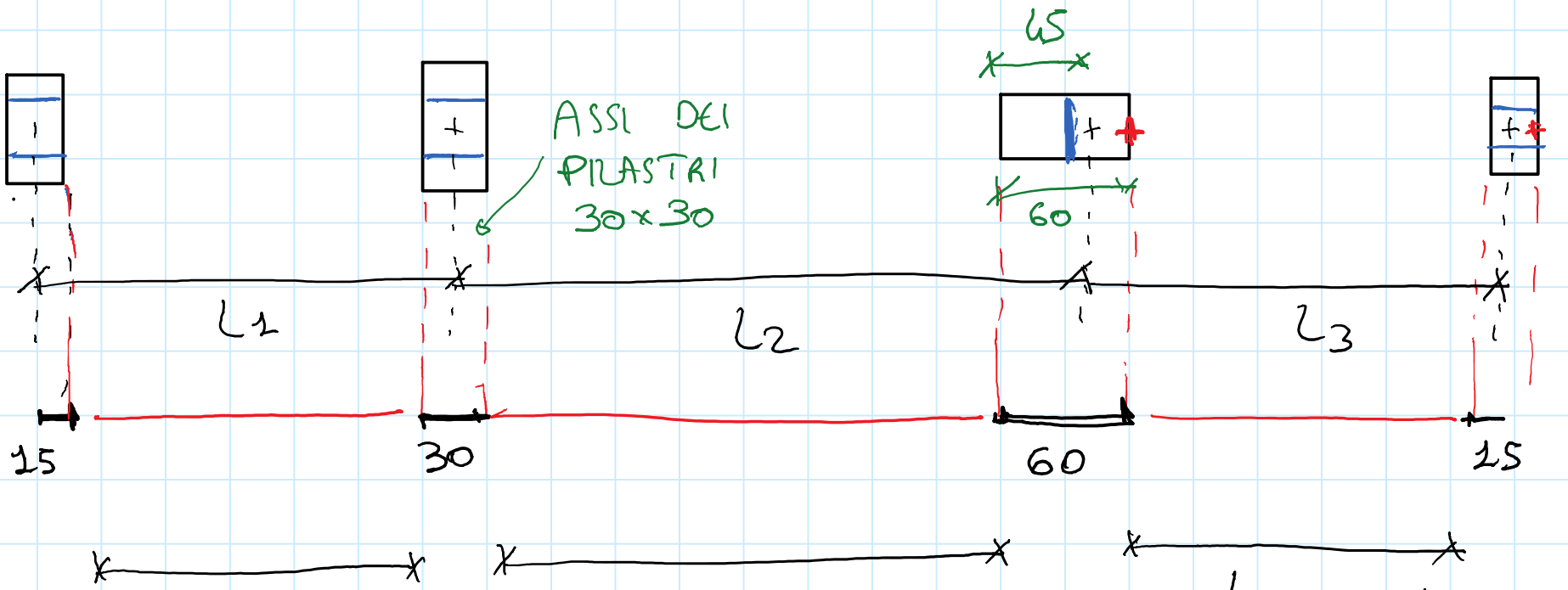
UTILIZZO DI MOMCAD PER LO SCHEMA LIMITE

DEFINISCO UN NUMERO DI ASTE FITTIZIAMENTE MAGGIORE DELLE CAMPATE PRESENTI

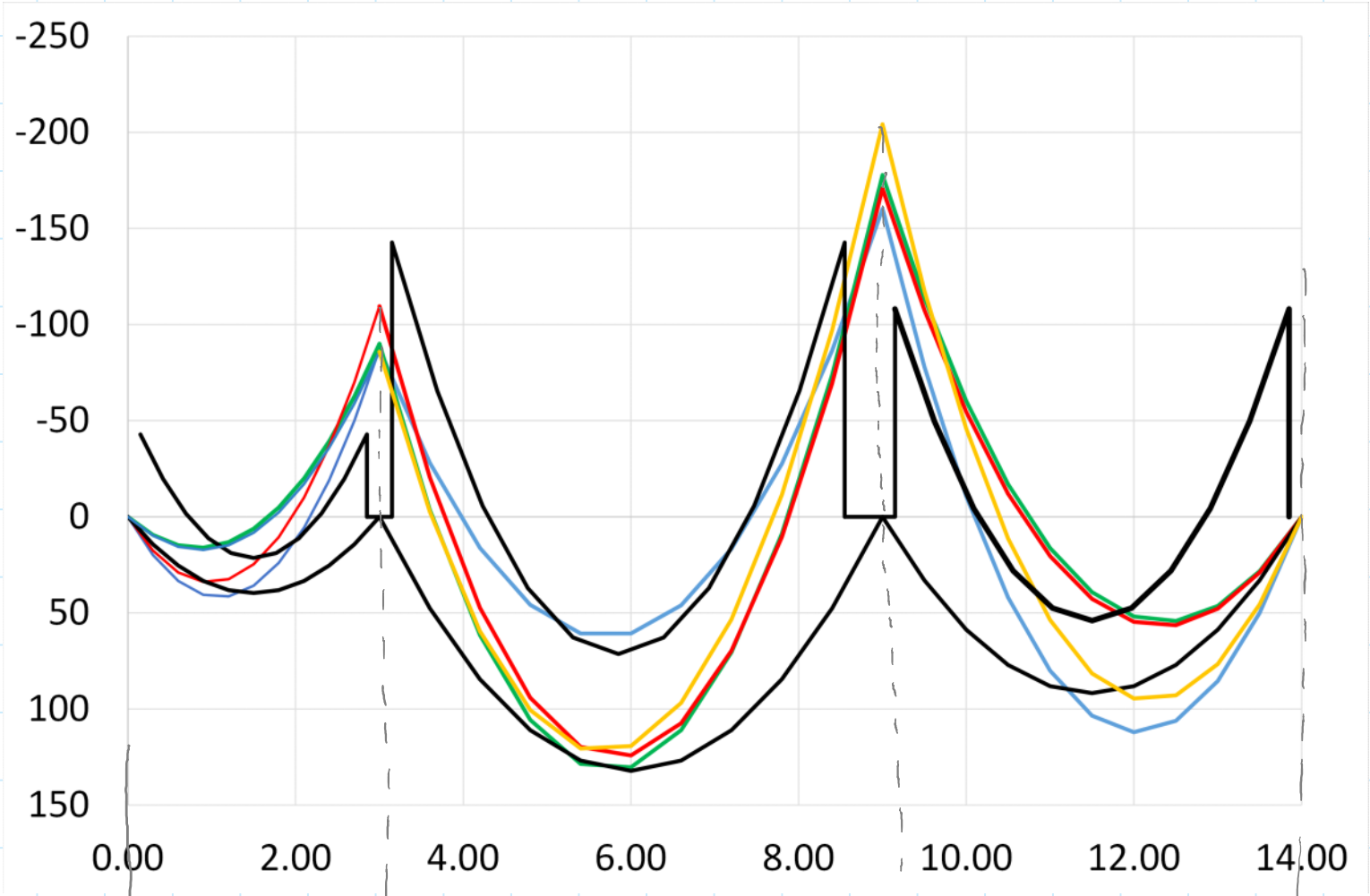


$L_{NET\,1} = L_1 - 30$

$L_{NET\,2} = L_2 - 15 - 45$

$L_{NET\,3} = L_3 - 30$

DIAGRAMMI DEI MOMENTI OTTENUTI

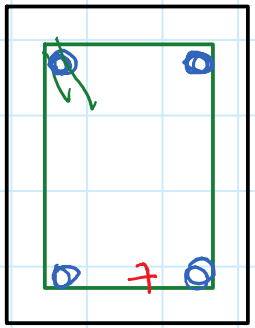


ASSI PILASTRI
30 x 30

ARMATURA MINIMA

NUMERO DI BARRE:

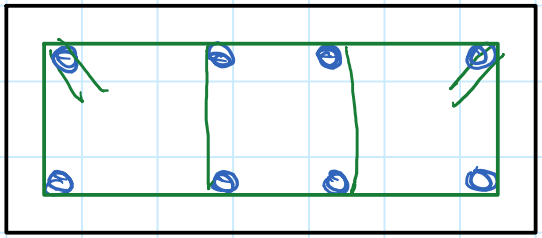
TRAVE EMERGENTE



2 BARRE SUPERIORI

2 BARRE INFERIORI
(MEGLIO 3 PER RIDURRE AMPIEZZA FESSURE)

TRAVE A SPESSORE



ALMENO
4 BARRE SUP;
4 BARRE INF.

