Chapter 07:

Chapter Name: Design of Fink type roof truss (Analysis)

7·1 Truss Analysis:

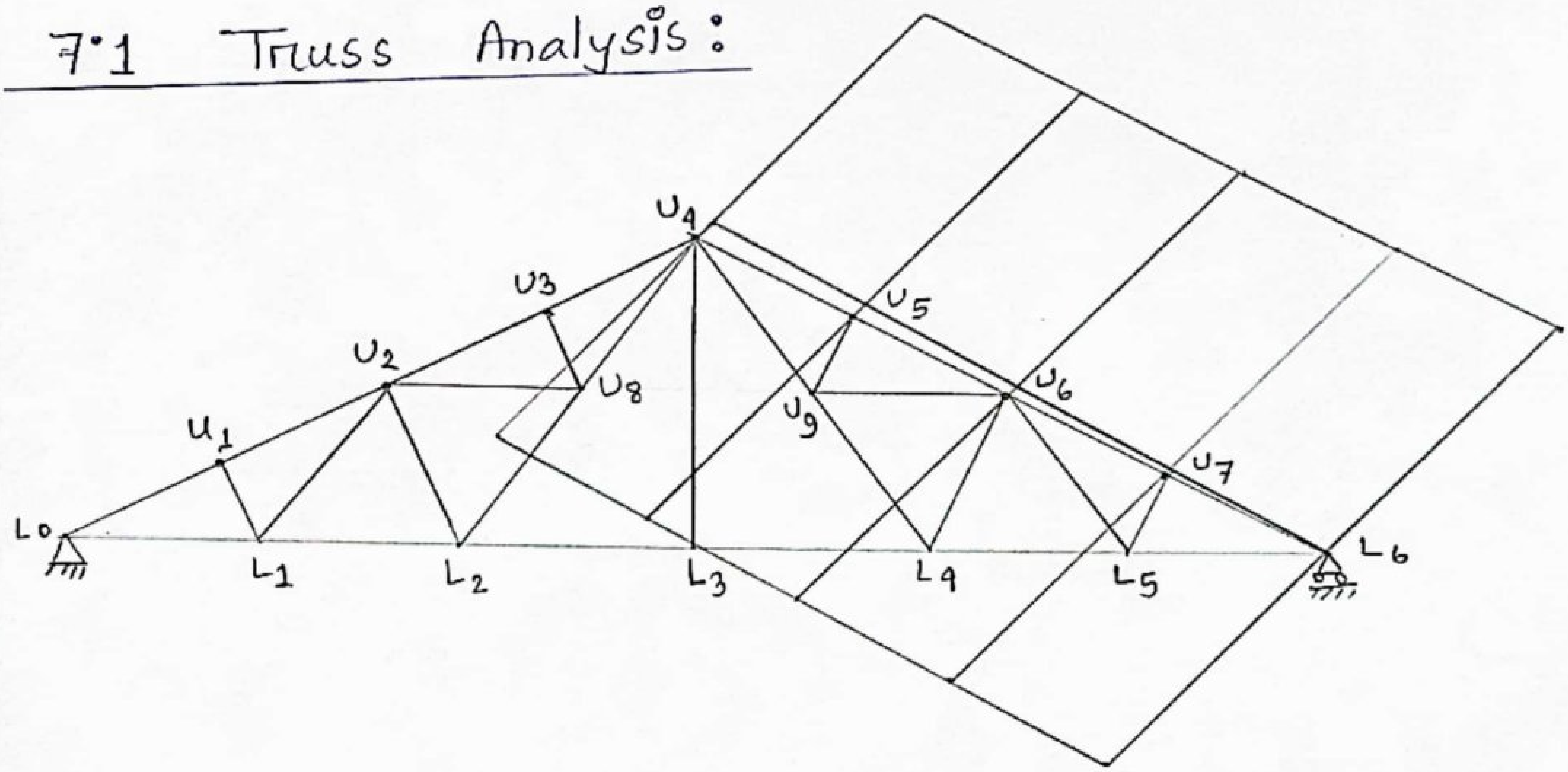

Figure 7·1 : Truss Analysis

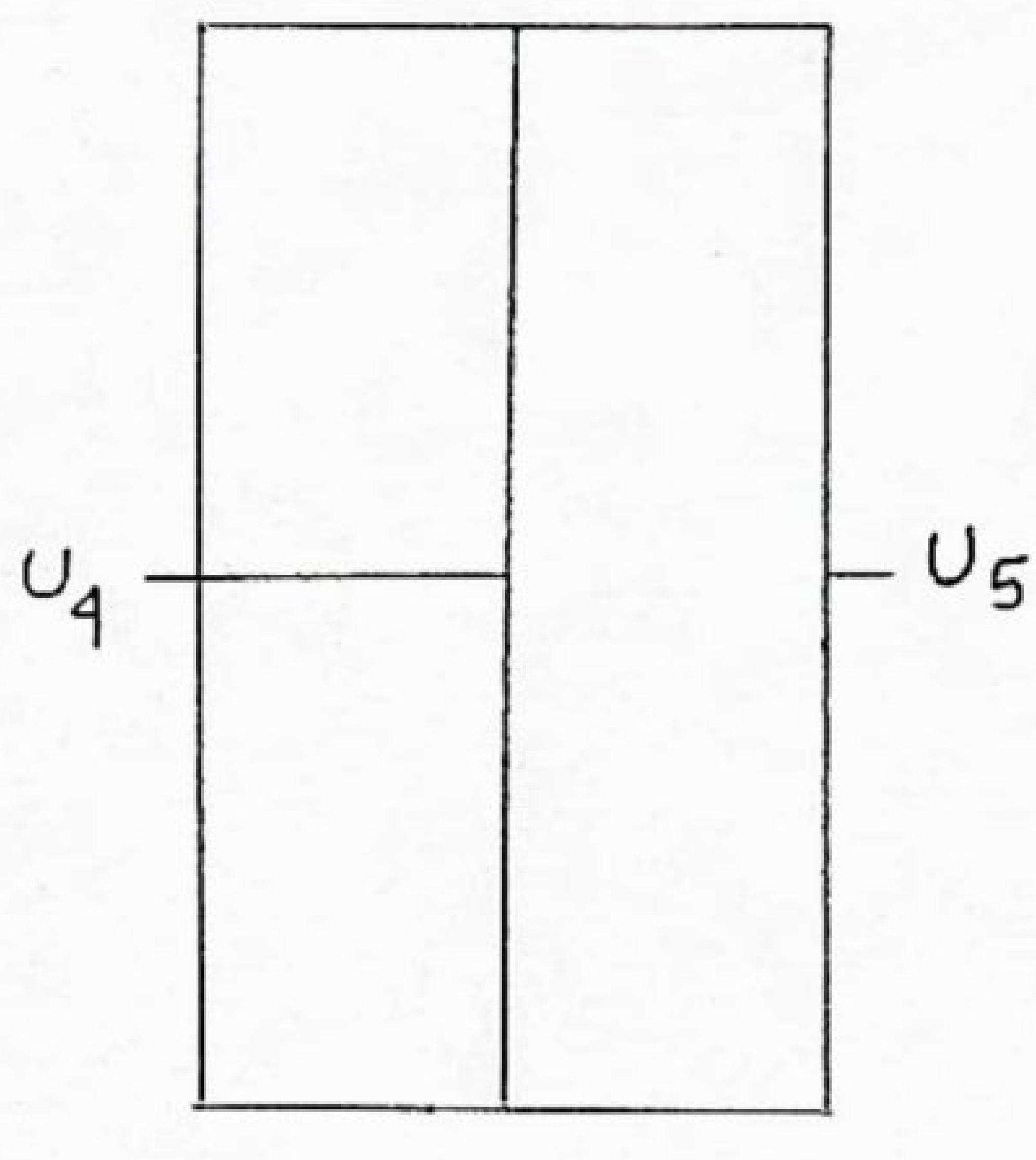

Figure 7·2: Half load on joint U_4

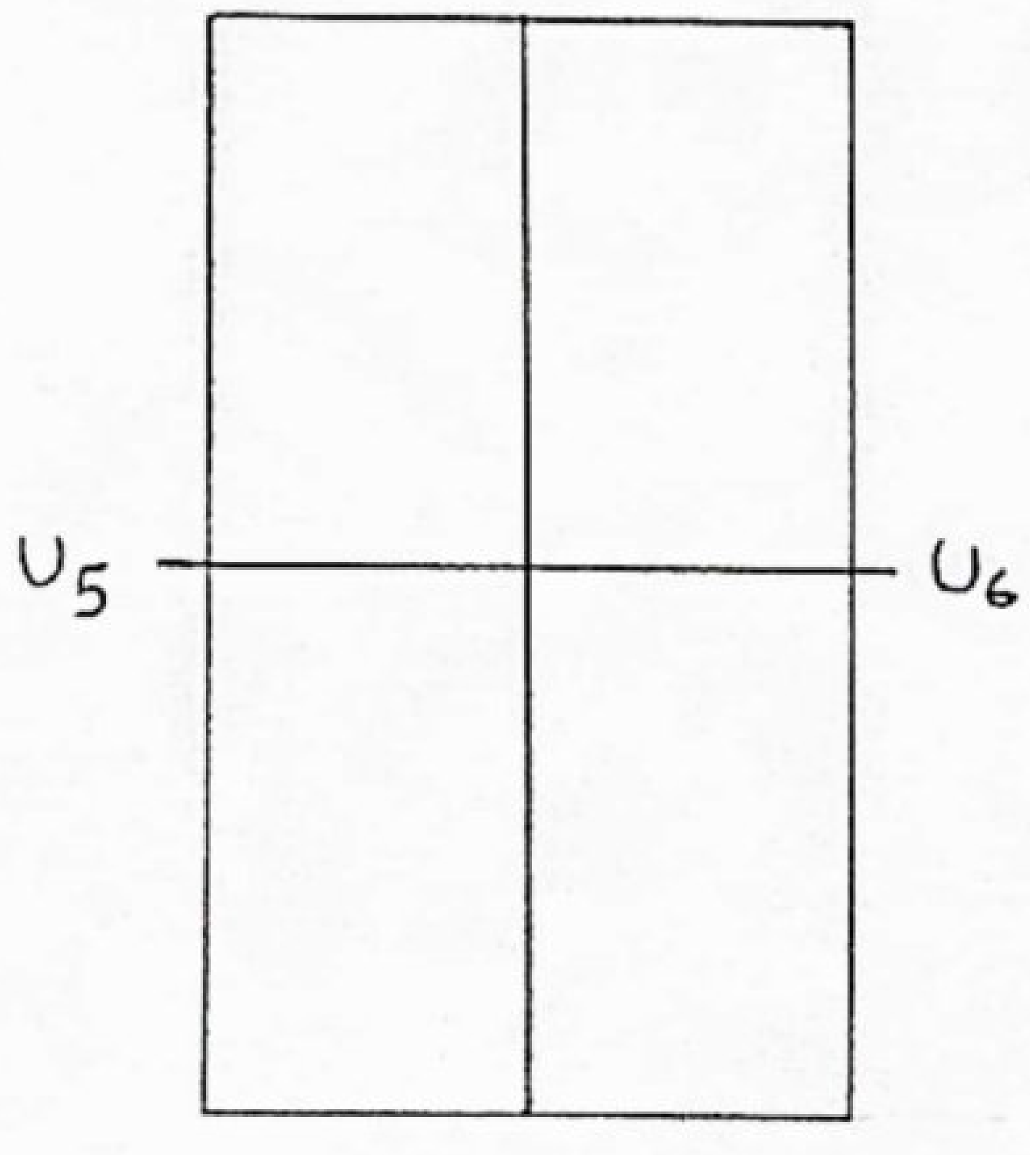

Figure 7·3: Full load on joint U_5 or U_6

7·2 Dead Load Analysis:

ⓐ Wt. of roof = Spacing of truss × Spacing of purlin × 2·25

= (19·41 × 14·395 × 2·25) lb

= 629 lb

ⓑ Wt. of purlin = Spacing of truss × (Design Wt/ft of purlin)

= (19·41 × 25) lb

= 485·28 lb

ⓒ Wt of truss = 0·4 + 0·04 L (for steel)

= 0·4 + 0·04 × 103 [L = Span length of truss = 103 ft]

= 4·52 lb/sq-ft

= 4·52 × 19·41 × 14·395 × cos 26·56°

= 1130·22 lb

ⓓ Wt. of Ceiling = 10 lb/sq-ft (assumed)

Load on joints:

$U_1 = U_2 = U_3 = (a) + (b) + (c)$

= 629 + 485·28 + 1130·22

= 2244·58 lb

= 2·245 Kips

Load on joints:

$U_5 = U_6 = U_7 = (a) + (b) + (c)$

= 629 + 485·28 + 1130·22

= 2244·58 lb = 2·245 kips

Load on Joints:

$U_4 = (a) + 2(b) + (c)$

$= (629 + 2\times 485.25 + 1130.22)\ lb$

$= 2730.22\ lb = 2.73\ kips$

Load on Joints:

$L_1 = L_5 = 10 \times \left(\frac{L_0L_1}{2} + \frac{L_1L_2}{2}\right) \times$ Spacing of truss

$= 10 \times \left(\frac{16.09}{2} + \frac{16.09}{2}\right) \times 19.41$

$= 3125.338\ lb$

$= 3.125\ kips$

Load on Joints:

$L_2 = L_4 = 10 \times \left(\frac{L_1L_2}{2} + \frac{L_2L_3}{2}\right) \times$ Spacing of truss

$= 10 \times \left(\frac{16.09}{2} + \frac{19.31}{2}\right) \times 19.41$

$= 3438.11\ lb = 3.438\ kips$

Load on Joints:

$L_3 = 10 \times \left(\frac{L_2L_3}{2} + \frac{L_3L_4}{2}\right) \times$ Spacing of truss

$= 10 \times \left(\frac{19.31}{2} + \frac{19.31}{2}\right) \times 19.41$

$= 3750.88\ lb = 3.75\ kips$

Load on Joints :

$$L_0 = L_6 = U_1 + \frac{L_1}{2}$$

$$= 2.245 + \frac{3.125}{2}$$

$$= 3.81 \text{ kips}$$

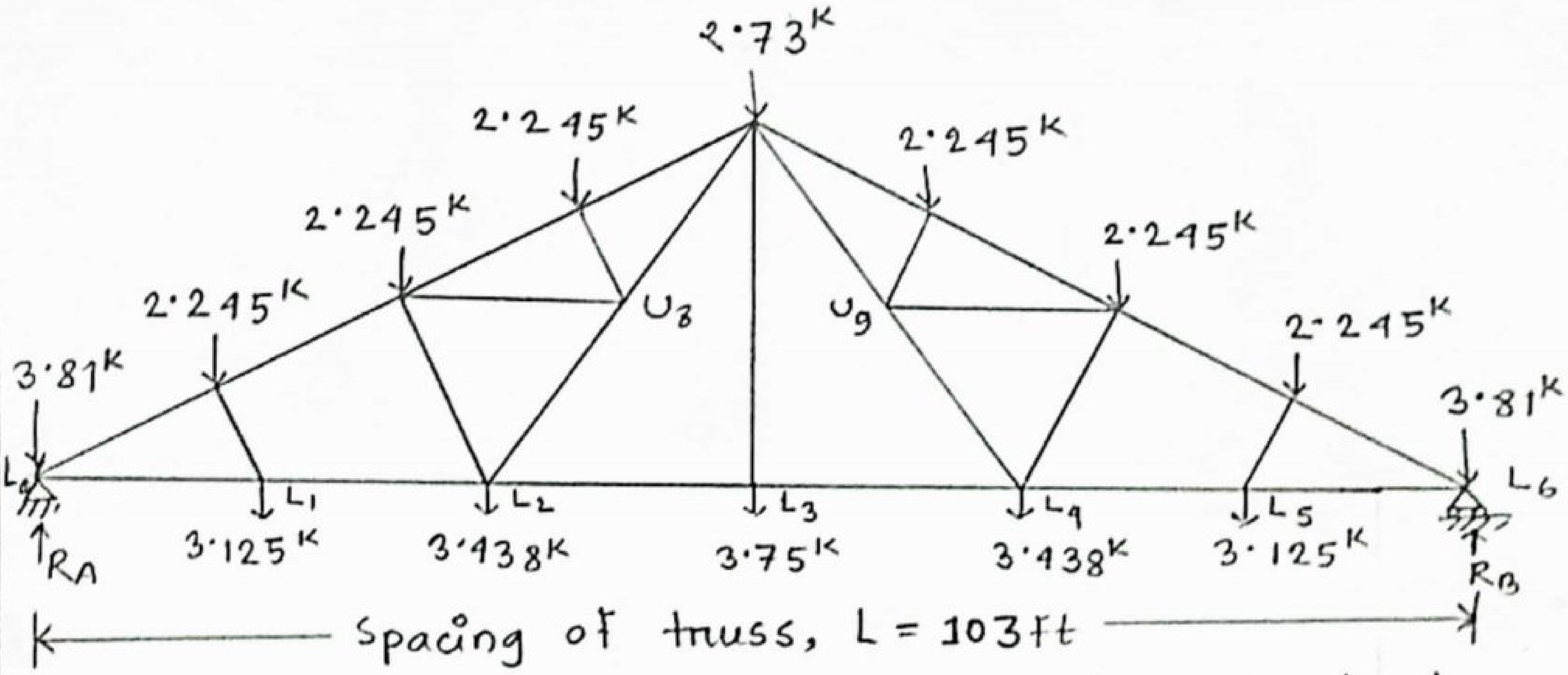

Figure : 7.4: Fink type Roof Truss (Showing Dead Load)

