COMUNE DI AMEGLIA
PROVINCIA DELLA SPEZIA

Committente:
Cantieri Navali
S. Lorenzo S.p.a

Livello di Progetto:
Esecutivo

Titolo:

Nuovo Insediamento D2

Oggetto:

RELAZIONE SULLE STRUTTURE
VERIFICA STRUTTURE PARETI TAGLIAFUOCO
EDIF. G

Codice Progetto:
P093-16

Nome File:
P093-16-E-RE-STR-G051-A

Firme:

Rev.	Modifiche/Revisioni	Redatto	Data	Contr./Appr.	Data
A	PRIMA EMISSIONE	GB	06/12/18	DG/RV	06/12/18

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Sistema Certificato UNI EN ISO 9001
SC 10-2588/IAF 34

INDICE

PARETI TAGLIAFUOCO PICCH. 10

1 PREMESSA

La presente nota ha ad oggetto la determinazione delle caratteristiche della sollecitazioni di progetto e le verifiche SLU SLE delle strutture in acciaio che costituiscono l'ossatura della parete tagliafuoco ubicata sul picc. 10 dell'Edificio G.
Tale parete tagliafuoco ha dimensioni oltre gli standard direttamente certificabili dai produttori dei sistemi in cartongesso EI e, pertanto, si è proceduto a dimensionare una struttura specifica.
Le azioni che sollecitano la parete, oltre ai carichi gravitazionali G1 (peso proprio strutture metalliche) e G2 (peso orditura secondaria e lastre in cartongesso EI) sono l'azione del vento e l'azione sismica. L'azione della temperatura (variazione giornaliera – struttura non esposta), visto lo schema di vincolo adottato (fori asolati all'attacco su un bordo verticale) risulta non significativa ai fini statici.

2 Descrizione del modello strutturale

La struttura risulta costituita da travi orizzontali in profilati a doppio T con anima disposta in orizzontale connesse ai pilastri prefabbricati (vincolo cerniera – appoggio) e sostenute ai terzi da colonnine in profilati HEA 100. L'azione preponderante ai fini del dimensionamento e verifica è l'azione del vento, che risulta significativa ancorché si tratti di ambiente interno in quanto le due porzioni in cui risulta suddiviso il capannone possono essere alternativamente con portone a impacchettamento chiuso e con portone aperto (portoni di dimensione > 1/3 sup. parete. Sono stati realizzati due modelli FEM distinti. Il primo è relativo al campo ricompreso tra i fili C ed E (valido anche per il campo compreso tra i fili A e C)

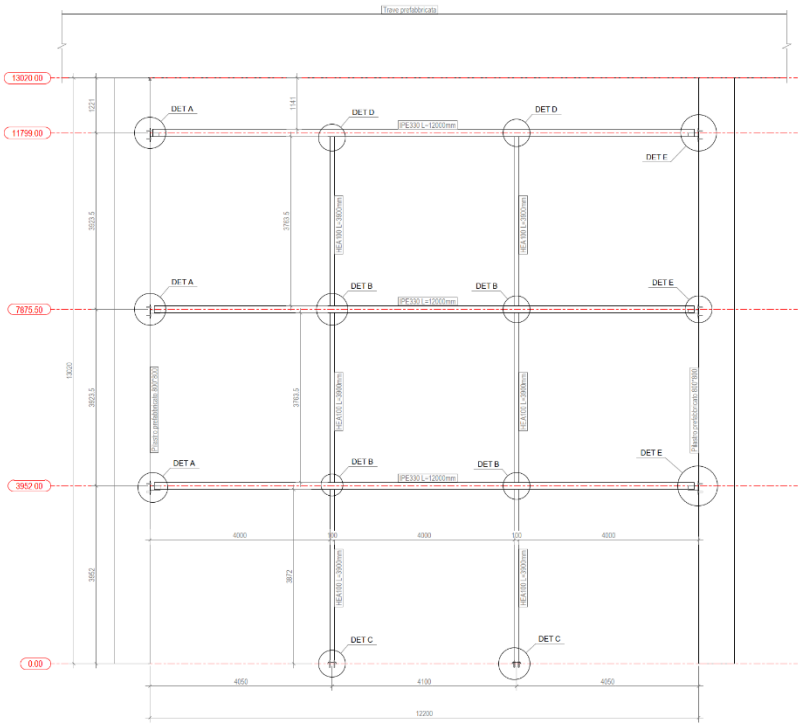


Figura 1 - Prospetto Campo tra fili C ed E

Il secondo modello FEM è relativo al campo ricompreso tra i fili E e H.

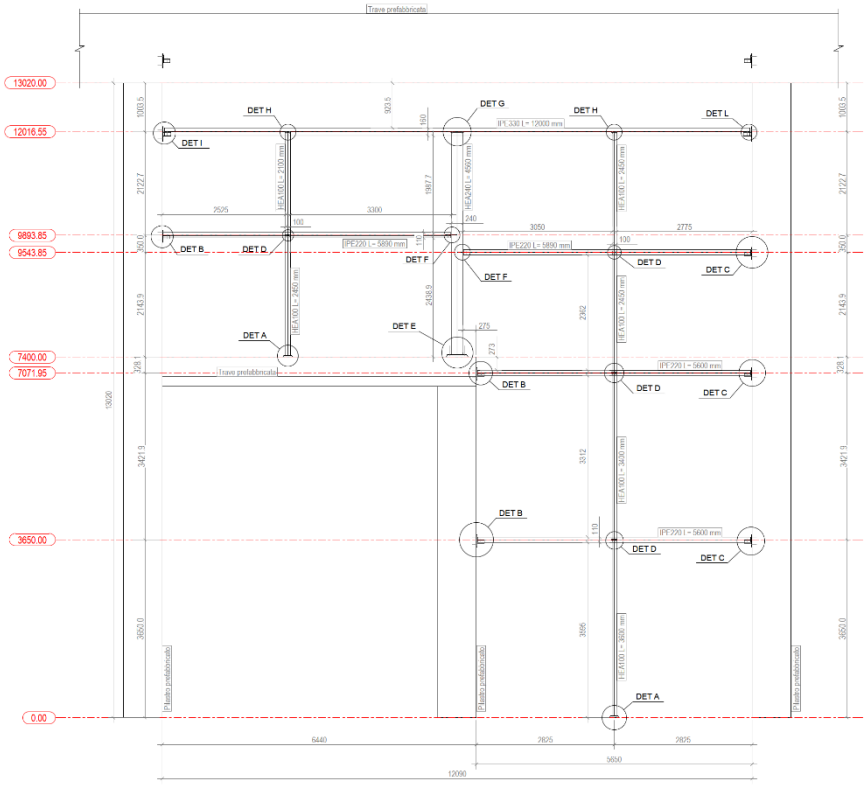


Figura 2 - Prospetto Campo tra fili E ed H

Si riportano nel seguito alcune immagini descrittive dei modelli strutturali implementati.

