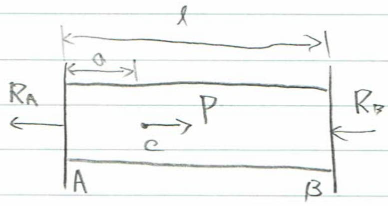
No.
Date . .

H31 材力

[1] (1) 力のつり合いより

$P - R_A - R_B = 0$ ①



また AC間の伸びとCB間の伸びは

$\delta_{AC} = \varepsilon l = \frac{\sigma l}{E} = \frac{R_A a}{SE}$

$\delta_{CB} = \frac{R_B}{SE}(l-a)$

条件より $\delta_{AC} = \delta_{CB}$ より

$$\frac{R_A a}{SE} = \frac{R_B}{SE}(l-a)$$

よって $R_A = \frac{l-a}{a} R_B$ ②

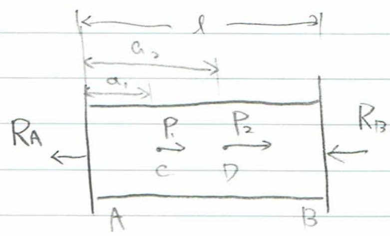
①,②より

$$R_A = \frac{l-a}{l}P \quad , \quad R_B = \frac{a}{l}P$$

(2) (1)を使って

$$\delta_{AC} = \frac{R_A a}{SE} = \frac{a(l-a)P}{lSE}$$

$$\delta_{CB} = \frac{R_B}{SE}(l-a) = \frac{a(l-a)P}{lSE}$$



(3) 力のつり合いより

$P_2 - R_A - R_B = 0$

伸び

$\delta_{AD} = \frac{R_A a_2}{SE} \quad , \quad \delta_{DB} = \frac{R_B}{SE}(l-a_2)$

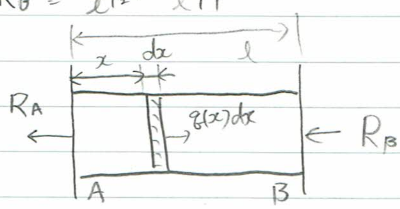
これより $\delta_{AD} = \delta_{DB}$

$$R_A = \frac{l-a_2}{a_2} R_B$$

よって $R_A = \frac{l-a_2}{l}P_2 \quad , \quad R_B = \frac{a_2}{l}P_2$

したがって

$$R_A = \frac{l-a_1}{l}P_1 + \frac{l-a_2}{l}P_2 \quad , \quad R_B = \frac{a_2}{l}P_2 + \frac{a}{l}P_1$$



(4) 力のつり合いより

$-R_A - R_B + \int_0^l g(x)dx = 0$

また

$\delta_A = \frac{R_A x}{SE} \quad , \quad \delta_B = \frac{R_B}{SE}(l-x)$

$\delta_A = \delta_B$ より $R_A = \frac{l-x}{x}R_B$

したがって

$$R_A = \int_0^l \frac{l-x}{l} g(x)dx \quad , \quad R_B = \int_0^l \frac{x}{l} g(x)dx$$

(5) $g(x) = g_0 \frac{x}{l}$ のとき

$$R_A = \int_0^l \frac{(l-x)x}{l^2} g_0 \, dx = \frac{g_0}{l^2}\left[\frac{1}{2}x^2 - \frac{1}{3}x^3\right]_0^l = \frac{l}{6}g_0$$

$$R_B = \int_0^l \frac{x^2}{l^2} g_0 \, dx = \frac{g_0}{l^2}\left[\frac{1}{3}x^3\right]_0^l = \frac{l}{3}g_0$$

