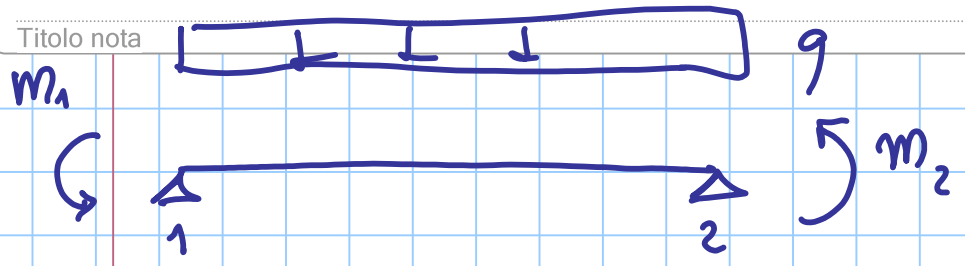


$$\varphi_1 = \alpha_1 m_1 - \beta m_2 + \varphi_{1(q)}$$

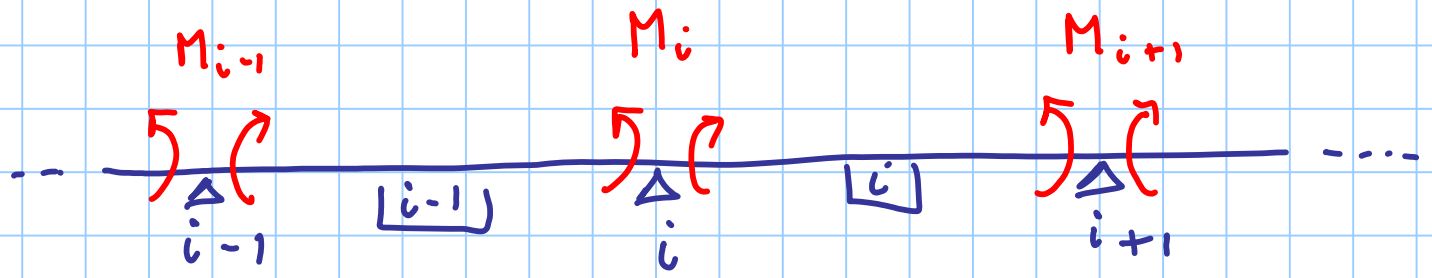
$$\varphi_2 = -\beta m_1 + \alpha_2 m_2 + \varphi_{2(q)}$$

$$\alpha_1 = \frac{l}{3EI} = \alpha_2$$

$$\beta = \frac{l}{6EI}$$

$$\varphi_{1(q)} = -\frac{q l^3}{24 EI}$$

$$\varphi_{2(q)} = -\varphi_{1(q)}$$



$$\varphi_{i,sin} = \varphi_{i,dx}$$

$$\beta^{i-1} M_{i-1} + \left(\alpha_1^{i} + \alpha_2^{i-1}\right) M_i + \beta^{i} M_{i+1} = -\varphi_{2(q)}^{i-1} + \varphi_{1(q)}^{i}$$

$$m_1 = \rho_1 \varphi_1 + \rho_{12} \varphi_2 + \bar{m}_{1(q)} \qquad \frac{q\ell^2}{12}$$

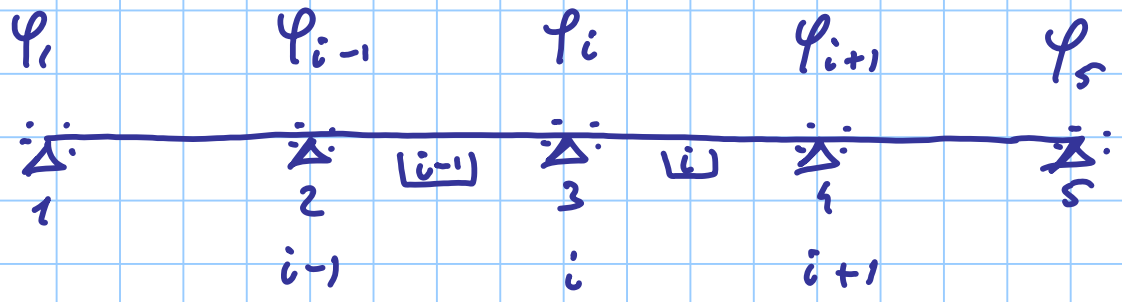
$$m_2 = \rho_{12} \varphi_1 + \rho_2 \varphi_2 + \bar{m}_{2(q)} \qquad -\frac{q\ell^2}{12}$$