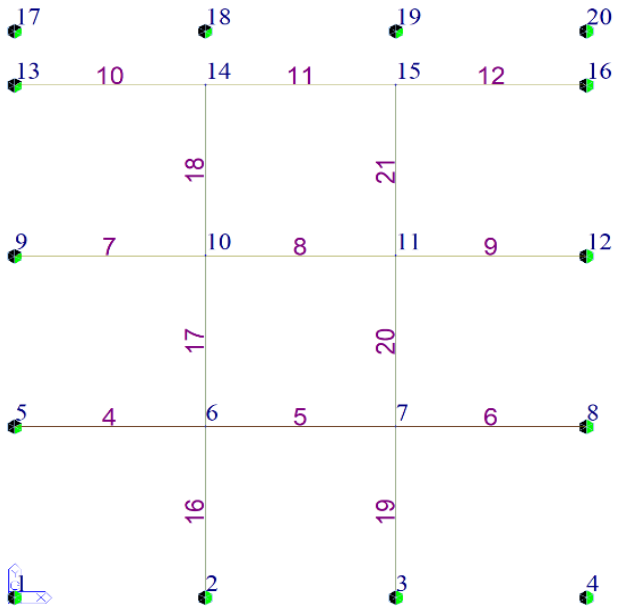


Figura 3 Modello FEM 1

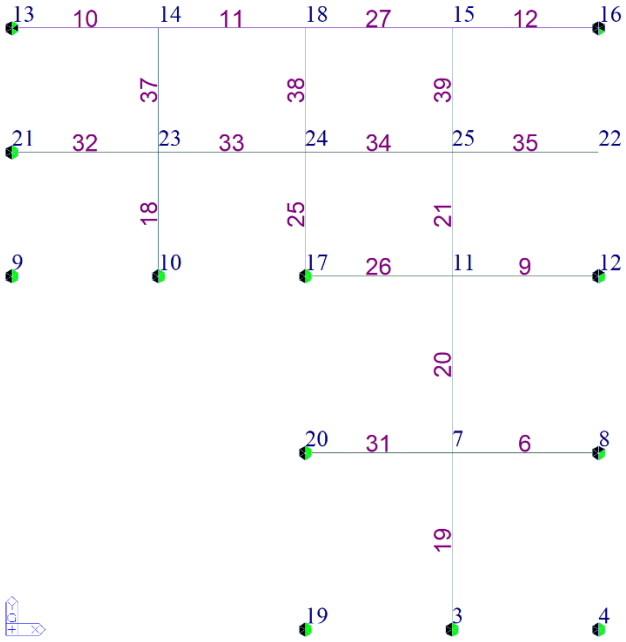


Figura 4 Modello FEM 2

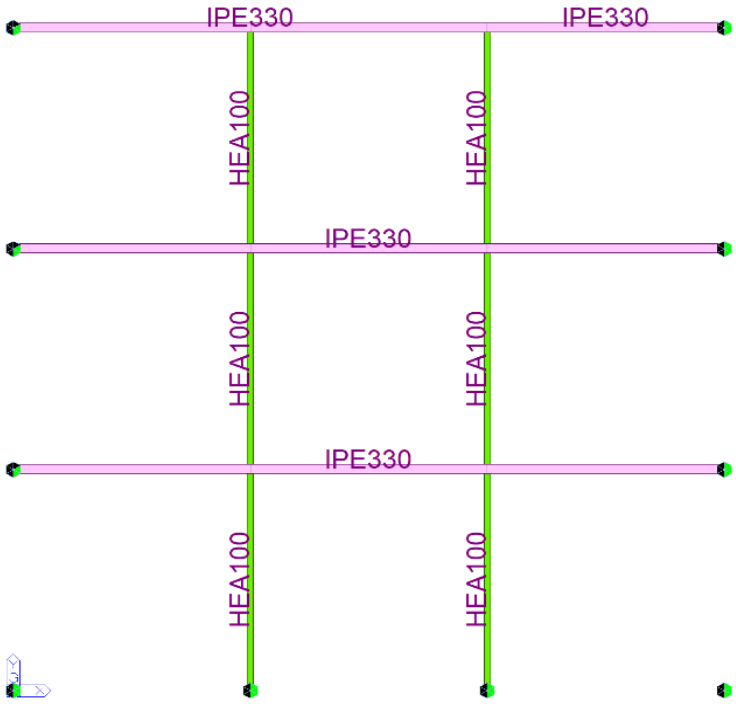


Figura 5 TAGLIAFUOCO Modello FEM 1

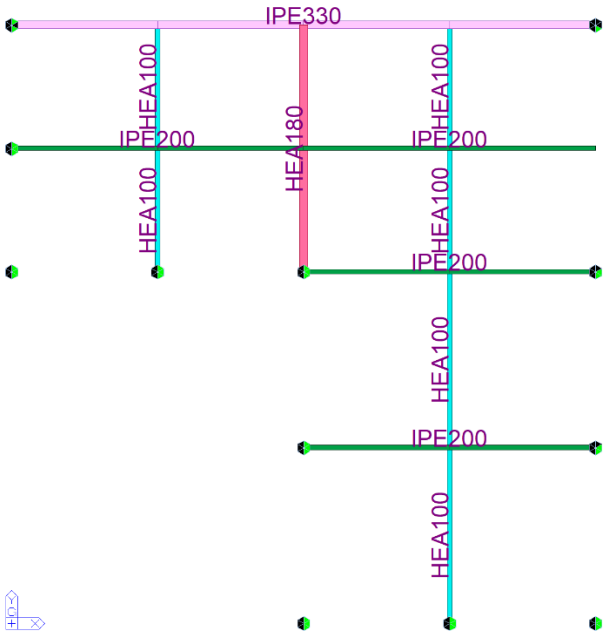


Figura 6 TAGLIAFUOCO Modello FEM 2

2.1 CONDIZIONI DI CARICO STATICHE

< Static Loadcase >

*** LOAD CASE DATA

NO	NAME	TYPE	SELF WEIGHT FACTOR X	Y	Z	DESCRIPTION
1	G1	D	0.000	-1.100	0.000	
2	G2	D	0.000	0.000	0.000	
3	W1	W	0.000	0.000	0.000	
4	E1	E	0.000	0.000	0.000	

