' JOIST	1.68 E^6	22.52 E^3E^3	1.68 E^6	22.52E^3
2'x11'-16' S.BEAM	11.48 E^6	75.93 E^3	11.35 E^6	74.71E^3
4'X11'-16' D.BEAM	350.9 E^6	247.8 E^3	349.5 E^6	244.3 E^3

Table 1.2: Effective section properties

Design assumptions are as follows;

Load types	DL	LL	WLs
Floor	0.5kPa	2.0kPa or 1.8kN	N/A
Roof	0.4kPa	0.25kPa or 1.1kN	Refer below

Wind loading parameters below as per AS 1170.2-2.11

- Region: A5
- $Cpe_{\_internal}$: 0.9 & $Cpe_{\_cantilever}$:1.2
- Terrain Category: 3
- Regional wind $speed_{\_ser}$:37m/sec

- Regional wind speed$_{ulti}$:45m/sec
- Shielding Multiplier, M_s: 1
- Topographic Multiplier, M_t: 1
- M_{zcat}: 0.83

Load combinations are as follows:

Load types	Strength	Serviceability
Floor	1.2DL+1.5LL	DL + Ψ_{long_term}LL [Span/400] Cantilever: DL + Ψ_{long_term}LL [Span/200]
Roof	1.2DL+1.5LL 0.8DL+1.5WLs	DL + Ψ_{long_term}LL [Span/200] Cantilever: DL + Ψ_{long_term}LL [Span/150]

Floor loading combinations

The maximum span lengths for joist, single beam and double beam shown below are assessed for the continuous beams with both the simply-supported and cantilevered span conditions. Various Live load conditions are considered for this structural assessment as follows;

- Case 1: Uniformly distributed load(UDL) at simply-supported span and equal double span
- Case2: UDL at both simply-supported, equal double span and cantilevers span
- Case3: UDL at both simply-supported and equal double span with 1.8kN at cantilever span
- Case4: UDL at cantilever span and 1.8kN at both simply-supported and equal double span

The maximum span lengths are determined based on combined bending and shear (AS/NZS:4600), deflection criteria and minimum fundamental frequency of vibration in accordance with AS1170.0 for the members with various loading conditions described above.

	Maximum recommended span(mm)		
Spacing(mm)	Single span	Equal double span	Maximum Cantilever
300	5200	5600	1400
406	4600	4800	1400
450	4600	4600	1400
600	4000	4000	1400

Table 2.1: FF-EVOLUTION -2"X6" -16'-16GA (50x150x1.6T) FLOOR JOIST SPAN TABLE

	Maximum recommended span(mm)	
Load width(mm)	Single span/ Equal double span	Maximum Cantilever
2000	2100	1000
2500	1900	900
3000	1700	800
3500	1500	700
4000	1400	600
4500	1300	500
5000	1200	400

Table 2.2: FF-EVOLUTION -2"X6" -16'-16GA (50x150x1.6T) FLOOR BEARER SPAN TABLE

	Maximum recommended span(mm)	
Load width(mm)	Single/Equal double span	Maximum Cantilever
2000	3700	1600
2500	3200	1500
3000	2900	1400
3500	2600	1200
4000	2400	1100
4500	2300	1000
5000	2100	900

Table 2.3: FF-EVOLUTION -2"X11" SINGLE -16'-16GA(50x280x1.6T) FLOOR BEARER SPAN TABLE

	Maximum recommended span(mm)	
Load width(mm)	Single span/Equal double span	Maximum Cantilever
2000	6900	3300
2500	6100	2900
3000	5400	2500
3500	5000	2300
4000	4600	2100
4500	4300	2000
5000	4000	1800

Table 2.4: FF-EVOLUTION -4"X11" DOUBLE -16'-16GA(100x280x1.6T) FLOOR BEARER SPAN TABLE

Roof loading combinations

The maximum span lengths for rafter, single roof beam and double roof beam shown below are assessed for the continuous beams with both the simply-supported and cantilevered span conditions. Various Live load conditions are considered for this structural assessment as follows;

- Case 1: Uniformly distributed load(UDL) at simply-supported span and equal double span
- Case2: UDL at both simply-supported, equal double span and cantilevers span
- Case3: UDL at both simply-supported and equal double span with 1.1kN at cantilever span
- Case4: UDL at cantilever span and 1.1kN at both simply-supported and equal double span

The maximum span lengths are determined based on combined bending and shear (AS/NZS:4600), deflection criteria in accordance with AS1170.0 for the members with various loading conditions described above.

	Maximum recommended span(mm)		
Spacing(mm)	Single span	Equal double span	Maximum Cantilever
406	7000	9350	2200
450	6800	9100	2200
600	6250	8000	2200
900	5500	6600	2200

Table 3.1: FF-EVOLUTION -2"X6" -16'-16GA (50x150x1.6T) ROOF RAFTER SPAN TABLE

	Maximum recommended span(mm)	
Load width(mm)	Single span/ Equal double span	Maximum Cantilever
2000	7900	3000
2500	7100	2800
3000	6500	2600
3500	6000	2400
4000	5600	2200
4500	5200	2000
5000	4900	1800

Table 3.2: FF-EVOLUTION -2"X11" SINGLE -16'-16GA(50x280x1.6T) ROOF BEAM SPAN TABLE

	Maximum recommended span(mm)	
Load width(mm)	Single span/Equal double span	Maximum Cantilever
2000	11200/13800	5800
2500	10500/12400	5600
3000	10000/11400	5200
3500	9600/10600	4800
4000	9200/9900	4400
4500	8900/9300	4000
5000	8600/8800	3800

Table 2.4: FF-EVOLUTION -4"X11" DOUBLE -16'-16GA(100x280x1.6T) ROOF BEAM SPAN TABLE

FF-EVOLUTION -2X6 JOIST-16'-16GA-PC

Given:

F_y	234	Mpa	
E	199950	Mpa	
k	4		c.2.2.1.2(5)
v	0.3		
t	1.6	mm	
b_{actual}	50	mm	
d_{actual}	150	mm	
r_{inside}	1.6	mm	assumed
r_{med}	2.4	mm	
b	43.6	mm	
d	143.6	mm	

Effective width for capacity

Check compression flange effective width

f_{cr}	973.4765484	Mpa	
λ	0.490281134		
$b_{effective}$	43.6	mm	c.2.2.1.2

Check web effective width

Strength

f^*_1	224.016	Mpa	
f^*_2	224.016	Mpa	
ψ	1		
k	4		
f_{cr}	89.74072883	Mpa	
λ	1.579955019		web may be subject to local buckling
λ_c	1.267060415		
$\rho_{strength}$	0.54479749		
$d_{effective\_strength}$	78.23291962		
d_{e1}	39.11645981		
d_{e2}	39.11645981		
$d_{e1} + d_{e2}$	78.23291962		
Depth of compression block	71.8		web is fully effective

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

d_{neg}	0	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{med}+d_{e1}+b_{neg/2})$	42.31645981	mm

Element	$L_{(mm)}$	y from top fiber$_{(mm)}$	$Ly_{(mm^2)}$	$Ly^2_{(mm^3)}$	I_x about own axis $_{(mm^3)}$
Top flange	43.6	0.8	34.88	27.904	-
Bottom flange	43.6	149.2	6505.12	970563.9	-
Web_{left}	143.6	75	10770	807750	246764.1547
Web_{right}	143.6	75	10770	807750	246764.1547
Negative web element $_{left}$	0	42.31645981	0	0	0
Negative web element $_{right}$	0	42.31645981	0	0	0
Top inside corner	3.769911184	1.2	4.523893421	5.428672	4.464903842
Bottom inside corner	3.769911184	148.8	560.9627842	83471.26	4.464903842
Top outside cornder	3.769911184	1.2	4.523893421	5.428672	4.464903842
Bottom outside cornder	3.769911184	148.8	560.9627842	83471.26	4.464903842
Sum	389.4796447		29210.97336	2753045	493546.1689

y_{bar}	75	mm	below top fibre
I_x	1689229.372	mm^4	
Z_e	22523.05829	mm^3	
M_n	5.270395639	kNm	
$ØM_n$	4.743356075	kNm	

Check Shear

d_1/t	48.89557477	mm	
k_v	5.34		c 3.3.4
$sqrt(Ek_v/f_y)$	67.54969681		
$1.45*sqrt(Ek_v/f_y)$	135.0993936		
V_v	37.49171854	kN	
$ØV_v$	33	kN	

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Serviceability

$f^*_1(0.6xf^*_1)$	224.016	Mpa	Assuming the netural axis is at the section centreline
$f^*_2(0.6xf^*_2)$	224.016	Mpa	By symmetry
ψ	1		
k	4		c.2.2.3.2(4)
f_{cr}	89.74072883	Mpa	
λ	1.579955019		web may be subject to local buckling
λ_c	1.267060415		
$\rho_{Serviceability}$	0.674841706		
$d_{effective\_ser}$	96.90726905	mm	c.2.2.1.2 & c.2.2.1.3
d_{e1}	48.45363453	mm	
d_{e2}	48.45363453	mm	
$d_{e1} + d_{e2}$	96.90726905	mm	c 2.2.3.2(3)
Depth of compression block	71.8	mm	web is fully effective

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

d_{neg}	0	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{med}+d_{e1}+b_{neg/2})$	48.45363453	mm

Element	$L_{(mm)}$	y from top	$Ly_{(mm^2)}$	$Ly^2_{(mm^3)}$	I_x about own axis $_{(mm^3)}$
Top flange	43.6	0.8	34.88	27.904	-
Bottom flange	43.6	149.2	6505.12	970563.9	-
Web_{left}	143.6	75	10770	807750	246764.1547
Web_{right}	143.6	75	10770	807750	246764.1547
Negative web element $_{left}$	0	48.45363	0	0	0
Negative web element $_{right}$	0	48.45363	0	0	0
Top inside corner	3.769911184	1.2	4.523893	5.428672	4.464903842
Bottom inside corner	3.769911184	148.8	560.9628	83471.26	4.464903842
Top outside cornder	3.769911184	1.2	4.523893	5.428672	4.464903842
Bottom outside cornder	3.769911184	148.8	560.9628	83471.26	4.464903842
Sum	389.4796447		29210.97	2753045	493546.1689

y_{bar}	75	mm	below top fibre
I_x	1689229.372	mm^4	
Z_e	22523.05829	mm^3	
$0.6xM_n$	5.270395639	kNm	assumed that fully laterally braced Msx = Mbx
$0.6xØM_n$	4.743356075	kNm	

2"x11" 16 Gauge single beam

Given:

F_y	235	Mpa	
E	199950	Mpa	
k	4		c.2.2.1.2(5)
v	0.3		
t	1.6	mm	
$b_{\_actual}$	50	mm	
$d_{\_actual}$	280	mm	
$r_{\_inside\ (1t\_conservative)}$	1.6	mm	assumed
$r_{\_med}$	2.4	mm	
b	43.6	mm	
d	273.6	mm	

Effective width for capacity

Check compression flange effective width

f_{cr}	973.4765484	Mpa	
λ	0.491327626		
$b_{\_effective}$	43.6	mm	c.2.2.1.2

Check web effective width

Strength

f^*_1	229.6285714	Mpa	
f^*_2	229.6285714	Mpa	
ψ	1		
k	4		
f_{cr}	24.72101431	Mpa	
λ	3.047753362		web may be subject to local buckling
λ_c	2.182840146		
$\rho_{\_strength}$	0.304426104		
$d_{\_effective\_strength}$	83.290982		
d_{e1}	41.645491		
d_{e2}	41.645491		
$d_{e1} + d_{e2}$	83.290982		
Depth of compression block	136.8		Web is not fully effective

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$	-53.509018	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg/2})$	71.6	mm

Element	$L_{(mm)}$	y from top fiber$_{(mm)}$	$Ly_{(mm^2)}$	$Ly^2_{(mm^3)}$	I_x about own axis $_{(mm^3)}$
Top flange	43.6	0.8	34.88	27.904	-
Additional top plate	42	2.4	100.8	241.92	-
Additional bottom plate	42	277.6	11659.2	3236594	-
Bottom flange	43.6	279.2	12173.12	3398735	-
$Web_{\_left}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_right\ top\ corner}$	23	16.3	374.9	6110.87	1013.916667
$Web_{\_right}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_left\ bottom\ corner}$	23	263.7	6065.1	1599367	1013.916667
Negative web element $_{\_left}$	-53.509018	71.6	-3831.245689	-274317	-12767.31861
Negative web element $_{\_right}$	-53.509018	71.6	-3831.245689	-274317	-12767.31861
Top inside corner	3.769911184	1.2	4.523893421	5.428672	4.464903842
Top insdie corner	3.769911184	2.8	10.55575132	29.5561	4.464903842
Bottom inside corner	3.769911184	278.8	1051.051238	293033.1	4.464903842
Top outside cornder	3.769911184	1.2	4.523893421	5.428672	4.464903842
Bottom outside corner	3.769911184	277.2	1045.01938	289679.4	4.464903842
Bottom outside cornder	3.769911184	278.8	1051.051238	293033.1	4.464903842
Sum	680.0014311		102520.234	19293348	3389997.362

y_{bar}	150.7647327	mm	below top fibre
I_x	11563055.75	mm^4	
Z_e	76696.02524	mm^3	

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Serviceability

$f^*_1(0.6xf^*_1)$	229.6285714	Mpa	Assuming the netural axis is at the section centrelin
$f^*_2(0.6xf^*_2)$	229.6285714	Mpa	By symmetry
ψ	1		
k	4		c.2.2.3.2(4)
f_{cr}	24.72101431	Mpa	
λ	3.047753362		web may be subject to local buckling
λ_c	2.182840146		
$\rho_{Serviceability}$	0.395944454		
$d_{\_effective\_ser}$	108.3304027	mm	c.2.2.1.2 & c.2.2.1.3
d_{e1}	54.16520133	mm	
d_{e2}	54.16520133	mm	
$d_{e1} + d_{e2}$	108.3304027	mm	c 2.2.3.2(3)
Depth of compression block	136.8	mm	Web is not fully effective for this iteration

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$	-28.46959734	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg/2})$	68.4	mm

Element	$L_{(mm)}$	y from top	$Ly_{(mm^2)}$	$Ly^2_{(mm^3)}$	I_x about own axis $_{(mm^3)}$
Top flange	43.6	0.8	34.88	27.904	-
Additional top plate	42	2.4	100.8	241.92	-
Additional bottom plate	42	277.6	11659.2	3236594	-
Bottom flange	43.6	279.2	12173.12	3398735	-
$Web_{\_left}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_right\ top\ corner}$	23	16.3	374.9	6110.87	1013.916667
$Web_{\_right}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_left\ bottom\ corner}$	23	263.7	6065.1	1599367	1013.916667
Negative web element $_{\_left}$	-28.46959734	68.4	-1947.32	-133197	-1922.926693
Negative web element $_{\_right}$	-28.46959734	68.4	-1947.32	-133197	-1922.926693
Top inside corner	3.769911184	1.2	4.523893	5.428672	4.464903842
Top insdie corner	3.769911184	2.8	10.55575	29.5561	4.464903842
Bottom inside corner	3.769911184	278.8	1051.051	293033.1	4.464903842
Top outside cornder	3.769911184	1.2	4.523893	5.428672	4.464903842
Bottom outside corner	3.769911184	277.2	1045.019	289679.4	4.464903842
Bottom outside cornder	3.769911184	278.8	1051.051	293033.1	4.464903842
Sum	730.0802724		106288.1	19575589	3411686.145

y_{bar}	145.584107	mm	below top fibre
I_x	12021471.02	mm^4	
Z_e	82574.06165	mm^3	

2nd iteration with new N.A location

Check web effective width

Strength

f^*_1	230.0120961	
f^*_2	196.4536883	
ψ	0.854101552	
k	4	
f_{cr}	24.72101431	
λ	3.050297472	web may be subject to local buckling
λ_c	2.182840146	
$\rho_{\_strength}$	0.304191934	
$d_{\_effective\_strength}$	83.2269131	
d_{e1}	38.78418067	
d_{e2}	44.44273243	
$d_{e1} + d_{e2}$	83.2269131	
Depth of compression block	136.8	Web is not fully effective for this iteration

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$ -53.5730869 mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg/2})$ 68.77072412 mm

Element	L(mm)	y from top fiber(mm)	Ly(mm2)	Ly2(mm3)	Ix about own axis (mm3)
Top flange	43.6	0.8	34.88	27.904	-
Additional top plate	42	2.4	100.8	241.92	-
Additional bottom plate	42	277.6	11659.2	3236594	-
Bottom flange	43.6	279.2	12173.12	3398735	-
$Web_{\_left}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_right\ top\ corner}$	23	16.3	374.9	6110.87	1013.916667
$Web_{\_right}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_left\ \ bottom\ corner}$	23	263.7	6065.1	1599367	1013.916667
Negative web element $_{\_left}$	-53.5730869	68.77072412	-3684.25998	-253369	-12813.23431
Negative web element $_{\_right}$	-53.5730869	68.77072412	-3684.25998	-253369	-12813.23431
Top inside corner	3.769911184	1.2	4.523893421	5.428672	4.464903842
Top inside corner	3.769911184	2.8	10.55575132	29.5561	4.464903842
Bottom inside corner	3.769911184	278.8	1051.051238	293033.1	4.464903842
Top outside cornder	3.769911184	1.2	4.523893421	5.428672	4.464903842
Bottom outside cornder	3.769911184	277.2	1045.01938	289679.4	4.464903842
Bottom outside cornder	3.769911184	278.8	1051.051238	293033.1	4.464903842
Sum	679.8732933		102814.2054	19335244	3389905.53

y_{bar}	151.2255393	mm	below top fibre
I_x	11483225.53	mm^4	
Z_e	75934.43266	mm^3	
M_n	17.84459167	kNm	
$ØM_n$	16.06013251	kNm	

Check Shear

d_1/t	52.01682069	mm
k_v	5.34	c 3.3.4
$sqrt(Ek_v/f_y)$	67.40582082	
$1.45*sqrt(Ek_v/f_y)$	134.8116416	
V_v	40.05544874	kN
$ØV_v$	36	kN

2nd iteration with new N.A location

Serviceability

f^*_1	224.9563333	
f^*_2	163.1309505	
ψ	0.725167183	
k	4	
f_{cr}	24.72101431	
λ	3.016587793	web may be subject to local buckling
λ_c	2.182840146	
$\rho_{\_strength}$	0.30732403	
$d_{\_effective\_strength}$	84.08385452	
d_{e1}	36.96265232	
d_{e2}	47.12120219	
$d_{e1} + d_{e2}$	84.08385452	
Depth of compression block	136.8	Web is not fully effective for this iteration

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$ -52.71614548 mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg/2})$ 63.32072506 mm

Element	L(mm)	y from top	Ly(mm2)	Ly2(mm3)	Ix about own axis (mm3)
Top flange	43.6	0.8	34.88	27.904	-
Additional top plate	42	2.4	100.8	241.92	-
Additional bottom plate	42	277.6	11659.2	3236594	-
Bottom flange	43.6	279.2	12173.12	3398735	-
$Web_{\_left}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_right\ top\ corner}$	23	16.3	374.9	6110.87	1013.916667
$Web_{\_right}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_left\ \ bottom\ corner}$	23	263.7	6065.1	1599367	1013.916667
Negative web element $_{\_left}$	-52.71614548	63.32073	-3338.02	-211366	-12208.14552
Negative web element $_{\_right}$	-52.71614548	63.32073	-3338.02	-211366	-12208.14552
Top inside corner	3.769911184	1.2	4.523893	5.428672	4.464903842
Top inside corner	3.769911184	2.8	10.55575	29.5561	4.464903842
Bottom inside corner	3.769911184	278.8	1051.051	293033.1	4.464903842
Top outside cornder	3.769911184	1.2	4.523893	5.428672	4.464903842
Bottom outside cornder	3.769911184	277.2	1045.019	289679.4	4.464903842
Bottom outside cornder	3.769911184	278.8	1051.051	293033.1	4.464903842
Sum	681.5871761		103506.7	19419250	3391115.708

y_{bar}	151.8612437	mm	below top fibre
I_x	11346741.42	mm^4	
Z_e	74717.82225	mm^3	
M_{n_Ser}	17.55868823	kNm	assumed that fully laterally braced Msx =
$ØM_{n\_ser}$	15.80281941	kNm	

3rd iteration with new N.A location

Check web effective width

Strength

f^*_1	230.027295	
f^*_2	195.1389851	
ψ	0.848329696	
k	4	
f_{cr}	24.72101431	
λ	3.05039825	web may be subject to local buckling
λ_c	2.182840146	
$\rho_{\_strength}$	0.304182665	
$d_{\_effective\_strength}$	83.2243772	
d_{e1}	38.67896351	
d_{e2}	44.54541368	
$d_{e1} + d_{e2}$	83.2243772	
Depth of compression block	98.22684414	Web is not fully effective for this iteration

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$ -15.0024669 mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg/2})$ 46.98019699 mm

Element	L(mm)	y from top fiber(mm)	Ly(mm2)	Ly2(mm3)	Ix about own axis (mm3)
Top flange	43.6	0.8	34.88	27.904	-
Additional top plate	42	2.4	100.8	241.92	-
Additional bottom plate	42	277.6	11659.2	3236594	-
Bottom flange	43.6	279.2	12173.12	3398735	-
$Web_{\_left}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_right\ top\ corner}$	23	16.3	374.9	6110.87	1013.916667
$Web_{\_right}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_left\ \ bottom\ corner}$	23	263.7	6065.1	1599367	1013.916667
Negative web element $_{\_left}$	-15.0024669	46.98019699	-704.8188524	-33112.5	-281.3887885
Negative web element $_{\_right}$	-15.0024669	46.98019699	-704.8188524	-33112.5	-281.3887885
Top inside corner	3.769911184	1.2	4.523893421	5.428672	4.464903842
Top inside corner	3.769911184	2.8	10.55575132	29.5561	4.464903842
Bottom inside corner	3.769911184	278.8	1051.051238	293033.1	4.464903842
Top outside cornder	3.769911184	1.2	4.523893421	5.428672	4.464903842
Bottom outside cornder	3.769911184	277.2	1045.01938	289679.4	4.464903842
Bottom outside cornder	3.769911184	278.8	1051.051238	293033.1	4.464903842
Sum	757.0145332		108773.0877	19775757	3414969.221

y_{bar}	143.6869213	mm	below top fibre
I_x	12098330.58	mm^4	
Z_e	84199.247	mm^3	
M_n	19.78682304	kNm	
$ØM_n$	17.80814074	kNm	

3rd iteration with new N.A location

0.6

Serviceability

f^*_1	225.1801903	
f^*_2	160.5440697	
ψ	0.712958229	
k	4	
f_{cr}	24.72101431	
λ	3.018088343	web may be subject to local buckling
λ_c	2.182840146	
$\rho_{\_strength}$	0.307183247	
$d_{\_effective\_strength}$	84.04533632	
d_{e1}	36.74849204	
d_{e2}	47.29684428	
$d_{e1} + d_{e2}$	84.04533632	
Depth of compression block	136.8	Web is not fully effective for this iteration

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$ -52.75466368 mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg/2})$ 46.15622654 mm

Element	L(mm)	y from top	Ly(mm2)	Ly2(mm3)	Ix about own axis (mm3)
Top flange	43.6	0.8	34.88	27.904	-
Additional top plate	42	2.4	100.8	241.92	-
Additional bottom plate	42	277.6	11659.2	3236594	-
Bottom flange	43.6	279.2	12173.12	3398735	-
$Web_{\_left}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_right\ top\ corner}$	23	16.3	374.9	6110.87	1013.916667
$Web_{\_right}$	273.6	140	38304	5362560	1706738.688
Additional $web_{\_left\ \ bottom\ corner}$	23	263.7	6065.1	1599367	1013.916667
Negative web element $_{\_left}$	-52.75466368	46.15623	-2434.96	-112388	-12234.92552
Negative web element $_{\_right}$	-52.75466368	46.15623	-2434.96	-112388	-12234.92552
Top inside corner	3.769911184	1.2	4.523893	5.428672	4.464903842
Top inside corner	3.769911184	2.8	10.55575	29.5561	4.464903842
Bottom inside corner	3.769911184	278.8	1051.051	293033.1	4.464903842
Top outside cornder	3.769911184	1.2	4.523893	5.428672	4.464903842
Bottom outside cornder	3.769911184	277.2	1045.019	289679.4	4.464903842
Bottom outside cornder	3.769911184	278.8	1051.051	293033.1	4.464903842
Sum	681.5101397		105312.8	19617206	3391062.148

y_{bar}	154.5286076	mm	below top fibre
I_x	10775080.89	mm^4	
Z_e	69728.71273	mm^3	
M_{n_ser}	16.38624749	kNm	assumed that fully laterally braced Msx =
$ØM_{n\_ser}$	14.74762274	kNm	

2"x11" 16 Gauge double beam

Given:

F_y	235	Mpa	
E	199950	Mpa	
k	4		c.2.2.1.2(5)
ν	0.3		
t	1.6	mm	
$b_{\_actual}$	50	mm	
$d_{\_actual}$	280	mm	
$d_{\_actual\ including\ track}$	283.2	mm	
$r_{\_inside\ (1t\_conservative)}$	1.6	mm	assumed
$r_{\_med}$	2.4	mm	
b	43.6	mm	
d	273.6	mm	

Effective width for capacity

Check compression flange effective width

f_{cr}	973.4765484	Mpa	
λ	0.491327626		
$b_{\_effective}$	43.6	mm	c.2.2.1.2

Check web effective width

Strength

f^*_1	229.6285714	Mpa	
f^*_2	229.6285714	Mpa	
ψ	1		
k	4		
f_{cr}	24.72101431	Mpa	
λ	3.047753362		web may be subject to local buckling
λ_c	2.182840146		
$\rho_{\_strength}$	0.304426104		
$d_{\_effective\_strength}$	83.290982		
d_{e1}	41.645491		
d_{e2}	41.645491		
$d_{e1} + d_{e2}$	83.290982		
Depth of compression block	136.8		Web is not fully effective

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$	-53.509018	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg/2})$	71.6	mm

Element	$L_{(mm)}$	y from top fiber$_{(mm)}$	$Ly_{(mm^2)}$	$Ly^2_{(mm^3)}$	I_x about own axis $_{(mm^3)}$
Additional top plate $_{\_track}$	52	0.8	41.6	33.28	-
Additional bottom plate $_{\_track}$	52	282.4	14684.8	4146987.52	-
Top flange	43.6	2.4	104.64	251.136	-
Bottom flange	43.6	280.8	12242.88	3437800.704	-
Additional top plate	42	4	168	672	-
Additional bottom plate	42	279.2	11726.4	3274010.88	-
Web $_{\_right}$	273.6	141.6	38741.76	5485833.216	1706738.688
Web $_{\_left}$	273.6	141.6	38741.76	5485833.216	1706738.688
Additional web $_{\_right\ top\ corner}$	23	17.9	411.7	7369.43	1013.916667
Additional web $_{\_left\ top\ corner}$	45.7	27.65	1263.605	34938.67825	7953.666083
Additional web $_{\_left\ \ bottom\ corner\ in}$	23	265.3	6101.9	1618834.07	1013.916667
Additional web $_{\_left\ bottom\ corner\ out}$	45.7	257.15	11751.755	3021963.798	7953.666083
Negative web element $_{\_left}$	-53.509018	71.6	-3831.245689	-274317.1913	-12767.31861
Negative web element $_{\_right}$	-53.509018	71.6	-3831.245689	-274317.1913	-12767.31861
Top inside corner	3.769911184	4.4	16.58760921	72.98548053	4.464903842
Bottom inside corner	3.769911184	278.8	1051.051238	293033.0852	4.464903842
Top outside cornder	3.769911184	4.4	16.58760921	72.98548053	4.464903842
Bottom outside cornder	3.769911184	278.8	1051.051238	293033.0852	4.464903842
Sum	867.8616087		130453.5863	26552105.69	3405895.764

y_{bar}	150.3161161	mm	below top fibre
I_x	16557960.04	mm^4	
Z_e	110154.2568	mm^3	

1

Check web effective width

Serviceability

f^*_1	229.6285714	Mpa	Assuming the netural axis is at the section centreline
f^*_2	229.6285714	Mpa	By symmetry
ψ	1		
k	4		c.2.2.3.2(4)
f_{cr}	24.72101431	Mpa	
λ	3.047753362		web may be subject to local buckling
λ_c	2.182840146		
$\rho_{\_Serviceability}$	0.395944454		
$d_{\_effective\_ser}$	108.3304027	mm	c.2.2.1.2 & c.2.2.1.3
d_{e1}	54.16520133	mm	
d_{e2}	54.16520133	mm	
$d_{e1} + d_{e2}$	108.3304027	mm	c 2.2.3.2(3)
Depth of compression block	136.8	mm	Web is not fully effective for this iteration

