13.5

A cm m²	d cm m	Ad² (10⁶ mm)	I (10⁵ m²)
3200	160,5	82,43	0,02
6580	0	0	92,9
3200	160,5	82,43	0,02
		164,86	95,04

$$I = \Sigma Ad^2 + \Sigma I$$
$$= 259 \cdot 10^{-6} \, m^3$$

$$Q = Ad$$
$$= (3200) \cdot (160.5) = 513,6 \cdot 10^{-3} \, m^3$$

$$A = \frac{\pi}{4} d = \frac{\pi}{4} (18 \cdot 10^{-3})^2 =$$
$$= 254,47 \cdot 10^{-6}$$

$$q = \frac{VQ}{I}$$

$$F = \tau \cdot A$$
$$= (90 \cdot 10^6)(254,47 \cdot 10^{-6}) =$$
$$= 22,90 \cdot 10^3 \, N$$

$$\tau = \frac{Iq}{Q}$$
$$= \frac{(259 \cdot 10^6)(381,7 \cdot 10^3)}{513,6 \cdot 10^6}$$

$$I = \sum A d^2 + \sum I$$
$$= 259 \cdot 0^{-6} \, m^3$$

$$Q = A d$$
$$= (3200)(160.5) = 513,6 \cdot 10^{-3} \, m^3$$

$$A = \frac{\pi}{4} d^2 = \frac{\pi}{4}(18 \cdot 10^{-3})^2 =$$
$$= 254,47 \cdot 10^{-6}$$

$$q = \frac{VQ}{I}$$

$$V = \frac{Iq}{Q}$$

$$F = \tau \cdot A$$
$$= (90 \cdot 10^6)(254,47 \cdot 10^{-6}) =$$
$$= (259 \cdot 10^6)(381,7 \cdot 10^3)$$
$$= 22,90 \cdot 10^3 \, N$$
$$\overline{513,6 \cdot 10^6}$$

$$q s = 2 \cdot F$$
$$\boxed{= 193,2 \, kN}$$
$$q = \frac{2F}{s}$$

$$= \frac{2 \cdot (22,90 \cdot 10^3)}{120 \cdot 10^{-3}}$$

$$= 381,7 \cdot 10^3$$

$$I = I_1 + 4I_2$$

$$= \frac{1}{12} b h^3 + 4 \left[\frac{1}{12} b h^3 + A d^2 \right]$$

$$= \frac{1}{12} (100)(150)^3 + 4 \left[\frac{1}{12} (50)(12)^3 + (50)(12)(69)^2 \right]$$

$$= 28.125 + 4 \left[0.0072 \cdot 10^6 + 2.8566 \cdot 10^6 \right]$$

$$= 39.58 \cdot 10^{-6} \, m^4$$

a) $Q = A_1 y + 2A x$

$$= (100)(75)(37.5) + (2)(50)(12)(69)$$

$$= 364.05 \cdot 10^{-6} \, m^3$$

$t = 0.100 \, m$

$$\tau_{max} = \frac{VQ}{It} = \frac{(50 \cdot 10^3)(364.05 \cdot 10^{-6})}{(39.58 \cdot 10^{-6})(0.100)}$$

a) $Q = A \cdot y + 2AX$

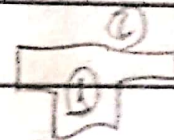$\qquad = (900)(75)(37,5) + (2)(50)(\sqrt{2})(69)$

$\qquad = 364,05 \cdot 10^{-6} \, m^3$

$t = 0,100 \, m$

$\tau_{max} = \dfrac{VQ}{It} = \dfrac{(10 \cdot 10^3)(364,05 \cdot 10^{-6})}{(39,58 \cdot 10^{-6})(0,100)}$

