Laboratorio di Progettazione Strutturale 1M – Prof. Ginevra Salerno

Esercitazione 4: Dimensionamento di massima di una trave Vierendeel

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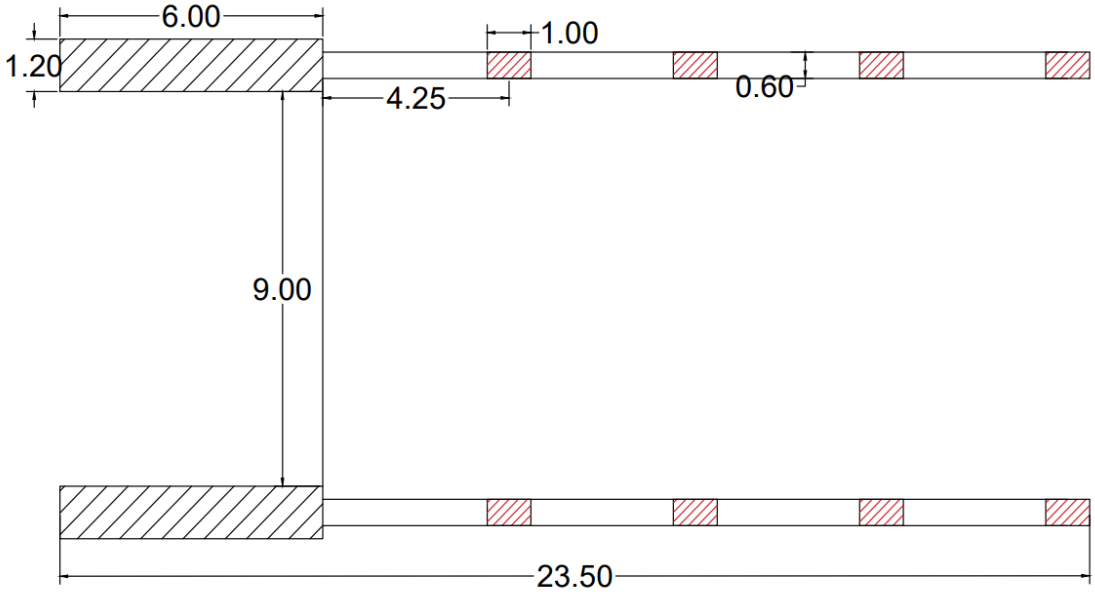
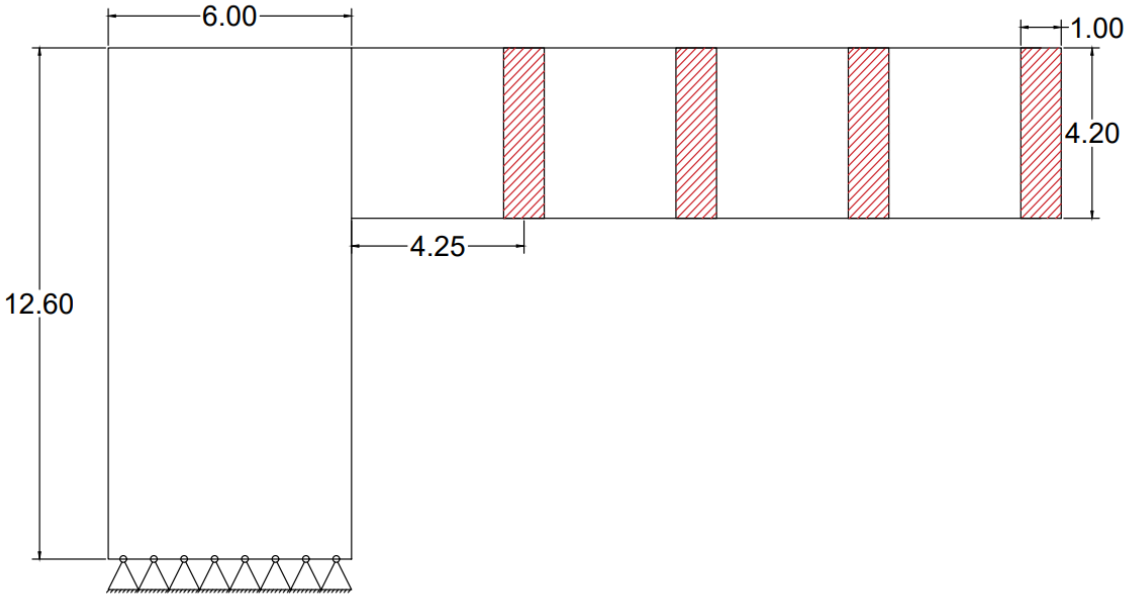
Questa esercitazione ha l'obiettivo di dimensionare una trave Vierendeel per risolvere una struttura in aggetto. La trave Vierendeel è caratterizzata da collegamenti rigidi e presenta sollecitazioni di taglio e momento flettente.

Disegniamo quindi una struttura ipotetica con gli estremi di sinistra incastrati ad un supporto esterno e quelli di destra liberi. La lunghezza complessiva è di 23.5m, con interassi da 4.25m, altezza di 12.6m.

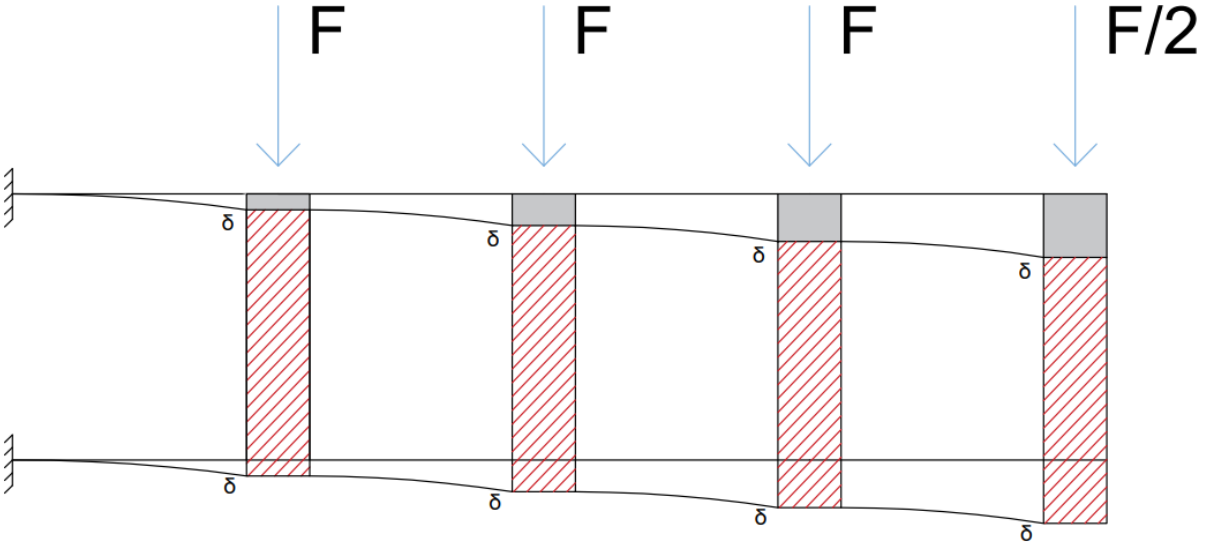
Pianta:



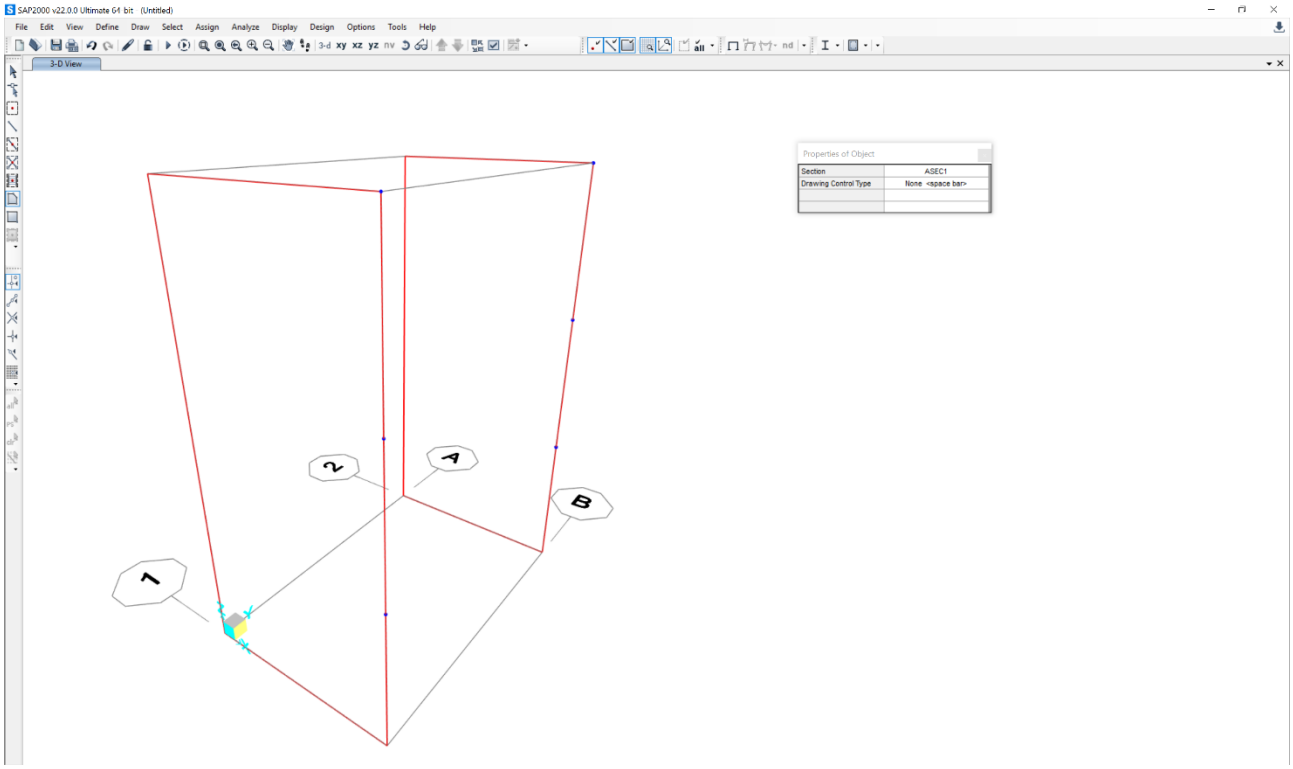
Prospetto:



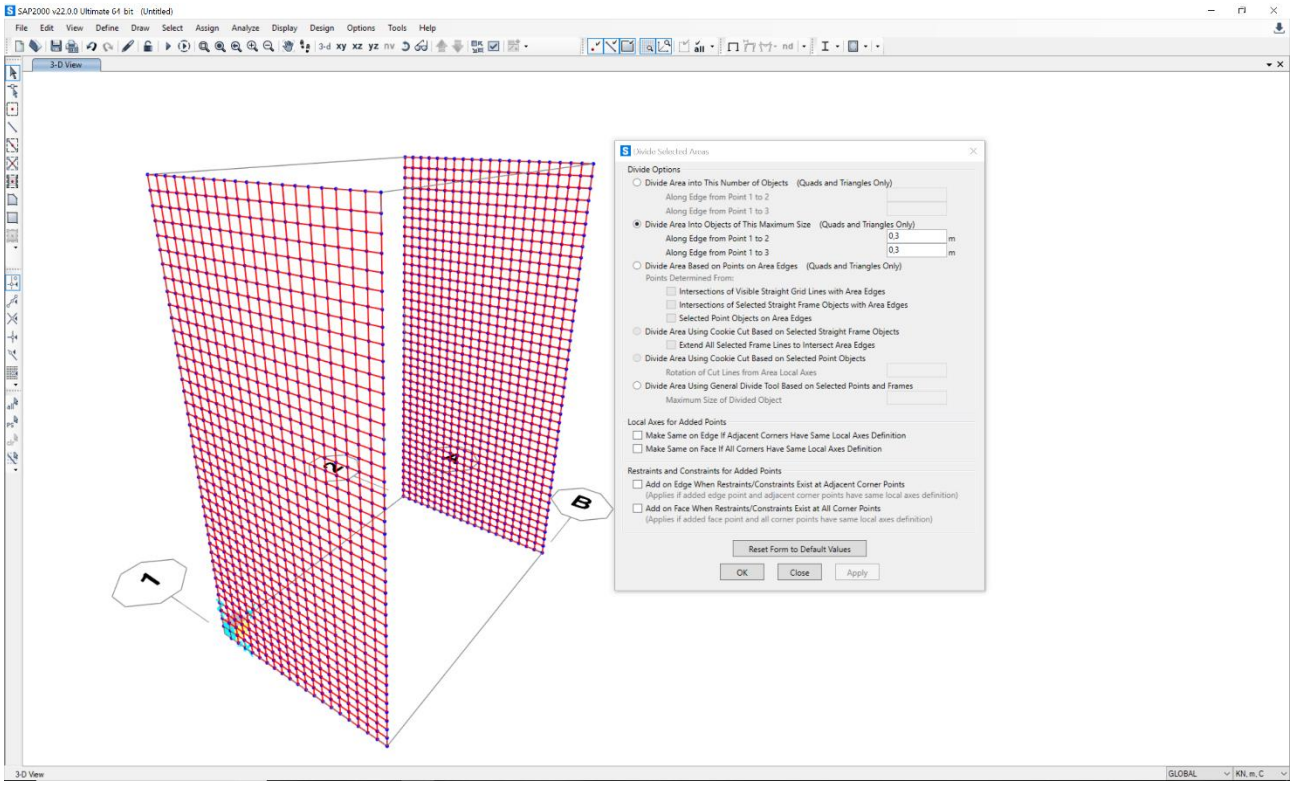
Dato che la trave Virendeel è assimilabile alla configurazione di un telaio di tipo Shear ruotato di 90^0, possiamo delineare la deformata del nostro modello.



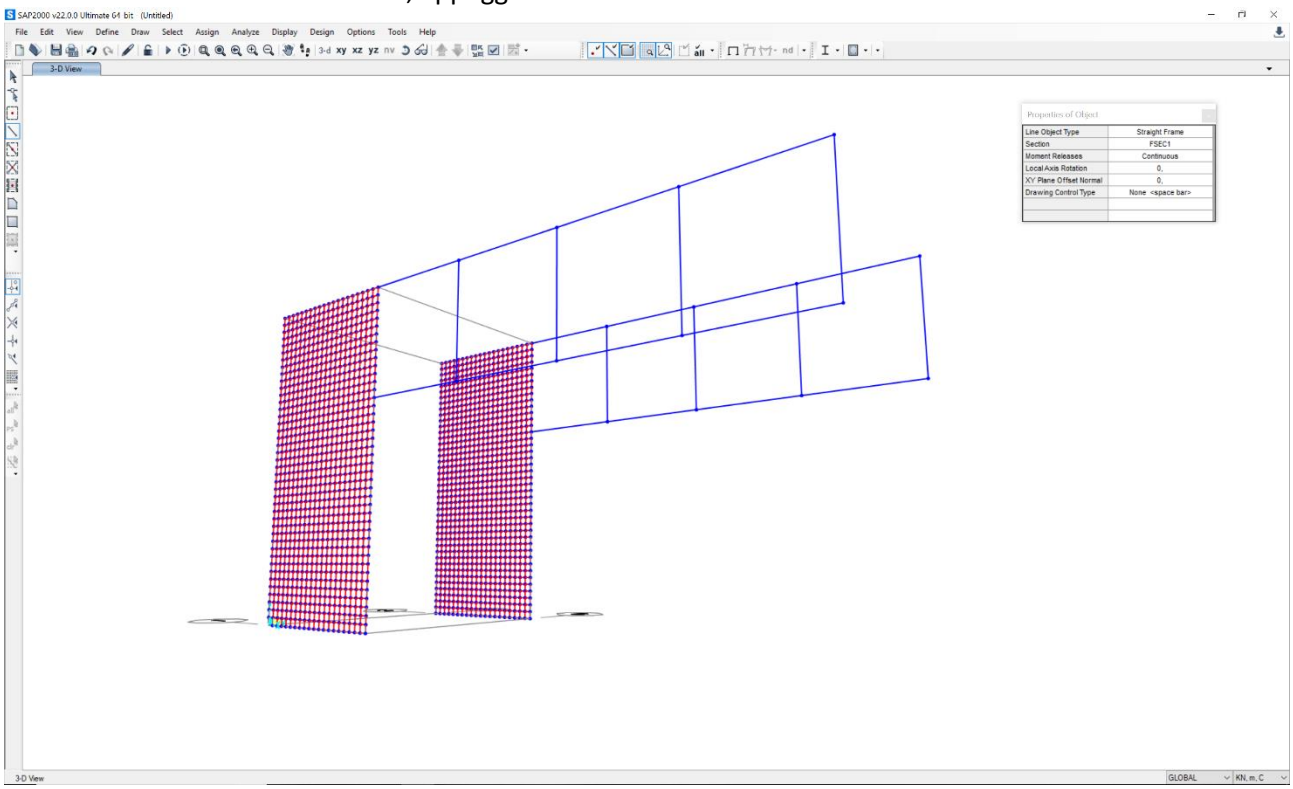
A questo punto passiamo su SAP e modelliamo la struttura tramite il comando Draw Poly Area.