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$	-28.46959734	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg/2})$	68.4	mm

Element	$L_{(mm)}$	y from top	$Ly_{(mm^2)}$	$Ly^2_{(mm^3)}$	I_x about own axis $_{(mm^3)}$
Additional top plate $_{\_track}$	52	0.8	41.6	33.28	-
Additional bottom plate $_{\_track}$	52	282.4	14684.8	4146987.52	-
Top flange	43.6	2.4	104.64	251.136	-
Bottom flange	43.6	280.8	12242.88	3437800.7	-
Additional top plate	42	4	168	672	-
Additional bottom plate	42	279.2	11726.4	3274010.88	-
Web $_{\_right}$	273.6	141.6	38741.76	5485833.22	1706738.688
Web $_{\_left}$	273.6	141.6	38741.76	5485833.22	1706738.688
Additional web $_{\_right\ top\ corner}$	23	17.9	411.7	7369.43	1013.916667
Additional web $_{\_left\ top\ corner}$	45.7	27.65	1263.605	34938.6783	7953.666083
Additional web $_{\_left\ \ bottom\ corner\ in}$	23	265.3	6101.9	1618834.07	1013.916667
Additional web $_{\_left\ bottom\ corner\ out}$	45.7	257.15	11751.76	3021963.8	7953.666083
Negative web element $_{\_left}$	-28.46959734	68.4	-1947.32	-133196.719	-1922.926693
Negative web element $_{\_right}$	-28.46959734	68.4	-1947.32	-133196.719	-1922.926693
Top inside corner	3.769911184	4.4	16.58761	72.9854805	4.464903842
Bottom inside corner	3.769911184	278.8	1051.051	293033.085	4.464903842
Top outside cornder	3.769911184	4.4	16.58761	72.9854805	4.464903842
Bottom outside cornder	3.769911184	278.8	1051.051	293033.085	4.464903842
Sum	917.9404501		134221.4	26834346.6	3427584.548

y_{bar}	146.2202006	mm	below top fibre
I_x	17017673.22	mm^4	
Z_e	116383.8727	mm^3	

2nd iteration with new N.A location

Check web effective width

Strength

f^*_1	229.9972097	
f^*_2	197.7413567	
ψ	0.859755459	
k	4	
f_{cr}	24.72101431	
λ	3.050198763	web may be subject to local buckling
λ_c	2.182840146	
$\rho_{\_strength}$	0.304201013	
$d_{\_effective\_strength}$	83.22939708	
d_{e1}	38.88779786	
d_{e2}	44.34159922	
$d_{e1} + d_{e2}$	83.22939708	
Depth of compression block	136.8	Web is not fully effective for this iteration

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$	-53.5706029	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg}/2)$	68.87309932	mm

Element	L(mm)	y from top fiber(mm)	Ly(mm2)	Ly2(mm3)	Ix about own axis (mm3)	
Additional top plate $_{\_track}$	52	0.8	41.6	33.28	-	
Additional bottom plate $_{\_track}$	52	282.4	14684.8	4146987.52	-	
Top flange	43.6	2.4	104.64	251.136	-	
Bottom flange	43.6	280.8	12242.88	3437800.704	-	
Additional top plate	42	4	168	672	-	
Additional bottom plate	42	279.2	11726.4	3274010.88	-	
Web $_{\_left}$	273.6	141.6	38741.76	5485833.216		1706738.688
Web $_{\_right}$	273.6	141.6	38741.76	5485833.216		1706738.688
Additional web $_{\_right\ top\ corner}$	23	17.9	411.7	7369.43		1013.916667
Additional web $_{\_left\ top\ corner}$	45.7	27.65	1263.605	34938.67825		7953.666083
Additional web $_{\_left\ \ bottom\ corner\ in}$	23	265.3	6101.9	1618834.07		1013.916667
Additional web $_{\_left\ bottom\ corner\ ou}$	45.7	257.15	11751.755	3021963.798		7953.666083
Negative web element $_{\_left}$	-53.5706029	68.87309932	-3689.573455	-254112.359		-12811.45208
Negative web element $_{\_right}$	-53.5706029	68.87309932	-3689.573455	-254112.359		-12811.45208
Top inside corner	3.769911184	4.4	16.58760921	72.98548053		4.464903842
Bottom inside corner	3.769911184	278.8	1051.051238	293033.0852		4.464903842
Top outside corndер	3.769911184	4.4	16.58760921	72.98548053		4.464903842
Bottom outside corndер	3.769911184	278.8	1051.051238	293033.0852		4.464903842
Sum	867.7384389		130736.9308	26592515.35		3405807.497

y_{bar}	150.6639846	mm	
I_x	16481561.48	mm^4	
Z_e	109392.8421	mm^3	
M_n	25.7073179	kNm	
$ØM_n$	23.13658611	kNm	Based on half section
2ØMn	46.27317222	kNm	Full section

Check Shear

d_1/t	52.01837318	mm	
k_v	5.34	c 3.3.4	
$\sqrt{(Ek_v/f_y)}$	67.40582082		
$1.45*\sqrt{(Ek_v/f_y)}$	134.8116416		
V_v	40.05664423	kN	
$ØV_v$	36	kN	
$2ØV_v$	72	kN	

3rd iteration with new N.A location

Check web effective width

Strength

f^*_1	230.0087607	
f^*_2	196.7421989	
ψ	0.855368284	
k	4	
f_{cr}	24.72101431	
λ	3.050275356	web may be subject to local buckling
λ_c	2.182840146	
$\rho_{\_strength}$	0.304193968	
$d_{\_effective\_strength}$	83.22746963	
d_{e1}	38.80734813	
d_{e2}	44.4201215	
$d_{e1} + d_{e2}$	83.22746963	
Depth of compression block	68.4	web is fully effective

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$	0	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg}/2)$	38.80734813	mm

Element	L(mm)	y from top fiber(mm)	Ly(mm2)	Ly2(mm3)	Ix about own axis (mm3)	
Additional top plate $_{\_track}$	52	0.8	41.6	33.28	-	
Additional bottom plate $_{\_track}$	52	282.4	14684.8	4146987.52	-	
Top flange	43.6	2.4	104.64	251.136	-	
Bottom flange	43.6	280.8	12242.88	3437800.704	-	
Additional top plate	42	4	168	672	-	
Additional bottom plate	42	279.2	11726.4	3274010.88	-	
Web $_{\_left}$	273.6	141.6	38741.76	5485833.216		1706738.688
Web $_{\_right}$	273.6	141.6	38741.76	5485833.216		1706738.688
Additional web $_{\_right\ top\ corner}$	23	16.3	374.9	6110.87		1013.916667
Additional web $_{\_left\ top\ corner}$	45.7	27.65	1263.605	34938.67825		7953.666083
Additional web $_{\_left\ \ bottom\ corner\ in}$	23	266.9	6138.7	1638419.03		1013.916667
Additional web $_{\_left\ bottom\ corner\ ou}$	45.7	255.55	11678.635	2984475.174		7953.666083
Negative web element $_{\_left}$	0	38.80734813	0	0		0
Negative web element $_{\_right}$	0	38.80734813	0	0		0
Top inside corner	3.769911184	4.4	16.58760921	72.98548053		4.464903842
Bottom inside corner	3.769911184	278.8	1051.051238	293033.0852		4.464903842
Top outside corndер	3.769911184	4.4	16.58760921	72.98548053		4.464903842
Bottom outside corndер	3.769911184	278.8	1051.051238	293033.0852		4.464903842
Sum	974.8796447		138042.9577	27081577.85		3431430.401

y_{bar}	141.6	mm	
I_x	17545800.7	mm^4	
Z_e	123911.0219	mm^3	
M_n	29.11909014	kNm	
$ØM_n$	26.20718113	kNm	Based on half section

Check Shear

d_1/t	52.01716852	mm	
k_v	5.34	c 3.3.4	
$\sqrt{(Ek_v/f_y)}$	766.9574506		
$1.45*\sqrt{(Ek_v/f_y)}$	1533.914901		
V_v	40.05571658	kN	additional plate ingonored for shear calculation
$ØV_v$	36	kN	

2nd iteration with new N.A location

Serviceability

f^*_1	224.9637666	
f^*_2	176.5900099	
ψ	0.784970898	
k	4	
f_{cr}	24.72101431	
λ	3.016637631	web may be subject to local buckling
λ_c	2.182840146	
$\rho_{\_strength}$	0.307319352	
$d_{\_effective\_strength}$	84.08257463	
d_{e1}	37.96003157	
d_{e2}	46.12254306	
$d_{e1} + d_{e2}$	84.08257463	
Depth of compression block	136.8	Web is not fully effective for this iteration

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$	-52.71742537	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg}/2)$	64.31874425	mm

Element	L(mm)	y from top	Ly(mm2)	Ly2(mm3)	Ix about own axis (mm3)	
Additional top plate $_{\_track}$	52	0.8	41.6	33.28	-	
Additional bottom plate $_{\_track}$	52	282.4	14684.8	4146987.52	-	
Top flange	43.6	2.4	104.64	251.136	-	
Bottom flange	43.6	280.8	12242.88	3437800.7	-	
Additional top plate	42	4	168	672	-	
Additional bottom plate	42	279.2	11726.4	3274010.88	-	
Web $_{\_left}$	273.6	141.6	38741.76	5485833.22		1706738.688
Web $_{\_right}$	273.6	141.6	38741.76	5485833.22		1706738.688
Additional web $_{\_right\ top\ corner}$	23	17.9	411.7	7369.43		1013.916667
Additional web $_{\_left\ top\ corner}$	45.7	27.65	1263.605	34938.6783		7953.666083
Additional web $_{\_left\ \ bottom\ corner\ in}$	23	265.3	6101.9	1618834.07		1013.916667
Additional web $_{\_left\ bottom\ corner\ out}$	45.7	257.15	11751.76	3021963.8		7953.666083
Negative web element $_{\_left}$	-52.71742537	64.31874	-3390.72	-218086.762		-12209.03474
Negative web element $_{\_right}$	-52.71742537	64.31874	-3390.72	-218086.762		-12209.03474
Top inside corner	3.769911184	4.4	16.58761	72.9854805		4.464903842
Bottom inside corner	3.769911184	278.8	1051.051	293033.085		4.464903842
Top outside corndер	3.769911184	4.4	16.58761	72.9854805		4.464903842
Bottom outside corndер	3.769911184	278.8	1051.051	293033.085		4.464903842
Sum	869.444794		131334.6	26664566.5		3407012.332

y_{bar}	151.0557558	mm
I_x	16372360.79	mm^4
Z_e	108386.2094	mm^3

3rd iteration with new N.A location

Serviceability

f^*_1	225.136202	
f^*_2	163.7752826	
ψ	0.727449789	
k	4	
f_{cr}	24.72101431	
λ	3.017793541	web may be subject to local buckling
λ_c	2.182840146	
$\rho_{\_strength}$	0.307210895	
$d_{\_effective\_strength}$	84.05290093	
d_{e1}	36.98615789	
d_{e2}	47.06674304	
$d_{e1} + d_{e2}$	84.05290093	
Depth of compression block	136.8	Web is not fully effective for this iteration

Recompute properties by parts

Represnet the ineffective portion of the web as an element with a negative length

$d_{\_neg}$	-52.74709907	mm

Its centroidal location below the top fiber:

$y\ (t/2+r_{\_med}+d_{e1}+b_{\_neg}/2)$	130.0597074	mm

Element	L(mm)	y from top	Ly(mm2)	Ly2(mm3)	Ix about own axis (mm3)	
Additional top plate $_{\_track}$	52	0.8	41.6	33.28	-	
Additional bottom plate $_{\_track}$	52	282.4	14684.8	4146987.52	-	
Top flange	43.6	2.4	104.64	251.136	-	
Bottom flange	43.6	280.8	12242.88	3437800.7	-	
Additional top plate	42	4	168	672	-	
Additional bottom plate	42	279.2	11726.4	3274010.88	-	
Web $_{\_left}$	273.6	141.6	38741.76	5485833.22		1706738.688
Web $_{\_right}$	273.6	141.6	38741.76	5485833.22		1706738.688
Additional web $_{\_right\ top\ corner}$	23	17.9	411.7	7369.43		1013.916667
Additional web $_{\_left\ top\ corner}$	45.7	27.65	1263.605	34938.6783		7953.666083
Additional web $_{\_left\ \ bottom\ corner\ in}$	23	265.3	6101.9	1618834.07		1013.916667
Additional web $_{\_left\ bottom\ corner\ out}$	45.7	257.15	11751.76	3021963.8		7953.666083
Negative web element $_{\_left}$	-52.74709907	130.0597	-6860.27	-892245.005		-12229.6631
Negative web element $_{\_right}$	-52.74709907	130.0597	-6860.27	-892245.005		-12229.6631
Top inside corner	3.769911184	4.4	16.58761	72.9854805		4.464903842
Bottom inside corner	3.769911184	278.8	1051.051	293033.085		4.464903842
Top outside corndер	3.769911184	4.4	16.58761	72.9854805		4.464903842
Bottom outside corndер	3.769911184	278.8	1051.051	293033.085		4.464903842
Sum	869.3854466		124395.5	25316250.1		3406971.075

y_{bar}	143.0844439	mm
I_x	17478648.72	mm^4
Z_e	122156.1775	mm^3

				Space Gass				Manual Calculation						
Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{xx(mm^4)}$	$C_{xx(mm)}$	$Z_{xx(mm^3)}$	$A_{(mm^2)}$	$I_{xx(mm^4)}$	$C_{xx(mm)}$	$Z_{xx(mm^3)}$	$A_{(mm^2)}$	$r_{(mm)}$	Self weight (kg/m)	Strength
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	150	50	2.6	2631000.0	75.0	35085.0	995.6	2631357.0	75.0	35167.8	995.5	51.4	7.814989	Serviceability
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	150	50	2	2075000.0	75.0	27670.0	773.7	2078127.1	75.0	27708.4	773.7	51.8	6.073545	Vibration
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	150	50	1.6	1688000.0	75.0	22500.0	62.3	1689229.4	75.0	22523.1	623.2	52.0	4.891869	
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	150	50	1.2	1287000.0	75.0	17160.0	470.5	1287255.9	75.0	17163.4	470.5	52.3	3.693582	
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	150	50	0.9	976800.0	75.0	13020.0	354.7	977022.0	75.0	13027.0	354.6	52.5	2.78361	

Strength(manual calculatoin)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\ xx(mm^4)}$	$C_{xx(mm)}$	$Z_{eff\ xx(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$	$\emptyset M_s$(kN.m)	$\emptyset V_s$(kN)
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	150	50	2.6	2637580.4	75.0	35167.7	995.6	51.4	7.4	80
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	150	50	2	2078127.1	75.0	27708.4	773.7	51.8	5.8	50
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	150	50	1.6	1689229.4	75.0	22523.1	623.2	52.0	4.7	33
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	150	50	1.2	1244073.7	69.1	16069.9	442.0	52.3	3.4	19
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	150	50	0.9	842845.2	61.8	10156.4	299.6	52.5	2.1	11

Serviceability(manual calculation)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\ xx(mm^4)}$	$C_{xx(mm)}$	$Z_{eff\ xx(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	150	50	2.6	2637580.4	75.0	35167.7	995.6	51.4
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	150	50	2	2078127.1	75.0	27708.4	773.7	51.8
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	150	50	1.6	1689229.4	75.0	22523.1	623.2	52.0
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	150	50	1.2	1286225.0	75.0	17142.9	470.3	52.3
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	150	50	0.9	882263.2	68.2	11030.7	322.6	52.5

Reduction

	single span		
	400	600	900
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	1

	Double span		
	300	4590	600
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	1
FF-EVOLUT	1	0.97	0.96
FF-EVOLUT	0.9	0.94	0.93
FF-EVOLUT	0.94	0.92	0.9

f_y	234	MPa	
E	199950	Mpa	
DL	0.4	kPa	WLs -0.763914321
LL	0.25	kPa	0.9DL+1.5WLs -0.785871482
$\Psi_{long-term}$	0.4		
1.2DL+1.5LL	0.855	kPa	
DL+ΨLL	0.5	kPa	L/300
Min fundamental frequency required	0	Hz	
mode (single span)	0		
mode (double equal span)	0		

Spacing (mm)	400	600	900	400	600	900
	Maximum recommended span(mm)					
Joist sections	Single span			Equal double span		
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	7859	7094	6347	10535	9510	8508
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	7417	6656	5928	9942	8922	7946
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	7030	6281	5575	9423	8420	7474
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	6526	5803	5133	8748	7779	6880
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	5831	5165	4555	7816	6923	6106

Spacing (mm)	Maximum recommended span(mm)					
	400	600	900	400	600	900
Joist sections	Single span			Equal double span		
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	7859	7094	6347	10535	9510	8285
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	7417	6656	5928	9942	8922	7444
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	7030	6281	5575	9423	8024	6632
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	6526	5803	5133	7942	6758	5562
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	5831	5165	4555	6546	5368	4380

Single span

Joist sections	400				600				900			
	M*	V*	$/\emptyset M_s)^{1.4}+(V^*/\emptyset$	Result	M*	V*	$(M^*/\emptyset M_s)^{1.4}+(V^*/\emptyset V_s)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_s)^{1.4}+(V^*/\emptyset V_s)^{1.4}$	Result
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	3.36	1.71	0.34	ok	3.23	2.15	0.32	ok	4.35	2.74	0.48	ok
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	2.85	1.54	0.37	ok	2.84	1.95	0.38	ok	3.70	2.50	0.54	ok
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	2.48	1.41	0.41	ok	2.53	1.80	0.43	ok	3.22	2.31	0.61	ok
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	2.06	1.26	0.52	ok	2.16	1.62	0.56	ok	2.68	2.09	0.77	ok
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	1.60	1.09	0.70	ok	1.71	1.41	0.79	ok	2.08	1.83	1.04	not ok & reduce span

Joist sections	qual double span											
	400				600				900			
	M*	V*	$/\emptyset M_s)^{1.4}+(V^*/\emptyset$	Result	M*	V*	$(M^*/\emptyset M_s)^{1.4}+(V^*/\emptyset V_s)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_s)^{1.4}+(V^*/\emptyset V_s)^{1.4}$	Result
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	6.05	2.30	0.76	ok	6.86	2.89	0.91	ok	7.41	3.58	1.01	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	5.13	2.06	0.85	ok	5.83	2.61	1.01	not ok & re	5.84	3.14	1.02	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	4.45	1.89	0.93	ok	4.60	2.29	0.98	ok	4.55	2.75	0.98	ok
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	3.05	1.53	0.89	ok	3.18	1.88	0.96	ok	3.15	2.26	0.95	ok
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	2.01	1.23	0.96	ok	1.97	1.47	0.95	ok	1.93	1.76	0.94	ok

SPACE GASS 14.00 - TINGMORE STRUCTURES
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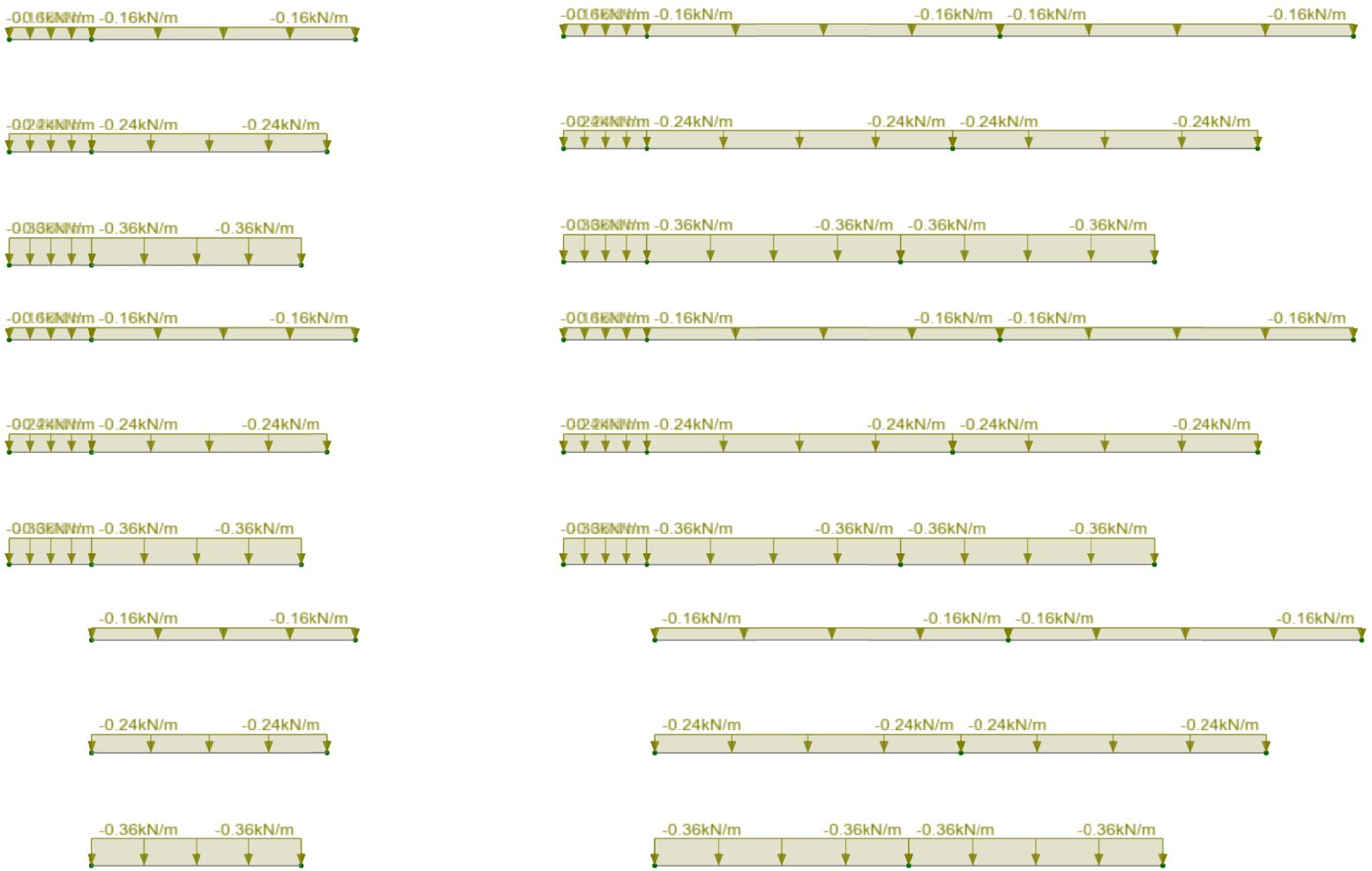
Designer: Date: Tuesday, July 26, 2022 1:49 PM, Page: 1

Load case 1
1 (SW) dl



Viewpoint (0,0), Loads

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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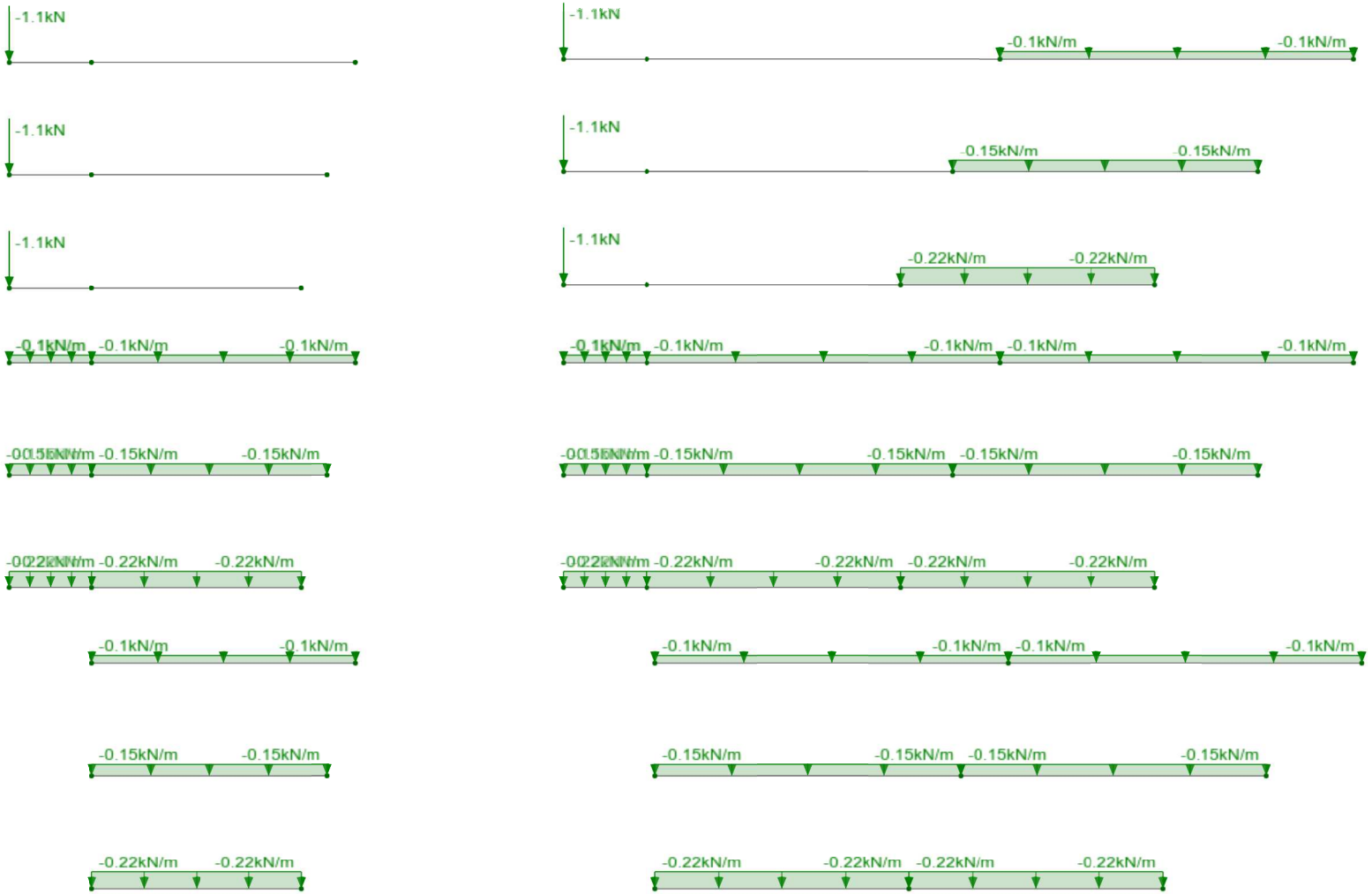
Designer: Date: Tuesday, July 26, 2022 1:50 PM, Page: 1

Load case 2
2 ll



Viewpoint (0,0), Loads

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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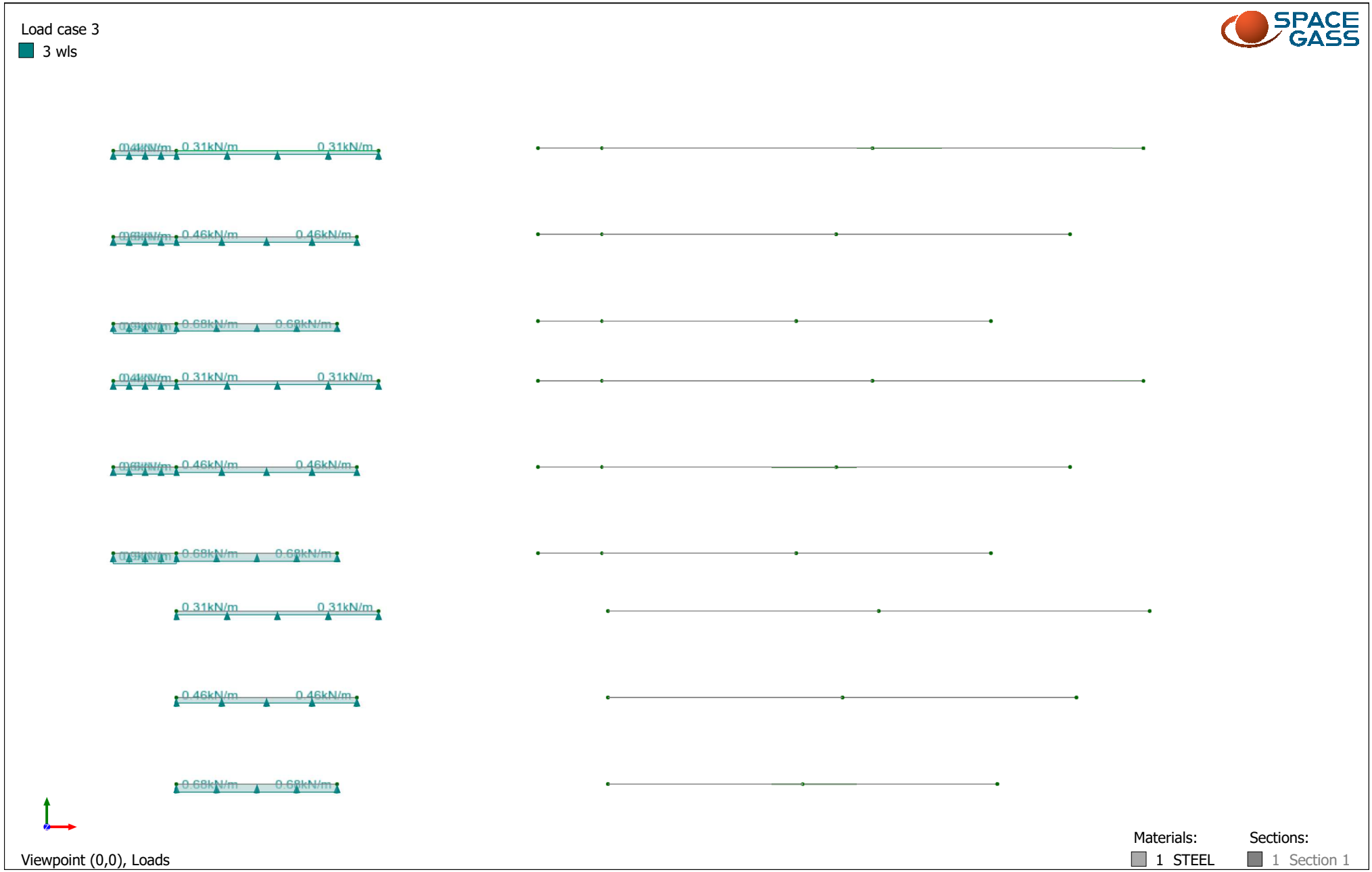
Designer: Date: Tuesday, July 26, 2022 1:51 PM, Page: 1