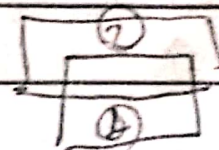$\boxed{= 920 \cdot 10^3 \, P_0}$

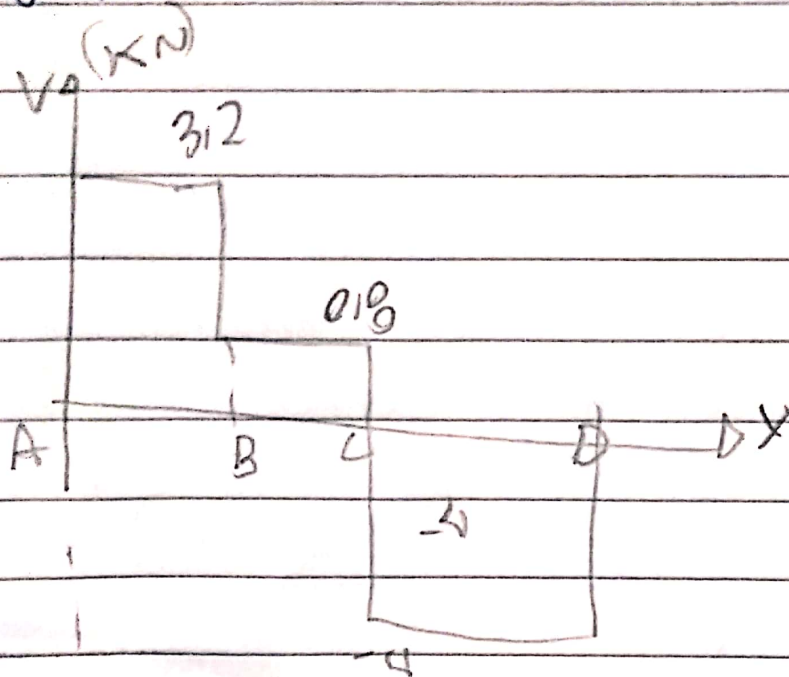b) $Q = A \, y + 2Ay$

$\qquad = (500)(40)(55) + 2(50)(\sqrt{2})(69)$

$\qquad = 302,8 \cdot 10^{2-6} \, m^3$

$t = 0,050 \, m$

$\tau = \dfrac{VQ}{It} \Rightarrow \dfrac{(10 \cdot 10^3)(302,8 \cdot 10^{-5})}{(39,58 \cdot 10^{-6})(0,100)} \boxed{= 765 \cdot 10^3 \, P_0}$
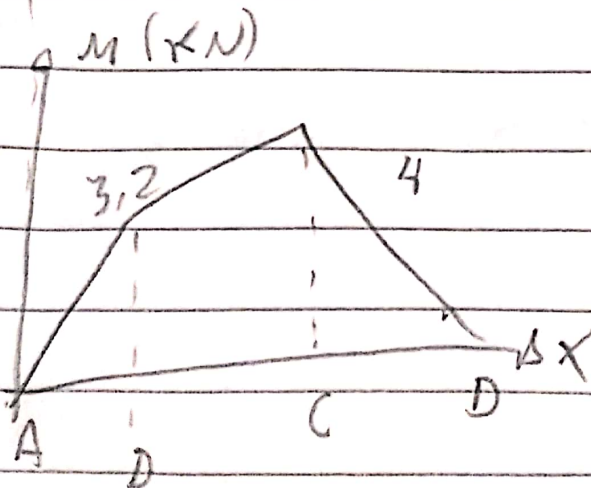
13.14

V_A (KN)

3,2

0,8

A   B   C   D   → X

$\sum M_D = 0$

$-3 R_A + 2 \cdot 2,4 + 1 \cdot 1,8 =$

$R_A = 3.200 \, N$

$V_{max} = 4000 \, N$

$M_{max} = 4000 \, N$

M (KN)

3,2   4

A   D   C   D   → X

$S = \dfrac{|M|_{max}}{J} = \dfrac{4000}{12,106}$

$S = 333,30 \cdot 6^3 \, m^3$

$S = \dfrac{I}{C} = \dfrac{1}{12} \, b \cdot g^3 = \dfrac{1}{6} b \cdot g^2$

$$S = \frac{M_{lones}}{J} = \frac{4000}{12 \cdot 10^6}$$
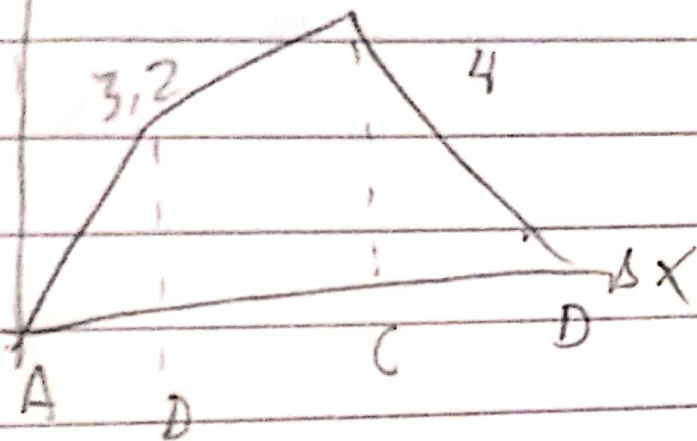
$$S = 333,30 \cdot 10^{3} m^{3}$$