Consider the free body diagram of above truss,

$R_A = R_B =$ summation of applied force $\div 2$

$$= (3.81 \times 2 + 2.245 \times 6 + 2.73 + 3.125 \times 2 + 3.438 \times 2 + 3.75) \div 2$$

$$= 40.696 \div 2$$

$$= 20.348 \text{ kips}$$

$$\approx 20.35 \text{ kips}$$

Consider the joint L_0,

$\Sigma F_y = 0$

$\Rightarrow F_{L_0U_1} \sin 26.56 + 3.81 - 20.35 = 0$

$\Rightarrow F_{L_0U_1} = \dfrac{20.35 - 3.81}{\sin 26.56}$

$F_{L_0U_1} = 37$ kips (C)

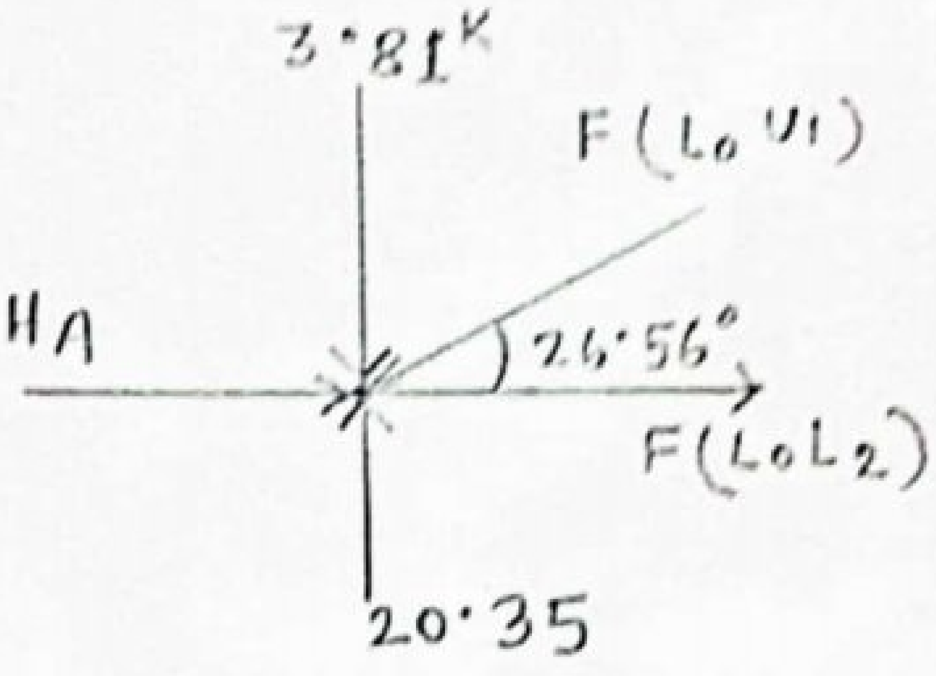

Figure: 7.5: Joint L_0

$\Sigma F_x = 0 \Rightarrow F_{L_0L_1} - F_{L_0U_1} \cos 26.56 = 0$

$\Rightarrow F_{L_0L_1} = 37 \cos 26.56$

$\therefore F_{L_0L_1} = 33.10$ kips (T)

consider the joint U_1,

$\Sigma F_y = 0$

$\Rightarrow F_{L_1U_1} - 2.245 \cos 26.56° = 0$

$\therefore F_{L_1U_1} = 2.008$ kips (C)

