

PRILOGA A: IZPIS IZ PROGRAMA SCIA ENGINEER 14

Priloga A.1: Kontrola nosilnosti in stabilnosti momentnega okvira 2 - MSN

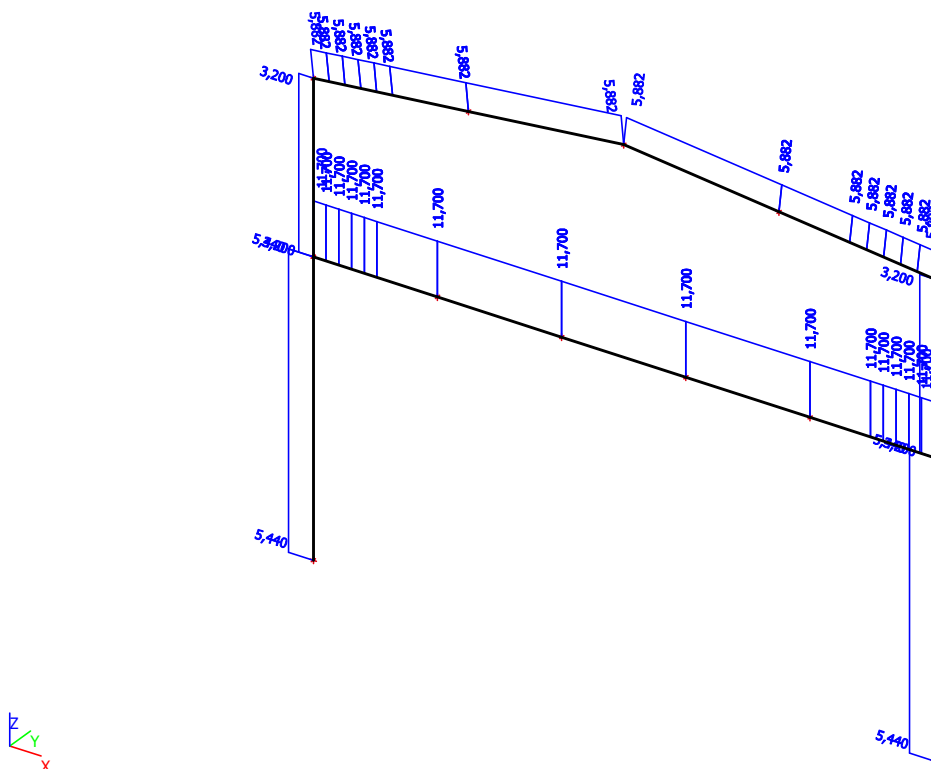
Priloga A.2: Kontrola nosilnosti in stabilnosti okvira 1 s centričnim povezjem (sistem nateznih diagonal) - MSN