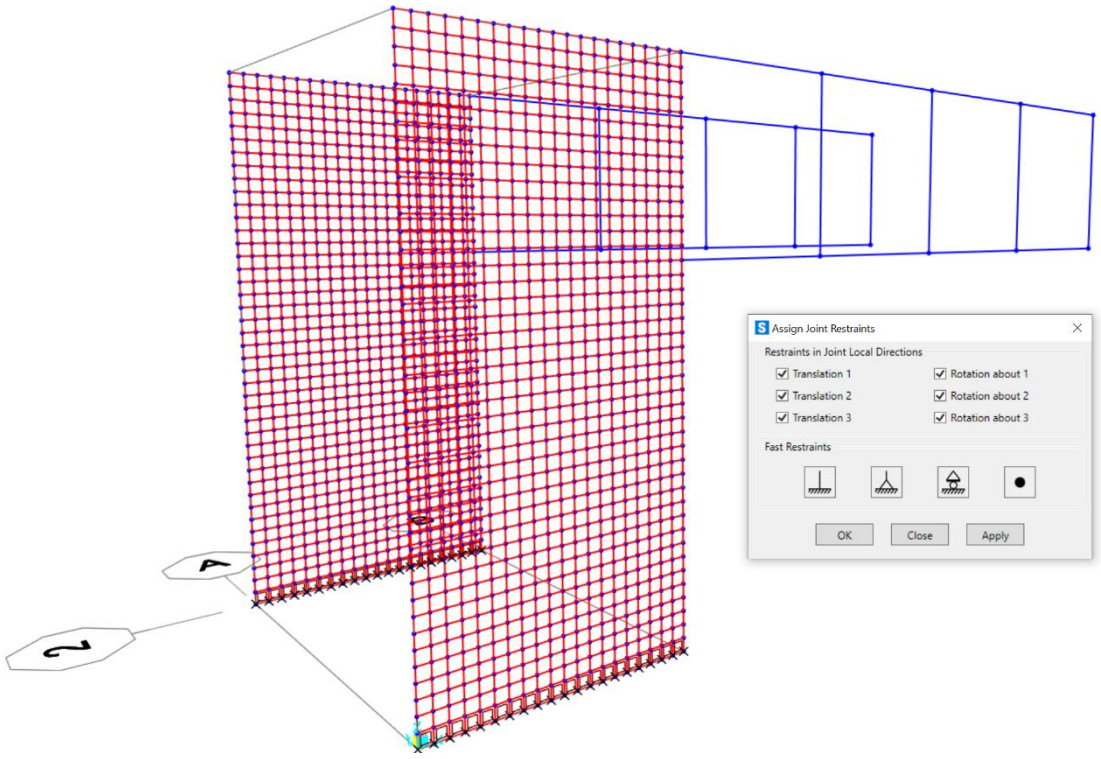
Tramite il comando Edit Area – Divide Area, creiamo una griglia di 0,3mx0,3m.

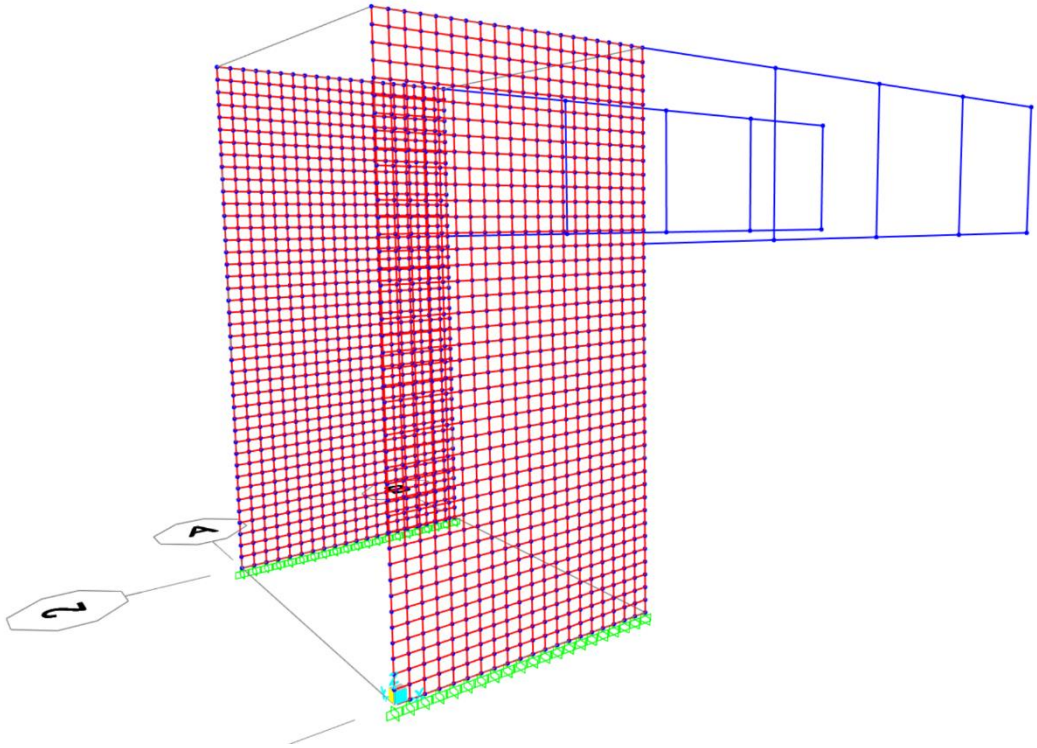


Ora costruiamo la trave Virendeel, appoggiandola ai setti.

