Relazione di Calcolo - FASCICOLO 2
Calcoli delle STRUTTURE PORTANTI
Rev. A - 25/10/2020

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Sommario
Opere strutturali - Relazione di calcolo dell'opera (fascicolo 2): analisi e verifica elementi strutturali

Rev.	Descrizione revisione	Data
A	Emissione	25/10/2020

Dott. Ing. ANDREA VAGO Sez. A a) civile e ambientale n° A 20013 ORDINE DEGLI INGEGNERI DELLA PROVINCIA DI MILANO

Il Prog. Dip. Strutturali
(timbro e firma)

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1. Analisi strutturale globale

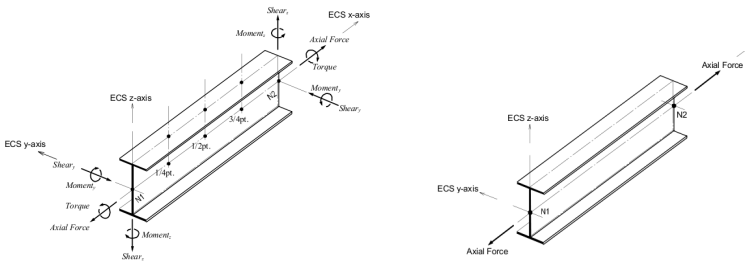
1.1. Modello FEM 1 - Corpo di collegamento

Come descritto nella relazione generale è stato eseguito un modello di calcolo per E.F. con l'esclusivo scopo di le sollecitazioni sugli elementi facendo ricorso ad un programma di calcolo agli elementi finiti denominato MIDAS GEN .

I pilastri, sono stati modellati come elementi beam, incastrati alla base

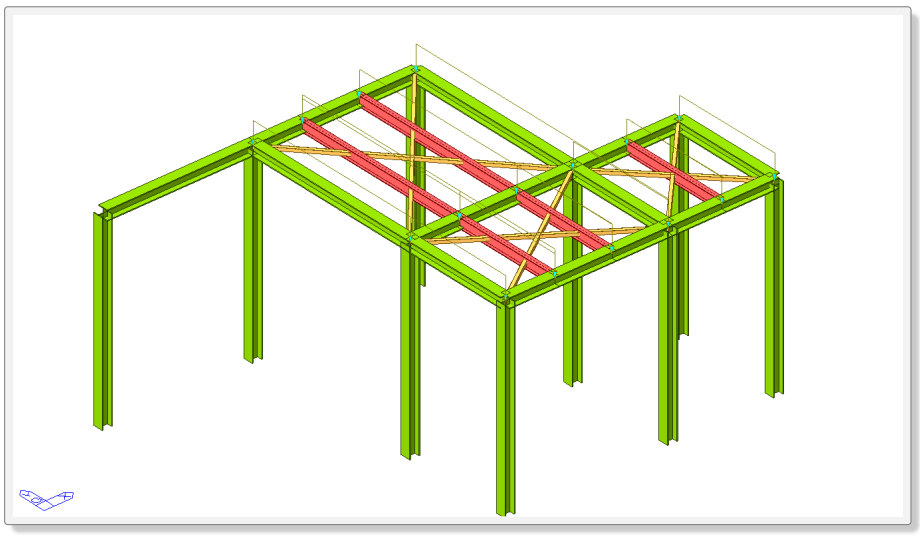
I carichi verticali di ogni piano sono applicati al modello attraverso una ripartizione in base alle rispettive aree di influenza sulle travi (elementi "beam" classici).

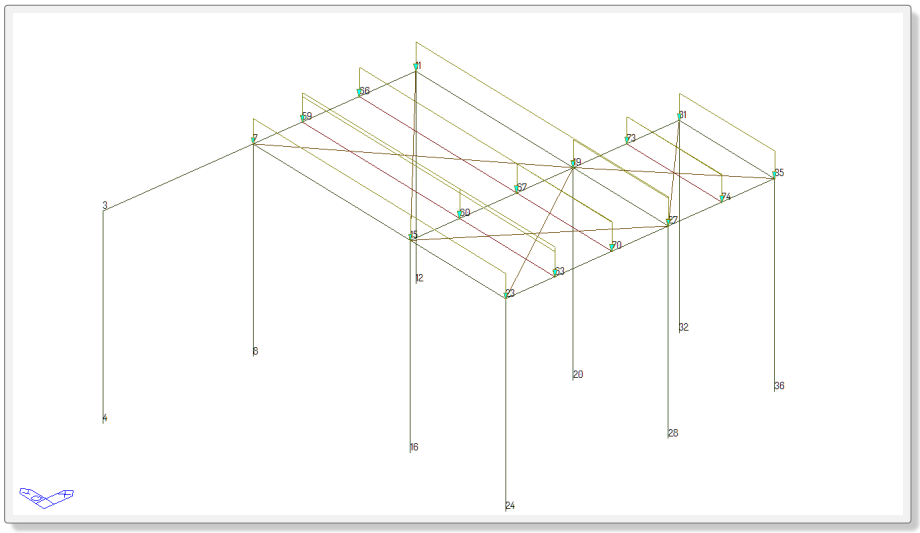
Tutti i carichi sono poi tradotti in masse ai vari piani.