1. Priloga A.1

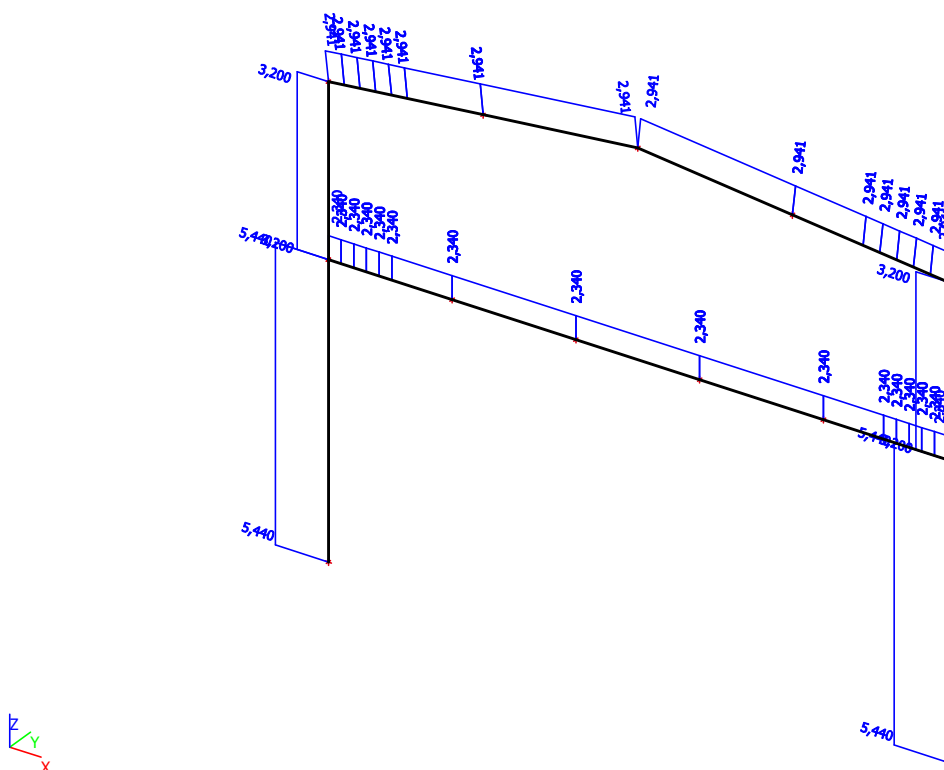
Linear calculation

Member	CS Name	Part	Sway y	Ly [m]	ky [-]	ly [m]	Lam y [-]	lyz [m]	I LTB [m]
			Sway z	Lz [m]	kz [-]	lz [m]	Lam z [-]		
B1	CS2	1	Yes	5,440	1,00	5,440	28,76	5,440	5,440
			No	5,440	1,00	5,440	74,58		
B1	CS2	2	Yes	3,200	1,00	3,200	16,92	3,200	3,200
			No	3,200	1,00	3,200	43,87		
B2	CS2	1	Yes	5,440	1,00	5,440	28,76	5,440	5,440
			No	5,440	1,00	5,440	74,58		
B2	CS2	2	Yes	3,200	1,00	3,200	16,92	3,200	3,200
			No	3,200	1,00	3,200	43,87		
B3	CS4	1	Yes	11,700	1,00	11,700	42,11	2,340	2,340
			No	2,340	1,00	2,340	32,76		
B3	CS4	2	Yes	11,700	1,00	11,700	45,68	2,340	2,340
			No	2,340	1,00	2,340	32,32		
B3	CS4	3	Yes	11,700	1,00	11,700	49,69	2,340	2,340
			No	2,340	1,00	2,340	31,86		
B3	CS4	4	Yes	11,700	1,00	11,700	54,13	2,340	2,340
			No	2,340	1,00	2,340	31,40		
B3	CS4	5	Yes	11,700	1,00	11,700	58,84	2,340	2,340
			No	2,340	1,00	2,340	30,94		
B3	CS4	6	Yes	11,700	1,00	11,700	61,84	2,340	2,340
			No	2,340	1,00	2,340	32,10		
B3	CS4	7	Yes	11,700	1,00	11,700	61,84	2,340	2,340
			No	2,340	1,00	2,340	32,10		
B3	CS4	8	Yes	11,700	1,00	11,700	61,84	2,340	2,340
			No	2,340	1,00	2,340	32,10		
B3	CS4	9	Yes	11,700	1,00	11,700	61,84	2,340	2,340
			No	2,340	1,00	2,340	32,10		
B3	CS4	10	Yes	11,700	1,00	11,700	61,84	2,340	2,340
			No	2,340	1,00	2,340	32,10		
B3	CS4	11	Yes	11,700	1,00	11,700	58,84	2,340	2,340
			No	2,340	1,00	2,340	30,94		
B3	CS4	12	Yes	11,700	1,00	11,700	54,13	2,340	2,340
			No	2,340	1,00	2,340	31,40		
B3	CS4	13	Yes	11,700	1,00	11,700	49,69	2,340	2,340
			No	2,340	1,00	2,340	31,86		
B3	CS4	14	Yes	11,700	1,00	11,700	45,68	2,340	2,340
			No	2,340	1,00	2,340	32,32		
B3	CS4	15	Yes	11,700	1,00	11,700	42,11	2,340	2,340
			No	2,340	1,00	2,340	32,76		
B4	CS7	1	Yes	5,882	1,00	5,882	31,38	2,941	2,941
			No	2,941	1,00	2,941	90,70		
B4	CS7	2	Yes	5,882	1,00	5,882	34,13	2,941	2,941
			No	2,941	1,00	2,941	88,90		
B4	CS7	3	Yes	5,882	1,00	5,882	37,25	2,941	2,941
			No	2,941	1,00	2,941	87,06		
B4	CS7	4	Yes	5,882	1,00	5,882	40,72	2,941	2,941
			No	2,941	1,00	2,941	85,19		
B4	CS7	5	Yes	5,882	1,00	5,882	44,40	2,941	2,941
			No	2,941	1,00	2,941	83,27		
B4	CS7	6	Yes	5,882	1,00	5,882	47,20	2,941	2,941
			No	2,941	1,00	2,941	87,82		
B4	CS7	7	Yes	5,882	1,00	5,882	47,20	2,941	2,941
			No	2,941	1,00	2,941	87,82		
B5	CS7	1	Yes	5,882	1,00	5,882	31,38	2,941	2,941
			No	2,941	1,00	2,941	90,70		
B5	CS7	2	Yes	5,882	1,00	5,882	34,13	2,941	2,941
			No	2,941	1,00	2,941	88,90		
B5	CS7	3	Yes	5,882	1,00	5,882	37,25	2,941	2,941
			No	2,941	1,00	2,941	87,06		
B5	CS7	4	Yes	5,882	1,00	5,882	40,72	2,941	2,941
			No	2,941	1,00	2,941	85,19		
B5	CS7	5	Yes	5,882	1,00	5,882	44,40	2,941	2,941
			No	2,941	1,00	2,941	83,27		
B5	CS7	6	Yes	5,882	1,00	5,882	47,20	2,941	2,941
			No	2,941	1,00	2,941	87,82		
B5	CS7	7	Yes	5,882	1,00	5,882	47,20	2,941	2,941
			No	2,941	1,00	2,941	87,82		

2. Iy



3. Iz



4. Result classes

4.1. Result classes - All MSN Nonlinear

Name	List
All MSN Nonlinear	MSN1nelin
	MSN2nelin
	MSN3nelin
	MSN4nelin

Name	List
	MSN5nelin
	MSN6nelin
	MSN7nelin
	MSN8nelin
	MSN9nelin
	MSN10nelin
	MSN11nelin
	MSN12nelin
	MSN13nelin
	MSN14nelin

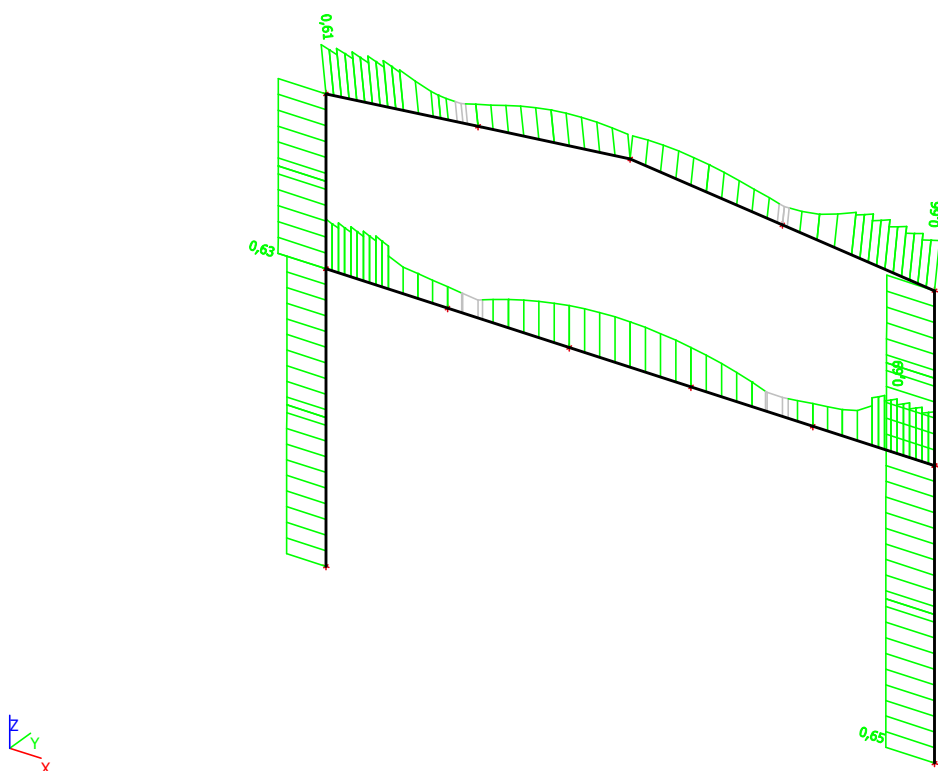
4.1.1. Check of steel

Nonlinear calculation, Extreme : Member

Selection : All

Class : All MSN Nonlinear

Member	css	mat	Case	dx [m]	un.check [-]	sec.check [-]	stab.check [-]
B1	CS2 - HEA450	S 235	MSN7nelin	5,440	0,63	0,62	0,63
B2	CS2 - HEA450	S 235	MSN9nelin	0,000	0,65	0,11	0,65
B3	CS4 - I + I var	S 235	MSN1nelin	10,980	0,69	0,69	0,00
B4	CS7 - I + I var	S 235	MSN3nelin	0,000	0,61	0,50	0,61
B5	CS7 - I + I var	S 235	MSN3nelin	0,000	0,66	0,55	0,66



Nonlinear calculation, Extreme : Cross-section

Selection : All

Class : All MSN Nonlinear

Member B2	8,640 m	HEA450	S 235	MSN9nelin	0,65 -
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Partial safety factors	
Gamma M0 for resistance of cross-sections	1,00
Gamma M1 for resistance to instability	1,00
Gamma M2 for resistance of net sections	1,25

Material		
Yield strength fy	23,5	kN/cm ²
Ultimate strength fu	36,0	kN/cm ²
Fabrication	Rolled	

.....SECTION CHECK:.....

Classification for cross-section design

According to EN 1993-1-1 article 5.5.2

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	29,91
Class 1 Limit	33,00
Class 2 Limit	38,00
Class 3 Limit	42,00

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	5,58
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	14,00

=> Outstand Flanges Class 1

=> Section classified as Class 1 for cross-section design

The critical check is on position 0.000 m

Internal forces	Calculated	Unit
N _{Ed}	-466,47	kN
V _{y,Ed}	0,00	kN
V _{z,Ed}	72,21	kN
T _{Ed}	0,00	kNm
M _{y,Ed}	0,00	kNm
M _{z,Ed}	0,00	kNm

Compression check

According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	178,0000	cm ²
N _{c,Rd}	4183,00	kN
Unity check	0,11	-

Shear check for V_z

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

Eta	1,20	
A _v	65,7550	cm ²
V _{pl,z,Rd}	892,15	kN
Unity check	0,08	-

The member satisfies the section check.

