

## Chap. 5

$$11. A_1 = \frac{2}{3} \cdot 75 \cdot (60+60) = 6000 \text{ mm}^2 \quad A_2 = \frac{1}{2} \cdot 75 \cdot 60 = 2250 \text{ mm}^2$$

$$A = A_1 - A_2 = 3750 \text{ mm}^2$$

$$\bar{x}_1 = \frac{3}{8}a = \frac{3}{8} \times 75 = 28.125 \text{ mm} \quad \bar{x}_2 = \frac{1}{3}a = \frac{1}{3} \times 75 = 25 \text{ mm}$$

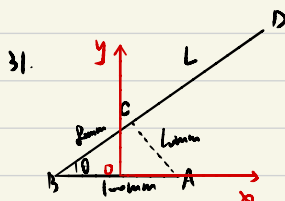
$$y_1 = \frac{2}{5}h = \frac{2}{5} \times 120 = 48 \text{ mm} \quad y_2 = \frac{1}{3}b = \frac{1}{3} \times 60 = 20 \text{ mm}$$

$$\bar{x} = \frac{28.125 \times 6000 - 25 \times 2250}{3750} = 30.0 \text{ mm}$$

$$\bar{y} = \frac{48 \cdot 6000 - 20 \cdot 2250}{3750} = 64.8 \text{ mm}$$

$$\bar{x} = \frac{\sum L\bar{x}}{\sum L} = \frac{-320}{227.3805} = -1.407 \text{ in}$$

$$\bar{y} = \frac{\sum L\bar{y}}{\sum L} = \frac{3464}{227.3805} = 215.234 \text{ in}$$



$$AB: \bar{x}_1 = 80 \times \frac{4}{5} - 50 = 14$$

$$BC: \bar{x}_2 = \frac{1}{2} \times 80 \times \frac{4}{5} = 32$$

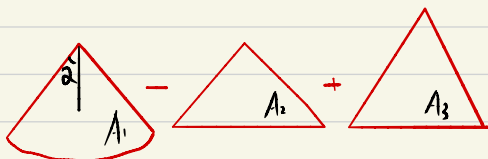
$$CD: \bar{x}_3 = \frac{1}{2} L \times \frac{4}{5} = \frac{2}{5} L$$

$$1400 + 2560 - \frac{2}{5} L^2 = 0$$

$$\Rightarrow L^2 = 3960 \times \frac{5}{2}$$

$$\Rightarrow L = 99.4987 \text{ mm}$$

15.



$$A_1 = \pi r^2 \cdot \frac{2}{3} = 84.853^2 \pi \cdot \frac{2}{360} = 5654.892 \text{ mm}^2$$

$$A_2 = \frac{1}{2} \times 120 \times 60 = 3600 \text{ mm}^2$$

$$A_3 = \frac{1}{2} \times 120 \times 90 = 5400 \text{ mm}^2$$

$$y_1 = 60 - \frac{15 \sin 2}{32} = 60 - \frac{2 \times 84.853 \times \sin \frac{\pi}{6}}{\frac{3}{360}} = 1232 \text{ mm}$$

$$y_2 = \frac{1}{3} \times 60 = 20 \text{ mm} \quad y_3 = \frac{1}{3} \times 90 = 30 \text{ mm}$$

$$\bar{y} = \frac{1232 \times 5654.892 - 20 \times 3600 + 30 \times 5400}{7454.892} = 19.076 \text{ mm}$$

$$23. (a) Q_x = \frac{1}{2} (c+y) \times b (c-y)$$

$$= \frac{1}{2} b (c^2 - y^2)$$

$$(b) Q_{x_{max}} = \frac{1}{2} b c^2 \text{ when } y=0$$

$$27. \begin{array}{c} L \quad \bar{x} \quad \bar{y} \quad L\bar{x} \quad L\bar{y} \\ 1 \quad \pi r^2 = 119.3805 \quad 0 \quad \frac{24}{\pi} = 7.64 \text{ mm} \quad 0 \quad 2887.9934 \end{array}$$

$$2 \quad 38 \quad 19 \quad 0 \quad 722 \quad 0$$

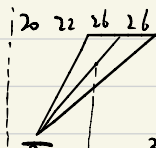
$$3 \quad 18 \quad -29 \quad 0 \quad -522 \quad 0$$

$$4 \quad 16 \quad 0 \quad 8 \quad 0 \quad 128$$

$$5 \quad 20 \quad -10 \quad 16 \quad -200 \quad 320$$

$$6 \quad 16 \quad -20 \quad 8 \quad -320 \quad 120$$

61.