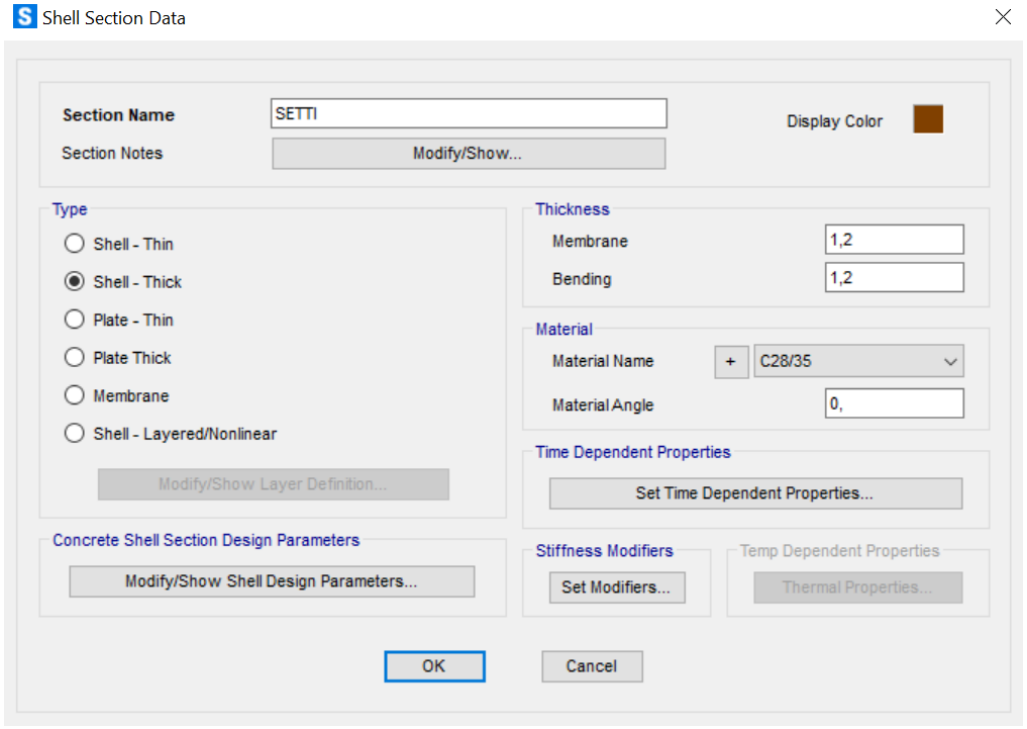


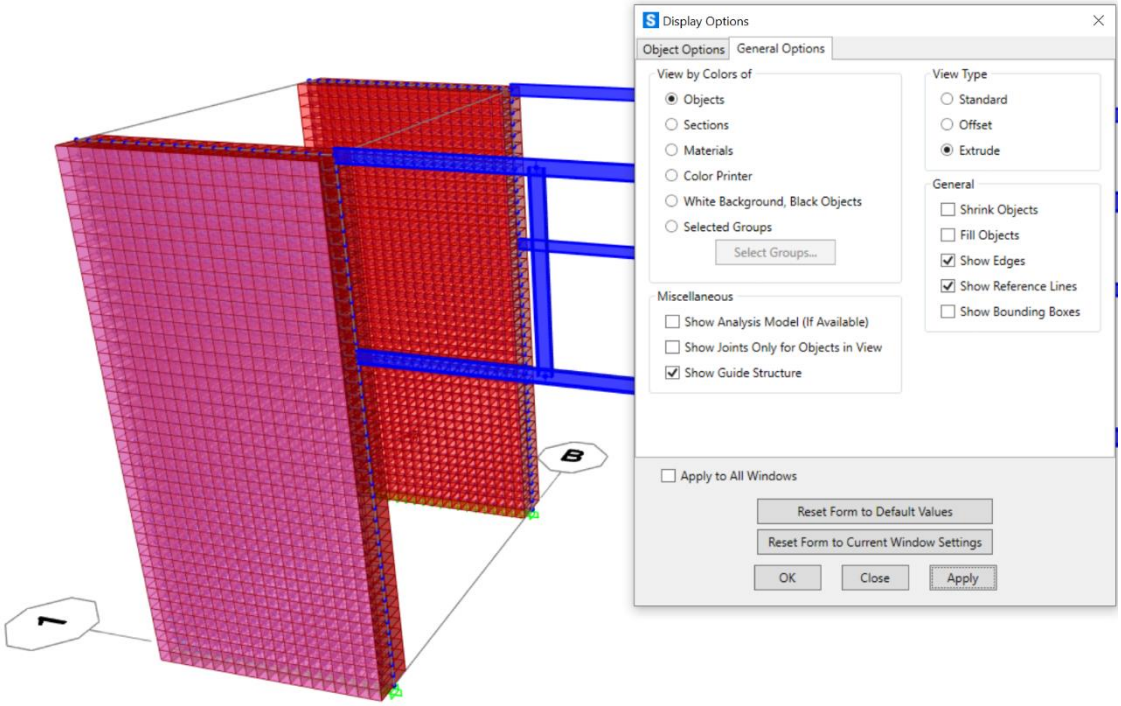
Aggiungiamo ora i vincoli esterni alla base dei setti (Joint Restraints).


A
2
Assign Joint Restraints
Restraints in Joint Local Directions
Translation 1
Translation 2
Translation 3
Rotation about 1
Rotation about 2
Rotation about 3
Fast Restraints
OK
Close
Apply


A
2

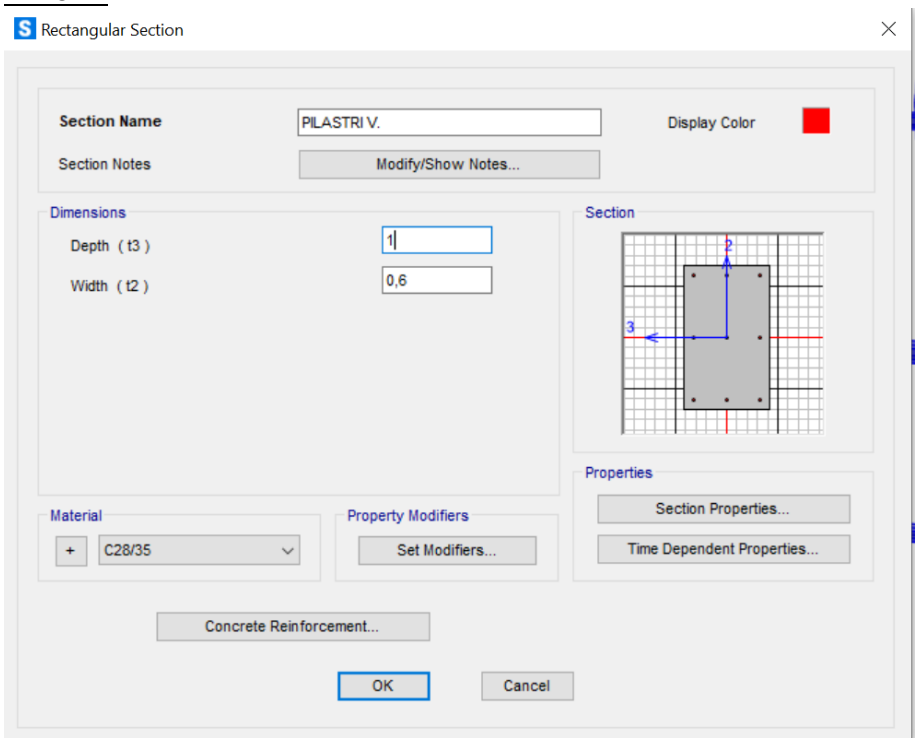
Definiamo la sezione dell'area: tipo (Shell-Thick); materiale (C28/35); spessore (1,2m).