.....STABILITY CHECK:.....**Classification for member buckling design**

Decisive position for stability classification: 0,000 m

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	29,91
Class 1 Limit	33,00
Class 2 Limit	38,00
Class 3 Limit	42,00

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	5,58
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	14,00

=> Outstand Flanges Class 1

=> Section classified as Class 1 for member buckling design

Flexural Buckling Check

According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	5,440	5,440	m
Buckling factor k	1,00	1,00	
Buckling length L _{cr}	5,440	5,440	m
Critical Euler load N _{cr}	44612,92	6632,41	kN
Slenderness Lambda	28,76	74,58	
Relative slenderness Lambda _{rel}	0,31	0,79	
Limit slenderness Lambda _{rel,0}	0,20	0,20	
Buckling curve	a	b	

Buckling parameters	yy	zz	
Imperfection Alpha	0,21	0,34	
Reduction factor Chi	0,98	0,73	
Buckling resistance Nb,Rd	4082,77	3045,44	kN

Flexural Buckling verification		
Cross-section area A	178,0000	cm ²
Buckling resistance Nb,Rd	3045,44	kN
Unity check	0,15	-

Compression and bending check

According to article EN 1993-1-1 : 6.3.3. and formula (6.61), (6.62)

Interaction Method 1

Table of values		
kyy	1.062	
kyz	0.899	
kzy	0.559	
kzz	1.114	
Delta My	0.00	kNm
Delta Mz	0.00	kNm
A	178.0000	cm ²
Wy	3216.6700	cm ³
Wz	966.6670	cm ³
NRk	4183.00	kN
My,Rk	755.92	kNm
Mz,Rk	227.17	kNm
My,Ed	380.04	kNm
Mz,Ed	0.00	kNm
Interaction Method 1		
Mcr0	1798.25	kNm
reduced slenderness 0	0.65	
Psi y	0.000	
Psi z	1.000	
Cmy,0	0.996	
Cmz,0	1.017	
Cmy	0.999	
Cmz	1.017	
CmLT	1.052	
muy	1.000	
muz	0.980	
wy	1.109	
wz	1.500	
npl	0.112	
aLT	0.996	
bLT	0.000	
cLT	0.390	
dLT	0.000	
eLT	1.110	
Cyy	0.999	
Cyz	0.849	
Czy	0.960	
Czz	0.962	

Unity check (6.61) = 0.11 + 0.53 + 0.00 = 0.65

Unity check (6.62) = 0.15 + 0.28 + 0.00 = 0.43

Shear buckling check

in buckling field 1

According to article EN 1993-1-5 : 5. & 7.1. and formula (5.10) & (7.1)

Table of values	
hw/t	34.609

The web slenderness is such that the Shear Buckling Check is not required.

The member satisfies the stability check.

Member B3	11,700 m	I + I var	S 235	MSN1nelin	0,69 -
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Partial safety factors	
Gamma M0 for resistance of cross-sections	1,00
Gamma M1 for resistance to instability	1,00
Gamma M2 for resistance of net sections	1,25

Material		
Yield strength fy	23,5	kN/cm ²
Ultimate strength fu	36,0	kN/cm ²
Fabrication	Welded	

Warning: Strength reduction in function of the thickness is not supported for this type of cross-section.

....SECTION CHECK:....

Classification for cross-section design

According to EN 1993-1-1 article 5.5.2

Warning: Classification is not supported for this type of cross-section.
The section is checked as elastic, class 3.

The critical check is on position 10.980 m

Internal forces	Calculated	Unit
N _{Ed}	112,36	kN
V _{y,Ed}	0,00	kN
V _{z,Ed}	-369,76	kN
T _{Ed}	0,00	kNm
M _{y,Ed}	-557,15	kNm
M _{z,Ed}	0,00	kNm

Section properties

A	2.556822e+004 mm ²		
A _{y/A}	0.711	A _{z/A}	0.271
I _y	1.194644e+009 mm ⁴	I _z	1.419727e+008 mm ⁴
I _{yz}	1.084202e-007 mm ⁴	I _t	3.051402e+006 mm ⁴
I _w	7.561526e+012 mm ⁶		
W _{ely}	3.768931e+006 mm ³	W _{elz}	9.464847e+005 mm ³
W _{ply}	4.608365e+006 mm ³	W _{plz}	1.445252e+006 mm ³
c _y	242.74 mm	c _z	150.00 mm
d _y	-0.00 mm	d _z	-12.31 mm

Tension check

According to EN 1993-1-1 article 6.2.3 and formula (6.5)

A	255,6822	cm ²
N _{pl,Rd}	6008,53	kN
N _{u,Rd}	6627,28	kN
N _{t,Rd}	6008,53	kN
Unity check	0,02	-

Bending moment check for M_y

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.14)

W _{el,y,min}	3768,9311	cm ³
M _{el,y,Rd}	885,70	kNm
Unity check	0,63	-

Shear check for V_z

According to EN 1993-1-1 article 6.2.6 and formula (6.19)

Tau _{Vz,Ed}	6,8	kN/cm ²
Tau _{Rd}	13,6	kN/cm ²
Unity check	0,50	-

Note: No shear area is given for this section/fabrication, therefore the plastic shear resistance cannot be determined. As a result the elastic shear resistance according to EN 1993-1-1 article 6.2.6(4) is verified.

Combined bending, axial force and shear force check

According to EN 1993-1-1 article 6.2.1(5) and formula (6.1)

Elastic verification		
Fibre	19	
Sigma _{N,Ed}	-0,4	kN/cm ²
Sigma _{My,Ed}	-12,5	kN/cm ²
Sigma _{Mz,Ed}	0,0	kN/cm ²
Sigma _{tot,Ed}	-13,0	kN/cm ²
Tau _{Vy,Ed}	0,0	kN/cm ²
Tau _{Vz,Ed}	5,7	kN/cm ²
Tau _{t,Ed}	0,0	kN/cm ²
Tau _{tot,Ed}	5,7	kN/cm ²
Sigma _{von Mises,Ed}	16,3	kN/cm ²
Unity check	0,69	-

The member satisfies the section check.

....STABILITY CHECK:....

Lateral Torsional Buckling Check

According to article EN 1993-1-1 : 6.3.2.1. and formula (6.54)

LTB Parameters		
Method for LTB curve	Art. 6.3.2.2.	
W _y	3768.9311	cm ³
Elastic critical moment M _{cr}	24288.26	kNm
Relative slenderness Lambda _{LT}	0.19	
Limit slenderness Lambda _{LT,0}	0.40	

Mcr Parameters		
LTB length	2.340	m
k	1.00	
kw	1.00	
C1	1.88	
C2	0.05	
C3	1.00	

The slenderness or bending moment is such that Lateral Torsional Buckling effects may be ignored according to EN 1993-1-1 article 6.3.2.2(4)

The member satisfies the stability check.

Member B5	5,882 m	I + I var	S 235	MSN3nelin	0,66 -
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Partial safety factors	
Gamma M0 for resistance of cross-sections	1,00
Gamma M1 for resistance to instability	1,00
Gamma M2 for resistance of net sections	1,25

Material		
Yield strength fy	23,5	kN/cm ²
Ultimate strength fu	36,0	kN/cm ²
Fabrication	Welded	

Warning: Strength reduction in function of the thickness is not supported for this type of cross-section.