ARMATURA MINIMA NTC 18 (ARMATURA TESA)

1. $A_s \geq 0.13\% \; bd$

2. $A_s \geq 0.26 \dfrac{f_{ctm}}{f_{yk}} bd$ (EVITARE SNERVAMENTO DOPO FESSURAZIONE CLS)

PER C30/37 → $f_{ctm} = 0.3 \sqrt[3]{f_{ck}^2} = 2.89 \text{ MPa}$ →

$$A_s \geq 0.26 \times \frac{2.89}{450} bd = 0.167\% \; bd$$

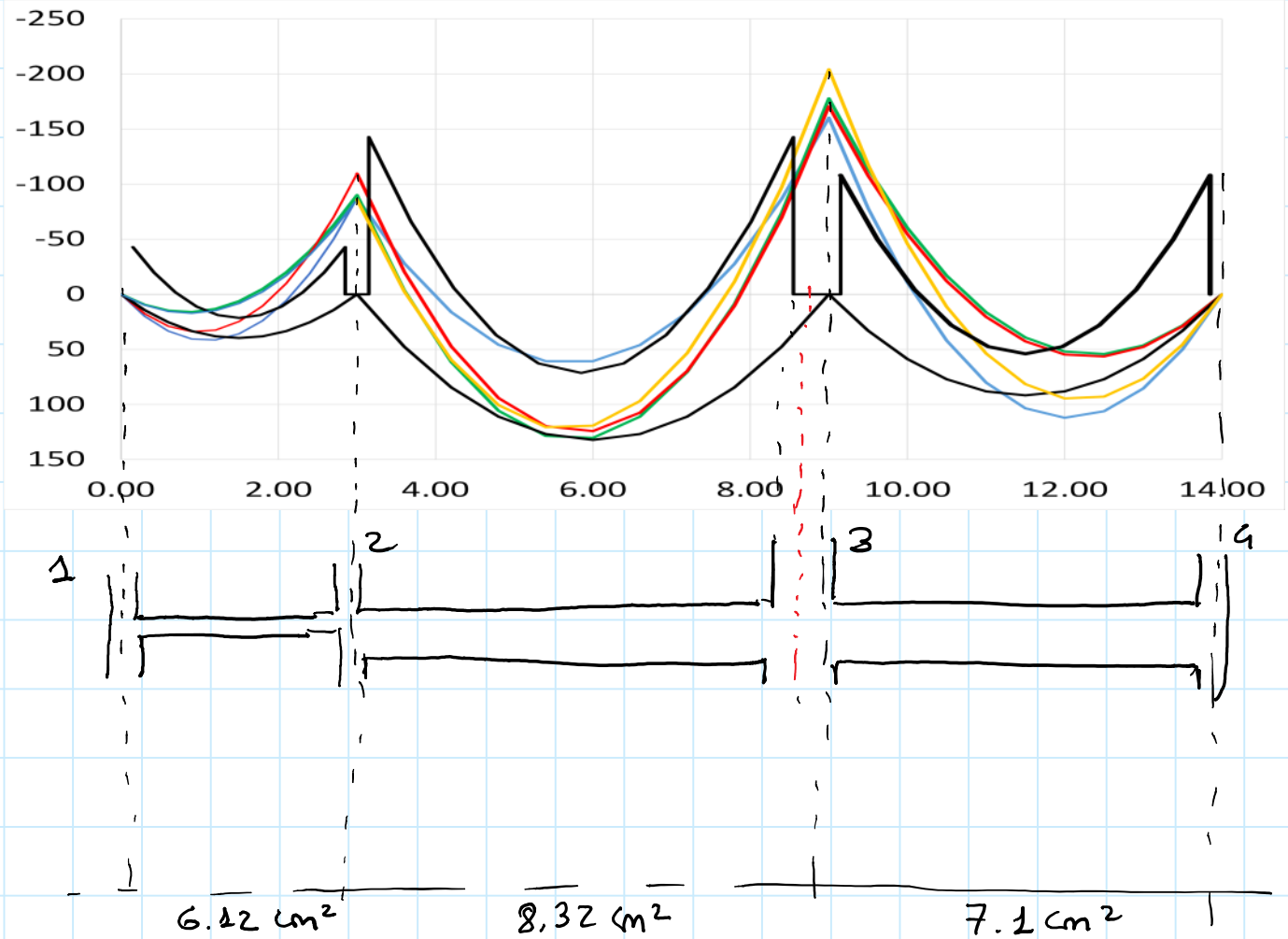
PER TRAVE 30×50 ⇒

$$A_s \geq 0.167\% \times 30 \times 45 \text{ cm}^2 = 2.26 \text{ cm}^2 \Rightarrow 2\phi 14$$

PER TRAVE 100×23 → ($d = 19$ cm) →

$$A_s \geq 0.167\% \times 100 \times 19 \text{ cm}^2 = 3.18 \text{ cm}^2 \rightarrow 4\phi 14$$

PROGETTO ARMATURA INFERIORE



$$A_s = \frac{M}{0{,}9\, d\, f_{yd}}$$

CAMPATA 1-2

$M = 41$ kNm

$d = 23 - 4 = 19$ cm

$$A_s = \frac{41\ \text{kNm} \times 10}{0{,}9 \times 0.19\,\text{m} \times 391.3\ \text{N/mm}^2} = 6.12\ \text{cm}^2$$

