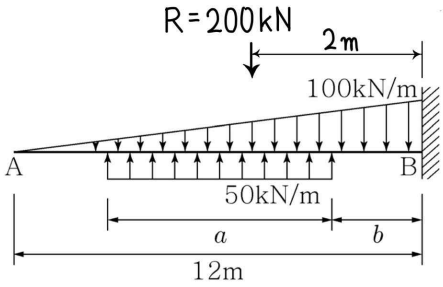
1. ①번

바리농정리 이용



•합력 $R(\downarrow)=\Sigma$분력 $P(\downarrow)$

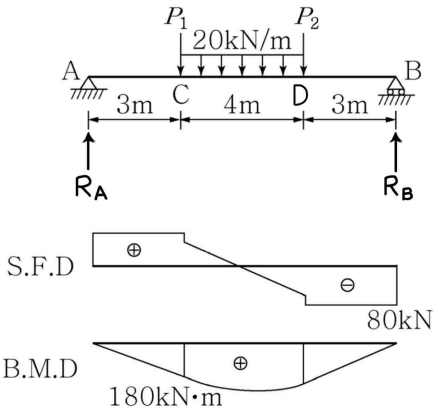
$$200=\left(\frac{1}{2}\times 12\times 100\right)-(50\times a),\ a=8[\mathrm{m}]$$

•합력 $M_B(\curvearrowleft)=$분력 $M_B(\curvearrowleft)$

$$200(2)=\left(\frac{1}{2}\times 12\times 100\right)\left(\frac{12}{3}\right)-(50\times 8)\left(\frac{8}{2}+b\right)$$

$$\therefore b=1[\mathrm{m}]$$

2. ②번



•$M_A(=180\mathrm{kN\cdot m})=R_A\times 3\mathrm{m},\ R_A=60[\mathrm{kN}]$

•$V_B(=-80\mathrm{kN})=-R_B,\ R_B=80[\mathrm{kN}]$

•$\Sigma M_D=0,\ \curvearrowright+$

$$60(3+4)-P_1(4)-(20\times 4)\left(\frac{4}{2}\right)-80(3)=0$$

$$\therefore P_1=5[\mathrm{kN}]$$

3. ①번

파푸스정리 이용

•$A=(2b\times h)\times\frac{2}{\pi}(\text{배})=\frac{4bh}{\pi}$

•$y_c=\frac{\pi h}{8},\ \ \theta=90^\circ=\frac{\pi}{2}$

$$\therefore V=A\times y_c\times\theta=\frac{4bh}{\pi}\times\frac{\pi h}{8}\times\frac{\pi}{2}=\frac{1}{4}\pi bh^2$$

4. ③번

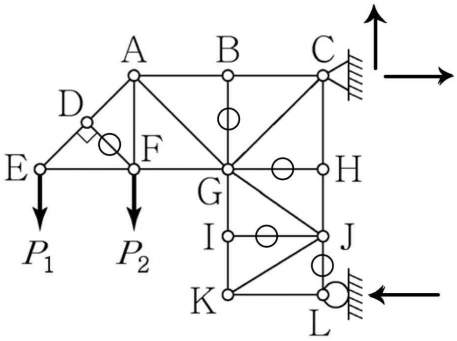
케이블정리 이용

•케이블 $y_C=\frac{4}{2}+1=3[\mathrm{m}]$

•등가보 $M_c=\frac{PL}{4}=\frac{20\times 6}{4}=30\,[\mathrm{kN\cdot m}]$

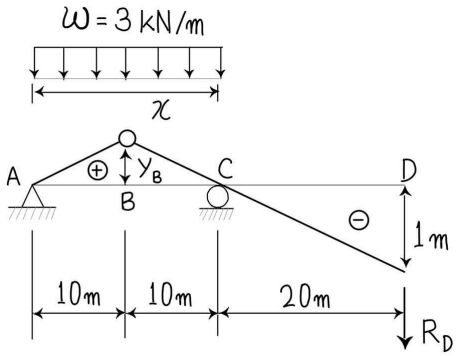
$$\therefore\text{케이블 } H=\frac{M_c}{y_C}=\frac{30}{3}=10[\mathrm{kN}]$$

5. ②번



$\therefore$부재력이 0인 부재는 5개이다.

