CALCOLO SOLAIO.

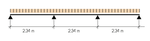
Carichi

$F_{d\,dle} = G_k + Q_k + Q_{Cp} = 2.4\ kN/m^2 + 3\ kN/m^2 + 3.5\ kN/m^2 = 8.9\ kN/m^2$

G_k = Carico strutturale
Q_k = Carico permanente
Q_{Cp} = Carico accidentale

Calcestruzzo C25/30
$f_{ck} = 25$ $Rck = 30\ MPa$ $E = 20000\ kN/m^2$ $P_{peso} = 2.4\ kN/m^2$

$Q_{dle} = F_{d\,dle} * i = 8.9\ kN/m^2 * i\ m = 8.9\ kN/m$



$M_A = P * L^2 = 8.9\ kN/m * (2.34\ m)^2 = 4.87\ kNm$
12 12

$W_I = \frac{M_A}{f_{yd}} = \frac{487.0000\ N*mm}{180\ N/mm^2} = 2705.5\ mm^3 = 27.055\ cm^3$

$M_A = P * L^2 = 8.9\ kN/m * (2.34\ m)^2 = 3.89\ kNm$
12.5 12.5

$W_I = M_A = 389.0000\ N*mm = 2159\ mm^3 = 21.659\ cm^3$
f_{yd} 180 N/mm

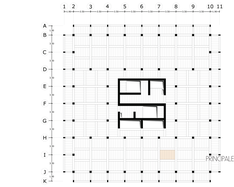
LAMIERA
$W = 30.76\ cm^3$ Spessore 1mm
$W_I = 23.72\ cm^3$ $I = 73.46\ cm^4$
$Cmax = 7.08\ Kg/m^2$

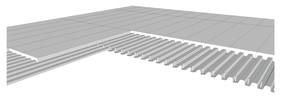
$d_C = \frac{2.65 * M_{dmm} * L^2}{384 * E * I} = \frac{2.65 * 0.024\ kN/m^2 * (234\ cm)^4}{384 * 20000\ kN/cm^2 * 73.46\ cm^4} = 0.3\ cm$

$d_V = \frac{2.65 * M_{dvg} * L^2}{384 * E * I} = \frac{2.65 * 0.065\ kN/m^2 * (234\ cm)^4}{384 * 20000\ kN/cm^2 * 73.46\ cm^4} = 0.76\ cm$

$d_C = \frac{L}{250} = \frac{234}{250} = 0.9\ cm$

$d_V = \frac{L}{300} = \frac{234}{300} = 0.78\ cm$





CALCOLO TRAVE SECONDARIA

Carichi

SLU

$F_{d\,dle} = 28.97\ kN/m$

SLE

$F_{d\,dle} = 21.04\ kN/m$

VERIFICA SLU

$Id_{dy} = 28.97\ kN/m * 3.50\ m = 101.39\ kN$

$M_{max} = P * \alpha = 101.39\ kN * 0.170\ m^2 = 237.25\ kNm$

$Wpl = \frac{M_{dy}}{F_{yd}} = \frac{23725000\ N*mm}{223.8\ N/mm^2} = 106009.83\ mm^3 = 1060.098\ cm^3$

$f_{ydI} = F_{yd} = \frac{235}{\gamma_{M0}} = 223.8\ N/mm^2$
1.05

HEB 320 $W_x = 2149\ cm^3$ $G = 127\ kg/m$
$I_x = 30820\ cm^4$

$Fd_{Gmax} = M_{dy} + G = 128.97\ kN/m + 1.27\ kN/m\ 3.50\ m = 105.84\ kN$

$M_{max} = P * \alpha = 15.84\ kN * (2.34\ m)^2 = 247.66\ kNm$

$M_{dI} = W_x * f_{yd} = 2149.000\ mm^3 * 223.8\ N/mm^2 = 480966.70\ N*mm = 480.96\ kN*m$

