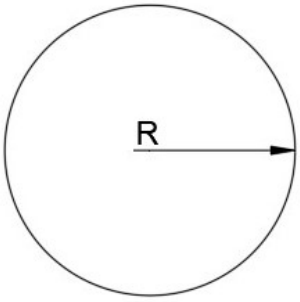
截面形状参数调研

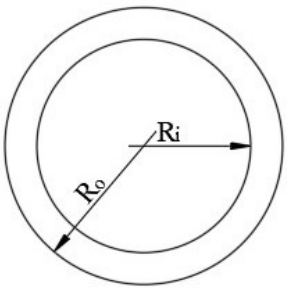
- **备注**
  - **有对称轴形状标"*"**
  - **矩形管和圆管没有计算周长**
  - **极惯性矩均为对形心的极惯性矩**
  - **x轴y轴为通过形心的水平轴与垂直轴**
  - **极惯性矩与两正交轴的惯性矩满足关系$I_\rho = I_x + I_y$**
  - **抗弯截面模量定义为杆件截面对其形心轴的惯性矩与截面上受拉或受压边缘至形心轴距离的比值，对于圆、矩形等一些对称截面，中性轴与两个边缘距离是相等的；对于大多数不具有对称性的截面，是不相等的。对于不具有对称性的截面形状，我们假设上边缘和左边缘都是受拉的，记为W_x^+, W_y^+，下边缘和右边缘都是受压的，记为W_x^-, W_y^-**
- **圆***



  - **面积$S = \pi R^2$**
  - **周长$C = 2\pi R$**
  - **极惯性矩$I_\rho = \frac{\pi R^4}{2}$**
  - **惯性矩$I_x = \frac{\pi R^4}{4}, I_y = \frac{\pi R^4}{4}$**
  - **抗弯截面模量**

$$W_X = \frac{\pi R^4}{2}$$
$$W_Y = \frac{\pi R^4}{2}$$

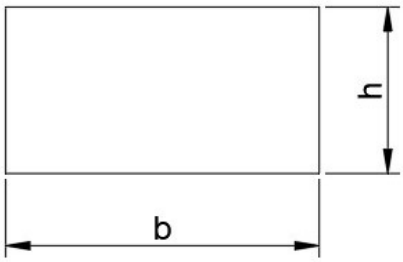
- **圆管***



  - **面积$S = \pi(R_o^2 - R_i^2)$**
    设内外径之比为$\alpha = \frac{R_i}{R_o}$
  - **极惯性矩$I_\rho = \frac{\pi R_o^4}{2}(1 - \alpha^4)$**
  - **惯性矩$I_x = \frac{\pi R_o^4}{4}(1 - \alpha^4), I_y = \frac{\pi R_o^4}{4}(1 - \alpha^4)$**
  - **抗弯截面模量**

$$W_x = \frac{\pi R_o^3}{4}(1 - \alpha^4)$$
$$W_y = \frac{\pi R_o^3}{4}(1 - \alpha^4)$$

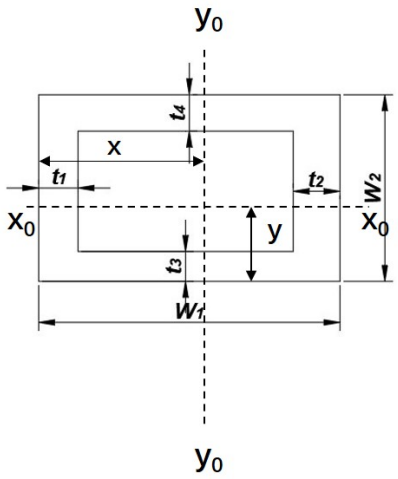
- **矩形***



  - **面积**$S = bh$
  - **周长**$C = 2(b + h)$
  - **极惯性矩**$I_\rho = \frac{bh}{12}(b^2 + h^2)$
  - **惯性矩**$I_x = \frac{bh^3}{12}, I_y = \frac{b^3h}{12}$
  - **抗弯截面模量**

$$W_x = \frac{bh^2}{6}$$
$$W_y = \frac{b^2h}{6}$$

- **矩形管**



  - **面积**$S = W_1(t_3 + t_4) + W_2(t_1 + t_2) - (t_1 + t_2)(t_3 + t_4)$

    令

$$x = \frac{W_1^2W_2 - (W_1 + t_1 - t_2)(W_1 - t_1 - t_2)(W_2 - t_3 - t_4)}{2S}$$
$$y = \frac{W_1W_2^2 - (W_2 + t_3 - t_4)(W_1 - t_1 - t_2)(W_2 - t_3 - t_4)}{2S}$$