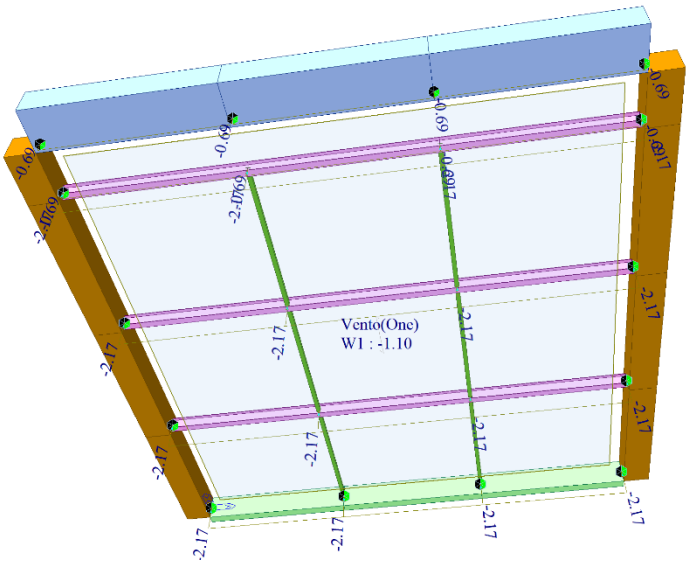


Figura 7 Azione Vento

2.2 AZIONE SISMICA

Gli elementi strutturali vengono dimensionati e verificati utilizzando lo spettro elastico (q=1) → non è richiesto il rispetto delle indicazioni sui dettagli costruttivi del capitolo 7 NTC2018.

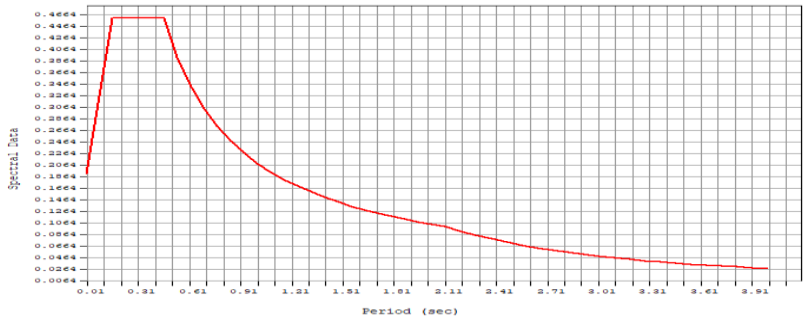


Figura 8 RSFunc Ameglia Elastico SLV

Stante l'entità dell'azione del vento l'azione sismica non risulta determinante ai fini del dimensionamento → le combinazioni di carico e le verifiche vengono pertanto omesse.

