

3.1

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解: (1) 强度:

$$N_R = \gamma_0 (0.29 + 0.54 \frac{d}{D}) \pi t d f$$

由题入球外径为 $220 \text{ mm} \leq 500 \text{ mm}$, 故 $\gamma_0 = 1.0$. $d = 60 \text{ mm}$. $D = 220 \text{ mm}$. $t = 5 \text{ mm} < 16 \text{ mm}$.

$$\Rightarrow f = 305 \text{ N/mm}^2$$

$$\Rightarrow N_R = 1.0 \times (0.29 + 0.54 \times \frac{60}{220}) \times \pi \times 5 \times 60 \times 305 = 125.7 \text{ kN} > N = 110 \text{ kN}$$

稳定性: 空心球外径与壁厚之比为 $\frac{220}{5} = 44 \in [25, 45]$. 外径与主钢管外径之比为 $\frac{220}{60} = 3.667$

满足要求, 取定。

(2) 在管端与入球之间留有一层焊缝予以焊接, 以实现该焊缝与钢管等强. 由于此处更不易焊接, 故按对接焊缝设计.

设该钢管壁厚为 t_c . 由空心球稳定性要求: $\frac{t}{t_c} = 1.5 \sim 2.0$. 即取 $t_c = 3 \text{ mm}$. 由于焊缝一圈, 焊缝厚度不定.

$$\Rightarrow \sigma = \frac{N}{lw t_c} = \frac{110 \times 10^3}{\pi \times 60 \times 3} = 194.52 \text{ N/mm}^2 \leq f_t^w = 305 \text{ N/mm}^2$$

满足要求。

3.2.

解: ①. 杆1: 拉杆. 下弦杆.

强度: $\sigma = \frac{N}{A} = \frac{79 \times 10^3}{308 \times 10^{-2}} = 256.49 \text{ N/mm}^2 > f = 215 \text{ N/mm}^2.$

稳定性: $\lambda = \frac{\mu l}{i_{\min}}$. 查附录3-3. 得 $\mu = 0.9$. $l = 3000 \text{ mm}$. 同时查附录3-4. 得 $[\lambda] = 300$.

$\Rightarrow \lambda = \frac{\mu l}{i_{\min}} = \frac{0.9 \times 3000}{17.3} = 156.07 \leq [\lambda] = 300.$

不满足设计要求.

②. 杆2: 压杆. 上弦杆.

强度: $\sigma = \frac{N}{A} = \frac{60.7 \times 10^3}{452 \times 10^{-2}} = 134.29 \text{ N/mm}^2 \leq f = 215 \text{ N/mm}^2.$

稳定性: 即 $\frac{N}{\varphi A} \leq f$. 查附录3-3. 得 $\mu = 0.9$. 查附录3-4. 得 $[\lambda] = 180$. 且 $\lambda = \frac{\mu l}{i} = \frac{0.9 \times 2267}{2.04} = 88.90 \leq [\lambda] = 180$. 查附录3-4. 得 $\varphi = 0.69$.

$\Rightarrow \frac{N}{\varphi A} = \frac{60.7 \times 10^3}{0.69 \times 452} = 213.50 \text{ N/mm}^2 \leq f = 215 \text{ N/mm}^2.$

满足设计要求.

③. 杆3: 压杆. 竖杆.

强度: $\sigma = \frac{N}{A} = \frac{93.1 \times 10^3}{577 \times 10^{-2}} = 161.35 \text{ N/mm}^2 \leq f = 215 \text{ N/mm}^2.$

稳定性: 同理. $\lambda = \frac{\mu l}{i} = \frac{0.9 \times 212}{2.60} = 73.38 \leq [\lambda] = 180$. 查附录3-4. 得 $\varphi = 0.730$.

$\Rightarrow \frac{N}{\varphi A} = \frac{93.1 \times 10^3}{0.730 \times 577} = 221.03 \text{ N/mm}^2 > f = 215 \text{ N/mm}^2.$

不满足设计要求.