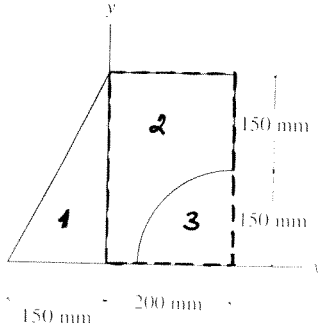
SOLUTIONS TO ASSIGNMENT

1. Select a system of co-ordinate axes such as the ones shown in the figures.

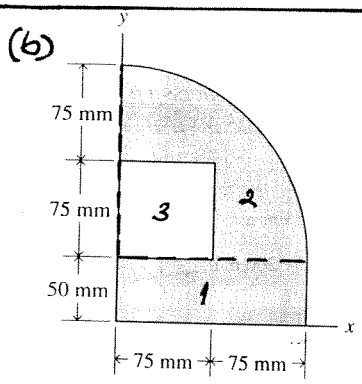
(a)



No.	Area	$\bar{x}_i$	$\bar{y}_i$	$\bar{x}_i A_i$	$\bar{y}_i A_i$
1	22,500	−50	100	−1,125,000	2,250,000
2	60,000	100	150	6,000,000	9,000,000
3	−17,671.5	136.34	63.66	−2,409,332	−1,124,968
TOTAL	64,828.5 mm²			2,465,668	10,125,032

$$\therefore \bar{X} = \frac{2,465,668}{64,828.5} = \underline{38.0 \text{ mm}}; \quad \bar{Y} = \frac{10,125,032}{64,828.5} = \underline{156.2 \text{ mm}}$$

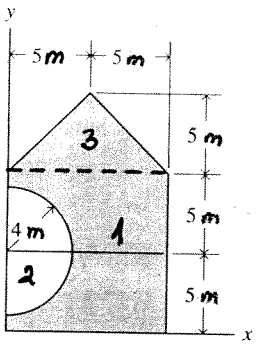
(b)



No.	Area	$\bar{x}_i$	$\bar{y}_i$	$\bar{x}_i A_i$	$\bar{y}_i A_i$
1	7,500	75	25	562,500	187,500
2	17,671.5	63.66	113.66	1,124,968	2,008,543
3	−5,625	37.5	87.5	−210,938	−492,188
TOTAL	19,546.5 mm²			1,476,530	1,703,855

$$\therefore \bar{X} = \frac{1,476,530}{19,546.5} = \underline{75.5 \text{ mm}}; \quad \bar{Y} = \frac{1,703,855}{19,546.5} = \underline{87.2 \text{ mm}}.$$

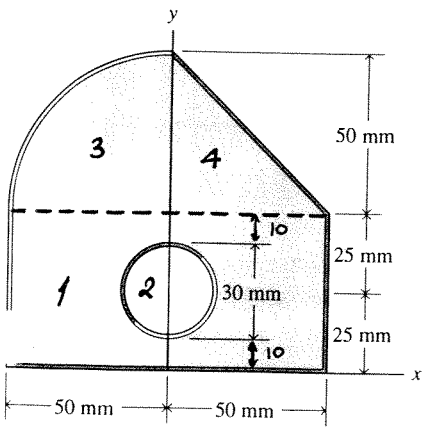
(c)



No.	Area	$\bar{x}_i$	$\bar{y}_i$	$\bar{x}_i A_i$	$\bar{y}_i A_i$
1	100	5	5	500	500
2	−25.13	1.6977	5	−42.66	−125.65
3	25	5	11.667	125	291.68
TOTAL	99.87 m²			582.34	666.03

$$\therefore \bar{X} = \frac{582.34}{99.87} = \underline{5.83 \text{ m}}; \quad \bar{Y} = \frac{666.03}{99.87} = \underline{6.67 \text{ m}}$$

(d)



No.	Area	$\bar{x}_i$	$\bar{y}_i$	$\bar{x}_i A_i$	$\bar{y}_i A_i$
1	5,000	0	25	0	125,000
2	−706.9	0	25	0	−17,672.5
3	1,963.5	−21.22	71.22	−41,665.5	139,840.5
4	1,250	16.667	66.667	20,833.8	83,333.8
TOTAL	7,506.6 mm²			−20,831.7	330,501.8

$$\therefore \bar{X} = \frac{-20,831.7}{7,506.6} = \underline{-2.78 \text{ mm}}; \quad \bar{Y} = \frac{330,501.8}{7,506.6} = \underline{44.0 \text{ mm}}$$

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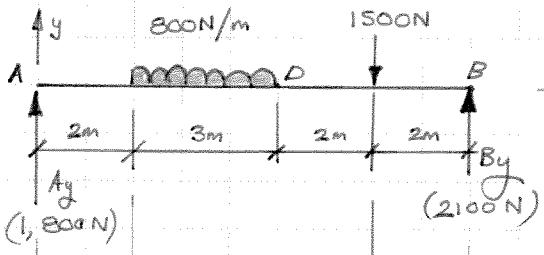
2.