.....SECTION CHECK:....

Classification for cross-section design

According to EN 1993-1-1 article 5.5.2

Warning: Classification is not supported for this type of cross-section.

The section is checked as elastic, class 3.

The critical check is on position 0.000 m

Internal forces	Calculated	Unit
N,Ed	-187,88	kN
Vy,Ed	0,00	kN
Vz,Ed	70,17	kN
T,Ed	0,00	kNm
My,Ed	-125,80	kNm
Mz,Ed	0,00	kNm

Section properties

A	8.617282e+003 mm ²		
Ay/A	0.555	Az/A	0.453
Iy	3.027227e+008 mm ⁴	Iz	9.059495e+006 mm ⁴
Iyz	2.168404e-007 mm ⁴	It	2.452421e+005 mm ⁴
Iw	4.016613e+011 mm ⁶		
Wely	1.125756e+006 mm ³	Welz	1.207933e+005 mm ³
Wply	1.339771e+006 mm ³	Wplz	1.888354e+005 mm ³
cy	257.16 mm	cz	75.00 mm
dy	-0.00 mm	dz	-4.55 mm

Compression check

According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	86,1728	cm ²
Nc,Rd	2025,06	kN
Unity check	0,09	-

Bending moment check for My

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.14)

Wel,y,min	1125,7556	cm ³
Mel,y,Rd	264,55	kNm
Unity check	0,48	-

Shear check for Vz

According to EN 1993-1-1 article 6.2.6 and formula (6.19)

Tau,Vz,Ed	2,2	kN/cm ²
Tau,Rd	13,6	kN/cm ²
Unity check	0,17	-

Note: No shear area is given for this section/fabrication, therefore the plastic shear resistance cannot be determined. As a result the elastic shear resistance according to EN 1993-1-1 article 6.2.6(4) is verified.

Combined bending, axial force and shear force check

According to EN 1993-1-1 article 6.2.1(5) and formula (6.1)

Elastic verification		
Fibre	26	
Sigma,N,Ed	2,2	kN/cm ²

Elastic verification		
Sigma,My,Ed	10,7	kN/cm ²
Sigma,Mz,Ed	0,0	kN/cm ²
Sigma,tot,Ed	12,9	kN/cm ²
Tau,Vy,Ed	0,0	kN/cm ²
Tau,Vz,Ed	0,4	kN/cm ²
Tau,t,Ed	0,0	kN/cm ²
Tau,tot,Ed	0,4	kN/cm ²
Sigma,von Mises,Ed	12,9	kN/cm ²
Unity check	0,55	-

The member satisfies the section check.

.....STABILITY CHECK:.....

Flexural Buckling Check

According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	5,882	2,941	m
Buckling factor k	1,00	1,00	
Buckling length Lcr	5,882	2,941	m
Critical Euler load Ncr	18136,59	2171,07	kN
Slenderness Lambda	31,38	90,70	
Relative slenderness Lambda,rel	0,33	0,97	
Limit slenderness Lambda,rel,0	0,20	0,20	
Buckling curve	b	c	
Imperfection Alpha	0,34	0,49	
Reduction factor Chi	0,95	0,56	
Buckling resistance Nb,Rd	1926,74	1134,10	kN

Flexural Buckling verification		
Cross-section area A	86,1728	cm ²
Buckling resistance Nb,Rd	1134,10	kN
Unity check	0,17	-

Torsional (-Flexural) Buckling check

According to article EN 1993-1-1 : 6.3.1.1. and formula (6.46)

Table of values		
Torsional Buckling length	2.941	m
Ncr,T	3205.89	kN
Ncr,TF	2168.48	kN
Relative slenderness Lambda,T	0.97	
Limit slenderness Lambda,0	0.20	
Buckling curve	c	
Imperfection Alpha	0.49	
A	86.1728	cm ²
Reduction factor Chi	0.56	
Buckling resistance Nb,Rd	1133.40	kN
Unity check	0.17	-

Lateral Torsional Buckling Check

According to article EN 1993-1-1 : 6.3.2.1. and formula (6.54)

LTB Parameters		
Method for LTB curve	Art. 6.3.2.2.	
Wy	1125.7556	cm ³
Elastic critical moment Mcr	981.96	kNm
Relative slenderness Lambda,LT	0.52	
Limit slenderness Lambda,LT,0	0.40	

Mcr Parameters		
LTB length	2.941	m
k	1.00	
kw	1.00	
C1	1.96	
C2	0.05	
C3	1.00	

The slenderness or bending moment is such that Lateral Torsional Buckling effects may be ignored according to EN 1993-1-1 article 6.3.2.2(4)

Compression and bending check

According to article EN 1993-1-1 : 6.3.3. and formula (6.61), (6.62)

Interaction Method 1

Table of values		
kyy	1.082	
kyz	1.117	
kzy	1.039	
kzz	1.073	
Delta My	0.00	kNm
Delta Mz	0.00	kNm
A	86.1728	cm ²
Wy	1125.7556	cm ³
Wz	120.7933	cm ³
NRk	2025.06	kN
My,Rk	264.55	kNm
Mz,Rk	28.39	kNm
My,Ed	-125.80	kNm
Mz,Ed	0.00	kNm
Interaction Method 1		
Mcr0	501.98	kNm
reduced slenderness 0	0.73	
Psi y	-0.160	
Psi z	1.000	
Cmy,0	0.993	
Cmz,0	1.021	
Cmy	0.998	
Cmz	1.021	
CmLT	1.073	
muy	0.999	
muz	0.960	
wy	1.190	
wz	1.500	
npl	0.093	
aLT	0.999	
bLT	0.000	
cLT	0.359	
dLT	0.000	
eLT	0.509	
Cyy	0.990	
Cyz	0.830	
Czy	0.939	
Czz	0.971	

Unity check (6.61) = $0.10 + 0.51 + 0.00 = 0.61$

Unity check (6.62) = $0.17 + 0.49 + 0.00 = 0.66$

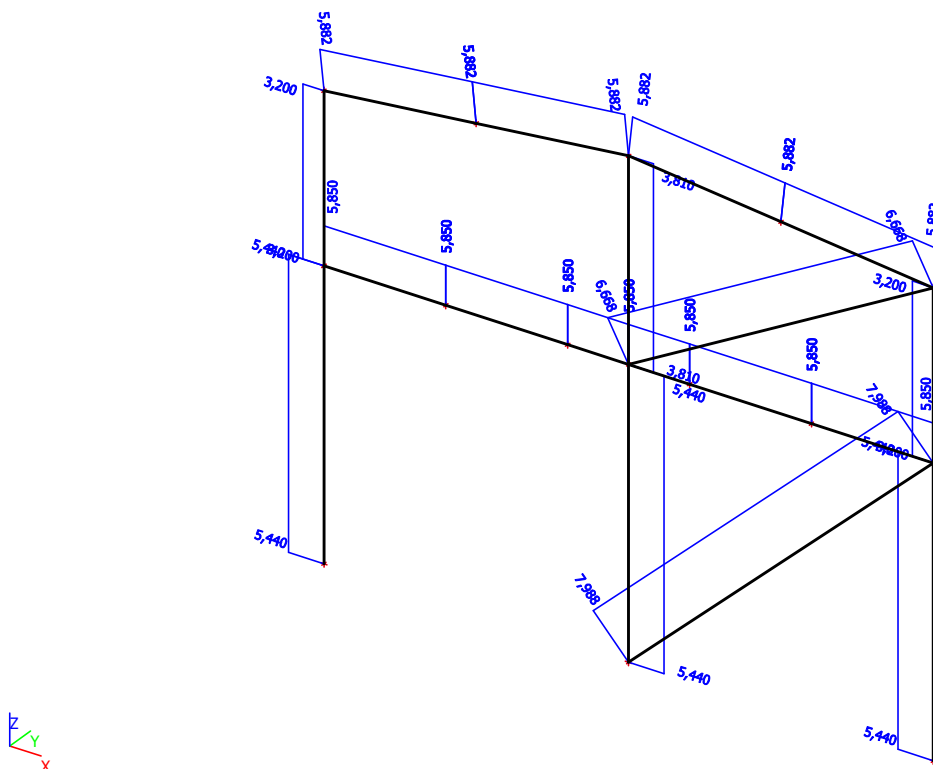
The member satisfies the stability check.

