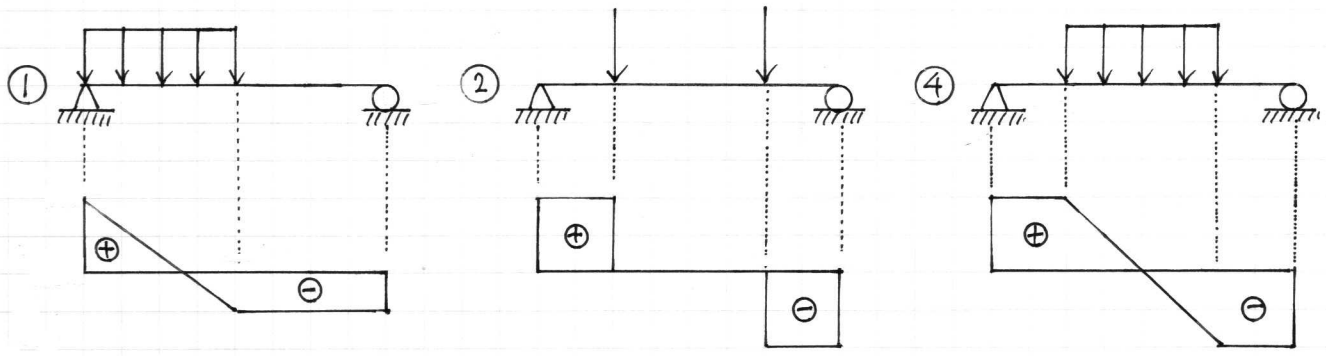
2015년 서울시 9급 응용역학 해설 (A형) 이학민

1. ④번

• $P_a = \frac{\pi^2 EI}{(2L)^2} = \frac{\pi^2 EI}{4L^2}$ • $P_b = \frac{\pi^2 EI}{(2L)^2} = \frac{\pi^2 EI}{4L^2}$ • $P_c = \frac{\pi^2 EI}{\left(\frac{4L}{\sqrt{2}}\right)^2} = \frac{\pi^2 EI}{8L^2}$

$\therefore P_a = P_b > P_c$

2. ③번



3. ④번

$\delta = \Sigma \frac{F_i L_i}{EA} = \frac{(2P+P)\left(\frac{2}{3}L\right) + (P)\left(\frac{1}{3}L\right)}{EA} = \frac{7PL}{3EA}$

4. ②번

$\delta_{중앙} = \frac{PL^3}{48EI} = \frac{L}{20}$ 이므로 $P = \frac{24EI}{L^2}$ 이다.

5. ③번

• $\sigma_{max} = \frac{M_{max}}{Z} = \frac{\left(\frac{wl^2}{2}\right)}{\left(\frac{bh^2}{6}\right)} = \frac{3wl^2}{bh^2}$ • $\tau_{max} = \frac{VQ}{Ib} = \frac{3V_{max}}{2A} = \frac{3(wl)}{2(bh)} = \frac{3wl}{2bh}$

$\therefore \frac{\sigma_{max}}{\tau_{max}} = \frac{\left(\frac{3wl^2}{bh^2}\right)}{\left(\frac{3wl}{2bh}\right)} = \frac{2}{h}l$