6. ④번



〈D점 영향선〉

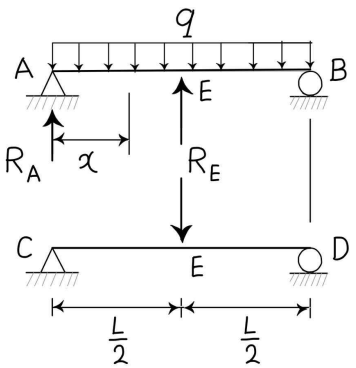
• $y_B = y_D \times \dfrac{L_{BC}}{L_{CD}} = 1 \times \dfrac{10}{20} = 0.5[\mathrm{m}]$

$\therefore x$=영향선의 (+)부분=$L_{AC} = 20[\mathrm{m}]$

$R_D = w \times A_{AC} = 3 \times \left(\dfrac{1}{2} \times 20 \times 0.5\right) = 15[\mathrm{kN}]$

7. ③번

변위일치법 이용



• $\dfrac{5qL^4}{384EI} - \dfrac{R_E L^3}{48EI} = \dfrac{R_E L^3}{48EI}$, $R_E = \dfrac{5qL}{16}$

•AB부재에서 $\Sigma M_B = 0$, $\curvearrowright +$

$R_A(L) + \dfrac{5qL}{16}\left(\dfrac{L}{2}\right) - (q \times L)\left(\dfrac{L}{2}\right) = 0$, $R_A = \dfrac{11qL}{32}$

•최대 정모멘트는 전단력이 0인 곳에서 발생한다.

즉, $V_x = R_A - q \times x = 0$,이다.

$\therefore x = \dfrac{q}{R_A} = \dfrac{11L}{32}$

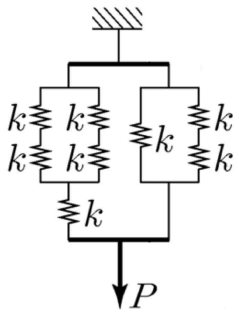
8. ④번

•접촉면 $\tau = \dfrac{6h_1h_2}{h^2}\dfrac{V}{A} = \dfrac{6 \times 8 \times 32}{40^2}\dfrac{V}{A} = \dfrac{24}{25}\dfrac{V}{A}$, 여기서 $V = \dfrac{P}{2} = 10[\mathrm{kN}]$

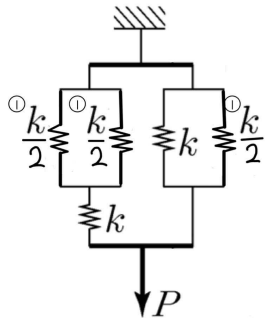
$\therefore \tau = \dfrac{24}{25} \times \dfrac{(10 \times 10^3)}{(30 \times 40)} = 8[\mathrm{MPa}]$

9. ①번

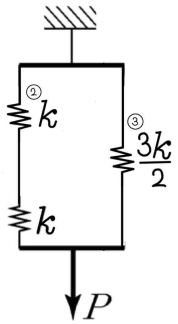
등가스프링 이용



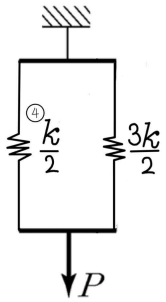
〈주어진 스프링〉



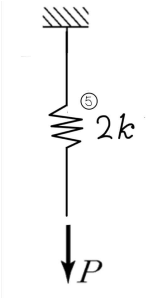
〈1단계〉



〈2단계〉



〈3단계〉



〈4단계〉

①직렬 $k_1 = \dfrac{k \times k}{k+k} = \dfrac{k}{2}$

②병렬 $k_2 = \dfrac{k}{2} + \dfrac{k}{2} = k$

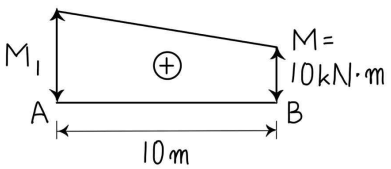
③병렬 $k_3 = k + \dfrac{k}{2} = \dfrac{3k}{2}$

④직렬 $k_4 = \dfrac{k \times k}{k+k} = \dfrac{k}{2}$

⑤병렬 $k_5 = \dfrac{k}{2} + \dfrac{3k}{2} = 2k$

$$\therefore \delta = \frac{P}{k_5} = \frac{P}{2k} = \frac{100}{2 \times 5{,}000} = 0.01\,[\mathrm{m}] = 10\,[\mathrm{mm}]$$