$$\rho_1 = \frac{\alpha_2}{\alpha_1 \alpha_2 - \beta^2} = \frac{4EI}{\ell} = \rho_2$$

per trave a sezione costante

$$\rho_{12} = \frac{\beta}{\alpha_1 \alpha_2 - \beta^2} = \frac{2EI}{\ell}$$

" "



$$m_2^{i-1} + m_1^{i} = 0 \quad \text{condizione di equilibrio}$$

$$\int_{12}^{i-1} \varphi_{i-1} + \int_{2}^{i-1} \varphi_i + \bar{m}_{2(q)}^{i-1} +$$

$$+ \int_{1}^{i} \varphi_i + \int_{12}^{i} \varphi_{i+1} + \bar{m}_{1(q)}^{i} = 0$$

$$\int_{12}^{i-1} \varphi_{i-1} + \left(\int_{1}^{i} + \int_{2}^{i-1} \right) \varphi_i + \int_{12}^{i} \varphi_{i+1} =$$

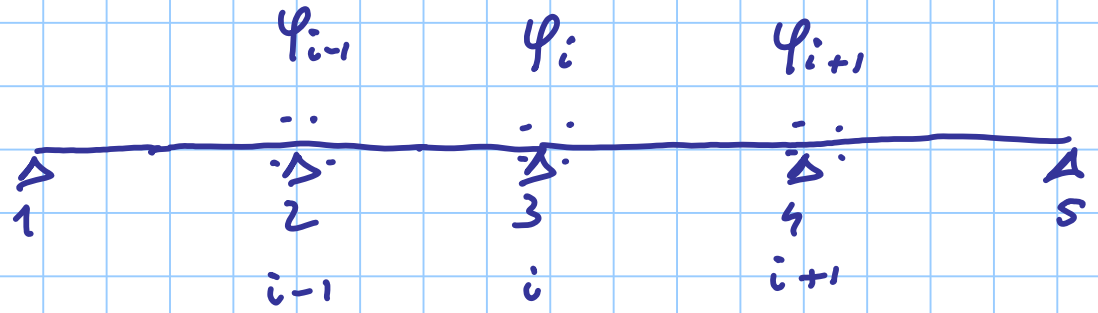
$$= - \bar{m}_{2(q)}^{i-1} - \bar{m}_{1(q)}^{i}$$

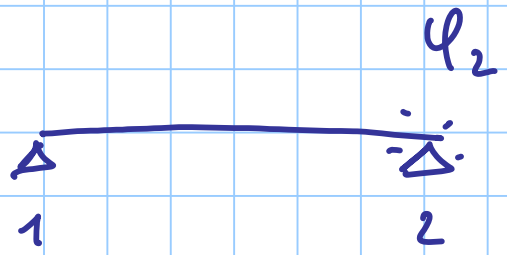
	A	B	C	D	E
1					
2	Dati:	riempire solo le caselle con fondo giallo			
3					
4	campata	1	2	3	4
5	q [kN/m]	8.0	8.0	5.0	8.0
6	L [m]	4.50	5.40	6.00	4.20
7	EI	1	1	1	1
8					
9	Risultato		M2	M3	M4
10			-20.56	-16.68	-15.59
11					
12	$\alpha1=\alpha2$	1.50	1.80	2.00	1.40
13	β	0.75	0.90	1.00	0.70
14	$\varphi1(q)$	-30.38	-52.49	-45.00	-24.70
15	$\varphi2(q)$	30.38	52.49	45.00	24.70
16					
17	congr.nodo		2	3	4
18	coeff i-1			0.90	1.00
19	coeff i		3.30	3.80	3.40
20	coeff i+1		0.90	1.00	
21	t. noto		-82.86	-97.49	-69.70
22					
23			-0.27	-0.28	
24			-25.11	-21.07	-15.59
25					
26					
27					
28					
29					
30					
31					

