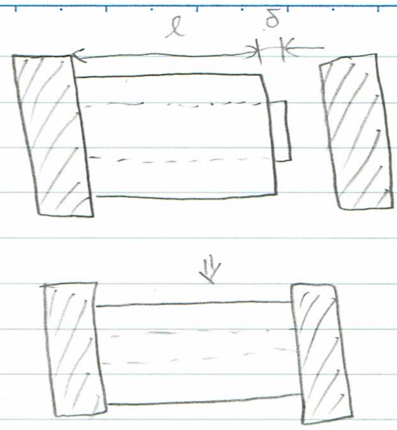
H30 材力



[1] (1)

$$Q_1 + Q_2 = 0$$

(2) $\delta_1 = \delta_2 + \delta$

(3) まず

$$\delta_1 = \varepsilon_1 l = \frac{\sigma_1 l}{E_1} = \frac{Q_1 l}{A_1 E_1}$$

$$\delta_2 = \varepsilon_2 l = \frac{\sigma_2 l}{E_2} = \frac{Q_2 l}{A_2 E_2}$$

(2) より

$$\frac{Q_1 l}{A_1 E_1} = \frac{Q_2 l}{A_2 E_2} + \delta$$

$$\frac{Q_1}{A_1 E_1} + \frac{Q_1}{A_2 E_2} = \frac{\delta}{l}$$

$$Q_1 = \frac{A_1 E_1 A_2 E_2}{A_1 E_1 + A_2 E_2} \cdot \frac{\delta}{l}$$

$$Q_2 = -\frac{A_1 E_1 A_2 E_2}{A_1 E_1 + A_2 E_2} \cdot \frac{\delta}{l}$$

よって

$$\sigma_1 = \frac{Q_1}{A_1} = \frac{A_2 E_1 E_2}{A_1 E_1 + A_2 E_2} \cdot \frac{\delta}{l}$$

$$\sigma_2 = \frac{Q_2}{A_2} = -\frac{A_1 E_1 E_2}{A_1 E_1 + A_2 E_2} \cdot \frac{\delta}{l}$$

(4) $A_1 = 2A_2$, $E_1 = 2E_2$ のとき

$$\sigma_1 = \frac{2 A_2 E_2^2}{5 A_2 E_2} \frac{\delta}{l}, \quad \sigma_2 = -\frac{4 A_2 E_2^2}{5 A_2 E_2} \cdot \frac{\delta}{l}$$

よって $\left|\frac{\sigma_1}{\sigma_2}\right| = \frac{1}{2}$

(5) $P = -\alpha A E \Delta T$ より

$$Q_1 = -\alpha_1 A_1 E_1 \Delta T, \quad Q_2 = -\alpha_2 A_2 E_2 \Delta T$$

よって

$$\sigma_1 = -\alpha_1 E_1 \Delta T, \quad \sigma_2 = -\alpha_2 E_2 \Delta T$$

$$\delta_1 = -\alpha_1 \Delta T l, \quad \delta_2 = -\alpha_2 \Delta T l$$

(2) より

$$(\alpha_2 - \alpha_1)\Delta T = \frac{\delta}{l}$$

$$\Delta T = \frac{\delta}{l(\alpha_2 - \alpha_1)}$$

No.

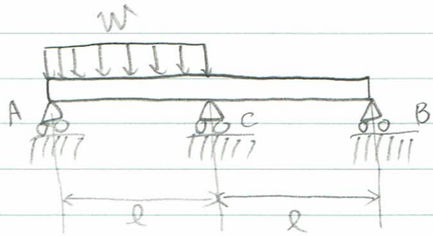
Date

[2] (1) 力のつり合いより

$$wl - R_A - R_C - R_B = 0 \quad -①$$

A点まわりのモーメントのつり合いより

$$\frac{wl^2}{2} - R_C l - R_B \cdot 2l = 0 \quad -②$$



①, ② より

$$\frac{wl^2}{2} - R_C l - 2l(wl - R_A - R_C) = 0$$

$$2lR_A + R_C l - \frac{3}{2}wl^2 = 0$$

$$R_A = \frac{3}{4}wl - \frac{1}{2}R_C$$

(2) (i) $0 \leqq x < l$ のとき

力のつり合いより

$$-R_A + wx - F = 0 \qquad \therefore F = wx - R_A$$

仮想断面まわりにおけるモーメントのつり合いより

$$M + \frac{wx^2}{2} - R_A x = 0$$

$$\therefore M = \left(\frac{3}{4}wl - \frac{1}{2}R_C\right)x - \frac{wx^2}{2}$$

(ii) $l \leqq x \leqq 2l$ のとき

力のつり合いより

$$-R_A - R_C - F + wl = 0 \qquad \therefore F = wl - R_A - R_C$$

仮想断面まわりのモーメントのつり合いより

$$M - R_A x - R_C(x - l) + wl\left(x - \frac{l}{2}\right) = 0$$

$$M = \left(\frac{3}{4}wl - \frac{1}{2}R_C\right)x + R_C(x - l) - wl\left(x - \frac{l}{2}\right)$$