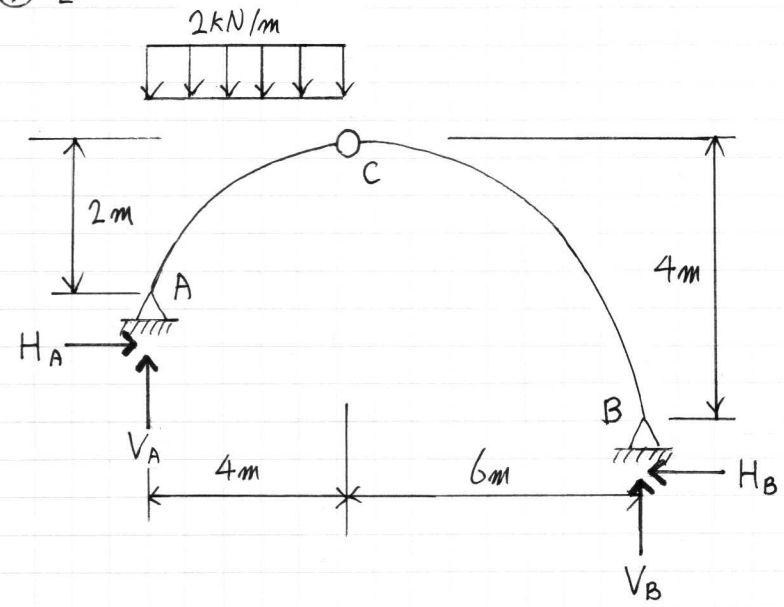
6. ② 번

• $G = \frac{E}{2(\nu+1)}$ 이므로 $\nu = \left(\frac{E}{2G} - 1\right)$ 이다.

• $\nu = \left(\frac{240}{2\times100} - 1\right) = 0.2$

$\therefore \epsilon_y = -\nu\epsilon_x = -0.2 \times 0.0001 = -0.00002$

7. ① 번



(전체) $\Sigma M_A = 0$, ↺+

$(2\times4)(2) + H_B(2) - V_B(10) = 0$ — (1)

(우측) $\Sigma M_C = 0$, ↺+

$H_B(4) - V_B(6) = 0$ ——— (2)

from (1)(2)

$\therefore H_B = \frac{24}{7}[kN]$, $V_B = \frac{16}{7}[kN]$

8. ④ 번

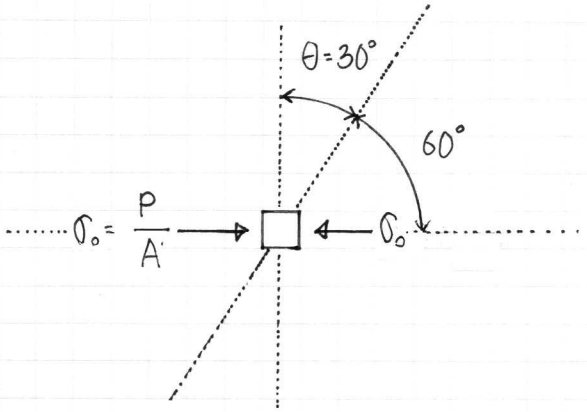
* 중첩공식 이용

• $b = L - a = 3l - l = 2l$

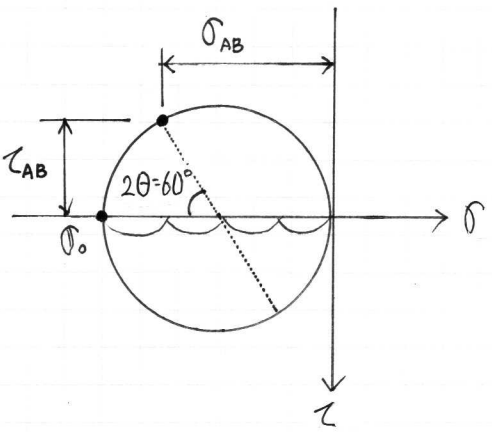
$\therefore \theta_A = \frac{Pab}{2EI} = \frac{P\times l\times 2l}{2EI} = \frac{Pl^2}{EI}$ (↻)

9. ③번

(1) 초기응력 산정



(2) 응력변환 경로

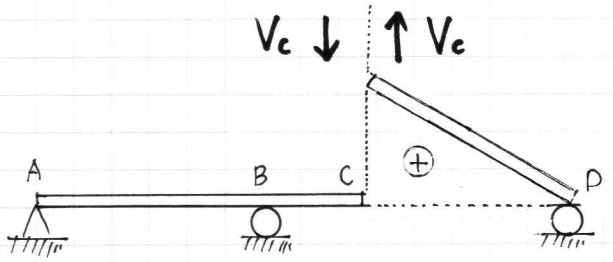


- $\sigma_{AB} = \sigma_0 \times \frac{3}{4}$ 배 $= \frac{P}{A} \times \frac{3}{4} = \frac{3P}{4A}$
- $\tau_{AB} = \sigma_0 \times \frac{\sqrt{3}}{4}$ 배 $= \frac{P}{A} \times \frac{\sqrt{3}}{4} = \frac{\sqrt{3}P}{4A}$
- $\sigma_{AB} \left(= \frac{3P}{4A_1}\right) \le \sigma_a$ 이므로 $A_1 \ge \frac{3P}{4\sigma_a} = \frac{3 \times (120 \times 10^3)}{4 \times 9} = 10,000\,[mm^2]$
- $\tau_{AB} \left(= \frac{\sqrt{3}P}{4A_2}\right) \le \tau_a$ 이므로 $A_2 \ge \frac{\sqrt{3}P}{4\tau_a} = \frac{\sqrt{3} \times (120 \times 10^3)}{4 \times 2\sqrt{3}} = 15,000\,[mm^2]$

$\therefore A_{min} = [A_1, A_2]_{max} = 15,000\,[mm^2]$

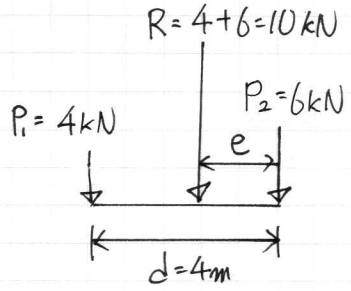
10. ④번

* 윌러브레슬로우의 원리 이용



11. ③번

(1) e (합력과 가까운 하중과의 거리) 산정

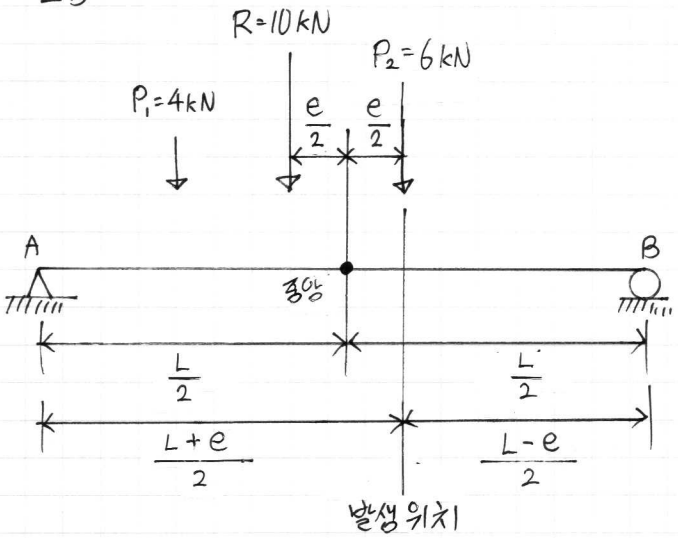


* 바리농정리 이용

$R \times e = P_1 \times d$

$e = \frac{P_1 \times d}{R} = \frac{4 \times 4}{10} = 1.6\,[m]$

(2) 발생위치 산정



∴ 발생위치 $= \frac{L+e}{2} = \frac{10+1.6}{2} = 5.8\,[m]$ (A점으로 부터)

12. ③번

* 3연모멘트법 이용

- $M_A\left(\frac{L_1}{I_1}\right) + 2M_B\left(\frac{L_1}{I_1} + \frac{L_2}{I_2}\right) + M_C\left(\frac{L_2}{I_2}\right) = 6E(\theta_{BL} + \theta_{BR}) - 6E(\beta_{BL} + \beta_{BR})$

그런데 $M_A = M_C = 0$, 상재하중에 의한 $\theta_{BL} = \theta_{BR} = 0$ 이므로

$2M_B\left(\frac{L_1}{I_1} + \frac{L_2}{I_2}\right) = -6E(\beta_{BL} + \beta_{BR})$ 이다.

- $2M_B\left(\frac{2l}{I} + \frac{l}{I}\right) = -6E\left(\frac{\Delta}{2l} + \frac{\Delta}{l}\right)$, $\therefore M_B = -\frac{3EI\Delta}{2l^2}$ (B점 하향 침하시)

13. ① 번

• $R = W \times L$

• $M = R(x) - (W \times x)\left(\frac{x}{2}\right) = (WL)x - \left(\frac{W}{2}\right)x^2$

• $K = \frac{M}{EI} = \left(\frac{WL}{EI}\right)x - \left(\frac{W}{2EI}\right)x^2$

• $\theta = \int K\,dx = \left(\frac{WL}{2EI}\right)x^2 - \frac{W}{6EI}x^3 + C_1$

• $v = \int \theta\,dx = \left(\frac{WL}{6EI}\right)x^3 - \left(\frac{W}{24EI}\right)x^4 + C_1 x + C_2$

$\therefore x^4$의 계수는 $\frac{W}{24EI}$ 이다.

14. ① 번

• $\text{core} = -\frac{I_y}{A \cdot x_0} = -\frac{Z}{A}$, (여기서 x_0는 중립축에서 연단(A점) 거리)

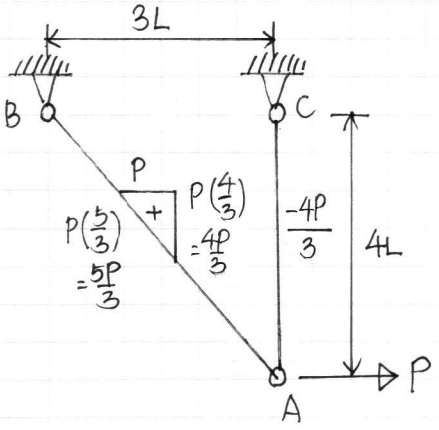
$\therefore$ $\text{core} = \frac{Z}{A} = \frac{2,500}{125} = 20\,[mm]$

15. ② 번

$\sigma = E\left\{\alpha(\Delta T) - \frac{\delta}{L}\right\}$

$= (2.0\times10^6)\times\left\{(1.0\times10^{-5})(50) - \frac{1}{(5\times10^3)}\right\} = 600\,[MPa]$

16. ① 번



<곡차법을 이용한 부재력 산정>

* 단위하중법 이용

$$\delta = \sum \frac{F_i f_i l}{EA}$$

$$= \frac{\left(\frac{5P}{3}\right)\left(\frac{5}{3}\right)(5L) + \left(\frac{-4P}{3}\right)\left(\frac{-4}{3}\right)(4L)}{EA} = \frac{21PL}{EA}$$

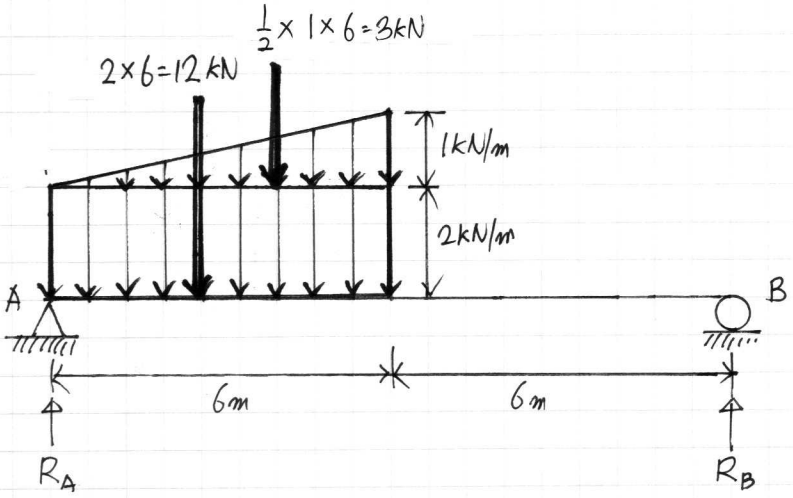
$$= \frac{21 \times (90\,kN) \times (1{,}000\,mm)}{(200\,GPa) \times (500\,mm^2)} = 18.9\,[mm]$$

17. ② 번

- $M_{DC} = \frac{K_C}{K_A + K_B + K_C} \times M = \frac{2}{0.5 + 1.5 + 2} \times 10 = 5\,[kN \cdot m]$