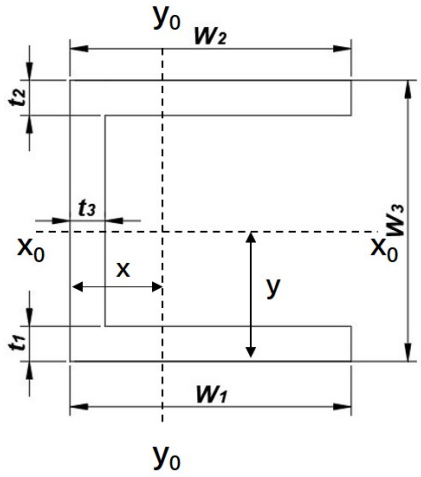
  - **惯性矩**

$$I_X = W_1W_2[\frac{W_2^2}{12} + (\frac{W_2}{2} - y)^2] - (W_1 - t_1 - t_2)(W_2 - t_3 - t_4)[\frac{(W_2 - t_3 - t_4)^2}{12} + (\frac{W_2 + t_3 - t_4}{2} - y)^2]$$
$$I_y = W_1W_2[\frac{W_1^2}{12} + (\frac{W_1}{2} - x)^2] - (W_1 - t_1 - t_2)(W_2 - t_3 - t_4)[\frac{(W_1 - t_1 - t_2)^2}{12} + (\frac{W_1 + t_1 - t_2}{2} - x)^2]$$

  - **抗弯截面模量**

$$W_x^+ = \frac{I_x}{W_2 - y}$$
$$W_x^- = \frac{I_x}{y}$$
$$W_y^+ = \frac{I_y}{x}$$
$$W_y^- = \frac{I_y}{W_1 - x}$$

- **C型**



  - **面积**$S = W_1 t_1 + W_2 t_2 + (W_3 - t_1 - t_2) t_3$
  - **周长**$C = 2(W_1 + W_2 + W_3 - t_3)$

    设

$$y = \frac{t_3 W_3^2 + (W_1 - t_3) t_1^2 + (W_2 - t_3)(2W_3 - t_2) t_2}{2S}$$
$$x = \frac{W_1^2 t_1 + W_3 t_3^2 - t_1 t_3^2 - t_2 t_3^2 + W_2^2 t_2}{2S}$$

  - **惯性矩**

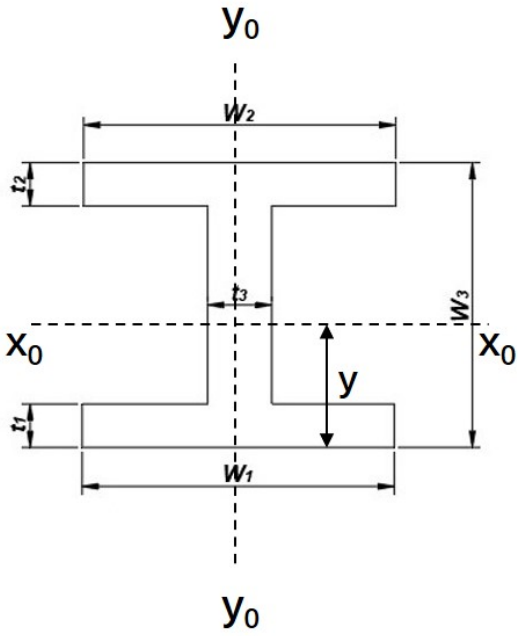
$$I_x = \frac{1}{3}[W_1 y^3 + W_2 (W_3 - y)^3 - (W_1 - t_3)(y - t_1)^3 - (W_2 - t_3)(W_3 - y - t_2)^3]$$
$$I_y = W_1 t_1 [\frac{W_1^2}{12} + (\frac{W_1}{2} - x)^2] + (W_3 - t_1 - t_2) t_3 [\frac{t_3^2}{12} + (\frac{t_3}{2} - x)^2] + W_2 t_2 [\frac{W_2^2}{12} + (\frac{W_2}{2} - x)^2]$$