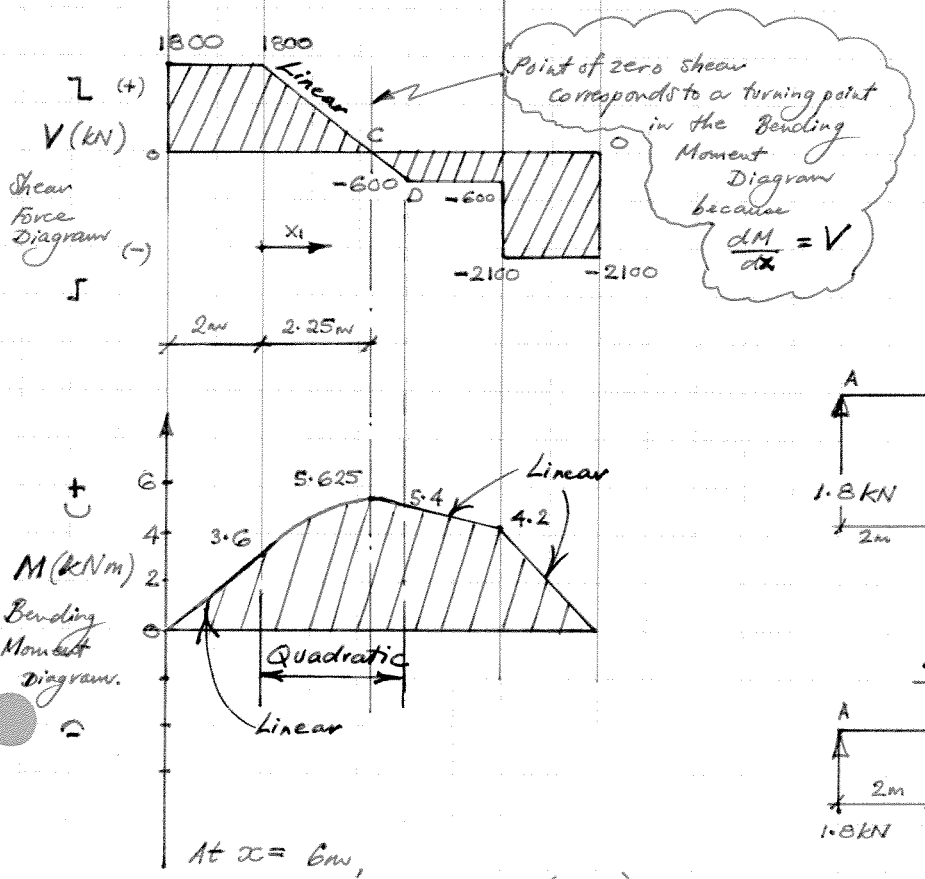


$\Sigma M_A = 0 \Rightarrow$

$(2400)(3.5) + (1500)(7) - 9B_y = 0$

$\therefore B_y = 2,100\ N$

$\Sigma F_y = 0 \quad \therefore A_y = 1,800\ N$

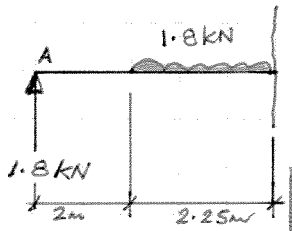


Slope of inclined V line = 800 N/m

$\therefore 1800 - 800(x_1) = 0$

$\therefore x_1 = 2.25\ m.$

• FBD from A to C:—

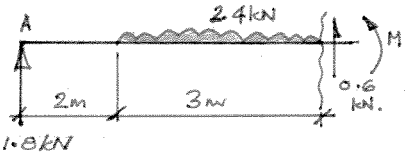


$(1.8)(3.125) = M$

$\therefore M = 5.625\ kNm$

$\therefore M_{max.} = 5.625\ kNm$

• FBD from A to D:—



$(2.4)(3.5) - (0.6)(5) - M = 0$

$\therefore M_D = 5.4\ kNm.$

At $x = 6m$,

Shear Force $(V) = -600\ kN$ (⌟)

