Remarks: See §2.6, pages 34 till 42

Answers:

a. $\Delta\ell_{\text{load}} = 37{,}9 \text{ mm}$

b. $\Delta\ell_{dw} = 4{,}2 \text{ mm}$

c. $\Delta\ell_{\text{total}} = 42{,}1 \text{ mm}$

d. $\sigma_{\max} = 64{,}8 \text{ N/mm}^2$ (At the point of suspension)

Explanation:

$$A = \tfrac{1}{4}\pi d^2 = 28{,}274 \text{ mm}^2;\; EA = 5{,}937\times10^6 \text{ N}$$

a. $$\Delta\ell_{\text{load}} = \frac{N\ell}{EA} = \frac{(1500 \text{ N})(150\times10^3 \text{ mm})}{5{,}937\times10^6 \text{ N}} = 37{,}9 \text{ mm}$$

b. Draw the N-diagram ignoring the effect of the load. As a result of uniform distribution of the steel wire's weight, N varies linearly from $N_{\text{max;dw}}$ at the point of suspension to zero at the bottom.

$$N_{\text{max;dw}} = \ell A\gamma = (150 \text{ m})(28{,}274\times10^{-6} \text{ mm}^2)(78{,}5 \text{ kN/m}^3) =$$
$$= 332{,}93\times10^{-3} \text{ kN}$$

Continuation b:

$$\Delta\ell_{dw} = \int_0^{150\text{ m}} \frac{N}{EA}\text{d}x = \frac{1}{EA}\int_0^{150\text{ m}} N\text{d}x = \frac{\text{Area under } N\text{-diagram}}{EA}$$

$$\Delta\ell_{dw} = \frac{\tfrac{1}{2}(150 \text{ m})(332{,}93 \text{ N})}{5{,}937\times10^6 \text{ N}} = 4{,}2\times10^{-3} \text{ m}$$

c. $$\Delta\ell_{\text{total}} = \Delta\ell_{\text{load}} + \Delta\ell_{dw} = 42{,}1 \text{ mm}$$

d. $$N_{\max} = (1500 \text{ N}) + (332{,}93 \text{ N}) = 1832{,}93 \text{ N}$$

$$\sigma_{\max} = \frac{1832{,}93 \text{ N}}{28{,}274 \text{ mm}^2} = 64{,}8 \text{ N/mm}^2$$