2.3 COMBINAZIONI DI CALCOLO

< Load Combination >

** STEEL DESIGN

NO	NAME	TYPE	ACTIVE	DESCRIPTION
1	SLU	Add	ACTIVE	
2	SLE	Add	SERVICE	

3 RISULTATI DELL'ELABORAZIONE SOLLECITAZIONI E DEFORMAZIONI

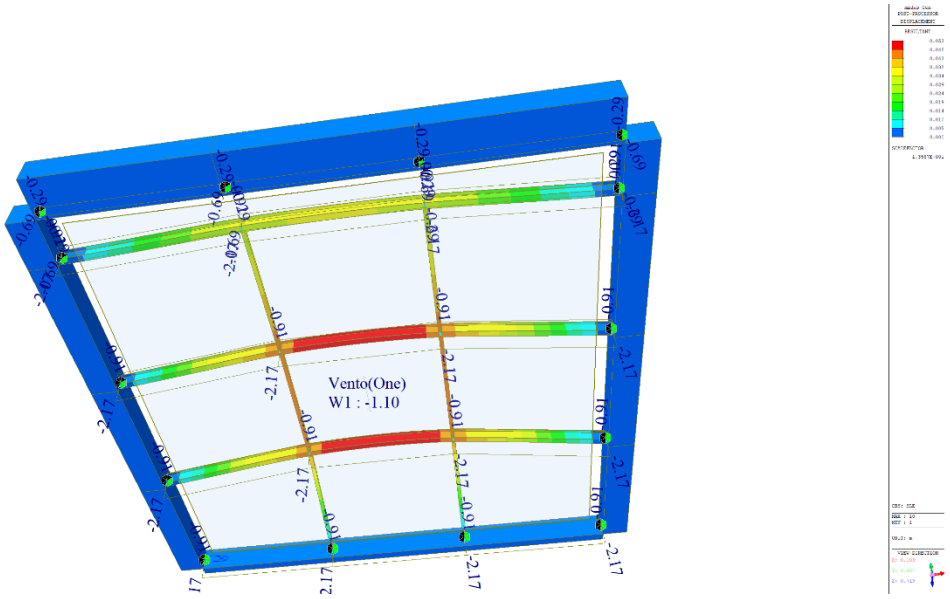


Figura 9 DeformCont SLE

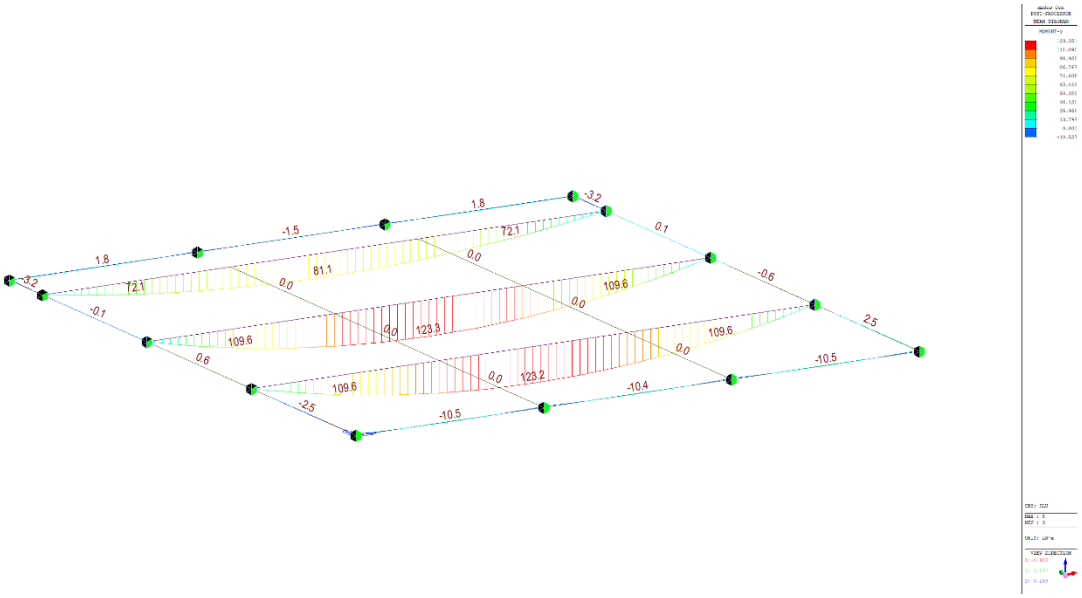


Figura 10 BeamDiag MOMENT Y SLU

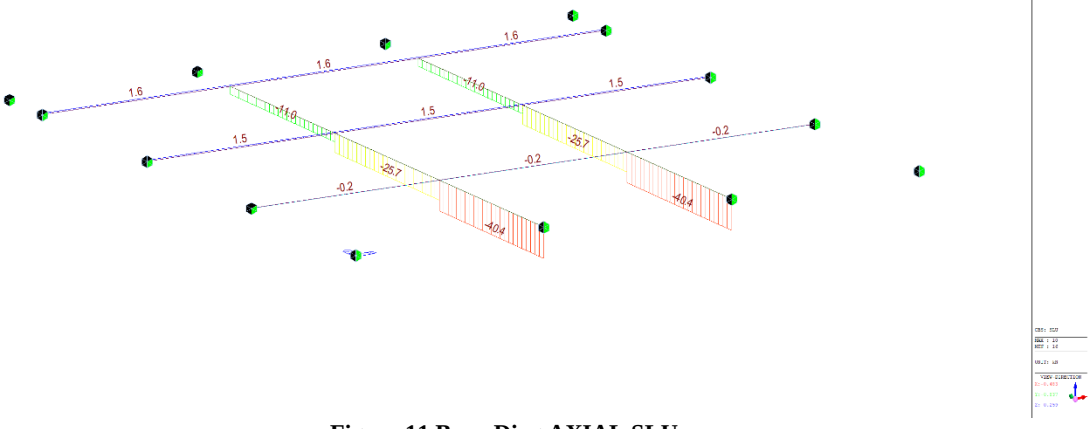


Figura 11 BeamDiag AXIAL SLU

4 VERIFICHE SEZIONI ACCIAIO

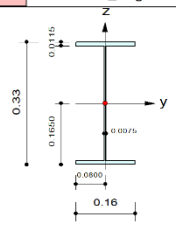
4.1 REPORT DI VERIFICA SINTETICI ELEMENTI IN ACCIAIO

midas Gen **Steel Checking Result**

Company	ITEC Engineering srl	**Project Title**	Pareti tagliafuoco D2
Author	ITEC-99	**File Name**	Y:\...93-16_Tagliafuoco_Rev_A1.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 4
Material : S355 (No:1)
(Fy = 355000, Es = 210000000)
Section Name : IPE330 (No:1)
(Rolled : IPE330).
Member Length : 12.3000



Depth	0.33000	Web Thick	0.00750
Top F Width	0.16000	Top F Thick	0.01150
Bot.F Width	0.16000	Bot.F Thick	0.01150
Area	0.00626	Asz	0.00248
Qyb	0.05085	Qzb	0.00320
Iyy	0.00012	Izz	0.00001
Ybar	0.08000	Zbar	0.16500
Wely	0.00071	Welz	0.00010
ry	0.13649	rz	0.03625

2. Member Forces

Axial Force Fxx = -0.1818 (LCB: 1, POS:1/2)
Bending Moments My = 123.246, Mz = 1.32651
End Moments Myi = 109.552, Myj = 109.552 (for Lb)
Myi = 0.00000, Myj = 0.00000 (for Ly)
Mzi = -5.0848, Mzj = -5.0848 (for Lz)
Shear Forces Fyy = 5.01477 (LCB: 1, POS:J)
Fzz = 40.0826 (LCB: 1, POS:J)

3. Design Parameters

Unbraced Lengths Ly = 12.3000, Lz = 4.10000, Lb = 4.10000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Results

Slenderness Ratio
KL/r = 113.1 < 200.0 (Memb:4, LCB: 1)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 0.18/2116.48 = 0.000 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 123.246/141.928 = 0.868 < 1.000 ..... O.K
M_Edz/M_Rdz = 1.3265/51.2272 = 0.026 < 1.000 ..... O.K
Combined Resistance
RNRd = MAX[M_Edy/Mny_Rd, M_Edz/Mnz_Rd]
Rmax1 = (M_Edy/Mny_Rd)^Alpha + (M_Edz/Mnz_Rd)^Beta
Rcom = N_Ed/(A*fy/Gamma_M0), Rbend = M_Edy/My_Rd + M_Edz/Mz_Rd
Rc_LT1 = N_Ed/(Xiy*A*fy/Gamma_M1)
Rb_LT1 = (kyy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (kyz*Msdz)/(Wplz*fy/Gamma_M1)
Rc_LT2 = N_Ed/(Xiz*A*fy/Gamma_M1)
Rb_LT2 = (Kzy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (Kzz*Msdz)/(Wplz*fy/Gamma_M1)
Rmax = MAX[RNRd, Rmax1, (Rcom+Rbend), MAX(Rc_LT1+Rb_LT1, Rc_LT2+Rb_LT2)] = 0.896 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.006 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.067 < 1.000 ..... O.K

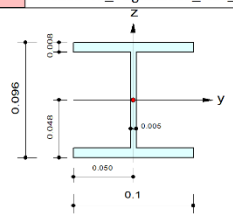
5. Deflection Checking Results

L/ 200.0 = 0.0615 > 0.0528 (Memb:7, LCB: 2, POS: 6.2m, Dir-Z)..... O.K

	Company	ITEC Engineering srl	**Project Title**	Pareti tagliafuoco D2
	Author	ITEC-99	**File Name**	Y:\...93-16_Tagliafuoco_Rev_A1.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 16
Material : S275 (No:2)
(Fy = 275000, Es = 210000000)
Section Name : HEA100 (No:2)
(Rolled : HEA100).
Member Length : 3.95000



2. Member Forces

Axial Force Fxx = -40.360 (LCB: 1, POS:I)
Bending Moments My = 0.00000, Mz = 0.00000
End Moments Myi = 0.00000, Myj = 0.00000 (for Lb)
Myi = 0.00000, Myj = 0.00000 (for Ly)
Mzi = 0.00000, Mzj = 0.00000 (for Lz)
Shear Forces Fyy = 0.00000 (LCB: 1, POS:1/2)
Fzz = 0.00000 (LCB: 1, POS:1/2)

Depth	0.09600	Web Thick	0.00500
Top F Width	0.10000	Top F Thick	0.00800
Bot.F Width	0.10000	Bot.F Thick	0.00800
Area	0.00212	Asz	0.00048
Qyb	0.00784	Qzb	0.00125
Iyy	0.00000	Izz	0.00000
Ybar	0.05000	Zbar	0.04800
Wely	0.00007	Welz	0.00003
ry	0.04060	rz	0.02510