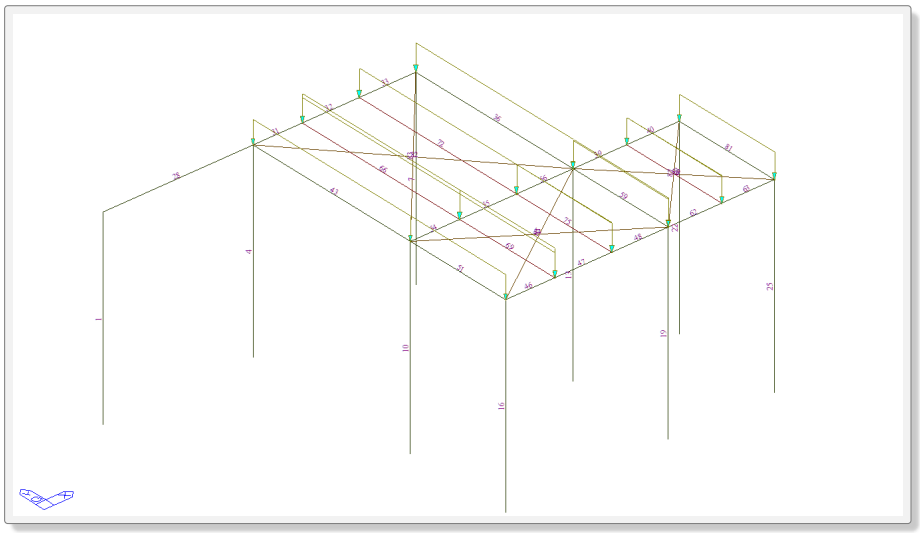


(a) Beam (b) Truss

Fig. 1: Formulazione E.F.







1.1.1. Condizioni elementari di carico

Le condizioni di carico elementari individuate per la struttura in oggetto sono le seguenti:

Tab. 1: Condizioni elementari

Condizione	Descrizione	Cod. Cat.	Descr. cat.	Mutua Escl.	Segno	inf/sup
PP	Peso Proprio	G1	Peso proprio strutturale	[]	False	False
PERM	Permanente	G21	Permanente non strutturale sempre presente	[]	False	False
NEVE	Variabile 1	Qnev1	Var. Neve (a quota <= 1000 m.s.l.m.)	[]	False	False
WX	Vento x	Qwin	Var. Vento	['WY']	True	False
WY	Vento y	Qwin	Var. Vento	['WX']	True	False
EX	Sisma x	Ex	Sisma direzione X	[]	True	False
EY	Sisma y	Ey	Sisma direzione Y	[]	True	False

1.1.2. Combinazioni di carico

Le combinazioni di carico adottate per il calcolo agli **SL** (Stati Limite) della struttura in oggetto sono le seguenti:

Tab. 2: Combinazioni STR-SLU

Comb.	PP	PERM	NEVE	WX	WY
SLU1	1.30	1.30	1.50	0.90	0.00
SLU2	1.30	1.30	1.50	0.00	0.90
SLU3	1.30	1.30	1.50	0.00	-0.90
SLU4	1.30	1.30	1.50	-0.90	0.00
SLU5	1.30	1.30	0.75	1.50	0.00
SLU6	1.30	1.30	0.75	0.00	0.90
SLU7	1.30	1.30	0.75	0.00	-0.90
SLU8	1.30	1.30	0.75	-1.50	0.00
SLU9	1.30	1.30	0.75	0.90	0.00
SLU10	1.30	1.30	0.75	0.00	1.50
SLU11	1.30	1.30	0.75	0.00	-1.50
SLU12	1.30	1.30	0.75	-0.90	0.00

Tab. 3: Combinazioni STR-SLER

Comb.	PP	PERM	NEVE	WX	WY
SLER1	1.00	1.00	1.00	-0.60	-0.00
SLER2	1.00	1.00	1.00	-0.00	-0.60
SLER3	1.00	1.00	1.00	-0.00	0.60
SLER4	1.00	1.00	1.00	0.60	-0.00
SLER5	1.00	1.00	0.50	1.00	-0.00
SLER6	1.00	1.00	0.50	0.00	-0.60
SLER7	1.00	1.00	0.50	0.00	0.60
SLER8	1.00	1.00	0.50	-1.00	-0.00
SLER9	1.00	1.00	0.50	-0.60	0.00
SLER10	1.00	1.00	0.50	-0.00	1.00
SLER11	1.00	1.00	0.50	-0.00	-1.00
SLER12	1.00	1.00	0.50	0.60	0.00

Tab. 4: Combinazioni STR-SLEQP

Comb.	PP	PERM	NEVE	WX	WY
SLEQP1	1.00	1.00	0.00	0.00	0.00

Tab. 5: Combinazioni STR-SLEF

Comb.	PP	PERM	NEVE	WX	WY
SLEF1	1.00	1.00	0.20	0.00	0.00
SLEF2	1.00	1.00	0.00	-0.20	0.00
SLEF3	1.00	1.00	0.00	-0.00	0.00
SLEF4	1.00	1.00	0.00	0.20	0.00
SLEF5	1.00	1.00	0.00	0.00	-0.20
SLEF6	1.00	1.00	0.00	0.00	0.20

Tab. 6: Combinazioni SISMA-SLV

Comb.	PP	PERM	NEVE	WX	WY	EX	EY
SLV1	1.00	1.00	0.00	0.00	0.00	1.00	-0.30
SLV2	1.00	1.00	0.00	0.00	0.00	1.00	0.30
SLV3	1.00	1.00	0.00	0.00	0.00	-1.00	-0.30
SLV4	1.00	1.00	0.00	0.00	0.00	-1.00	0.30
SLV5	1.00	1.00	0.00	0.00	0.00	-0.30	1.00
SLV6	1.00	1.00	0.00	0.00	0.00	-0.30	-1.00
SLV7	1.00	1.00	0.00	0.00	0.00	0.30	1.00
SLV8	1.00	1.00	0.00	0.00	0.00	0.30	-1.00

1.1.3. Verifiche

Si riportano verifiche ddegli elementi evidenziati:

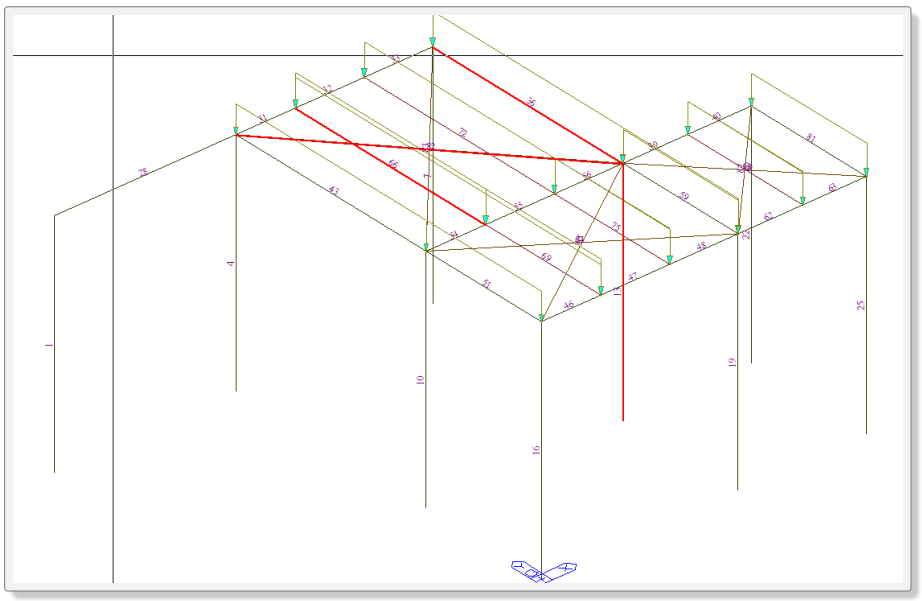


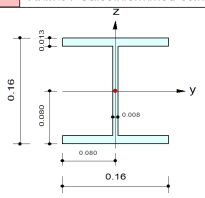
Fig. 2: Legenda

midas Gen **Steel Checking Result**

Company		Project Title	
Author		File Name	X:\...\01-Calcoli\fem\mod-cc.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 13
Material : S275 (No:3)
(Fy = 275000, Es = 210000000)
Section Name : HEB160 (No:2)
(Rolled : HEB160).
Member Length : 2.99000



2. Member Forces

Axial Force Fxx = -11.831 (LCB: 15, POS:J)
Bending Moments My = -0.8985, Mz = -2.0255
End Moments Myi = 0.44008, Myj = -0.8985 (for Lb)
Myi = 0.44008, Myj = -0.8985 (for Ly)
Mzi = 2.02817, Mzj = -2.0255 (for Lz)
Shear Forces Fyy = 1.35574 (LCB: 15, POS:I)
Fzz = 1.84456 (LCB: 9, POS:I)

Depth	0.16000	Web Thick	0.00800
Top F Width	0.16000	Top F Thick	0.01300
Bot.F Width	0.16000	Bot.F Thick	0.01300
Area	0.00543	Asz	0.00128
Qyb	0.02135	Qzb	0.00320
Iyy	0.00002	Izz	0.00001
Ybar	0.08000	Zbar	0.08000
Wely	0.00031	Welz	0.00011
ry	0.06780	rz	0.04050

3. Design Parameters

Unbraced Lengths Ly = 2.99000, Lz = 2.99000, Lb = 2.99000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 0.85, Cmz = 0.85, CmLT = 1.00

4. Checking Results

Slenderness Ratio
KL/r = 73.8 < 200.0 (LCB: 17)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 11.83/1493.25 = 0.008 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 0.8985/97.3500 = 0.009 < 1.000 ..... O.K
M_Edz/M_Rdz = 2.0255/46.3496 = 0.044 < 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)] = 0.061 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.002 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.007 < 1.000 ..... O.K

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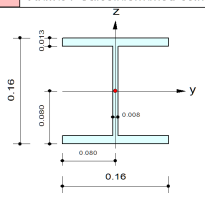
Fig. 3: Colonna

midas Gen **Steel Checking Result**

Company		Project Title	
Author		File Name	X:\...\01-Calcoli\fem\mod-cc.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 36
Material : S275 (No:3)
(Fy = 275000, Es = 210000000)
Section Name : HEB160 (No:2)
(Rolled : HEB160).
Member Length : 2.91000



2. Member Forces

Axial Force Fxx = 0.67591 (LCB: 15, POS:J)
Bending Moments My = -2.0120, Mz = 0.12245
End Moments Myi = 1.20614, Myj = -2.0120 (for Lb)
Myi = 1.20614, Myj = -2.0120 (for Ly)
Mzi = -0.1729, Mzj = 0.12245 (for Lz)
Shear Forces Fyy = 0.10758 (LCB: 14, POS:I)
Fzz = 3.49026 (LCB: 3, POS:J)

Depth	0.16000	Web Thick	0.00800
Top F Width	0.16000	Top F Thick	0.01300
Bot.F Width	0.16000	Bot.F Thick	0.01300
Area	0.00543	Asz	0.00128
Qyb	0.02135	Qzb	0.00320
Iyy	0.00002	Izz	0.00001
Ybar	0.08000	Zbar	0.08000
Wely	0.00031	Welz	0.00011
ry	0.06780	rz	0.04050

3. Design Parameters

Unbraced Lengths Ly = 2.91000, Lz = 2.91000, Lb = 2.91000
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 = 71.9 < 200.0 (LCB: 14)..... O.K
Axial Resistance
N_Ed/Nt_Rd = 0.68/1493.25 = 0.000 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 2.0120/97.3500 = 0.021 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.1224/46.3496 = 0.003 < 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
Rmax = MAX[RNRd, Rmax1, (Rcom+Rbend)] = 0.024 < 1.000 ..... O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.012 < 1.000 ..... O.K