SPACE GASS 14.00 - TINGMORE STRUCTURES
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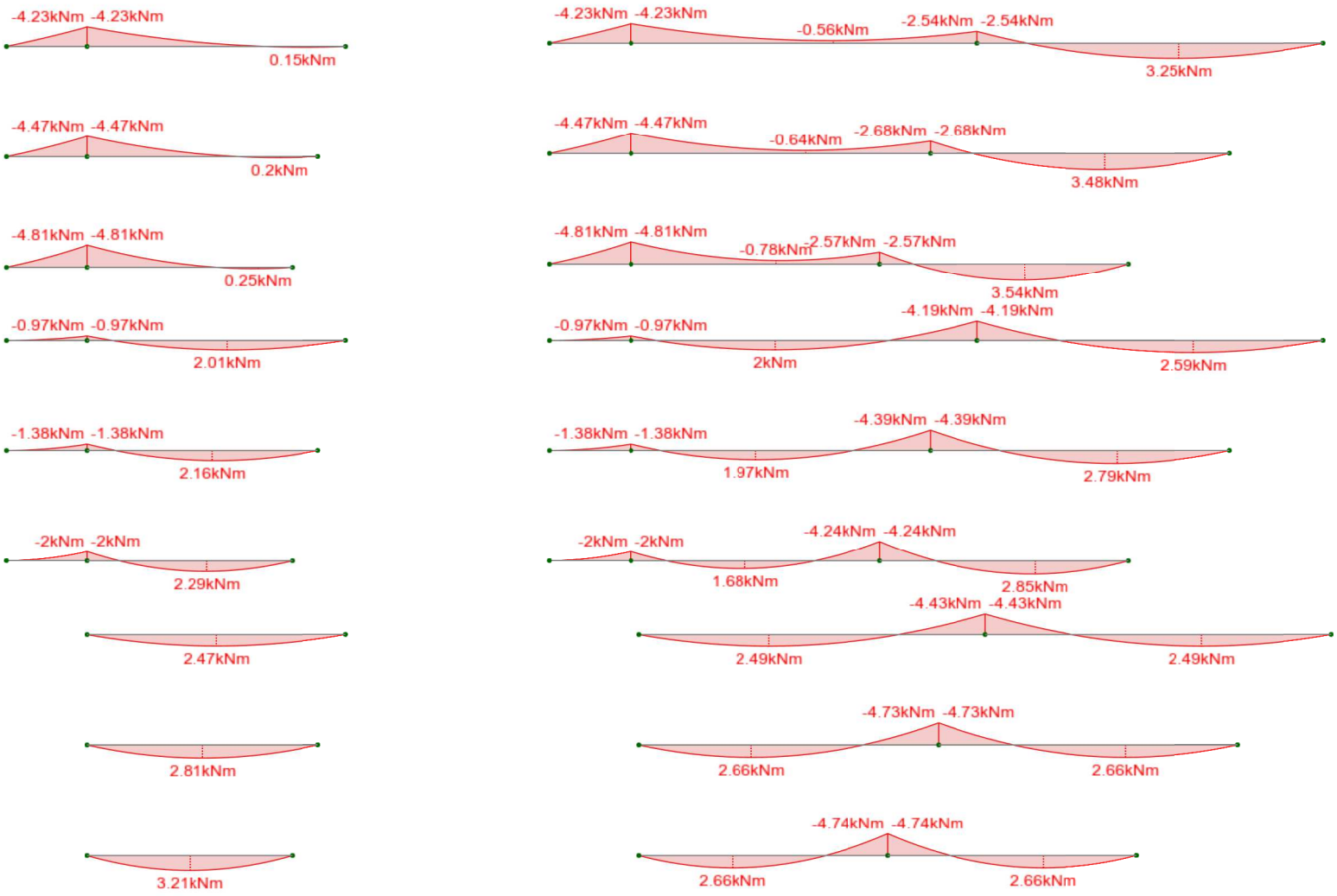
Designer: Date: Tuesday, July 26, 2022 1:55 PM, Page: 1

Load case 4
4 (SW) 1.2dl+1.5ll



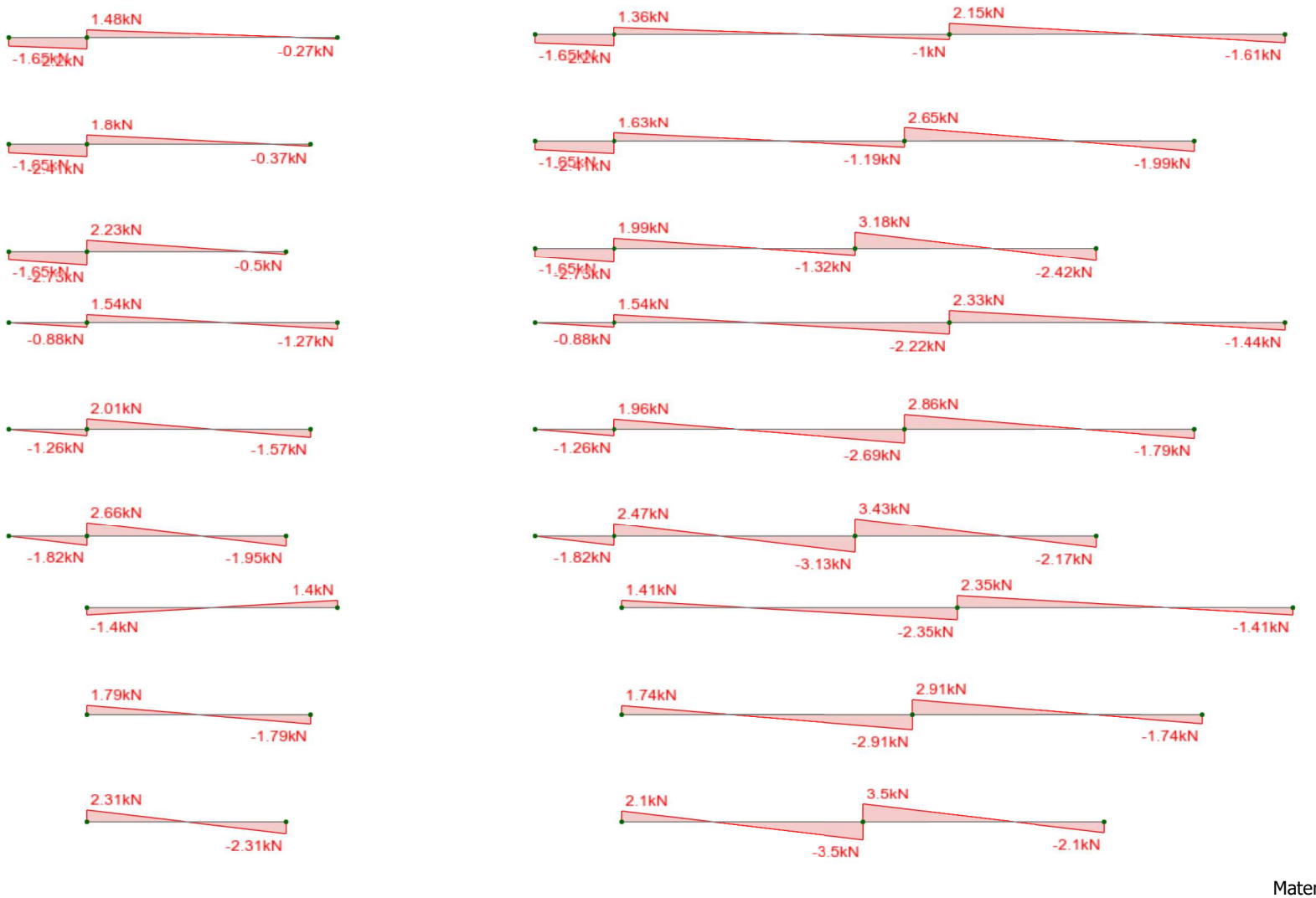
Viewpoint (0,0), Moments

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\Engineering\Structural\roof 150x50x.16
Designer: Date: Tuesday, July 26, 2022 1:56 PM, Page: 1

Load case 4
4 (SW) 1.2dl+1.5ll



Viewpoint (0,0), Shears

Materials: 1 STEEL
Sections: 1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\Engineering\Structural\roof 150x50x.16
Designer: Date: Tuesday, July 26, 2022 1:57 PM, Page: 1

Load case 5
5 (SW) dl+0.4ll

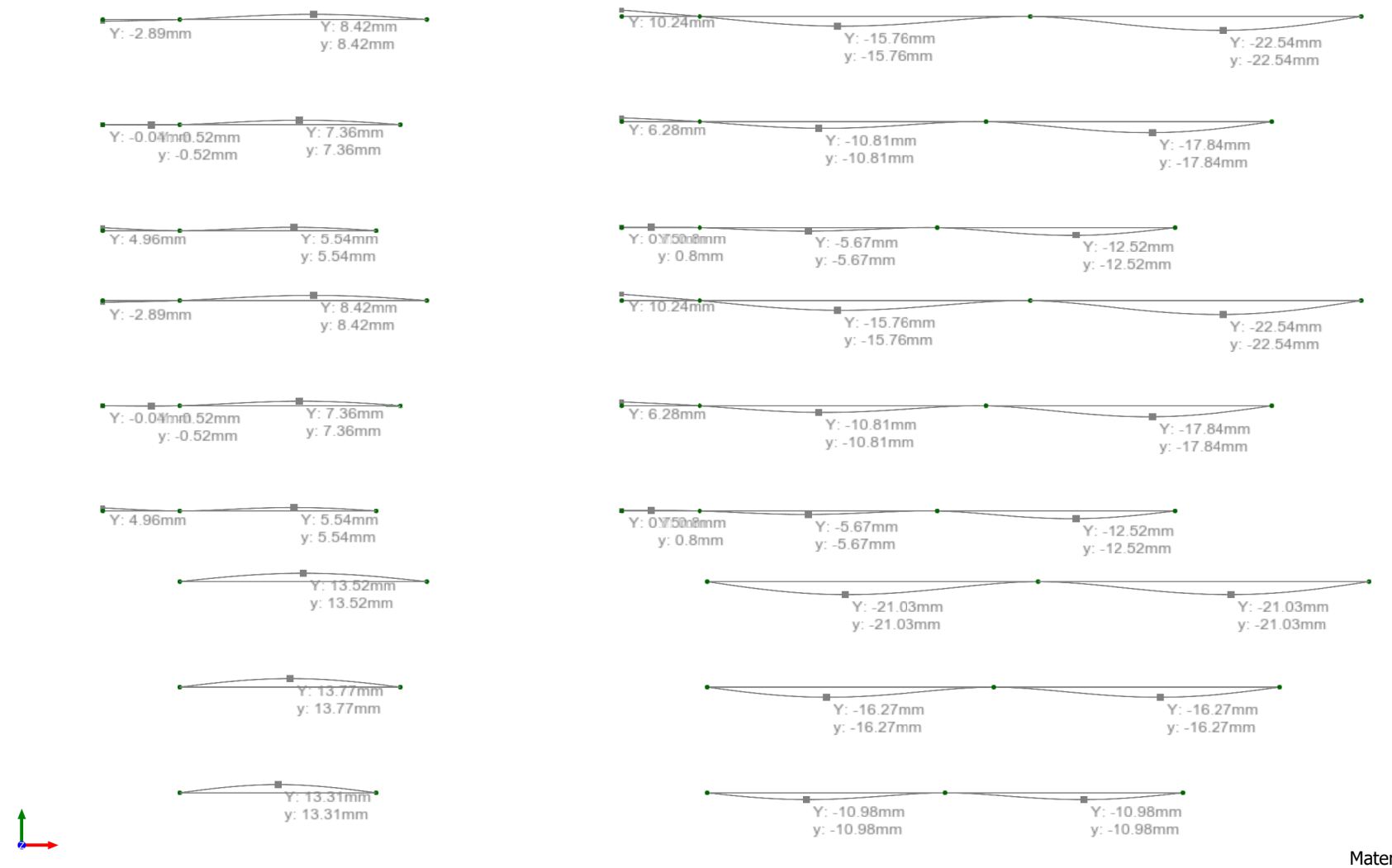
Viewpoint (0,0), Displacements

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\Engineering\Structural\roof 150x50x.16
Designer: Date: Tuesday, July 26, 2022 1:58 PM, Page: 1

Load case 6
6 (SW) 0.8dl+wls



Viewpoint (0,0), Displacements

Materials:
1 STEEL

Sections:
1 Section 1

				Space Gass				Manual Calculation											
Member	$Depth_{(mm)}$	$Width_{(mm)}$	$Gauge\ thickness_{(mm)}$	$I_{ad(mm}{}^4)$	$C_{ad(mm)}$	$Z_{ad(mm}{}^3)$	$A_{ad(mm}{}^2)$	$I_{ad(mm}{}^4)$	$C_{ad(mm)}$	$Z_{ad(mm}{}^3)$	$A_{ad(mm}{}^2)$	$f_{(mm)}$	Self weight (kg/m)	Strength					
FF-EVOLUTION -BEAM 2X11-8'	280	50	4.1					20730855.2	140.0	148077.5	2595.3	51.4	20.37311	Serviceability					
FF-EVOLUTION -BEAM 2X11-12'	280	50	2.6					13667273.7	140.0	97623.4	1671.5	51.8	13.12159	Vibration					
FF-EVOLUTION -BEAM 2X11-16'	280	50	1.6						140.0	61641.8	1039.2	52.0	8.157469						
FF-EVOLUTION -BEAM 2X11-20'	280	50	0.9					4942094.6	140.0	35300.0	588.7	52.3	4.621075						

Strength(manual calculatoin)

Member	$Depth_{(mm)}$	$Width_{(mm)}$	$Gauge\ thickness_{(mm)}$	$I_{eff\ ad(mm}{}^4)$	$C_{ad(mm)}$	$Z_{eff\ ad(mm}{}^3)$	$A_{ad(mm}{}^2)$	$f_{(mm)}$	ϕM_s(kN.m)	ϕV_s(kN)
FF-EVOLUTION -BEAM 2X11-8'	280	50	4.1	20730855.3	140.0	148077.5		2595.5	51.4	46.0	264
FF-EVOLUTION -BEAM 2X11-12'	280	50	2.6	12960242.8	140.0	88758.0		1538.5	51.8	27.6	112
FF-EVOLUTION -BEAM 2X11-16'	280	50	1.6	11483225.5	140.0	75834.4		1087.8	52.0	16.1	36
FF-EVOLUTION -BEAM 2X11-20'	280	50	0.9	3117914.9	140.0	17700.1		400.1	52.3	5.5	14

Serviceability(manual calculation)

Member	$Depth_{(mm)}$	$Width_{(mm)}$	$Gauge\ thickness_{(mm)}$	$I_{eff\ ad(mm}{}^4)$	$C_{ad(mm)}$	$Z_{eff\ ad(mm}{}^3)$	$A_{ad(mm}{}^2)$	$f_{(mm)}$	
FF-EVOLUTION -BEAM 2X11-8'	280	50	4.1	20730855.3	140.0	148077.5		2595.5	51.4
FF-EVOLUTION -BEAM 2X11-12'	280	50	2.6	13667273.7	140.0	97623.4		1671.6	51.8
FF-EVOLUTION -BEAM 2X11-16'	280	50	1.6	10770082.9	140.0	74727.8		1090.4	52.0
FF-EVOLUTION -BEAM 2X11-20'	280	50	0.9	3233864.4	140.0	18734.5		420.6	52.3

Reduction

	single span						
	2000	2500	3000	3500	4000	4500	5000
FF-EVOLUTION -BEAM 2X11-8'	1	0.95	0.945	1	1	1	1
FF-EVOLUTION -BEAM 2X11-12'	0.5	0.895	0.88	1	1	1	1
FF-EVOLUTION -BEAM 2X11-16'	0.91	0.89	0.885	0.875	0.865	0.855	0.85
FF-EVOLUTION -BEAM 2X11-20'	0.605	0.545	0.495	1	1	1	1
	Double span						
	2000	2500	3000	3500	4000	4500	5000
FF-EVOLUTION -BEAM 2X11-8'	1	1	1	1	1	1	1
FF-EVOLUTION -BEAM 2X11-12'	1	1	1	1	1	1	1
FF-EVOLUTION -BEAM 2X11-16'	0.91	0.89	0.89	0.875	0.865	0.855	0.85
FF-EVOLUTION -BEAM 2X11-20'	1	1	1	1	1	1	1

f_y	234 MPa																		
E	199950 Mpa																		
DL	0.4 kPa		WLs	-0.763914321															
LL	0.25 kPa		0.9DL+1.5WLs	-0.785871482															
$\Psi_{long-term}$	0.4																		
1.2DL+1.5LL	0.855 kPa																		
DL+WLL	0.5 kPa		L/300																
Min fundamental frequency required	0 Hz		Min																
mode (single span)	0																		
mode (double equal span)	0																		
Spacing (mm)	2000	2500	3000	3500	4000	4500	5000	2000	2500	3000	3500	4000	4500	**5000**					
								Single span											
Joist sections																			
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	9588	9004	8540	8159	7838	7562	7322	12853.45	12069.84	11447.99	10937.25	10506.95	10137.26	9814.66					
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	8520	7971	7541	7191	6898	6648	6430	11420.96	10685.56	10109.14	9639.88	9247.17	8911.52	8619.84					
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	7989	7454	7039	6703	6423	6185	5978	10709.73	9992.53	9435.56	8985.09	8609.94	8290.51	8013.75					
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	5409	5036	4748	4517	4325	4162	4021	7250.34	6750.55	6365.15	6054.97	5797.59	5579.06	5390.14					

	Maximum recommended span(mm)																		
Spacing (mm)	2000	2500	3000	3500	4000	4500	5000	2000	2500	3000	3500	4000	4500	5000					
				Single span							Equal double span								
Joist sections																			
FF-EVOLUTION -BEAM 2X11-8'	9588	9004	8540	8159	7838	7562	7322	12853	12070	11442	10660	10019	9481	9023					
FF-EVOLUTION -BEAM 2X11-12'	7683	7971	7541	7191	6898	6648	6430	10866	9801	8999	8366	7850	7420	7053					
FF-EVOLUTION -BEAM 2X11-16'	7989	7152	6535	6031	5621	5277	4997	8042	7152	6353	6031	5621	5277	4997					
FF-EVOLUTION -BEAM 2X11-20'	3882	3306	2882	3798	3557	3356	3186	4990	4478	4096	3798	3557	3356	3186					

								Single span											
Beam sections	2000				2500				3000										
	M*	V*	$(\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result							
FF-EVOLUTION -BEAM 2X11-8'	22.46	9.370231834	0.38	ok	24.14	10.72356341	0.42	ok	25.61	12.00	0.45	ok							
FF-EVOLUTION -BEAM 2X11-12'	13.78	7.173880632	0.40	ok	18.23	9.144863146	0.59	ok	19.35	10.27	0.64	ok							
FF-EVOLUTION -BEAM 2X11-16'	14.42	7.221881914	0.97	ok	14.29	7.993945421	0.97	ok	14.21	8.70	0.98	ok							
FF-EVOLUTION -BEAM 2X11-20'	3.33	3.42641495	0.63	ok	3.00	3.624491655	0.58	ok	2.72	3.78	0.53	ok							

								Single span											
Beam sections	3500				4000				4500				5000						
	M*	V*	$(\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result			
FF-EVOLUTION -BEAM 2X11-8'	26.94	13.20527929	0.49	ok	28.14	14.36	0.52	ok	29.25	15.47	0.55	ok	30.28	16.54	0.58	ok			
FF-EVOLUTION -BEAM 2X11-12'	20.36	11.32599738	0.70	ok	21.28	12.34	0.74	ok	22.12	13.31	0.79	ok	22.91	14.25	0.83	ok			
FF-EVOLUTION -BEAM 2X11-16'	14.05	9.319652926	0.98	ok	13.89	9.89	0.98	ok	13.73	10.41	0.98	ok	13.65	10.93	0.98	ok			
FF-EVOLUTION -BEAM 2X11-20'	5.50	5.788130667	1.29	not ok & reduc	5.50	6.18	1.32	not ok & reduce span	5.50	6.55	1.35	not ok & reduce span	5.50	6.90	1.37	not ok & reduce span			

Beam sections	qual double span																		
	2000				2500				3000										
	M*	V*	$(\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result							
FF-EVOLUTION -BEAM 2X11-8'	40.36	12.5608927	0.85	ok	43.38	14.37504768	0.94	ok	45.98	16.07322975	1.02	not ok & reduce span							
FF-EVOLUTION -BEAM 2X11-12'	27.56	10.14554071	1.03	not ok & reduc	27.56	11.24701111	1.04	not ok & reduce span	27.56	12.24983761	1.05	not ok & reduce span							
FF-EVOLUTION -BEAM 2X11-16'	14.61	7.269362094	0.98	ok	14.29	7.993945421	0.97	ok	14.29	8.724913823	0.99	ok							
FF-EVOLUTION -BEAM 2X11-20'	5.50	4.405165902	1.20	not ok & reduc	5.50	4.909631007	1.23	not ok & reduce span	5.50	5.36688612	1.26	not ok & reduce span							

Beam sections	qual double span																		
	3500				4000				4500				5000						
	M*	V*	$(\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result			
FF-EVOLUTION -BEAM 2X11-8'	45.98	17.25282496	1.02	not ok & reduc	45.98	18.35677596	1.02	not ok & reduce span	45.98	19.39800191	1.03	not ok & reduce span	45.98	20.38611617	1.03	not ok & reduce span			
FF-EVOLUTION -BEAM 2X11-12'	27.56	13.17656192	1.05	not ok & reduc	27.56	14.04225931	1.05	not ok & reduce span	27.56	14.85760106	1.06	not ok & reduce span	27.56	15.63046934	1.06	not ok & reduce span			
FF-EVOLUTION -BEAM 2X11-16'	14.05	9.319652926	0.98	ok	13.89	9.886412302	0.98	ok	13.73	10.40920511	0.98	ok	13.65	10.92655561	0.98	ok			
FF-EVOLUTION -BEAM 2X11-20'	5.50	5.788130667	1.29	not ok & reduc	5.50	6.180731884	1.32	not ok & reduce span	5.50	6.549842488	1.35	not ok & reduce span	5.50	6.89923377	1.37	not ok & reduce span			