Equazione 3 momenti | Metodo spostamenti

	A	B	C	D	E	F
1						
2	Dati:	riempire solo le caselle con fondo giallo				
3						
4	campata	1	2	3	4	
5	q [kN/m]	8.0	8.0	5.0	8.0	
6	L [m]	4.50	5.40	6.00	4.20	
7	EI	1	1	1	1	
8						
9	Risultato	M1	M2	M3	M4	M5
10		0.00	-20.56	-16.68	-15.59	0.00
11						
12	$\rho1=\rho2$	0.89	0.74	0.67	0.95	
13	$\rho12$	0.44	0.37	0.33	0.48	
14	Minc,1	13.50	19.44	15.00	11.76	
15	Minc,2	-13.50	-19.44	-15.00	-11.76	
16						
17	eq.nodo	1	2	3	4	5
18	coeff i-1		0.44	0.37	0.33	0.48
19	coeff i	0.89	1.63	1.41	1.62	0.95
20	coeff i+1	0.44	0.37	0.33	0.48	
21	t. noto	-13.50	-5.94	4.44	3.24	11.76
22						
23		-0.50	-0.26	-0.25	-0.31	
24		-15.19	0.58	3.23	1.41	13.78
25						
26		$\varphi1$	$\varphi2$	$\varphi3$	$\varphi4$	$\varphi5$
27		-14.95	-0.47	3.96	-2.87	13.78
28						
29						
30						
31						

Equazione 3 momenti | Metodo spostamenti | Metodo





$$m_2 = \frac{3EI}{\ell}\varphi_2 + \overline{m}_{2(q)}$$

$$-\frac{q\ell^2}{8}$$

	A	B	C	D	E	F	G	H
1								
2	Dati:	riempire solo le caselle con fondo giallo						
3								
4	campata	1	2	3	4			
5	q [kN/m]	8.0	8.0	5.0	8.0			
6	L [m]	4.50	5.40	6.00	4.20			
7	EI	1	1	1	1			
8								
9	Risultato		M2	M3	M4			
10			-20.56	-16.68	-15.59			
11								
12	$\rho 1$	0.00	0.74	0.67	0.71			
13	$\rho 2$	0.67	0.74	0.67	0.00			
14	$\rho 12$	0.00	0.37	0.33	0.00			
15	Minc,1	20.25	19.44	15.00	17.64			
16	Minc,2	-20.25	-19.44	-15.00	-17.64			
17								
18	eq.nodo		2	3	4			
19	coeff i-1			0.37	0.33			
20	coeff i		1.41	1.41	1.38			
21	coeff i+1		0.37	0.33				
22	t. noto		0.81	4.44	-2.64			
23								
24			-0.26	-0.25				
25			0.58	3.23	-2.87			
26								
27			$\varphi 2$	$\varphi 3$	$\varphi 4$			
28			-0.47	3.96	-2.87			
29								
30								
31								

Equazione 3 momenti | Metodo spostamenti | **Metodo spostamenti (2)**

$$\rho_{12}^{i-1}\,\varphi_{i-1} + \left(\rho_1^{i} + \rho_2^{i-1}\right)\varphi_i + \rho_{12}^{i}\,\varphi_{i+1} =$$

$$= -\overline{m}_{2(1)}^{\,i-1} - \overline{m}_{1(1)}^{\,i}$$

$$\varphi_i = \frac{1}{\rho_1^{i} + \rho_2^{i-1}}\left[-\overline{m}_{2(1)}^{\,i-1} - \overline{m}_{1(1)}^{\,i} - \rho_{12}^{i-1}\,\varphi_{i-1} - \rho_{12}^{i}\,\varphi_{i+1}\right]$$