CAMPATA 2-3

$M = 132$ kNm

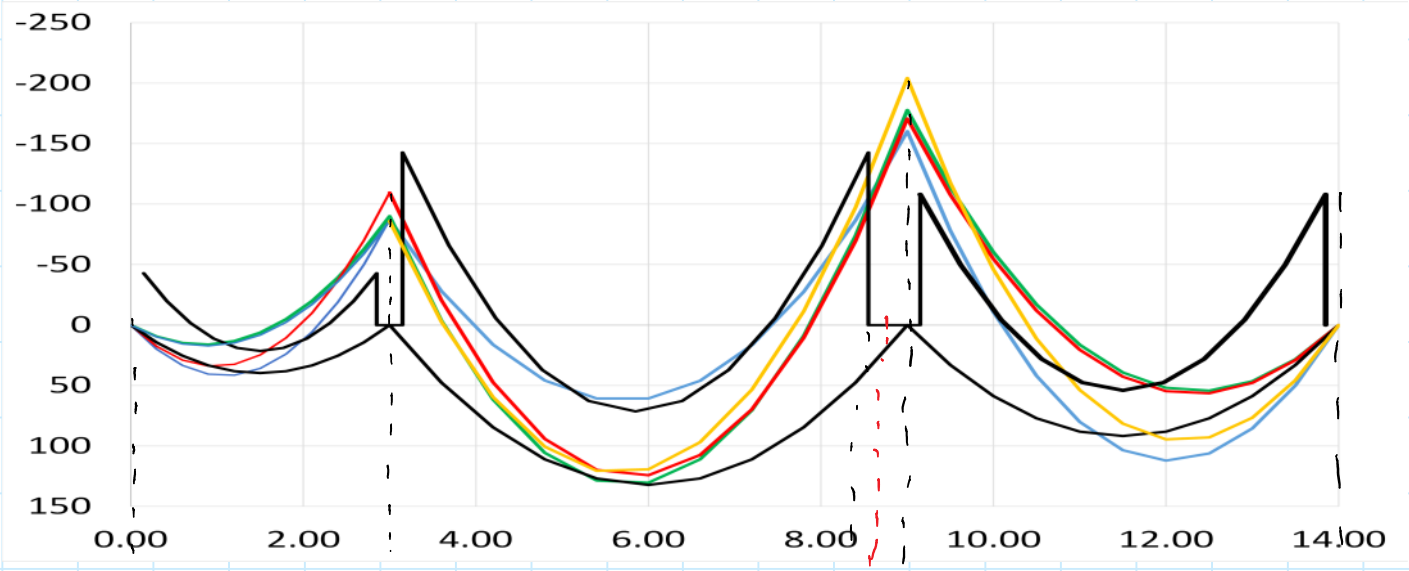
$d = 50 - 5 = 45$ cm

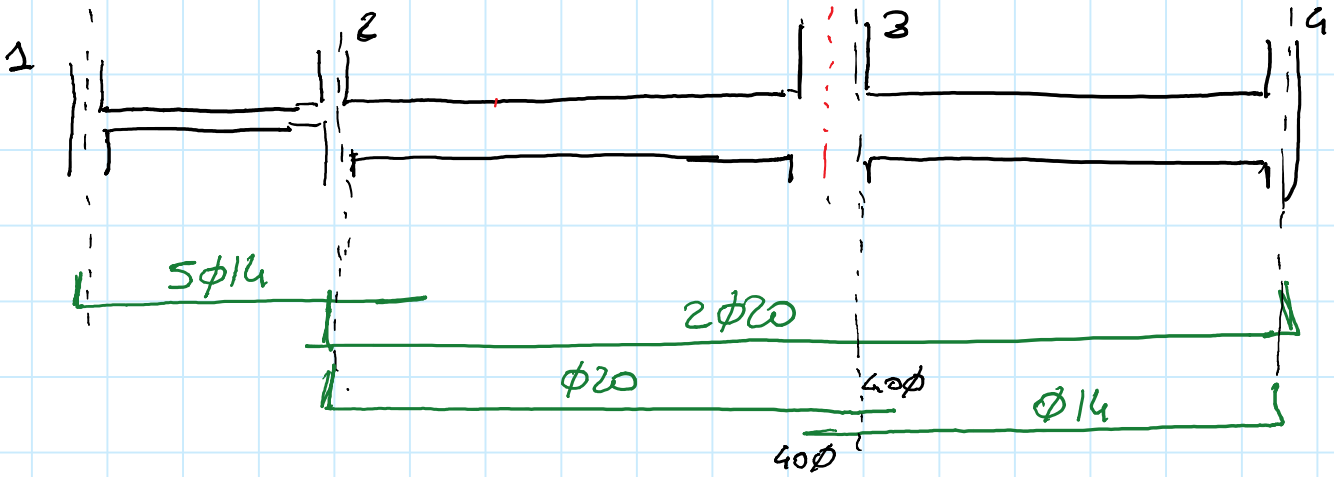
$$A_s = \frac{132 \times 10}{0{,}9 \times 0{,}45 \times 391.3} = 8{,}32\ \text{cm}^2$$

CAMPATA 3-4

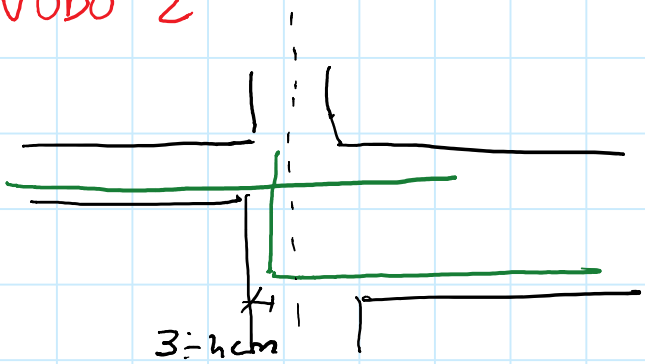
$M = 112$ kNm $\longrightarrow$ $A_s = 7.1\ \text{cm}^2$

DISPOSIZIONE ARMATURA INFERIORE

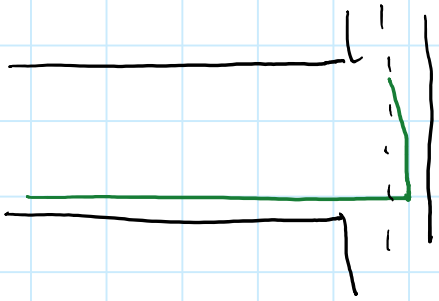




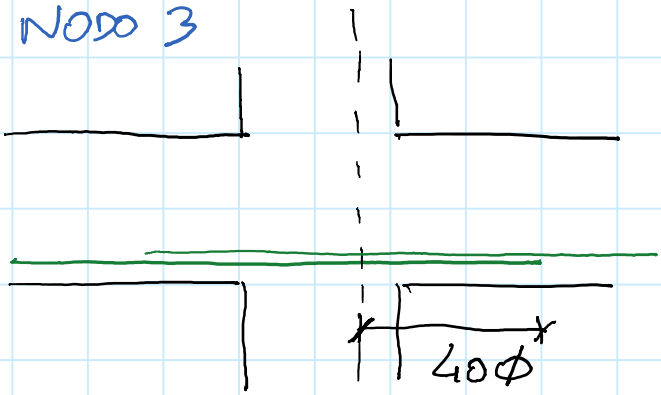
NODO 2



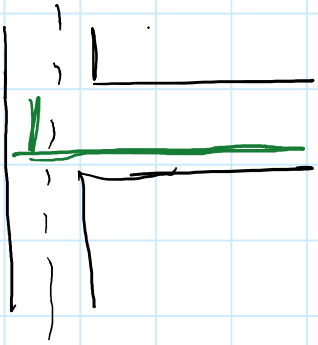
NODO 4



NODO 3



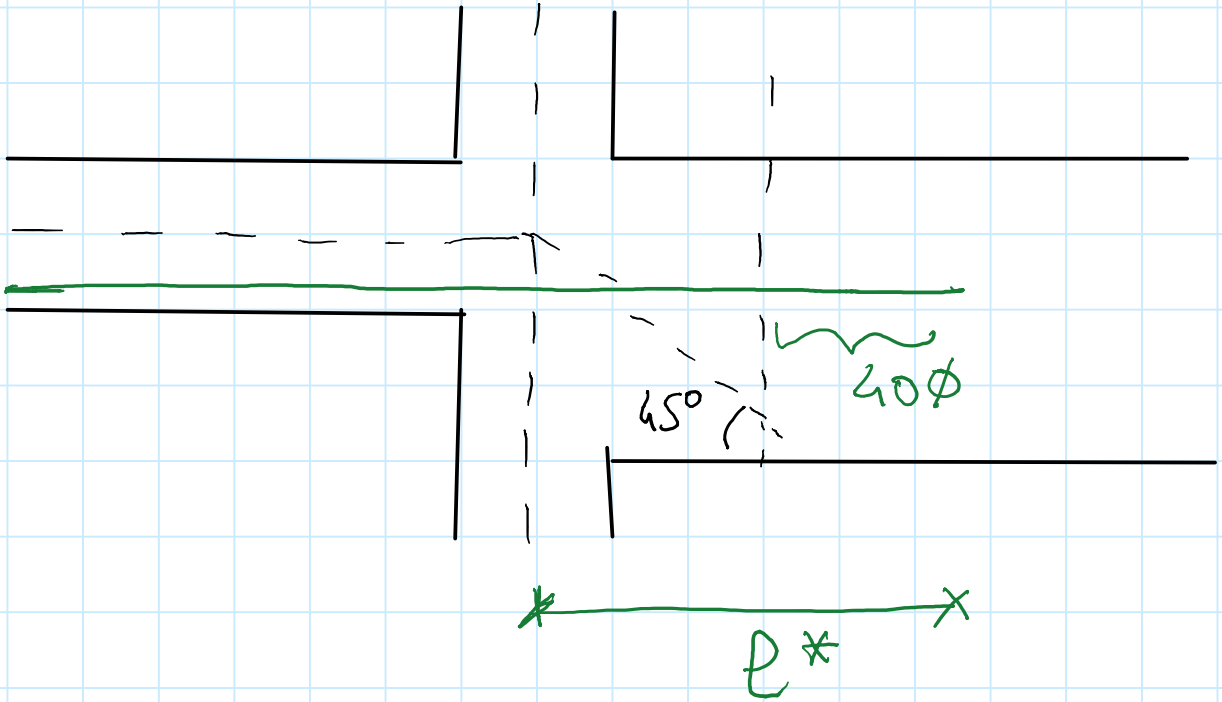
NODO 1



ZONA DI PERTINENZA DELLA TRAVE A SPESSORE

1. PROLUNGO ASSE TRAVE A SPESSORE FINO AD INCONTRARE ASSE PILASTRO

2. CONSIDERO DIFFUSIONE DELLE TENSIONI A 45°



MOMENTO RESISTENTE ARMATURE INFERIORI

TRAVE A SPESSORE

$$M_{Rd} = A_s \times 0.9\, d\, f_{yd}$$

$$M_{Rd}(1\phi 14) = 1.54\,cm^2 \times 0,9 \times 0,19m \times 391,3 \frac{N}{mm^2} \frac{1}{10} = 10.30\ kNm$$