- $M_{CD} = M_{DC} \times \frac{1}{2}(\text{전달률}) = 5 \times \frac{1}{2} = 2.5\,[kN \cdot m]$

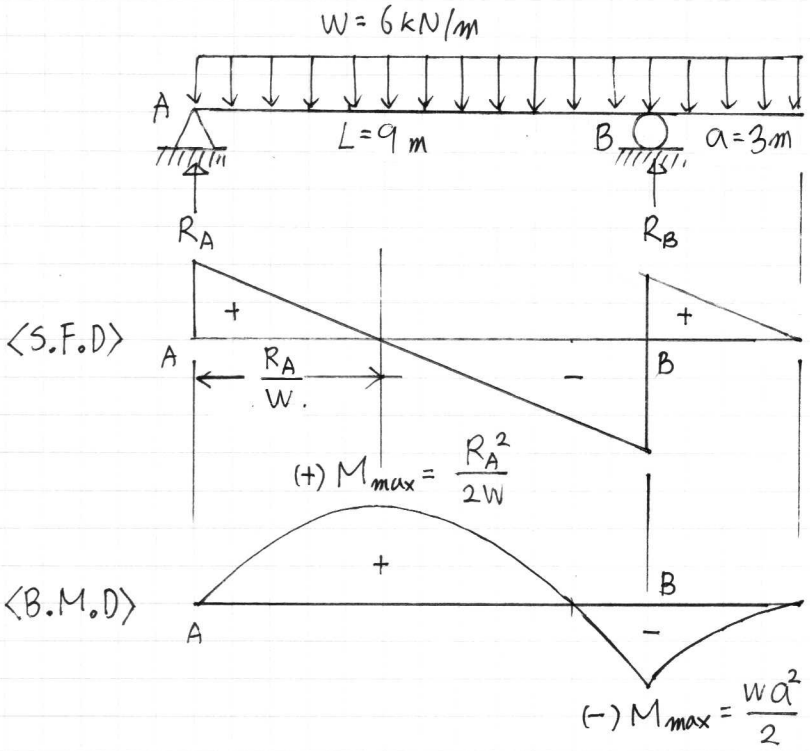
18. ④ 번



$\Sigma M_A = 0, (+\circlearrowleft)$; $12\left(6 \times \frac{1}{2}\right) + 3\left(6 \times \frac{2}{3}\right) - R_B(12) = 0, \quad R_B = 4\,[kN]$

$\Sigma V = 0, (+\uparrow)$; $R_A + R_B - \frac{(2+3) \times 6}{2} = 0, \quad R_A = 11\,[kN]$

19. ③번



(1) R_A, R_B 산정

$\Sigma M_A = 0$, $\circlearrowright +$

$(6\times 12)\times \frac{12}{2} - R_B(9) = 0$, $R_B = 48[kN]$

$\Sigma V = 0$, $\uparrow +$

$R_A + R_B - (6\times 12) = 0$, $R_A = 24[kN]$

(1) R_A, R_B 산정

$\Sigma M_A = 0$, $\circlearrowright +$ 로 $(6\times 12)\times \frac{12}{2} - R_B(9) = 0$, $R_B = 48[kN]$

$\Sigma V = 0$, $\uparrow +$ 로 $R_A + R_B - (6\times 12) = 0$, $R_A = 24[kN]$

(2) M_{max} 산정

- $(+)M_{max} = \frac{R_A^2}{2W} = \frac{24^2}{2\times 6} = 48[kN\cdot m]$
- $(-)M_{max} = \frac{Wa^2}{2} = \frac{6\times 3^2}{2} = 27[kN\cdot m]$

$\therefore M_{max} = (+)M_{max} = 48[kN\cdot m]$

20. ④번

* 바리농 정리 이용

합력 $R(\downarrow) = \Sigma$분력 $P(\downarrow)$, $R = 5+10+15+20 = 50[kN]$

합력 $M(\circlearrowright) = \Sigma$분력 $M(\circlearrowright)$, $50(x) = 5(2)+10(5)+15(7)+20(9)$, $\therefore x = 6.9[m]$