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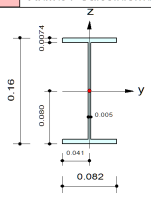
Fig. 4: Trave HEB160

midas Gen **Steel Checking Result**

Company		Project Title	
Author		File Name	X:\...\01-Calcoli\fem\mod-cc.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 66
Material : S275 (No:3)
(Fy = 275000, Es = 210000000)
Section Name : IPE160 (No:3)
(Rolled : IPE160).
Member Length : 2.91000



2. Member Forces

Axial Force Fxx = -1.0891 (LCB: 4, POS:1/2)
Bending Moments My = 2.73357, 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: 3, POS:I)
Fzz = -3.7575 (LCB: 3, POS:I)

Depth	0.16000	Web Thick	0.00500
Top F Width	0.08200	Top F Thick	0.00740
Bot.F Width	0.08200	Bot.F Thick	0.00740
Area	0.00201	Asz	0.00080
Qyb	0.01190	Qzb	0.00084
Iyy	0.00001	Izz	0.00000
Ybar	0.04100	Zbar	0.08000
Wely	0.00011	Welz	0.00002
ry	0.06560	rz	0.01875

3. Design Parameters

Unbraced Lengths Ly = 2.91000, Lz = 2.91000, Lb = 2.91000
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 = 155.2 < 200.0 (LCB: 14)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 1.089/552.750 = 0.002 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 2.7336/34.0450 = 0.080 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.00000/7.09123 = 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)] = 0.143 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.024 < 1.000 ..... O.K

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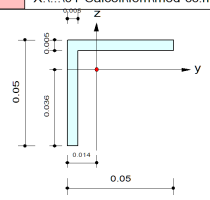
Fig. 5: Trave IPE160

midas Gen **Steel Checking Result**

Company		Project Title	
Author		File Name	X:\...\01-Calcoli\fem\mod-cc.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 82
Material : S275 (No:3)
(Fy = 275000, Es = 210000000)
Section Name : L50x5 (No:5)
(Rolled : L50x5).
Member Length : 3.88240



2. Member Forces

Axial Force Fxx = -0.2993 (LCB: 12, 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: 3, POS:I)
Fzz = 0.00000 (LCB: 3, POS:I)

Depth	0.05000	Web Thick	0.00500
Top F Width	0.05000	Top F Thick	0.00500
Area	0.00048	Asz	0.00021
Qyb	0.00064	Qzb	0.00064
Iyy	0.00000	Izz	0.00000
Ybar	0.01400	Zbar	0.03600
Wely	0.00000	Welz	0.00000
rp	0.00983		
ry	0.01510	rz	0.01510

3. Design Parameters

Unbraced Lengths Ly = 3.88240, Lz = 3.88240, Lb = 3.88240
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 = 395.0 > 200.0 (LCB: 14)..... N.G
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 0.29926/5.93285 = 0.050 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 0.00000/0.83875 = 0.000 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.00000/0.83875 = 0.000 < 1.000 ..... O.K
Combined Resistance
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*Wely*fy/Gamma_M1) + (kyz*Msdz)/(Welz*fy/Gamma_M1)
Rc_LT2 = N_Ed/(Xiz*A*fy/Gamma_M1)
Rb_LT2 = (Kzy*M_Edy)/(Xi_LT*Wely*fy/Gamma_M1) + (Kzz*Msdz)/(Welz*fy/Gamma_M1)
Rmax = MAX[Rcom+Rbend, MAX(Rc_LT1+Rb_LT1, Rc_LT2+Rb_LT2)] = 0.022 < 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

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Fig. 6: Controvento

■ **VERIFICATO !**

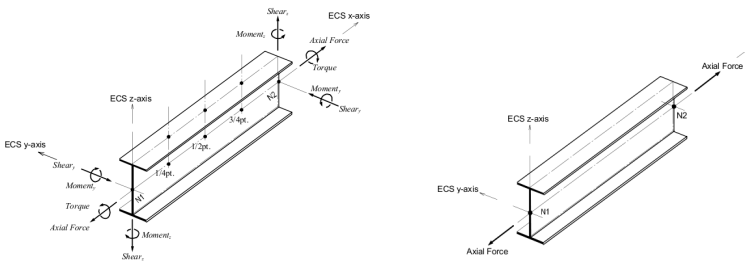
1.2. Modello FEM 2 - Guardiola

Come descritto nella relazione generale è stato eseguito un modello di calcolo per E.F. con l'esclusivo scopo di le sollecitazioni sugli elementi facendo ricorso ad un programma di calcolo agli elementi finiti denominato MIDAS GEN .