10. ③번



〈휨모멘트도〉

• 휨모멘트도의 면적의 합(=사다리꼴 넓이)

• $A_{AB}(=120) = \dfrac{(M_1+10)\times 10}{2} = 5M_1 + 50$

$$\therefore M_1 = \frac{120-50}{5} = 14\,[\mathrm{kN \cdot m}]$$

11. ④번

• $\sigma_{\max} = \dfrac{M_A}{Z} = \dfrac{P \times 4b}{\left(\dfrac{b^3}{6}\right)} = \dfrac{24P}{b^2}$

• $\tau_{\max} = \dfrac{3V}{2A} = \dfrac{3P}{2b^2}$

$$\therefore \frac{\sigma_{\max}}{\tau_{\max}} = \frac{\left(\dfrac{24P}{b^2}\right)}{\left(\dfrac{3P}{2b^2}\right)} = 16$$

12. ②번

모멘트분배법 이용

(1) 분배율 산정

- $K_{AB}=\dfrac{4EI}{L_{AB}}=\dfrac{4EI}{3}$,

$K_{BC}=\dfrac{4E(2I)}{L_{BC}}=\dfrac{4E(2I)}{4}=2EI$

- $DF_{AB}=\dfrac{K_{AB}}{K_{AB}+K_{BC}}=\dfrac{2}{5}$

$DF_{BC}=\dfrac{K_{BC}}{K_{AB}+K_{BC}}=\dfrac{3}{5}$

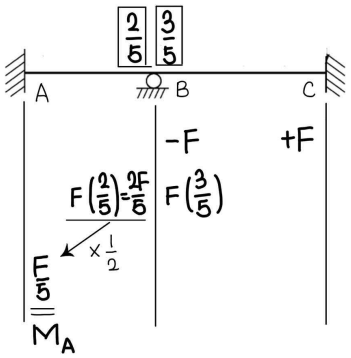
(2) 고정모멘트 산정

- $FEM_{BC}=\dfrac{-wL_{BC}^{\,2}}{12}=\dfrac{-6{,}000\times 4^2}{12}$

$=-8{,}000[\mathrm{N\cdot m}]$

$FEM_{CB}=\dfrac{wL_{BC}^{\,2}}{12}=8{,}000[\mathrm{N\cdot m}]$

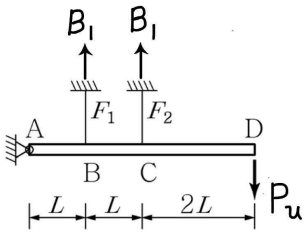
(3) 재단모멘트 산정



- $F=8{,}000[\mathrm{kN\cdot m}]$ (가정)

$\therefore M_A=\dfrac{F}{5}=\dfrac{8{,}000}{5}=1{,}600[\mathrm{N\cdot m}]$(시계방향)

13. ③번



- $\Sigma M_A=0,\ \circlearrowleft+$

$-B_1(L)-B_1(2L)+P_u(4L)=0$

$\therefore P_u=\dfrac{3}{4}B_1$

14. ①번

- $k_{BA}:k_{BC}:k_{BD}=\dfrac{4EI}{10}:\dfrac{4EI}{5}:\dfrac{3EI}{3}=2:4:5$

- $DF_{BC}=\dfrac{k_{BC}}{k_{BA}+k_{BC}+k_{BD}}=\dfrac{4}{2+4+5}=\dfrac{4}{11}$

- $M_{BC}=M\times DF_{BC}=55\times\dfrac{4}{11}=20\,[\mathrm{kN\cdot m}]$

$\therefore M_{CB}=M_{BC}\times COF=20\times\dfrac{1}{2}=10\,[\mathrm{kN\cdot m}]$(시계방향)

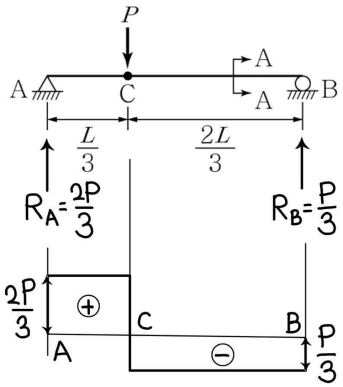
15. ④번

$\bullet \epsilon_x = \dfrac{\delta_x}{L_x} = \dfrac{-0.36}{500} = -0.00072, \quad \epsilon_y = 0 (\because$ 강체벽 구속)