1. Priloga A.2

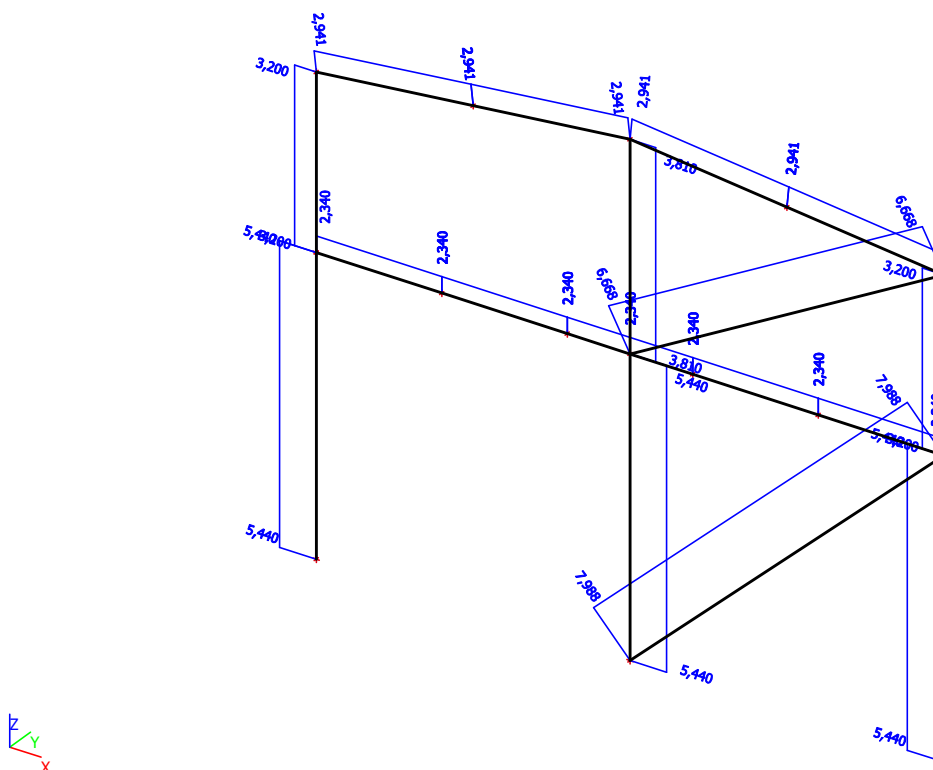
Linear calculation

Member	CS Name	Part	Sway y	Ly [m]	ky [-]	ly [m]	Lam y [-]	lyz [m]	I LTB [m]
			Sway z	Lz [m]	kz [-]	lz [m]	Lam z [-]		
B1	CS2	1	Yes	5,440	1,00	5,440	59,31	5,440	5,440
			No	5,440	1,00	5,440	98,53		
B1	CS2	2	Yes	3,200	1,00	3,200	34,89	3,200	3,200
			No	3,200	1,00	3,200	57,96		
B2	CS2	1	Yes	5,440	1,00	5,440	59,31	5,440	5,440
			No	5,440	1,00	5,440	98,53		
B2	CS2	2	Yes	3,200	1,00	3,200	34,89	3,200	3,200
			No	3,200	1,00	3,200	57,96		
B3	CS2	1	Yes	5,850	1,00	5,850	63,78	2,340	2,340
			No	2,340	1,00	2,340	42,38		
B3	CS2	2	Yes	5,850	1,00	5,850	63,78	2,340	2,340
			No	2,340	1,00	2,340	42,38		
B3	CS2	3	Yes	5,850	1,00	5,850	63,78	2,340	2,340
			No	2,340	1,00	2,340	42,38		
B3	CS2	4	Yes	5,850	1,00	5,850	63,78	2,340	2,340
			No	2,340	1,00	2,340	42,38		
B3	CS2	5	Yes	5,850	1,00	5,850	63,78	2,340	2,340
			No	2,340	1,00	2,340	42,38		
B3	CS2	6	Yes	5,850	1,00	5,850	63,78	2,340	2,340
			No	2,340	1,00	2,340	42,38		
B4	CS3	1	Yes	5,882	1,00	5,882	79,23	2,941	2,941
			No	2,941	1,00	2,941	143,06		
B4	CS3	2	Yes	5,882	1,00	5,882	79,23	2,941	2,941
			No	2,941	1,00	2,941	143,06		
B5	CS3	1	Yes	5,882	1,00	5,882	79,23	2,941	2,941
			No	2,941	1,00	2,941	143,06		
B5	CS3	2	Yes	5,882	1,00	5,882	79,23	2,941	2,941
			No	2,941	1,00	2,941	143,06		
B6	CS9	1	Yes	3,810	1,00	3,810	66,34	3,810	3,810
			No	3,810	1,00	3,810	230,26		
B7	CS10	1	Yes	5,440	1,00	5,440	82,92	5,440	5,440
			No	5,440	1,00	5,440	136,53		
B11	CS12	1	Yes	7,988	1,00	7,988	2690,50	7,988	7,988
			No	7,988	1,00	7,988	2690,50		
B12	CS12	1	Yes	6,668	1,00	6,668	2245,77	6,668	6,668
			No	6,668	1,00	6,668	2245,77		

2. ly



3. Iz



4. Result classes

4.1. Result classes - All MSN Nonlinear

Name	List
All MSN Nonlinear	MSN1nelin
	MSN2nelin
	MSN3nelin
	MSN4nelin

Name	List
	MSN5nelin
	MSN6nelin
	MSN7nelin
	MSN8nelin
	MSN9nelin
	MSN10nelin
	MSN11nelin
	MSN12nelin
	MSN13nelin
	MSN14nelin