in Termini di variazione

$$\Delta\varphi_i = \frac{1}{\rho_1^i + \rho_2^{i-1}} \left[-\overbrace{\overline{m}^{i-1}_{2(1)} - \overline{m}^{i}_{1(1)}}^{} - \Delta m - \rho_{12}^{i-1} \cancel{\Delta\varphi_{i-1}} - \rho_{12}^{i} \cancel{\Delta\varphi_{i+1}} \right]$$

nodo i nota

nodi $i-1$ e $i+1$ bloccati

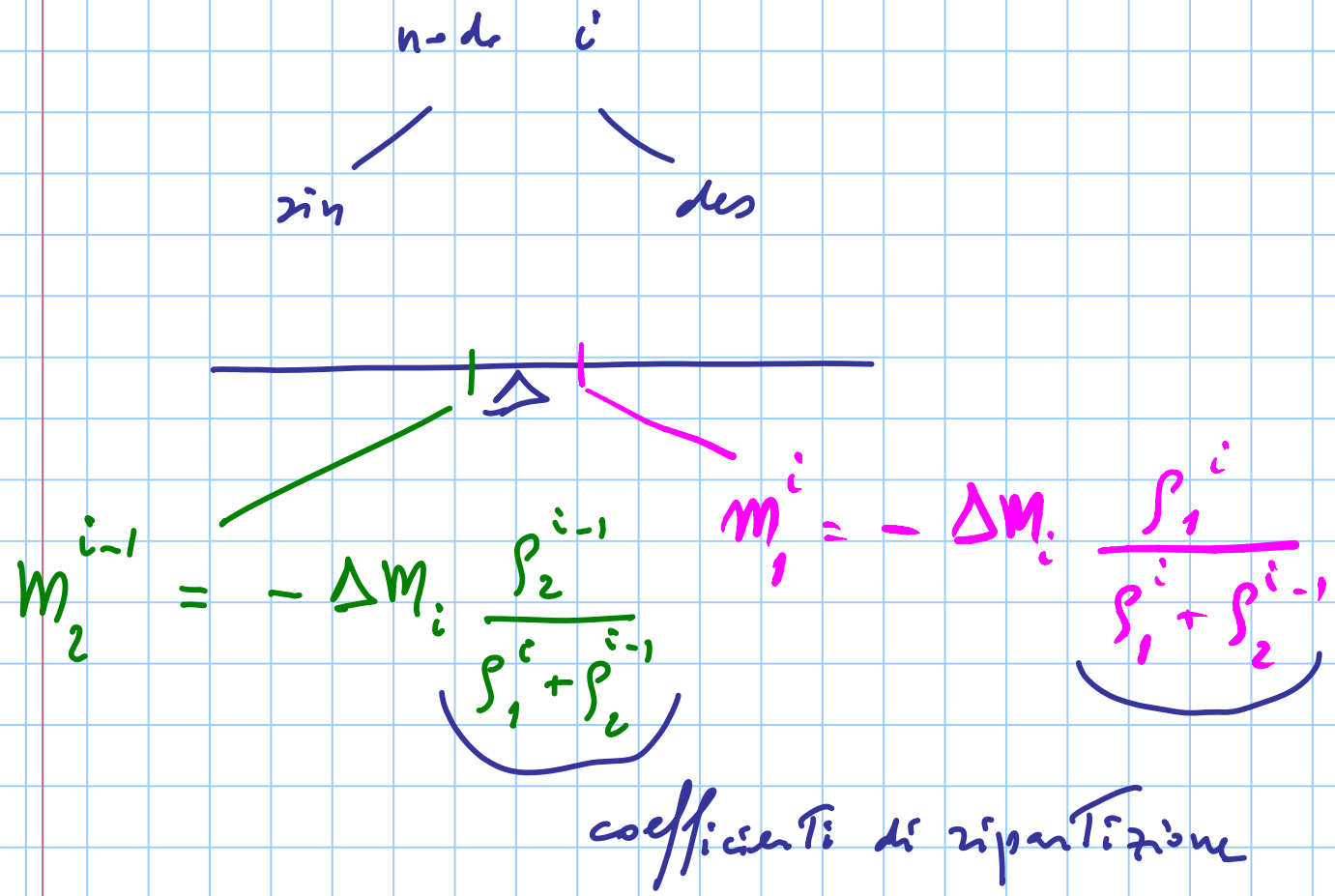
$$\Delta\varphi_i = -\frac{\Delta m_i}{\rho_1^i + \rho_2^{i-1}}$$