SPACE GASS 14.00 - TINGMORE STRUCTURES
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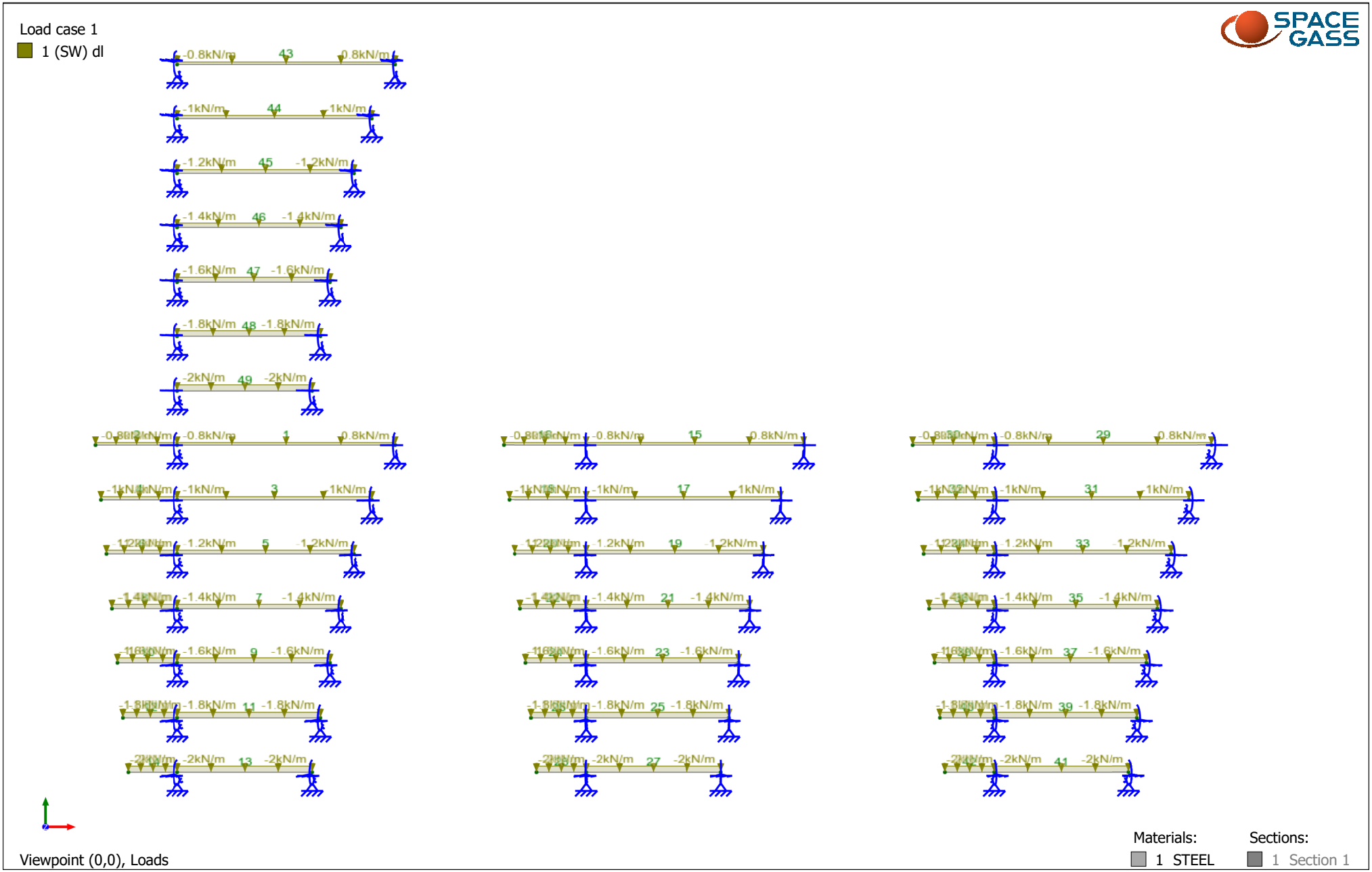
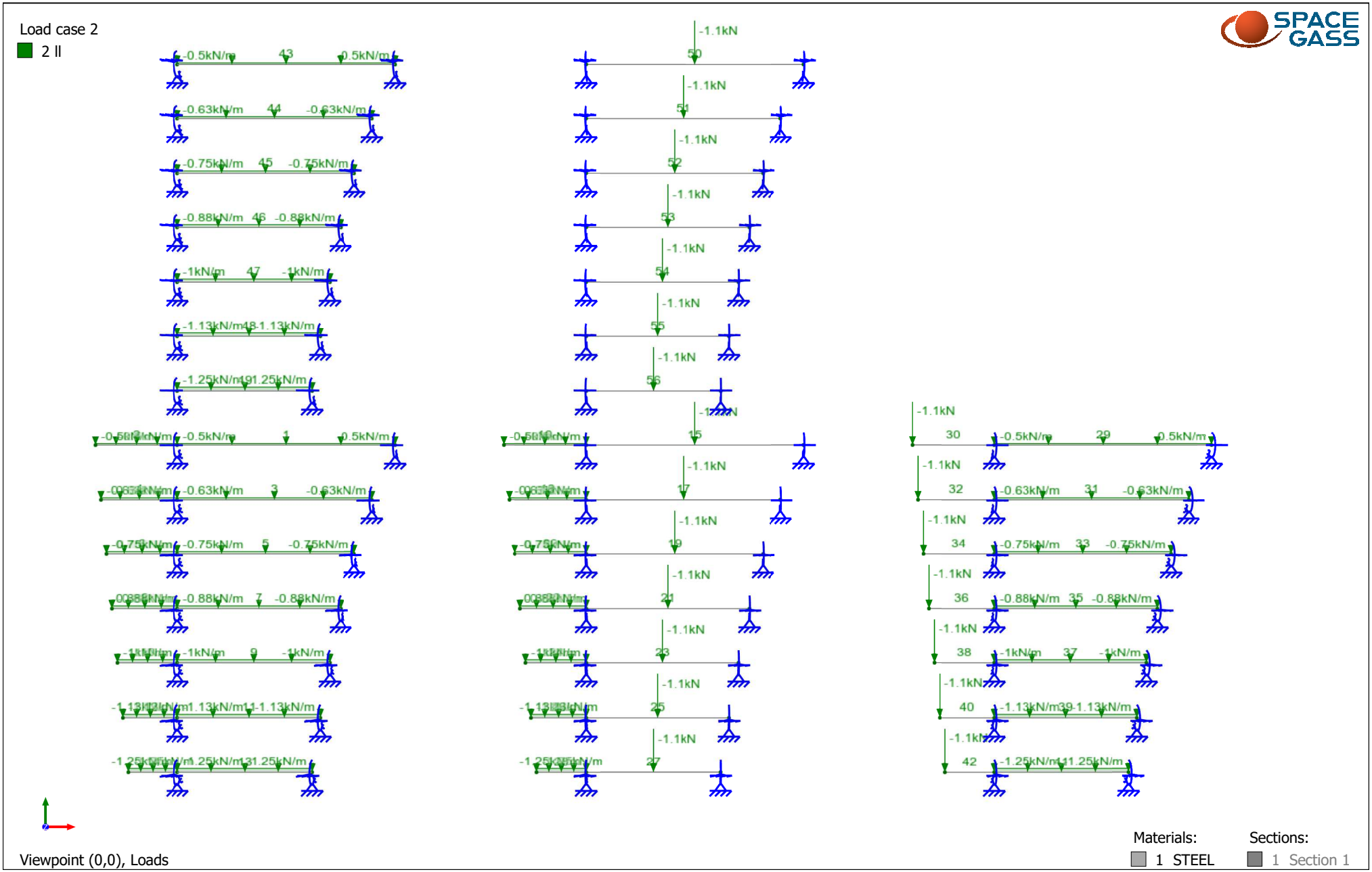
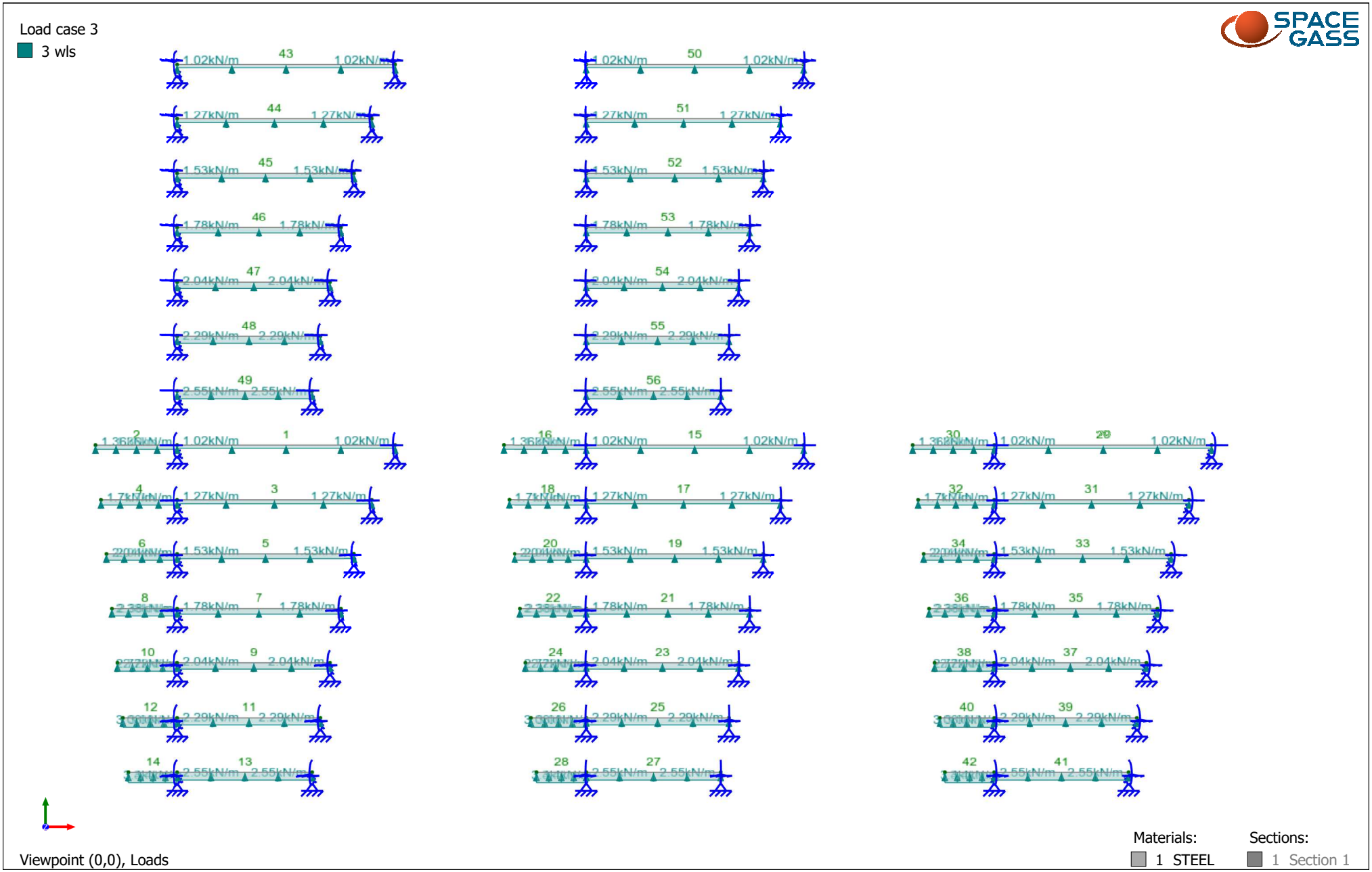
Designer: Date: Tuesday, July 26, 2022 4:05 PM, Page: 1



SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\Eng...\Structural\280x50 single roof beam
Designer: Date: Tuesday, July 26, 2022 4:12 PM, Page: 1



SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\Eng...\Structural\280x50 single roof beam
Designer: Date: Tuesday, July 26, 2022 4:12 PM, Page: 1



SPACE GASS 14.00 - TINGMORE STRUCTURES
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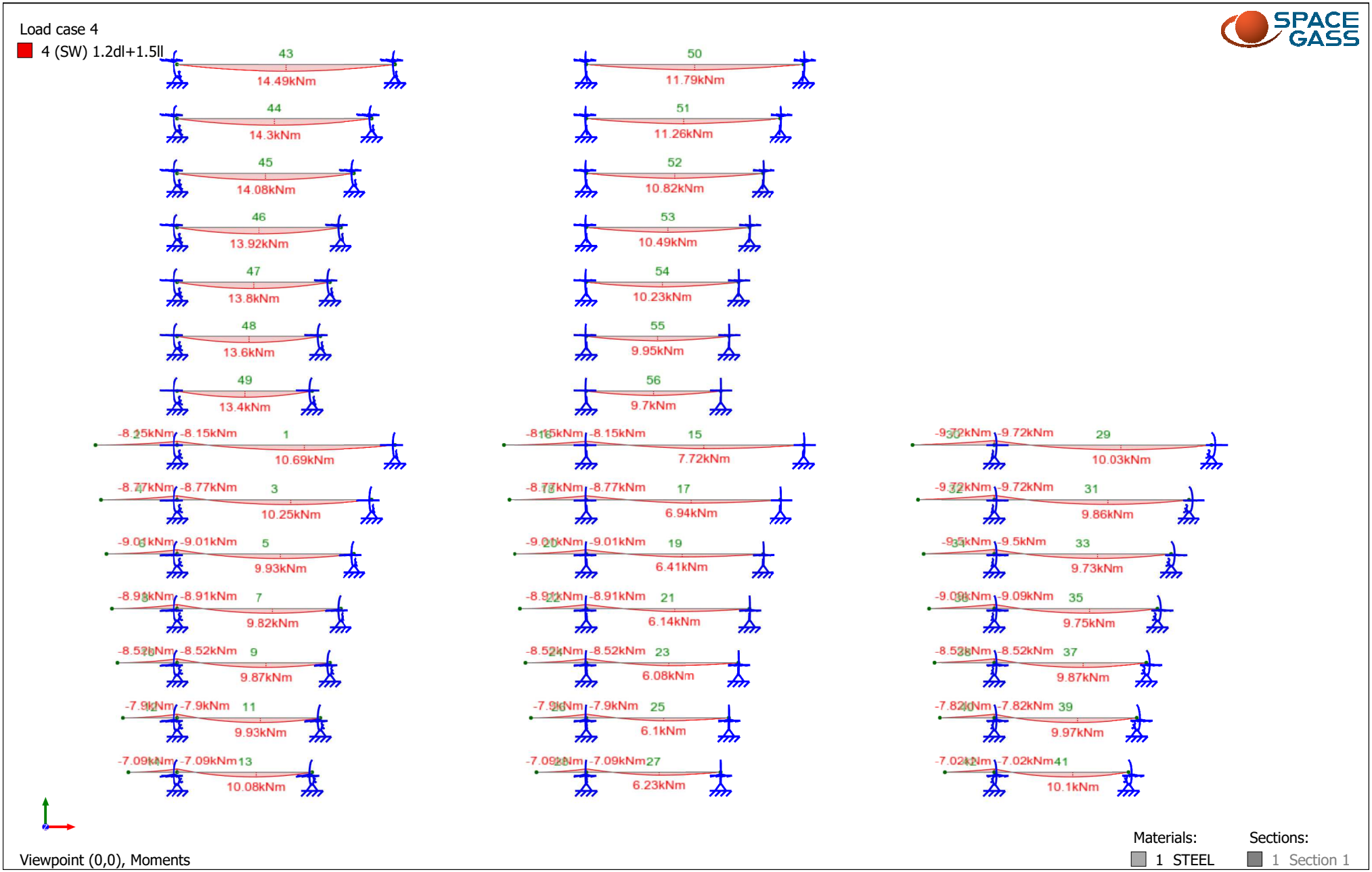
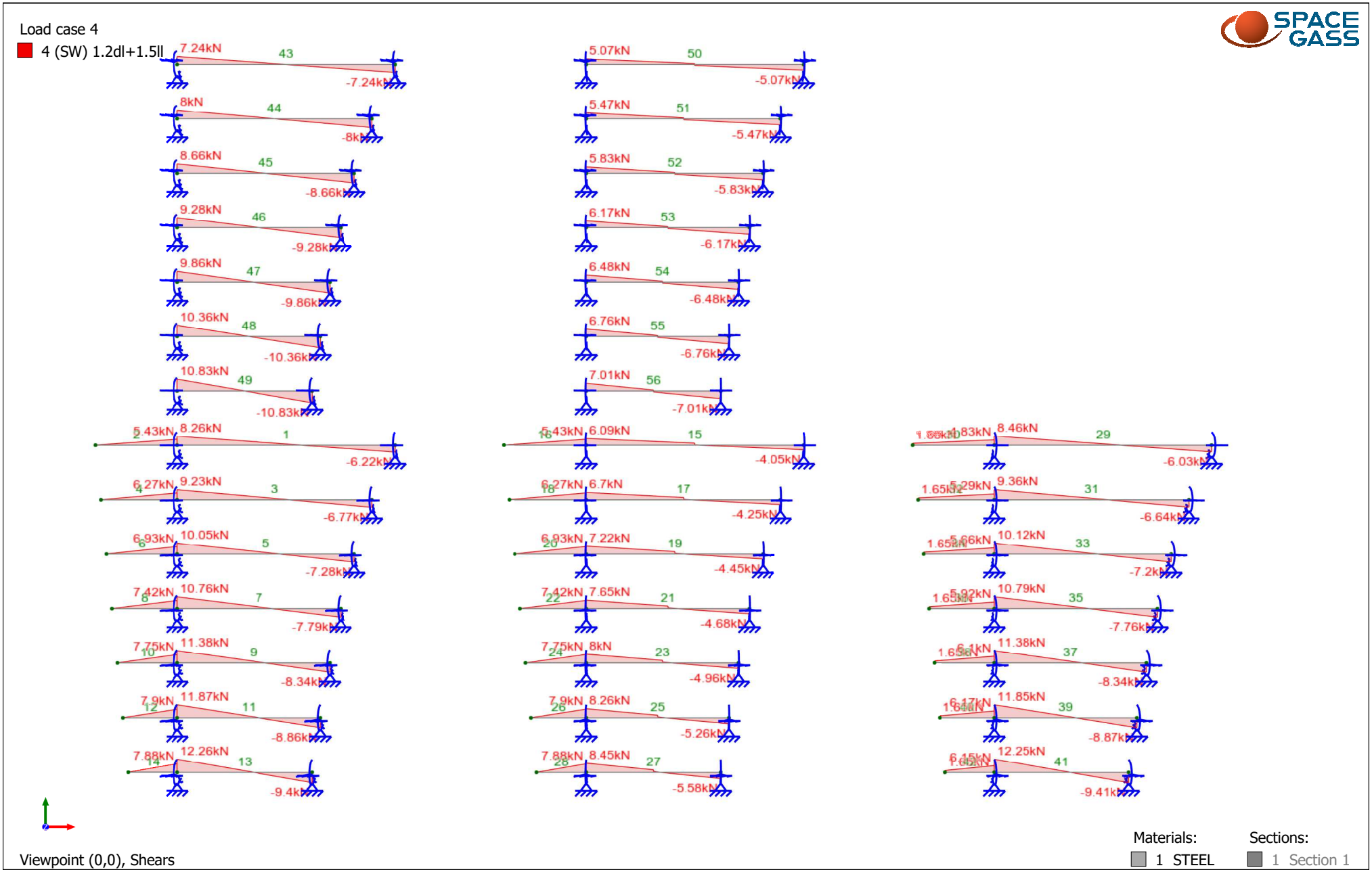
Designer: Date: Tuesday, July 26, 2022 4:13 PM, Page: 1

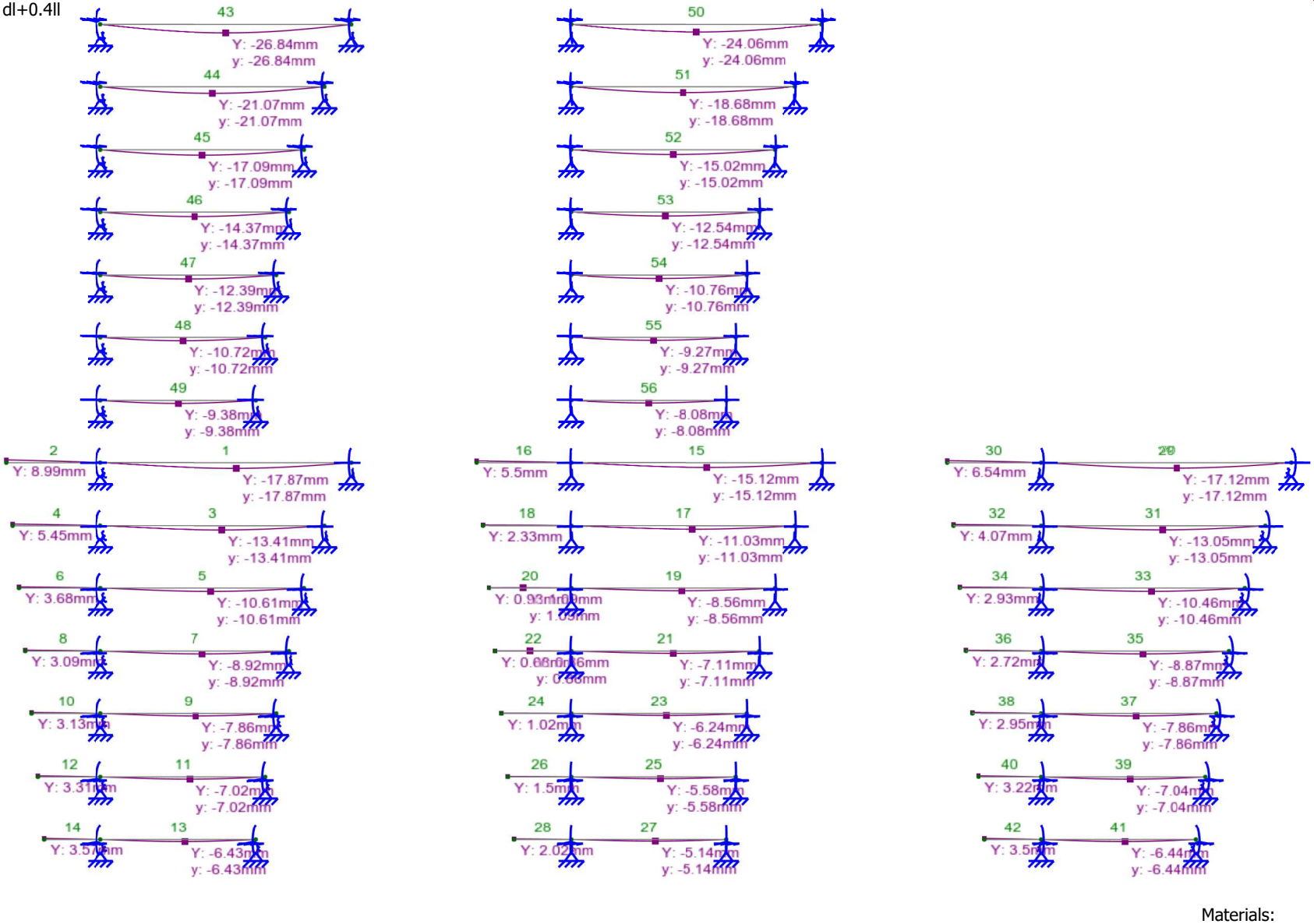


SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\Eng...\Structural\280x50 single roof beam
Designer: Date: Tuesday, July 26, 2022 4:14 PM, Page: 1



SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\Eng...\Structural\280x50 single roof beam
Designer: Date: Tuesday, July 26, 2022 4:14 PM, Page: 1

Load case 5
5 (SW) dl+0.4ll



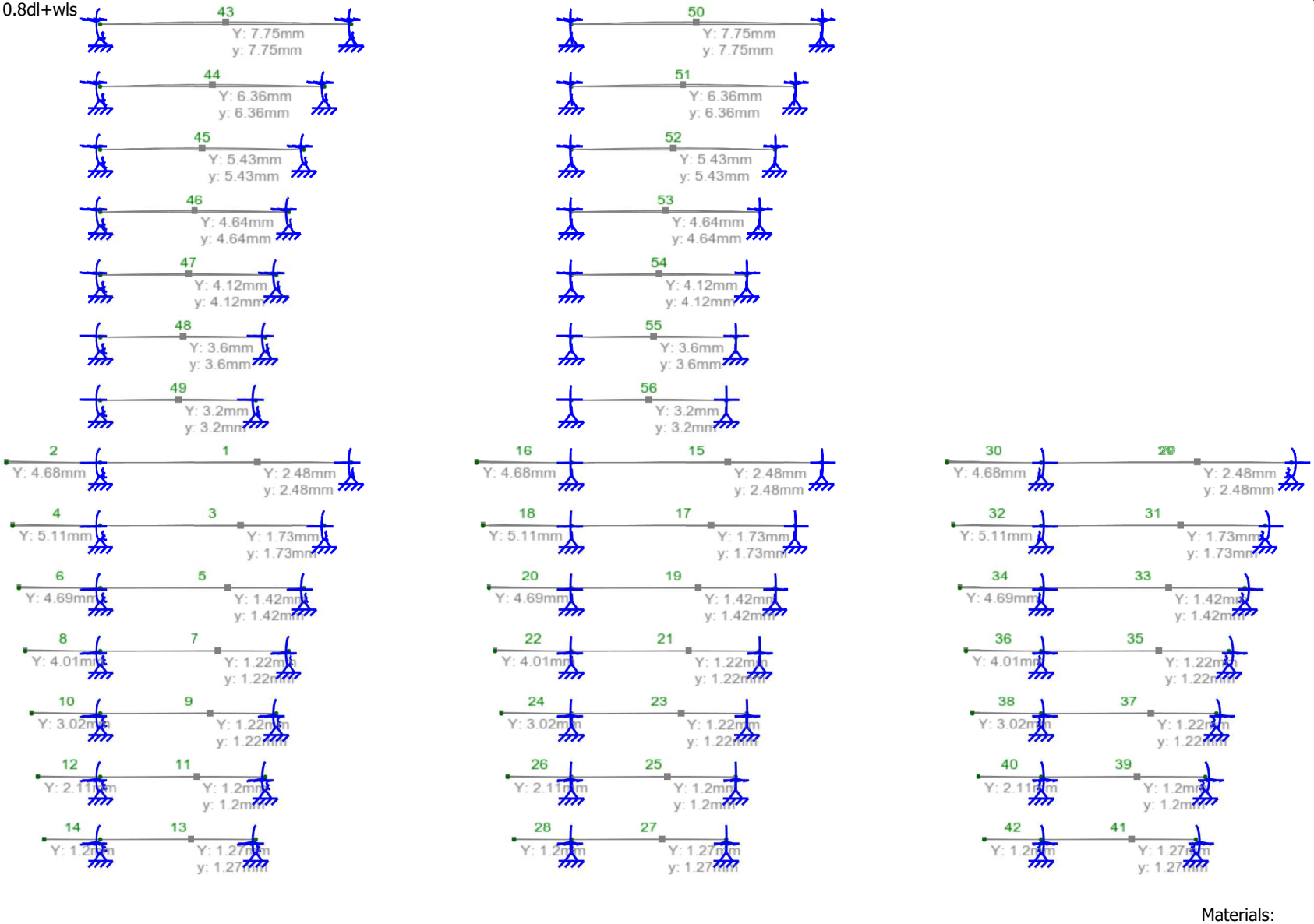
Materials:
1 STEEL

Sections:
1 Section 1

Viewpoint (0,0), Displacements

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\Eng...\Structural\280x50 single roof beam
Designer: Date: Tuesday, July 26, 2022 4:15 PM, Page: 1

Load case 6
6 (SW) 0.8dl+wls



Materials:
1 STEEL

Sections:
1 Section 1

Viewpoint (0,0), Displacements

				Space Gass					Manual Calculation								
Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eq(mm}$ ^{4}$_{)}$	$C_{eq(mm)}$	$Z_{eq(mm}$ ^{3}$_{)}$	$A_{(mm}$ ^{2}$_{)}$		$I_{eq(mm}$ ^{4}$_{)}$	$C_{eq(mm)}$	$Z_{eq(mm}$ ^{3}$_{)}$	$A_{(mm}$ ^{2}$_{)}$	$r_{(mm)}$	Self weight (kg/m)	Strength		
FF-EVOLUTION -BEAM 4X11-8'															Serviceability		
FF-EVOLUTION -BEAM 4X11-12'															Vibration		
FF-EVOLUTION -BEAM 4X11-16'	280	102	1.6	35750000.0	140.0	252400.0			3155.0	35086638.7	140.0	247655.8	3119.6	106.5	24.48899		
FF-EVOLUTION -BEAM 4X11-20'																	

Strength(manual calculatoin)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\ eq(mm}$ ^{4}$_{)}$	$C_{eq(mm)}$	$Z_{eff\ eq(mm}$ ^{3}$_{)}$	$A_{eff(mm}$ ^{2}$_{)}$	$r_{(mm)}$	ØM$_x$(kN.m)	ØV$_x$(kN)
FF-EVOLUTION -BEAM 2X11-8'										
FF-EVOLUTION -BEAM 2X11-12'										
FF-EVOLUTION -BEAM 2X11-16'	280	102	1.6	35091601.4	140.0	247822.0		3119.6	106.5	52.4	72
FF-EVOLUTION -BEAM 2X11-20'										

Serviceability(manual calculation)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\ eq(mm}$ ^{4}$_{)}$	$C_{eq(mm)}$	$Z_{eff\ eq(mm}$ ^{3}$_{)}$	$A_{eff(mm}$ ^{2}$_{)}$	$r_{(mm)}$	
FF-EVOLUTION -BEAM 2X11-8'	0	0	0	0.0	0.0	0.0		0.0	0.0
FF-EVOLUTION -BEAM 2X11-12'	0	0	0	0.0	0.0	0.0		0.0	106.5
FF-EVOLUTION -BEAM 2X11-16'	280	102	1.6	34957297.4	140.0	244312.4		2782.0	52.0
FF-EVOLUTION -BEAM 2X11-20'	0	0	0	0.0	0.0	0.0		0.0	0.0

Reduction

	single span						
	2000	2500	3000	3500	4000	4500	5000
FF-EVOLUTION -BEAM 2X11-8'	1	0.95	0.945	1	1	1	1
FF-EVOLUTION -BEAM 2X11-12'	0.91	0.895	0.88	1	1	1	1
FF-EVOLUTION -BEAM 2X11-16'	1	1	1	1	1	1	1
FF-EVOLUTION -BEAM 2X11-20'	0.605	0.545	0.495	1	1	1	1

	Double span						
	2000	2500	3000	3500	4000	4500	5000
FF-EVOLUTION -BEAM 2X11-8'	0.955	0.95	0.945	1	1	1	1
FF-EVOLUTION -BEAM 2X11-12'	0.915	0.895	0.88	1	1	1	1
FF-EVOLUTION -BEAM 2X11-16'	0.915	0.9	0.895	0.885	0.875	0.87	0.86
FF-EVOLUTION -BEAM 2X11-20'	0.605	0.545	0.495	1	1	1	1

f_y	234	MPa
E	199950	Mpa
DL	0.4	kPa
LL	0.25	kPa
$\psi_{long-term}$	0.4	
1.2DL+1.5LL	0.855	kPa
DL+ψLL	0.5	kPa
Min fundamental frequency required	0	Hz
mode (single span)	0	
mode (double equal span)	0	

WLs -0.763914321
0.9DL+1.5WLs -0.785871482
L/300

Spacing (mm)	2000	2500	3000	3500	4000	4500	5000	2000	2500	3000	3500	4000	4500	**5000**
Joist sections	Single span													
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	11286	10618	10084	9644	9272	8951	8671	15128.40	14233.12	13518.05	12927.97	12429.06	11999.21	11623.27
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	0	0	0	0	0	0	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00

	Maximum recommended span(mm)													
Spacing (mm)	2000	2500	3000	3500	4000	4500	5000	2000	2500	3000	3500	4000	4500	5000
Joist sections	Single span							Equal double span						
FF-EVOLUTION -BEAM 2X11-8'	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FF-EVOLUTION -BEAM 2X11-12'	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FF-EVOLUTION -BEAM 2X11-16'	11286	10618	10084	9644	9272	8951	8671	13837	12459	11457	10626	9939	9386	8884
FF-EVOLUTION -BEAM 2X11-20'	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Single span

Beam sections	2000				2500				3000			
	M*	V*	$(\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-12'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-16'	31.90	11.30737622	0.57 ok		34.26	12.90775399	0.64 ok		36.34	14.41	0.70 ok	
FF-EVOLUTION -BEAM 2X11-20'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!