$$\rightarrow M_{Rd}(5\phi 14) = 5 \times 10.30 = 51,5\ kNm$$

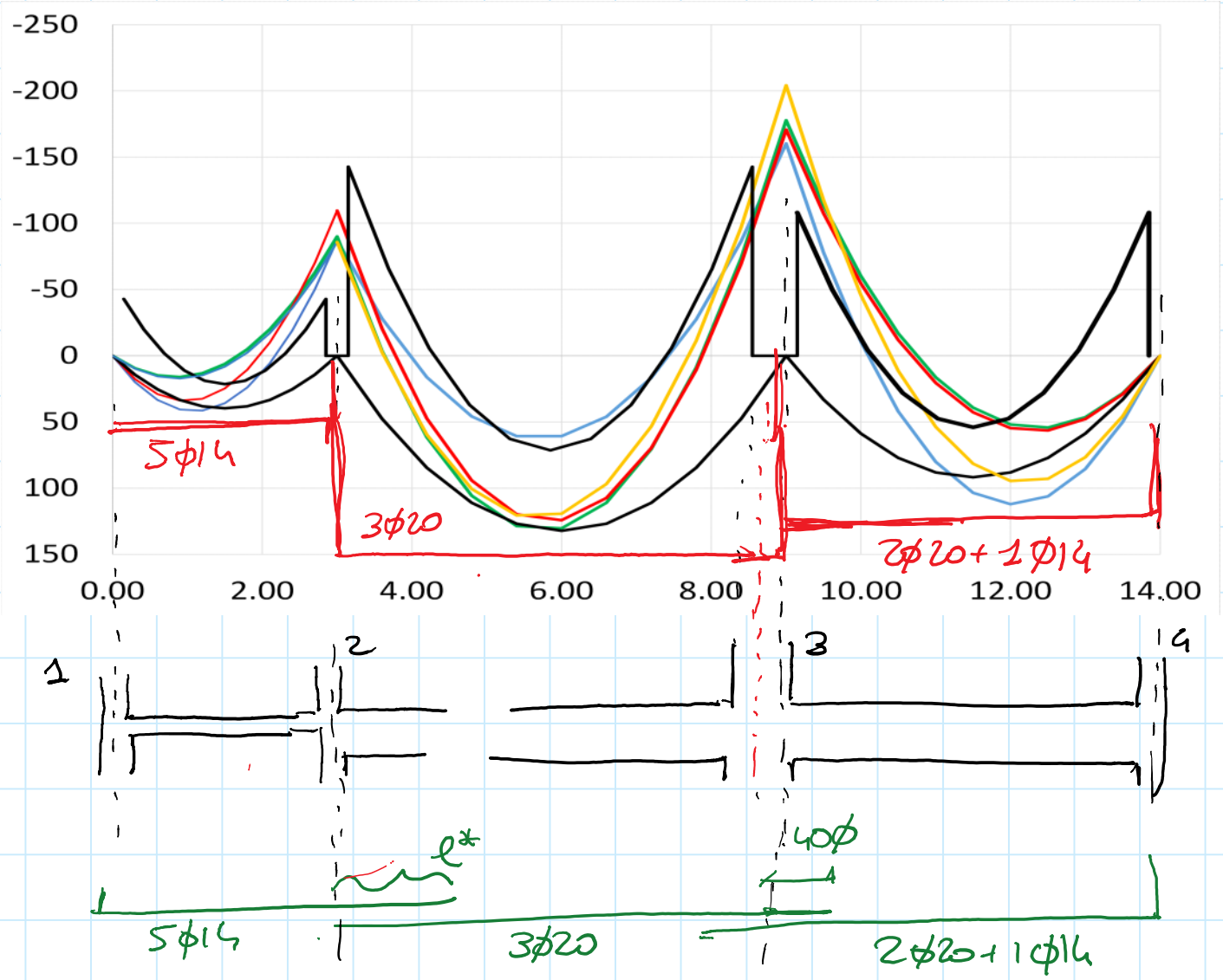
TRAVE EMERGENTE

$$M_{Rd}(1\phi 20) = 3,14\,cm^2 \times 0,9 \times 0.45m \times \frac{391.3\,N}{mm^2} \frac{1}{10} = 49,76\ kNm$$

CAMPATA 2-3 $3\phi 20 \rightarrow 3 \times 49.76 \simeq 150\ kNm$

3-4 $2\phi 20 + 1\phi 14 \rightarrow 2,5 \times 49.76 \simeq 124\ kNm$

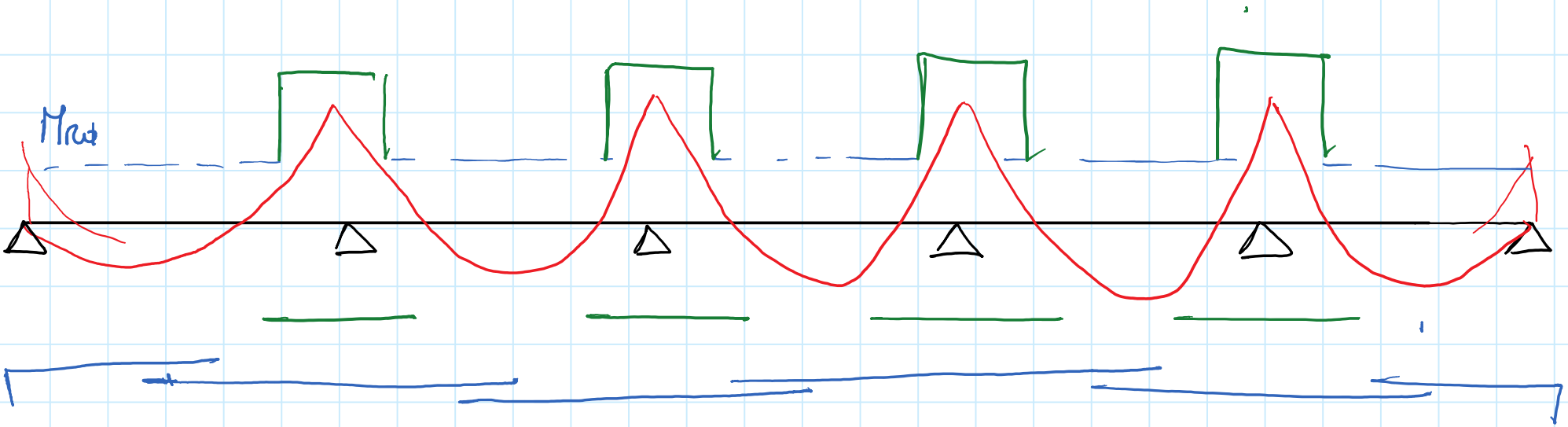
DIAGRAMMA M_{Rd}

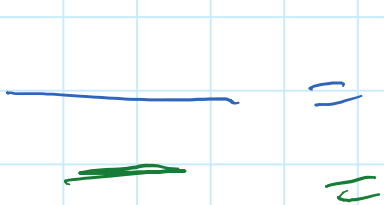


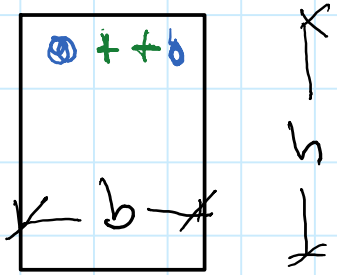
ARMATURA SUPERIORE — METODO 1

- DISPONGO DA METÀ CAMPATA A METÀ CAMPATA REGGI-STAFFA PER PORTARE $\simeq$ 0,40 ÷ 0,50 M_{max}

- AGGIUNGO MONCONI PER PORTARE INCREMENTO DI MOMENTO





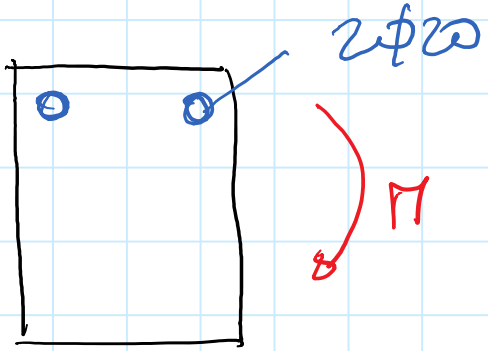


NEL NOSTRO CASO

TRAVE EMERGENTE $M_{max} \simeq 204$ KNM

$$A_s = \frac{0,40 \times 204 \text{ KNM}}{0,9 \times 0,45\text{m} \times 391,3 \text{ N/mm}^2} \times 10 = 5,15 \text{ cm}^2$$