3. Design Parameters

Unbraced Lengths Ly = 3.95000, Lz = 3.95000, Lb = 3.95000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Results

Slenderness Ratio
KL/r = 157.4 < 200.0 (Memb:16, LCB: 1)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 40.360/128.689 = 0.314 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 0.0000/21.7381 = 0.000 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.0000/10.6071 = 0.000 < 1.000 ..... O.K
Combined Resistance
RNRd = MAX[M_Edy/Mny_Rd, M_Edz/Mnz_Rd]
Rcom = N_Ed/(A*fy/Gamma_M0), Rbend = M_Edy/My_Rd + M_Edz/Mz_Rd
Rc_LT1 = N_Ed/(Xiy*A*fy/Gamma_M1)
Rb_LT1 = (kyy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (kyz*Msdz)/(Wplz*fy/Gamma_M1)
Rc_LT2 = N_Ed/(Xiz*A*fy/Gamma_M1)
Rb_LT2 = (Kzy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (Kzz*Msdz)/(Wplz*fy/Gamma_M1)
Rmax = MAX[RNRd, (Rcom+Rbend), MAX(Rc_LT1+Rb_LT1, Rc_LT2+Rb_LT2)] = 0.313 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.000 < 1.000 ..... O.K

5. Deflection Checking Results

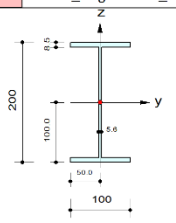
L/ 200.0 = 0.0198 > 0.0000 (Memb:16, LCB: 2, POS: 2.4m, Dir-Z)..... O.K

Steel Checking Result

	Company	ITEC Engineering srl	**Project Title**	Pareti tagliafuoco D2
	Author	ITEC-99	**File Name**	Y:\...6_Tagliafuoco_LAT_Rev_A1.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, mm
Member No : 31
Material : S355 (No:1)
(Fy = 0.35500, Es = 210.000)
Section Name : IPE200 (No:7)
(Rolled : IPE200).
Member Length : 6150.00



Depth	200.000	Web Thick	5.60000
Top F Width	100.000	Top F Thick	8.50000
Bot.F Width	100.000	Bot.F Thick	8.50000
Area	2850.00	Asz	1120.00
Qyb	18719.6	Qzb	1250.00
Iyy	19430000	Izz	1420000
Ybar	50.0000	Zbar	100.000
Wely	194000	Welz	28500.0
ry	82.3001	rz	22.8232

2. Member Forces

Axial Force Fxx = -1.1544 (LCB: 1, POS:1/2)
Bending Moments My = 28863.3, Mz = -2958.2
End Moments Myi = 0.00000, Myj = 28863.3 (for Lb)
Myi = 0.00000, Myj = 0.00000 (for Ly)
Mzi = 0.00000, Mzj = -2958.2 (for Lz)
Shear Forces Fyy = -4.8463 (LCB: 1, POS:1/2)
Fzz = -18.773 (LCB: 1, POS:I)

3. Design Parameters

Unbraced Lengths Ly = 6150.00, Lz = 3075.00, Lb = 3075.00
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Results

Slenderness Ratio
KL/r = 134.7 < 200.0 (Memb:31, LCB: 1)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 1.154/963.571 = 0.001 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 28863.3/38806.0 = 0.744 < 1.000 ..... O.K
M_Edz/M_Rdz = 2958.2/14854.1 = 0.199 < 1.000 ..... O.K
Combined Resistance
RNRd = MAX[M_Edy/Mny_Rd, M_Edz/Mnz_Rd]
Rmax1 = (M_Edy/Mny_Rd)^Alpha + (M_Edz/Mnz_Rd)^Beta
Rcom = N_Ed/(A*fy/Gamma_M0), Rbend = M_Edy/My_Rd + M_Edz/Mz_Rd
Rc_LT1 = N_Ed/(Xiy*A*fy/Gamma_M1)
Rb_LT1 = (kyy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (kyz*Msdz)/(Wplz*fy/Gamma_M1)
Rc_LT2 = N_Ed/(Xiz*A*fy/Gamma_M1)
Rb_LT2 = (Kzy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (Kzz*Msdz)/(Wplz*fy/Gamma_M1)
Rmax = MAX[RNRd, Rmax1, (Rcom+Rbend), MAX(Rc_LT1+Rb_LT1, Rc_LT2+Rb_LT2)] = 0.927 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.014 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.069 < 1.000 ..... O.K

5. Deflection Checking Results

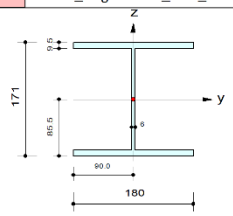
L/ 200.0 = 30.7500 > 18.7925 (Memb:31, LCB: 2, POS:3075.0mm, Dir-Z)..... O.K

midas Gen **Steel Checking Result**

Company	ITEC Engineering srl	**Project Title**	Pareti tagliafuoco D2
Author	ITEC-99	**File Name**	Y:\...6_Tagliafuoco_LAT_Rev_A1.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, mm
Member No : 25
Material : S355 (No:1)
(Fy = 0.35500, Es = 210.000)
Section Name : HEA180 (No:8)
(Rolled : HEA180).
Member Length : 5200.00



Depth	171.000	Web Thick	6.00000
Top F Width	180.000	Top F Thick	9.50000
Bot.F Width	180.000	Bot.F Thick	9.50000
Area	4530.00	Asz	1026.00
Qyb	25901.8	Qzb	4050.00
Iyy	25100000	Izz	9250000
Ybar	90.0000	Zbar	85.5000
Wely	294000	Welz	103000
ry	74.5000	rz	45.2000

2. Member Forces

Axial Force Fxx = -5.7386 (LCB: 1, POS:1/2)
Bending Moments My = 34302.7, Mz = -0.6791
End Moments Myi = 0.00000, Myj = 34302.7 (for Lb)
Myi = 0.00000, Myj = 0.00000 (for Ly)
Mzi = 0.00000, Mzj = -0.6851 (for Lz)
Shear Forces Fyy = 0.00026 (LCB: 1, POS:1/4)
Fzz = -13.193 (LCB: 1, POS:1/4)

3. Design Parameters

Unbraced Lengths Ly = 5200.00, Lz = 2600.00, Lb = 2600.00
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 1.00, Cmz = 1.00, CmLT = 1.00

