2015년 서울시 7급 응용역학 해설 (A형) 이학민

1. ① 번

• $\tau_A = \frac{V_{중앙} Q}{Ib} = 0$, ($\because V_{중앙} = 0$, $Q = 0$ (연단))

• $\sigma_A = \frac{M_{중앙}}{I} y = \frac{M_{중앙}}{Z} = +\frac{6Pa}{bh^2}$ ($\because$ 정모멘트)

$\therefore \quad \sigma_A \longleftarrow \boxed{A} \longrightarrow \sigma_A = \frac{6Pa}{bh^2}$

2. ③ 번

$I = \frac{5\pi D^4}{64} = \frac{5\pi (2d)^4}{64} = \frac{5}{4}\pi d^4$

3. ② 번

• ΔT_1 (닿을 때) $= \frac{d}{\alpha h}$, ($\because \alpha(\Delta T_1)h = d$)

• ΔT (총 온도 변화량) $= 2(\Delta T_1) = \frac{2d}{\alpha h}$

$\therefore \sigma = E\left\{\alpha(\Delta T) - \frac{d}{h}\right\} = E\left\{\alpha \times \left(\frac{2d}{\alpha h}\right) - \frac{d}{h}\right\} = E\frac{d}{h}$

4. ② 번

* 스프링 기둥 공식이용

$P_{cr} = \frac{\beta_R}{L} + \frac{4\beta_R}{L} + \frac{\beta_R}{L} = \frac{6\beta_R}{L} = \frac{6\beta_R}{18} = \frac{1}{3}\beta_R$

5. ③ 번

* 모멘트분배법 이용

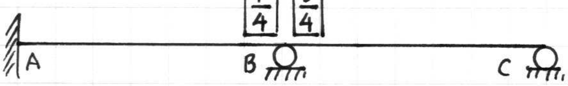
(1) 분배율 산정

- $K_{AB} = \dfrac{4EI}{L_{AB}} = \dfrac{4EI}{6} = \dfrac{2EI}{3}$
- $K_{BC} = \dfrac{3(3EI)}{L_{BC}} = \dfrac{3(3EI)}{6} = \dfrac{3EI}{2}$
- $DF_{AB} = \dfrac{K_{AB}}{K_{AB}+K_{BC}} = \dfrac{4}{13}$
- $DF_{BC} = \dfrac{K_{BC}}{K_{AB}+K_{BC}} = \dfrac{9}{13}$

(2) 고정단모멘트 산정

- $FEM_{AB} = -\dfrac{6EI\Delta}{(L_{AB})^2} = -\dfrac{6\times100\times0.01}{6^2} = -\dfrac{1}{6}$
- $FEM_{BA} = -\dfrac{6EI\Delta}{(L_{AB})^2} = -\dfrac{6\times100\times0.01}{6^2} = -\dfrac{1}{6}$
- $FEM_{BC} = +\dfrac{3(3EI)\Delta}{(L_{BC})^2} = +\dfrac{3\times(3\times100)\times0.01}{6^2} = +\dfrac{1}{4}$

(3) M_B 산정



	A	B (AB)	B (BC)	C	
DF		$\frac{1}{4}$	$\frac{3}{4}$		⇐ DF (분배율)
FEM	$\frac{-1}{6}$	$\frac{-1}{6}$	$\frac{1}{4}$		⇐ FEM (고정단모멘트)
DM		$-\left(\frac{-1}{6}+\frac{1}{4}\right)\left(\frac{4}{13}\right)$	$-\left(\frac{-1}{6}+\frac{1}{4}\right)\left(\frac{9}{13}\right)$		⇐ DM (분배모멘트)
			M_B		

$\therefore M_B$ (B점 모멘트단면력) $= \dfrac{1}{4} - \left(\dfrac{-1}{6}+\dfrac{1}{4}\right)\left(\dfrac{9}{13}\right) = +\dfrac{5}{26}$ [kN·m]

6. ② 번

- $\gamma = \dfrac{dx}{dy} = \dfrac{d}{dy}\left\{h\times\left(\dfrac{y}{b}\right)^2\right\} = \dfrac{2hy}{b^2}$