Single span

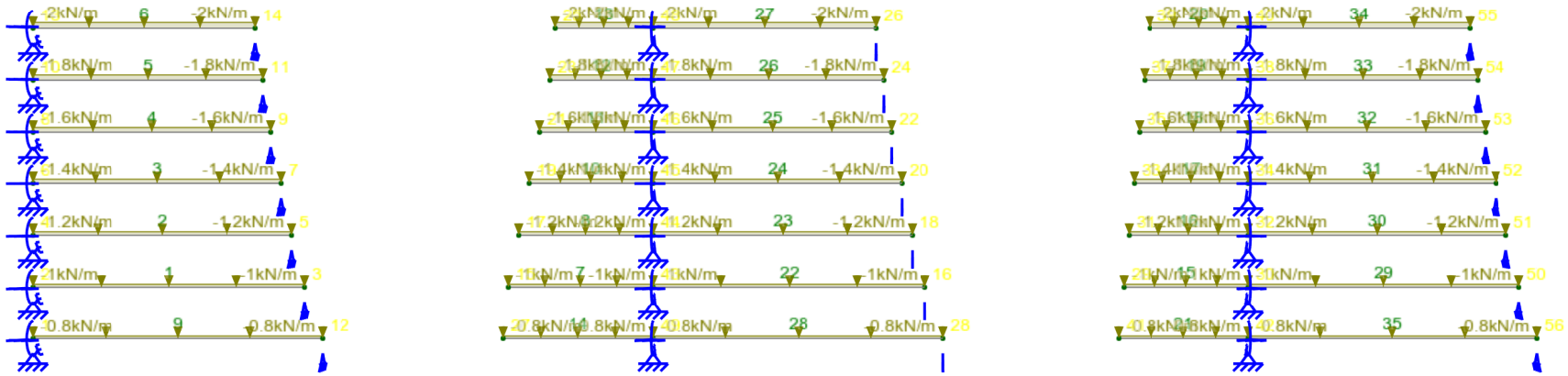
Beam sections	3500				4000				4500				5000			
	M*	V*	$(\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-12'	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-16'	38.21	15.84697144	0.76 ok		39.91	17.22	0.82 ok		41.48	18.54	0.87 ok		42.94	19.81	0.92 ok	
FF-EVOLUTION -BEAM 2X11-20'	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!

Beam sections	qual double span 2000				2500				3000			
	M*	V*	$(\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-12'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-16'	47.96	13.86389416	0.98 ok		47.17	15.14560891	0.98 ok		46.91	16.37754144	0.98 ok	
FF-EVOLUTION -BEAM 2X11-20'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!

Beam sections	qual double span 3500				4000				4500				5000			
	M*	V*	$(\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-12'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-16'	46.39	17.46103052	0.98 ok		45.86	18.4568422	0.98 ok		45.60	19.43442428	0.98 ok		45.08	20.29521581	0.98 ok	
FF-EVOLUTION -BEAM 2X11-20'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\En...\Structural\280x100 double roof beam
Designer: Date: Tuesday, July 26, 2022 4:23 PM, Page: 1

Load case 1
1 (SW) dl



Viewpoint (0,0), Loads

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\En...\Structural\280x100 double roof beam
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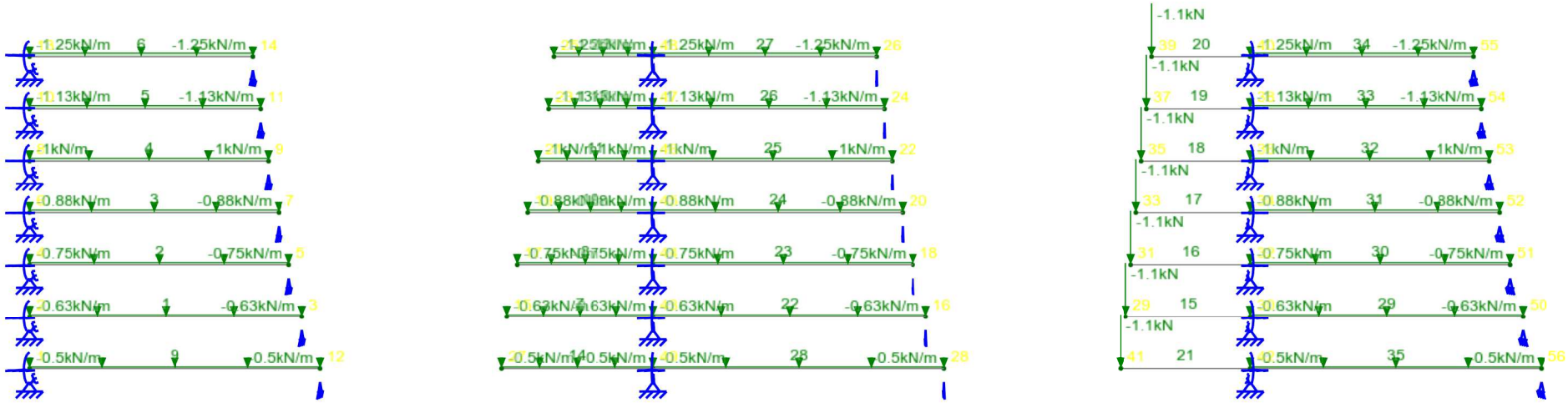
Load case 2
2 ll



Viewpoint (0,0), Loads

Materials: 1 STEEL
Sections: 1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\En...\Structural\280x100 double roof beam
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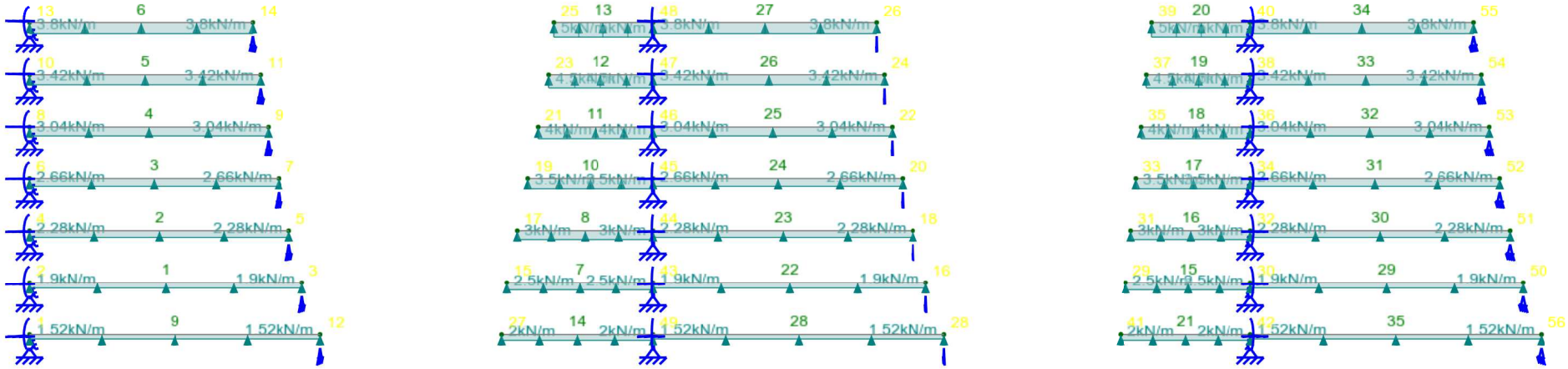
Load case 3
3 wls



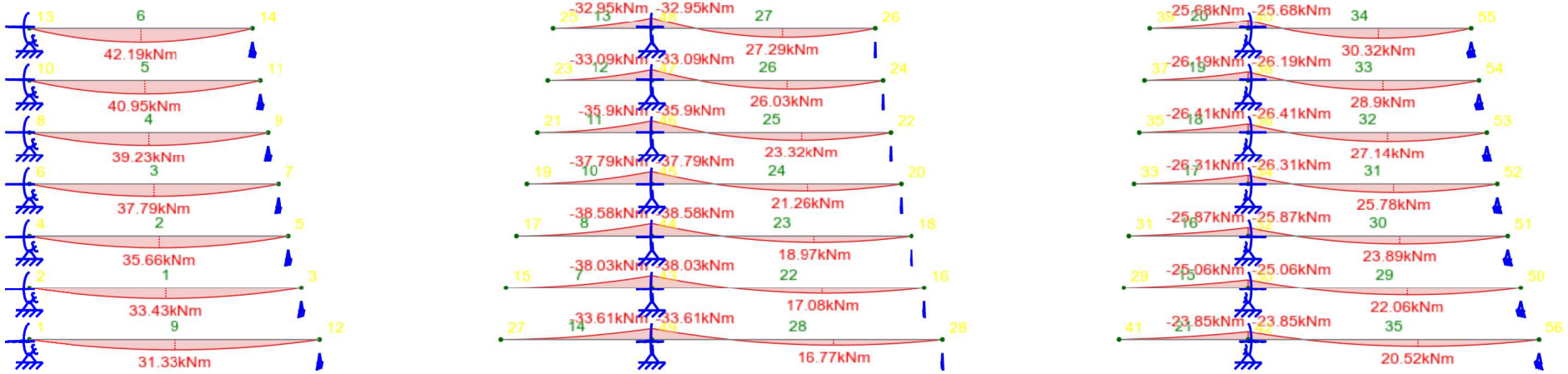
Viewpoint (0,0), Loads

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\En...\Structural\280x100 double roof beam
Designer: Date: Tuesday, July 26, 2022 4:24 PM, Page: 1

Load case 4
4 (SW) 1.2dl+1.5ll



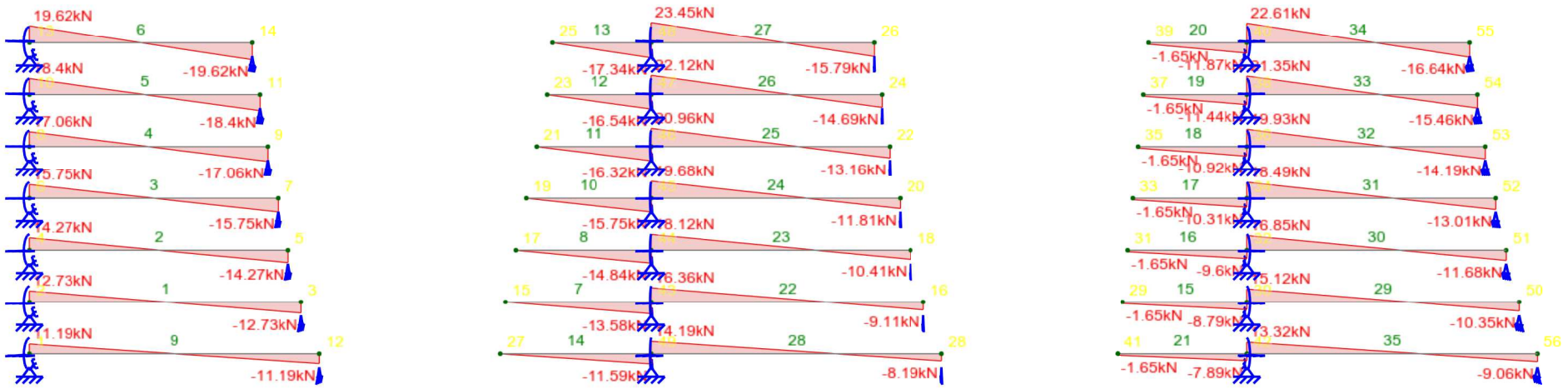
Viewpoint (0,0), Moments

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\En...\Structural\280x100 double roof beam
Designer: Date: Tuesday, July 26, 2022 4:25 PM, Page: 1

Load case 4
4 (SW) 1.2dl+1.5ll



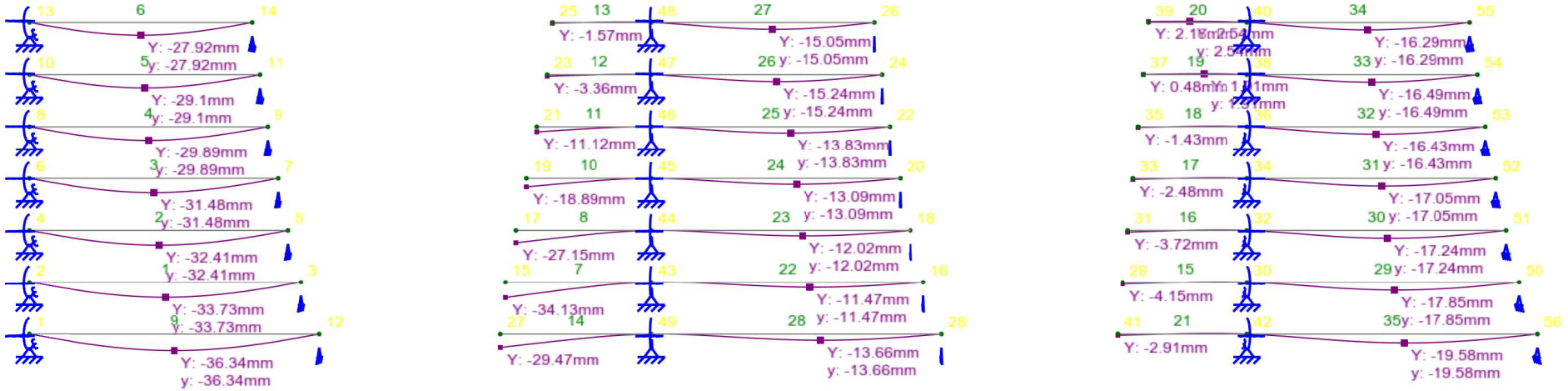
Viewpoint (0,0), Shears

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\En...\Structural\280x100 double roof beam
Designer: Date: Tuesday, July 26, 2022 4:25 PM, Page: 1

Load case 5
5 (SW) dl+0.4ll



Viewpoint (0,0), Displacements

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: E:\220088 Fortress Evolution\En...\Structural\280x100 double roof beam
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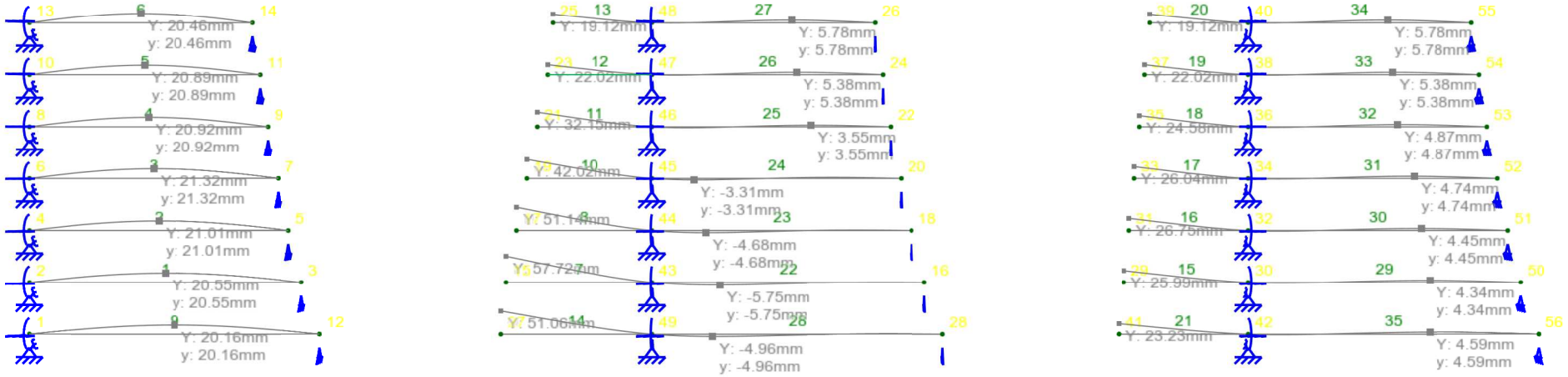
Load case 6
6 (SW) 0.8dl+wls



Viewpoint (0,0), Displacements

Materials:
1 STEEL

Sections:
1 Section 1

				Space Gass				Manual Calculation						
Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{xx(mm^4)}$	$C_{xx(mm)}$	$Z_{xx(mm^3)}$	$A_{(mm^2)}$	$I_{xx(mm^4)}$	$C_{xx(mm)}$	$Z_{xx(mm^3)}$	$A_{(mm^2)}$	$r_{(mm)}$	Self weight (kg/m)	Strength
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	150	50	2.6	2631000.0	75.0	35085.0	995.6	2631357.0	75.0	35167.8	995.5	51.4	7.814989	Serviceability
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	150	50	2	2075000.0	75.0	27670.0	773.7	2078127.1	75.0	27708.4	773.7	51.8	6.073545	Vibration
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	150	50	1.6	1688000.0	75.0	22500.0	62.3	1689229.4	75.0	22523.1	623.2	52.0	4.891869	
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	150	50	1.2	1287000.0	75.0	17160.0	470.5	1287255.9	75.0	17163.4	470.5	52.3	3.693582	
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	150	50	0.9	976800.0	75.0	13020.0	354.7	977022.0	75.0	13027.0	354.6	52.5	2.78361	

Strength(manual calculatain)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\ xx(mm^4)}$	$C_{xx(mm)}$	$Z_{eff\ xx(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$	$\emptyset M_s$(kN.m)	$\emptyset V_s$(kN)
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	150	50	2.6	2637580.4	75.0	35167.7	995.6	51.4	7.4	80
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	150	50	2	2078127.1	75.0	27708.4	773.7	51.8	5.8	50
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	150	50	1.6	1689229.4	75.0	22523.1	623.2	52.0	4.7	33
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	150	50	1.2	1244073.7	69.1	16069.9	442.0	52.3	3.4	19
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	150	50	0.9	842845.2	61.8	10156.4	299.6	52.5	2.1	11

Serviceability(manual calculation)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\ xx(mm^4)}$	$C_{xx(mm)}$	$Z_{eff\ xx(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	150	50	2.6	2637580.4	75.0	35167.7	995.6	51.4
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	150	50	2	2078127.1	75.0	27708.4	773.7	51.8
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	150	50	1.6	1689229.4	75.0	22523.1	623.2	52.0
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	150	50	1.2	1286225.0	75.0	17142.9	470.3	52.3
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	150	50	0.9	882263.2	68.2	11030.7	322.6	52.5

Reduction

single span

	300	450	600
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	0.945
FF-EVOLUT	1	0.94	0.93
FF-EVOLUT	0.935	0.915	0.895

Double span

	300	4590	600
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	1
FF-EVOLUT	0.96	0.95	0.94
FF-EVOLUT	0.96	0.94	0.93
FF-EVOLUT	0.94	0.92	0.9

f_y	234	MPa
E	199950	Mpa
DL	0.5	kPa
LL	2	kPa
$\Psi_{long\text{-}term}$	0.4	
1.2DL+1.5LL	3.6	kPa
DL+ΨLL	1.3	kPa
Min fundamental frequency required	8	Hz
mode (single span)	9.87	
mode (double equal span)	15.4	

L/400

Spacing (mm) 300 450 600 300 450 600

Maximum recommended span(mm)

Joist sections	Single span			Equal double span		
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	6000	5300	4900	7570	6840	6370
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	5600	4900	4500	7140	6450	6000
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	5200	4600	4200	6780	6120	5700
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	4800	4200	3900	6330	5720	5320
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	4300	3800	3400	5760	5200	4840

Simply Supported Beam

$$f = \frac{K}{2 \times L^2}\sqrt{E.I / m}$$

Mode	1	2	3	4
K	9.87	39.5	88.8	158

Note: if equation used for whirling speed assume rotating member is supported using "short bearings providing little angular restraint e.g a spherical ball bearing"

Beam with one end fixed and one end Simply Supported

$$f = \frac{K}{2 \times L^2}\sqrt{E.I / m}$$

Mode	1	2	3	4
K	15.4	50	104	178

Note: if equation used for whirling speed assume rotating member is supported using "a long bearing /bearing proving substantial angular support e.g. needle bearings" and a short bearing providing little angular support e.g a spherical ball bearing

Maximum recommended span(mm)

Spacing (mm)	405	450	600	300	450	600
Joist sections	Single span			Equal double span		
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	6000	5300	4900	7105	5880	5127
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	5522	4900	4500	6363	5251	4572
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	4850	4600	4020	5656	4634	4010
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	4245	3910	3380	4808	3910	3380
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	3275	3077	2642	3801	3086	2650

Single span

Joist sections	405 M*	405 V*	405 $/\emptyset M_s)^{1.4}+(V^*/\emptyset$	405 Result	450 M*	450 V*	450 $(M^*/\emptyset M_s)^{1.4}+(V^*/\emptyset V_s)^{1.4}$	450 Result	600 M*	600 V*	600 $(M^*/\emptyset M_s)^{1.4}+(V^*/\emptyset V_s)^{1.4}$	600 Result
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	6.98	4.655339604	0.94	ok	5.69	4.54151665	0.71	ok	6.76	5.52	0.90	ok
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	5.84	4.226886049	1.03	not ok & reduce	4.86	4.147562223	0.81	ok	5.65	5.02	1.00	ok
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	4.46	3.678003382	0.96	ok	4.28	3.861015579	0.92	ok	4.48	4.46	0.98	ok
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	3.38	3.188840263	1.08	not ok & reduce	3.10	3.254122077	0.97	ok	3.15	3.73	1.01	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	2.00	2.442402318	1.03	not ok & reduce	1.92	2.543980599	0.99	ok	1.91	2.90	1.01	not ok & reduce span

Joist sections	qual double span 300 M*	300 V*	300 $/\emptyset M_s)^{1.4}+(V^*/\emptyset$	300 Result	450 M*	450 V*	450 $(M^*/\emptyset M_s)^{1.4}+(V^*/\emptyset V_s)^{1.4}$	450 Result	600 M*	600 V*	600 $(M^*/\emptyset M_s)^{1.4}+(V^*/\emptyset V_s)^{1.4}$	600 Result
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	7.41	4.169747291	1.02	not ok & reduce	7.41	5.038414874	1.02	not ok & re	7.41	5.77793	1.03	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	5.84	3.668108185	1.03	not ok & reduce	5.84	4.444910472	1.03	not ok & re	5.84	5.10484	1.04	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	4.55	3.220316825	0.98	ok	4.51	3.889614166	0.98	ok	4.46	4.44807	0.98	ok
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	3.25	2.702914263	1.01	not ok & reduce	3.18	3.254122077	1.00	not ok & re	3.15	3.72503	1.01	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	2.01	2.11594331	1.02	not ok & reduce	1.97	2.550921896	1.02	not ok & re	1.93	2.90599	1.02	not ok & reduce span

SPACE GASS 14.00 - TINGMORE STRUCTURES
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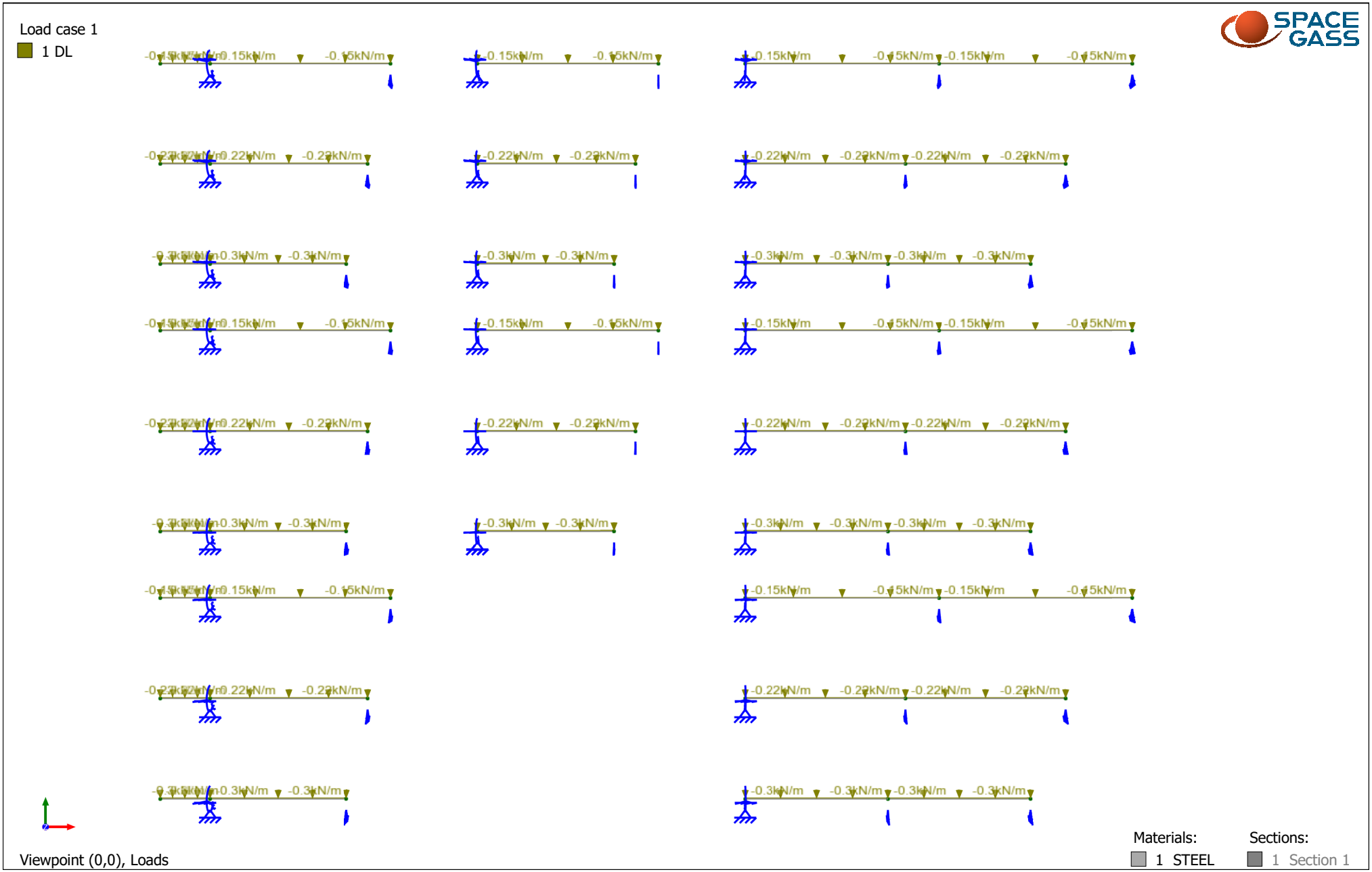

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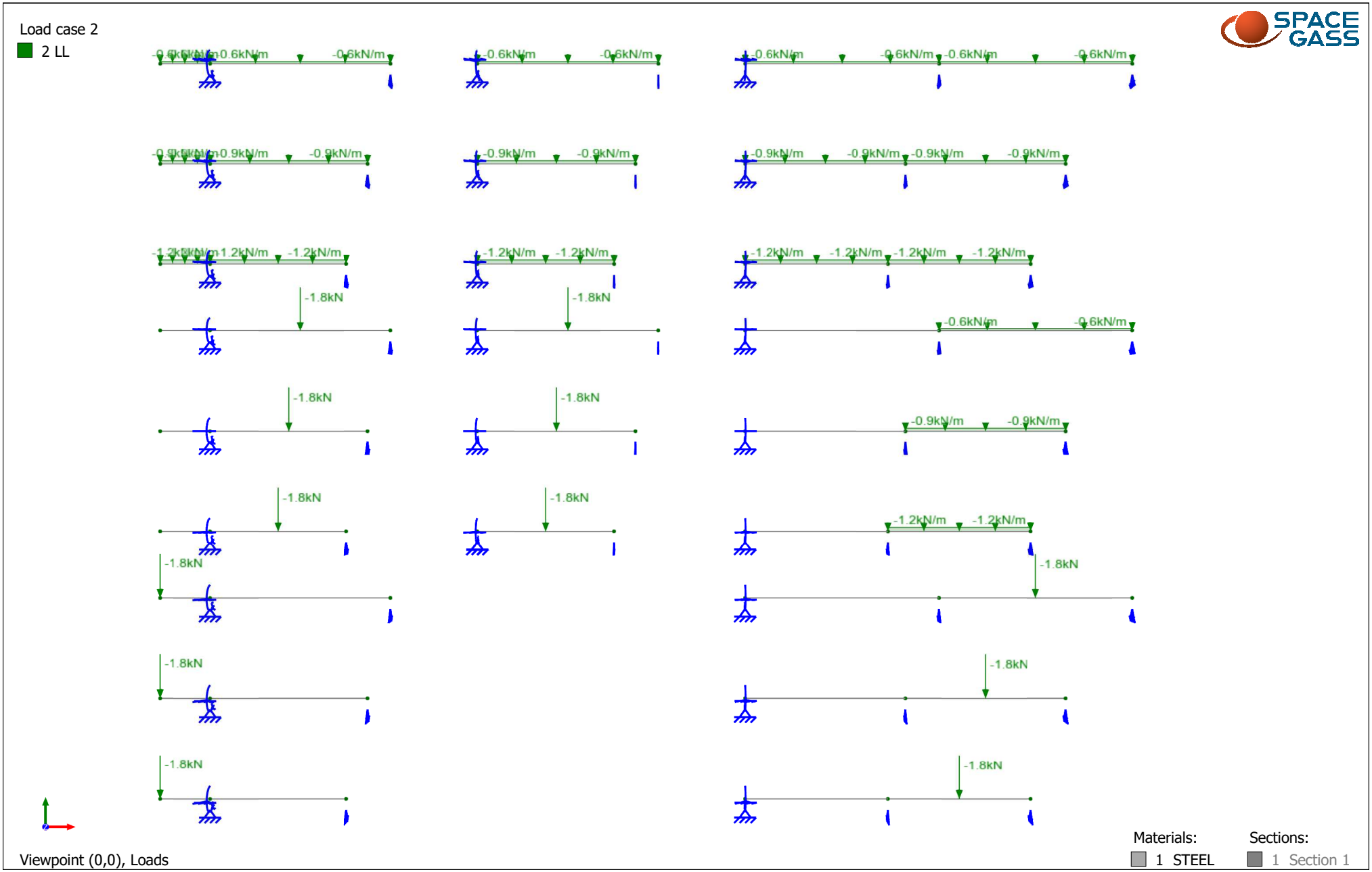