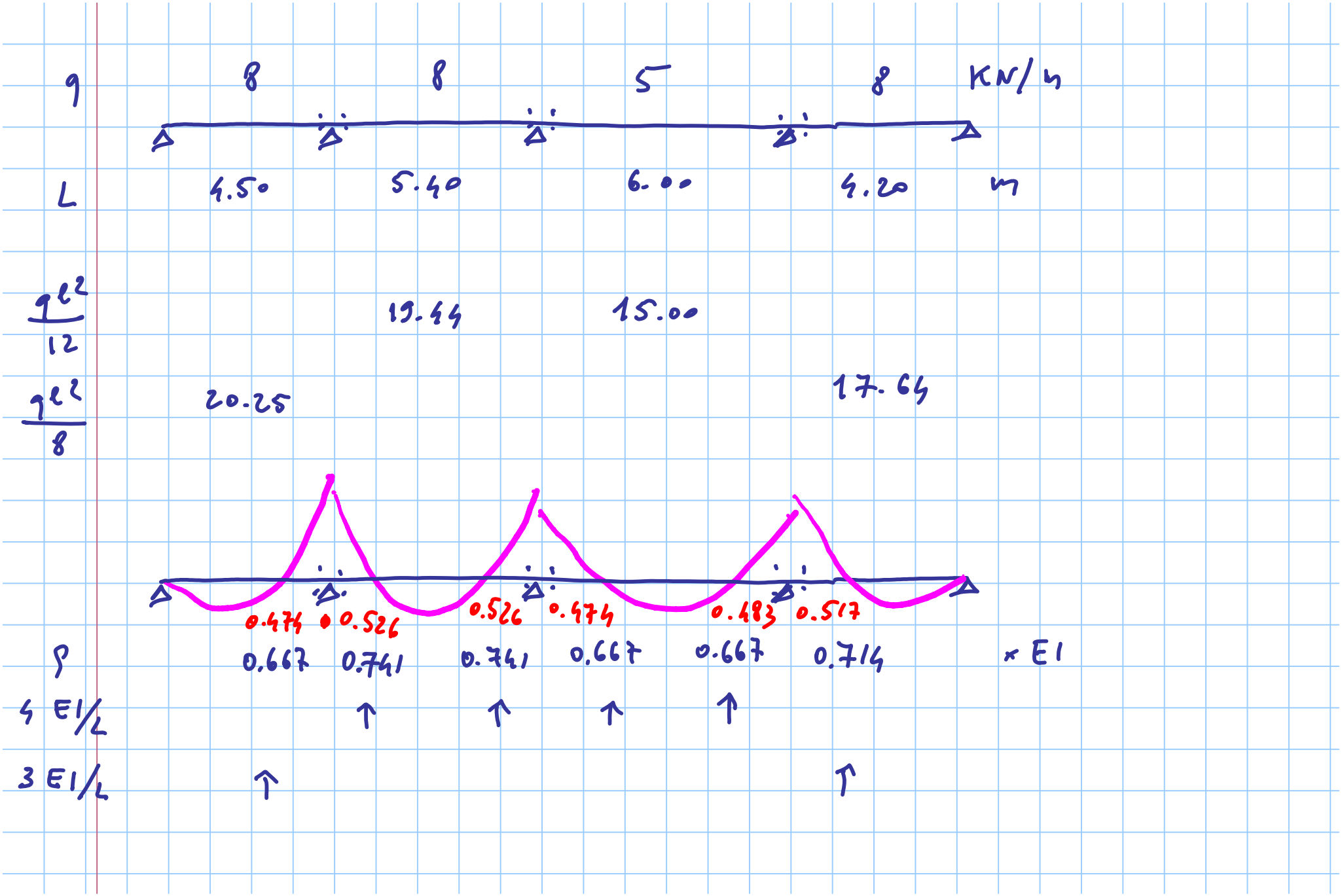
$$m_1 = \int_1 \Delta\varphi_1 + \int_{12} \Delta\varphi_2 \rightarrow -\Delta m_i \frac{\rho_1^i}{\rho_1^i + \rho_2^{i-1}}$$