$M_{max} = 247.66\ kN*m < 0.5I\ 4$
M_{dI} 480.96 kN*m

VERIFICA A TAGLIO_SLU

$V = P * \frac{L}{2} = 28.97\ kN/m * \frac{3.50\ m}{2} = 50.69\ kN$

$Av = A - (2b * (t + 1w + 2)t + (w + 2)t) =$
$= 3340\ mm^2 - (2 * 80\ mm * 9.2\ mm) + (5.9\ mm + 2*(2mm)*9.2mm) =$
$= 3340\ mm^2 - 2024\ mm^2 + 275.08\ mm^2 = 1591.08\ mm^2$

$Vpl = Av\ fy/\sqrt{3} = \frac{1591.08\ mm2\ (235N/mm2 / \sqrt{3})}{\gamma m0} = \frac{205593.7\ N}{1.05} = 205.59\ kN$

$\frac{V}{Vpl} = \frac{50.69\ kN}{205.59\ kN} = 0.2 < 1$

VERIFICA SLE

$Fd\ dle = 8.9\ kN/m * 2.34\ m = 20.82\ kN/m$

$Gt = 26.2\ kg/m$

$Fd\ dle = 20.82\ kN/m + 0.26\ kN/m = 21.08\ kN/m$

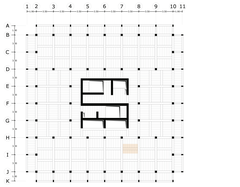
Verifica rigidezza permanente

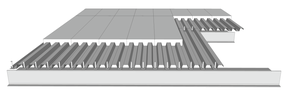
$df = \frac{5}{384} * \frac{Fdlw * L^4}{E*I} = \frac{5}{384} * \frac{0.21\ kN/m * (350\ cm)^4}{2000\ kN/cm^2 * 2772\ cm^4} = 0.7\ cm$

$df_2 = \frac{5}{384} * \frac{Fdlsovv * L^4}{E*I} = \frac{5}{384} * \frac{0.15\ kN/m * (350\ cm)^4}{2000\ kN/cm^2 * 2772\ cm^4} = 0.5\ cm$

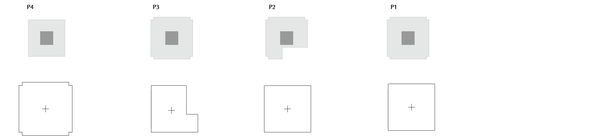
$\frac{L}{400} = \frac{350}{400} = 0.87\ cm$

$\frac{L}{500} = \frac{350}{500} = 0.70\ cm$





GEOMETRIA DELLE MASSE



P4
Area 795.2400
Perimeter 112.8000
Bounding box X: 2.0000 — 30.2000
Y: 2.0000 — 30.2000
Centroid X: 16.1000
Y: 16.1000
Moments of inertia X: 2568.1752
Y: 2568.1752
Product of inertia XY: 2060.4604
Radii of gyration X: 18.048
Y: 18.048
Principal moments and X-Y directions about centroid
I: 527.1000 [-0.5548, 0.8320, 0.0000]
J: 527.1000 [0.8320, 0.5548, 0.0000]

P2
Area 675.1800
Perimeter 112.8000
Bounding box X: 2.0000 — 30.2000
Y: 2.0000 — 30.2000
Centroid X: 15.0918
Y: 17.0938
Moments of inertia X: 2547.0950
Y: 2030.7.8664
Product of inertia XY: 1972.1664.0299
Radii of gyration X: 19.4260
Y: 17.2242
Principal moments and X-Y directions about centroid
I: 3148.3.0324 along [0.8657, 0.5006, 0.0000]
J: 502.5001.7796 along [-0.5006, 0.8657, 0.0000]

