

< 단면검토 >

◆ S16 정모멘트부

▷ 검토 조건

$$\begin{aligned} f_{ck} &= 27.0 \text{ MPa} & f_y &= 400.0 \text{ MPa} & \lambda &= 1.00 \\ \beta_1 &= 0.850 & \phi_f &= 0.85 & \phi_v &= 0.75 \\ \rho_{\min} &= \max(0.25 \sqrt{f_{ck}} / f_y, 1.4 / f_y) = 0.00350 \end{aligned}$$

$$\begin{aligned} \text{계수 모멘트 } M_u &= 1470.523 \text{ KN} \cdot \text{m} & \text{계수 전단력 } V_u &= 0.000 \text{ KN} \\ \text{단면의 두께 } H &= 900.000 \text{ mm} & \text{단면 폭 } B &= 1000.000 \text{ mm} \\ \text{유효 깊이 } D &= 830.000 \text{ mm} & \text{피복 두께 } D_c &= 70.000 \text{ mm} \end{aligned}$$

▷ 휨모멘트 검토

- . 휨강도 검토

$$\begin{aligned} \text{사용철근량 } A_{s, \text{use}} &= H25 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm}) \\ &+ H22 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm}) \\ &= 8938.000 \text{ mm}^2 \quad \therefore P = A_s / (B \cdot D) = 0.01077 \end{aligned}$$

$$\text{공칭강도시 등가응력깊이 } a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 155.782 \text{ mm}$$

$$\text{최외단 인장철근 변형률 } \epsilon_t = 0.01059 \geq 0.004 \dots \therefore \text{O.K}$$

$$\dots \text{여기서 } \epsilon_t = 0.003 \cdot (H - a / \beta_1 - D_{c, \min}) / (a / \beta_1)$$

0.005 ≤ ϵ_t 이므로 인장지배단면, $\phi_f = 0.85$ 를 적용한다.

$$\begin{aligned} \phi M_n &= \phi_f \cdot f_y \cdot A_s \cdot (D - a/2) = 2,285,599,000 \text{ N} \cdot \text{mm} \\ &= 2285.599 \text{ KN} \cdot \text{m} \geq M_u = 1470.523 \text{ KN} \cdot \text{m} \dots \therefore \text{O.K} \quad (S.F = 1.554) \end{aligned}$$

- . 필요철근량 및 철근비 검토

소요등가응력깊이 $a = 96.423 \text{ mm}$ 로 가정

$$A_s = M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \} = 5532.274 \text{ mm}^2$$

$$a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 96.423 \text{ mm} \quad \therefore \text{가정과 비슷함 O.K}$$

$$\rho_{\text{req}} = [M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \}] / (B \cdot D) = 0.00667 \Rightarrow 4/3 \rho_{\text{req}} = 0.00889$$

$$\therefore \text{필요철근량 } A_{s, \text{req}} = \rho_{\text{req}} \times (B \cdot D) = 5532.274 \text{ mm}^2 \leq \text{사용철근량} \dots \text{O.K}$$

$$\text{철근비검토 : } \rho_{\min} \leq \rho \dots \therefore \text{O.K}$$

◆ S17 정모멘트부

▷ 검토 조건

$$\begin{aligned} f_{ck} &= 27.0 \text{ MPa} & f_y &= 400.0 \text{ MPa} & \lambda &= 1.00 \\ \beta_1 &= 0.850 & \phi_f &= 0.85 & \phi_v &= 0.75 \\ \rho_{\min} &= \max(0.25 \sqrt{f_{ck}} / f_y, 1.4 / f_y) = 0.00350 \end{aligned}$$

$$\begin{aligned} \text{계수 모멘트 } M_u &= 2229.415 \text{ KN} \cdot \text{m} & \text{계수 전단력 } V_u &= 0.000 \text{ KN} \end{aligned}$$

단면의 두께 $H = 1200.000 \text{ mm}$
유효 깊이 $D = 1130.000 \text{ mm}$

단면 폭 $B = 1000.000 \text{ mm}$
피복 두께 $D_c = 70.000 \text{ mm}$

▷ 휨모멘트 검토

- 휨강도 검토

사용철근량 $A_{s,use} = H25 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm})$
 $+ H22 @ 200.00 \text{ mm} \quad (D_c = 70.00 \text{ mm})$
 $= 7002.500 \text{ mm}^2 \quad \therefore P = A_s / (B \cdot D) = 0.00620$

공칭강도시 등가응력깊이 $a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 122.048 \text{ mm}$

최외단 인장철근 변형률 $\epsilon_t = 0.02061 \geq 0.004 \dots \therefore O.K$

...여기서 $\epsilon_t = 0.003 \cdot (H - a / \beta_1 - D_{c,min}) / (a / \beta_1)$

$0.005 \leq \epsilon_t$ 이므로 인장지배단면, $\phi_f = 0.85$ 를 적용한다.