  - **抗弯截面模量**

$$W_x^+ = \frac{I_x}{W_3 - y}$$
$$W_x^- = \frac{I_x}{y}$$
$$W_y^+ = \frac{I_y}{x}$$
$$W_y^- = \frac{I_y}{W_1 - x}$$

  - **抗扭截面模量**W_p

- **工型*(H型)**



- **面积**$S = W_1t_1 + W_2t_2 + (W_3 - t_1 - t_2)t_3$
- **周长**$C = 2(W_1 + W_2 + W_3 - t_3)$

  设

$$y = \frac{t_3W_3^2 + (W_1 - t_3)t_1^2 + (W_2 - t_3)(2W_3 - t_2)t_2}{2S}$$

- **惯性矩**

$$I_x = \frac{1}{3}[W_1y^3 + W_2(W_3 - y)^3 - (W_1 - t_3)(y - t_1)^3 - (W_2 - t_3)(W_3 - y - t_2)^3]$$

$$I_y = \frac{1}{12}[t_2W_2^3 + t_1W_1^3 + (W_3 - t_1 - t_2)t_3^3]$$

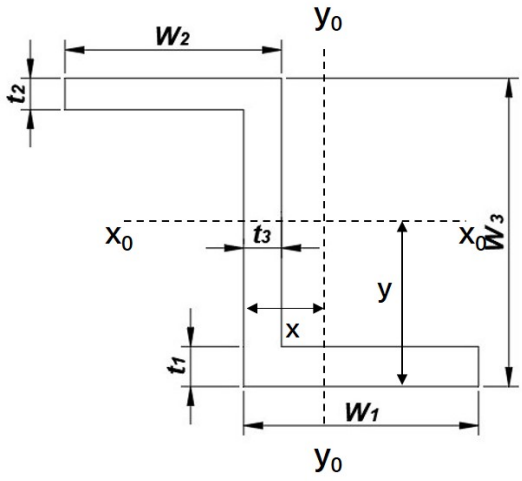
- **抗弯截面模量**

$$W_x^+ = \frac{I_x}{W_3 - y}$$

$$W_x^- = \frac{I_x}{y}$$

$$W_y = \frac{2I_y}{max(W_1, W_2)}$$

- **Z型**



- **面积**$S = W_1t_1 + W_2t_2 + (W_3 - t_1 - t_2)t_3$

- **周长**$C=2(W_1+W_2+W_3)$

  设

$$y=\frac{t_3W_3^2+(W_1-t_3)t_1^2+(W_2-t_3)(2W_3-t_2)t_2}{2S}$$
$$x=\frac{W_1^2t_1+W_3t_3^2-t_1t_3^2-t_2t_3^2+2W_2t_2t_3-W_2^2t_2}{2S}$$

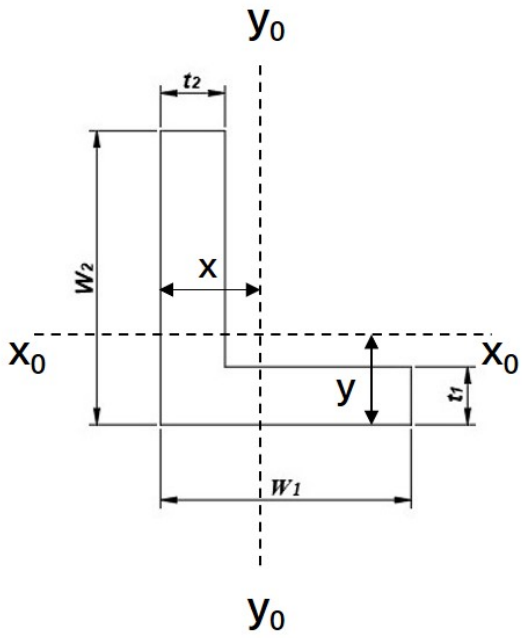
- **惯性矩**

$$I_x=\frac{1}{3}[W_1y^3+W_2(W_3-y)^3-(W_1-t_3)(y-t_1)^3-(W_2-t_3)(W_3-y-t_2)^3]$$
$$I_y=W_1t_1[\frac{W_1^2}{12}+(\frac{W_1}{2}-x)^2]+(W_3-t_1-t_2)t_3[\frac{t_3^2}{12}+(\frac{t_3}{2}-x)^2]+W_2t_2[\frac{W_2^2}{12}+(\frac{W_2}{2}+x-t_3)^2]$$