P1/P3
Area 1020.8400
Perimeter 128.8000
Bounding box X: 0.0000 — 32.2000
Y: 0.0000 — 32.2000
Centroid X: 16.1000
Y: 16.1000
Moments of inertia X: 3505.4.8752
Y: 3505.4.8752
Product of inertia XY: 2646.9364
Radii of gyration X: 18.3307
Y: 18.3307
Principal moments and X-Y directions about centroid
I: 8599.2.9388 along [1.0000, 0.0000, 0.0000]
J: 8599.2.9388 along [0.0000, 1.0000, 0.0000]

CALCOLO TRAVE SECONDARIA

Carichi

SLU

$F_{d\,dle} = 28.97\ kN/m$

SLE

$F_{d\,dle} = 21.04\ kN/m$

VERIFICA SLU

$Id_{dy} = 28.97\ kN/m * 3.50\ m = 101.39\ kN$

$M_{max} = P * \alpha = 101.39\ kN * 0.170\ m^2 = 237.25\ kN*m$

$Wpl = \frac{M_{dy}}{F_{yd}} = \frac{23725000\ N*mm}{223.8\ N/mm^2} = 106009.83\ mm^3 = 1060.098\ cm^3$

$f_{ydI} = F_{yd} = \frac{235}{\gamma_{M0}} = 223.8\ N/mm^2$
1.05

HEB 320 $W_x = 2149\ cm^3$ $G = 127\ kg/m$
$I_x = 30820\ cm^4$

$Fd_{Gmax} = M_{dy} + G = 128.97\ kN/m + 1.27\ kN/m\ 3.50\ m = 105.84\ kN$

$M_{max} = P * \alpha = 15.84\ kN * (2.34\ m)^2 = 247.66\ kNm$

$M_{dI} = W_x * f_{yd} = 2149.000\ mm^3 * 223.8\ N/mm^2 = 480966.70\ N*mm = 480.96\ kN*m$

$M_{max} = 247.66\ kN*m < 0.5I\ 4$
M_{dI} 480.96 kN*m

VERIFICA A TAGLIO_SLU

$V = P * \frac{L}{2} = 101.49\ kN$

$Av = A - (2b * (t + 1w + 2)t + (w + 2)t) =$
$= 1600\ mm^2 - (2 * 300\ mm * 20.5\ mm) + (8.5\ mm + 2*(2mm)*20.5mm =$
$= 1600\ mm^2 - 2024\ mm^2 + 1247.75\ mm^2 = 1548.75\ mm^2$

$Vpl = Av\ fy/\sqrt{3} = \frac{1548.75\ mm2\ (235N/mm2 / \sqrt{3})}{\gamma m0} = \frac{1996233.23\ N}{1.05} = 1996.233\ kN$

$\frac{V}{Vpl} = \frac{50.69\ kN}{1996.233\ kN} = 0.025 < 1$

VERIFICA SLE

$Gt = 127\ kg/m$

$Fd\ dle = 21.04\ kN/m + 127\ kN/m = 22.31\ kN/m * 3.5\ m = 78.08\ kN$

Verifica rigidezza permanente

$df = \frac{1}{24} * \frac{Fdlw * a * (3 * L^2 - 4a^2)}{E*I} =$

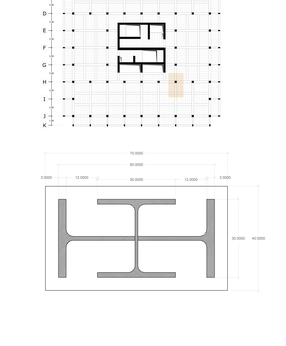
$= \frac{1}{24} * \frac{78.08\ kN * 234\ cm}{2000\ kN/cm^2 * 30820\ cm^4} * \frac{3^4\ 0.00\ cm^2 - 4^4 234\ cm^2 = 1.47\ cm}{}$

$df_2 = \frac{1}{24} * \frac{Fdlsov * a * (3 * L^2 - 4a^2)}{E*I} =$

$= \frac{1}{24} * \frac{28.44\ kN * 234\ cm}{2000\ kN/cm^2 * 30820\ cm^4} * \frac{3^4\ 0.00\ cm^2 - 4^4 234\ cm^2 = 0.54\ cm}{}$

$\frac{L}{400} = \frac{700}{400} = 1.75\ cm$

$\frac{L}{500} = \frac{700}{500} = 1.4\ cm$



CALCOLO TRAVE SECONDARIA II

Carichi
$Pdu = 28.97\ kN/m * 3.50\ m = \frac{50.69\ kN}{2}$
$Pdle = 21.04\ kN/m * 3.50\ m = \frac{36.82\ kN}{2}$
$Qdu = 12.27\ kN/m2 * 2.34\ m = \frac{14.35\ kN/m}{2}$
$Qdu = 12.27\ kN/m2 * 2.34\ m = \frac{14.35\ kN/m}{2}$
$Gdu = 50.69\ kN * 3.50\ m = 14.48\ kN/m$
$Gdle = 36.82\ kN * 3.50\ m = 10.52\ kN/m$
$Fdu = 14.35\ kN/m + 14.48\ kN/m = 28.83\ kN/m$
$Fdle = 10.41\ kN/m + 10.52\ kN/m = 20.93\ kN/m$

VERIFICA SLU

$Id_{dy} = 28.83\ kN/m$

$M_{max} = P * \alpha = 28.83\ kN/m * 13.50\ m^2 = 414.41\ kN*m$

$Wpl = \frac{M_{dy}}{F_{yd}} = \frac{4841598.74\ N*mm}{223.8\ N/mm^2} = 19725.6.2\ mm^3 = 197.25\ cm^3$

$f_{ydI} = F_{yd} = \frac{235}{\gamma_{M0}} = 223.8\ N/mm^2$
1.05

IPE 220 $W_x = 225cm^3$ $G = 26.2\ kg/m$
$I_x = 2772\ cm^4$

$Fd_{Gmax} = Id_{dy} + G = 28.83\ kN/m + 0.26\ kN/m = 29.09\ kN/m$

$M_{max} = P * \alpha = 29.09\ kN/m * 13.50\ m^2 = 441.41\ kN*m$

$M_{dI} = W_x * f_{yd} = 285000\ mm^3 * 223.8\ N/mm^2 = 63780.00\ N*mm = 63.78\ kN*m$

$M_{max} = 441.41\ kN*m > 0.6I\ 4$
M_{dI} 63.78 kN*m

VERIFICA A TAGLIO_SLU

$V = P * \frac{L}{2} = 29.09\ kN/m * \frac{3.50\ m}{2} = 50.90\ kN$

$Av = A - (2b * (t + 1w + 2)t + (w + 2)t) =$
$= 3340\ mm^2 - (2 * 80\ mm * 9.2\ mm) + (5.9\ mm + 2*(2mm)*9.2mm =$
$= 3340\ mm^2 - 2024\ mm^2 + 275.08\ mm^2 = 1591.08\ mm^2$

$Vpl = Av\ fy/\sqrt{3} = \frac{1591.08\ mm2\ (235N/mm2 / \sqrt{3})}{\gamma m0} = \frac{205593.7\ N}{1.05} = 205.59\ kN$

$\frac{V}{Vpl} = \frac{50.90\ kN}{205.59\ kN} = 0.24 < 1$

VERIFICA SLE

$Id\ dle = 20.93\ kN/m$

$Gt = 26.2\ kg/m$

$Fd\ dle = 20.93\ kN/m + 0.26\ kN/m = 21.19\ kN/m$

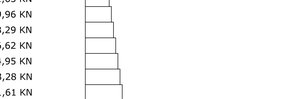
Verifica rigidezza permanente

$df = \frac{5}{384} * \frac{Fdlw * L^4}{E*I} = \frac{5}{384} * \frac{0.21\ kN/m * (350\ cm)^4}{2000\ kN/cm^2 * 2772\ cm^4} = 0.7\ cm$

$df_2 = \frac{5}{384} * \frac{Fdlsovv * L^4}{E*I} = \frac{5}{384} * \frac{0.08\ kN/m * (350\ cm)^4}{2000\ kN/cm^2 * 2772\ cm^4} = 0.268\ cm$

$\frac{L}{400} = \frac{350}{400} = 0.87\ cm$

$\frac{L}{500} = \frac{350}{500} = 0.70\ cm$



Baricentro totale di un blocco di 4 piani

$d = \frac{S_x}{S1} = \frac{d\,y\,i}{S1}$

$Dx = (3505.44.87\ N/m^2 * 6.00\ m) + (3505.44.87\ N/m^2 * 16.00\ m) + (254.972.29\ N/m^2 * 17.99\ m) + (254.834.71\ N/m^2 * 16.00\ m) = 200.384.96.94\ N/m$

$Sx = 3505.44.87 + 3505.44.87 + 254.972.29 + 254.834.71 = 1.967.6.74\ N/m$

$y = dx = \frac{200.384.96.94\ N/m}{1.967.6.74\ N/m} = 16.49\ m$

$Dy = (3505.44.87\ N/m^2 * 6.00\ m) + (3505.44.87\ N/m^2 * 16.00\ m) + (1.000.07.86\ N/m^2 * 11.09\ m) + (254.834.71\ N/m^2 * 16.00\ m) = 184.854.48.56\ N/m$

$Sy = 3505.44.87 + 3505.44.87 + 1.000.07.86 + 254.834.71 = 1.860.232.31\ N/m^2$

$x = dy = \frac{1.848.548.56\ N/m}{1.860.232.31\ N/m^2} = 15.93\ m$

Scala - 40cm
Area R7.7600
Perimeter 01.6000
Bounding box X: 0.0000 — 10.6000
Y: 0.0000 — 10.6000
Centroid X: 5.2887
Y: 5.3000
Moments of inertia X: 7333.7472
Y: 7287.4632
Product of inertia XY: 5543.2064
Radii of gyration X: 6.0897
Y: 6.0704
Principal moments and X-Y directions about centroid
I: 1756.1.034 along [0.0000, 1.0000, 0.0000]
J: 1778.6688 along [-1.0000, 0.0000, 0.0000]

Scala - 50cm
Area R9.4200
Perimeter 128.2.000
Bounding box X: 0.0000 — 10.6000
Y: 0.0000 — 10.6000
Centroid X: 5.2920
Y: 5.3000
Moments of inertia X: 7085.8351
Y: 7040.583
Product of inertia XY: 5349.9053
Radii of gyration X: 6.0842
Y: 6.0647
Principal moments and X-Y directions about centroid
I: 1708.8473 along [0.0000, 1.0000, 0.0000]
J: 1679.6751 along [1.0000, 0.0000, 0.0000]

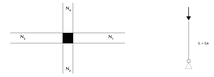
Scala - 60cm
Area R7.7600
Perimeter 01.6000
Bounding box X: 0.0000 — 10.6000
Y: 0.0000 — 10.6000
Centroid X: 5.2887
Y: 5.3000
Moments of inertia X: 7333.7472
Y: 7287.4632
Product of inertia XY: 5543.2064
Radii of gyration X: 6.0897
Y: 6.0704
Principal moments and X-Y directions about centroid
I: 1756.1.034 along [0.0000, 1.0000, 0.0000]
J: 1778.6688 along [-1.0000, 0.0000, 0.0000]

CALCOLO PILASTRO SINGOLO

Carichi

$F_{d\,dle} = N_1 + N_2 + N_3 + N_4 = 50.90\ kN + 105.84\ kN + 50.90\ kN + 50.69\ kN = 258.337\ kN$

N_1 = Trave secondaria II = 29.09 kN/m * 3.50/2 m = 50.90 kN
N_2 = Trave principale = 30.24 kN/m * 7.00/2 m = 105.84 kN
N_3 = Trave secondaria = N
$N4$ = Trave secondaria = 28.97 kN/m * 3.50/2 m = 50.69 kN