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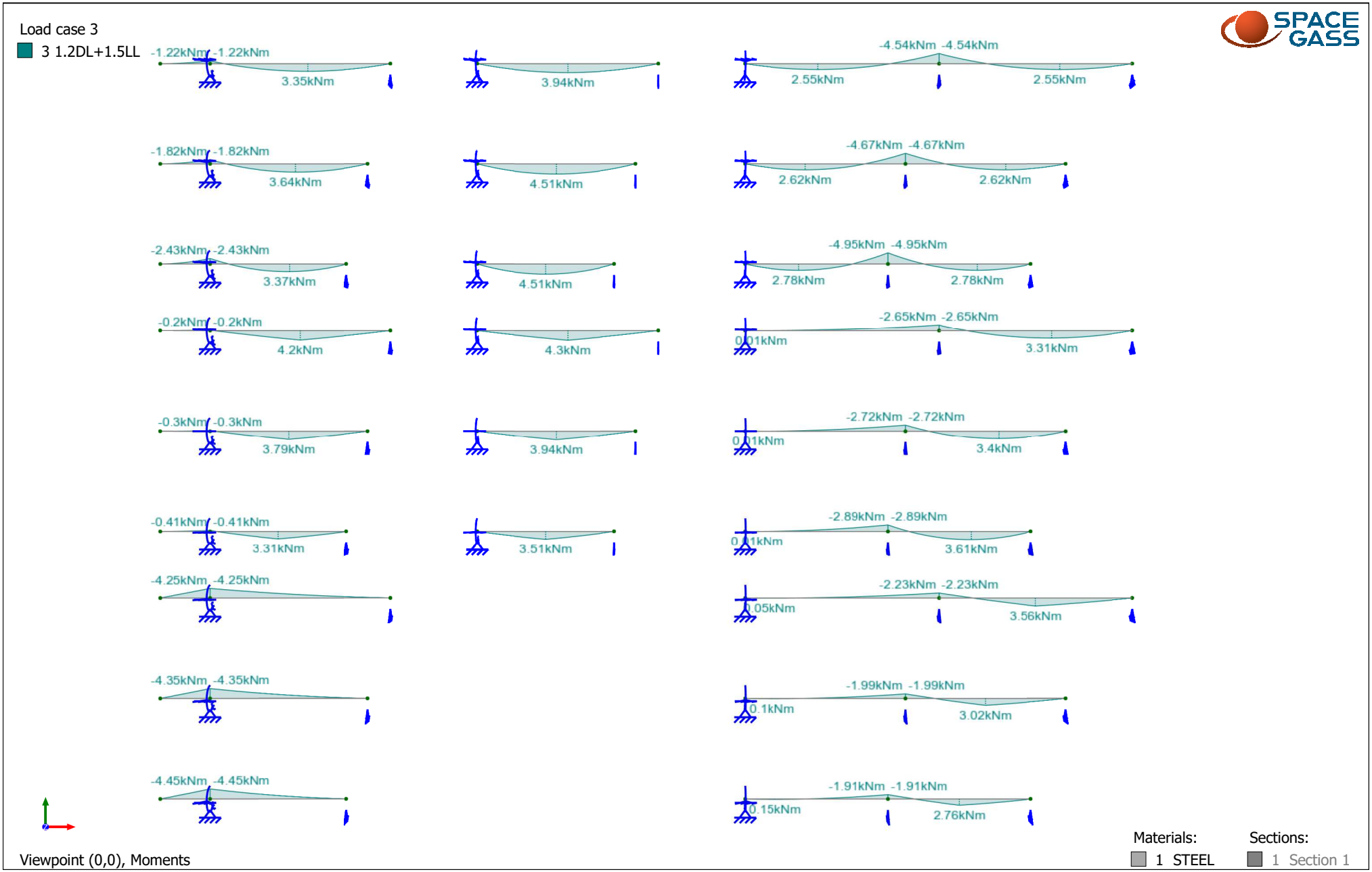

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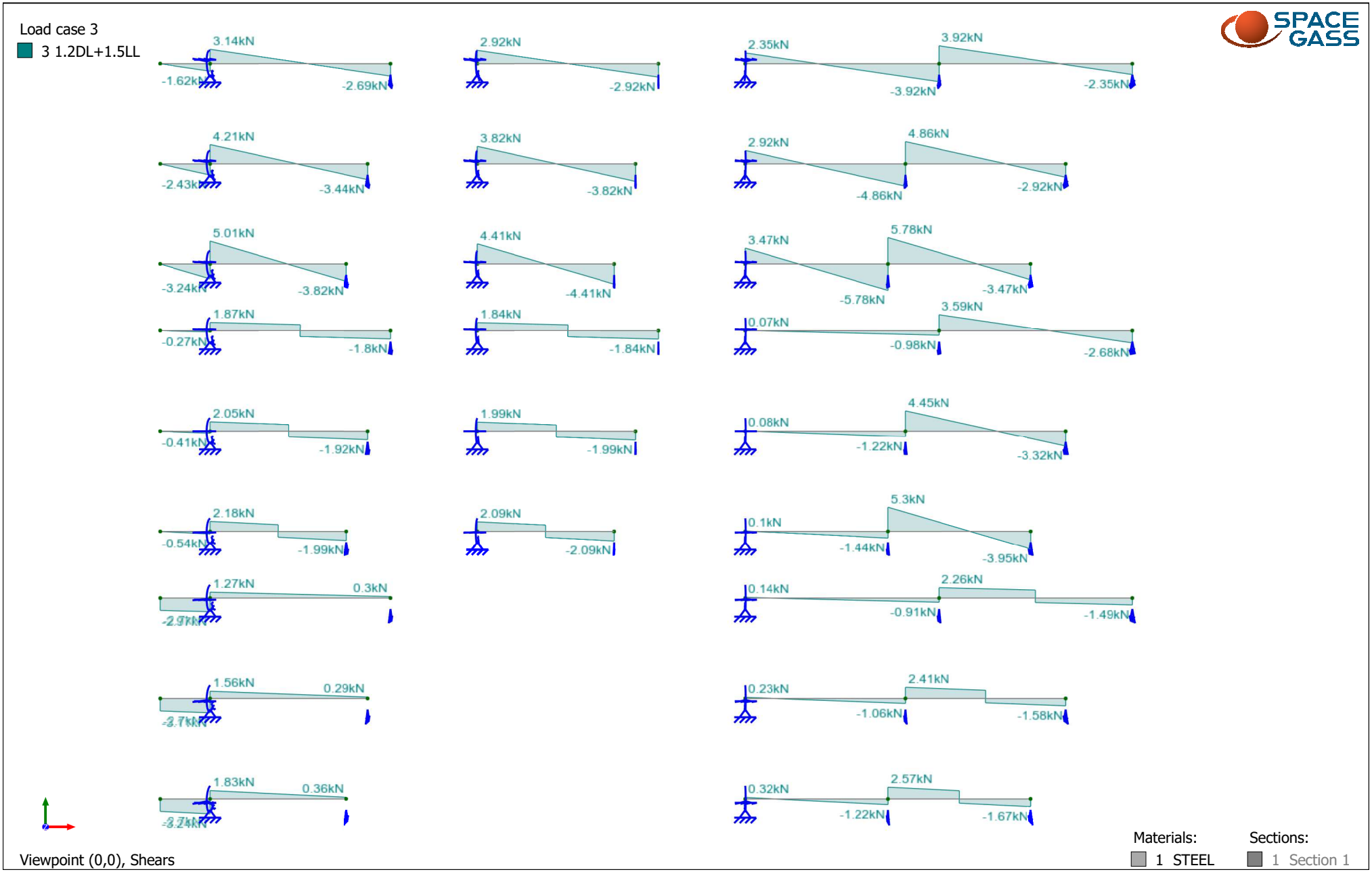

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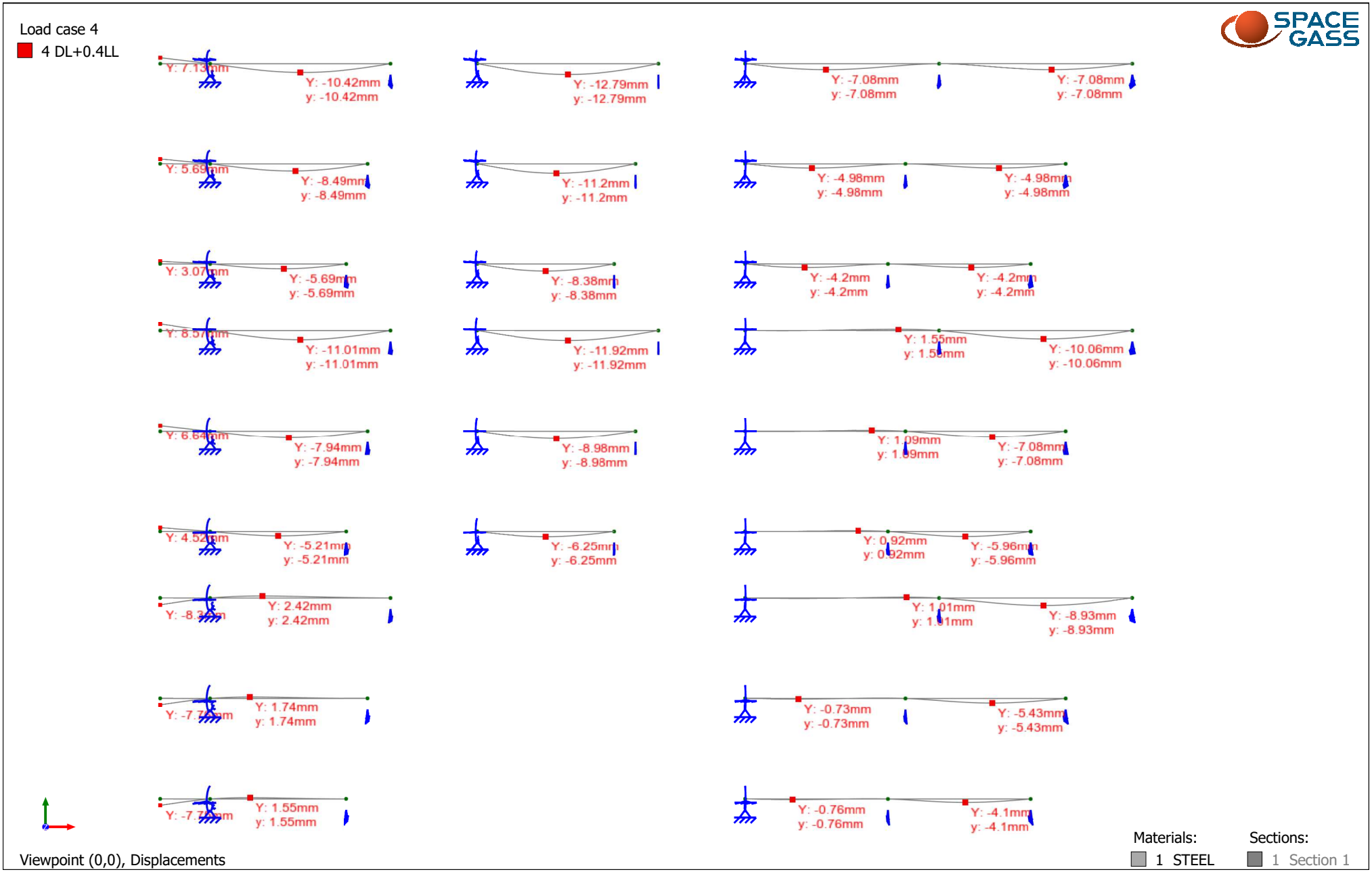

				Space Gass				Manual Calculation						
Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{xx(mm^4)}$	$C_{xx(mm)}$	$Z_{xx(mm^3)}$	$A_{(mm^2)}$	$I_{xx(mm^4)}$	$C_{xx(mm)}$	$Z_{xx(mm^3)}$	$A_{(mm^2)}$	$r_{(mm)}$	Self weight (kg/m)	
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	150	50	2.6	2631000.0	75.0	35085.0	995.6	2631357.0	75.0	35167.8	995.5	51.4	7.814989	
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	150	50	2	2075000.0	75.0	27670.0	773.7	2078127.1	75.0	27708.4	773.7	51.8	6.073545	
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	150	50	1.6	1688000.0	75.0	22500.0	62.3	1689229.4	75.0	22523.1	623.2	52.0	4.891869	
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	150	50	1.2	1287000.0	75.0	17160.0	470.5	1287255.9	75.0	17163.4	470.5	52.3	3.693582	
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	150	50	0.9	976800.0	75.0	13020.0	354.7	977022.0	75.0	13027.0	354.6	52.5	2.78361	

Strength(manual calculatoin)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\,xx(mm^4)}$	$C_{xx(mm)}$	$Z_{eff\,xx(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$	$\emptyset M_x$(kN.m)	$\emptyset V_x$(kN)
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	150	50	2.6	2637580.4	75.0	35167.7	995.6	51.4	7.4	80
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	150	50	2	2078127.1	75.0	27708.4	773.7	51.8	5.8	50
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	150	50	1.6	1689229.4	75.0	22523.1	623.2	52.0	4.7	33
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	150	50	1.2	1244073.7	69.1	16069.9	442.0	52.3	3.4	19
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	150	50	0.9	842845.2	61.8	10156.4	299.6	52.5	2.1	11

Serviceability(manual calculation)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\,xx(mm^4)}$	$C_{xx(mm)}$	$Z_{eff\,xx(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	150	50	2.6	2637580.4	75.0	35167.7	995.6	51.4
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	150	50	2	2078127.1	75.0	27708.4	773.7	51.8
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	150	50	1.6	1689229.4	75.0	22523.1	623.2	52.0
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	150	50	1.2	1286225.0	75.0	17142.9	470.3	52.3
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	150	50	0.9	882263.2	68.2	11030.7	322.6	52.5

Reduction

single span

	2000	2500	3000
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	1
FF-EVOLUT	0.9	0.89	0.875
FF-EVOLUT	1	0.94	0.93
FF-EVOLUT	0.935	0.915	0.895

Double span

	300	4590	600
FF-EVOLUT	1	1	1
FF-EVOLUT	1	1	1
FF-EVOLUT	0.85	0.84	0.83
FF-EVOLUT	0.96	0.94	0.93
FF-EVOLUT	0.94	0.92	0.9

f_y	234	MPa	
E	199950	Mpa	
DL	0.5	kPa	
LL	2	kPa	
$\Psi_{long\text{-}term}$	0.4		
1.2DL+1.5LL	3.6	kPa	
DL+ΨLL	1.3	kPa	L/400
Min fundamental frequency required	8	Hz	
mode (single span)	9.87		
mode (double equal span)	15.4		

Strength
Serviceability
Vibration

Spacing (mm) 300 450 600 300 450 600

Maximum recommended span(mm)

Joist sections	Single span			Equal double span		
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	6000	5300	4900	7570	6840	6370
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	5600	4900	4500	7140	6450	6000
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	5200	4600	4200	6780	6120	5700
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	4800	4200	3900	6330	5720	5320
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	4300	3800	3400	5760	5200	4840

Simply Supported Beam

$$f = \frac{K}{2\pi L^2}\sqrt{E.I/m}$$

Mode	1	2	3	4
K	9.87	39.5	88.8	158

Note: if equation used for whirling speed assume rotating member is supported using "short bearings providing little angular restraint e.g a spherical ball bearing"

Beam with one end fixed and one end Simply Supported

$$f = \frac{K}{2\pi L^2}\sqrt{E.I/m}$$

Mode	1	2	3	4
K	15.4	50	104	178

Note: if equation used for whirling speed assume rotating member is supported using "a long bearing, bearing proving substantial angular support e.g. needle bearings" and a short bearing providing little angular support e.g a spherical ball bearing

Spacing (mm) 2000 2500 3000 2000 2500 3000

Maximum recommended span(mm)

Joist sections	Single span			Equal double span		
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	2850	2553	2332	2850	2553	2332
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	2534	2268	2072	2534	2268	2072
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	2169	1931	1749	2108	1876	1703
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	1933	1677	1524	1894	1677	1524
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	1487	1317	1189	1491	1320	1192

Single span

Joist sections	2000				2500				3000			
	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	7.41	10.39	1.06	not ok & reduc	7.33	11.61	1.05	not ok & r	7.41	12.70	1.08	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	5.84	9.21	1.09	not ok & reduc	5.79	10.29	1.10	not ok & r	5.84	11.26	1.12	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	4.27	7.87	1.00	ok	4.19	8.75	1.00	ok	4.15	9.49	1.00	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	3.38	7.00	1.25	not ok & reduc	3.17	7.59	1.19	not ok & r	3.15	8.26	1.22	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	2.00	5.38	1.28	not ok & reduc	1.95	5.95	1.30	not ok & r	1.91	6.44	1.33	not ok & reduce span

qual double span

Joist sections	2000				2500				3000			
	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result	M*	V*	$(M^*/\emptyset M_x)^{1.4}+(V^*/\emptyset V_x)^{1.4}$	Result
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	7.41	10.39	1.06	not ok & reduc	7.41	11.61	1.07	not ok & r	7.41	12.70	1.08	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	5.84	9.21	1.09	not ok & reduc	5.84	10.29	1.11	not ok & r	5.84	11.26	1.12	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	4.03	7.65	0.93	ok	3.98	8.50	0.93	ok	3.94	9.25	0.94	ok
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	3.25	6.86	1.18	not ok & reduc	3.18	7.59	1.19	not ok & r	3.15	8.26	1.22	not ok & reduce span
FF-EVOLUTION -2X6 JOIST-20'-16GA-PC	2.01	5.39	1.29	not ok & reduc	1.97	5.96	1.31	not ok & r	1.93	6.46	1.34	not ok & reduce span

SPACE GASS 14.00 - TINGMORE STRUCTURES
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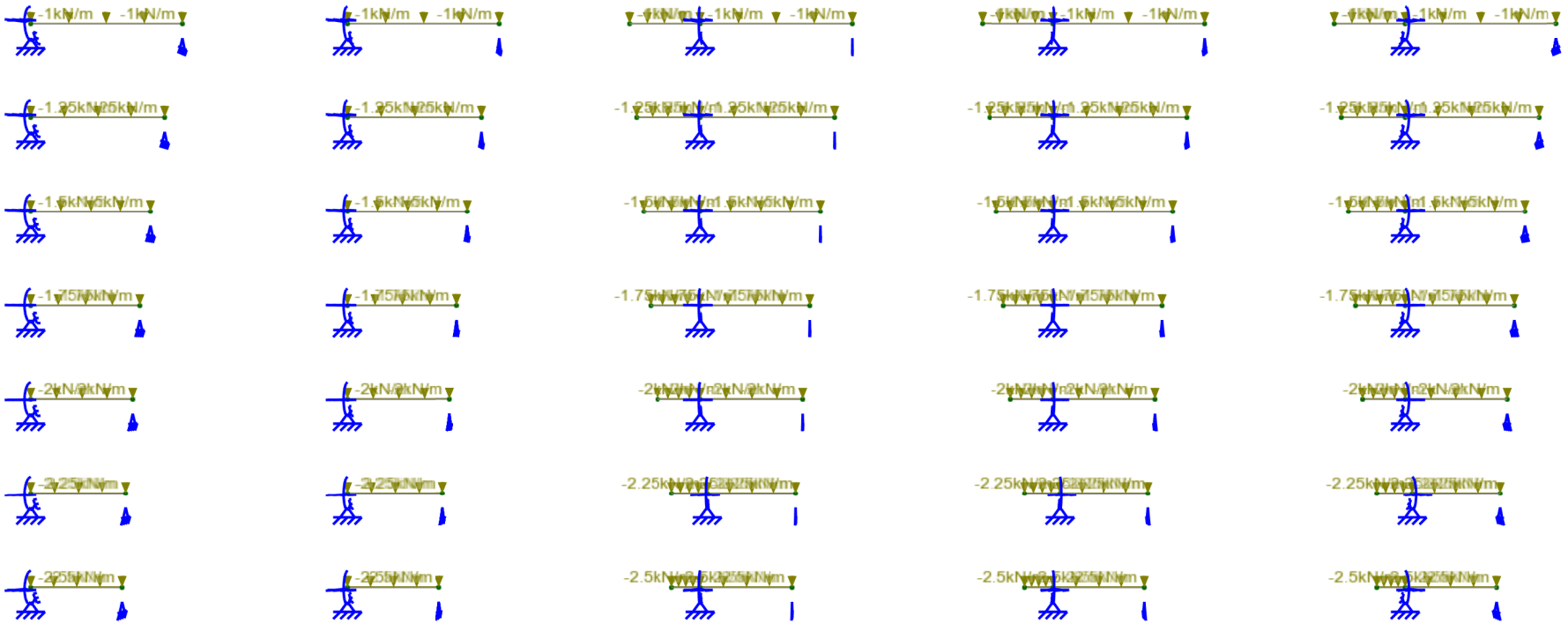

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Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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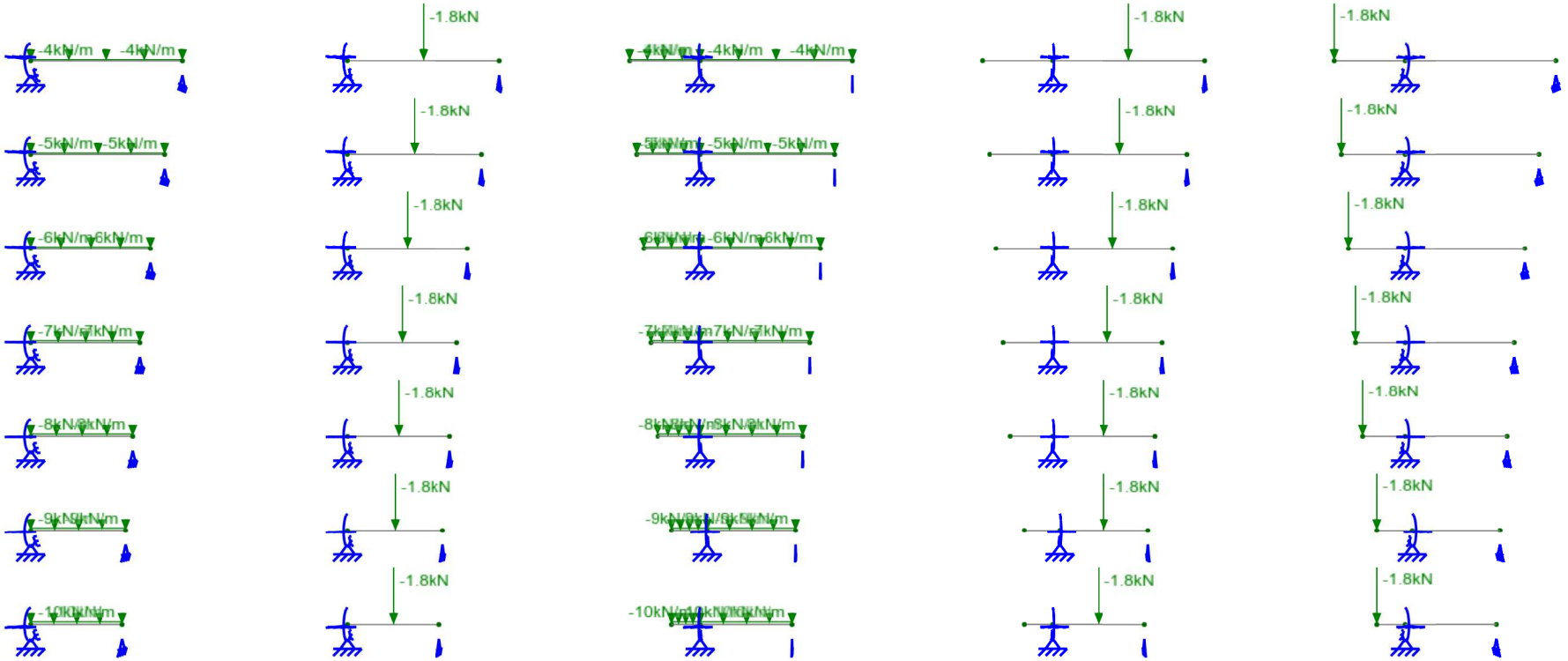

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Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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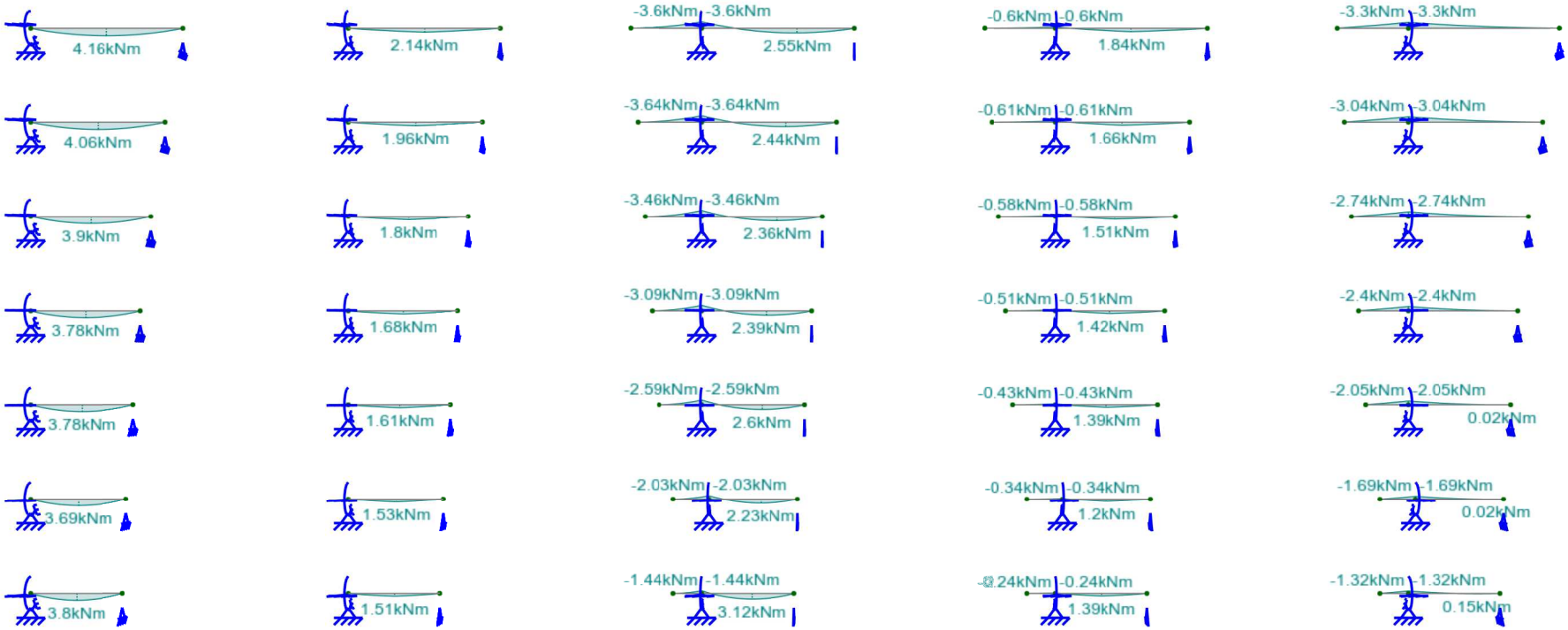
Load case 3
3 1.2dl+1.5ll



