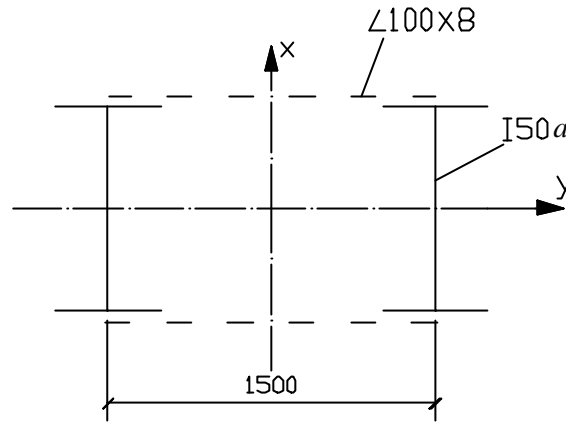


【题目】试验算如图所示一厂房柱的下柱截面。柱的计算长度 $l_{ox} = 19.8\text{m}$, $l_{oy} = 6.6\text{m}$, 最不利内力设计值为 $N = 1700\text{kN}$, $M = \pm 2000\text{kN}\cdot\text{m}$ 。缀条倾角为 45° , 且设有横缀条。钢材 Q235 - A · F。



【解答】

分析：根据已知条件，该厂房下柱弯矩带正、负号且大小相等，说明在荷载作用下柱可能向左或向右弯曲，但因系对称截面，故在验算稳定性时，仅须按一个方向弯曲验算弯矩作用平面内的稳定性即可。在弯矩作用平面外的稳定性由验算分肢平面外的稳定性确定，若分肢的稳定性满足，即可保证。分肢按轴心压杆计算。对工字钢可不验算局部稳定。

1. 截面几何特性

查表得，I50a：

$$A = 119\text{cm}^2, I_{x1} = 1120\text{cm}^4, I_{y1} = 46470\text{cm}^4, i_{x1} = 19.7\text{cm}, i_{y1} = 3.07\text{cm};$$

$$100 \times 8: A = 15.6\text{cm}^2$$

$$I_x = 2(1120 + 119 \times 75^2) = 1341000\text{cm}^4$$

$$I_y = 2 \times 46470 = 92940\text{cm}^4$$

$$i_x = \sqrt{\frac{I_x}{A}} = \sqrt{\frac{1341000}{2 \times 119}} = 75\text{cm}$$

$$i_y = \sqrt{\frac{I_y}{A}} = \sqrt{\frac{92940}{2 \times 119}} = 19.8\text{cm}$$

2. 截面验算

(1) 弯矩作用平面内的稳定性：

$$I_x = l_{ox} / i_x = 1980 / 75 = 26.4$$

$$I_{ox} = \sqrt{I_x^2 + 27 \frac{A}{A_1}} = \sqrt{26.4^2 + 27 \times \frac{2 \times 119}{2 \times 15.6}} = 30 < [I] = 150 \text{ (刚度满足)}$$

查表得, $j_x = 0.936$

$$N_{Ex} = \frac{p^2 EA}{I_{ox}^2} = \frac{p^2 \times 206 \times 10^3 \times 2 \times 119 \times 10^2}{30^2} = 53710000\text{N} = 53710\text{kN}$$

$$W_{1x} = \frac{I_x}{y_o} = \frac{1341000}{75} = 17880\text{cm}^3$$

(注意工字钢截面的 y_o 取值为 x 轴到压力较大分肢轴线的距离)

按有侧移框架柱, 取 $b_{mx} = 1.0$,

$$\begin{aligned} \frac{N}{j_x A} + \frac{b_{mx} M_x}{W_{1x} (1 - j_x \frac{N}{N_{Ex}})} &= \frac{1700 \times 10^3}{0.936 \times 2 \times 119 \times 10^2} + \frac{1.0 \times 2000 \times 10^6}{17880 \times 10^3 (1 - 0.936 \times \frac{1700 \times 10^3}{53710 \times 10^3})} \\ &= 191.6\text{N/mm}^2 < f = 215\text{N/mm}^2 \text{ (满足)} \end{aligned}$$

(2) 分肢的整体稳定性:

分肢承受的轴心压力

$$N_1 = \frac{N}{2} + \frac{M}{a} = \frac{1700}{2} + \frac{2000}{1.5} = 2183\text{kN}$$

$$I_{x1} = \frac{l_{ox}}{i_{x1}} = \frac{150}{3.07} = 48.9 < [I] = 150 \text{ (刚度满足)} \text{ (} l_{o1} \text{取值按缀条倾角为 } 45^\circ \text{, 且在其}$$

间设有横缀条计算)

$$I_{y1} = \frac{l_{oy}}{i_{y1}} = \frac{660}{19.7} = 33.5 < [I] = 150 \text{ (刚度满足)} \text{ (分肢平面外计算长度即柱的平面外}$$

计算长度 l_{oy})

按 $I_{\max} = I_{x1}$, 查表得, $j_{x1} = 0.861$

$$\frac{N_1}{j_{\min} A_1} = \frac{2183 \times 10^3}{0.861 \times 119 \times 10^2} = 213\text{N/mm}^2 < f = 215\text{N/mm}^2 \text{ (满足)}$$