$N_d = 258.337\ kN * 8\ piani = 2.84.66\ kN$

$I_{min} = \frac{N_d * L^2}{12 * E} = \frac{3875.055\ kN * (360\ cm)^2}{12 * (0.90 * 20000\ kN/cm^2)} = 2405.51\ cm^4$

PILASTRO
HEM 300
$I_x = 8563\ cm^4$ $I = 25170\ cm^4$
$A = 149.10\ cm^2$ $G = 87\ cm^2$

$N_{cr} = \frac{\rho 2 * \Pi^2 * E * 0.5I0^2 * 8563\ cm^4 * 20000\ kN/cm^2}{L0^2} = \frac{13680.42\ kN}{(360cm)^2}$

$Ned = \frac{3875.055\ kN}{Ncr} = 0.28 < 0.4$
$Ncr = 13680.42\ kN$

$I = \frac{A^2 * L}{\lambda} = \frac{(8900\ mm2 * 235\ N/mm2)^2 * 0.505}{13680900\ N}$

$\frac{h}{b} = \frac{30}{30} = 1 < 1.1 \qquad \alpha = 0.49$

CALCOLO PILASTRO

Carichi

$F_{d\,dle} = N_1 + N_2 + N_3 + N_4 = 50.90\ kN + 105.84\ kN + 50.90\ kN + 50.69\ kN = 258.337\ kN$

N_1 = Trave secondaria II = 29.09 kN/m * 3.50/2 m = 50.90 kN
N_2 = Trave principale = 30.24 kN/m * 7.00/2 m = 105.84 kN
N_3 = Trave secondaria = N
$N4$ = Trave secondaria = 28.97 kN/m * 3.50/2 m = 50.69 kN

$N_d = 258.337\ kN * 30\ piani = 7750.11\ kN$

$I_{min} = \frac{N_d * L^2}{12 * E} = \frac{7750.11\ kN * (360cm)^2}{12 * (0.90 * 20000\ kN/cm^2)} = \frac{4850.13\ cm^4}{}$

PILASTRO
HEM 300
$I_x = 8563\ cm^4$ $I = 25170\ cm^4$
$A = 149.10\ cm^2$ $G = 87\ cm^2$

HEM 600
$I_x = 187.00\ cm^4$ $I = 170000\ cm^4$
$A = 270\ Kg/m^2$ $G = 257\ KG/m$

$Atot = 149.10\ cm^2 + 270\ cm^2 = 419.10\ cm^2$

$N_{cr} = \frac{\rho 2 * \Pi^2 * E * 0.5I02 * 25170\ cm4 * 20000\ kN/cm2}{L0^2} = \frac{40212.10\ kN}{(360cm)^2}$

$Ned = \frac{7750.11\ kN}{Ncr} = 0.19 < 0.04$
$Ncr = 40212.10\ kN$

$I = \frac{A^2 * L}{\lambda} = \frac{(4190\ mm2 * 235\ N/mm2)^2 * 0.49}{40212100\ N}$

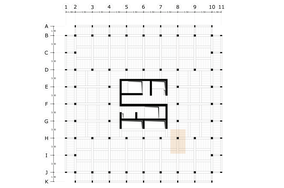
$\frac{h}{b} = \frac{30}{30} = 0.5 < 1 \qquad \alpha = 0.49$

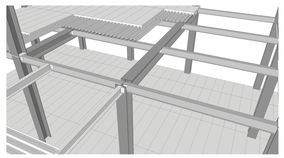
$f = 0.5\ (1 + \alpha\ (\lambda - 0.2) + \lambda^2 = 0.5\ (1 + 0.49\ (0.50 - 0.2) + 0.50^2 = 0.69$

$c = \frac{1}{I + \sqrt{\Phi^2 + I^2}} = \frac{1}{0.69 + \sqrt{0.69^2 - 0.50^2}} = \frac{1}{1.16} = 0.86$