4. Checking Results

Slenderness Ratio
KL/r = 69.8 < 200.0 (Memb:25, LCB: 1)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 5.74/1531.57 = 0.004 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 34303/ 109543 = 0.313 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.7/52495.4 = 0.000 < 1.000 ..... O.K
Combined Resistance
RNRd = MAX[M_Edy/Mny_Rd, M_Edz/Mnz_Rd]
Rmax1 = (M_Edy/Mny_Rd)^Alpha + (M_Edz/Mnz_Rd)^Beta
Rcom = N_Ed/(A*fy/Gamma_M0), Rbend = M_Edy/My_Rd + M_Edz/Mz_Rd
Rc_LT1 = N_Ed/(Xiy*A*fy/Gamma_M1)
Rb_LT1 = (kyy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (kyz*Msdz)/(Wplz*fy/Gamma_M1)
Rc_LT2 = N_Ed/(Xiz*A*fy/Gamma_M1)
Rb_LT2 = (Kzy*M_Edy)/(Xi_LT*Wply*fy/Gamma_M1) + (Kzz*Msdz)/(Wplz*fy/Gamma_M1)
Rmax = MAX[RNRd, Rmax1, (Rcom+Rbend), MAX(Rc_LT1+Rb_LT1, Rc_LT2+Rb_LT2)] = 0.318 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.047 < 1.000 ..... O.K

5. Deflection Checking Results

L/ 250.0 = 20.8000 > 10.0503 (Memb:25, LCB: 2, POS:2600.0mm, Dir-Z)..... O.K

4.2 REPORT DI VERIFICA ESTESI ELEMENTI IPE 330 IN ACCIAIO

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------------------------------------------------------------------------------------------
 midas Gen - Steel Code Checking  [ Eurocode3:05 ]                          Gen 2019
==========================================================================================


        +============================================================+
        |  MIDAS(Modeling, Integrated Design & Analysis Software)    |
        |  midas Gen - Design & checking system for windows          |
        +============================================================+
        |  Steel Member Applicable Code Checking                     |
        |  Based On  Eurocode3:05, Eurocode3, AISC(15th)-LRFD16,     |
        |            AISC(15th)-ASD16, AISC(14th)-LRFD10,            |
        |            AISC(14th)-ASD10, AISC(13th)-LRFD05,            |
        |            AISC(13th)-ASD05, AISC-LRFD2K, AISC-LRFD93,     |
        |            AISC-ASD89, CSA-S16-01, BS5950-90               |
        |                                                            |
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+==========================================================+
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|  MIDAS IT Design Development Team                        |
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|  Gen 2019                                                |
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```

*. DEFINITION OF LOAD COMBINATIONS WITH SCALING UP FACTORS.

LCB	C	Loadcase Name(Factor) +	Loadcase Name(Factor) +	Loadcase Name(Factor)
1	1	G1(1.300) +	G2(1.300) +	W1(1.500)
2	2	G1(1.000) +	G2(1.000) +	W1(1.000)

```
   *. PROJECT     : Pareti tagliafuoco D2
   *. MEMBER NO   =      4,  ELEMENT TYPE = Beam
   *. LOADCOMB NO =      1,  MATERIAL NO  =     1,  SECTION NO =     1
   *. UNIT SYSTEM : kN, m

   *. SECTION PROPERTIES : Designation = IPE330
      Shape     = I - Section. (Rolled)
      Depth     =      0.330,  Top F Width =      0.160,  Bot.F Width =      0.160
      Web Thick =      0.007,  Top F Thick =      0.012,  Bot.F Thick =      0.012

      Area = 6.26000e-003,  Avy  = 3.95750e-003,  Avz  = 3.08025e-003
      Ybar = 8.00000e-002,  Zbar = 1.65000e-001,  Qyb  = 5.08505e-002,  Qzb  = 3.20000e-003
      Wely = 7.13000e-004,  Welz = 9.85000e-005,  Wply = 8.04000e-004,  Wplz = 1.51517e-004
      Iyy  = 1.17700e-004,  Izz  = 7.88000e-006,  Iyz  = 0.00000e+000
      iy   = 1.36490e-001,  iz   = 3.62502e-002
      J    = 2.07016e-007,  Cwp  = 1.99097e-007

   *. DESIGN PARAMETERS FOR STRENGTH EVALUATION :
      Ly   = 1.23000e+001,  Lz   = 4.10000e+000,  Lb   = 4.10000e+000
      Ky   = 1.00000e+000,  Kz   = 1.00000e+000

   *. MATERIAL PROPERTIES :
      Fy   = 3.55000e+005,  Es   = 2.10000e+008,  MATERIAL NAME  = S355


   *. FORCES AND MOMENTS AT (1/2) POINT :
      Axial Force      Fxx =-1.81818e-001
      Shear Forces     Fyy = 0.00000e+000,  Fzz = 0.00000e+000
      Bending Moments  My  = 1.23246e+002,  Mz  = 1.32651e+000
      End Moments      Myi = 1.09552e+002,  Myj = 1.09552e+002  (for Lb)
                       Myi = 0.00000e+000,  Myj = 0.00000e+000  (for Ly)
                       Mzi =-5.08484e+000,  Mzj =-5.08484e+000  (for Lz)

   *. Sign conventions for stress and axial force.
      - Stress : Compression positive.
      - Axial force: Tension positive.


================================================================================
   [[[*]]]   CLASSIFY LEFT-TOP FLANGE OF SECTION (BTR).
================================================================================

   ( ). Determine classification of compression outstand flanges.
        [ Eurocode3:05 Table 5.2 (Sheet 2 of 3), EN 1993-1-5 ]
        -. e      = SQRT( 235/fy )  =    0.81
        -. b/t    = BTR =    5.07
        -. sigma1 =  150940.430 KPa.
        -. sigma2 =  144565.782 KPa.
        -. BTR < 9*e  ( Class 1 : Plastic ).
================================================================================
   [[[*]]]   CLASSIFY RIGHT-TOP FLANGE OF SECTION (BTR).
================================================================================

   ( ). Determine classification of compression outstand flanges.
        [ Eurocode3:05 Table 5.2 (Sheet 2 of 3), EN 1993-1-5 ]
        -. e      = SQRT( 235/fy )  =    0.81
        -. b/t    = BTR =    5.07
        -. sigma1 =  162075.546 KPa.
        -. sigma2 =  155700.897 KPa.
        -. BTR < 9*e  ( Class 1 : Plastic ).

================================================================================
   [[[*]]]   CLASSIFY LEFT-BOTTOM FLANGE OF SECTION (BTR).
```

```
================================================================================

      ( ). Determine classification of tension outstand flanges.
           -. Not Checking the Section Classification.

================================================================================
   [[[*]]]   CLASSIFY RIGHT-BOTTOM FLANGE OF SECTION (BTR).
================================================================================

      ( ). Determine classification of tension outstand flanges.
           -. Not Checking the Section Classification.

================================================================================
   [[[*]]]   CLASSIFY WEB OF SECTION (HTR).
================================================================================

      ( ). Determine classification of bending and compression Internal Parts.
           [ Eurocode3:05 Table 5.2 (Sheet 1 of 3), EN 1993-1-5 ]
           -. e      = SQRT( 235/fy )  =    0.81
           -. d/t    = HTR =   36.13
           -. sigma1 =  125913.980 KPa.
           -. sigma2 = -125855.891 KPa.
           -. Psi    = [2*(Nsd/A)*(1/fy)]-1 =  -1.000
           -. Alpha   =   0.500  >  0.5
           -. HTR < 396*e/(13*Alpha-1)  ( Class 1 : Plastic ).

================================================================================
   [[[*]]]   APPLIED FACTORS.
================================================================================

      ( ). Calculate equivalent uniform moment factors (Cmy,Cmz,CmLT).
           [ Eurocode3:05 Annex A. Table A.1, A.2 ]
           -. Cmy,0    = 1.000
           -. Cmz,0    = 1.000
           -. Cmy (Default or User Defined Value) = 1.000
           -. Cmz (Default or User Defined Value) = 1.000
           -. CmLT (Default or User Defined Value) = 1.000

      ( ). Partial Factors (Gamma_Mi).
           [ Eurocode3:05 6.1 ]
           -. Gamma_M0 =  1.05
           -. Gamma_M1 =  1.05
           -. Gamma_M2 =  1.25

================================================================================
   [[[*]]]   CHECK AXIAL RESISTANCE.
================================================================================

      ( ). Check slenderness ratio of axial compression member (Kl/i).
           [ Eurocode3:05  6.3.1 ]
           -. Kl/i  =   113.1  <   200.0  --->  O.K.

      ( ). Calculate axial compressive resistance (Nc_Rd).
           [ Eurocode3:05  6.1, 6.2.4 ]
           -. Nc_Rd    = fy * Area / Gamma_M0 =       2116.48 kN.

      ( ). Check ratio of axial resistance (N_Ed/Nc_Rd).
                N_Ed              0.18
           -. -----  =  ---------------  =8.591e-005  <  1.000  --->  O.K.
              Nc_Rd           2116.48

      ( ). Calculate buckling resistance of compression member (Nb_Rdy, Nb_Rdz).
           [ Eurocode3:05  6.3.1.1, 6.3.1.2 ]
           -. Beta_A    = Aeff / Area      =   1.000
           -. Lambda1   = Pi * SQRT(Es/fy) =  76.409
           -. Lambda_by = {(Ky*Ly/iy)/Lambda1} * SQRT(Beta_A) =   1.179
           -. Ncry      = Pi^2*Es*Iyy / (Ky*Ly)^2            =       1612.45 kN.
           -. Lambda_by < 0.2 or N_Ed/Ncry < 0.04 --> No need to check.

           -. Lambda_bz = {(Kz*Lz/iz)/Lambda1} * SQRT(Beta_A) =   1.480
           -. Ncrz      = Pi^2*Es*Izz / (Kz*Lz)^2            =        971.58 kN.
           -. Lambda_bz < 0.2 or N_Ed/Ncrz < 0.04 --> No need to check.

================================================================================
   [[[*]]]   CHECK SHEAR RESISTANCE.
================================================================================

      ( ). Calculate shear area.
           [ Eurocode3:05  6.2.6, EN1993-1-5:04 5.1 NOTE 2 ]
           -. eta   = 1.2 (Fy < 460 MPa.)
           -. r     =    0.0180 m.
           -. Avy   = Area - hw*tw                  =        0.0040 m^2.
           -. Avz1  = eta*hw*tw                     =        0.0028 m^2.
           -. Avz2  = Area - 2*B*tf + (tw + 2*r)*tf =        0.0031 m^2.
```

```
          -. Avz   = MAX[ Avz1, Avz2 ]             =        0.0031 m^2.

      ( ). Calculate plastic shear resistance in local-y direction (Vpl_Rdy).
           [ Eurocode3:05  6.1, 6.2.6 ]
           -. Vpl_Rdy = [ Avy*fy/SQRT(3) ] / Gamma_M0 =        772.50 kN.

      ( ). Check ratio of shear resistance (V_Edy/Vpl_Rdy).
           ( LCB =    1, POS =    J )
           -. Applied shear force : V_Edy   =          5.01 kN.
               V_Edy              5.01
           -. -------  =  ---------------  =  0.006  <  1.000  --->  O.K.
              Vpl_Rdy            772.50

      ( ). Calculate plastic shear resistance in local-z direction (Vpl_Rdz).