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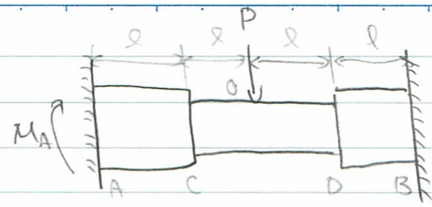
[2] (1) 力のつり合いより

$$-2R_0 + P = 0$$

$$R_0 = \frac{P}{2}$$



仮想断面まわりのモーメントのつり合いより

$0 \leqq x < l$

$$-M_A - R_0 x + M = 0$$

$$M = M_A + \frac{Px}{2}$$

$l \leqq x \leqq 2l$

$$-M_A - R_0 x + M = 0$$

$$M = M_A + \frac{Px}{2}$$

よって

$$M = M_A + \frac{Px}{2}$$

(2)

$$\frac{dy^2}{d^2x} = -\frac{M}{EI_1} = -\frac{1}{EI_1}\left(M_A + \frac{Px}{2}\right)$$

$$\frac{dy}{dx} = -\frac{1}{EI_1}\left(M_A x + \frac{P}{4}x^2\right) + C_1$$

$$y = -\frac{1}{EI_1}\left(\frac{M_A}{2}x^2 + \frac{P}{12}x^3\right) + C_1 x + C_2$$

$x = 0$ のとき $y = 0$, $\frac{dy}{dx} = 0$ となるので

$$C_1 = 0, \quad C_2 = 0$$

$x = l$ のとき

$$\delta_C = y(l) = -\frac{1}{EI_1}\left(\frac{M_A}{2}l^2 + \frac{P}{12}l^3\right)$$

$$= -\frac{l^2}{2EI_1}\left(M_A + \frac{Pl}{6}\right)$$

(3) $2l < x \leqq 4l$ のとき

仮想断面まわりのモーメントのつり合いより

$$-M_A - R_0 x + P(x - 2l) + M = 0$$

$$M = M_A + R_0 x - P(x - 2l)$$

$$\frac{dy^2}{d^2x} = -\frac{M}{EI_2} = -\frac{1}{EI_2}\left\{M_A + \frac{P}{2}x - P(x - 2l)\right\} = -\frac{1}{EI_2}\left(M_A - \frac{P}{2}x - 2l\right)$$

$$\frac{dy}{dx} = -\frac{1}{EI_2}\left\{(M_A - 2l)x - \frac{P}{4}x^2\right\} + C_1$$

$$y = -\frac{1}{EI_2}\left\{\frac{1}{2}(M_A - 2l)x^2 - \frac{P}{12}x^3\right\} + C_1 x + C_2$$

$x = 0$ のとき $C_1 = 0$, $C_2 = 0$ となり, $x = 3l$ のとき (2)と等しくなる

$$-\frac{1}{EI_2}\left\{\frac{9l^2}{2}(M_A - 2l) - \frac{27Pl^3}{12}\right\} = -\frac{l^2}{2EI_1}\left(M_A + \frac{Pl}{6}\right)$$

$$\frac{1}{I_2}\left\{\frac{9}{2}(M_A - 2l) - \frac{9}{4}Pl\right\} = \frac{1}{I_1}\left(M_A + \frac{Pl}{6}\right)$$

$$\left(\frac{9}{2I_2} - \frac{1}{I_1}\right)M_A = \frac{Pl}{6I_1} + \frac{Pl}{4I_2}$$

$$\frac{9I_1 - 2I_2}{2I_1 I_2}$$

$$\frac{2I_2 + 3I_1}{6 \cdot 12 I_1 I_2} \times \frac{2I_1 I_2}{9I_1 - 2I_2}$$

[3] (1)

$$\tau_s \geqq \tau_{max} = \frac{T_s}{Z_p}$$

$$\frac{16T_s}{\pi D^3} = \tau_s$$

$$T_s = \frac{\pi D^3}{16}\tau_s$$

(2) せん断応力をτとおく、またせん断力をPとする

$$\tau = \frac{4P}{\pi d^2}$$

ボルト一本にかかるトルクは

$$T_r = n\tau R = nPR \quad \therefore P = \frac{T_r}{nR} \quad , \quad \tau = \frac{4T_r}{\pi d^2 Rn}$$

$\tau \leqq \tau_b$ より　$n=4$ より

$$\frac{4T_r}{\pi d^2 Rn} = \tau_b$$

$$T_r = \pi d^2 R \tau_b$$

(3) $T_s = T_r$ のとき

$$\frac{\pi D^3 \tau_s}{16} = \pi d^2 R \tau_b$$

$$d^2 = \frac{D^3 \tau_s}{16R\tau_b}$$

$$d = \frac{D}{4}\sqrt{\frac{D\tau_s}{R\tau_b}}$$