$$S = \frac{I}{C} = \frac{\frac{1}{12} b h^{3}}{\frac{1}{2} h} = \frac{1}{6} b h^{2}$$

$$b = \frac{6S}{a,2} = \frac{6 \cdot 3,33 \cdot 10^{3}}{330^{2}} = 88,9 \, N$$

$$A = \frac{1}{2} b h \quad e \quad x = \frac{1}{4} a$$

$$Q = A\bar{y} = \frac{1}{6} b h^{3} \quad e \quad I = \frac{1}{12} b h^{3}$$

$$\tau = \frac{V \cdot Q}{I \cdot t} = \frac{3V}{2bh}$$

$$bh = \frac{3}{2} \frac{V}{\tau} = \boxed{\frac{3V}{2\tau}}$$

$$= \frac{3}{2} \frac{1770}{825 \cdot 10^3}$$

$$= \boxed{3,2727 \cdot 10^3 \quad mm^2}$$

$$b = \frac{bh}{h} = \frac{3,2727 \cdot 10^3}{150} = \boxed{18,5 \; mm}$$

menor

valor de B é
88.7

14.17

	A_{mm}	Y	AY	d_{mm}	$Ad^2 \cdot 10^6$	I_{b^6}
I	11250	125	1406,25	50	28,125	21,094
II	11250	15	281,25	50	28,125	21,09
	22500					

$$\bar{Y} = \frac{1687 \cdot 10^3}{22500} = 29,688 \cdot 10^6 \, m^4$$

a) $Q = A\bar{Y}$
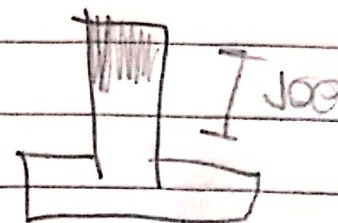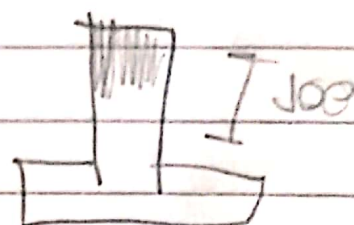
$= (75)(50)(200)$

$= 375 \cdot 10^{-6} \, m^4$

$t = 75 \cdot 10^{-3}$

$\tau = \frac{VQ}{It} = \frac{200 \cdot 10^3}{79,768 \cdot 10^6} \left(\frac{375 \cdot 10^6}{75 \cdot 10^3} \right)$

①	11250	125	1406,25	50	28,125
⊞	11250	15	281,25	50	28,125
	22500				

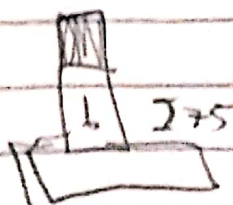$$\bar{y} = \frac{1687 \cdot 10^3}{22500} = 79,688 \cdot 10^6 \ m^4$$

a) $Q = A\bar{y}$

$$= (75)(50)(200)$$
$$= 375 \cdot 10^{-6} \ m^4$$

$t = 75 \cdot 10^{-3}$

$$\tau = \frac{VQ}{It} = \frac{200 \cdot 10^3}{79,768 \cdot 10^6} \left(\frac{375 \cdot 10^6}{75 \cdot 10^3} \right)$$

$$= 12,55 \cdot 10^6 \ Pa$$

①   375

$t = 75 \cdot 10^{-3} \ m$

$Q_b = A\bar{y}$
$$= 75 \cdot 100 \cdot 75$$
$$= 562,5 \cdot 10^{-6} \ m^3$$

$$\tau = \frac{VQ}{Id} = \frac{2000 \cdot 10^3}{(79,688 \cdot 10^6)(75 \cdot 10^6)} \cdot 562,5 \cdot 10^{-6}$$

$$\boxed{\tau = 18,82 \cdot 10^6 \ Pa}$$