           [ Eurocode3:05  6.1, 6.2.6 ]
           -. Vpl_Rdz = [ Avz*fy/SQRT(3) ] / Gamma_M0 =        601.26 kN.

      ( ). Shear Buckling Check.
           [ Eurocode3:05 6.2.6 ]
           -. HTR < 72*e/Eta   --->  No need to check!

      ( ). Check ratio of shear resistance (V_Edz/Vpl_Rdz).
           ( LCB =    1, POS =    J )
           -. Applied shear force : V_Edz   =         40.08 kN.
               V_Edz              40.08
           -. -------  =  ---------------  =  0.067  <  1.000  --->  O.K.
              Vpl_Rdz            601.26

================================================================================
   [[[*]]]   CHECK BENDING MOMENT RESISTANCE ABOUT MAJOR AXIS.
================================================================================

      ( ). Calculate plastic resistance moment about major axis.
           [ Eurocode3:05  6.1, 6.2.5 ]
           -. Wply     =        0.0008 m^3.
           -. Mc_Rdy   = Wply * fy / Gamma_M0 =        271.83 kN-m.

      ( ). Check ratio of moment resistance (M_Edy/Mc_Rdy).
               M_Edy             123.25
           -. ------  =  ---------------  =  0.453  <  1.000  --->  O.K.
              Mc_Rdy             271.83

================================================================================
   [[[*]]]   CHECK BENDING MOMENT RESISTANCE ABOUT MINOR AXIS.
================================================================================

      ( ). Calculate plastic resistance moment about minor axis.
           [ Eurocode3:05  6.1, 6.2.5 ]
           -. Wplz     =        0.0002 m^3.
           -. Mc_Rdz   = Wplz * fy / Gamma_M0 =         51.23 kN-m.

      ( ). Check ratio of moment resistance (M_Edz/Mc_Rdz).
              M_Edz               1.33
           -. ------  =  ---------------  =  0.026  <  1.000  --->  O.K.
              Mc_Rdz             51.23
================================================================================
   [[[*]]]   CHECK LATERAL-TORSIONAL BUCKLING RESISTANCE.
================================================================================

      ( ). Calculate lateral-torsional buckling resistance (Mb_Rd).
           [ Eurocode3:05  6.1, 6.3.2 ]
           -. Por       =   0.300
           -. Gs        = Es / [ 2*(1+Por) ]  =80769230.769 KPa.
           -. Ncr       = Pi^2*Es*Izz / Lu^2  =        971.58 kN.
           -. psi       =   0.000
           -. C1        =   1.132
           -. Mcr       = C1 * Ncr * SQRT [ (Cwp/Izz) + (Gs*Ixx)/Ncr ] =        226.67 kN-m.

           -. Lambda_LT_bar  = SQRT [ Wply*fy / Mcr ] =   1.122
           -. Lambda_LT_bar0 =    0.400

           -. Lambda_LT_bar =    1.122 > Lambda_LT_bar0   =    0.400
           -. M_Ed/Mcr      =    0.544 > Lambda_LT_bar0^2 =    0.160
           If Lambda_LT_bar > Lambda_LT_bar0 and M_Ed/Mcr > Lambda_LT_bar0^2,
           Allowance for lateral-torsional buckling necessary.

           -. Alpha_LT  =   0.340
           -. Phi_LT    = 0.5 * { 1+Alpha_LT*(Lambda_LT_bar-0.2) + Lambda_LT_bar^2 }   =   1.286
           -. Xi_LT     = MIN [ 1 / {Phi_LT + SQRT(Phi_LT^2 - Lambda_LT_bar^2)}, 1.0 ] =   0.522
           -. Mb_Rd     = Xi_LT*Wply*fy / Gamma_M1 =        141.93 kN-m.

      ( ). Check ratio of lateral-torsional buckling resistance (M_Edy/Mb_Rdy).
               M_Edy             123.25
           -. --------  =  ---------------  =  0.868  <  1.000  --->  O.K.
```

```
              Mb_Rdy              141.93

================================================================================
   [[[*]]]   CHECK INTERACTION OF COMBINED RESISTANCE.
================================================================================

      ( ). Calculate Major reduced design resistance of bending and shear.
           [ Eurocode3:05  6.2.8 (6.30) ]
           -. In case of V_Edz / Vpl_Rdz < 0.5
           -. My_Rd = Mc_Rdy =        271.83 kN-m.

      ( ). Calculate Minor reduced design resistance of bending and shear.
           [ Eurocode3:05  6.2.8 (6.30) ]
           -. In case of V_Edy / Vpl_Rdy < 0.5
           -. Mz_Rd = Mc_Rdz =         51.23 kN-m.
      ( ). Check general interaction ratio.
           [ Eurocode3:05  6.2.1 (6.2) ] - Class1 or Class2
                       N_Ed     M_Edy     M_Edz
           -. Rmax1  = ------ + ------- + -------
                       N_Rd     My_Rd     Mz_Rd
                     =  0.479  <  1.000  --->  O.K.

      ( ). Check interaction ratio of bending and axial force member.
           [ Eurocode3:05  6.2.9 (6.31 ~ 6.41) ] - Class1 or Class2
           -. n      = N_Ed / Npl_Rd   =8.591e-005
           -. a      = MIN[ (Area-2b*tf)/Area, 0.5 ] =  0.412
           -. Alpha  =  2.000
           -. Beta   = MAX[ 5*n, 1.0 ] =  1.000

           -. N_Ed < 0.25*Npl_Rd           =        529.12 kN.
           -. N_Ed < 0.5*hw*tw*fy/Gamma_M0 =        389.23 kN.
              Therefore, No allowance for the effect of axial force.
           -. Mny_Rd = Mply_Rd        =        271.83 kN-m.
           -. Rmaxy  = M_Edy / Mny_Rd =  0.453  <  1.000  --->  O.K.

           -. N_Ed < hw*tw*fy/Gamma_M0 =       1193.65 kN.
              Therefore, No allowance for the effect of axial force.
           -. Mnz_Rd = Mplz_Rd        =          51.23 kN-m.
           -. Rmaxz  = M_Edz / Mnz_Rd =  0.026  <  1.000  --->  O.K.

                       [ | M_Edy  |^(Alpha)   | M_Edz  |^(Beta) ]
           -. Rmax2  =  [ |--------|      +   |--------|        ]
                       [ | Mny_Rd |          | Mnz_Rd |        ]
                     =  0.231  <  1.000  --->  O.K.

      ( ). Check interaction ratio of bending and axial compression member.
           [ Eurocode3:05  6.3.1, 6.2.9.3 (6.61, 6.62), Annex A ]
           -. N_Ed     =         -0.18 kN.
           -. M_Edy    =        123.25 kN-m.
           -. M_Edz    =          1.33 kN-m.
           -. kyy      =   1.001
           -. kyz      =   1.011
           -. kzy      =   0.521
           -. kzz      =   1.095
           -. Xiy      =   1.000
           -. Xiz      =   1.000
           -. XiLT     =   0.522
           -. N_Rk     = A*fy    =       2222.30 kN.
           -. My_Rk    = Wply*fy =        285.42 kN-m.
           -. Mz_Rk    = Wplz*fy =         53.79 kN-m.
           -. N_Ed*eNy = 0.0 (Not Slender)
           -. N_Ed*eNZ = 0.0 (Not Slender)
                              N_Ed                M_Edy + N_Ed*eNy           M_Edz + N_Ed*eNz
           -. Rmax_LT1 = ------------------ + kyy * ------------------- + kyz * ----------------
                         Xiy*N_Rk/Gamma_M1         XiLT*My_Rk/Gamma_M1          Mz_Rk/Gamma_M1
                       =  0.896  <  1.000  --->  O.K.
                              N_Ed                M_Edy + N_Ed*eNy           M_Edz + N_Ed*eNz
           -. Rmax_LT2 = ------------------ + kzy * ------------------- + kzz * ----------------
                         Xiz*N_Rk/Gamma_M1         XiLT*My_Rk/Gamma_M1          Mz_Rk/Gamma_M1
                       =  0.481  <  1.000  --->  O.K.
           -. Rmax   = MAX[ MAX(Rmax1, Rmax2), MAX(Rmax_LT1, Rmax_LT2) ] =  0.896  <  1.000  --->  O.K.

================================================================================
   [[[*]]]   CHECK DEFLECTION.
================================================================================

      ( ). Compute Maximum Deflection.
           -. LCB      =    2
           -. DAF      =     1.000 (Deflection Amplification Factor).
           -. Position =     6.150m From i-end(Node 5).
           -. Def      =    -0.053 * DAF =   -0.053m (Global Z)
           -. Def_Lim  =     0.061m
              Def < Def_Lim   --->  O.K !
```