$$m_2 = \int_{12} \Delta\varphi_1 + \int_2 \Delta\varphi_2 \rightarrow \frac{m_1}{2}$$

$\Delta\varphi_1$ ricavo. no prn

$\Delta\varphi_2 = 0$


nodo i
sin
des
$m_2^{i-1} = -\Delta m_i \frac{\rho_2^{i-1}}{\rho_1^i + \rho_2^{i-1}}$
$m_1^i = -\Delta m_i \frac{\rho_1^i}{\rho_1^i + \rho_2^{i-1}}$
coefficienti di ripartizione


q
8
8
5
8
KN/m
L
4.50
5.40
6.00
4.20
m
ql²/12
19.44
15.00
ql²/8
20.25
17.64
0.474
0.526
0.526
0.474
0.483
0.517
ρ
0.667
0.741
0.741
0.667
0.667
0.714
× EI
4 EI/L
3 EI/L

$$\frac{0.667}{0.667 + 0.741} = 0.474$$

$$\frac{0.741}{0.667 + 0.741} = 0.526$$

0.474 [2] 0.526

−20.25 19.44

0.38 0.43 ---->

1.11 <-- 2.22 2.01 ---> 1.00

−0.88 <--- −1.76 −1.88

0.526 [3] 0.474

−19.44 15.00

0.21

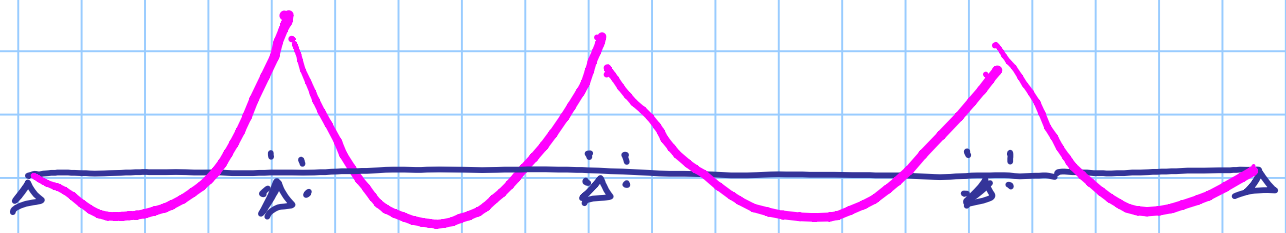
2.01

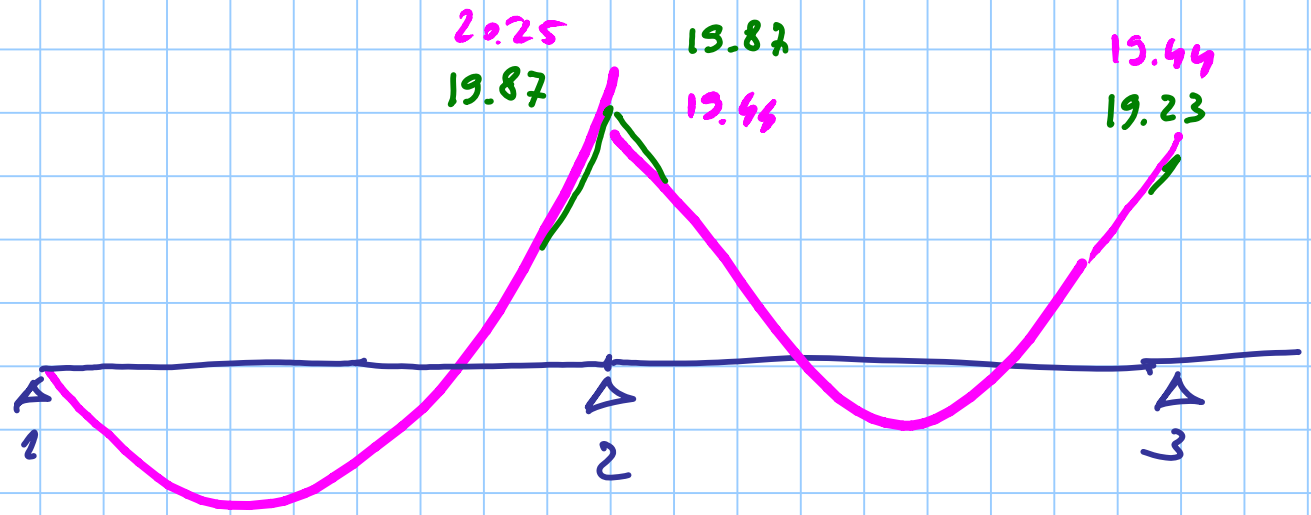
0.483 [4] 0.517

−15.00 17.64

eqil. n. 1:

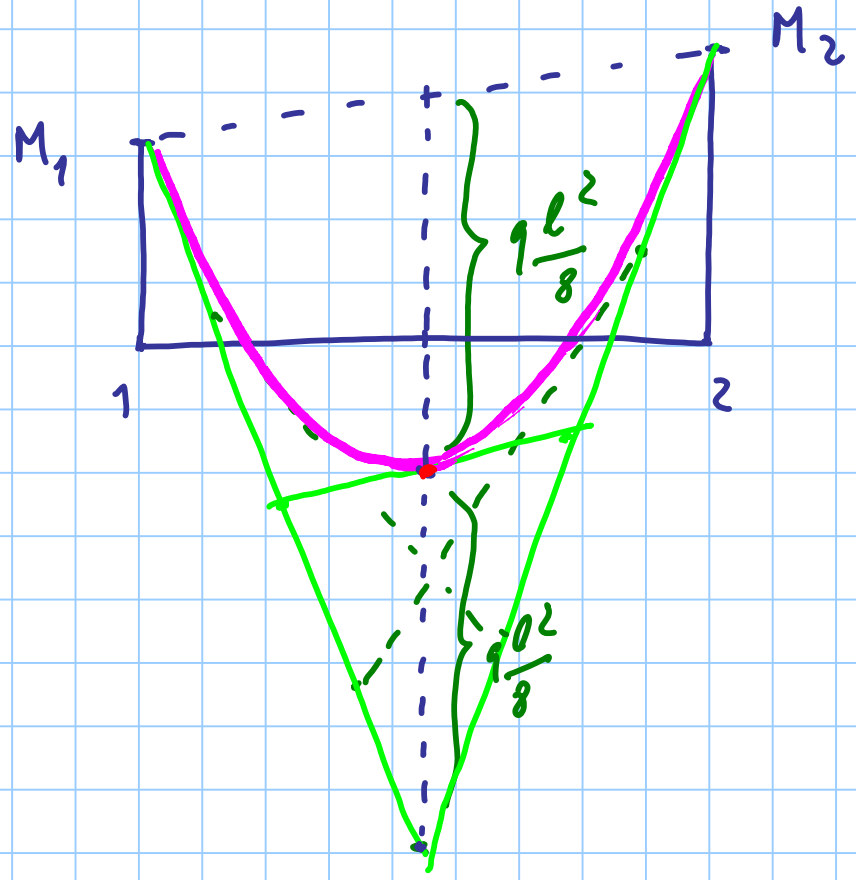
−0.81




20.25
19.87
19.87
19.44
19.44
19.23
1
2
3

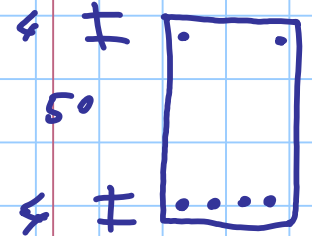
	A	B	C	D	E	F	G	H	I	J	K
1											
2	Dati:	riempire solo le caselle con fondo giallo									
3											
4	campata	1			2			3			4
5	q [kN/m]	8.0			8.0			5.0			8.0
6	L [m]	4.50			5.40			6.00			4.20
7	EI	1			1			1			1
8											
9			2			3			4		
10	Risultato		-20.56	20.56		-16.68	16.68		-15.59	15.59	
11											
12	ρ1	0.00			0.74			0.67			0.71
13	ρ2	0.67			0.74			0.67			0.00
14	ρ12	0.00			0.37			0.33			0.00
15	Minc.1	20.25			19.44			15.00			17.64
16	Minc.2	-20.25			-19.44			-15.00			-17.64
17											
18			2			3			4		
19			sin	des		sin	des		sin	des	
20	coeff.rip.		0.474	0.526		0.526	0.474		0.483	0.517	
21											
22	M inc		-20.25	19.44		-19.44	15.00		-15.00	17.64	
23			0.38	0.43		0.21					
24				1.11		2.22	2.00		1.00		
25							-0.88		-1.76	-1.88	
26			-0.53	-0.59		-0.29					