$N_{Rd} = c * \frac{A * fyk}{\gamma M0} = 0.86 * \frac{4900\ mm^2 * 235\ N/mm}{1.05} = 2867895.23\ N > 2867.89\ kN$

$\frac{N_{ed}}{N_{Rd}} = \frac{2841.66\ kN\ (1.3 * 0.19 * 4) + 2842.61\ kN + 0.99 < 1}{2867.89\ kN} = \frac{2867.89\ kN}{}$



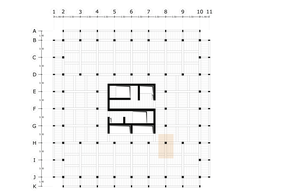


$f = 0.5\ (1 + \alpha\ (\lambda - 0.2) + \lambda^2 = 0.5\ (1 + 0.49\ (0.49 - 0.2) + 0.49^2 = 0.69$

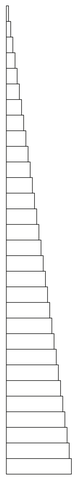
$c = \frac{1}{I + \sqrt{\Phi^2 + I^2}} = \frac{1}{0.69 + \sqrt{0.69^2 - 0.49^2}} = \frac{1}{1.17} = 0.85$

$N_{Rd} = c * \frac{A * fyk}{\gamma M0} = 0.85 * \frac{4990\ mm^2 * 235\ N/mm}{1.05} = 803697.09\ N = 8036.97\ kN$

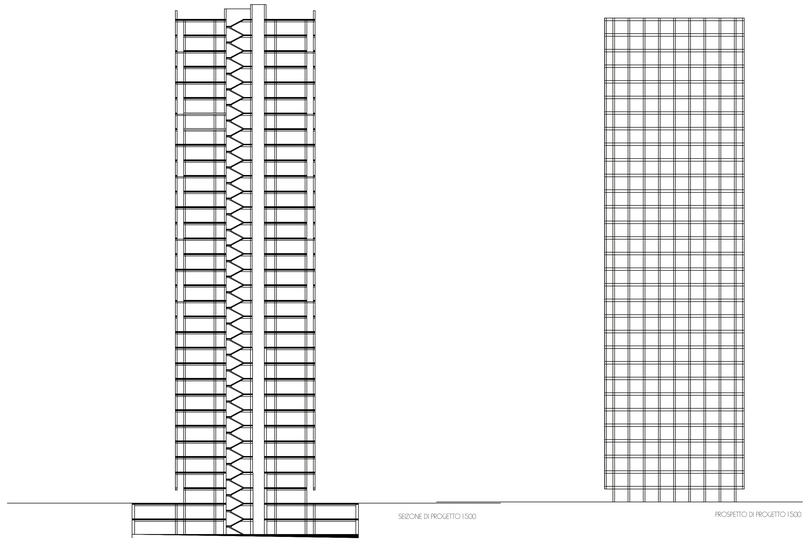
$\frac{N_{ed}}{N_{Rd}} = \frac{7750.11 + (1.3 * 0.19 * 4) + 7751.09\ kN + 0.96 < 1}{8036.97} = \frac{8036.97\ kN}{}$



258,33 KN
516,66 KN
774,99 KN
1033,32 KN
1291,65 KN
1549,98 KN
1808,31 KN
2066,64 KN
2324,97 KN
2583,30 KN
2841,63 KN
3099,96 KN
3358,29 KN
3616,62 KN
3874,95 KN
4133,28 KN
4391,61 KN
4649,94 KN
4908,27 KN
5166,6 KN
5424,93 KN
5683,26 KN
5941,59 KN
6199,92 KN
6458,25 KN
6716,58 KN
6974,91 KN
7233,24 KN
7491,57 KN
7749,90 KN



CARICHI VERTICALI



SEZIONE DI PROGETTO 1:500

PROSPETTO DI PROGETTO 1:500