$\therefore \sigma_x = \dfrac{E(\epsilon_x + \nu\epsilon_y)}{1-\nu^2} = \dfrac{(200\times 10^3)\times(-0.00072+0.2\times 0)}{1-0.2^2} = -150[\mathrm{MPa}]$

16. ②번 (오류 의심)

샌드위치 보의 근사이론 이용



〈외력도와 전단력도〉

$\bullet R_A = \dfrac{2P}{3}, \quad R_B = \dfrac{P}{3}$

$\bullet V_C = R_A = \dfrac{2P}{3}$ (오류 의심)

$\bullet \tau_{aver.} = \dfrac{V_C}{A} = \dfrac{V_C}{b\times(h+2t)} \simeq \dfrac{V_C}{b\times h} (\because t \ll h)$

$\therefore \tau_{aver.} = \dfrac{\left(\frac{2P}{3}\right)}{b\times h} = \dfrac{2P}{3bh}$

※C점은 전단력 불연속점에 해당한다. C점의 전단력을 2P/3로 적용했다면 오류가 의심된다.

17. ④번

변위일치법 이용

$\bullet k_s = 2{,}000[\mathrm{N/mm}] = 2[\mathrm{kN/mm}]$

$\bullet R = k_s \times x = 2\times(5-3) = 4[\mathrm{kN}]$

$\bullet k_b = \dfrac{EA}{L} = \dfrac{200\times 100}{1{,}000} = 20[\mathrm{kN/mm}]$

$\bullet \alpha(\Delta T)L + \alpha(\Delta T)L = \dfrac{R}{k_b} + \dfrac{R}{k_b} + \dfrac{R}{k_s} = 2.4[\mathrm{mm}]$

$\left(\because \dfrac{R}{k_b} + \dfrac{R}{k_b} + \dfrac{R}{k_s} = \dfrac{4}{20} + \dfrac{4}{20} + \dfrac{4}{2} = 2.4[\mathrm{mm}]\right)$

$\therefore \Delta T = \dfrac{2.4}{2\alpha L} = \dfrac{2.4}{2\times 10^{-5}\times 1{,}000} = 120[\mathrm{℃}]$

18. ①번

B점에서 변위일치법 이용

$\bullet \dfrac{PL^3}{8EI} - \dfrac{R_B L^3}{3EI} = \dfrac{PL^3}{24EI}$

$\therefore R_B = \dfrac{P}{4}$

19. ④번

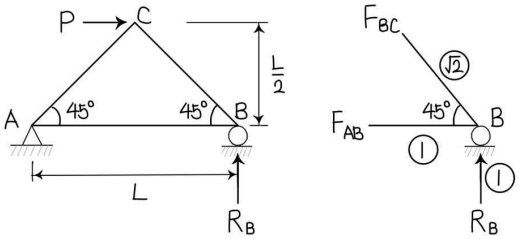
중첩공식(비례관계) 이용

• $\delta_C = \delta_B \times \dfrac{2a+3b}{2a} = \delta_B \times \dfrac{2\times 6+3\times 4}{2\times 6} = \delta_B \times 2\,(\text{배})$

$\therefore \delta_C = \delta_B \times 2 = \dfrac{PL_{AB}{}^3}{3EI} \times 2 = \dfrac{100\times 6^3}{3EI} \times 2 = \dfrac{14{,}400}{EI}\ [\text{kN}\cdot\text{m}^3]$

20. ③번

재료역학 공식 이용



(a) (b)

• 그림 (a)에서 $\Sigma M_A = 0,\ (\curvearrowright +);\ P\left(\dfrac{L}{2}\right) - R_B(L) = 0,\ R_B = \dfrac{P}{2}$

• 그림 (b)에서 시력도를 적용하면 $F_{AB} = R_B \times \dfrac{1}{1} = \dfrac{P}{2}$이다.

• $\delta_{Bh} = \dfrac{F_{AB}L}{EA} = \dfrac{\left(\dfrac{P}{2}\right)L}{EA} = \dfrac{PL}{2EA}$

$\therefore \delta_{Bh}\left(= \dfrac{PL}{2EA}\right) \le \delta_{\max}(=3\delta)$이므로 $P_{\max} = \dfrac{6EA}{L}\delta$이다.