$$\bar{x}_0 = 20 + \frac{2}{3} (22 + 26) = 52 \text{ mm}$$

$$A_1 = \frac{1}{2} (2 \times 26 \times 60) = 1560 \text{ mm}^2$$

$$V = \pi \bar{x}_0 A_1 = 254845.9961 \text{ mm}^3$$

$$A_2 = \pi \bar{r}^2 L + \bar{x}_2 L_2 + \bar{y}_2 L_3$$

$$A = A_1 + A_2 = 37512.1520 \text{ mm}^2 = \pi [314.159 \times 11.2 + 68 \times 52 + 57 \times 11.2 \pi]$$

$$69. W_1 = \frac{1}{2} \times 12 \times 50 = 300 \text{ lb} \quad \bar{y}_1 = \frac{2}{3}h = \frac{2}{3} \times 12 = 8 \text{ in}$$

$$W_2 = 20 \times 50 = 1000 \text{ lb} \quad \bar{y}_2 = 12 + \frac{1}{2} \times 12 = 22 \text{ in}$$

$$\therefore \sum F_y = 0$$

$$\therefore A + B - W_1 - W_2 = 0$$

$$\Rightarrow A = W_1 + W_2 - B = 1000 + 300 - 400 = 900 \text{ lb}$$

$$\therefore \sum M_A = 0$$

$$\therefore -8W_1 - 22W_2 + 38B - M_A = 0$$

$$\Rightarrow M_A = 38 \times 400 - 8 \times 900 - 22 \times 1000 = -9200 \text{ lb-in}$$

105.

V

$\bar{x}$

$\bar{x}V$

$$1 \quad 12 \times 100 \times 10 = 12000$$

$$5$$

$$600 \times 10^3$$

$$2 \quad 12 \times 50 \times 10 = 6000$$

$$35$$

$$2100 \times 10^3$$

$$3 \quad \frac{\pi}{2} \times 60^2 \times 10 = 56548.668$$

$$85.5$$

$$4834811.084$$

$$4 \quad \pi \times 40^2 \times 10 = 50265.4825$$

$$60$$

$$3015988.947$$

$$5 \quad -7000^2 \times 10 = -280743333$$

$$5$$

$$-141371.6684$$

$$\Sigma \quad 258539.8176$$

$$10409468.37$$

$$\bar{x} = \frac{\Sigma \bar{x}V}{\Sigma V} = 40.2625 \text{ mm}$$

102.

$$\text{body 1: } \bar{y}_1 = 1.5 - \frac{40}{30} = \frac{1.5 - 40 \times 15}{30} = 0.402 \text{ in}$$

$$V_1 = -\frac{\pi}{2}h = -1.0632 \text{ in}^3$$

$$\bar{y}_1 V_1 = -1.1661 \text{ in}^4$$

$$\text{body 2: } \bar{y}_2 = \frac{1.5}{2} = 0.75 \text{ in}$$

$$V_2 = 1.5 \times 3 \times 25 = 3.375 \text{ in}^3$$

$$\bar{y}_2 V_2 = 2.5313 \text{ in}^4$$

$$\text{body 3: } \bar{y}_3 = -\frac{40}{2} = -0.25 \text{ in}$$

$$V_3 = 5.25 \times 0.5 \times 5 = 7.875 \text{ in}^3$$

$$\bar{y}_3 V_3 = -1.9675 \text{ in}^4$$

$$\text{body 4: } \bar{y}_4 = -\frac{0.5}{2} = -0.25 \text{ in}$$

$$V_4 = \frac{\pi}{2}h = 1.7671 \text{ in}^3$$

$$\bar{y}_4 V_4 = -0.4418 \text{ in}^4$$