$$= \left(\frac{1}{2}R_C - \frac{1}{4}wl\right)x + \frac{wl^2}{2} - R_C l$$

(3) i)

$$\frac{dy^2}{dx} = -\frac{1}{EI}\left\{\left(\frac{3}{4}wl - \frac{1}{2}R_C\right)x - \frac{wx^2}{2}\right\}$$

$$\frac{dy}{dx} = -\frac{1}{EI}\left\{\frac{1}{2}\left(\frac{3}{4}wl - \frac{1}{2}R_C\right)x^2 - \frac{wx^3}{6}\right\} + C_1$$

$$y = -\frac{1}{EI}\left\{\frac{1}{6}\left(\frac{3}{4}wl - \frac{1}{2}R_C\right)x^3 - \frac{wx^4}{24}\right\} + C_1 x + C_2$$

ここで $x = 0$ のとき $\frac{dy}{dx} = 0$, $y = 0$ なので $C_1 = 0$, $C_2 = 0$

$$\frac{dy^2}{dx} = -\frac{1}{EI}\left\{\left(\frac{1}{2}R_C - \frac{1}{4}wl\right)x + \frac{wl^2}{2} - R_C l\right\}$$

$$\frac{dy}{dx} = -\frac{1}{EI}\left\{\frac{1}{2}\left(\frac{1}{2}R_C - \frac{1}{4}wl\right)x^2 + \left(\frac{wl^2}{2} - R_C l\right)x\right\} + C_1$$

$$y = -\frac{1}{EI}\left\{\frac{1}{6}\left(\frac{1}{2}R_C - \frac{1}{4}wl\right)x^3 + \frac{1}{2}\left(\frac{wl^2}{2} - R_C l\right)x^2\right\} + C_1 x + C_2$$

ここで $x=0$ のとき $C_1 = 0$, $C_2 = 0$, $x = l$ のとき $y = 0$ より

$$0 = \frac{R_C l^3}{12} - \frac{wl^4}{24} + \frac{wl^4}{4} - \frac{R_C l^3}{2}$$

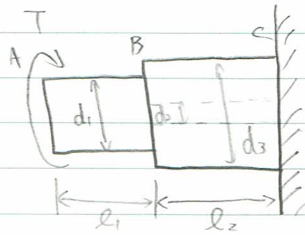
$$R_C = -\frac{wl}{2}$$

No.

Date . .

[3] (1) $\theta_1 = \dfrac{T l_1}{G_1 I_p}$

$= \dfrac{32 T l_1}{G_1 \pi d_1^4}$



(2) 組合せ軸であるため ねじれ角 θ_2 と θ_3 は等しい

また $\theta_2 = \dfrac{T_2 l_2}{G_2 I_p} = \dfrac{32 T_2 l_2}{G_2 \pi d_2^4}$

$\theta_3 = \dfrac{T_3 l_2}{G_3 I_p} = \dfrac{32 T_3 l_2}{G_3 \pi (d_3^4 - d_2^4)}$

よって $\theta_2 = \theta_3$ より

$\dfrac{32 T_2 l_2}{G_2 \pi d_2^4} = \dfrac{32 T_3 l_2}{G_3 \pi (d_3^4 - d_2^4)}$

$\dfrac{T_2}{T_3} = \dfrac{G_2 d_2^4}{G_3 (d_3^4 - d_2^4)}$

(3) $T - T_2 - T_3 = 0$

$T = T_2 + T_3$

(2) より

$T_2 = \dfrac{G_2 d_2^4}{G_3 (d_3^4 - d_2^4)} T_3$

これより

$T = \dfrac{G_2 d_2^4}{G_3 (d_3^4 - d_2^4)} T_3 + T_3$

$T = \dfrac{G_2 d_2^4 + G_3 (d_3^4 - d_2^4)}{G_3 (d_3^4 - d_2^4)} T_3$

$T_3 = \dfrac{G_3 (d_3^4 - d_2^4)}{G_2 d_2^4 + G_3 (d_3^4 - d_2^4)} T$

したがって ねじれ角 は

$\theta = \theta_1 + \theta_3 = \dfrac{32 T l_1}{G_1 \pi d_1^4} + \dfrac{32 T l_2}{\{G_2 d_2^4 + G_3 (d_3^4 - d_2^4)\} \pi}$

$= \dfrac{32 T}{\pi} \left(\dfrac{l_1}{G_1 d_1^4} + \dfrac{l_2}{G_2 d_2^4 + G_3 (d_3^4 - d_2^4)} \right)$