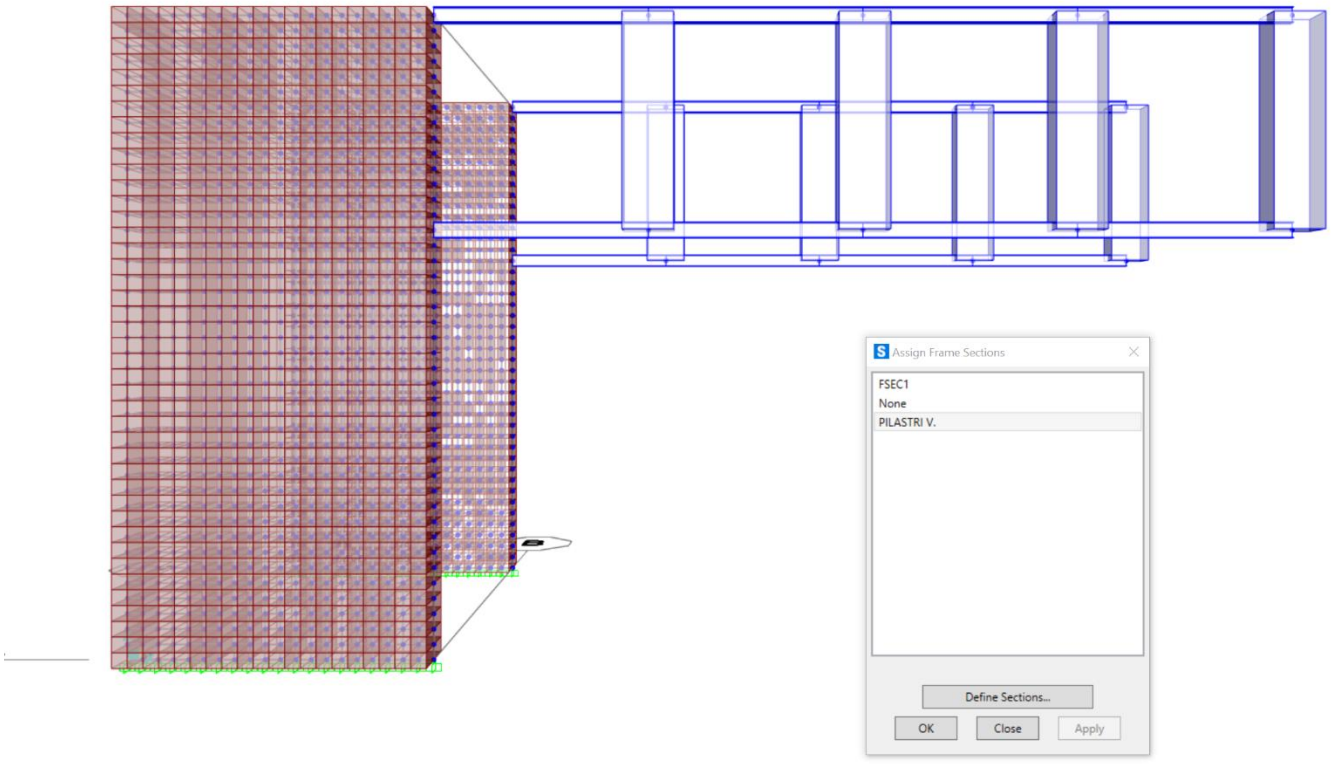




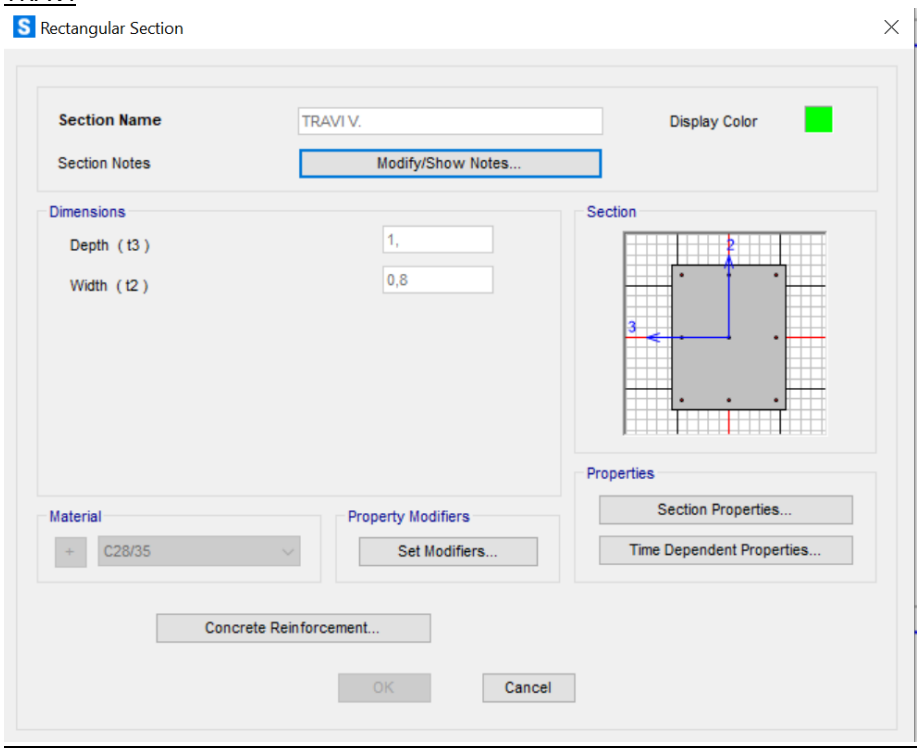
Infine definiamo le sezioni di travi (30x60) e pilastri (100x60):

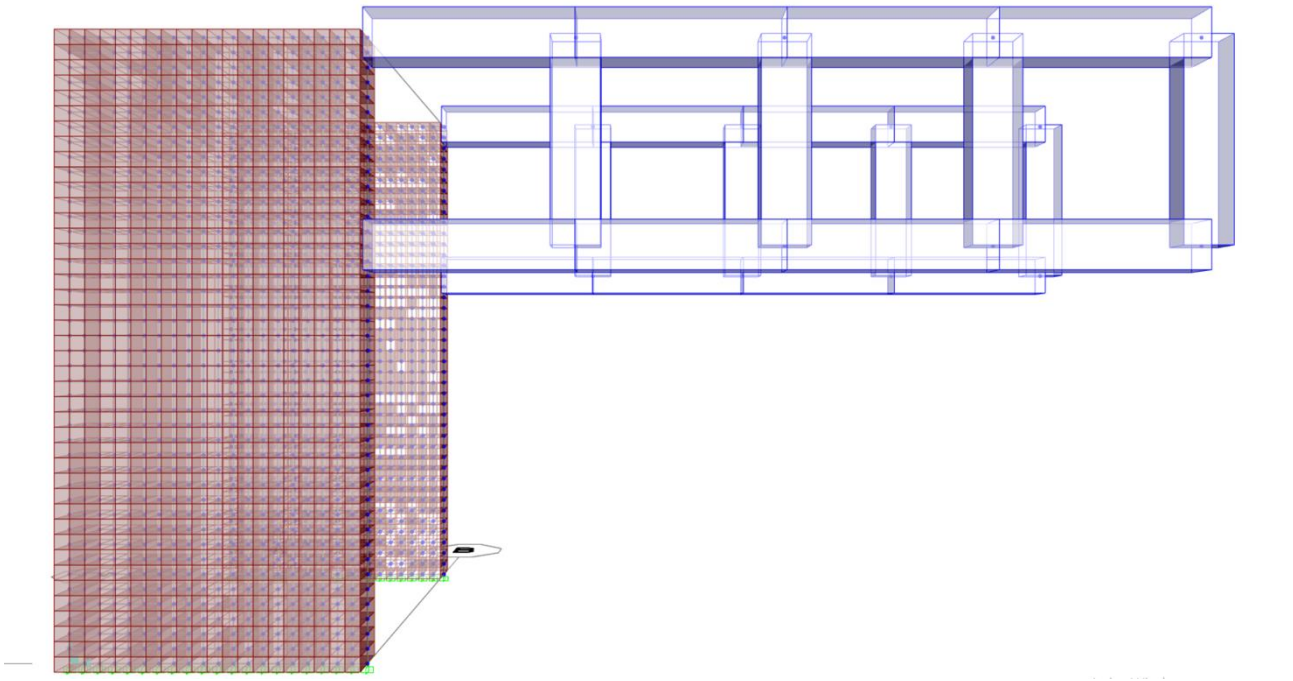
PILASTRI



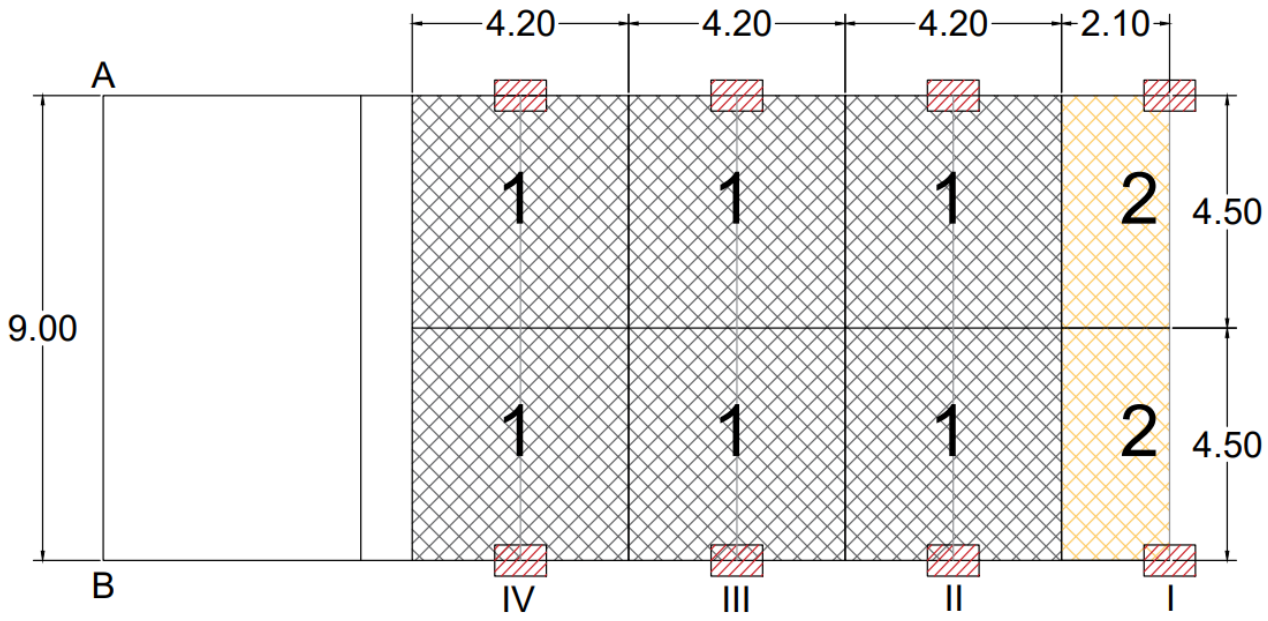


TRAVI


Rectangular Section
Section Name
TRAVI V.
Display Color
Section Notes
Modify/Show Notes...
Dimensions
Depth (t3)
1,
Width (t2)
0,8
Section
2
3
Properties
Section Properties...
Time Dependent Properties...
Material
C28/35
Property Modifiers
Set Modifiers...
Concrete Reinforcement...
OK
Cancel