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Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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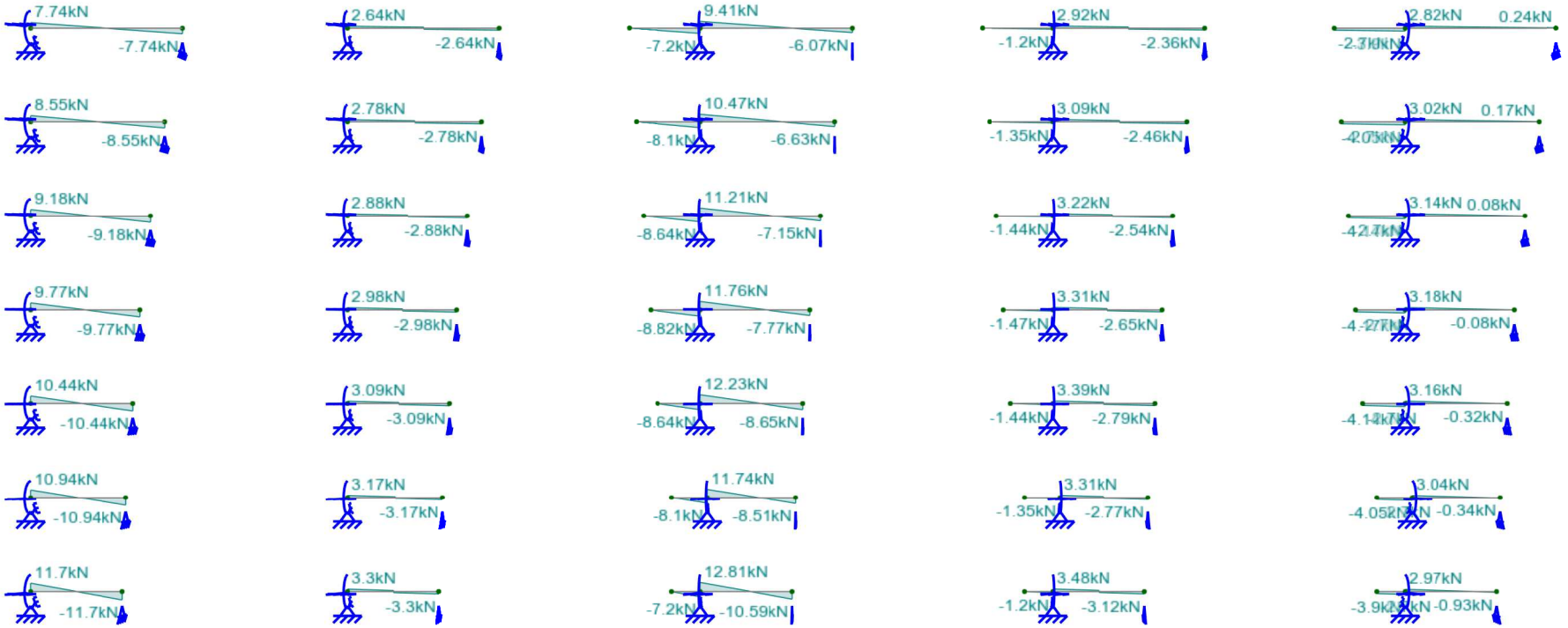
Load case 3
3 1.2dl+1.5ll



Viewpoint (0,0), Shears

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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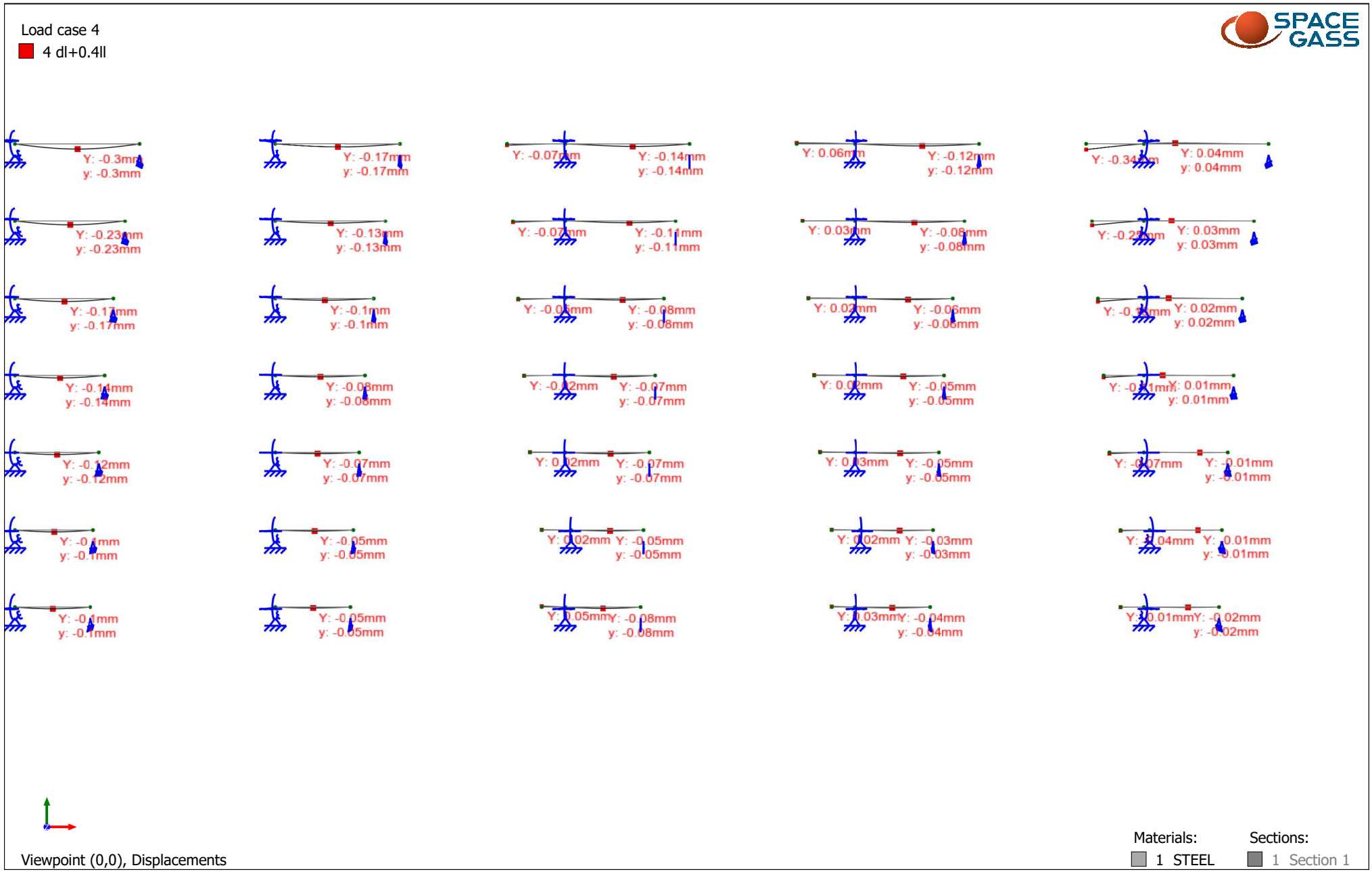
Designer: Date: Tuesday, July 26, 2022 11:24 AM, Page: 1



f_y	234 MPa
E	199950 Mpa
DL	0.5 kPa
LL	2 kPa
$\Psi_{long-term}$	0.4
1.2DL+1.5LL	3.6 kPa
DL+ΨLL	1.3 kPa
Min fundamental frequency required	8 Hz
mode (single span)	9.87
mode (double equal span)	15.4

L/300

Space Gass / Manual Calculation

Member	Depth (mm)	Width (mm)	Gauge thickness (mm)	$I_{eq(mm^4)}$	$C_{eq(mm)}$	$Z_{eq(mm^3)}$	$A_{(mm^2)}$	$r_{(mm)}$	Self weight (kg/m)	Strength	Serviceability	Vibration
FF-EVOLUTION -BEAM 2X11-8'	280	50	4.1	20730855.2	140.0	148077.5	2595.3	51.4	20.37311			
FF-EVOLUTION -BEAM 2X11-12'	280	50	2.6	13667273.7	140.0	97623.4	1671.5	51.8	13.12159			
FF-EVOLUTION -BEAM 2X11-16'	280	50	1.6		140.0	61641.8	1039.2	52.0	8.157469			
FF-EVOLUTION -BEAM 2X11-20'	280	50	0.9	4942094.6	140.0	35300.0	588.7	52.3	4.621075			

Joist sections — Single span

Spacing (mm)	2000	2500	3000	3500	4000	4500	5000	2000	2500	3000	3500	4000	4500	5000
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	7233	6748	6371	6066	5812	5597	5409	7890	6880	6470	6150	5880	5660	5460
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	6351	5915	5578	5307	5082	4890	4725	7110	5990	5630	5350	5120	4920	4750
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	5903	5491	5174	4920	4709	4530	4376	6700	5530	5210	4940	4730	4550	4390
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	3970	3689	3475	3302	3160	3039	2935	4960	3700	3480	3310	3160	3040	2940

Strength(manual calculatoin)

Member	Depth (mm)	Width (mm)	Gauge thickness (mm)	$I_{eff\ eq(mm^4)}$	$C_{eq(mm)}$	$Z_{eff\ eq(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$	ϕM_s (kN.m)	ϕV_s (kN)
FF-EVOLUTION -BEAM 2X11-8'	280	50	4.1	20730855.3	140.0	148077.5		2595.5	51.4	46.0	264
FF-EVOLUTION -BEAM 2X11-12'	280	50	2.6	12960242.8	140.0	88758.0		1538.5	51.8	27.6	112
FF-EVOLUTION -BEAM 2X11-16'	280	50	1.6	11483225.5	140.0	75934.4		1087.8	52.0	16.1	36
FF-EVOLUTION -BEAM 2X11-20'	280	50	0.9	3117914.9	140.0	17700.1		400.1	52.3	5.5	14

Serviceability(manual calculation)

Member	Depth (mm)	Width (mm)	Gauge thickness (mm)	$I_{eff\ eq(mm^4)}$	$C_{eq(mm)}$	$Z_{eff\ eq(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$
FF-EVOLUTION -BEAM 2X11-8'	280	50	4.1	20730855.3	140.0	148077.5		2595.5	51.4
FF-EVOLUTION -BEAM 2X11-12'	280	50	2.6	13667273.7	140.0	97623.4		1671.6	51.8
FF-EVOLUTION -BEAM 2X11-16'	280	50	1.6	10775080.9	140.0	74717.8		1090.4	52.0
FF-EVOLUTION -BEAM 2X11-20'	280	50	0.9	3233864.4	140.0	18734.5		420.6	52.3

Maximum recommended span(mm)

Spacing (mm)	2000	2500	3000	3500	4000	4500	5000	2000	2500	3000	3500	4000	4500	5000
Joist sections	Single span							Equal double span						
FF-EVOLUTION -BEAM 2X11-8'	7147	6231	5673	5403	5054	4765	4520	6985	6231	5673	5403	5054	4765	4520
FF-EVOLUTION -BEAM 2X11-12'	5279	4682	4238	4183	3913	3689	3500	5293	4682	4238	4183	3913	3689	3500
FF-EVOLUTION -BEAM 2X11-16'	3731	3294	2957	2691	2481	2305	2164	4224	3778	3449	2944	2738	2573	2434
FF-EVOLUTION -BEAM 2X11-20'	1922	1632	1420	1868	1747	1647	1563	1922	1632	1420	1868	1747	1647	1563

Reduction

single span

	2000	2500	3000	3500	4000	4500	5000
FF-EVOLUTION -BEAM 2X11-8'	1	0.95	0.945	1	1	1	1
FF-EVOLUTION -BEAM 2X11-12'	0.91	0.895	0.88	1	1	1	1
FF-EVOLUTION -BEAM 2X11-16'	0.78	0.76	0.735	0.71	0.69	0.67	0.656
FF-EVOLUTION -BEAM 2X11-20'	0.605	0.545	0.495	1	1	1	1

Double span

	2000	2500	3000	3500	4000	4500	5000
FF-EVOLUTION -BEAM 2X11-8'	0.955	0.95	0.945	1	1	1	1
FF-EVOLUTION -BEAM 2X11-12'	0.915	0.895	0.88	1	1	1	1
FF-EVOLUTION -BEAM 2X11-16'	1	1	1	0.85	0.84	0.835	0.83
FF-EVOLUTION -BEAM 2X11-20'	0.605	0.545	0.495	1	1	1	1

Single span

Beam sections	2000				2500				3000			
	M*	V*	$(\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	47.54	26.60	1.09	not ok & reduce	44.87	28.80	1.01	not ok & n	44.43	31.33	1.00	not ok & reduce span
FF-EVOLUTION -BEAM 2X11-12'	25.63	19.42	0.99	ok	25.10	21.44	0.98	ok	24.61	23.22	0.96	ok
FF-EVOLUTION -BEAM 2X11-16'	12.70	13.61	0.98	ok	12.34	14.98	0.98	ok	11.91	16.11	0.98	ok
FF-EVOLUTION -BEAM 2X11-20'	3.35	6.97	0.88	ok	3.01	7.39	0.84	ok	2.73	7.71	0.81	ok

Single span

Beam sections	3500.00				4000.00				4500.00				5000.00			
	M*	V*	$(\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	46.87	34.70	1.09	not ok & reduce	46.76	37.01	1.09	not ok & n	46.67	39.18	1.09	not ok & re	46.60	41.24	1.09	not ok & reduce span
FF-EVOLUTION -BEAM 2X11-12'	27.90	26.68	1.15	not ok & reduce	27.86	28.48	1.16	not ok & n	27.83	30.17	1.17	not ok & re	27.80	31.77	1.18	not ok & reduce span
FF-EVOLUTION -BEAM 2X11-16'	11.49	17.08	0.98	ok	11.16	17.99	0.98	ok	10.83	18.78	0.98	ok	10.59	19.58	0.98	ok
FF-EVOLUTION -BEAM 2X11-20'	5.52	11.82	1.80	not ok & reduce	5.52	12.63	1.87	not ok & n	5.51	13.39	1.94	not ok & re	5.51	14.11	2.02	not ok & reduce span

Beam sections — ual double span

	2000.00				2500.00				3000.00			
	M*	V*	$(\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	45.40	26.00	1.02	not ok & reduce	44.87	28.80	1.01	not ok & n	44.43	31.33	1.00	not ok & reduce span
FF-EVOLUTION -BEAM 2X11-12'	25.77	19.47	1.00	ok	25.10	21.44	0.98	ok	24.61	23.22	0.96	ok
FF-EVOLUTION -BEAM 2X11-16'	16.28	15.41	1.32	not ok & reduce	16.23	17.19	1.37	not ok & re	16.21	18.79	1.42	not ok & reduce span
FF-EVOLUTION -BEAM 2X11-20'	3.35	6.97	0.88	ok	3.01	7.39	0.84	ok	2.73	7.71	0.81	ok

Beam sections — ual double span

	3500.00				4000.00				4500.00				5000.00			
	M*	V*	$(\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result	M*	V*	$(M^*/\phi M_s)^{1.4}+(V^*/\phi V_s)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	46.87	34.70	1.09	not ok & reduce	46.76	37.01	1.09	not ok & n	46.67	39.18	1.09	not ok & re	46.60	41.24	1.09	not ok & reduce span
FF-EVOLUTION -BEAM 2X11-12'	27.90	26.68	1.15	not ok & reduce	27.86	28.48	1.16	not ok & n	27.83	30.17	1.17	not ok & re	27.80	31.77	1.18	not ok & reduce span
FF-EVOLUTION -BEAM 2X11-16'	13.76	18.69	1.20	not ok & reduce	13.58	19.85	1.23	not ok & n	13.49	20.97	1.25	not ok & re	13.40	22.03	1.28	not ok & reduce span
FF-EVOLUTION -BEAM 2X11-20'	5.52	11.82	1.80	not ok & reduce	5.52	12.63	1.87	not ok & n	5.51	13.39	1.94	not ok & re	5.51	14.11	2.02	not ok & reduce span

SPACE GASS 14.00 - TINGMORE STRUCTURES
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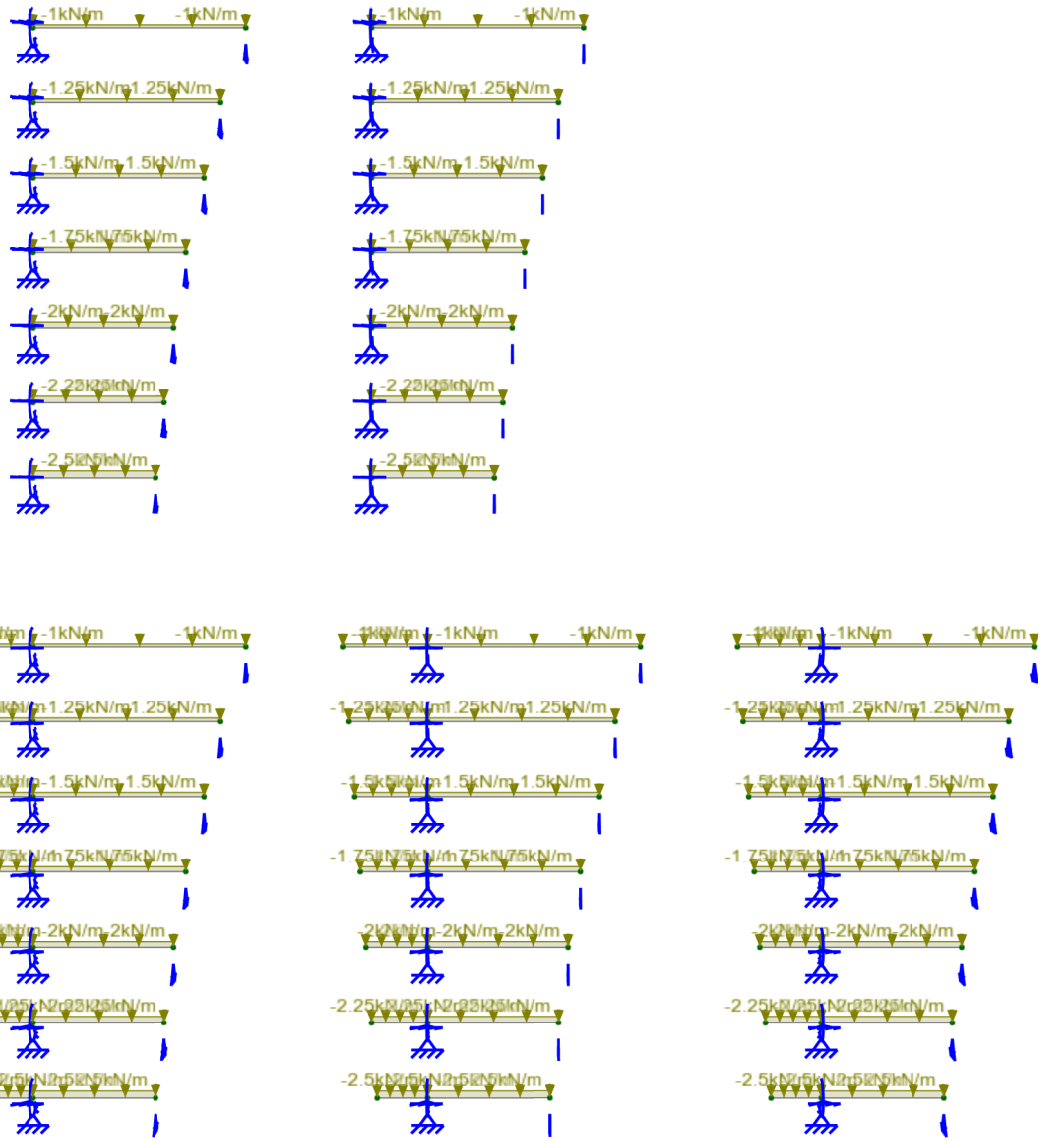
Designer: Date: Tuesday, July 26, 2022 12:05 PM, Page: 1

Load case 1
1 dl



Viewpoint (0,0), Loads

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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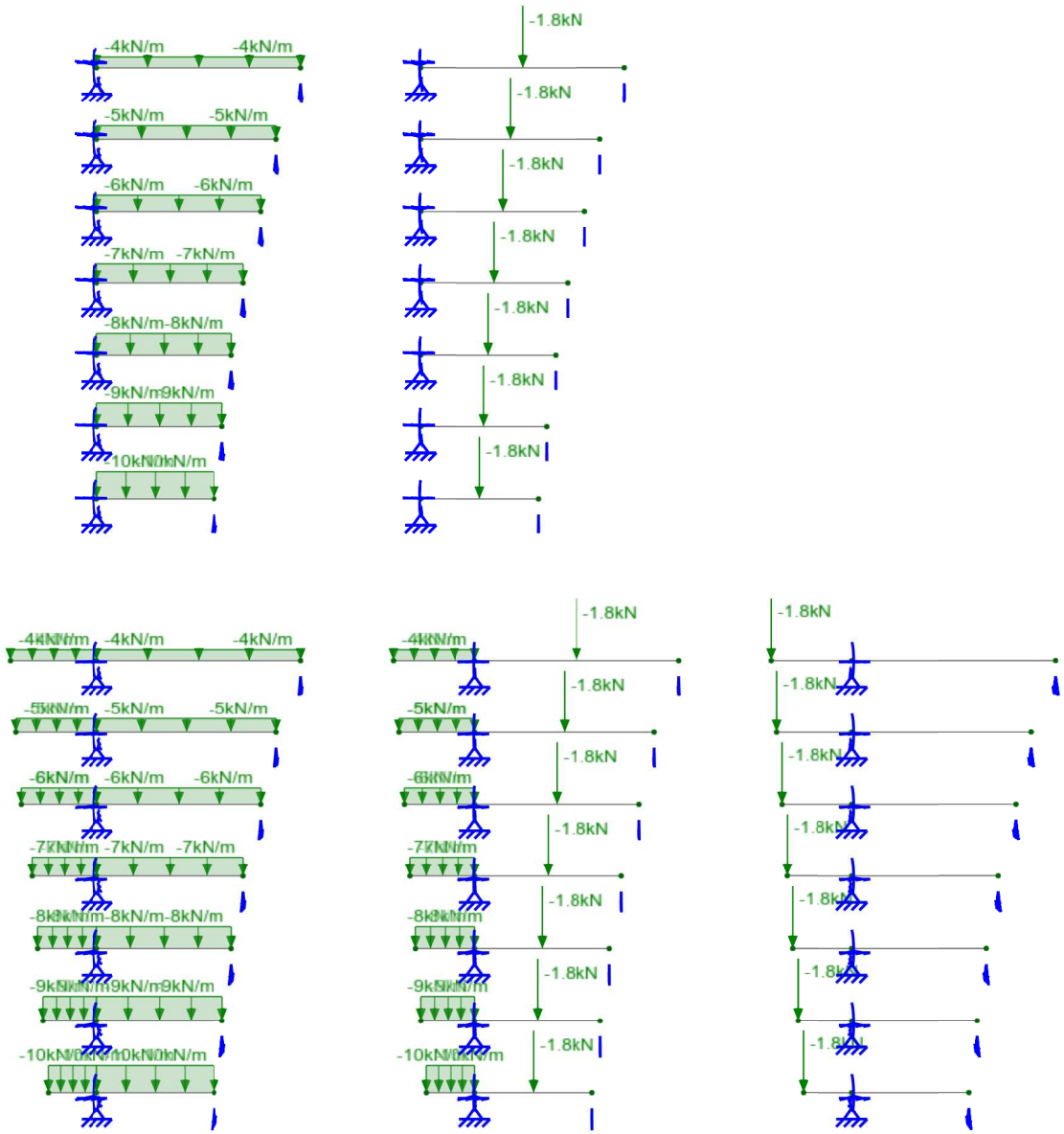
Designer: Date: Tuesday, July 26, 2022 12:05 PM, Page: 1

Load case 2
2 ll



Viewpoint (0,0), Loads

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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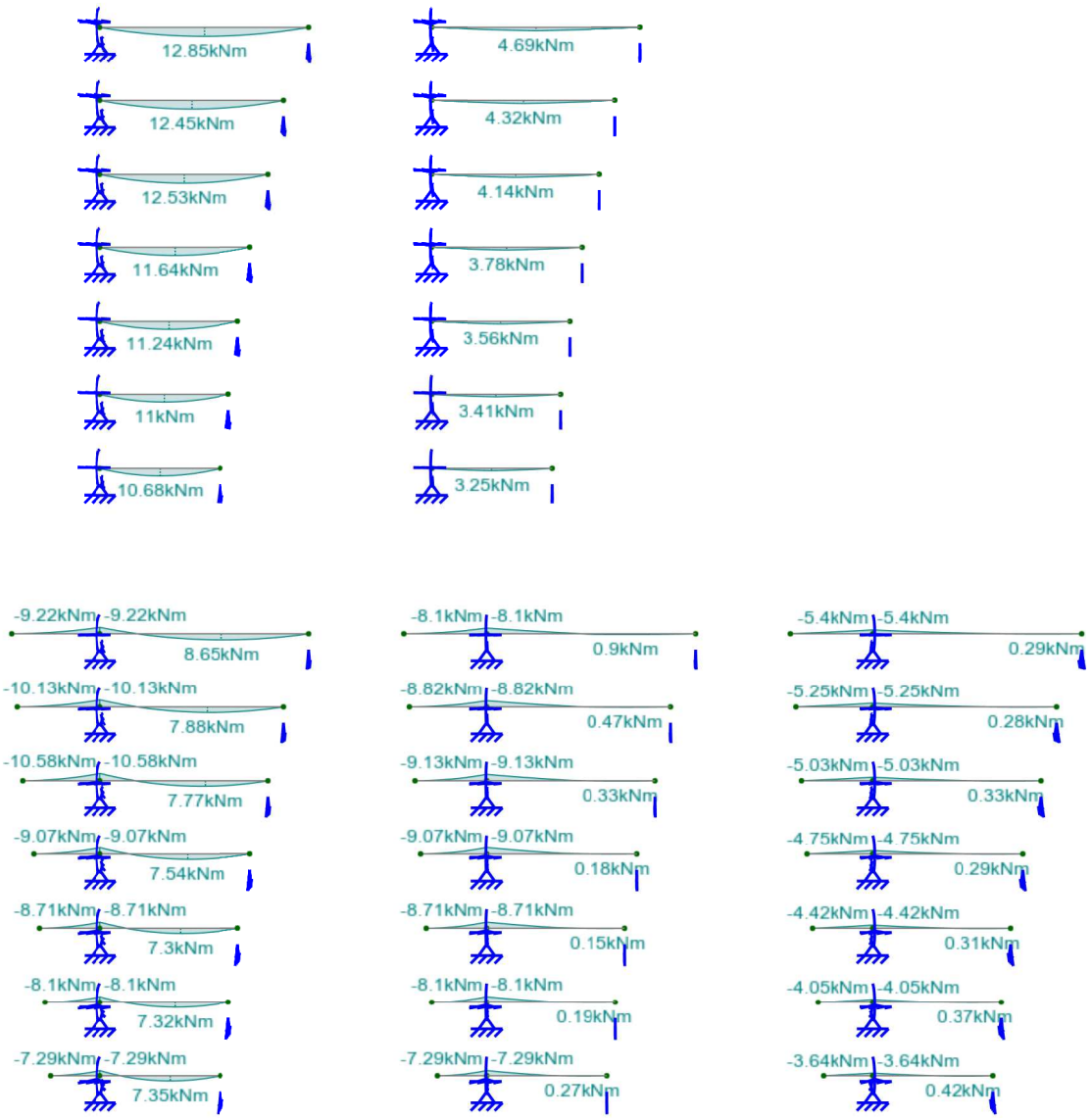
Load case 3
3 1.2dl+1.5ll