27				0.31		0.62	0.55		0.28		
28							-0.07		-0.13	-0.14	

рама 6



CEMENTO ARMATO – FLESSIONE

1° modello di comportamento



$2\phi 14 = 3.08\ cm^2$ $\quad M = 20\ KNm$

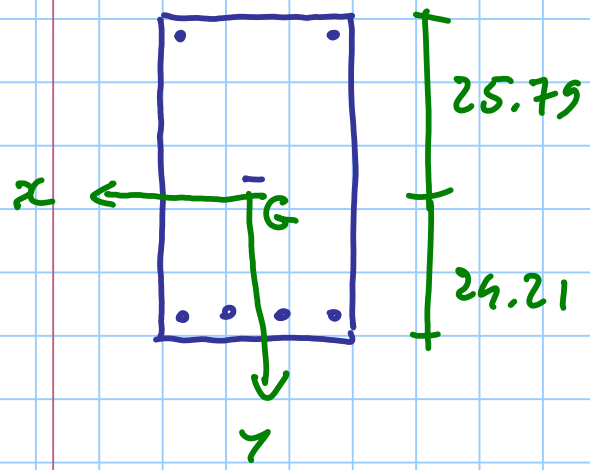
$4\phi 20 = 12.56$ $\quad n = \frac{200000}{31500} \simeq 6.35$

1. Determinare la posizione del baricentro

$$A = 30 \times 50 + 6.35(3.08 + 12.56) = 1599.3\ cm^2$$

$$S_{,xy} = \frac{30 \times 50^2}{2} + 6.35(3.08 \times 4 + 12.56 \times 46) = 41247\ cm^3$$

$$d_{G,sup} = \frac{S_{sup}}{A} = \frac{41247}{1599.3} = 25.79 \text{ cm}$$



$$I = \frac{30 \times 50^3}{12} + 30 \times 50 \times 0.79^2 +$$

$$+ 6.35 \left[3.08 \times 21.79^2 + 12.56 \times 20.21^2 \right] =$$

$$= 355298 \text{ cm}^4$$

$$\sigma_{c,inf} = \frac{M}{I} y = \frac{2{,}0 \times 10^6}{3{,}55298 \times 10^4} \times 24{,}21 \times 10^1 =$$

$$= 1.36 \text{ MPa}$$

è è fessurato ? confronto con f_{cfk}

C 25/30 $\longrightarrow$ 2.16 MPa

$$M_2 = 31.76 \text{ KNm}$$