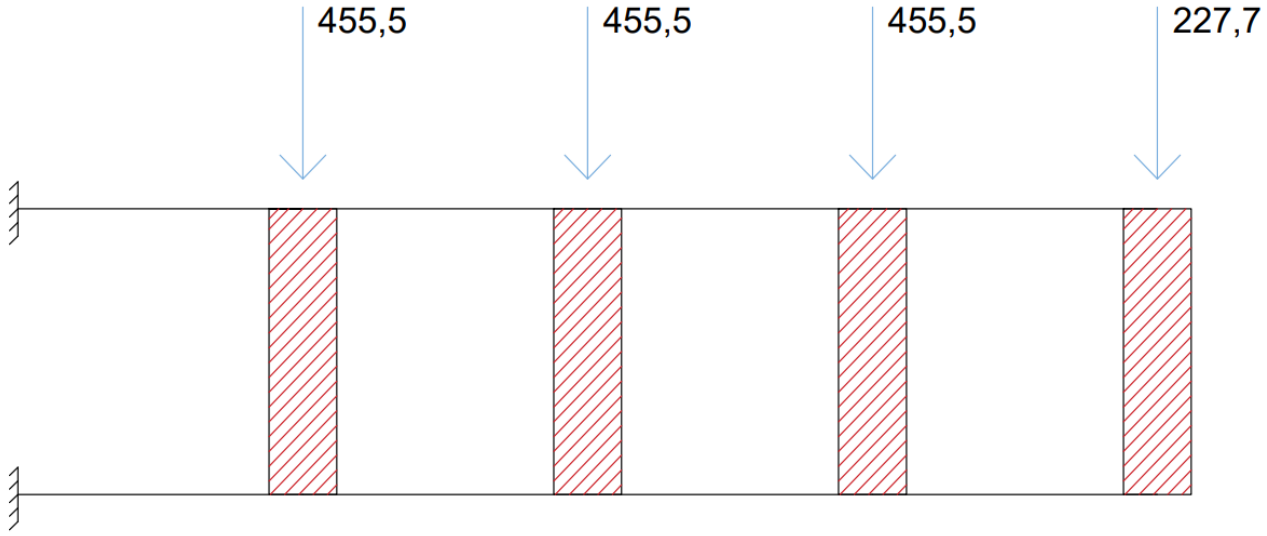


Ora passiamo all'<u>assegnazione dei carichi.</u>



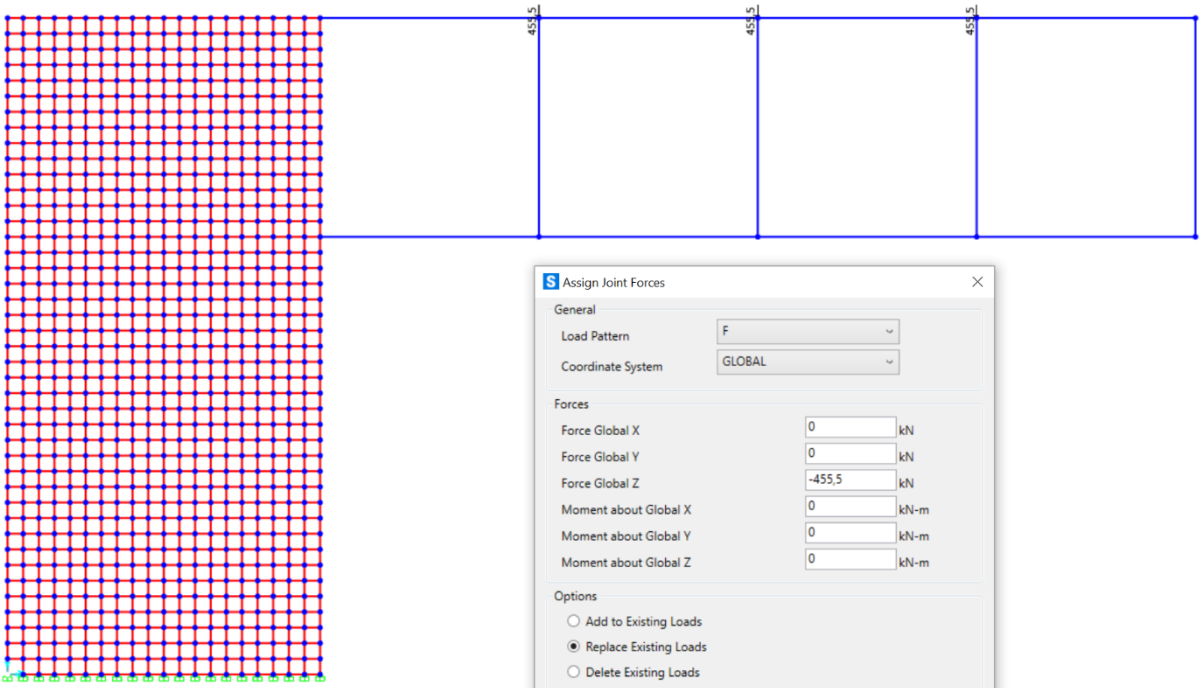
Qs = 3,5 Kn/m^2 Qa = 2,00 Kn/m^2 Qp = 3,0 Kn/m^2 Qu = 12,05 Kn/m^2

1) Ai = 18,9 m^2 q solaio = 227,74 Kn x 2
2) Ai = 9,45 m^2 q solaio = 113,87 Kn x 2

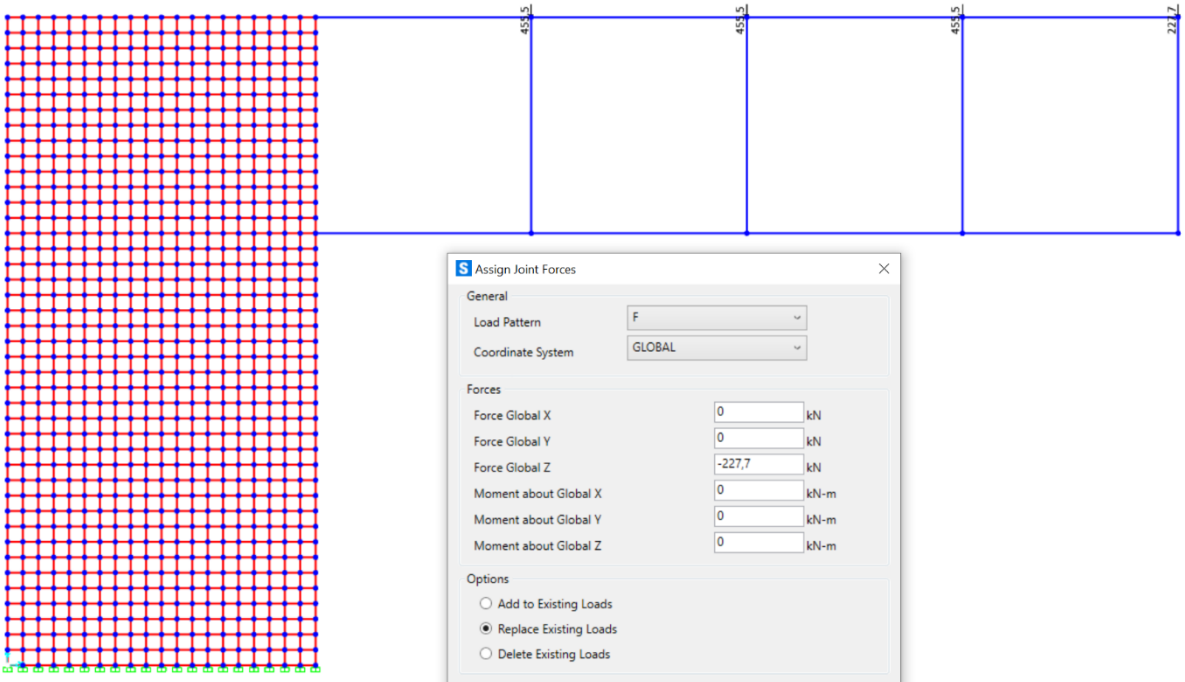


F = 455,5 Kn F/2 = 227,7 Kn

Assegniamo il tutto su SAP (Assign Joint Forces).