I pilastri, sono stati modellati come elementi beam, incastrati alla base

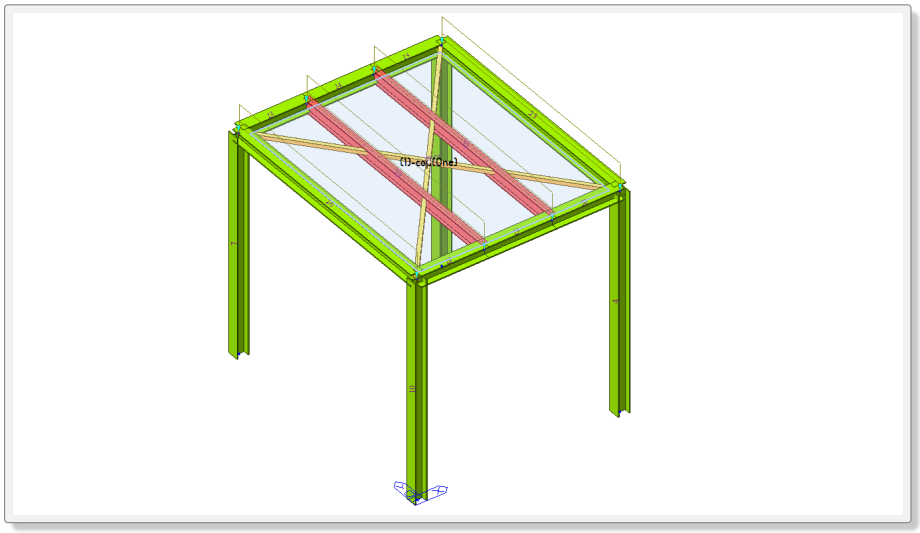
I carichi verticali di ogni piano sono applicati al modello attraverso una ripartizione in base alle rispettive aree di influenza sulle travi (elementi "beam" classici).

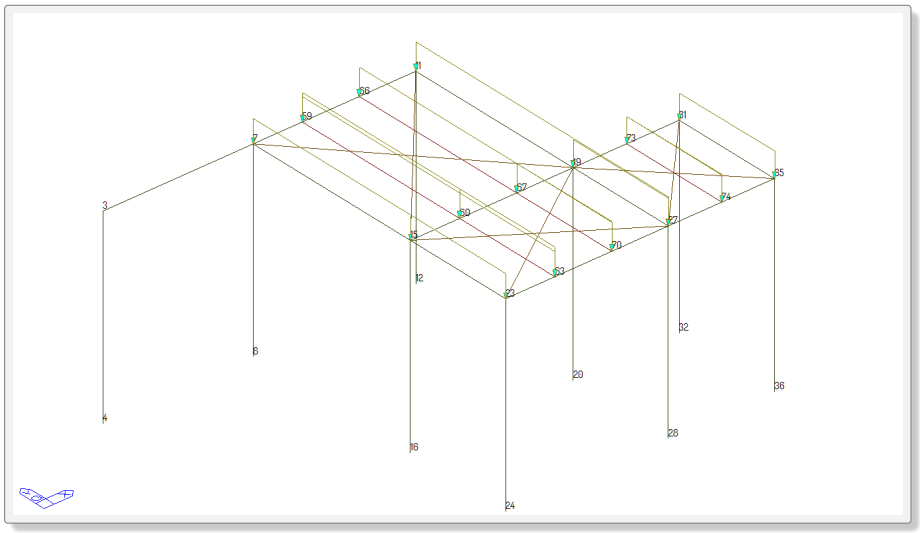
Tutti i carichi sono poi tradotti in masse ai vari piani.

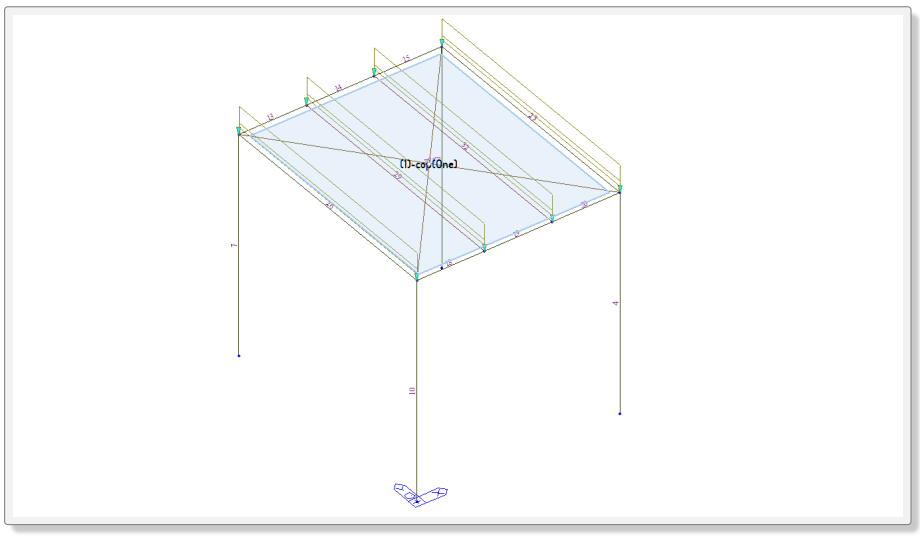


(a) Beam **(b)** Truss

Fig. 7: Formulazione E.F.







1.2.1. Condizioni elementari di carico

Le condizioni di carico elementari individuate per la struttura in oggetto sono le seguenti:

Tab. 7: Condizioni elementari

Condizione	Descrizione	Cod. Cat.	Descr. cat.	Mutua Escl.	Segno	inf/sup
PP	Peso Proprio	G1	Peso proprio strutturale	[]	False	False
PERM	Permanente	G21	Permanente non strutturale sempre presente	[]	False	False
NEVE	Variabile 1	Qnev1	Var. Neve (a quota <= 1000 m.s.l.m.)	[]	False	False
WX	Vento x	Qwin	Var. Vento	['WY']	True	False
WY	Vento y	Qwin	Var. Vento	['WX']	True	False
EX	Sisma x	Ex	Sisma direzione X	[]	True	False
EY	Sisma y	Ey	Sisma direzione Y	[]	True	False

1.2.2. Combinazioni di carico

Le combinazioni di carico adottate per il calcolo agli **SL** (Stati Limite) della struttura in oggetto sono le seguenti:

Tab. 8: Combinazioni STR-SLU

Comb.	PP	PERM	NEVE	WX	WY
SLU1	1.30	1.30	1.50	0.90	0.00
SLU2	1.30	1.30	1.50	0.00	0.90
SLU3	1.30	1.30	1.50	0.00	-0.90
SLU4	1.30	1.30	1.50	-0.90	0.00
SLU5	1.30	1.30	0.75	1.50	0.00
SLU6	1.30	1.30	0.75	0.00	0.90
SLU7	1.30	1.30	0.75	0.00	-0.90
SLU8	1.30	1.30	0.75	-1.50	0.00
SLU9	1.30	1.30	0.75	0.90	0.00
SLU10	1.30	1.30	0.75	0.00	1.50
SLU11	1.30	1.30	0.75	0.00	-1.50
SLU12	1.30	1.30	0.75	-0.90	0.00

Tab. 9: Combinazioni STR-SLER

Comb.	PP	PERM	NEVE	WX	WY
SLER1	1.00	1.00	1.00	-0.60	-0.00
SLER2	1.00	1.00	1.00	-0.00	-0.60
SLER3	1.00	1.00	1.00	-0.00	0.60
SLER4	1.00	1.00	1.00	0.60	-0.00
SLER5	1.00	1.00	0.50	1.00	-0.00
SLER6	1.00	1.00	0.50	0.00	-0.60
SLER7	1.00	1.00	0.50	0.00	0.60
SLER8	1.00	1.00	0.50	-1.00	-0.00
SLER9	1.00	1.00	0.50	-0.60	0.00
SLER10	1.00	1.00	0.50	-0.00	1.00
SLER11	1.00	1.00	0.50	-0.00	-1.00
SLER12	1.00	1.00	0.50	0.60	0.00

Tab. 10: Combinazioni STR-SLEQP

Comb.	PP	PERM	NEVE	WX	WY
SLEQP1	1.00	1.00	0.00	0.00	0.00

Tab. 11: Combinazioni STR-SLEF

Comb.	PP	PERM	NEVE	WX	WY
SLEF1	1.00	1.00	0.20	0.00	0.00
SLEF2	1.00	1.00	0.00	-0.20	0.00
SLEF3	1.00	1.00	0.00	-0.00	0.00
SLEF4	1.00	1.00	0.00	0.20	0.00
SLEF5	1.00	1.00	0.00	0.00	-0.20
SLEF6	1.00	1.00	0.00	0.00	0.20

Tab. 12: Combinazioni SISMA-SLV

Comb.	PP	PERM	NEVE	WX	WY	EX	EY
SLV1	1.00	1.00	0.00	0.00	0.00	1.00	-0.30
SLV2	1.00	1.00	0.00	0.00	0.00	1.00	0.30
SLV3	1.00	1.00	0.00	0.00	0.00	-1.00	-0.30
SLV4	1.00	1.00	0.00	0.00	0.00	-1.00	0.30
SLV5	1.00	1.00	0.00	0.00	0.00	-0.30	1.00
SLV6	1.00	1.00	0.00	0.00	0.00	-0.30	-1.00
SLV7	1.00	1.00	0.00	0.00	0.00	0.30	1.00
SLV8	1.00	1.00	0.00	0.00	0.00	0.30	-1.00

1.2.3. Verifiche

Si riportano verifiche ddegli elementi evidenziati:

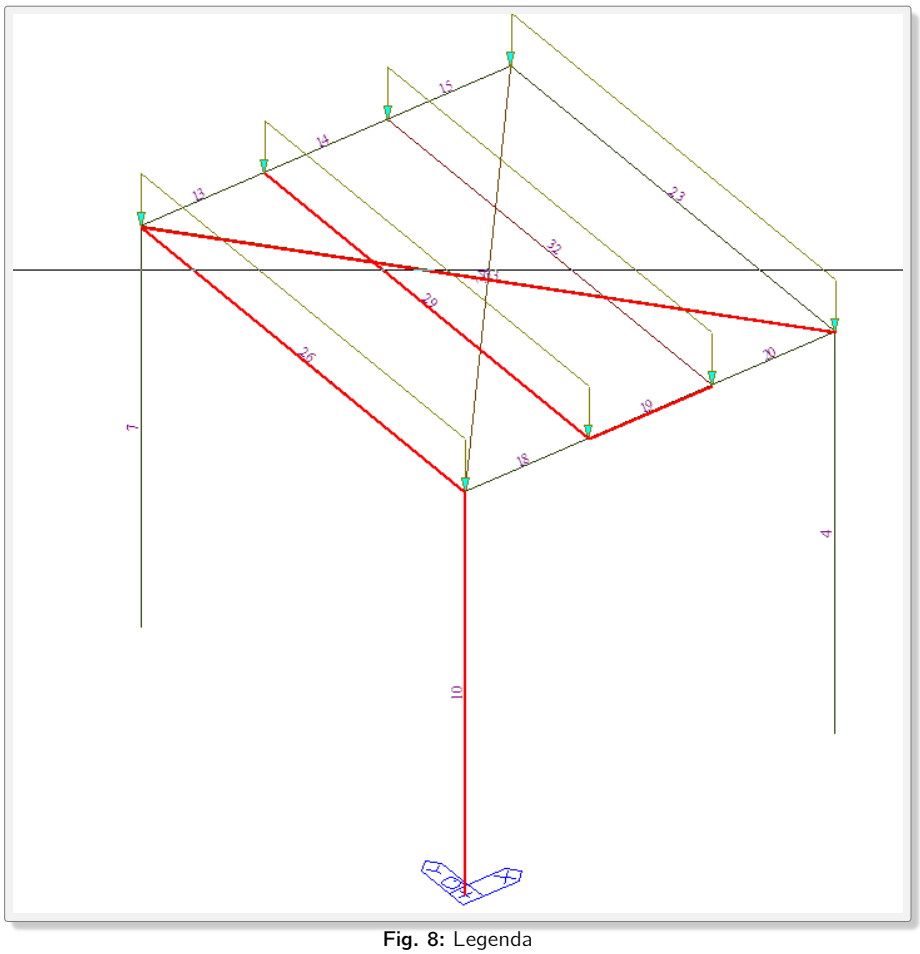


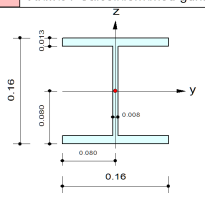
Fig. 8: Legenda

midas Gen **Steel Checking Result**

Company		Project Title	
Author		File Name	X:\...\01-Calcoli\fem\mod-gdrl.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 10
Material : S275 (No:3)
(Fy = 275000, Es = 210000000)
Section Name : HEB160 (No:2)
(Rolled : HEB160).
Member Length : 2.99000



2. Member Forces

Axial Force Fxx = -2.6370 (LCB: 14, POS:I)
Bending Moments My = 1.29789, Mz = -7.8406
End Moments Myi = 1.29789, Myj = -0.0053 (for Lb)
Myi = 1.29789, Myj = -0.0053 (for Ly)
Mzi = -7.8406, Mzj = 6.54290 (for Lz)
Shear Forces Fyy = -4.8105 (LCB: 14, POS:I)
Fzz = 3.78825 (LCB: 9, POS:I)

Depth	0.16000	Web Thick	0.00800
Top F Width	0.16000	Top F Thick	0.01300
Bot.F Width	0.16000	Bot.F Thick	0.01300
Area	0.00543	Asz	0.00128
Qyb	0.02135	Qzb	0.00320
Iyy	0.00002	Izz	0.00001
Ybar	0.08000	Zbar	0.08000
Wely	0.00031	Welz	0.00011
ry	0.06780	rz	0.04050

3. Design Parameters

Unbraced Lengths Ly = 2.99000, Lz = 2.99000, Lb = 2.99000
Effective Length Factors Ky = 1.00, Kz = 1.00
Equivalent Uniform Moment Factors Cmy = 0.85, Cmz = 0.85, CmLT = 1.00

4. Checking Results

Slenderness Ratio
KL/r = 73.8 < 200.0 (LCB: 17)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 2.64/1493.25 = 0.002 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 1.2979/97.3500 = 0.013 < 1.000 ..... O.K
M_Edz/M_Rdz = 7.8406/46.3496 = 0.169 < 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)] = 0.184 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.007 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.014 < 1.000 ..... O.K

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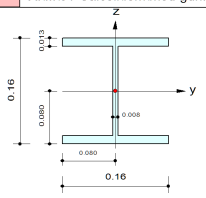
Fig. 9: Colonna

midas Gen **Steel Checking Result**

Company		Project Title	
Author		File Name	X:\...\01-Calcoli\fem\mod-gdrl.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 19
Material : S275 (No:3)
(Fy = 275000, Es = 210000000)
Section Name : HEB160 (No:2)
(Rolled : HEB160).
Member Length : 0.91167



2. Member Forces

Axial Force Fxx = -0.2893 (LCB: 1, POS:I)
Bending Moments My = 4.28908, Mz = 0.04184
End Moments Myi = 4.28908, Myj = 1.01571 (for Lb)
Myi = 4.28908, Myj = 1.01571 (for Ly)
Mzi = 0.04184, Mzj = -0.0322 (for Lz)
Shear Forces Fyy = 0.09431 (LCB: 3, POS:I)
Fzz = 4.48379 (LCB: 9, POS:J)

Depth	0.16000	Web Thick	0.00800
Top F Width	0.16000	Top F Thick	0.01300
Bot.F Width	0.16000	Bot.F Thick	0.01300
Area	0.00543	Asz	0.00128
Qyb	0.02135	Qzb	0.00320
Iyy	0.00002	Izz	0.00001
Ybar	0.08000	Zbar	0.08000
Wely	0.00031	Welz	0.00011
ry	0.06780	rz	0.04050

3. Design Parameters

Unbraced Lengths Ly = 0.91167, Lz = 0.91167, Lb = 0.91167
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 = 22.5 < 200.0 (LCB: 17)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 0.29/1493.25 = 0.000 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 4.2891/97.3500 = 0.044 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.0418/46.3496 = 0.001 < 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)] = 0.045 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.016 < 1.000 ..... O.K

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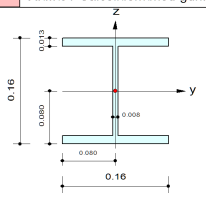
Fig. 10: Trave HEB160 principale

midas Gen **Steel Checking Result**

Company		Project Title	
Author		File Name	X:\...\01-Calcoli\fem\mod-gdrl.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 26
Material : S275 (No:3)
(Fy = 275000, Es = 210000000)
Section Name : HEB160 (No:2)
(Rolled : HEB160).
Member Length : 3.30000



2. Member Forces

Axial Force Fxx = -3.9470 (LCB: 14, POS:I)
Bending Moments My = -7.6927, Mz = -0.0724
End Moments Myi = -7.6927, Myj = 6.59023 (for Lb)
Myi = -7.6927, Myj = 6.59023 (for Ly)
Mzi = -0.0724, Mzj = 0.07161 (for Lz)
Shear Forces Fyy = -0.1061 (LCB: 22, POS:I)
Fzz = -6.7694 (LCB: 2, POS:I)