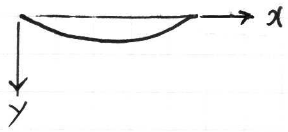
$\therefore \gamma = \dfrac{2hy}{b^2} = \dfrac{2\times0.004\times0.5}{2^2} = 0.001$

7. ④번

- $\Delta T_1 = 20 - 10 = 10[^\circ C]$, $\Delta T_2 = 50 - 20 = 30[^\circ C]$

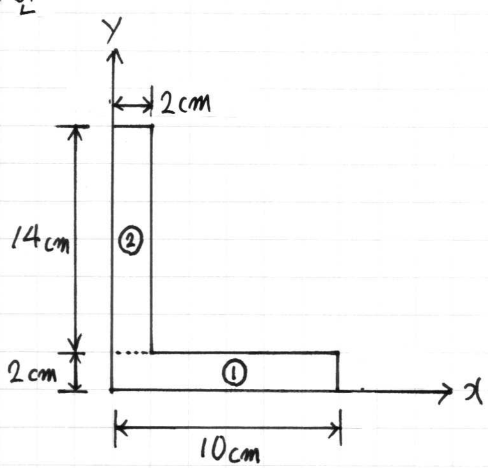
- $K = \dfrac{\alpha(\Delta T)}{h} = \dfrac{10^{-5}\times(30-10)}{1} = 2\times10^{-4}$

$\therefore K = -2\times10^{-4}$

(

$\boxed{주의}$ y축의 아래방향이 (+))

8. ②번



- $I_{xy} = I_{xy,도심} + A\cdot x\cdot y = \Sigma A_i x_i y_i$

$\therefore I_{xy} = (10\times2)(5)(1) + (2\times14)(1)(9)$

$= 352\ [cm^4]$

9. ①번

* 케이블정리 이용

- 케이블 $y_c = 2m + 4m \times \dfrac{10m}{40m} = 3\ [m]$

- 등가보 $V_a = \dfrac{12+12+12}{2} = 18\ [kN]$

- 등가보 $M_c = V_a \times 10m = 18\times10 = 180\ [kN\cdot m]$

$\therefore H = \dfrac{M_c\ (등가보)}{y_c\ (케이블)} = \dfrac{180}{3} = 60\ [kN]$

10. ③ 번

방법 1. 처짐각방정식 이용

$$\bullet\ M_{BA} = \Big(\underbrace{\frac{2EI\theta_A}{L}}_{\text{A점 회전에 의한}} + \underbrace{\frac{4EI\theta_B}{L}}_{\text{B점 회전에 의한}} - \underbrace{\frac{6EI\Delta}{L^2}}_{\text{지점 연직방향 처짐에 의한}} \Big) + \underbrace{FEM_{BA}}_{\text{상재하중에 의한 고정단모멘트}}$$

여기서 $\theta_A = 0$, $\Delta = 0$, $FEM_{BA} = 0$ 이다.

$$\therefore M_{BA} = \frac{4EI\theta_B}{L} = \frac{4EI(-1)}{5} = -\frac{4EI}{5}$$

방법 2. 암기하면 편리한 단일구간해석

$\bullet\ M_{AB}$(회전변위와 원단) $= \dfrac{2EI\theta_B}{L}$ $\qquad\bullet\ M_{BA}$(회전변위와 근단) $= \dfrac{4EI\theta_B}{L}$

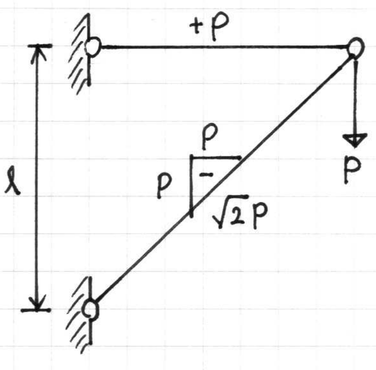
$$\therefore M_{BA} = \frac{4EI\theta_B}{L} = \frac{4EI(-1)}{5} = -\frac{4EI}{5}$$

11. ③ 번

$$M_{max} = A_{AD} = \frac{1}{2} \times 6 \times 3 = 9\ [kN \cdot m]$$

12. ② 번

(1) 부재력 산정



(2) 변형에너지 산정

$$U = \Sigma \frac{F^2 L}{2EA} = \frac{(P^2)(l) + (\sqrt{2}P)^2(\sqrt{2}l)}{2EA}$$

$$= \frac{1 + 2\sqrt{2}}{2EA} P^2 l$$

13. ① 번

- $A = b^2 = \frac{\pi d^2}{4}$

- $I_{(a)} = \frac{b^4}{12} = \frac{A^2}{12}$, $I_{(b)} = \frac{\pi d^4}{64} = \frac{A^2}{4\pi}$

- $P_{cr} = \frac{\pi^2 EI}{L^2}$ 이므로 $P_{cr} \propto I$ 이다.

$$\therefore \frac{P_{cr(a)}}{P_{cr(b)}} = \frac{I_{(a)}}{I_{(b)}} = \frac{\left(\frac{A^2}{12}\right)}{\left(\frac{A^2}{4\pi}\right)} = \frac{\pi}{3}$$

14. ② 번

(1) 철판에 의한 P_t 산정

- $P_t = \sigma_{ta} \times A_{min} = 100 \times (40 \times 10) = 40,000\ [N]$

(2) 볼트에 의한 P_v, P_b 산정

- $P_v = \tau_a \times A_{단면} = 50 \times \frac{\pi \times 10^2}{4} = 1,250\pi\ [N]$

- $P_b = \sigma_{ba} \times A_{투영} = 50 \times (10 \times 10) = 5,000\ [N]$

$\therefore P_{allow} = P_{max} = [P_t,\ P_v,\ P_b]_{min} = 1,250\pi\ [N]$

15. ④ 번

$$i = 1 + \sqrt{1 + \frac{2h}{\delta_{st}}} = 1 + \sqrt{1 + \frac{2 \times 90}{60}} = 3$$

16. ④ 번

* 중첩공식 이용

$$\delta_B = \frac{5PL^3}{48EI} = \frac{5 \times 10 \times 6^3}{48EI} = \frac{225}{EI}$$

17. ① 번

$\cdot\ \tau_{max}\left(= \dfrac{16T_a}{\pi d^3}\right) \le \tau_a$ 이므로 $d \ge \sqrt[3]{\dfrac{16T_a}{\pi\tau_a}}$ 이다.

$\therefore\ d_{min} = \sqrt[3]{\dfrac{16T_a}{\pi\tau_a}}$

18. ④ 번

* 모멘트분배법 이용

(1) DF_{co} 산정

$\cdot\ K_{AO} = \dfrac{4E(2I)}{L_{AO}} = \dfrac{4E(2I)}{8} = EI$

$\cdot\ K_{BO} = \dfrac{4E(3I)}{L_{BO}} = \dfrac{4E(3I)}{4} = 3EI$

$\cdot\ K_{co} = \dfrac{4E(3I)}{L_{co}} = \dfrac{4E(3I)}{3} = 4EI$

$\cdot\ DF_{co} = \dfrac{K_{co}}{K_{AO}+K_{BO}+K_{co}} = \dfrac{1}{2}$

(2) M_{oc} 산정

$\cdot\ M_{oc} = M \times DF_{co} = M \times \dfrac{1}{2} = 40\,[kN\cdot m]$

$\therefore\ M = 80\,[kN\cdot m]$

19. ③ 번

* 분배법 이용

$$R_A = \frac{K_1}{K_2+K_1}P = \frac{\frac{EA_1}{a}}{\frac{EA_2}{b}+\frac{EA_1}{a}} \times P = \frac{bA_1}{aA_2+bA_1}P$$

20. ③ 번

$$\sigma_{1,2} = \frac{\sigma_x+\sigma_y}{2} \pm \sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2 + (\tau_{xy})^2}$$

$$= \frac{20+0}{2} \pm \sqrt{\left(\frac{20-0}{2}\right)^2 + (10)^2} = 10 \pm 10\sqrt{2}\ [MPa]$$