$\phi M_n = \phi_f \cdot f_y \cdot A_s \cdot (D - a/2) = 2,545,072,000 \text{ N} \cdot \text{mm}$
 $= 2545.072 \text{ KN} \cdot \text{m} \geq M_u = 2229.415 \text{ KN} \cdot \text{m} \dots \therefore O.K \quad (S.F = 1.142)$

- 필요철근량 및 철근비 검토

소요등가응력깊이 $a = 106.120 \text{ mm}$ 로 가정

$A_s = M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \} = 6088.643 \text{ mm}^2$

$a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 106.120 \text{ mm} \quad \therefore$ 가정과 비슷함 $O.K$

$\rho_{req} = [M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \}] / (B \cdot D) = 0.00539 \Rightarrow 4/3 \rho_{req} = 0.00718$

$\therefore$ 필요철근량 $A_{s,req} = \rho_{req} \times (B \cdot D) = 6088.643 \text{ mm}^2 \leq$ 사용철근량... $O.K$

철근비검토 : $\rho_{min} \leq \rho \dots \therefore O.K$

◆ S18 정모멘트부

▷ 검토 조건

$f_{ck} = 27.0 \text{ MPa} \quad f_y = 400.0 \text{ MPa} \quad \lambda = 1.00$
 $\beta_1 = 0.850 \quad \phi_f = 0.85 \quad \phi_v = 0.75$
 $\rho_{min} = \max(0.25 \sqrt{f_{ck}} / f_y, 1.4 / f_y) = 0.00350$

계수 모멘트 $M_u = 1761.664 \text{ KN} \cdot \text{m}$

계수 전단력 $V_u = 0.000 \text{ KN}$

단면의 두께 $H = 1200.000 \text{ mm}$

단면 폭 $B = 1000.000 \text{ mm}$

유효 깊이 $D = 1130.000 \text{ mm}$

피복 두께 $D_c = 70.000 \text{ mm}$

▷ 휨모멘트 검토

- 휨강도 검토

사용철근량 $A_{s,use} = H25 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm})$
 $+ H22 @ 200.00 \text{ mm} \quad (D_c = 70.00 \text{ mm})$
 $= 7002.500 \text{ mm}^2 \quad \therefore P = A_s / (B \cdot D) = 0.00620$

$$\text{공칭강도시 등가응력깊이 } a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 122.048 \text{ mm}$$

$$\text{최외단 인장철근 변형률 } \epsilon_t = 0.02061 \geq 0.004 \dots \therefore \text{O.K}$$

$$\dots \text{여기서 } \epsilon_t = 0.003 \cdot (H - a / \beta_1 - D_{c_min}) / (a / \beta_1)$$

0.005 ≤ ϵ_t 이므로 인장지배단면, $\phi_f = 0.85$ 를 적용한다.

$$\phi M_n = \phi_f \cdot f_y \cdot A_s \cdot (D - a/2) = 2,545,072,000 \text{ N} \cdot \text{mm}$$

$$= 2545.072 \text{ KN} \cdot \text{m} \geq M_u = 1761.664 \text{ KN} \cdot \text{m} \dots \therefore \text{O.K} \quad (\text{S.F} = 1.445)$$

- . 필요철근량 및 철근비 검토

소요등가응력깊이 $a = 82.963 \text{ mm}$ 로 가정

$$A_s = M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \} = 4760.015 \text{ mm}^2$$

$$a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 82.963 \text{ mm} \quad \therefore \text{가정과 비슷함 O.K}$$

$$\rho_{req} = [M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \}] / (B \cdot D) = 0.00421 \Rightarrow 4/3 \rho_{req} = 0.00562$$

$$\therefore \text{필요철근량 } A_{s,req} = \rho_{req} \times (B \cdot D) = 4760.015 \text{ mm}^2 \leq \text{사용철근량} \dots \text{O.K}$$

$$\text{철근비검토 : } \rho_{min} \leq \rho \dots \therefore \text{O.K}$$

◆ S19 정모멘트부

▷ 검 토 조 건

$$f_{ck} = 27.0 \text{ MPa} \quad f_y = 400.0 \text{ MPa} \quad \lambda = 1.00$$

$$\beta_1 = 0.850 \quad \phi_f = 0.85 \quad \phi_v = 0.75$$

$$\rho_{min} = \max(0.25 \sqrt{f_{ck}} / f_y, 1.4 / f_y) = 0.00350$$

$$\text{계수 모멘트 } M_u = 2746.117 \text{ KN} \cdot \text{m}$$

$$\text{계수 전단력 } V_u = 0.000 \text{ KN}$$

$$\text{단면의 두께 } H = 1200.000 \text{ mm}$$

$$\text{단 면 폭 } B = 1000.000 \text{ mm}$$

$$\text{유효 깊이 } D = 1130.000 \text{ mm}$$

$$\text{피 복 두께 } D_c = 70.000 \text{ mm}$$

▷ 휨모멘트 검토

- . 휨강도 검토

$$\text{사용철근량 } A_{s,use} = H25 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm})$$

$$+ H22 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm})$$

$$= 8938.000 \text{ mm}^2 \quad \therefore P = A_s / (B \cdot D) = 0.00791$$

$$\text{공칭강도시 등가응력깊이 } a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 155.782 \text{ mm}$$

$$\text{최외단 인장철근 변형률 } \epsilon_t = 0.01550 \geq 0.004 \dots \therefore \text{O.K}$$

$$\dots \text{여기서 } \epsilon_t = 0.003 \cdot (H - a / \beta_1 - D_{c_min}) / (a / \beta_1)$$

0.005 ≤ ϵ_t 이므로 인장지배단면, $\phi_f = 0.85$ 를 적용한다.

$$\phi M_n = \phi_f \cdot f_y \cdot A_s \cdot (D - a/2) = 3,197,275,000 \text{ N} \cdot \text{mm}$$

$$= 3197.275 \text{ KN} \cdot \text{m} \geq M_u = 2746.117 \text{ KN} \cdot \text{m} \dots \therefore \text{O.K} \quad (\text{S.F} = 1.164)$$

- . 필요철근량 및 철근비 검토

소요등가응력깊이 $a = 132.325 \text{ mm}$ 로 가정

$$A_s = M_u / \{ \phi_f \cdot f_y \cdot (D-a/2) \} = 7592.150 \text{ mm}^2$$

$$a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 132.325 \text{ mm} \quad \therefore \text{가정과 비슷함 0.K}$$

$$\rho_{req} = [M_u / \{ \phi_f \cdot f_y \cdot (D-a/2) \}] / (B \cdot D) = 0.00672 \Rightarrow 4/3 \rho_{req} = 0.00896$$

$$\therefore \text{필요철근량 } A_{s,req} = \rho_{req} \times (B \cdot D) = 7592.150 \text{ mm}^2 \leq \text{사용철근량} \dots 0.K$$

$$\text{철근비검토 : } \rho_{min} \leq \rho \quad \dots \therefore 0.K$$

◆ P16 부모멘트부

▷ 검토 조건

$$f_{ck} = 27.0 \text{ MPa} \quad f_y = 400.0 \text{ MPa} \quad \lambda = 1.00$$

$$\beta_1 = 0.850 \quad \phi_f = 0.85 \quad \phi_v = 0.75$$

$$\rho_{min} = \max(0.25 \sqrt{f_{ck}} / f_y, 1.4 / f_y) = 0.00350$$

$$\text{계수 모멘트 } M_u = 3322.404 \text{ KN} \cdot \text{m} \quad \text{계수 전단력 } V_u = 0.000 \text{ KN}$$

$$\text{단면의 두께 } H = 1700.000 \text{ mm} \quad \text{단면 폭 } B = 1000.000 \text{ mm}$$

$$\text{유효 깊이 } D = 1630.000 \text{ mm} \quad \text{피복 두께 } D_c = 70.000 \text{ mm}$$

▷ 휨모멘트 검토

- . 휨강도 검토

$$\text{사용철근량 } A_{s,use} = H29 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm})$$

$$+ H25 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm})$$

$$= 11491.000 \text{ mm}^2 \quad \therefore \rho = A_s / (B \cdot D) = 0.00705$$

$$\text{공칭강도시 등가응력깊이 } a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 200.279 \text{ mm}$$

$$\text{최외단 인장철근 변형률 } \epsilon_t = 0.01775 \geq 0.004 \quad \dots \therefore 0.K$$

$$\dots \text{여기서 } \epsilon_t = 0.003 \cdot (H - a / \beta_1 - D_{c,min}) / (a / \beta_1)$$

$$0.005 \leq \epsilon_t \text{ 이므로 인장지배단면, } \phi_f = 0.85 \text{를 적용한다.}$$

$$\phi M_n = \phi_f \cdot f_y \cdot A_s \cdot (D - a/2) = 5,977,074,000 \text{ N} \cdot \text{mm}$$

$$= 5977.074 \text{ KN} \cdot \text{m} \geq M_u = 3322.404 \text{ KN} \cdot \text{m} \quad \dots \therefore 0.K \quad (S.F = 1.799)$$

- . 필요철근량 및 철근비 검토

$$\text{소요등가응력깊이 } a = 108.070 \text{ mm로 가정}$$

$$A_s = M_u / \{ \phi_f \cdot f_y \cdot (D-a/2) \} = 6200.503 \text{ mm}^2$$

$$a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 108.070 \text{ mm} \quad \therefore \text{가정과 비슷함 0.K}$$

$$\rho_{req} = [M_u / \{ \phi_f \cdot f_y \cdot (D-a/2) \}] / (B \cdot D) = 0.00380 \Rightarrow 4/3 \rho_{req} = 0.00507$$

$$\therefore \text{필요철근량 } A_{s,req} = \rho_{req} \times (B \cdot D) = 6200.503 \text{ mm}^2 \leq \text{사용철근량} \dots 0.K$$

$$\text{철근비검토 : } \rho_{min} \leq \rho \quad \dots \therefore 0.K$$

◆ P17 부모멘트부

▷ 검토 조건

$$f_{ck} = 27.0 \text{ MPa} \quad f_y = 400.0 \text{ MPa} \quad \lambda = 1.00$$

$$\beta_1 = 0.850 \quad \phi_f = 0.85 \quad \phi_v = 0.75$$

$$\rho_{min} = \max(0.25 \sqrt{f_{ck}}/f_y, 1.4/f_y) = 0.00350$$

$$\begin{aligned} \text{계수 모멘트 } M_u &= 3805.895 \text{ KN} \cdot \text{m} & \text{계수 전단력 } V_u &= 0.000 \text{ KN} \\ \text{단면의 두께 } H &= 1700.000 \text{ mm} & \text{단 면 폭 } B &= 1000.000 \text{ mm} \\ \text{유효 깊이 } D &= 1630.000 \text{ mm} & \text{피복 두께 } D_c &= 70.000 \text{ mm} \end{aligned}$$

▷ 휨모멘트 검토

- 휨강도 검토

$$\begin{aligned} \text{사용철근량 } A_{s,use} &= H29 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm}) \\ &+ H25 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm}) \\ &= 11491.000 \text{ mm}^2 \quad \therefore \rho = A_s/(B \cdot D) = 0.00705 \end{aligned}$$

$$\begin{aligned} \text{공칭강도시 등가응력깊이 } a &= (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 200.279 \text{ mm} \\ \text{최외단 인장철근 변형률 } \epsilon_t &= 0.01775 \geq 0.004 \dots \therefore \text{O.K} \\ \dots \text{여기서 } \epsilon_t &= 0.003 \cdot (H - a/\beta_1 - D_{c,min}) / (a/\beta_1) \\ 0.005 \leq \epsilon_t &\text{ 이므로 인장지배단면, } \phi_f = 0.85 \text{를 적용한다.} \end{aligned}$$

$$\begin{aligned} \phi M_n &= \phi_f \cdot f_y \cdot A_s \cdot (D - a/2) = 5,977,074,000 \text{ N} \cdot \text{mm} \\ &= 5977.074 \text{ KN} \cdot \text{m} \geq M_u = 3805.895 \text{ KN} \cdot \text{m} \dots \therefore \text{O.K} \quad (S.F = 1.570) \end{aligned}$$

- 필요철근량 및 철근비 검토

$$\begin{aligned} \text{소요등가응력깊이 } a &= 124.443 \text{ mm로 가정} \\ A_s &= M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \} = 7139.917 \text{ mm}^2 \\ a &= (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 124.443 \text{ mm} \quad \therefore \text{가정과 비슷함 O.K} \end{aligned}$$

$$\begin{aligned} \rho_{req} &= [M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \}] / (B \cdot D) = 0.00438 \Rightarrow 4/3 \rho_{req} = 0.00584 \\ \therefore \text{필요철근량 } A_{s,req} &= \rho_{req} \times (B \cdot D) = 7139.917 \text{ mm}^2 \leq \text{사용철근량} \dots \text{O.K} \end{aligned}$$

$$\text{철근비검토 : } \rho_{min} \leq \rho \dots \therefore \text{O.K}$$

◆ P18 부모멘트부

▷ 검토 조건

$$f_{ck} = 27.0 \text{ MPa} \quad f_y = 400.0 \text{ MPa} \quad \lambda = 1.00$$

$$\beta_1 = 0.850 \quad \phi_f = 0.85 \quad \phi_v = 0.75$$

$$\rho_{min} = \max(0.25 \sqrt{f_{ck}}/f_y, 1.4/f_y) = 0.00350$$

$$\begin{aligned} \text{계수 모멘트 } M_u &= 4133.833 \text{ KN} \cdot \text{m} & \text{계수 전단력 } V_u &= 0.000 \text{ KN} \\ \text{단면의 두께 } H &= 1700.000 \text{ mm} & \text{단 면 폭 } B &= 1000.000 \text{ mm} \\ \text{유효 깊이 } D &= 1630.000 \text{ mm} & \text{피복 두께 } D_c &= 70.000 \text{ mm} \end{aligned}$$

▷ 휨모멘트 검토

- . 휨강도 검토

$$\begin{aligned}\text{사용철근량 } A_{s,use} &= H29 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm}) \\ &+ H25 @ 100.00 \text{ mm} \quad (D_c = 70.00 \text{ mm}) \\ &= 11491.000 \text{ mm}^2 \quad \therefore P = A_s / (B \cdot D) = 0.00705\end{aligned}$$

$$\text{공칭강도시 등가응력깊이 } a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 200.279 \text{ mm}$$

$$\text{최외단 인장철근 변형률 } \epsilon_t = 0.01775 \geq 0.004 \dots \therefore \text{O.K}$$

$$\dots \text{여기서 } \epsilon_t = 0.003 \cdot (H - a / \beta_1 - D_{c_min}) / (a / \beta_1)$$

0.005 $\leq \epsilon_t$ 이므로 인장지배단면, $\phi_f = 0.85$ 를 적용한다.

$$\begin{aligned}\phi M_n &= \phi_f \cdot f_y \cdot A_s \cdot (D - a/2) = 5,977,074,000 \text{ N} \cdot \text{mm} \\ &= 5977.074 \text{ KN} \cdot \text{m} \geq M_u = 4133.833 \text{ KN} \cdot \text{m} \dots \therefore \text{O.K} \quad (S.F = 1.446)\end{aligned}$$

- . 필요철근량 및 철근비 검토

소요등가응력깊이 $a = 135.651 \text{ mm}$ 로 가정

$$A_s = M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \} = 7782.954 \text{ mm}^2$$

$$a = (A_s \cdot f_y) / (0.85 \cdot f_{ck} \cdot B) = 135.651 \text{ mm} \quad \therefore \text{가정과 비슷함 O.K}$$

$$\rho_{req} = [M_u / \{ \phi_f \cdot f_y \cdot (D - a/2) \}] / (B \cdot D) = 0.00477 \Rightarrow 4/3 \rho_{req} = 0.00637$$

$$\therefore \text{필요철근량 } A_{s,req} = \rho_{req} \times (B \cdot D) = 7782.954 \text{ mm}^2 \leq \text{사용철근량} \dots \text{O.K}$$

$$\text{철근비검토 : } \rho_{min} \leq \rho \dots \therefore \text{O.K}$$