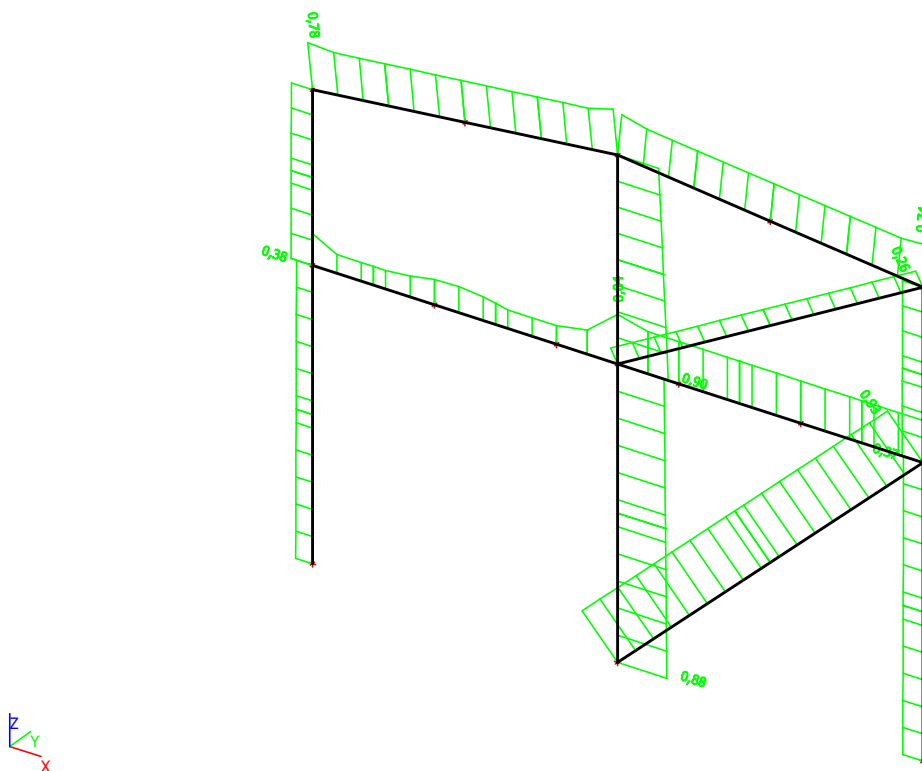
4.1.1. Check of steel

Nonlinear calculation, Extreme : Member

Selection : All

Class : All MSN Nonlinear

Member	css	mat	Case	dx [m]	un.check [-]	sec.check [-]	stab.check [-]
B1	CS2 - HEA220	S 235	MSN7nelin	5,440	0,38	0,36	0,38
B2	CS2 - HEA220	S 235	MSN2nelin	5,440	0,37	0,35	0,37
B3	CS2 - HEA220	S 235	MSN10nelin	5,850	0,84	0,84	0,00
B4	CS3 - IPE180	S 235	MSN3nelin	0,000	0,78	0,59	0,78
B5	CS3 - IPE180	S 235	MSN3nelin	0,000	0,74	0,54	0,74
B6	CS9 - IPE140	S 235	MSN3nelin	3,810	0,90	0,13	0,90
B7	CS10 - HEA160	S 235	MSN7nelin	5,440	0,88	0,29	0,88
B11	CS12 - RD12	S 235	MSN5nelin	7,988	0,93	0,93	0,00
B12	CS12 - RD12	S 235	MSN5nelin	6,668	0,26	0,26	0,00



Nonlinear calculation, Extreme : Cross-section

Selection : All

Class : All MSN Nonlinear

Member B3	11,700 m	HEA220	S 235	MSN10nelin	0,84 -
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Partial safety factors		
Gamma M0 for resistance of cross-sections		1,00
Gamma M1 for resistance to instability		1,00
Gamma M2 for resistance of net sections		1,25

Material		
Yield strength fy	23,5	kN/cm ²
Ultimate strength fu	36,0	kN/cm ²
Fabrication	Rolled	

....:SECTION CHECK:....

Classification for cross-section design

According to EN 1993-1-1 article 5.5.2

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	21,71
Class 1 Limit	72,67
Class 2 Limit	83,77
Class 3 Limit	124,01

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	8,05
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	13,77

=> Outstand Flanges Class 1

=> Section classified as Class 1 for cross-section design

The critical check is on position 5.850 m

Internal forces	Calculated	Unit
N _{Ed}	9,31	kN
V _{y,Ed}	0,00	kN
V _{z,Ed}	-108,74	kN
T _{Ed}	0,00	kNm
M _{y,Ed}	-111,59	kNm
M _{z,Ed}	0,00	kNm

Tension check

According to EN 1993-1-1 article 6.2.3 and formula (6.5)

A	64,3000	cm ²
N _{pl,Rd}	1511,05	kN
N _{u,Rd}	1666,66	kN
N _{t,Rd}	1511,05	kN
Unity check	0,01	-

Bending moment check for M_y

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

W _{pl,y}	566,6670	cm ³
M _{pl,y,Rd}	133,17	kNm
Unity check	0,84	-

Shear check for V_z

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

E _a	1,20	
A _v	20,6300	cm ²
V _{pl,z,Rd}	279,90	kN
Unity check	0,39	-

Combined bending, axial force and shear force check

According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

M _{pl,y,Rd}	133,17	kNm
Alpha	2,00	
M _{pl,z,Rd}	63,55	kNm
Beta	1,00	

Unity check (6.41) = 0,70 + 0,00 = 0,70 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

Note: Since the axial force satisfies both criteria (6.33) and (6.34) of EN 1993-1-1 article 6.2.9.1(4) its effect on the moment resistance about the y-y axis is neglected.

Note: Since the axial force satisfies criteria (6.35) of EN 1993-1-1 article 6.2.9.1(4) its effect on the moment resistance about the z-z axis is neglected.

The member satisfies the section check.

....:STABILITY CHECK:....

Classification for member buckling design

Decisive position for stability classification: 0,000 m

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	21,71
Class 1 Limit	73,16

Class 2 Limit	84,34
Class 3 Limit	124,02

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	8,05
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	13,77

=> Outstand Flanges Class 1

=> Section classified as Class 1 for member buckling design

Lateral Torsional Buckling Check

According to article EN 1993-1-1 : 6.3.2.1. and formula (6.54)

LTB Parameters		
Method for LTB curve	Art. 6.3.2.2.	
W _y	566.6670	cm ³
Elastic critical moment M _{cr}	1138.65	kNm
Relative slenderness Lambda _{LT}	0.34	
Limit slenderness Lambda _{LT,0}	0.40	

Mcr Parameters		
LTB length	2.340	m
k	1.00	
k _w	1.00	
C1	1.35	
C2	0.63	
C3	0.41	

The slenderness or bending moment is such that Lateral Torsional Buckling effects may be ignored according to EN 1993-1-1 article 6.3.2.2(4)

Shear buckling check

in buckling field 1

According to article EN 1993-1-5 : 5. & 7.1. and formula (5.10) & (7.1)

Table of values	
hw/t	26.857

The web slenderness is such that the Shear Buckling Check is not required.

The member satisfies the stability check.

Member B4	5,882 m	IPE180	S 235	MSN3nelin	0,78 -
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Partial safety factors	
Gamma M0 for resistance of cross-sections	1,00
Gamma M1 for resistance to instability	1,00
Gamma M2 for resistance of net sections	1,25

Material		
Yield strength f _y	23,5	kN/cm ²
Ultimate strength f _u	36,0	kN/cm ²
Fabrication	Rolled	

.....SECTION CHECK:....

Classification for cross-section design

According to EN 1993-1-1 article 5.5.2

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	27,55
Class 1 Limit	61,91
Class 2 Limit	71,29
Class 3 Limit	107,57

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	4,23
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	13,77

=> Outstand Flanges Class 1

=> Section classified as Class 1 for cross-section design

The critical check is on position 0.000 m

Internal forces	Calculated	Unit
N _{Ed}	-25,08	kN
V _{y,Ed}	0,00	kN
V _{z,Ed}	23,29	kN
T _{Ed}	0,00	kNm
M _{y,Ed}	-22,88	kNm
M _{z,Ed}	0,00	kNm

Compression check

According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	23,9000	cm ²
N _{c,Rd}	561,65	kN
Unity check	0,04	-

Bending moment check for M_y

According to EN 1993-1-1 article 6.2.5 and formula (6.12),(6.13)

W _{pl,y}	166,0000	cm ³
M _{pl,y,Rd}	39,01	kNm
Unity check	0,59	-

Shear check for V_z

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

E _t	1,20	
A _v	11,2040	cm ²
V _{pl,z,Rd}	152,01	kN
Unity check	0,15	-

Combined bending, axial force and shear force check

According to EN 1993-1-1 article 6.2.9.1 and formula (6.41)

M _{pl,y,Rd}	39,01	kNm
Alpha	2,00	
M _{pl,z,Rd}	8,13	kNm
Beta	1,00	

Unity check (6.41) = 0,34 + 0,00 = 0,34 -

Note: Since the shear forces are less than half the plastic shear resistances their effect on the moment resistances is neglected.

Note: Since the axial force satisfies both criteria (6.33) and (6.34) of EN 1993-1-1 article 6.2.9.1(4) its effect on the moment resistance about the y-y axis is neglected.

Note: Since the axial force satisfies criteria (6.35) of EN 1993-1-1 article 6.2.9.1(4) its effect on the moment resistance about the z-z axis is neglected.

The member satisfies the section check.

....STABILITY CHECK:....

Classification for member buckling design

Decisive position for stability classification: 0,000 m

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	27,55
Class 1 Limit	61,91
Class 2 Limit	71,29
Class 3 Limit	107,57

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	4,23
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	13,77

=> Outstand Flanges Class 1

=> Section classified as Class 1 for member buckling design

Flexural Buckling Check

According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	5,882	2,941	m
Buckling factor k	1,00	1,00	
Buckling length L _{cr}	5,882	2,941	m
Critical Euler load N _{cr}	789,04	242,04	kN
Slenderness Lambda	79,23	143,06	
Relative slenderness	0,84	1,52	
Lambda _{rel}			

Buckling parameters	yy	zz	
Limit slenderness Lambda,rel,0	0,20	0,20	
Buckling curve	a	b	
Imperfection Alpha	0,21	0,34	
Reduction factor Chi	0,77	0,33	
Buckling resistance Nb,Rd	432,36	187,48	kN

Flexural Buckling verification		
Cross-section area A	23,9000	cm ²
Buckling resistance Nb,Rd	187,48	kN
Unity check	0,13	-

Lateral Torsional Buckling Check

According to article EN 1993-1-1 : 6.3.2.1. and formula (6.54)

LTB Parameters		
Method for LTB curve	Art. 6.3.2.2.	
Wy	166.0000	cm ³
Elastic critical moment Mcr	116.26	kNm
Relative slenderness Lambda,LT	0.58	
Limit slenderness Lambda,LT,0	0.40	
LTB curve	a	
Imperfection Alpha,LT	0.21	
Reduction factor Chi,LT	0.90	
Buckling resistance Mb,Rd	35.02	kNm
Unity check	0.65	-

Mcr Parameters		
LTB length	2.941	m
k	1.00	
kw	1.00	
C1	3.14	
C2	0.43	
C3	1.00	

Note: C Parameters according to ECCS 119 2006 / Galea 2002
load in center of gravity

Compression and bending check

According to article EN 1993-1-1 : 6.3.3. and formula (6.61), (6.62)
Interaction Method 1

Table of values		
kyy	1.102	
kyz	1.277	
kzy	0.581	
kzz	1.125	
Delta My	0.00	kNm
Delta Mz	0.00	kNm
A	23.9000	cm ²
Wy	166.0000	cm ³
Wz	34.6000	cm ³
NRk	561.65	kN
My,Rk	39.01	kNm
Mz,Rk	8.13	kNm
My,Ed	-22.88	kNm
Mz,Ed	0.00	kNm
Interaction Method 1		
Mcr0	36.98	kNm
reduced slenderness 0	1.03	
Psi y	0.945	
Psi z	1.000	
Cmy,0	0.979	
Cmz,0	1.025	
Cmy	0.996	
Cmz	1.025	
CmLT	1.057	
muy	0.993	
muz	0.929	
wy	1.137	
wz	1.500	
npl	0.045	
aLT	0.996	
bLT	0.000	
cLT	0.664	
dLT	0.000	
eLT	0.208	
Cyy	0.979	
Cyz	0.612	

Table of values		
Czy	0.909	
Czz	0.944	

Unity check (6.61) = $0.06 + 0.72 + 0.00 = 0.78$

Unity check (6.62) = $0.13 + 0.38 + 0.00 = 0.51$

Shear buckling check

in buckling field 1

According to article EN 1993-1-5 : 5. & 7.1. and formula (5.10) & (7.1)

Table of values	
hw/t	30.943

The web slenderness is such that the Shear Buckling Check is not required.

The member satisfies the stability check.

Member B6	3,810 m	IPE140	S 235	MSN3nelin	0,90 -
------------------	----------------	---------------	--------------	------------------	---------------

Partial safety factors	
Gamma M0 for resistance of cross-sections	1,00
Gamma M1 for resistance to instability	1,00
Gamma M2 for resistance of net sections	1,25

Material		
Yield strength fy	23,5	kN/cm ²
Ultimate strength fu	36,0	kN/cm ²
Fabrication	Rolled	

....SECTION CHECK:....

Classification for cross-section design

According to EN 1993-1-1 article 5.5.2

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	23,87
Class 1 Limit	33,00
Class 2 Limit	38,00
Class 3 Limit	42,00

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	3,93
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	14,00

=> Outstand Flanges Class 1

=> Section classified as Class 1 for cross-section design

The critical check is on position 3.810 m

Internal forces	Calculated	Unit
N,Ed	-50,25	kN
Vy,Ed	0,00	kN
Vz,Ed	0,00	kN
T,Ed	0,00	kNm
My,Ed	0,00	kNm
Mz,Ed	0,00	kNm

Compression check

According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	16,4000	cm ²
Nc,Rd	385,40	kN
Unity check	0,13	-

Shear check for Vy

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

Eta	1,20	
Av	10,6239	cm ²
Vpl,y,Rd	144,14	kN
Unity check	0,00	-

The member satisfies the section check.

....STABILITY CHECK:....

Classification for member buckling design

Decisive position for stability classification: 0,000 m

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	23,87
Class 1 Limit	33,00
Class 2 Limit	38,00
Class 3 Limit	42,00

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	3,93
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	14,00

=> Outstand Flanges Class 1

=> Section classified as Class 1 for member buckling design

Flexural Buckling Check

According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	3,810	3,810	m
Buckling factor k	1,00	1,00	
Buckling length Lcr	3,810	3,810	m
Critical Euler load Ncr	772,44	64,11	kN
Slenderness Lambda	66,34	230,26	
Relative slenderness Lambda,rel	0,71	2,45	
Limit slenderness Lambda,rel,0	0,20	0,20	
Buckling curve	a	b	
Imperfection Alpha	0,21	0,34	
Reduction factor Chi	0,84	0,14	
Buckling resistance Nb,Rd	325,56	55,80	kN

Warning: Slenderness 230,26 is larger than the limit value of 200,00.