455,5
455,5
455,5

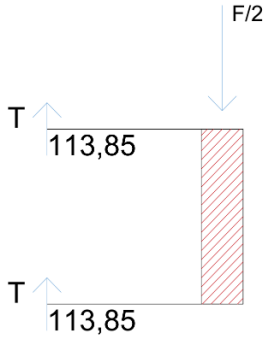
Assign Joint Forces
General
Load Pattern
F
Coordinate System
GLOBAL
Forces
Force Global X
0
kN
Force Global Y
0
kN
Force Global Z
-455,5
kN
Moment about Global X
0
kN-m
Moment about Global Y
0
kN-m
Moment about Global Z
0
kN-m
Options
Add to Existing Loads
Replace Existing Loads
Delete Existing Loads
Reset Form to Default Values
OK
Close
Apply


455,5
455,5
455,5
227,7

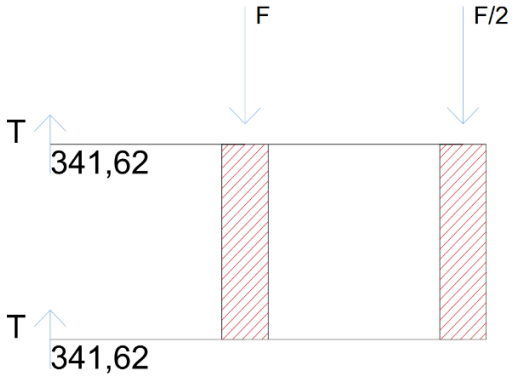
Assign Joint Forces
General
Load Pattern
F
Coordinate System
GLOBAL
Forces
Force Global X
0
kN
Force Global Y
0
kN
Force Global Z
-227,7
kN
Moment about Global X
0
kN-m
Moment about Global Y
0
kN-m
Moment about Global Z
0
kN-m
Options
Add to Existing Loads
Replace Existing Loads
Delete Existing Loads
Reset Form to Default Values
OK
Close
Apply

TAGLIO

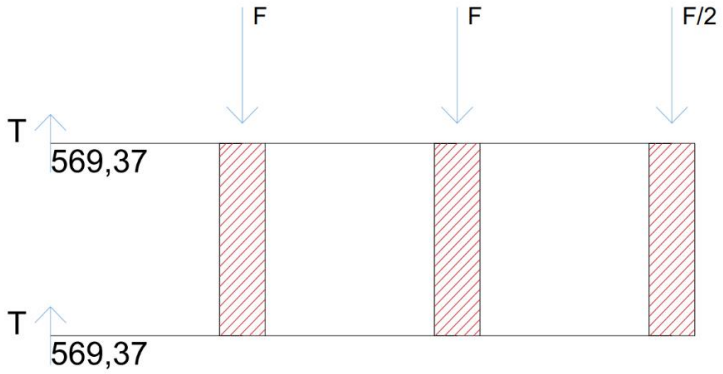
Trave I: 2T = F/2 → T = F/4 → T = 113, 85 Kn



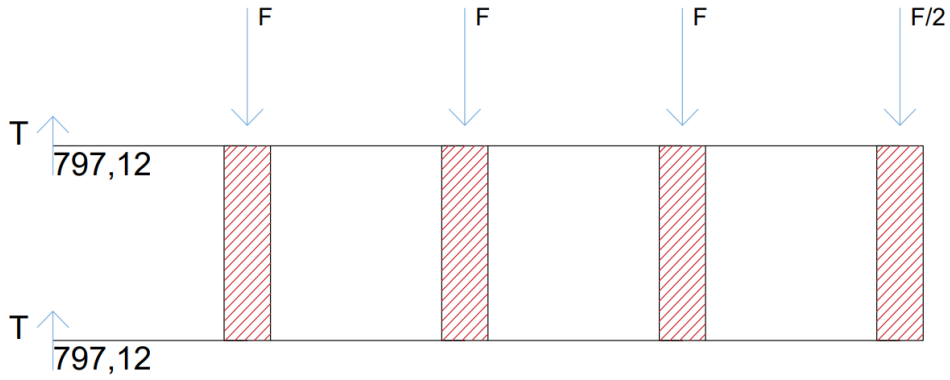
Trave II: 2T = F + F/2 → T = ¾ F → 341, 62 Kn



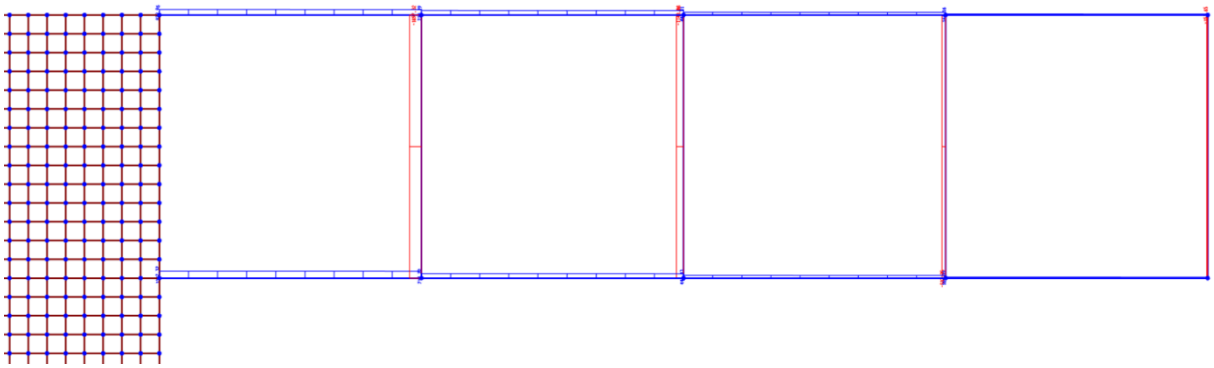
Trave III: 2T = F/2 + F + F = T = 5/4 F → 569,37 Kn



Trave IV: 2T = F +F + F + F/2 → 7/4 F T = 797,12 Kn



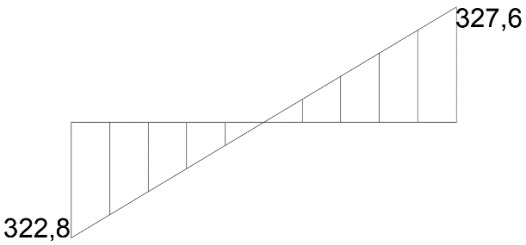
Visualizziamo il grafico del **taglio** su SAP:



MOMENTO FLETTENTE

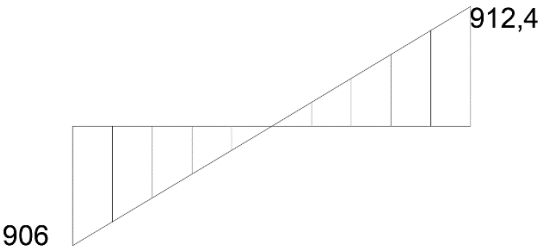
M' = T → M = ∫ T → M = T*X+C

I) F = 455,5 Kn ; L = 4,2m
M(l) = F/4*4,2+C = 478,27 + C
M(0) = F/4*0+C = C



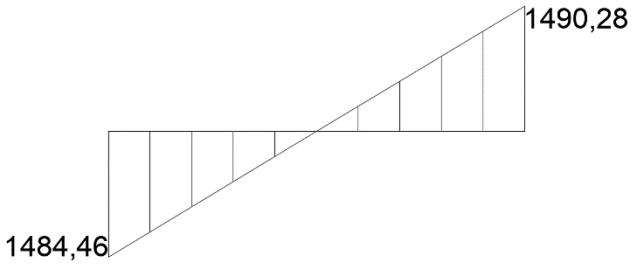
C = M(l) = 478,27 – 327,6 = 150,67
C = M(0) = 150,67

II) F = 455,5 Kn ; L = 4,2m
M(l) = ¾ Fl + C = 1434,82 + C
M(0) = ¾ F*0+C = C



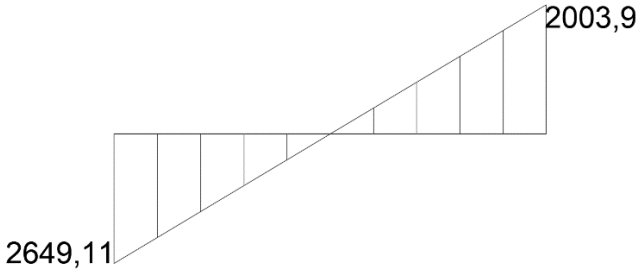
C = M(l) = 1434,82 – 912,4 = 522,42
C = M(0) = 522,42

III) F = 455,5 ; L = 4,2
M(l) = 5/4 F*L+C = 2391,37
M(0) = 5/4 F*0+C = C



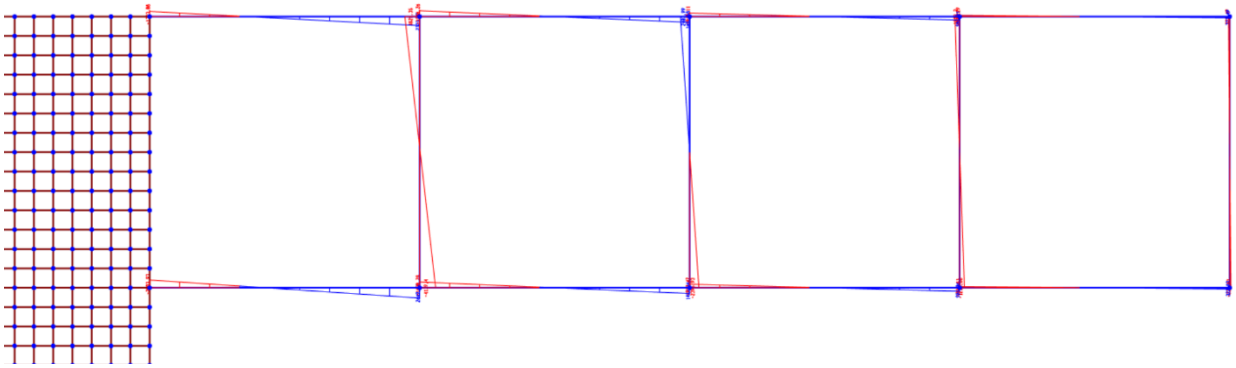
C = M(l) = 2391,37-1490,28 = 901,09
C = M(0) = 901,08