Moment $(M) = \frac{5.4+4.2}{2} = +4.8\ kNm$ (⌣)

$M_{max.}$ in beam $= 5.625\ kNm = 5.625 \times 10^6\ Nmm$

$\sigma_{allowable} = 200\ N/mm^2 \quad \therefore S_{required} = \frac{M_{max}}{\sigma_{allowable}} = 28.1 \times 10^3\ mm^3.$

$\therefore$ From Section Property Tables,

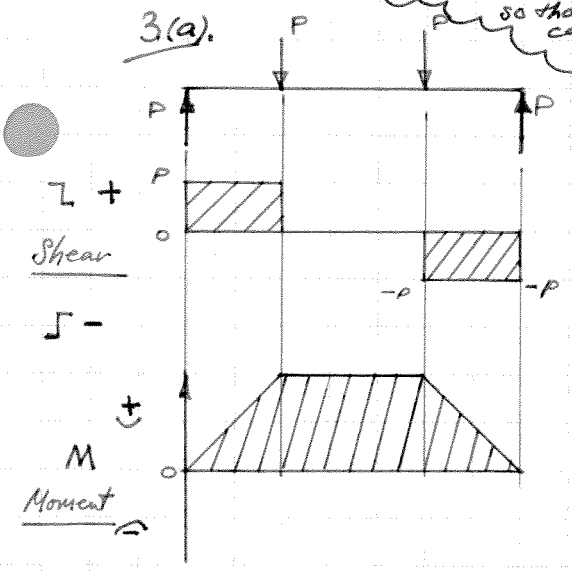
Select either HSS102 x 51 x 4.8 (S_x $31.8 \times 10^3\ mm^3$, Mass = 10.3 kg/m)

or HSS89 x 64 x 4.8 ($S_x = 30.6 \times 10^3\ mm^3$, Mass = 10.3 kg/m).

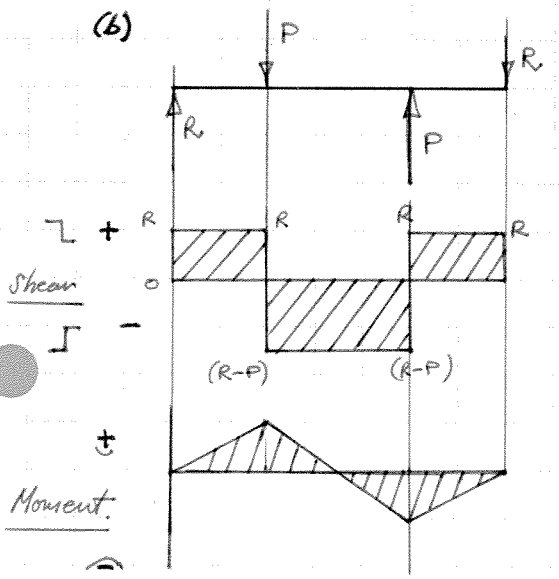
because they have the same mass per metre, hence probably the same cost.

First find suitable reactions so that the beam can be in equilibrium

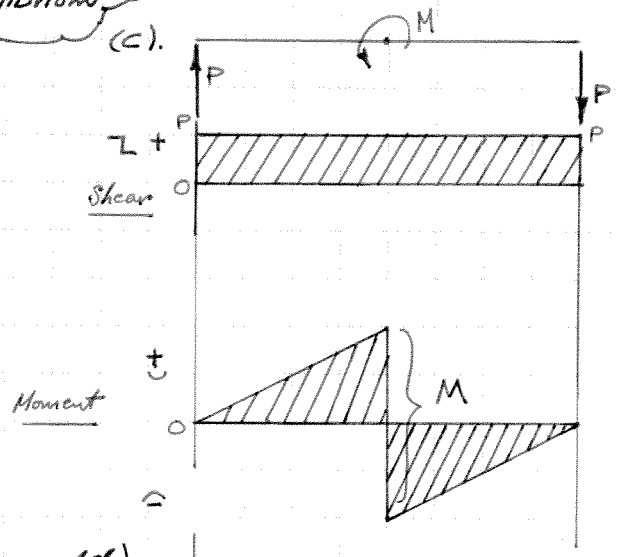
3(a).



(b)



(c).



(d).