Flexural Buckling verification		
Cross-section area A	16,4000	cm ²
Buckling resistance Nb,Rd	55,80	kN
Unity check	0,90	-

Compression and bending check

According to article EN 1993-1-1 : 6.3.3. and formula (6.61), (6.62)

Interaction Method 1

Table of values		
kyy	2.826	
kyz	7.348	
kzy	0.697	
kzz	1.812	
Delta My	0.00	kNm
Delta Mz	0.00	kNm
A	16.4000	cm ²
Wy	88.3000	cm ³
Wz	19.3000	cm ³
NRk	385.40	kN
My,Rk	20.75	kNm
Mz,Rk	4.54	kNm
My,Ed	0.00	kNm
Mz,Ed	0.00	kNm
Interaction Method 1		
Mcr0	12.04	kNm
reduced slenderness 0	1.31	
Psi y	1.000	
Psi z	1.000	
Cmy,0	1.016	
Cmz,0	1.024	
Cmy	1.016	
Cmz	1.024	
CmLT	2.302	
muy	0.989	
muz	0.244	
wy	1.142	
wz	1.500	
npl	0.130	
aLT	0.995	
bLT	0.000	
cLT	0.000	
dLT	0.000	

Table of values		
eLT	0.000	
Cyy	0.875	
Cyz	0.438	
Czy	0.458	
Czz	0.637	

Unity check (6.61) = $0.15 + 0.00 + 0.01 = 0.16$

Unity check (6.62) = $0.90 + 0.00 + 0.00 = 0.90$

The member satisfies the stability check.

Member B7	5,440 m	HEA160	S 235	MSN7nelin	0,88 -
------------------	----------------	---------------	--------------	------------------	---------------

Partial safety factors	
Gamma M0 for resistance of cross-sections	1,00
Gamma M1 for resistance to instability	1,00
Gamma M2 for resistance of net sections	1,25

Material		
Yield strength fy	23,5	kN/cm ²
Ultimate strength fu	36,0	kN/cm ²
Fabrication	Rolled	

....SECTION CHECK:....

Classification for cross-section design

According to EN 1993-1-1 article 5.5.2

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	17,33
Class 1 Limit	33,00
Class 2 Limit	38,00
Class 3 Limit	42,00

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	6,89
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	14,00

=> Outstand Flanges Class 1

=> Section classified as Class 1 for cross-section design

The critical check is on position 5.440 m

Internal forces	Calculated	Unit
N _{Ed}	-263,76	kN
V _{y,Ed}	0,01	kN
V _{z,Ed}	0,00	kN
T _{Ed}	0,00	kNm
M _{y,Ed}	0,00	kNm
M _{z,Ed}	0,00	kNm

Compression check

According to EN 1993-1-1 article 6.2.4 and formula (6.9)

A	38,8000	cm ²
N _{c,Rd}	911,80	kN
Unity check	0,29	-

Shear check for V_y

According to EN 1993-1-1 article 6.2.6 and formula (6.17)

Eta	1,20	
Av	30,0600	cm ²
V _{pl,y,Rd}	407,85	kN
Unity check	0,00	-

The member satisfies the section check.

....STABILITY CHECK:....

Classification for member buckling design

Decisive position for stability classification: 0,000 m

Classification of Internal Compression parts

According to EN 1993-1-1 Table 5.2 Sheet 1

Maximum width-to-thickness ratio	17,33
Class 1 Limit	33,00
Class 2 Limit	38,00
Class 3 Limit	42,00

=> Internal Compression parts Class 1

Classification of Outstand Flanges

According to EN 1993-1-1 Table 5.2 Sheet 2

Maximum width-to-thickness ratio	6,89
Class 1 Limit	9,00
Class 2 Limit	10,00
Class 3 Limit	14,00

=> Outstand Flanges Class 1

=> Section classified as Class 1 for member buckling design

Flexural Buckling Check

According to EN 1993-1-1 article 6.3.1.1 and formula (6.46)

Buckling parameters	yy	zz	
Sway type	sway	non-sway	
System length L	5,440	5,440	m
Buckling factor k	1,00	1,00	
Buckling length Lcr	5,440	5,440	m
Critical Euler load Ncr	1169,60	431,42	kN
Slenderness Lambda	82,92	136,53	
Relative slenderness Lambda,rel	0,88	1,45	
Limit slenderness Lambda,rel,0	0,20	0,20	
Buckling curve	b	c	
Imperfection Alpha	0,34	0,49	
Reduction factor Chi	0,67	0,33	
Buckling resistance Nb,Rd	612,85	300,88	kN

Flexural Buckling verification		
Cross-section area A	38,8000	cm ²
Buckling resistance Nb,Rd	300,88	kN
Unity check	0,88	-

Compression and bending check

According to article EN 1993-1-1 : 6.3.3. and formula (6.61), (6.62)

Interaction Method 1

Table of values		
kyy	2.625	
kyz	2.363	
kzy	1.400	
kzz	1.775	
Delta My	0.00	kNm
Delta Mz	0.00	kNm
A	38.8000	cm ²
Wy	245.0000	cm ³
Wz	117.5000	cm ³
NRk	911.80	kN
My,Rk	57.58	kNm
Mz,Rk	27.61	kNm
My,Ed	0.00	kNm
Mz,Ed	-0.01	kNm
Interaction Method 1		
Mcr0	72.11	kNm
reduced slenderness 0	0.89	
Psi y	1.000	
Psi z	1.000	
Cmy,0	1.054	
Cmz,0	1.018	
Cmy	1.054	
Cmz	1.018	
CmLT	1.897	
muy	0.913	
muz	0.487	
wy	1.114	
wz	1.500	
npl	0.289	
aLT	0.993	
bLT	0.000	
cLT	0.000	
dLT	0.000	
eLT	0.000	
Cyy	0.898	
Cyz	0.705	
Czy	0.464	
Czz	0.719	

Unity check (6.61) = $0.43 + 0.00 + 0.00 = 0.43$

Unity check (6.62) = $0.88 + 0.00 + 0.00 = 0.88$

The member satisfies the stability check.

Member B11	7,988 m	RD12	S 235	MSN5nelin	0,93 -
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Partial safety factors	
Gamma M0 for resistance of cross-sections	1,00
Gamma M1 for resistance to instability	1,00
Gamma M2 for resistance of net sections	1,25

Material		
Yield strength f_y	23,5	kN/cm ²
Ultimate strength f_u	36,0	kN/cm ²
Fabrication	Rolled	

Warning: Strength reduction in function of the thickness is not supported for this type of cross-section.

....:SECTION CHECK:....

Classification for cross-section design

According to EN 1993-1-1 article 5.5.2

Warning: Classification is not supported for this type of cross-section.

The section is checked as elastic, class 3.

The critical check is on position 7.988 m

Internal forces	Calculated	Unit
N _{Ed}	24,67	kN
V _{y,Ed}	0,00	kN
V _{z,Ed}	0,00	kN
T _{Ed}	0,00	kNm
M _{y,Ed}	0,00	kNm
M _{z,Ed}	0,00	kNm

Tension check

According to EN 1993-1-1 article 6.2.3 and formula (6.5)

A	1,1304	cm ²
N _{pl,Rd}	26,56	kN
N _{u,Rd}	29,30	kN
N _{t,Rd}	26,56	kN
Unity check	0,93	-

The member satisfies the section check.

....:STABILITY CHECK:....

The member satisfies the stability check.