IV) F = 455,5 ; L = 4,2
M(l) = 7/2 F*L+C = 6695,85+C
M(0) = 7/2 F*0+C = C



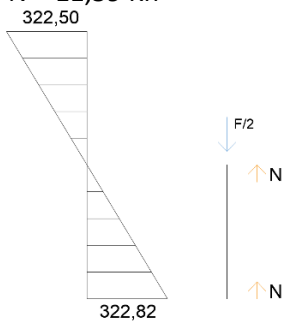
C = M(l) = 4046,74
C = M(0) = 4046,74

Visualizziamo il grafico del **momento** su SAP:

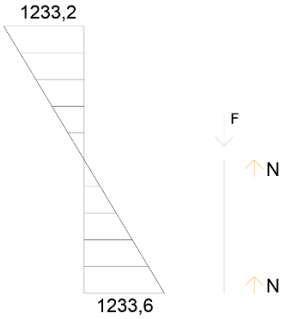


PILASTRI

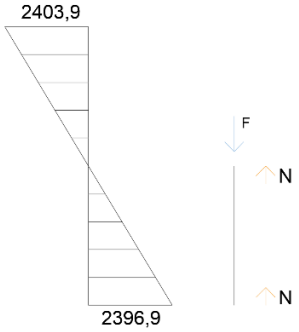
I) M' = T M = 322,82 T = 113,85
N+N – F/2 = 0
N+N = F/2
2N = F/2 → N = F/4 → 111,59
N = 11,59 Kn



II) M = 1233,6 Kn T = 341,62 Kn
N+N-F → N+N = F → 2N = F
N = F/2 → 616,9 Kn



III) T = 568,37 Kn M = 2396,9
N = F/2 → 1198,45 Kn



IV) M = 4139,4 T = 797,12 Kn
N+N = F → N = F/2 → 2069,7 Kn

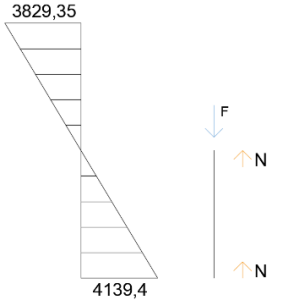
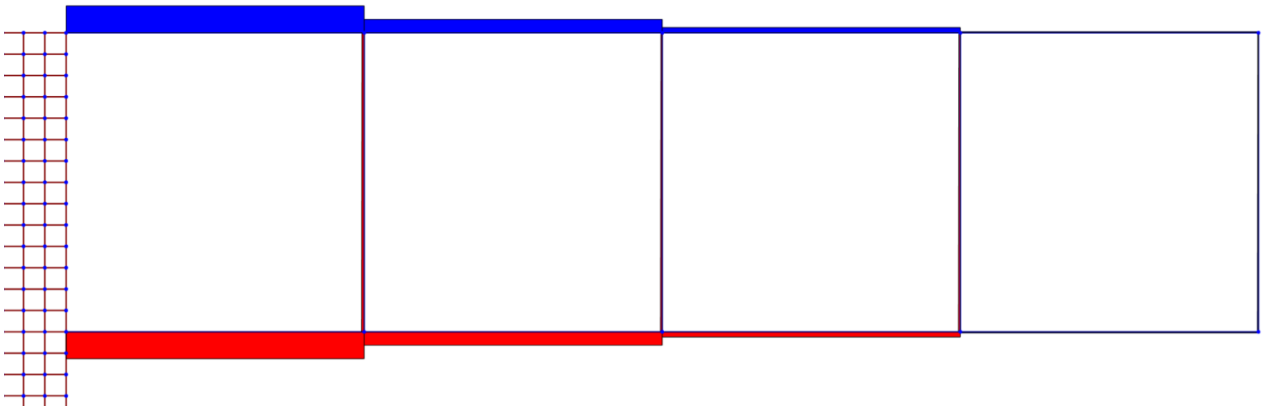
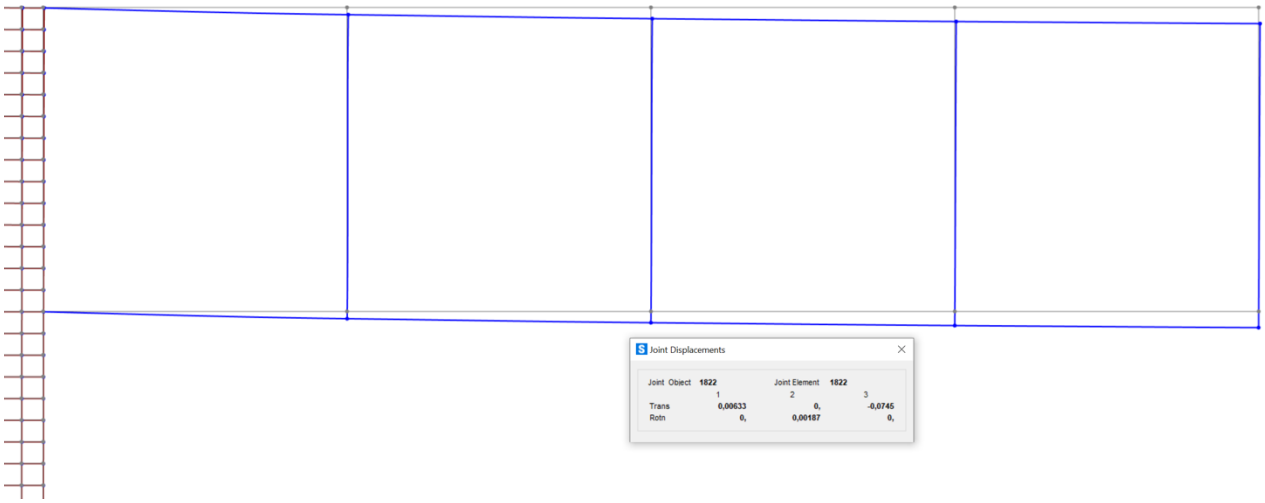


Diagramma **sforzo normale N**:



Visualizziamo la struttura deformata su SAP e constatiamo l'**ABBASSAMENTO**:



A questo punto possiamo procedere alle verifiche sulle relative tabelle Excel:

PILASTRI:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC
1	L_p	L_s	Area	$trave_p$	$trave_s$	q_{trave}	q_s	q_p	q_a	q_{solaio}	n_{piani}	N	f_{ck}	f_{cd}	fcd*	A_{min}	b_{min}	E	β	l	λ*	ρ_{min}	b_{min}	b	h_{min}	h	A_{design}		
2	m	m	m2	kN/m	kN/m	kN	kN/mq	kN/mq	kN/mq	kN		kN	Mpa	Mpa	Mpa	cm2	cm	Mpa		m		cm	cm	cm	cm	cm	cm2		
3																													
4	5,50	4,00	22,00	4,13	2,19	40,87	3,50	3,00	2,00	265,10	1	306	28,0	15,9	7,9	385,7	19,6	32308	1,00	3,50	141,76	2,47	8,55	100,00	3,86	60,00	6000		

TRAVI:

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	interasse (m)	q_e (KN/m^2)	q_p (KN/m^2)	q_a (KN/m^2)	q_u (KN/m)	luce (m)	M_{max} (KN*m)	f_{yk} (N/mm^2)	f_{yd} (N/mm^2)	f_{ck} (N/mm^2)	f_{cd} (N/mm^2)	β	r	b (cm)	h_u (cm)	δ (cm)	H_{min} (cm)	H	H/l	area (m^2)	peso unitario (KN/m)
2																					
3	4,20	3,50	3,00	2,00	50,61	5,00	158,16	450,00	391,30	28,00	15,87	0,38	2,46	80,00	27,46	5,00	32,46	100,00	0,06	0,80	20,00
4					76,61	5,00	239,41	450,00	391,30	28,00	15,87	0,38	2,46	80,00	33,78	5,00	38,78	verificata			

RENDER: