

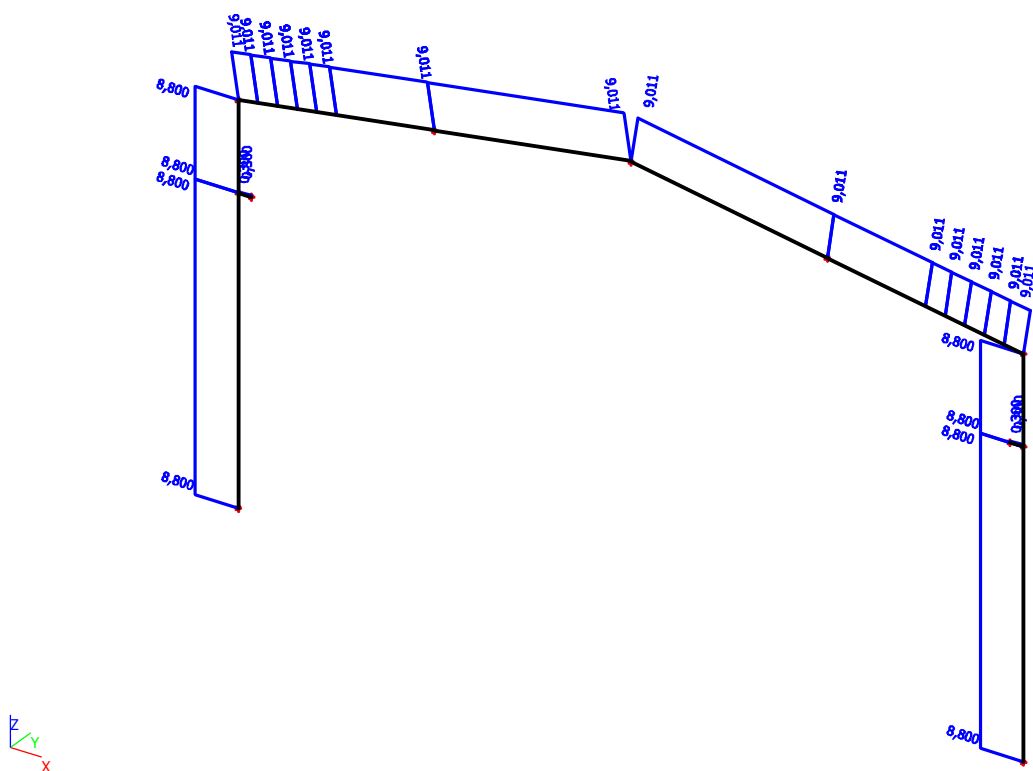
PRILOGA F: Kontrola nosilnosti in stabilnosti momentnega okvirja

1. Steel slenderness

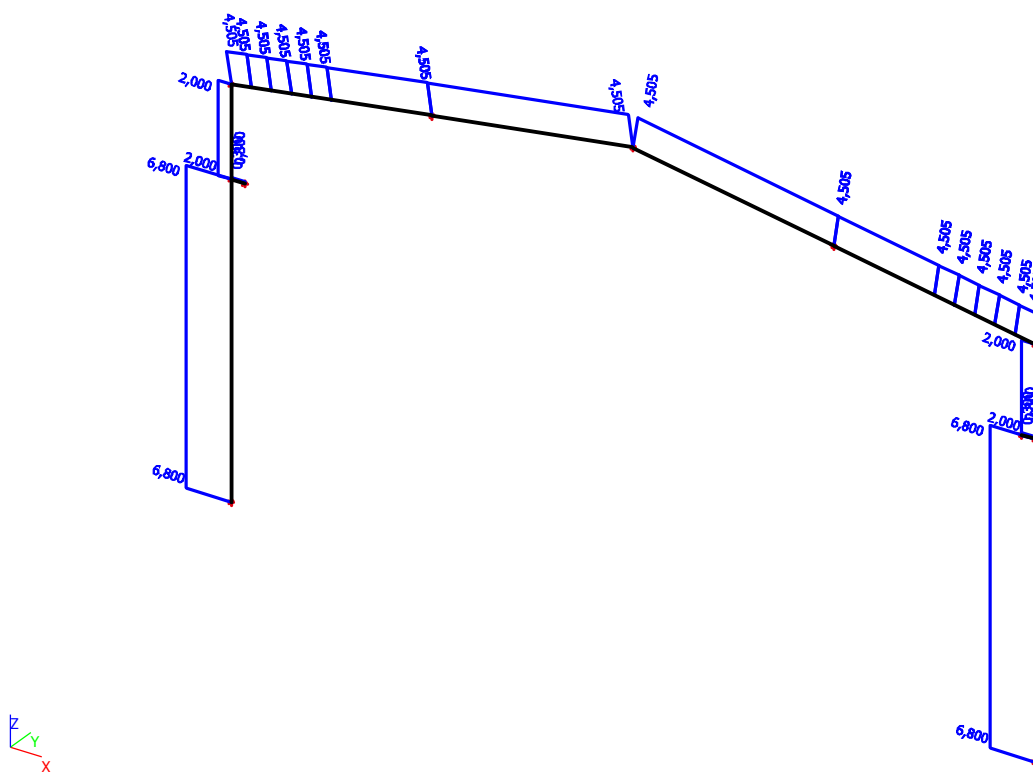
Linear calculation

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 [-]		
B2	CS22	1	Yes	9,011	1,00	9,011	31,21	4,505	4,505
			No	4,505	1,00	4,505	114,35		
B2	CS22	2	Yes	9,011	1,00	9,011	34,17	4,505	4,505
			No	4,505	1,00	4,505	111,71		
B2	CS22	3	Yes	9,011	1,00	9,011	37,57	4,505	4,505
			No	4,505	1,00	4,505	109,00		
B2	CS22	4	Yes	9,011	1,00	9,011	41,41	4,505	4,505
			No	4,505	1,00	4,505	106,23		
B2	CS22	5	Yes	9,011	1,00	9,011	45,56	4,505	4,505
			No	4,505	1,00	4,505	103,37		
B2	CS22	6	Yes	9,011	1,00	9,011	48,76	4,505	4,505
			No	4,505	1,00	4,505	109,44		
B2	CS22	7	Yes	9,011	1,00	9,011	48,76	4,505	4,505
			No	4,505	1,00	4,505	109,44		
B4	CS1	1	Yes	0,300	1,00	0,300	2,98	0,300	0,300
			No	0,300	1,00	0,300	5,00		
B5	CS7	1	Yes	8,800	1,00	8,800	57,84	2,000	2,000
			No	2,000	1,00	2,000	26,93		
B6	CS22	1	Yes	9,011	1,00	9,011	31,21	4,505	4,505
			No	4,505	1,00	4,505	114,35		
B6	CS22	2	Yes	9,011	1,00	9,011	34,17	4,505	4,505
			No	4,505	1,00	4,505	111,71		
B6	CS22	3	Yes	9,011	1,00	9,011	37,57	4,505	4,505
			No	4,505	1,00	4,505	109,00		
B6	CS22	4	Yes	9,011	1,00	9,011	41,41	4,505	4,505
			No	4,505	1,00	4,505	106,23		
B6	CS22	5	Yes	9,011	1,00	9,011	45,56	4,505	4,505
			No	4,505	1,00	4,505	103,37		
B6	CS22	6	Yes	9,011	1,00	9,011	48,76	4,505	4,505
			No	4,505	1,00	4,505	109,44		
B6	CS22	7	Yes	9,011	1,00	9,011	48,76	4,505	4,505
			No	4,505	1,00	4,505	109,44		
B7	CS1	1	Yes	0,300	1,00	0,300	2,98	0,300	0,300
			No	0,300	1,00	0,300	5,00		
B8	CS7	1	Yes	8,800	1,00	8,800	57,84	6,800	6,800
			No	6,800	1,00	6,800	91,55		
B9	CS7	1	Yes	8,800	1,00	8,800	57,84	2,000	2,000
			No	2,000	1,00	2,000	26,93		
B10	CS7	1	Yes	8,800	1,00	8,800	57,84	6,800	6,800
			No	6,800	1,00	6,800	91,55		

2. ly



3. lz



4. Result classes

4.1. Result classes - ovojnica MSN

Name	List
ovejnica MSN	MSN 1

Name	List
	MSN 2
	MSN 3
	MSN 4
	MSN 5
	MSN 6
	MSN 7
	MSN 8
	MSN 9
	MSN 10
	MSN 11
	MSN 12
	MSN 13
	MSN 14
	MSN 15
	MSN 16

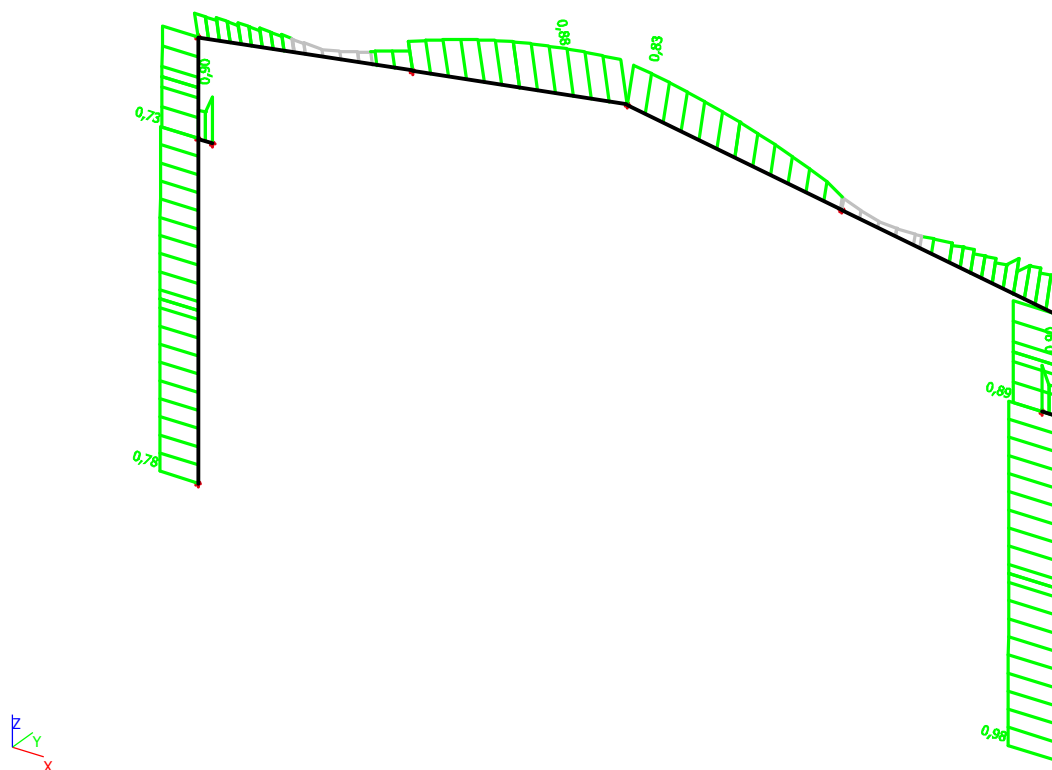
4.1.1. Check of steel

Nonlinear calculation, Extreme : Member

Selection : All

Class : ovojnica MSN

Member	css	mat	Case	dx [m]	un.check [-]	sec.check [-]	stab.check [-]
B2	CS22 - I + I var	S 235	MSN 7	7,885	0,88	0,55	0,88
B4	CS1 - HEA240	S 235	MSN 13	0,000	0,90	0,90	0,00
B5	CS7 - HEA360	S 235	MSN 1	0,000	0,89	0,51	0,89
B6	CS22 - I + I var	S 235	MSN 4	8,636	0,83	0,53	0,83
B7	CS1 - HEA240	S 235	MSN 16	0,000	0,90	0,90	0,34
B8	CS7 - HEA360	S 235	MSN 4	0,000	0,78	0,29	0,78
B9	CS7 - HEA360	S 235	MSN 4	0,000	0,73	0,42	0,73
B10	CS7 - HEA360	S 235	MSN 2	0,000	0,98	0,60	0,98



Nonlinear calculation, Extreme : Cross-section

Selection : All

Class : ovojnica MSN

Member B2	9,011 m	IPE450	S 235	MSN 7	0,88 -
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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	40,30
Class 1 Limit	65,85
Class 2 Limit	75,83
Class 3 Limit	112,37

=> 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	4,75
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 7.885 m

Internal forces	Calculated	Unit
N _{Ed}	-66,13	kN
V _{y,Ed}	0,00	kN
V _{z,Ed}	-2,21	kN
T _{Ed}	0,00	kNm
M _{y,Ed}	221,06	kNm
M _{z,Ed}	0,00	kNm

Section properties

A	9.889101e+003 mm ²		
A _y /A	0.565	A _z /A	0.435
I _y	3.377184e+008 mm ⁴	I _z	1.675997e+007 mm ⁴
I _{yz}	2.710505e-008 mm ⁴	I _t	6.687399e+005 mm ⁴
I _w	7.910051e+011 mm ⁶		
W _{ely}	1.500971e+006 mm ³	W _{elz}	1.764208e+005 mm ³
W _{ply}	1.703217e+006 mm ³	W _{plz}	2.764671e+005 mm ³
c _y	225.00 mm	c _z	95.00 mm
d _y	-0.00 mm	d _z	-0.00 mm

Compression check

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

A	98,8910	cm ²
N _{c,Rd}	2323,94	kN
Unity check	0,03	-

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}	1703,2171	cm ³
M _{pl,y,Rd}	400,26	kNm
Unity check	0,55	-

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	50,9154	cm ²
V _{pl,z,Rd}	690,81	kN
Unity check	0,00	-

Combined bending, axial force and shear force check

According to EN 1993-1-1 article 6.2.9.1 and formula (6.31)

M _{pl,y,Rd}	400,26	kNm
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Unity check	0,55	-
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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.

The member satisfies the section check.

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

Classification for member buckling design

Note: For this section the classification for cross-section design is also used for member buckling design.
=> 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	9,011	4,505	m
Buckling factor k	1,00	1,00	
Buckling length Lcr	9,011	4,505	m
Critical Euler load Ncr	8620,41	1711,22	kN
Slenderness Lambda	48,76	109,44	
Relative slenderness Lambda,rel	0,52	1,17	
Limit slenderness Lambda,rel,0	0,20	0,20	

Note: The slenderness or compression force is such that Flexural Buckling effects may be ignored according to EN 1993-1-1 article 6.3.1.2(4).

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	1703.2171	cm ³
Elastic critical moment Mcr	509.94	kNm
Relative slenderness Lambda,LT	0.89	
Limit slenderness Lambda,LT,0	0.40	
LTB curve	b	
Imperfection Alpha,LT	0.34	
Reduction factor Chi,LT	0.67	
Buckling resistance Mb,Rd	268.25	kNm
Unity check	0.82	-

Mcr Parameters		
LTB length	4.505	m
k	1.00	
kw	1.00	
C1	1.06	
C2	0.08	
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	1.039	
kyz	1.475	
kzy	0.556	
kzz	1.071	
Delta My	0.00	kNm
Delta Mz	0.00	kNm
A	98.8910	cm ²
Wy	1703.2171	cm ³
Wz	276.4671	cm ³
NRk	2323.94	kN
My,Rk	400.26	kNm
Mz,Rk	64.97	kNm
My,Ed	221.06	kNm
Mz,Ed	0.00	kNm
Interaction Method 1		
Mcr0	480.24	kNm

Table of values		
reduced slenderness	0	0.91
Psi y		-0.782
Psi z		1.000
Cmy,0		0.997
cmz,0		1.009
Cmy		0.999
cmz		1.009
CmLT		1.026
muy		1.000
muz		1.000
wy		1.135
wz		1.500
npl		0.028
aLT		0.998
bLT		0.000
cLT		1.002
dLT		0.000
eLT		0.657
Cyy		0.994
Cyz		0.491
Czy		0.969
Czz		0.980

Unity check (6.61) = $0.03 + 0.86 + 0.00 = 0.88$

Unity check (6.62) = $0.03 + 0.46 + 0.00 = 0.49$

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	44.766

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

The member satisfies the stability check.

Member B4	0,300 m	HEA240	S 235	MSN 13	0,90 -
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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:....

The critical check is on position **0.000 m**

Internal forces	Calculated	Unit
N,Ed	21,17	kN
Vy,Ed	0,00	kN
Vz,Ed	-192,21	kN
T,Ed	0,00	kNm
My,Ed	0,00	kNm
Mz,Ed	0,00	kNm

Tension check

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

A	76,8000	cm ²
Npl,Rd	1804,80	kN
Nu,Rd	1990,66	kN
Nt,Rd	1804,80	kN
Unity check	0,01	-

Shear check for Vz

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

Eta	1,20	
Av	25,1400	cm ²
Vpl,z,Rd	341,09	kN
Unity check	0,56	-

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	8	
Sigma,N,Ed	-0,3	kN/cm ²
Sigma,My,Ed	0,0	kN/cm ²
Sigma,Mz,Ed	0,0	kN/cm ²
Sigma,tot,Ed	-0,3	kN/cm ²
Tau,Vy,Ed	0,0	kN/cm ²
Tau,Vz,Ed	12,3	kN/cm ²
Tau,t,Ed	0,0	kN/cm ²
Tau,tot,Ed	12,3	kN/cm ²
Sigma,von Mises,Ed	21,2	kN/cm ²
Unity check	0,90	-

Note: Since there is no corresponding bending moment, the effect of the shear force cannot be accounted for in the plastic interaction. Therefore the elastic yield criterion according to EN 1993-1-1 article 6.2.1(5) is verified.

The member satisfies the section check.

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

Classification for member buckling design

Decisive position for stability classification: 0,150 m

Classification of Internal Compression parts

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

Maximum width-to-thickness ratio	21,87
Class 1 Limit	79,16
Class 2 Limit	91,25
Class 3 Limit	124,51

=> 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	7,94
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

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	27.467

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

The member satisfies the stability check.

Member B10	6,800 m	HEA360	S 235	MSN 2	0,98 -
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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	26,10
Class 1 Limit	42,06
Class 2 Limit	48,43
Class 3 Limit	91,42

=> 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	6,74
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}	-369,40	kN
V _{y,Ed}	0,00	kN
V _{z,Ed}	-85,43	kN
T _{Ed}	0,00	kNm
M _{y,Ed}	296,67	kNm
M _{z,Ed}	0,00	kNm

Compression check

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

A	143,0000	cm ²
N _{c,Rd}	3360,50	kN
Unity check	0,11	-

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}	2087,5000	cm ³
M _{pl,y,Rd}	490,56	kNm
Unity check	0,60	-

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	49,2000	cm ²
V _{pl,z,Rd}	667,53	kN
Unity check	0,13	-

Combined bending, axial force and shear force check

According to EN 1993-1-1 article 6.2.9.1 and formula (6.31)

M _{pl,y,Rd}	490,56	kNm
Unity check	0,60	-

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.

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	26,10
Class 1 Limit	42,06
Class 2 Limit	48,43
Class 3 Limit	91,42

=> 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	6,74
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	8,800	6,800	m
Buckling factor k	1,00	1,00	
Buckling length L _{cr}	8,800	6,800	m
Critical Euler load N _{cr}	8858,94	3536,54	kN

Buckling parameters	yy	zz	
Slenderness Lambda	57,84	91,55	
Relative slenderness Lambda,rel	0,62	0,97	
Limit slenderness Lambda,rel,0	0,20	0,20	
Buckling curve	b	c	
Imperfection Alpha	0,34	0,49	
Reduction factor Chi	0,83	0,55	
Buckling resistance Nb,Rd	2785,85	1864,06	kN

Flexural Buckling verification		
Cross-section area A	143,0000	cm ²
Buckling resistance Nb,Rd	1864,06	kN
Unity check	0,20	-

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	2087.5000	cm ³
Elastic critical moment Mcr	2279.53	kNm
Relative slenderness Lambda,LT	0.46	
Limit slenderness Lambda,LT,0	0.40	

Mcr Parameters		
LTB length	6.800	m
k	1.00	
kw	1.00	
C1	2.60	
C2	0.00	
C3	0.00	

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	1.101	
kyz	1.238	
kzy	0.578	
kzz	1.161	
Delta My	0.00	kNm
Delta Mz	0.00	kNm
A	143.0000	cm ²
Wy	2087.5000	cm ³
Wz	804.1670	cm ³
NRk	3360.50	kN
My,Rk	490.56	kNm
Mz,Rk	188.98	kNm
My,Ed	-378.91	kNm
Mz,Ed	0.00	kNm
Interaction Method 1		
Mcr0	877.86	kNm
reduced slenderness 0	0.75	
Psi y	-0.783	
Psi z	1.000	
Cmy,0	0.971	
Cmz,0	1.025	
Cmy	0.992	
Cmz	1.025	
CmLT	1.062	
muy	0.993	
muz	0.951	
wy	1.104	
wz	1.500	
npl	0.110	
aLT	0.995	
bLT	0.000	
cLT	0.733	
dLT	0.000	
eLT	0.982	
Cyy	0.991	

Table of values		
Cyz	0.642	
Czy	0.931	
Czz	0.937	

Unity check (6.61) = $0.13 + 0.85 + 0.00 = 0.98$

Unity check (6.62) = $0.20 + 0.45 + 0.00 = 0.64$

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	31.500

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

The member satisfies the stability check.