Viewpoint (0,0), Moments

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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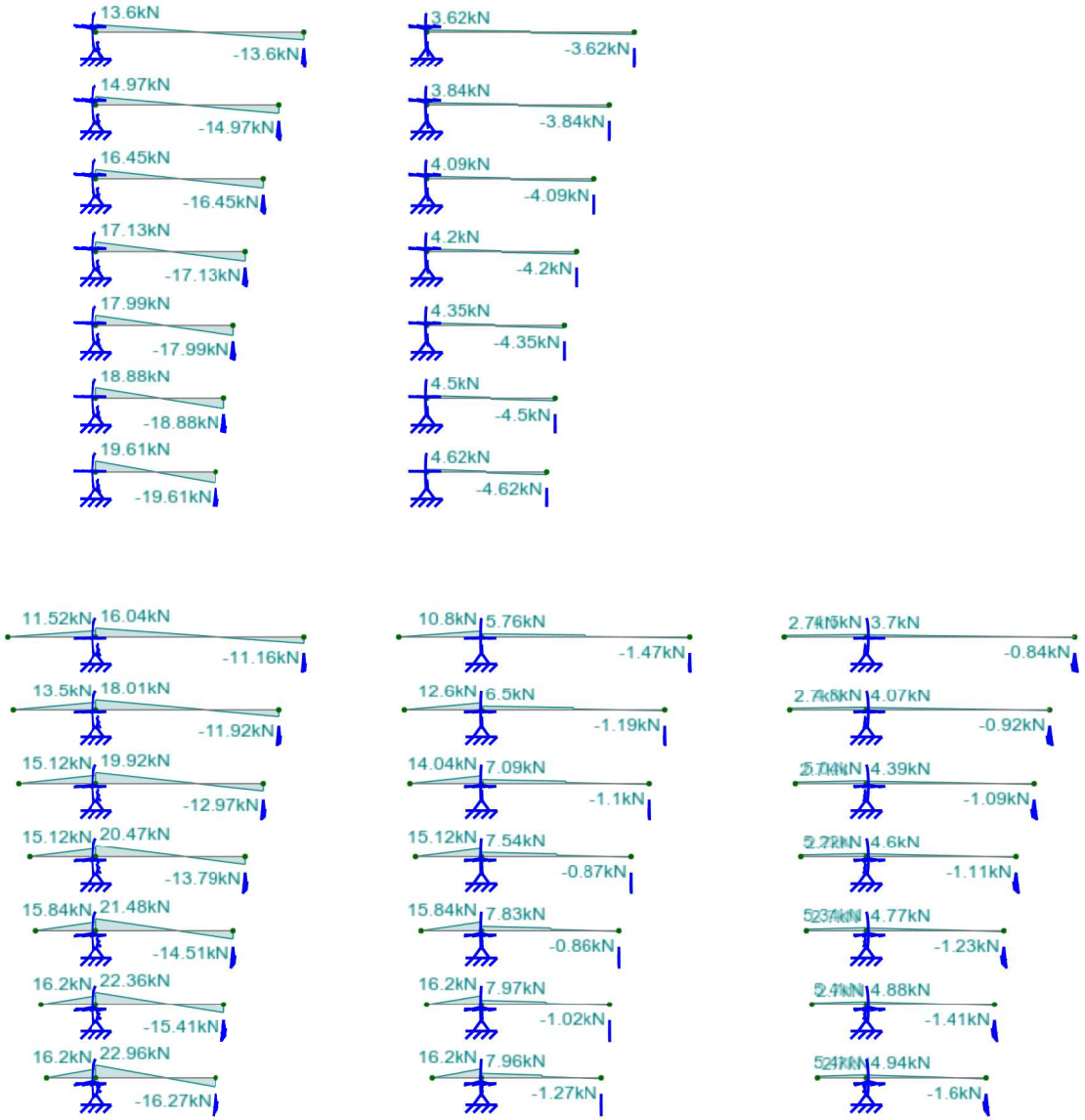
Load case 3
3 1.2dl+1.5ll



Viewpoint (0,0), Shears

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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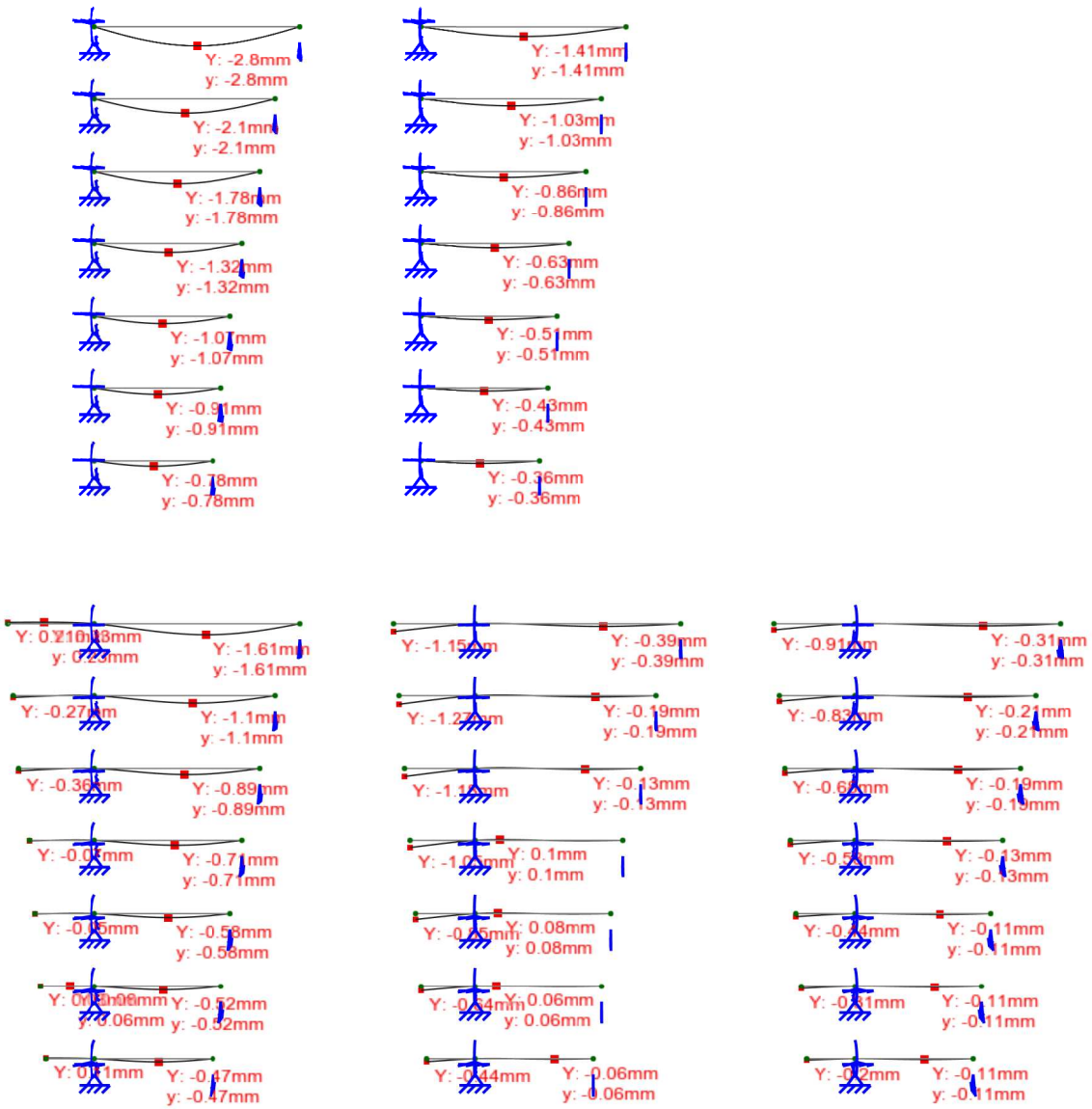
Designer: Date: Tuesday, July 26, 2022 12:08 PM, Page: 1

Load case 4
4 dl+0.4ll



Viewpoint (0,0), Displacements

Materials:
1 STEEL

Sections:
1 Section 1

				Space Gass				Manual Calculation						
Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eq(mm^4)}$	$C_{eq(mm)}$	$Z_{eq(mm^3)}$	$A_{(mm^2)}$	$I_{eq(mm^4)}$	$C_{eq(mm)}$	$Z_{eq(mm^3)}$	$A_{(mm^2)}$	$r_{(mm)}$	Self weight (kg/m)	Strength
FF-EVOLUTION -BEAM 4X11-8'														Serviceability
FF-EVOLUTION -BEAM 4X11-12'														Vibration
FF-EVOLUTION -BEAM 4X11-16'	280	102	1.6	35750000.0	140.0	252400.0		3155.0	35086638.7	140.0	247655.8	3119.6	106.5	24.48899
FF-EVOLUTION -BEAM 4X11-20'														

Strength(manual calculatoin)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\ eq(mm^4)}$	$C_{eq(mm)}$	$Z_{eff\ eq(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$	ØM$_s$(kN.m)	ØV$_s$(kN)
FF-EVOLUTION -BEAM 2X11-8'										
FF-EVOLUTION -BEAM 2X11-12'										
FF-EVOLUTION -BEAM 2X11-16'	280	102	1.6	35091601.4	140.0	247822.0		3119.6	106.5	52.4	72
FF-EVOLUTION -BEAM 2X11-20'										

Serviceability(manual calculation)

Member	Depth$_{(mm)}$	Width$_{(mm)}$	Gauge thickness$_{(mm)}$	$I_{eff\ eq(mm^4)}$	$C_{eq(mm)}$	$Z_{eff\ eq(mm^3)}$	$A_{eff(mm^2)}$	$r_{(mm)}$	
FF-EVOLUTION -BEAM 2X11-8'	0	0	0	0.0	0.0	0.0		0.0	0.0
FF-EVOLUTION -BEAM 2X11-12'	0	0	0	0.0	0.0	0.0		0.0	106.5
FF-EVOLUTION -BEAM 2X11-16'	280	102	1.6	34957297.4	140.0	244312.4		2782.0	52.0
FF-EVOLUTION -BEAM 2X11-20'	0	0	0	0.0	0.0	0.0		0.0	0.0

f_y	234 MPa
E	199950 Mpa
DL	0.5 kPa
LL	2 kPa
$\psi_{long-term}$	0.4
1.2DL+1.5LL	3.6 kPa
DL+ψLL	1.3 kPa L/400
Min fundamental frequency required	8 Hz
mode (single span)	9.87
mode (double equal span)	15.4

Spacing (mm)	2000	2500	3000	3500	4000	4500	5000	2000	2500	3000	3500	4000	4500	**5000**
Joist sections	Single span													
FF-EVOLUTION -2X6 JOIST-12'-16GA-PC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FF-EVOLUTION -2X6 JOIST-14'-16GA-PC	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FF-EVOLUTION -2X6 JOIST-16'-16GA-PC	7200	6800	6500	6200	6050	5880	5720	8990	7440	7000	6650	6360	6120	5910
FF-EVOLUTION -2X6 JOIST-18'-16GA-PC	0	0	0	0	0	0	0	0	0	0	0	0	0	0

	Maximum recommended span(mm)													
Spacing (mm)	2000	2500	3000	3500	4000	4500	5000	2000	2500	3000	3500	4000	4500	5000
Joist sections	Single span							Equal double span						
FF-EVOLUTION -BEAM 2X11-8'	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FF-EVOLUTION -BEAM 2X11-12'	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FF-EVOLUTION -BEAM 2X11-16'	6911	6105	5485	5013	4626	4302	4038	6932	6105	5485	5013	4626	4302	4038
FF-EVOLUTION -BEAM 2X11-20'	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Reduction

	single span						
	2000	2500	3000	3500	4000	4500	5000
FF-EVOLUTION -BEAM 2X11-8'	1	0.95	0.945	1	1	1	1
FF-EVOLUTION -BEAM 2X11-12'	0.91	0.895	0.88	1	1	1	1
FF-EVOLUTION -BEAM 2X11-16'	0.82	0.8	0.775	0.755	0.735	0.715	0.7
FF-EVOLUTION -BEAM 2X11-20'	0.605	0.545	0.495	1	1	1	1

	Double span						
	2000	2500	3000	3500	4000	4500	5000
FF-EVOLUTION -BEAM 2X11-8'	0.955	0.95	0.945	1	1	1	1
FF-EVOLUTION -BEAM 2X11-12'	0.915	0.895	0.88	1	1	1	1
FF-EVOLUTION -BEAM 2X11-16'	0.825	0.8	0.775	0.755	0.735	0.715	0.7
FF-EVOLUTION -BEAM 2X11-20'	0.605	0.545	0.495	1	1	1	1

Single span

Beam sections	2000				2500				3000			
	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-12'	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-16'	42.98	24.87787751	0.98	ok	41.93	27.47	0.99	ok	40.62	29.62	0.99	ok
FF-EVOLUTION -BEAM 2X11-20'	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!

Single span

Beam sections	3500				4000				4500				5000			
	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-12'	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-16'	39.57	31.57903824	0.99	ok	38.52	33.31	0.99	ok	37.48	34.85	0.99	ok	36.69	36.34	0.99	ok
FF-EVOLUTION -BEAM 2X11-20'	0.00	0	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!	0.00	0.00	#DIV/0!	#DIV/0!

Beam sections	qual double span 2000				2500				3000			
	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-12'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-16'	43.24	24.95360943	0.99	ok	41.93	27.47301979	0.99	ok	40.62	29.6212	0.99	ok
FF-EVOLUTION -BEAM 2X11-20'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!

Beam sections	qual double span 3500				4000				4500				5000			
	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result	M*	V*	$(M^*/ØM_s)^{1.4}+(V^*/ØV_s)^{1.4}$	Result
FF-EVOLUTION -BEAM 2X11-8'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-12'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!
FF-EVOLUTION -BEAM 2X11-16'	39.57	31.57903824	0.99	ok	38.52	33.30926628	0.99	ok	37.48	34.8458	0.99	ok	36.69	36.34339	0.99	ok
FF-EVOLUTION -BEAM 2X11-20'	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!	0.00	0	#DIV/0!	#DIV/0!

SPACE GASS 14.00 - TINGMORE STRUCTURES
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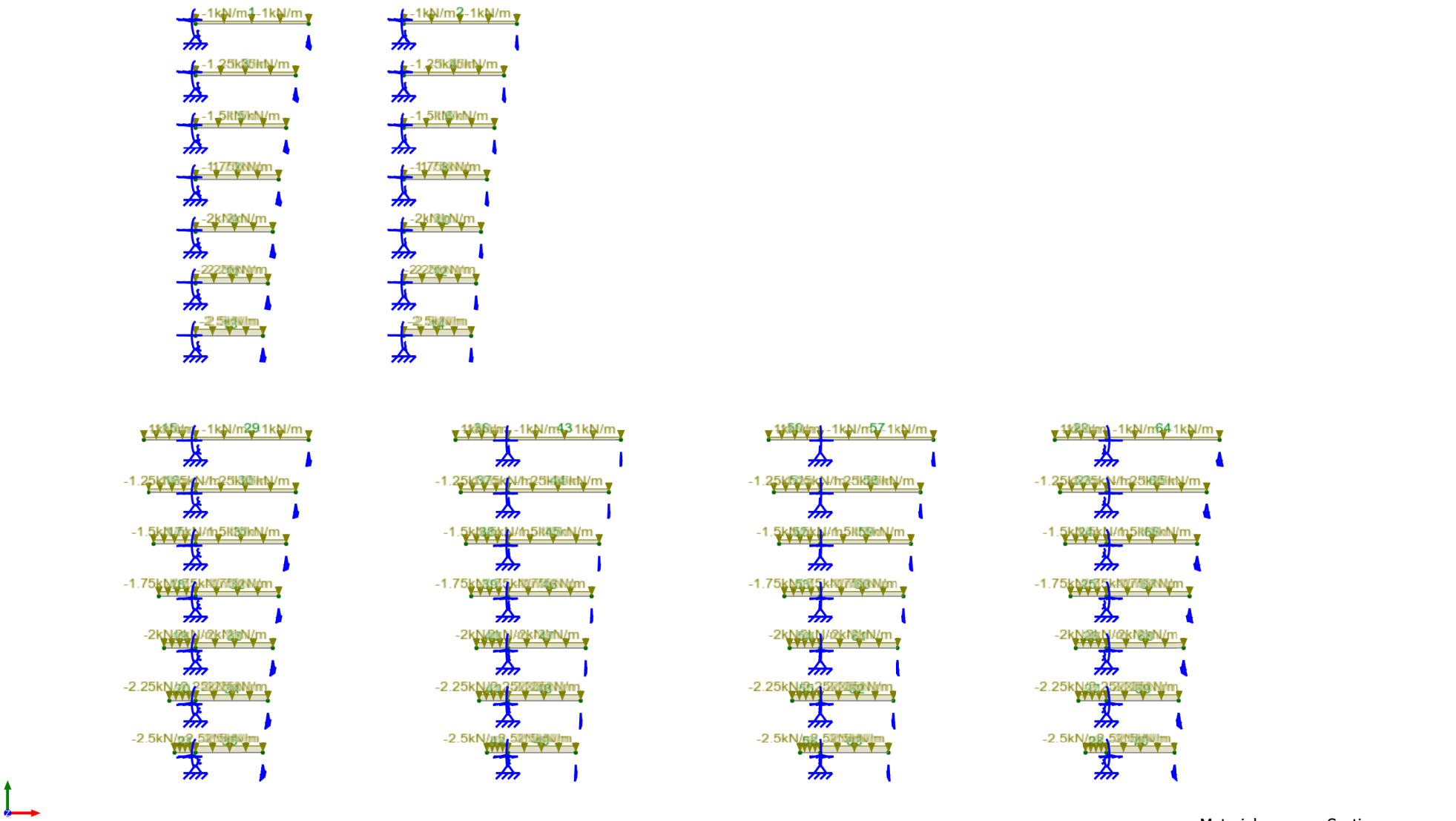
Designer: Date: Tuesday, July 26, 2022 12:44 PM, Page: 1

Load case 1
1 dl



Viewpoint (0,0), Loads

SPACE GASS 14.00 - TINGMORE STRUCTURES
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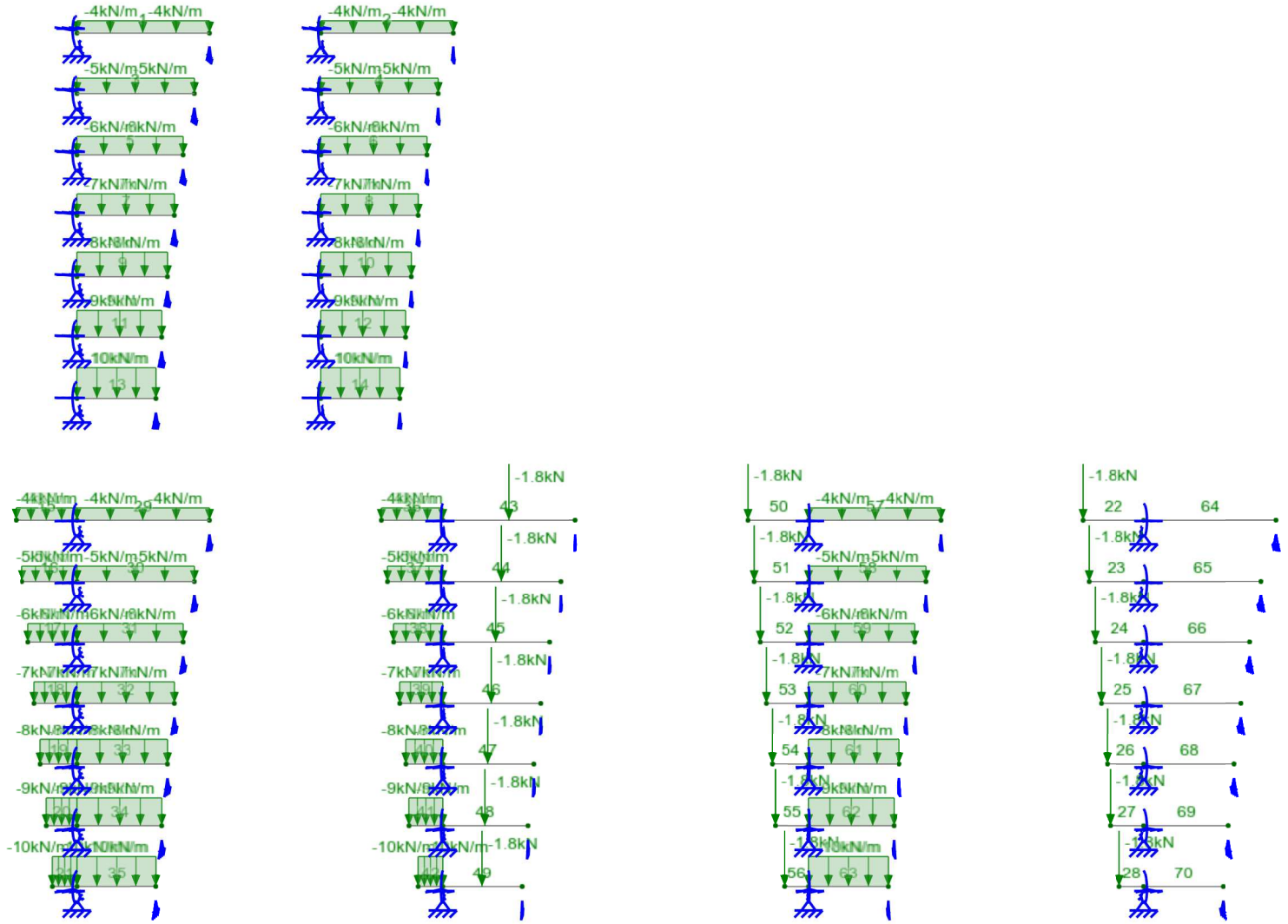
Designer: Date: Tuesday, July 26, 2022 12:45 PM, Page: 1

Load case 2
2 ll



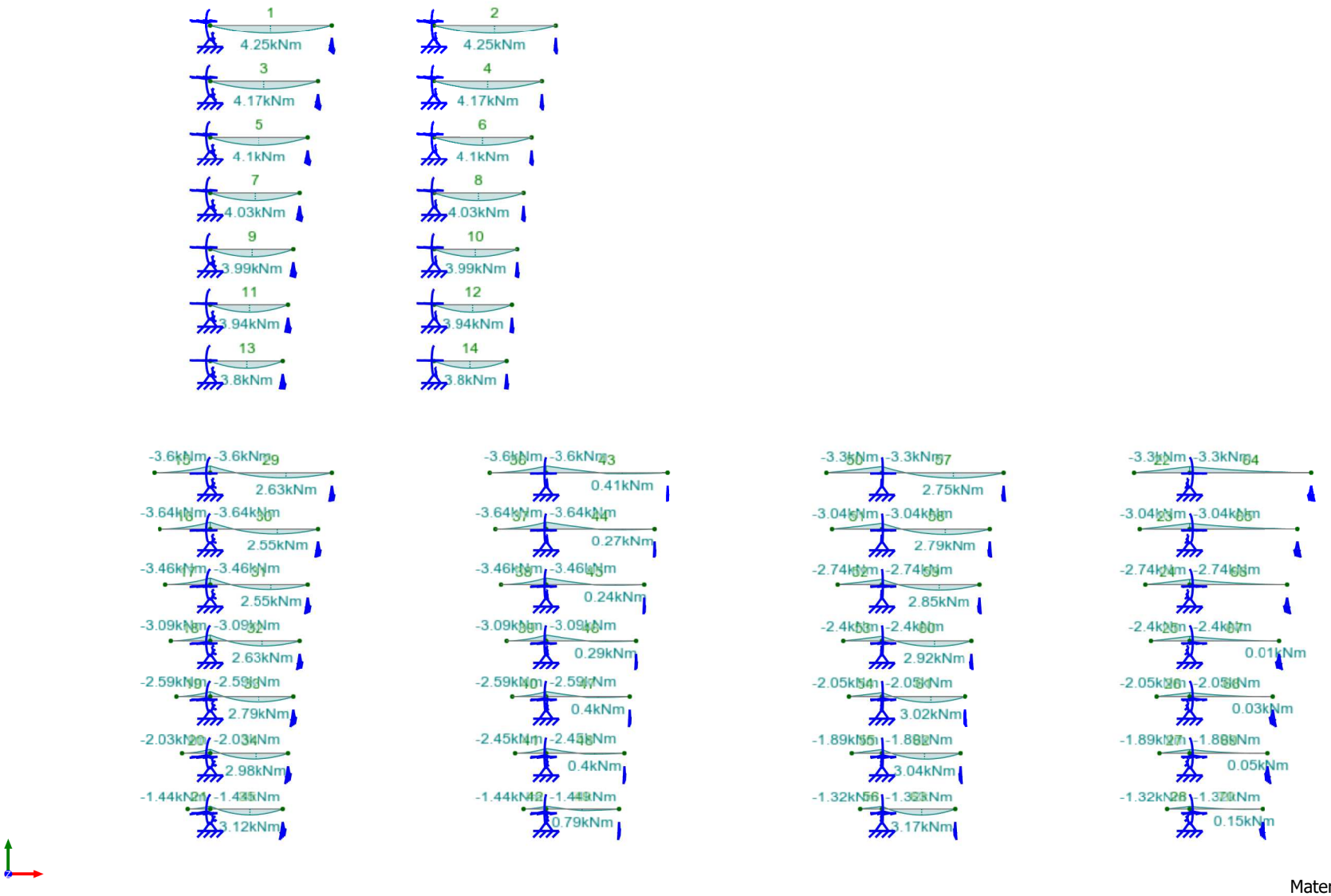
Viewpoint (0,0), Loads

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: C:\Users\Tingmore\Dropbox\Projects\2...\Structural\280x100 double beam
Designer: Date: Tuesday, July 26, 2022 12:45 PM, Page: 1

Load case 3
3 1.2dl+1.5ll



Viewpoint (0,0), Moments

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
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Designer: Date: Tuesday, July 26, 2022 12:46 PM, Page: 1

Load case 3
3 1.2dl+1.5ll

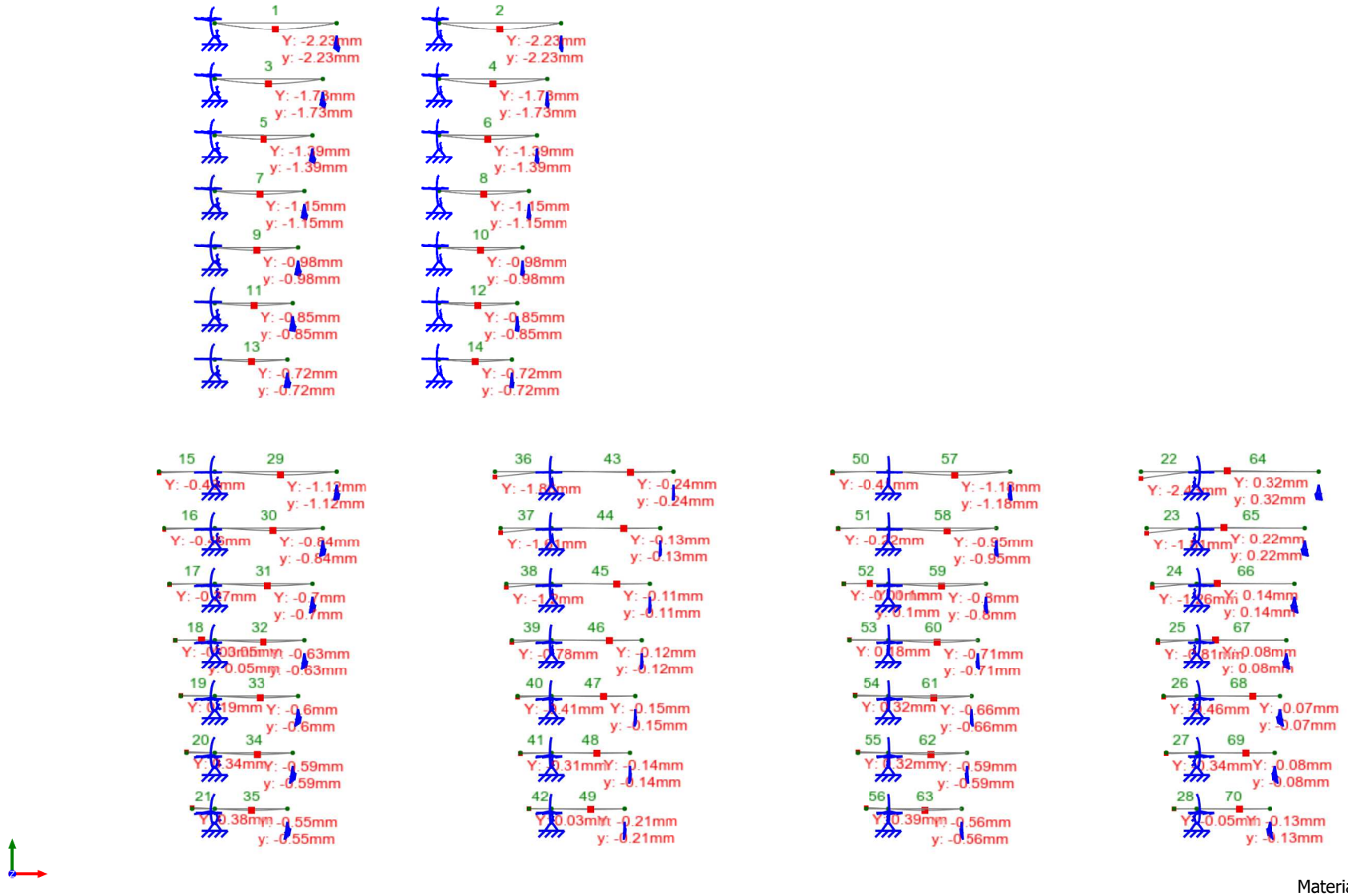
Viewpoint (0,0), Shears

Materials:
1 STEEL

Sections:
1 Section 1

SPACE GASS 14.00 - TINGMORE STRUCTURES
Path: C:\Users\Tingmore\Dropbox\Projects\2...\Structural\280x100 double beam
Designer: Date: Tuesday, July 26, 2022 12:47 PM, Page: 1

Load case 4
4 dl+0.4ll



Viewpoint (0,0), Displacements

Materials:
1 STEEL

Sections:
1 Section 1