Depth	0.16000	Web Thick	0.00800
Top F Width	0.16000	Top F Thick	0.01300
Bot.F Width	0.16000	Bot.F Thick	0.01300
Area	0.00543	Asz	0.00128
Qyb	0.02135	Qzb	0.00320
Iyy	0.00002	Izz	0.00001
Ybar	0.08000	Zbar	0.08000
Wely	0.00031	Welz	0.00011
ry	0.06780	rz	0.04050

3. Design Parameters

Unbraced Lengths Ly = 3.30000, Lz = 3.30000, Lb = 3.30000
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 = 81.5 < 200.0 (LCB: 17)..... O.K
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 3.95/1493.25 = 0.003 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 7.6927/97.3500 = 0.079 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.0724/46.3496 = 0.002 < 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)] = 0.092 < 1.000 .. O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.024 < 1.000 ..... O.K

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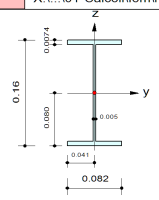
Fig. 11: Trave HEB160 di bordo

midas Gen **Steel Checking Result**

Company		Project Title	
Author		File Name	X:\...\01-Calcoli\fem\mod-gdrl.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 29
Material : S275 (No:3)
(Fy = 275000, Es = 210000000)
Section Name : IPE160 (No:3)
(Rolled : IPE160).
Member Length : 3.30000



2. Member Forces

Axial Force Fxx = 0.01434 (LCB: 3, POS:1/2)
Bending Moments My = 3.75293, Mz = -0.0000
End Moments Myi = -0.0566, Myj = -0.0341 (for Lb)
Myi = -0.0566, Myj = -0.0341 (for Ly)
Mzi = -0.0203, Mzj = 0.02021 (for Lz)
Shear Forces Fyy = -0.0123 (LCB: 3, POS:I)
Fzz = -4.6192 (LCB: 2, POS:I)

Depth	0.16000	Web Thick	0.00500
Top F Width	0.08200	Top F Thick	0.00740
Bot.F Width	0.08200	Bot.F Thick	0.00740
Area	0.00201	Asz	0.00080
Qyb	0.01190	Qzb	0.00084
Iyy	0.00001	Izz	0.00000
Ybar	0.04100	Zbar	0.08000
Wely	0.00011	Welz	0.00002
ry	0.06560	rz	0.01875

3. Design Parameters

Unbraced Lengths Ly = 3.30000, Lz = 3.30000, Lb = 3.30000
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 = 176.0 < 200.0 (LCB: 22)..... O.K
Axial Resistance
N_Ed/Nt_Rd = 0.014/552.750 = 0.000 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 3.7529/34.0450 = 0.110 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.00000/7.09123 = 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
Rmax = MAX[RNRd, Rmax1, (Rcom+Rbend)] = 0.110 < 1.000 ..... O.K
Shear Resistance
V_Edy/Vy_Rd = 0.000 < 1.000 ..... O.K
V_Edz/Vz_Rd = 0.030 < 1.000 ..... O.K

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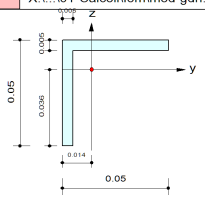
Fig. 12: Trave IPE160

midas Gen — **Steel Checking Result**

Company		Project Title	
Author		File Name	X:\...\01-Calcoli\fem\mod-gdrl.mgb

1. Design Information

Design Code : Eurocode3:05
Unit System : kN, m
Member No : 33
Material : S275 (No:3)
(Fy = 275000, Es = 210000000)
Section Name : L50x5 (No:5)
(Rolled : L50x5).
Member Length : 4.28605



2. Member Forces

Axial Force Fxx = -3.5664 (LCB: 3, 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: 3, POS:I)
Fzz = 0.00000 (LCB: 3, POS:I)

Depth	0.05000	Web Thick	0.00500
Top F Width	0.05000	Top F Thick	0.00500
Area	0.00048	Asz	0.00021
Qyb	0.00064	Qzb	0.00064
Iyy	0.00000	Izz	0.00000
Ybar	0.01400	Zbar	0.03600
Wely	0.00000	Welz	0.00000
rp	0.00983		
ry	0.01510	rz	0.01510

3. Design Parameters

Unbraced Lengths Ly = 4.28605, Lz = 4.28605, Lb = 4.28605
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 = 436.1 > 200.0 (LCB: 17)..... N.G
Axial Resistance
N_Ed/MIN[Nc_Rd, Nb_Rd] = 3.56639/4.90129 = 0.728 < 1.000 ..... O.K
Bending Resistance
M_Edy/M_Rdy = 0.00000/0.83875 = 0.000 < 1.000 ..... O.K
M_Edz/M_Rdz = 0.00000/0.83875 = 0.000 < 1.000 ..... O.K
Combined Resistance
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*Wely*fy/Gamma_M1) + (kyz*Msdz)/(Welz*fy/Gamma_M1)
Rc_LT2 = N_Ed/(Xiz*A*fy/Gamma_M1)
Rb_LT2 = (Kzy*M_Edy)/(Xi_LT*Wely*fy/Gamma_M1) + (Kzz*Msdz)/(Welz*fy/Gamma_M1)
Rmax = MAX[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 = 0.000 < 1.000 ..... O.K

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Fig. 13: Controvento

■ **VERIFICATO !**

A. Conclusioni

La presente relazione (fascicolo 2) è allegata al fascicolo 1 in cui sono esplicitati i metodi di calcolo ed i carichi utilizzati per le verifiche.

Tutti gli elementi strutturali, di cui si sono riportati a campione alcuni esempi, risultano verificati in base alle normative ed ai metodi di calcolo presi a riferimento e riportati nel fascicolo 1 della relazione di calcolo.