- **抗弯截面模量**

$$W_x^+=\frac{I_x}{W_3-y}$$
$$W_x^-=\frac{I_x}{y}$$
$$W_y^+=\frac{I_y}{W_2-t_3+x}$$
$$W_y^-=\frac{I_y}{W_1-x}$$

- **L型**



- **面积**$S=W_1t_1+W_2t_2-t_1t_2$
- **周长**$C=2(W_1+W_2)$

  令

$$y=\frac{t_2W_2^2+W_1t_1^2-t_2t_1^2}{2S}$$
$$x=\frac{t_1W_1^2+W_2t_2^2-t_1t_2^2}{2S}$$

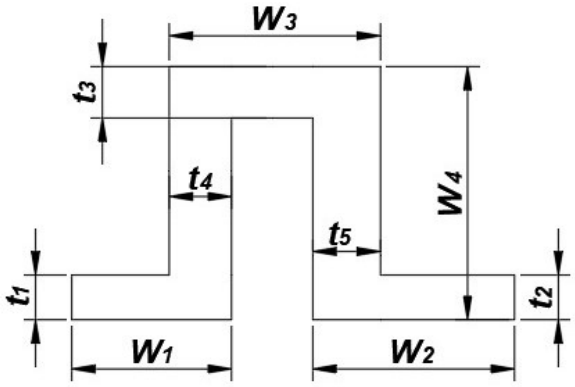
- **惯性矩**

$$I_x=\frac{1}{3}[W_1y^3-(W_1-t_2)(y-t_1)^3+t_2(W_2-y)^3]$$
$$I_y=\frac{1}{3}[W_2x^3-(W_2-t_1)(x-t_2)^3+t_1(W_1-x)^3]$$

- **抗弯截面模量**

$$W_x^+ = \frac{I_x}{W_2 - y}$$
$$W_x^- = \frac{I_x}{y}$$
$$W_y^+ = \frac{I_y}{x}$$
$$W_y^- = \frac{I_y}{W_1 - x}$$

- **帽型**



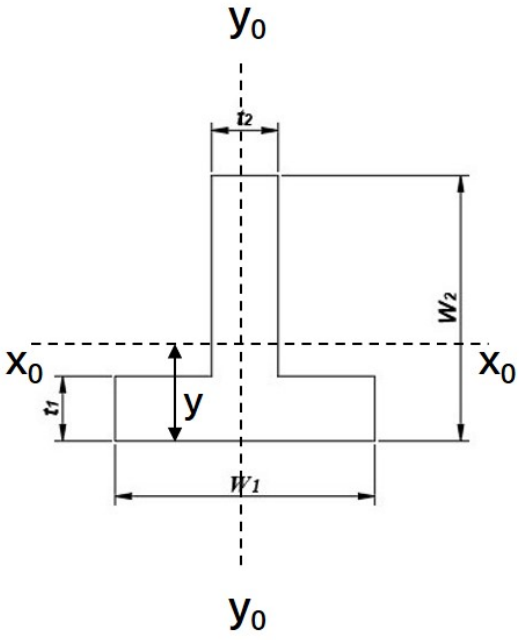
  - **面积**$S = W_1t_1 + W_2t_2 + W_3t_3 + W_4t_4 + W_4t_5 - t_2t_5 - t_3t_5 - t_1t_4 - t_3t_4$
  - **周长**$C = 2(W_1 + W_2 + W_3 + 2W_4 - t_3 - t_4 - t_5)$

    令

$$x =$$
$$y =$$

  - **惯性矩**I_x, I_y
  - **抗弯截面模量**W_x, W_y

- **T型***



  - **面积**$S = W_1t_1 + W_2t_2 - t_1t_2$
  - **周长**$C = 2(W_1 + W_2)$

$$y = \frac{t_2 W_2^2 + t_1^2 (W_1 - t_2)}{2S}$$

- **惯性矩**

$$I_x = \frac{1}{3}[t_2 (W_2 - y)^3 + W_1 y^3 - (W_1 - t_2)(y - t_1)^3]$$

$$I_y = \frac{1}{12}[t_1 W_1^3 + (W_2 - t_1) t_2^3]$$

- **抗弯截面模量**

$$W_x^+ = \frac{I_x}{W_2 - y}$$

$$W_x^- = \frac{I_x}{y}$$

$$W_y = \frac{2 I_y}{W_1}$$