$\Rightarrow$ 2ϕ20



+ MONCONI

MONCONI NECESSARI APPOGGIO 3

$$A_s = \frac{204 \text{ KNM}}{0,9 \times 0,45\text{m} \times 391.3 \text{ N/mm}^2} \times 10 = 12.37 \text{ cm}^2$$

$\rightarrow$ 4ϕ20

$\Rightarrow$ MONCONI AGGIUNTIVI = 2ϕ20

TRAVE A SPESSORE

ARMATURA NECESSARIA AI DUE ESTREMI

$$A_s^{(1)} \simeq \frac{50\ kNm \cdot \times 10}{0{,}9 \times 0{,}19\,m \times 391{,}3} = 7.47\,cm^2$$

$4\phi 20$
OPPURE
$2\phi 20 + 2\phi 14$

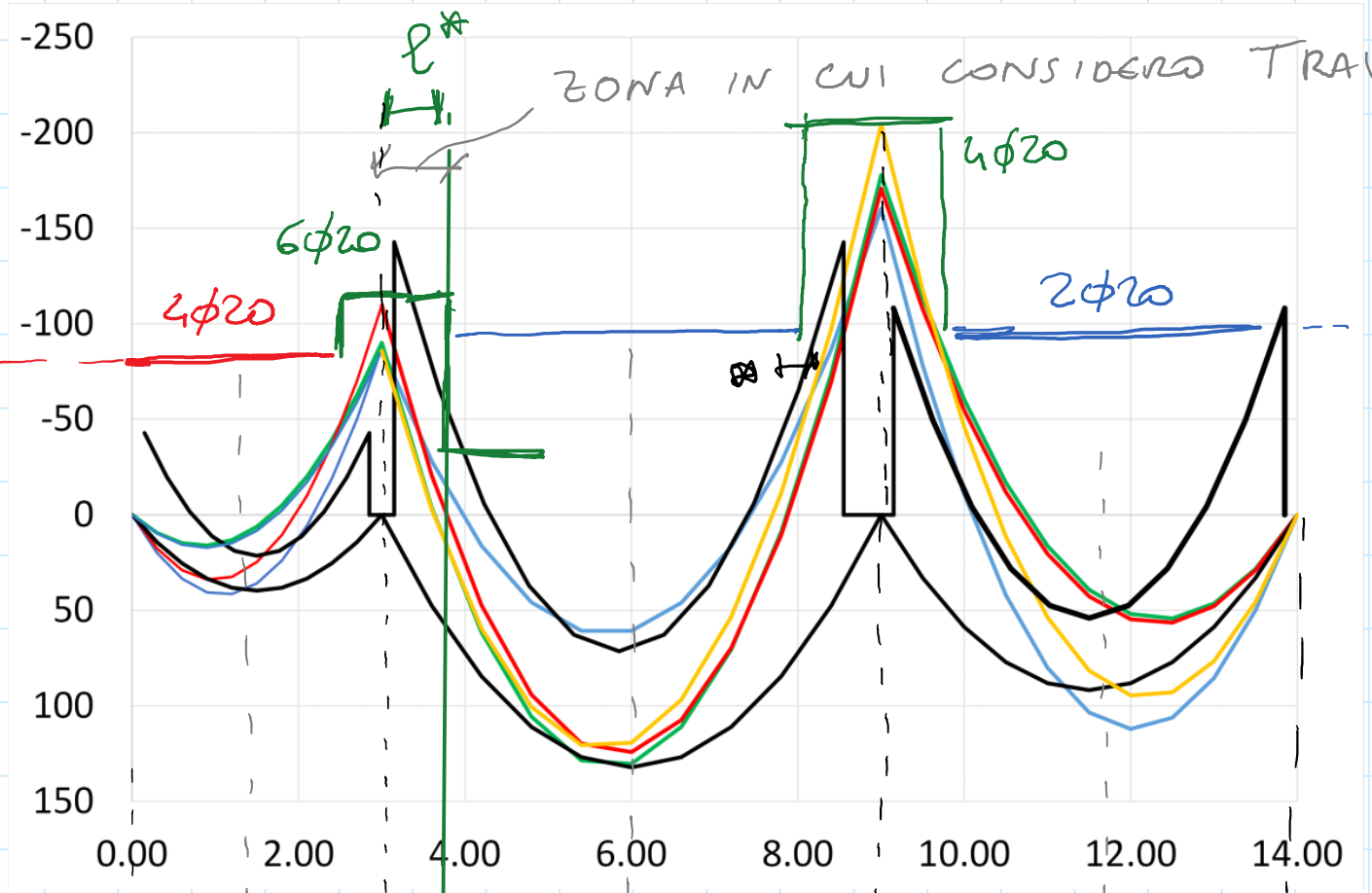
$$A_s^{(2)} \simeq \frac{110\ kNm \times 10}{0{,}9 \times 0{,}19 \times 391{,}3} = 16{,}44\,cm^2$$

$6\phi 20$

$$M_{Rd}^{4\phi 20} = 8 \times M_{Rd}^{\phi 14} = 88.4\ kNm$$

$$M_{Rd}^{6\phi 20} = 132.6\ kNm$$

ARMATURE SUPERIORI E M_{Rd}



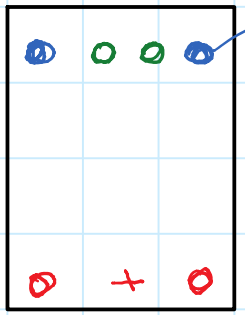
$M_{Rd}^{4\phi20}$ = 88.4 KNM (d = 0.13)

$M_{Rd}(2\phi20)$ = 99.5 KNM

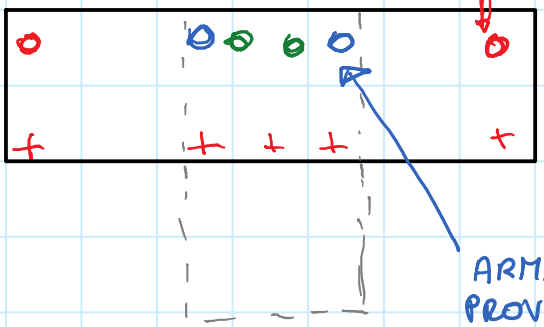
④ TRASLAZIONE DIAGRAMMA $\frac{z}{2}\cot\theta$

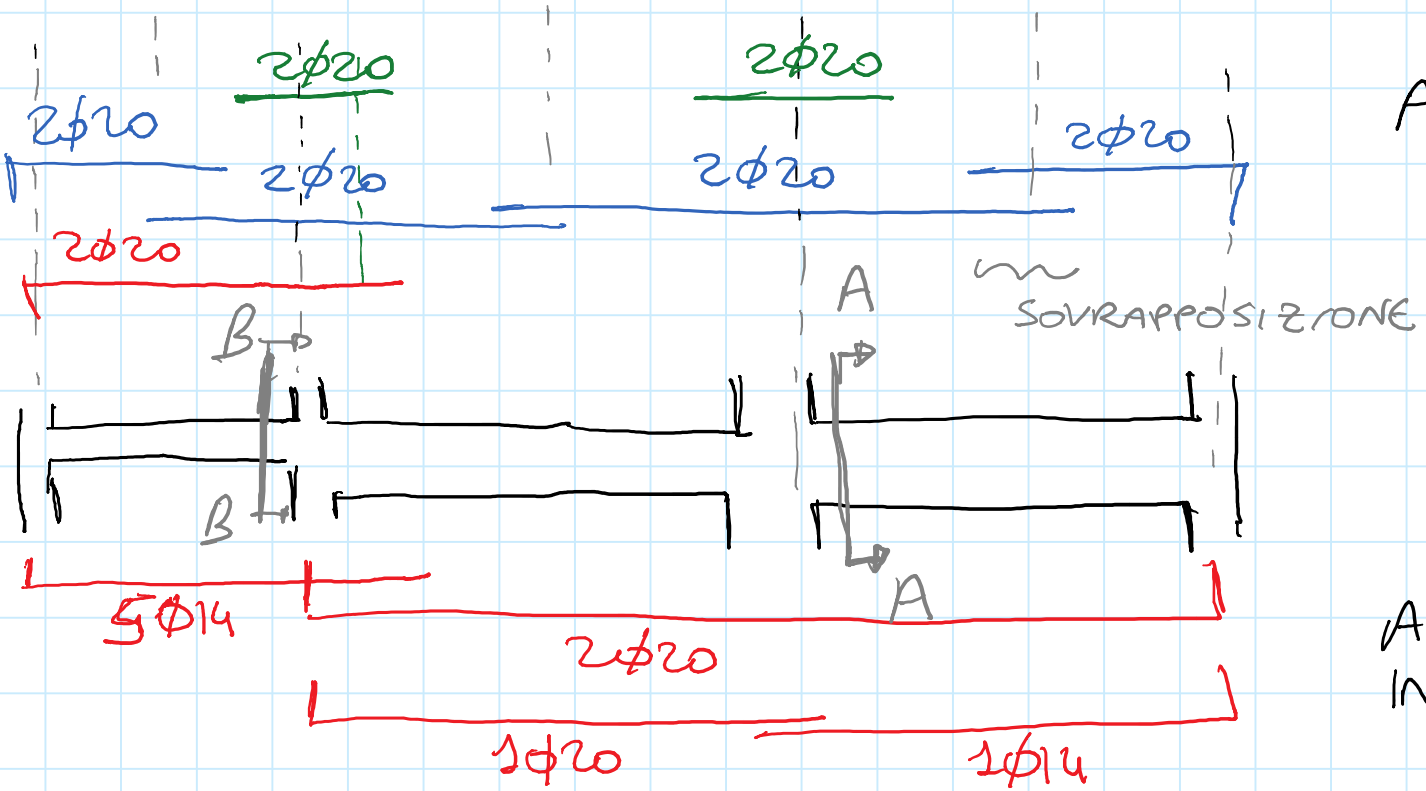
SEZIONI TRASVERSALI

SEZIONE A-A



SEZIONE B-B





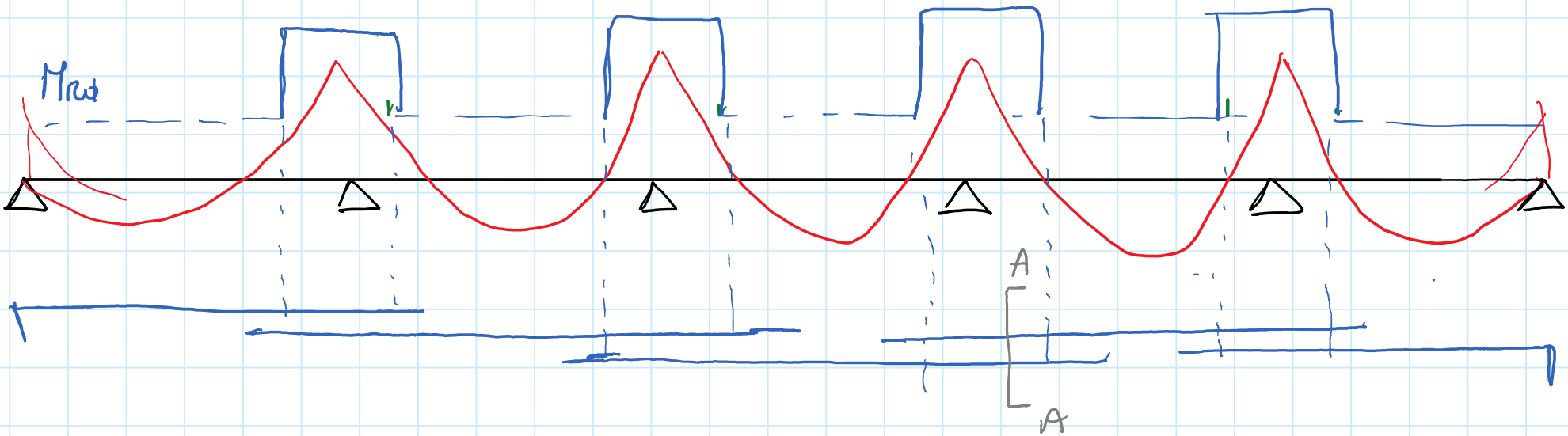
ARMATURA SUPERIORE

ARMATURA INFERIORE

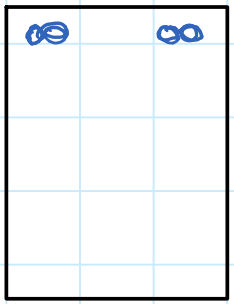
ARMATURA SUPERIORE — METODO 2

- DISPONGO L'ARMATURA MINIMA SU TUTTA LA CAMPATA E SFRUTTO LA SOVRAPPOSIZIONE DELLE ARMATURE AGLI APPOGGI

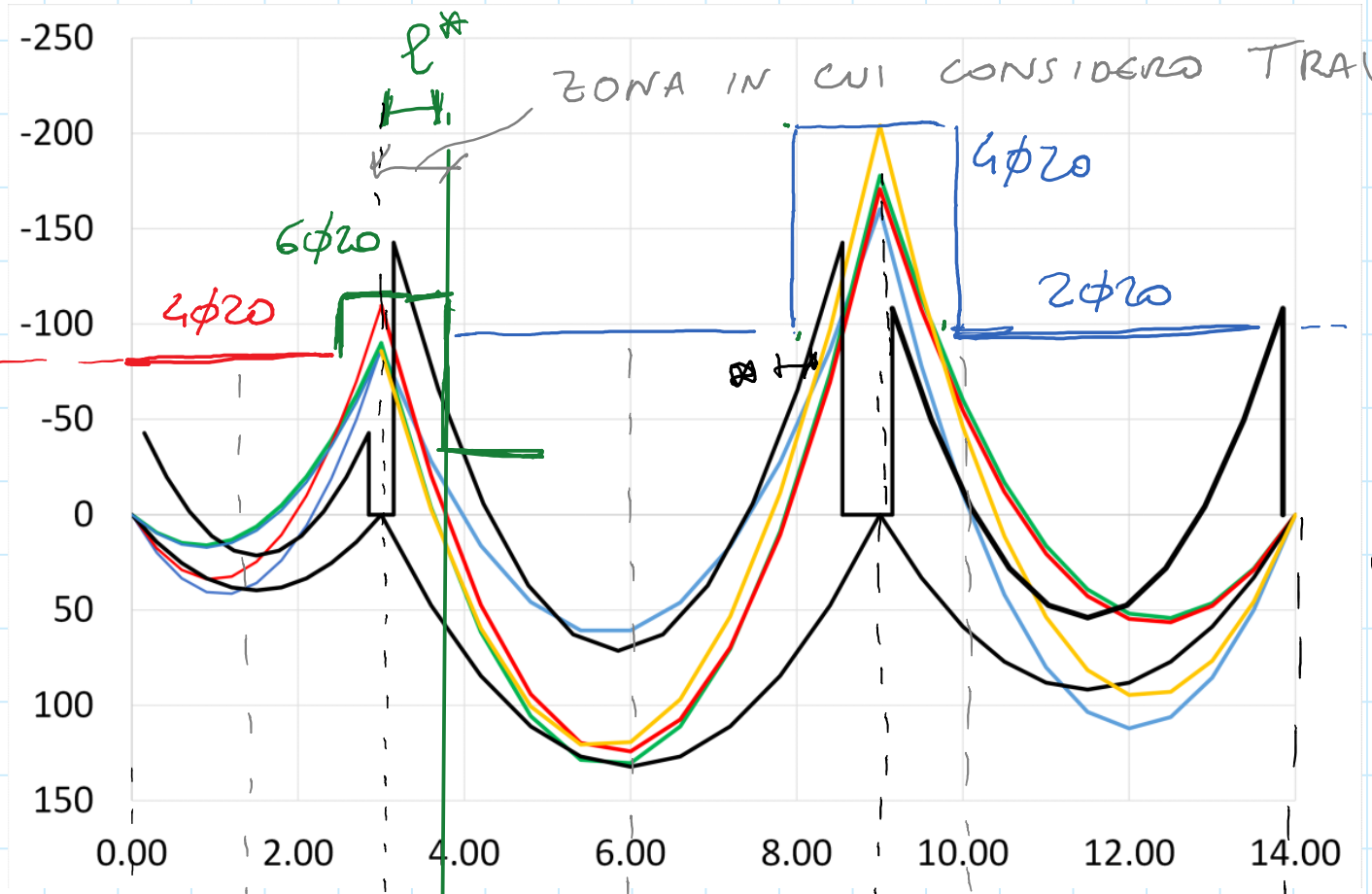
- SI RIDUCONO I TRONCONI NECESSARI



SEZIONE TIPO



DISPOSIZIONE DELLE ARMATURE SUPERIORI (METODO 2



M_{Rd} 4φ20 = 88.4 KNM (d = 0.13)

M_{Rd} (2φ20) = 99.5 KNM

④ TRASLAZIONE DIAGRAMMA $\frac{z}{2}\cot\theta$

4φ20

2φ20

2φ20

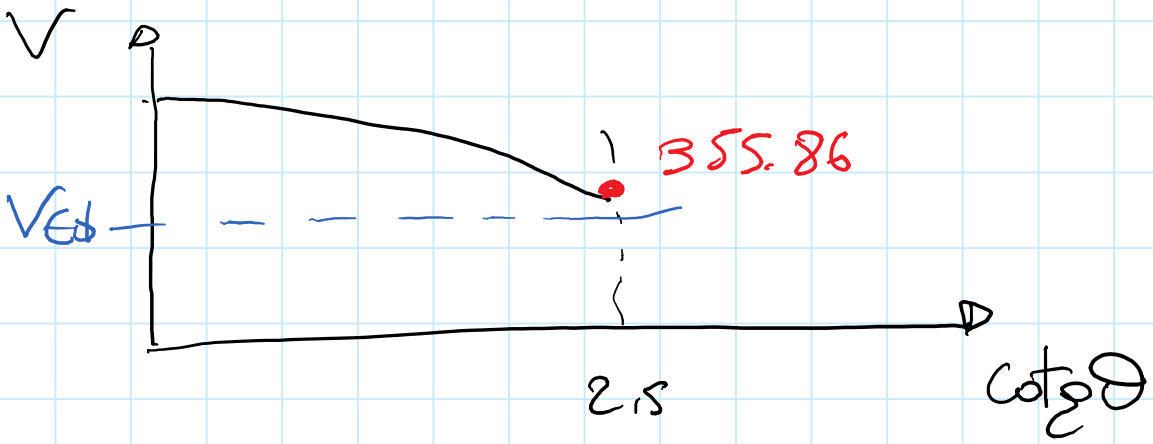
SOVRAPPOSIZIONE

PROGETTO ARMATURA A TAGLIO

1. CALCOLO $V_{Rd\,max} = \nu f_{cd}\, b z \dfrac{\cot\vartheta}{1+\cot^2\vartheta}$

TRAVE EMERGENTE

$V_{Ed,max} = 200\ kN$



SEZIONE 30×50

$z = 0{,}9\,d \Rightarrow$

$$V_{Rd,max} = \frac{1}{10}\,0{,}5 \times 17\ MPa \times 30\ cm \times 0{,}9 \times 45\ cm \times \frac{2{,}5}{1+2{,}5^2}$$

$$1032\ kN \times \frac{2{,}5}{1+2{,}5^2} = 355{,}86\ kN$$

$V_{Rd,max} > V_{Ed} \quad \forall \cot\vartheta : \quad 1 \leq \cot\vartheta \leq 2.5$

2. DETERMINO $\frac{n_b A_{st}}{s}$ CON $\cot\vartheta = 2$

$$V_{Rds} = \frac{n_b A_{st}}{s} \cdot z \, f_{yd} \cot\vartheta \geq V_{Ed}$$

USO $\phi 8$ CON $n_b = 2$ $\quad (A_{\phi 8} = 0{,}5\,cm^2)$

$$\frac{1}{10} \frac{2 \times 0{,}50\,cm^2}{s} \cdot 0{,}9 \times 45\,cm \times 391.3 \frac{N}{mm^2} \cdot 2 \geq 200\,KN$$

$$\frac{KN \cdot cm}{s} \geq KN \Rightarrow s \text{ IN } cm \rightarrow s \leq 15.84\,cm$$

LIMITI DI NORMATIVA:

$$\frac{A_{st} n_b}{s} \geq 0.15 b_w \frac{cm^2}{m}$$

$$s \leq 0.8d$$

$$s \leq 33\,cm$$

$\Big\}$ $\phi 8/20$

DOVE HO $V_{Ed\,max}$ $\Longrightarrow$ $\phi 8/15$

NOTA 1: POICHÉ $S < 15.85$ POTREI RICALCOLARE CON $\cot\theta$: $V_{Rd,s} = V_{Ed}$

NOTA 2: $V_{Ed,max}$ PUÒ ESSERE VALUTATO A DISTANZA d DALL'APPOGGIO

SCELTA FINALE:

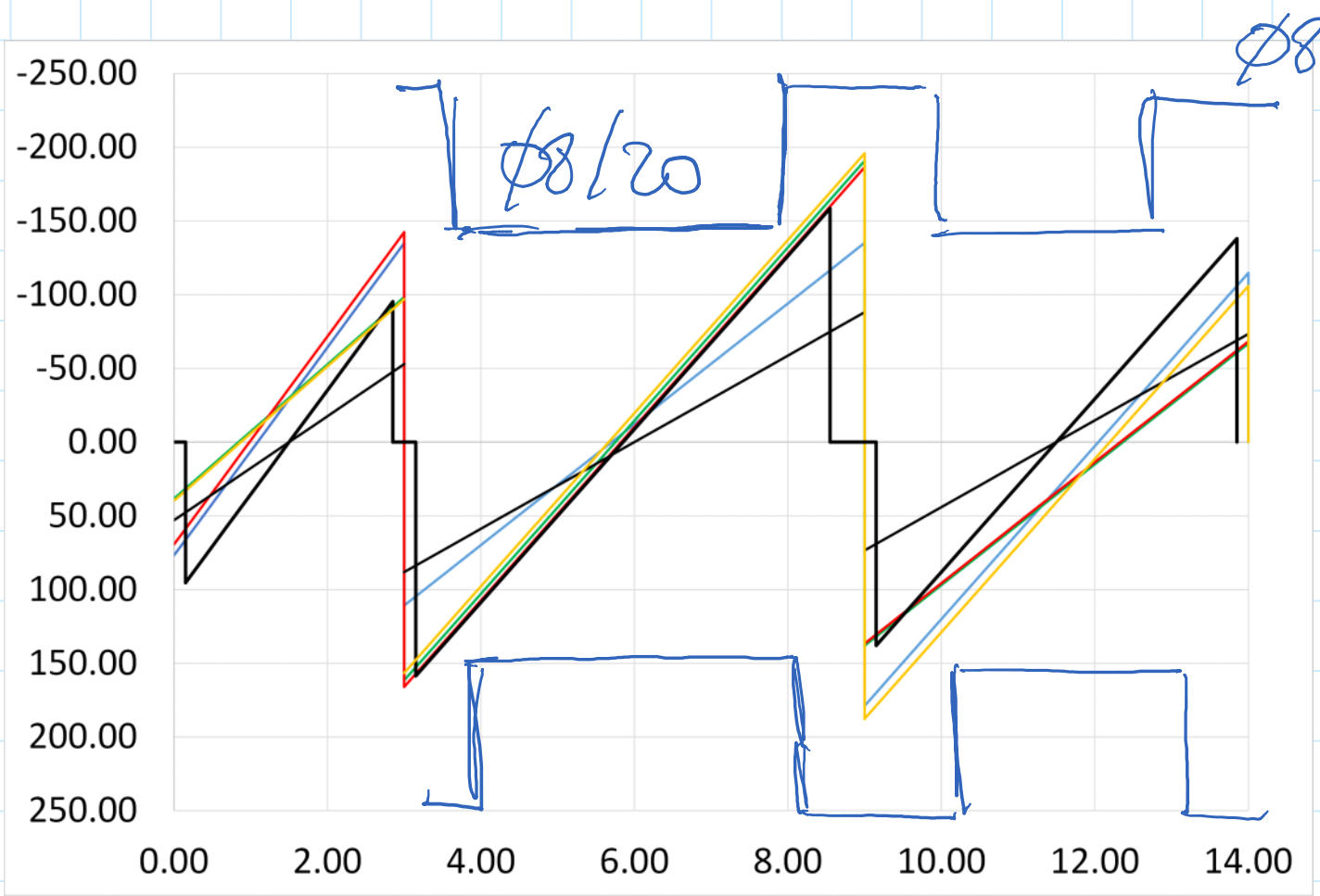
IN CAMPATA DISPONGO A_{st}/s SECONDO MINIMI DI NORMATIVA $\Longrightarrow$ $\phi 8/20$

$$V_{Rd,s} = \frac{1}{10}\frac{2 \times 0{,}5\,cm^2}{20\,cm} \times 0{,}9 \times 45\,cm \times 391{,}3\,\frac{N}{mm^2} \times \underset{\sim}{\overset{2}{\cot\theta}}$$

$$= 258.5\,kN$$

DOVE NECESSARIO RAFFITTISCO CON Ø8/15

(BUONA NORMA RAFFITTIRE AGLI ESTREMI INDIPENDENTEMENTE DA V_{Ed})

