

Σ'Δ, ΣΚΥΡΟΔΕΜΑ Ι

Χαλύβας

S 400

S 500

$f_{yk} = 500 \text{ MPa}$

και  $f_{yk} > f_{yk,red}$   
και  $f_{yk} > f_{yk,red}$

$f_{yd} = \frac{f_{yk}}{1.15} = \frac{500000 \text{ kPa}}{1.15} = 434783 \text{ kPa}$

Σκυροδέμα

C 16

(C 20)

C 25

C 30  $\mu > \eta$

αυτοί στ' δίνει  $f_{ck} = 20 \text{ MPa}$

$f_{cd} = \frac{f_{ck}}{1.5} = \frac{20000 \text{ kPa}}{1.5} = 13333$

" "  $f_{yk} \leq \frac{1}{10} f_{ck}$

13333

Φορτίς

G : μόνιμη

συντομία  $\alpha \text{ } \gamma \text{ } \delta$  :  $1 \div 1.35$

Q : κινητή

" " " "

:  $0 \div 1.50$

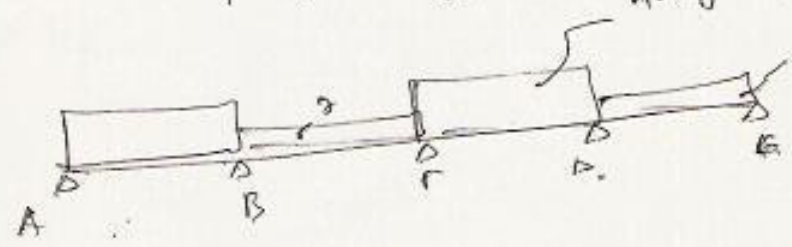
πορτίς υπερφόρτισης

(M)



πορτίς αναφόρτισης

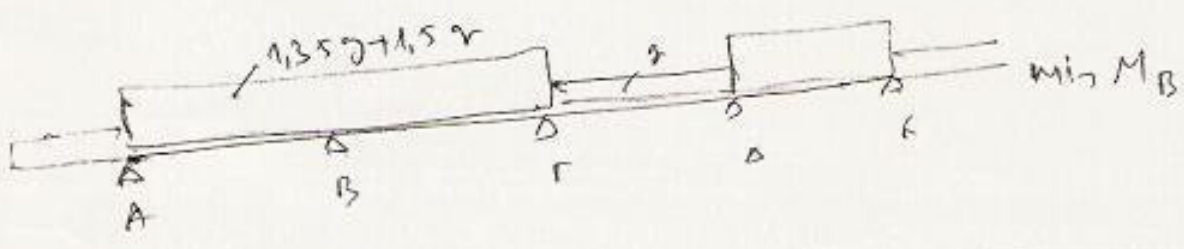
$1.35g + 1.5q = P_{max}$



$\gamma = P_{min}$

$\max M_{AB}, \max M_{CD}$

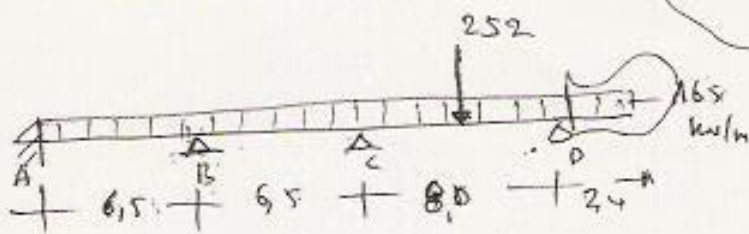
$\min M_{BC}, \min M_{DE}$



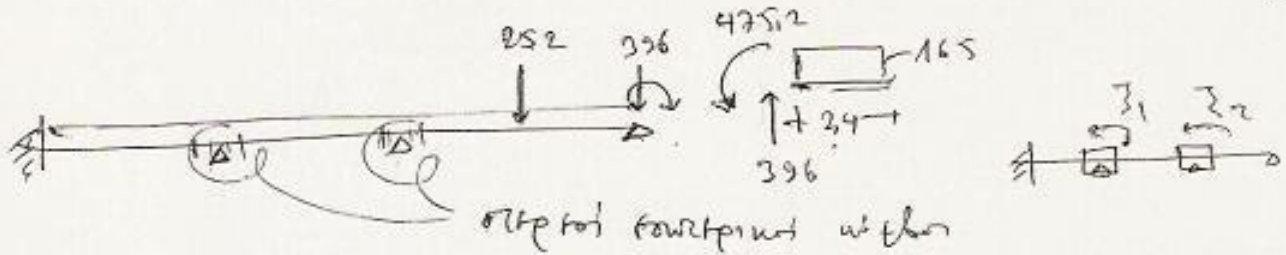
$\min M_B$

Φ46 06 11 CROSS

$P_{max} = 1,35 q_k + 1,5 q_k = -2-$   
 $= 1,35 \times 50 + 1,5 \cdot 65 = 165 \text{ kN/m}$

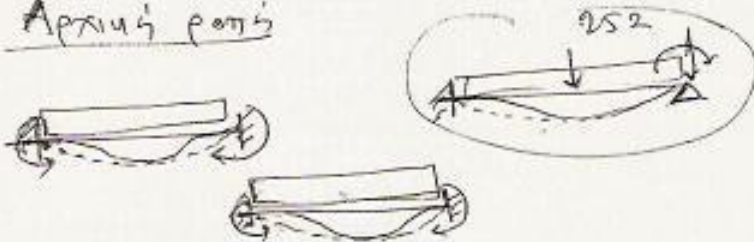


$P_{max} = 1,35 \cdot G_k + 1,5 Q_k =$   
 $= 1,35 \cdot 70 + 1,5 \cdot 105 = 252 \text{ kN}$



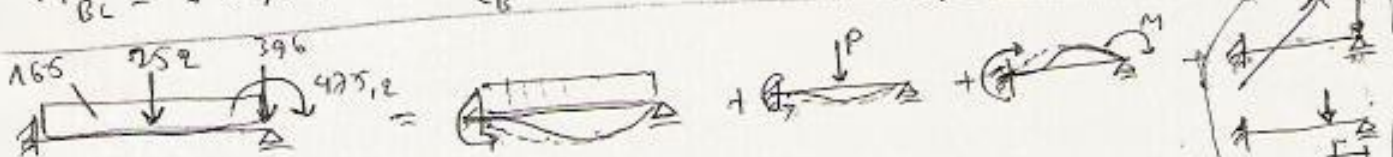
step to find point within

Approx points



$M_{AB}^0 = \frac{q l^2}{12} = \frac{165 \times 6,5^2}{12} = 580,94 \text{ kNm}$       $M_{BA}^0 = -580,94$

$M_{BC}^0 = 580,94$       $M_{CB}^0 = -580,94$



$M_{CD}^0 = + \frac{q l^2}{8} + \frac{3 P l}{16} - \frac{M}{2} =$

$= 165 \times \frac{8,0^2}{8} + \frac{3 \times 252 \times 8}{16} - \frac{475,2}{2} = 1460,4 \text{ kNm}$

$l_c = 6,5$       $I_c = I$

$k_{pr} \text{ i } k_{in}$

$k_{AB} = \frac{I}{l} \frac{l_c}{I_c} = 1$

$k_{BC} = \frac{I}{l} \frac{l_c}{I_c} = 1$

$k_{CD} = 0,75 \frac{I}{l} \frac{l_c}{I_c} = 0,75 \frac{6,5}{8} = 0,6094$

$k = \frac{I}{l} \frac{l_c}{I_c}$

$k = 0,75 \frac{I}{l} \frac{l_c}{I_c}$

$k = 0,25 \frac{I}{l} \frac{l_c}{I_c}$

$k_{k1} + k_{k2}$

$k_B = k_{AB} + k_{BC} = 1 + 1 = 2$   
 $k_C = k_{BC} + k_{CD} = 1 + 0,6094 = 1,6094$

Σmom) für die uerrampig ( $\mu = - \frac{k_{k1} > k_{k2}}{k_{k1} + k_{k2}}$ )

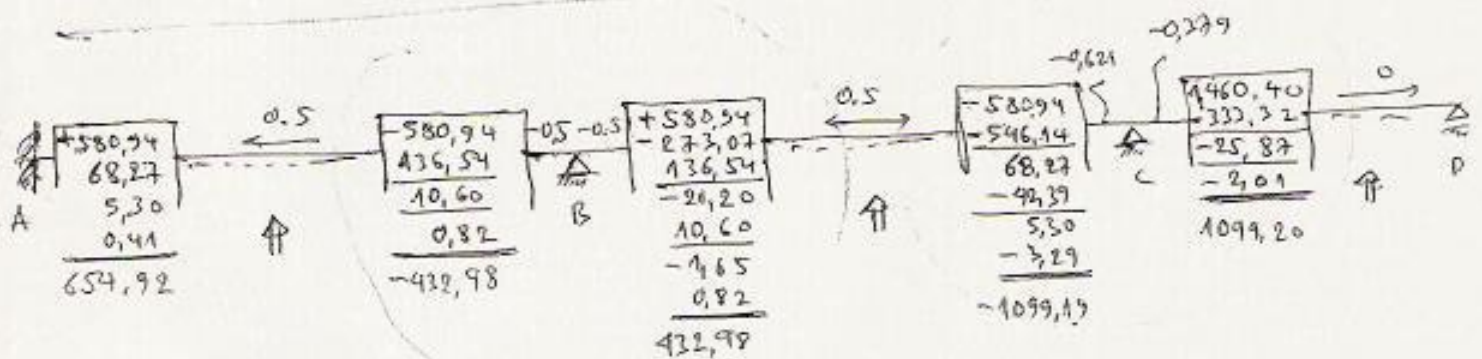
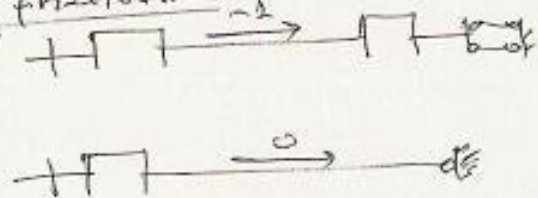
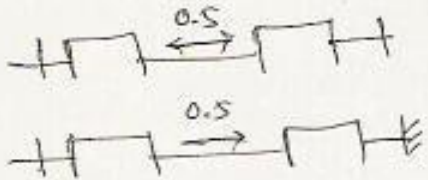
$\mu_{BA} = - \frac{k_{AB}}{k_B} = - \frac{1}{2} = -0,5$

$\mu_{CB} = - \frac{k_{BC}}{k_C} = - \frac{1}{1,6094} = -0,621$

$\mu_{BC} = - \frac{k_{BC}}{k_B} = - \frac{1}{2} = -0,5$

$\mu_{CD} = - \frac{k_{CD}}{k_C} = - \frac{0,6094}{1,6094} = -0,379$

Σmom) für die parallel, Bst. aus



≡ Für die 3 st. zw. k1 und k2 ist zu berücksichtigen dass die abgeleiteten abstände positiv. Weiterhin 3 st. zw. k1 und k2

knäuel c

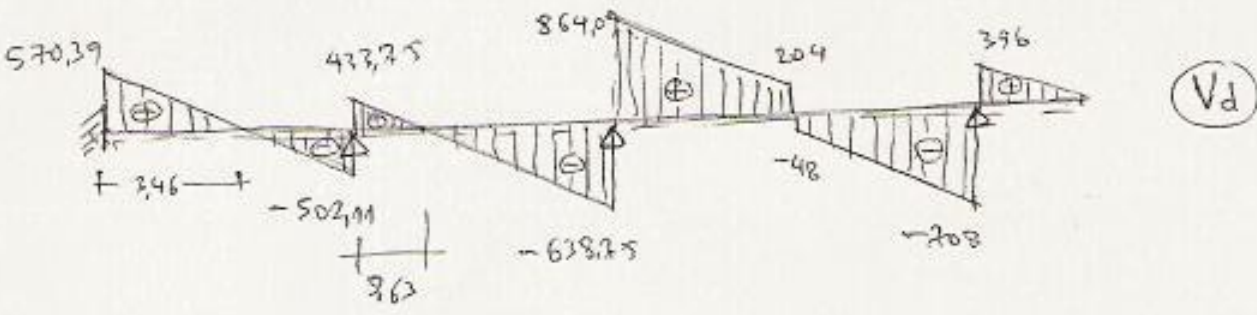
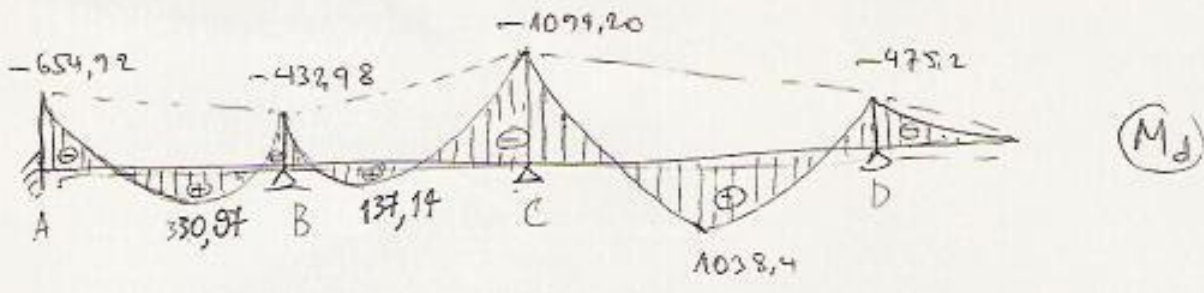
$\Sigma = 1460,4 - 580,94 = 879,46$   
 $879,46 \cdot (-0,621) = -546,14$   
 $" \cdot (-0,379) = -332,32$

knäuel B

$\Sigma = +580,94 - 580,94 - 273,07 =$   
 $= -273,07$   
 $-273,07 \cdot (-0,5) = 136,54$   
 $" \cdot " \cdot " \cdot "$

Ausgangspunkt für momis (Aussicht auf die st. zw. k1 und k2)

$M_{AB} = -654,92 \quad M_{BA} = -432,98 \quad M_{BC} = -432,98 \quad M_{CB} = -1099,20$   
 $M_{CD} = -1099,20$



$V = \Delta V + V^0$

$\Delta V = \frac{M^{\text{right}} - M^{\text{left}}}{L}$

$V^0$

$\Delta V_{AB} = \frac{-432,98 - (-654,92)}{6,5} = 34,14$

$V^0_{AB}$

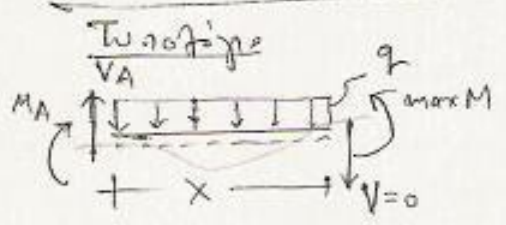
$\Delta V_{BC} = \frac{-1099,20 - (-432,98)}{6,50} = -102,50$

$V^0_{BC}$

$\Delta V_{CD} = \frac{-475,20 - (-1099,20)}{8,0} = 78,00$

$V^0_{CD}$

$113 \times \frac{8}{2} + \frac{252}{2} = 786$



$x = \frac{V_A}{q}$

$\max M = M_A + \frac{V_A^2}{2q}$

$$x = \frac{570,39}{465} = 3,42 \quad \max M_{AB} = -654,72 + \frac{570,39^2}{2 \cdot 465} = 330,97 \quad -5-$$

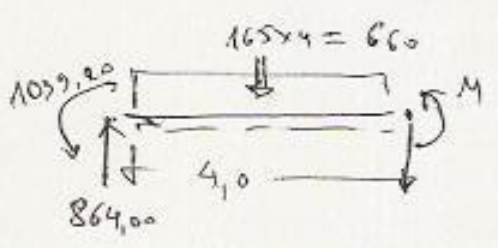
$$x = \frac{433,75}{465} = 2,63 \quad \max M_{BC} = -432,98 + \frac{433,75^2}{2 \cdot 465}$$

Köbonye az  $\Sigma M$

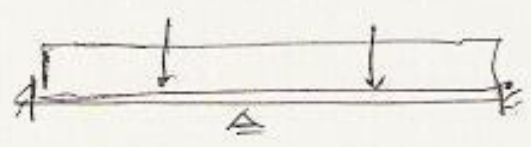
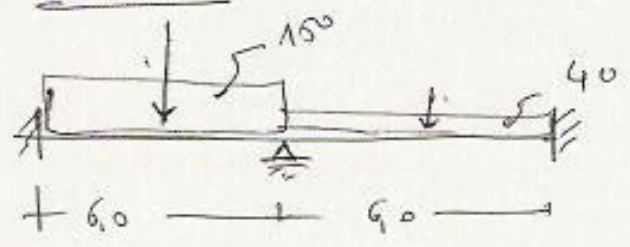
$$\Sigma M = 0 \Rightarrow M + 1099,20 - 864,0 \cdot 4 +$$

$$+ 660 \cdot 2 = 0 \Rightarrow$$

$$M = \cancel{1099,20} \cdot 1038,4$$



Övről 06

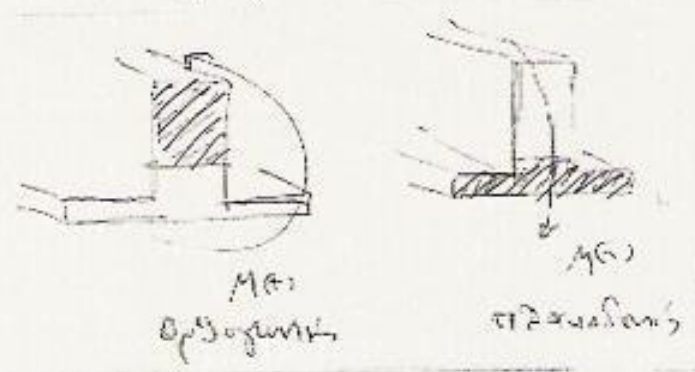
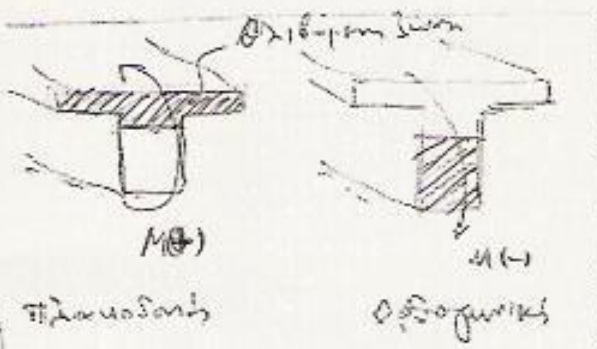


$$P_{max} = 135 \cdot 40 + 15 \cdot 64 = 150$$

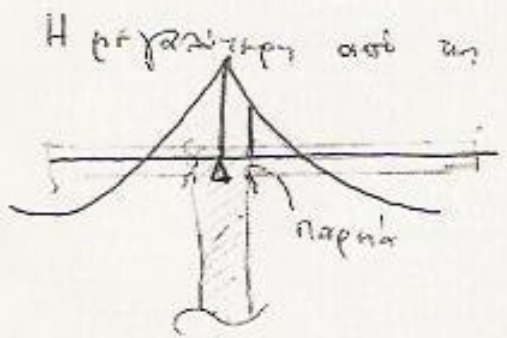
$$P_{min} = 40$$

Όταν  $M_{sds} \leq M_{lim} \rightarrow$  μόνο επαρκή ανάλυση

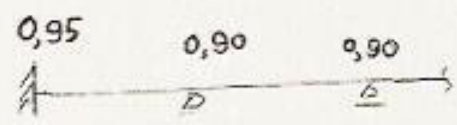
Όταν  $M_{sds} > M_{lim} \rightarrow$  συνολός = αλυσίδα δηλ & επαρκή ανάλυση & διακρίσεις



Ανεφεύξιμα προτιμώμενη είναι να διακρίνει η νεύρωση



Η μεγαλύτερη από τις αμνηστικές εφελκυστικές είναι 1099,20 kNm



$$M_{μαρ} = \begin{cases} 0,95 M \\ 0,90 M \end{cases}$$

$$M_{μαρ} = 0,9 \cdot 1099,20 = 989,28 \text{ kNm}$$



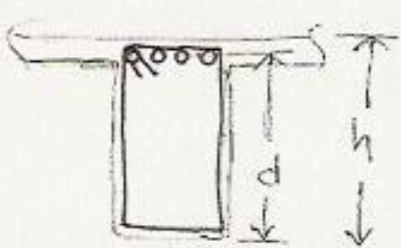
Ορθογωνικός

αξ 96  $\rightarrow$   $M_{lim} = 0,315$

$$f_{sds} = \frac{M_{sds}}{b d^2 f_{cd}} = M_{lim} \Rightarrow \frac{989,28}{0,40 \cdot d^2 \cdot 20000} = 0,315 \Rightarrow$$

$$f_{cd} = \frac{30000 \text{ kPa}}{1,5} = 20000$$

$$d = 0,627 \text{ m} \Rightarrow$$



$$d = h - 0,05 \text{ m}$$

στραυλι ύψος

$$h = 0,627 + 0,05 = 0,677 \text{ m}$$

ακέραιο πλάτος του 5m

$h = 0.70 \text{ m} \rightarrow d = 0.70 - 0.05 = 0.65$

Έλεγχος θλίψης σκυροδέματος κορμού σβ 255

$V = 0.7 - \frac{f_{ctk}}{200} = 0.7 - \frac{30}{200} = 0.55$  (Εάν λάβουμε το  $v$    
 πικρίσμα από 0.5 θα   
 το παίρνουμε 0.5)

$V_{Rd2} = \frac{1}{2} v \cdot f_{ctd} b_w \cdot z = \frac{1}{2} \cdot 0.55 \cdot 20000 \cdot 0.40 \cdot 0.65 = 1287 \text{ kN}$

$\max V_{sct} = 8640 \leq V_{Rd2} = 1287$  Μάξιμ, άλλως άλλως   
 διαφορά

Θαλίστρες  $\left\{ \begin{array}{l} \text{Διαμήκης} \quad [M-N] \text{ ύατη} \\ \text{Εγκάρσιες (δίνε οι συνδέσεις)} \quad [V] \text{ διαμήκη} \end{array} \right.$

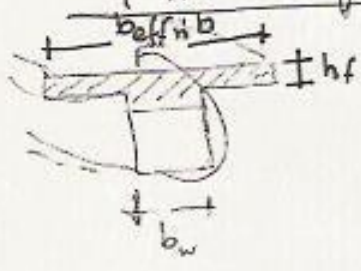
ΚΑΜΨΗ

$M \rightarrow$  ο σελ. σφίς συμπύκνωση κάτω   
 $M \leftarrow$  " " " " " πάνω.

Χαρίζεται σε πλάτος αντίστοιχο με το πλάτος της ραβδό   
 ύατης. Σε άλλα πλάτη γίνεται ένα υπολογιστ,  $f_{ct}$    
 με βάση την  $f_{ct}$  υπολογιστ γίνεται από της σφίξης   
 ανοίγματος

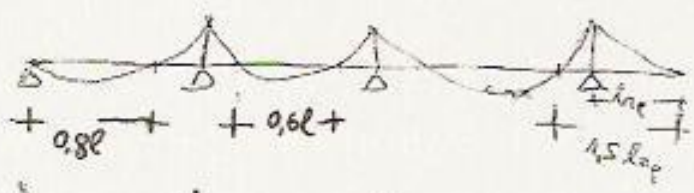
Έκταση 7 περιόδους

Περίοχη ανοίγματος AB Πλευροδωμής  $M = 330.97$

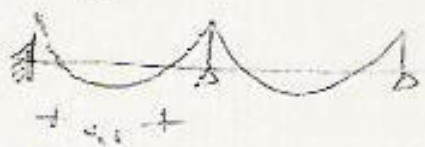


$b_{eff} = \text{συνεργητικό πλάτος}$

σβ 380



$l_0 = 0.6 \cdot l = 0.6 \cdot 6.5 = 3.90 \text{ m}$



$b_{ef} = b_w + \frac{l_0}{5} = 0.40 + \frac{3.90}{5} = 1.18 \text{ m}$

0.66 f<sub>yk</sub>  $\left\{ \begin{array}{l} \frac{b}{b_w} \geq 5 \Rightarrow \text{min } 6.33 \text{ or } 110 \\ \frac{b}{b_w} < 5 \Rightarrow \text{min } \text{or } 107-108 \end{array} \right.$

$\frac{b}{b_w} = \frac{1.18}{0.40} = 2.95 < 5$   $\frac{h_f}{d} = \frac{0.15}{0.65} = 0.231$

$\mu_{sds} = \frac{M_{sds}}{b d^2 f_{cd}} = \frac{230.97}{1.18 \cdot 0.65^2 \cdot 20000} = 0.033 \xrightarrow{\text{or } 108} \omega = 0.035$

$A_s = \omega b d \frac{f_{cd}}{f_{yd}} = 0.035 \cdot 1.18 \cdot 0.65 \cdot \frac{20000}{434783} = 0.001235 \text{ m}^2 = 12.35 \text{ cm}^2$

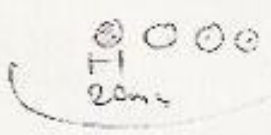
$f_{yd} = \frac{f_{yk}}{1.15} = \frac{500000}{1.15} = 434783$

Περ 107-108

or 21  $\rightarrow f_{ctm} = 290 \text{ MPa}$   
 or 36  $\rightarrow \rho_{min} = \frac{1}{2} \frac{f_{ctm}}{f_{yd}} = \frac{1}{2} \frac{290 \text{ MPa}}{500/1.15} = 0.003335$  min  $\phi = 12 \text{ mm}$

$A_{smin} = \rho_{min} b w h = 0.003335 \cdot 40 \cdot 70 = 9.34 \text{ cm}^2$

Βάση με 4 ή 5 περιφερειακά παξιμάκια or 355 4  $\phi 20 (= 12.57 \text{ cm}^2)$



Περ 107 αναγκαστικά BC

$M = 137.14$    $b = 1.18 \text{ m}$

$\mu_{sds} = \frac{M_{sds}}{b d^2 f_{cd}} = \frac{137.14}{1.18 \cdot 0.68^2 \cdot 20000} = 0.0138 \xrightarrow{\text{or } 108} \omega = 0.015$

$A_s = 0.015 \cdot 1.18 \cdot 0.65 \cdot \frac{20000}{434783} = 0.000527 \text{ m}^2 = 5.27 \text{ cm}^2$

$A_{smin} = 9.34 \rightarrow \boxed{4 \phi 18 (= 10.18 \text{ cm}^2)}$

divoixhe CD

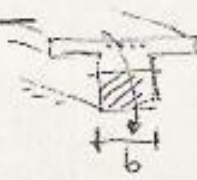
$M = 1038.4$   $\mu_{sds} = \frac{1038.4}{1.18 \cdot 0.65^2 \cdot 20000} = 0.104 \xrightarrow{\text{or } 108} \omega = 0.111$

$A_s = 0.111 \cdot 1.18 \cdot 0.65 \cdot \frac{20000}{434783} = 0.003916 \text{ m}^2 = 39.16 \text{ cm}^2 \rightarrow \boxed{9 \phi 24 (= 40.72 \text{ cm}^2)}$



Περιοχή σπρίγγματος Α

$M = -654,92$



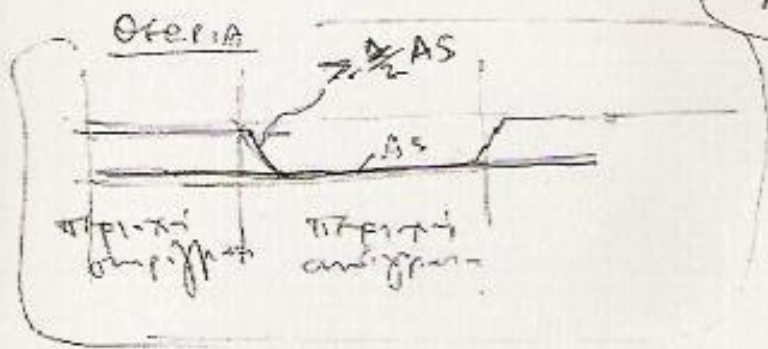
ορθογώνιος Διηλεκτικός  
ξύλι

$M_{req} = 0,95 \cdot 654,92 = 622,17$

$k_{sds} = \frac{M_{sds}}{bd^2 f_{cd}} = \frac{622,17}{0,40 \cdot 0,65^2 \cdot 20000} = 0,184 \xrightarrow{\sigma_{s100}} \omega = 0,210$

$A_s = \omega b d \frac{f_{cd}}{f_{yd}} = 0,210 \cdot 0,40 \cdot 0,65 \cdot \frac{20000}{434793} = 0,002512 \text{ m}^2 = 25,12 \text{ cm}^2$

$A_{s,req} = 9,34 \text{ cm}^2$



Υπόλοιπο από το άνω γράμ. ΑΒ  $2 \phi 20 (= 6,28 \text{ cm}^2)$   
 Πρόσθετα  $6 \phi 20 (= 23,85 \text{ cm}^2)$   
25,13

$25,12 - 6,28 = 18,84 \text{ cm}^2$

Περιοχή σπρίγγματος Β

$M = -432,98$

$M_{req} = 0,9 \cdot 432,98 = 389,68$

ορθογώνιος Διηλεκτικός

$k_{sds} = \frac{389,68}{0,40 \cdot 0,65^2 \cdot 20000} = 0,115 \xrightarrow{\sigma_{s100}} \omega = 0,125$

$A_s = \omega b d \frac{f_{cd}}{f_{yd}} = 0,125 \cdot 0,40 \cdot 0,65 \cdot \frac{20000}{434793} = 0,001495 \text{ m}^2 = 14,95 \text{ cm}^2$

$A_{s,req} = 9,34 \text{ cm}^2$

Υπόλοιπο από το ΑΒ  $2 \phi 20 (= 6,28 \text{ cm}^2)$

“ “ “ ΒΓ  $2 \phi 18 (= 5,09 \text{ cm}^2)$

Πρόσθετα  $2 \phi 16 (= 4,02 \text{ cm}^2)$   
15,39 cm<sup>2</sup>

Περιοχή σπρίγγματος Γ

$M = -1099,20$

$M_{req} = 0,9 \cdot 1099,20 = 989,28$

ορθογώνιος Διηλεκτικός

$k_{sds} = \frac{989,28}{0,40 \cdot 0,65^2 \cdot 20000} = 0,293 \xrightarrow{\sigma_{s100}} \omega = 0,378$

$A_s = \omega b d \frac{f_{cd}}{f_{yd}} = 0,378 \cdot 0,40 \cdot 0,65 \cdot \frac{20000}{434793} = 0,004521 \text{ m}^2 = 45,21 \text{ cm}^2$

$$A_{smin} = 9,34$$

Υαρίσμων	αριθ	BC	2φ18 (= 5,09)
"	"	CD	5φ24 (= 22,62)
Υπόλοιπα			4φ24 (= 18,10)
			<u>45,81</u>

### Περίοχη σπρίγγματος D

$$M = -475,2 \quad M_{max} = 0,9 \times 475,2 = 427,68$$

$$\mu_{scd} = \frac{427,68}{0,4 \cdot 0,65^2 \cdot 20000} = 0,127 \xrightarrow{\sigma_{scd} = 1} \omega = 0,138$$

$$A_s = \omega b d \frac{f_{cd}}{f_{yd}} = 0,138 \cdot 0,40 \cdot 0,65 \cdot \frac{20000}{434283} = 0,001650 \text{ m}^2 = 16,50 \text{ cm}^2$$

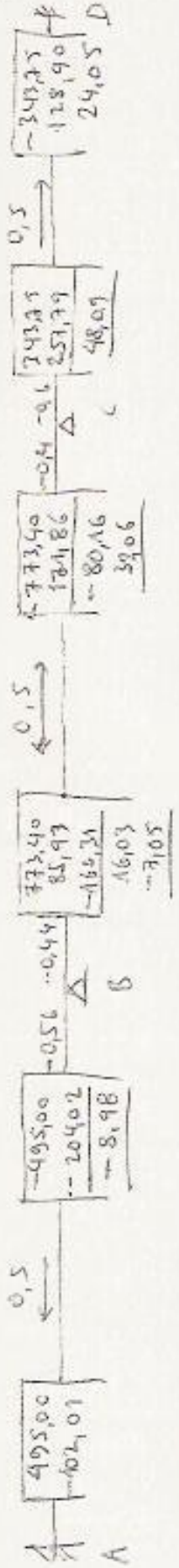
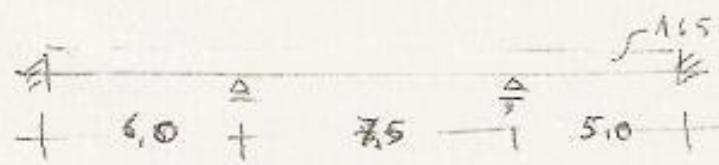
$$A_{smin} = 9,34 \text{ cm}^2$$

Υαρίσμων αριθ 2α CD 5φ24 (= 22,62) *μ/μ μ/μ*

Travin 05/B

$P_{max} = 165 \text{ kW/m}$

$l_c = 6,0$

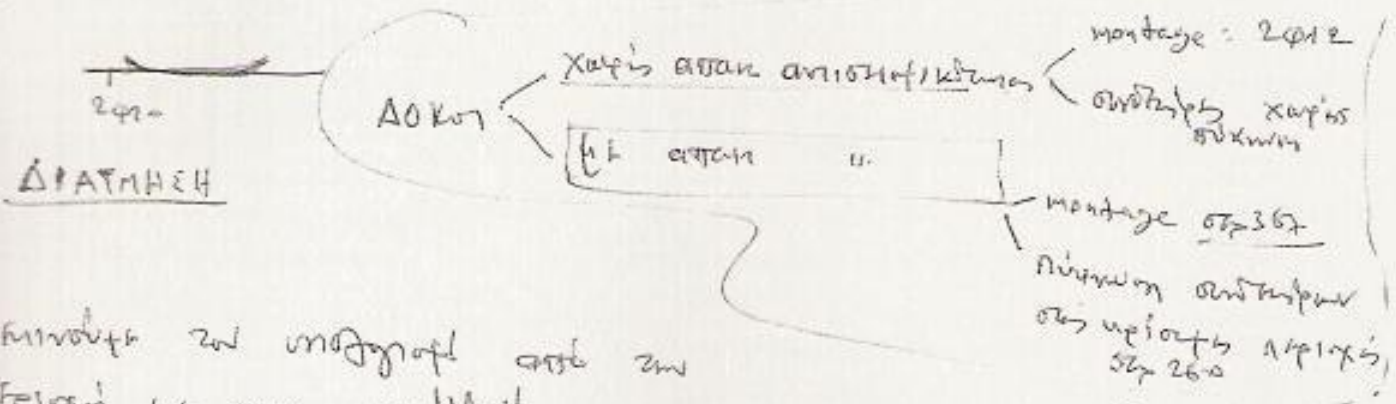
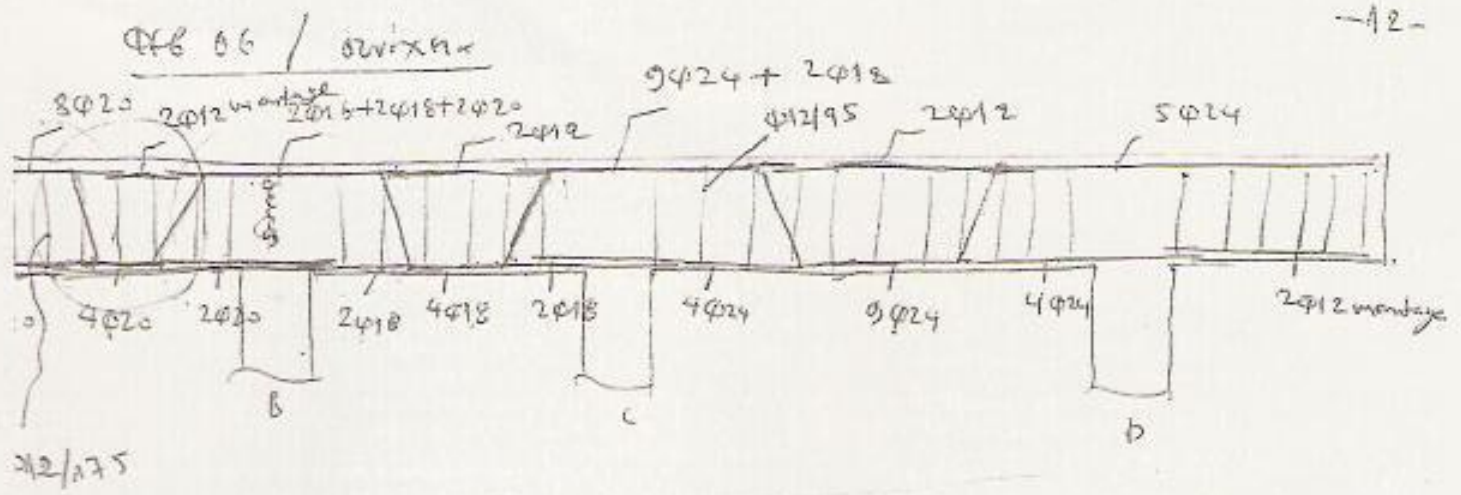


Kötény C

$\Sigma = -773,40 + 343,25 = -429,65$

kezflo B

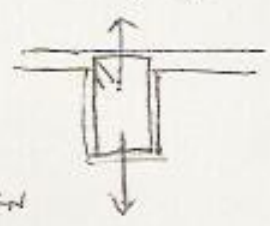
$\Sigma = -495 + 773,40 + 85,93 = 364,33$



Συνολική και υπολειπόμενη με  
 τηρώνται με και με  $V_{sd}$

Πρόσχη Cr

$V_{sd} = 864,0$        $V_{sd}(x=d) = 864,0 - 0,65 \cdot 165 = 756,75 \text{ kN}$



$\tau_{rd} = 0,34 \text{ MPa} = 340 \text{ kPa}$

$k = 1,6 - d = 1,6 - 0,65 = 0,95 \rightarrow k = 1,0$

$\rho = \frac{A_{st, reqd}}{b \cdot d} = \frac{45,81 \text{ cm}^2}{40 \times 65 \text{ cm}} = 0,0176$        $\sigma_{cp} = 0$

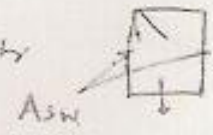
το αποτέλεσμα είναι  
 σπ σπ ανήκω  
 το συμπέρασμα  
 από πριν το

$V_{rd1} = [\tau_{rd} k (1,2 + 4 \rho \sigma_{cp}) + 0,15 \sigma_{cp}] b \cdot d =$   
 $= [340 \cdot 1 \cdot (1,2 + 4 \cdot 0,0176)] \cdot 0,40 \cdot 0,65 = 168,31 \text{ kN}$

$V_{wd} = V_{sd}(x=d) - V_{rd1} = 756,75 - 168,31 = 588,44 \text{ kN}$

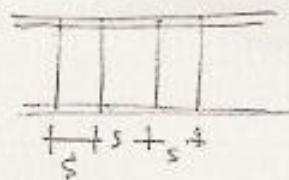
$\min \phi = 8 \text{ mm}$

επιλογή: 8'24+200 συνήθως 88



$A_{sw} = 2 \times 0,5 \text{ cm}^2$   
 είναι 2 οι ανεπτυγες

$$V_{wd} = \frac{A_{sw}}{s} \cdot 0,9 \cdot d \cdot f_{ywd}$$



$$588,49 = \frac{2 \times 0,5 \times 10^{-4}}{s} \cdot 0,9 \cdot 0,65 \cdot 434783 \Rightarrow s = 0,0432 \text{ m} = 4,32 \text{ cm}$$

Min  $s = 7 \text{ cm}$

N<sup>1</sup>2  $f_{m\lambda_{logi}}$  :  $\varnothing 10 (0,79 \text{ cm}^2) \rightarrow s = 0,0683 = 6,83 \text{ cm}$   
 >> >> :  $\varnothing 12 (1,13 \text{ cm}^2) \rightarrow s = 0,098 \text{ m} = 9,8 \text{ cm} = 98 \text{ mm}$

Πέριπτωση σ<sub>yk</sub> 368

$$\frac{1}{5} V_{Rd2} = \frac{1}{5} \cdot 1287 = 257,40 \text{ kW}$$

$$\frac{2}{3} V_{Rd2} = \frac{2}{3} \cdot 858,00 = 572,00$$

~~σ<sub>yk</sub>~~  $V_{sd} = 864 > \frac{2}{3} V_{Rd2} \Rightarrow s_{max} = 0,3d = 0,3 \cdot 650 = 195 \text{ mm}$   
 200 mm

→  $\varnothing 12 / 95$  (στρογγυλά προς τα κάτω - πιο μικροί!)

Άφιξη Ar

$V_{sd} = 570,39$   $V_{sd}(x=d) = 570,39 - 165 \cdot 0,65 = 463,14 \text{ kW}$

$$\rho_l = \frac{A_{sl}}{b_w d} = \frac{25,13 \text{ cm}^2}{40 \cdot 65 \text{ cm}} = 0,009665$$

$$V_{Rd1} = [2 \cdot \rho_l \cdot k \cdot (1,2 + 40 \cdot \rho_l) + 0,15 \cdot \sigma_{cp}] \cdot b_w \cdot d =$$

$$= [340 \cdot 1 \cdot (1,2 + 40 \cdot 0,009665)] \cdot 0,40 \cdot 0,65 = 140,26 \text{ kW}$$

$V_{wd} = V_{sd}(x=d) - V_{Rd1} = 463,14 - 140,26 = 322,88 \text{ kW}$   $\sigma_{yk} \rightarrow \varnothing 12$

$$V_{wd} = \frac{A_{sw}}{s} \cdot 0,9 \cdot d \cdot f_{ywd} \Rightarrow 322,88 = \frac{2 \times 1,13 \times 10^{-4}}{s} \cdot 0,9 \cdot 0,65 \cdot 434783 \Rightarrow$$

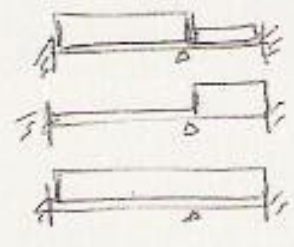
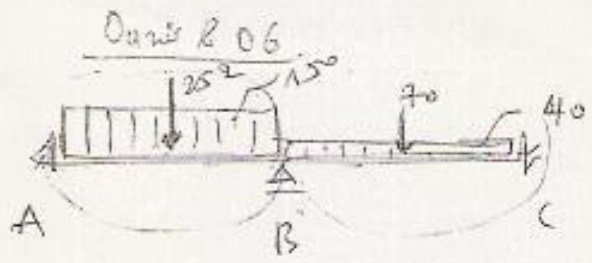
$s = 0,178 \text{ m} = 178 \text{ mm}$

Πέριπτωση σ<sub>yk</sub> 368

$$\frac{1}{5} V_{Rd2} < V_{sd} = 570,39 < 858,0 \Rightarrow s_{max} = 0,6d = 0,6 \cdot 650 = 390 \text{ mm}$$

200 mm

$\varnothing 12 / 175$



$$1.75 q_k + 1.5 q_k = 150$$

$$1.35 \cdot 70 + 1.5 \cdot 105 = 252$$

