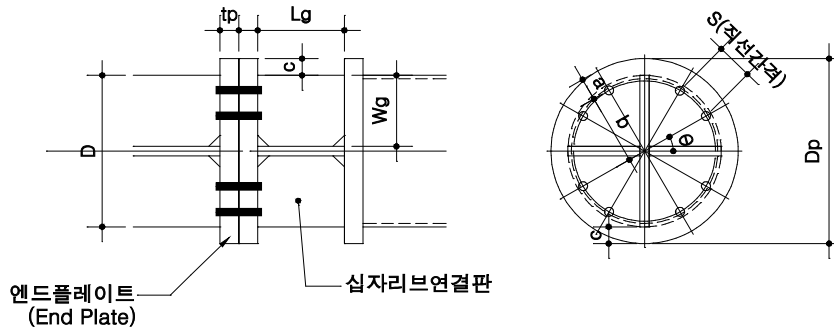


1. 설계조건

	E =	205000	MPa			
* 원형강관	Fy =	235	MPa	D =	φ406.4	mm
	Fu =	400	MPa	t =	9	mm
				Ag =	11200	mm ²
* 엔드플레이트	Fyp =	355	MPa	Dp =	φ496.4	mm
	Fup =	520	MPa	tp =	50	mm



* 십자리브연결판

					(1group당)
Fyg =	355	MPa	매수	연단거리	폭
Fug =	520	MPa		c (mm)	Wg (mm)
			1	45.0	190.7
					길이
					Lg (mm)
					230.0
					두께
					tg (mm)
					25
					Scallop
					Sc (mm)
					30

폭두께비 $b/t = Wg/Tg = 190.7/25 = 7.63 < 0.56 \cdot \sqrt{E/Fyg} = 13.46 \dots OK$

* 고력볼트

						(1group당)
고력볼트	직경	bolt hole	개수	단면적	인장강도	배치
	db (mm)	dbh (mm)	Nb (EA)	Ab (mm ²)	Fub (MPa)	a (mm) b (mm) 각도 θ (°) 직선간격 S (mm)
F10T	M27	30.00	2	573	1000	60.0 188.2 30.0 97.4

Σ 8 EA
 $S = 97.4 \text{ mm} \geq 2.5 \cdot db = 67.5 \text{ mm} \dots OK$
 $Lc = 81.6 \text{ mm} \geq 60 \text{ mm} \dots OK$

2. 소요인장용력

$\phi P_n = \phi t \cdot F_y \cdot A_g = 0.9 \cdot 235 \cdot 11200 \cdot 1/10^3 = 2368.8 \text{ kN}$

$\phi P_n = \phi t \cdot F_u \cdot A_e = \phi t \cdot F_u \cdot U \cdot A_n = 0.75 \cdot 400 \cdot 1 \cdot 11200 \cdot 1/10^3 = 3360.0 \text{ kN}$

$A_n = A_g = 11200 \text{ mm}^2 \quad U = 1.00$

$\therefore P_{u, req} = \text{MIN}(2368.8, 3360) = 2368.8 \text{ kN}$

3. 고력볼트 검토

$F_{nt} = 0.75 \cdot F_{ub} = 0.75 \cdot 1000 = 750.0 \text{ N/mm}^2$

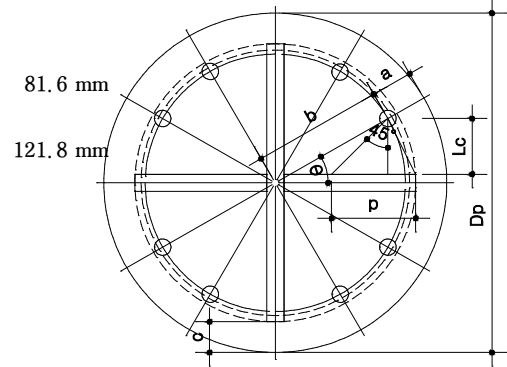
$\phi R_n = \phi \cdot F_{nt} \cdot A_b = 0.75 \cdot 750 \cdot 573 \cdot 1/10^3 = 322.3 \text{ kN/EA}$

$\therefore N_{req} = P_{u, req} / \phi R_n$

$= 2368.8 / 322.3 = 7.35 \text{ EA} \leq 8 \text{ EA} \dots OK (0.92)$

4. 엔드플레이트 소요두께 산정

$$\begin{aligned} L_c &= b \cdot \sin \theta - t_g / 2 \\ &= 188.2 \cdot \sin(30^\circ) - 25 / 2 = \\ p &= L_c + (D_p - c \cdot 2) / 2 - b \cdot \cos \theta \\ &= 81.6 + (496.4 - 45 \cdot 2) / 2 - 188.2 \cdot \cos(30^\circ) = \end{aligned}$$



$$\begin{aligned} M_{ut} &= P_{u, req} / N_b \cdot L_c / p = 2368.8 \cdot 10^3 / 8 \cdot 81.6 / 121.8 = \\ \phi M_n &= \phi \cdot F_y \cdot Z_x = 0.90 \cdot 355 \cdot (1 \cdot t_p^2 / 4) = \\ \therefore t_{p, req} &= \sqrt{(198372.4 / 79.88)} = 49.83 \text{ mm} \leq t_p = 50 \text{ mm} \quad \dots \text{OK} \end{aligned}$$

5. 엔드플레이트와 십자리브연결판 용접부 검토

(완전용입용접)

* 용접치수

$$\begin{aligned} S_{w1} &= 25.00 \text{ mm} \quad n_{w1} = 1 \text{ 개소/1group당} \\ L_{we} &= (W_g - S_c - 2 \cdot S_{w1}) \cdot 4_{\text{group}} = (190.7 - 30 - 2 \cdot 25) \cdot 4 = \\ A_w &= n_{w1} \cdot S_{w1} \cdot L_{we} = 1 \cdot 25 \cdot 442.8 = \end{aligned}$$

$$\begin{aligned} \text{엔드탭 유무} &: \text{없음.} \\ &442.8 \text{ mm} \\ &11070.0 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned} \phi R_n &= \phi \cdot F_u \cdot t_g \cdot L_{we} = 0.75 \cdot 520 \cdot 25 \cdot 442.8 \cdot 1 / 10^3 = 4317.3 \text{ kN} \\ \therefore P_{u, req} / \phi R_n &= 2368.8 / 4317.3 = 0.55 \leq 1.00 \quad \dots \text{OK} \end{aligned}$$

$$\begin{aligned} \phi R_n &= \phi \cdot F_y \cdot t_g \cdot L_{we} = 0.9 \cdot 355 \cdot 25 \cdot 442.8 \cdot 1 / 10^3 = 3536.9 \text{ kN} \\ \therefore P_{u, req} / \phi R_n &= 2368.8 / 3536.9 = 0.67 \leq 1.00 \quad \dots \text{OK} \end{aligned}$$

6. 십자리브연결판 교차부 용접부 검토

(완전용입용접)

- 십자리브 연결판 교차부의 용접은 필요없으나, 좌굴 등을 고려하여 전단력에 대해서만 검토한다.

* 용접치수

$$\begin{aligned} S_{w2} &= 25.00 \text{ mm} \quad n_{w2} = 1 \text{ 개소/1group당} \\ L_{we} &= (L_g - 2 \cdot S_c - 2 \cdot S_{w2}) \cdot 4_{\text{group}} = (230 - 2 \cdot 30 - 2 \cdot 25) \cdot 4 = \\ A_w &= n_{w2} \cdot S_{w2} \cdot L_{we} = 1 \cdot 25 \cdot 480 = \end{aligned}$$

$$\begin{aligned} \text{엔드탭 유무} &: \text{없음.} \\ &480.0 \text{ mm} \\ &12000.0 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned} \phi R_n &= \phi \cdot 0.6 \cdot F_u \cdot t_g \cdot L_{we} = 0.75 \cdot 0.6 \cdot 520 \cdot 25 \cdot 480 \cdot 1 / 10^3 = 2808.0 \text{ kN} \\ \therefore P_{u, req} / \phi R_n &= 2368.8 / 2808 = 0.84 \leq 1.00 \quad \dots \text{OK} \end{aligned}$$

$$\begin{aligned} \phi R_n &= \phi \cdot 0.6 \cdot F_y \cdot t_g \cdot L_{we} = 1 \cdot 0.6 \cdot 355 \cdot 25 \cdot 480 \cdot 1 / 10^3 = 2556.0 \text{ kN} \\ \therefore P_{u, req} / \phi R_n &= 2368.8 / 2556 = 0.93 \leq 1.00 \quad \dots \text{OK} \end{aligned}$$

7. 엔드플레이트와 원형강관 용접부 검토

용접재 인장강도 $F_{uw} = 420 \text{ MPa}$

- 용접치수

$$S_{w3} = 9.00 \text{ mm} \quad n_{w3} = 1 \text{ 개소}$$

필릿용접(1)/완전용입용접(2) : 2

$$\begin{aligned} L_{we} &= 2 \cdot \pi \cdot (D/2 - S_{w3}/2) = 2 \cdot \pi \cdot (406.4/2 - 9/2) = 1248.5 \text{ mm} \\ A_w &= n_{w3} \cdot S_{w3} \cdot L_{we} = 1 \cdot 9 \cdot 1248.5 = 11236.5 \text{ mm}^2 \end{aligned}$$

$$\begin{aligned} \phi R_n &= \phi \cdot F_u \cdot t \cdot L_{we} = 0.75 \cdot 400 \cdot 9 \cdot 1248.5 \cdot 1 / 10^3 = 3371.0 \text{ kN} \\ \therefore P_{u, req} / \phi R_n &= 2368.8 / 3371 = 0.70 \leq 1.00 \quad \dots \text{OK} \end{aligned}$$

$$\begin{aligned} \phi R_n &= \phi \cdot F_y \cdot t \cdot L_{we} = 0.9 \cdot 235 \cdot 9 \cdot 1248.5 \cdot 1 / 10^3 = 2376.5 \text{ kN} \\ \therefore P_{u, req} / \phi R_n &= 2368.8 / 2376.5 = 1.00 \leq 1.00 \quad \dots \text{OK} \end{aligned}$$