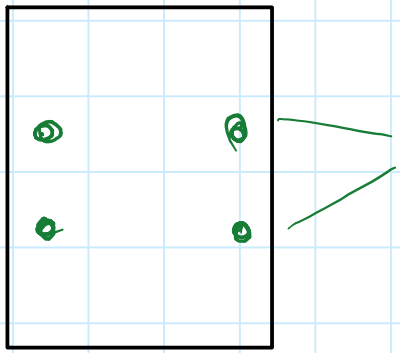


ARMATURA DI PARETE O TRASLAZIONE DIAGRAMMA MOMENTI

$$A_{sp} \cdot f_{yd} \geq \frac{V}{2} \cot\theta \Rightarrow$$

$$A_{s,p} = \frac{200\ KN}{2} \cdot \frac{2}{391.3\ N/mm^2} \times 10 = 5.1\ cm^2$$

SE USO $\phi 14 \Rightarrow A = 1.54 \Rightarrow 3,3$ BARRE $\Rightarrow 4$



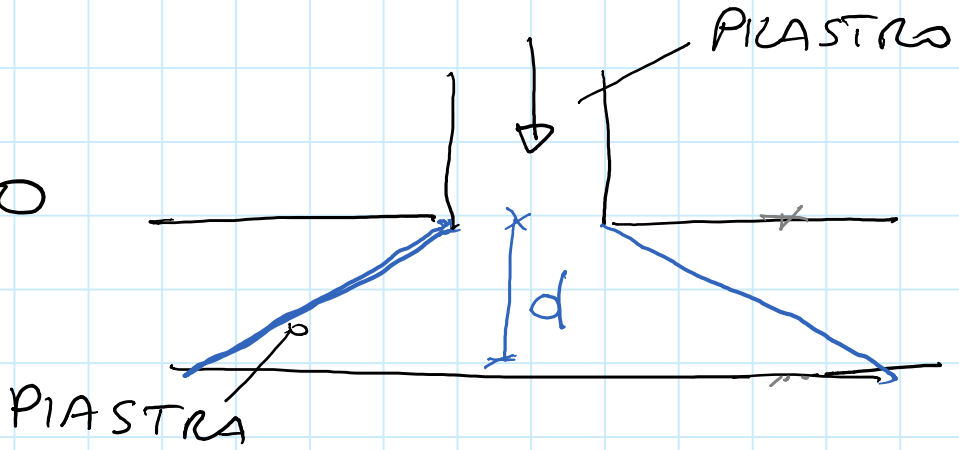
$2+2\phi 14$

SE DISPONGO SOLO $2\phi 14 \Rightarrow$ DEVO TRASLARE IL DIAGRAMMA DEI MOMENTI

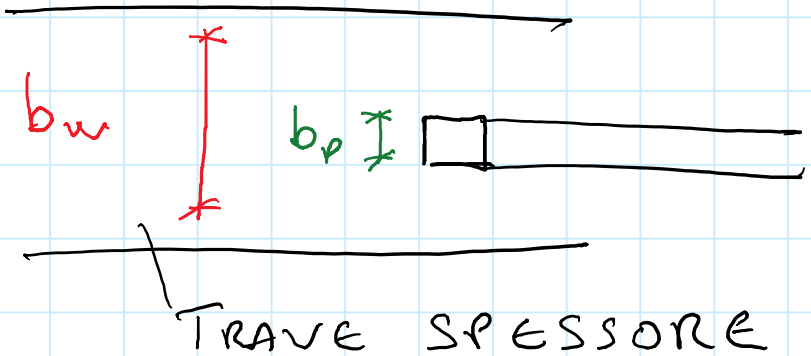
TRAVE A SPESSORE

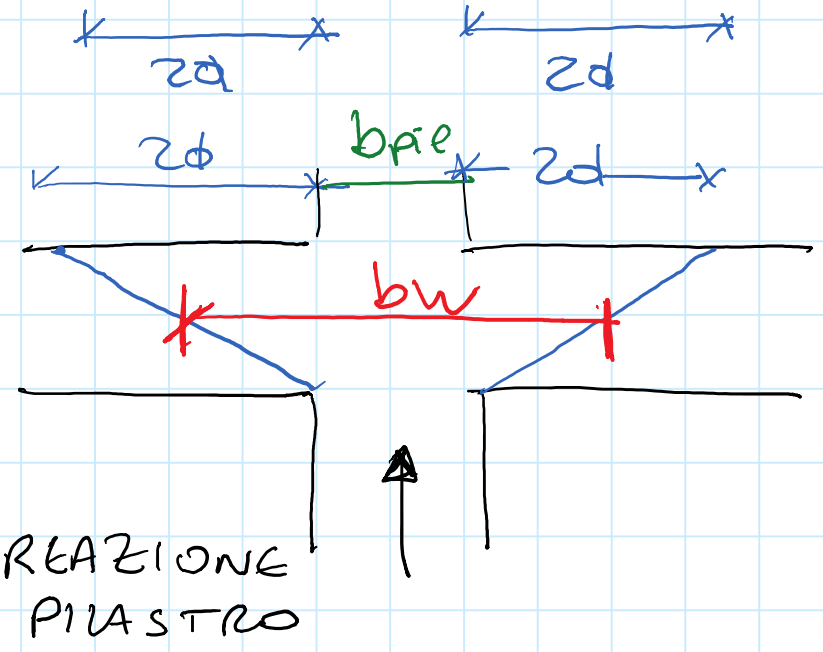
NON TUTTA LA TRAVE A SPESSORE REAGISCE A TAGLIO

FENOMENO PUNZONAMENTO



ANALOGAMENTE PER TRAVE A SPESSORE





$b_w = b_{pil} + 2d$ (ARMATURA A TAGLIO DA DISPORRE ENTRO b_w)

$b_w = 30\,cm + 2 \times 19 = 68\,cm$

$$V_{Rd,max} = \frac{1}{10} 0,5 \times 17 \frac{N}{mm^2} \times 68\,cm \times 0,9 \times 19\,cm \times \frac{\cot\vartheta}{1+\cot^2\vartheta}$$

Se $\cot\vartheta = 2.5 \Rightarrow V_{Rd,max} = 340.82\,kN$

$> V_{Ed.} \simeq 155\,kN$

ARMATURE NECESSARIE

$$n_b \cdot \frac{A_{st}}{s} z f_{yd} \cot\vartheta = 155\ kN$$

Σw_2

$n_b = 4 \quad A_{st} = 0{,}5\ cm^2 \Rightarrow$

$$\frac{1}{10} \frac{4 \times 0{,}5\ cm^2}{s} \times 0{,}9 \times 19\ cm \times 391.3 \frac{N}{mm^2} \times 2 = 155\ kN \Rightarrow$$

$s \leq 17{,}3\ cm$

ALTRI LIMITI DI NORMATIVA

- $\frac{n_b A_{st}}{s} \geq 0{,}15 b_w = 0.15 \times 68 \frac{cm^2}{m}$ $\quad n_b A_{st} = 2\ cm^2 \Rightarrow$

$s \leq 19{,}6\ cm$

- $s \leq 0{,}8d = 0{,}8 \times 19\ cm \Rightarrow$ $s \leq 15{,}2\ cm$

$\varnothing 8/15$ (4 BRACCI)