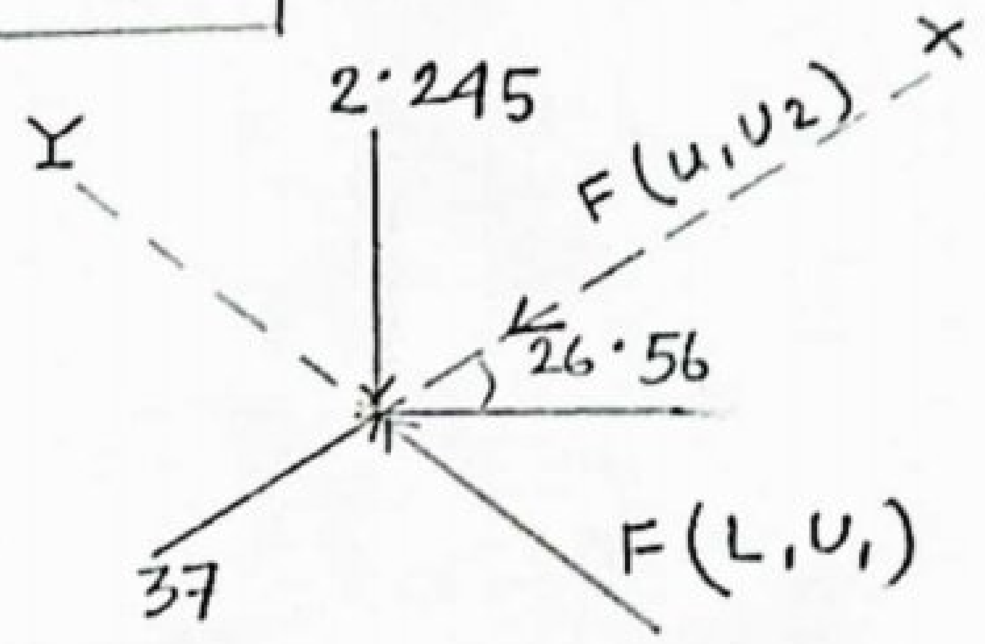

Figure 7.6: Joint U_1

$\Sigma F_x = 0 \Rightarrow F_{U_1U_2} - 37 + 2.245 \sin 26.56° = 0$

$\Rightarrow F_{U_1U_2} = 35.996$ kips (C)

$\therefore F_{U_1U_2} = 36$ kips (C)

Consider the joint L_1,

$\Sigma F_y = 0$

$\Rightarrow F_{L_1U_2} \sin 53.10 - 3.125 - 2.008 \sin 63.44 = 0$

$\Rightarrow F_{L_1U_2} = \dfrac{3.125 + 2.008 \sin 63.44}{\sin 53.10}$

$\therefore F_{L_1U_2} = 6.154$ kips (T)

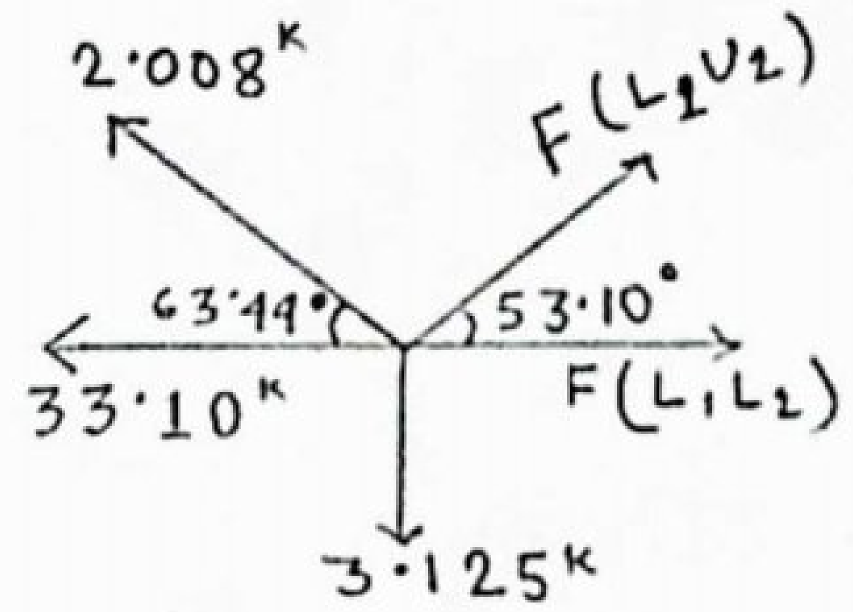

Figure 7.7: Joint L_1

$\sum F_x = 0$

$\Rightarrow F_{L_1L_2} - 33.10 + 2.008 \cos 63.44 + 6.154 \cos 53.10 = 0$

$\Rightarrow F_{L_1L_2} = 33.10 - 2.008 \cos 63.44 - 6.154 \cos 53.10$

$\therefore$ $\boxed{F_{L_1L_2} = 28.51 \text{ kips}}$ (T)

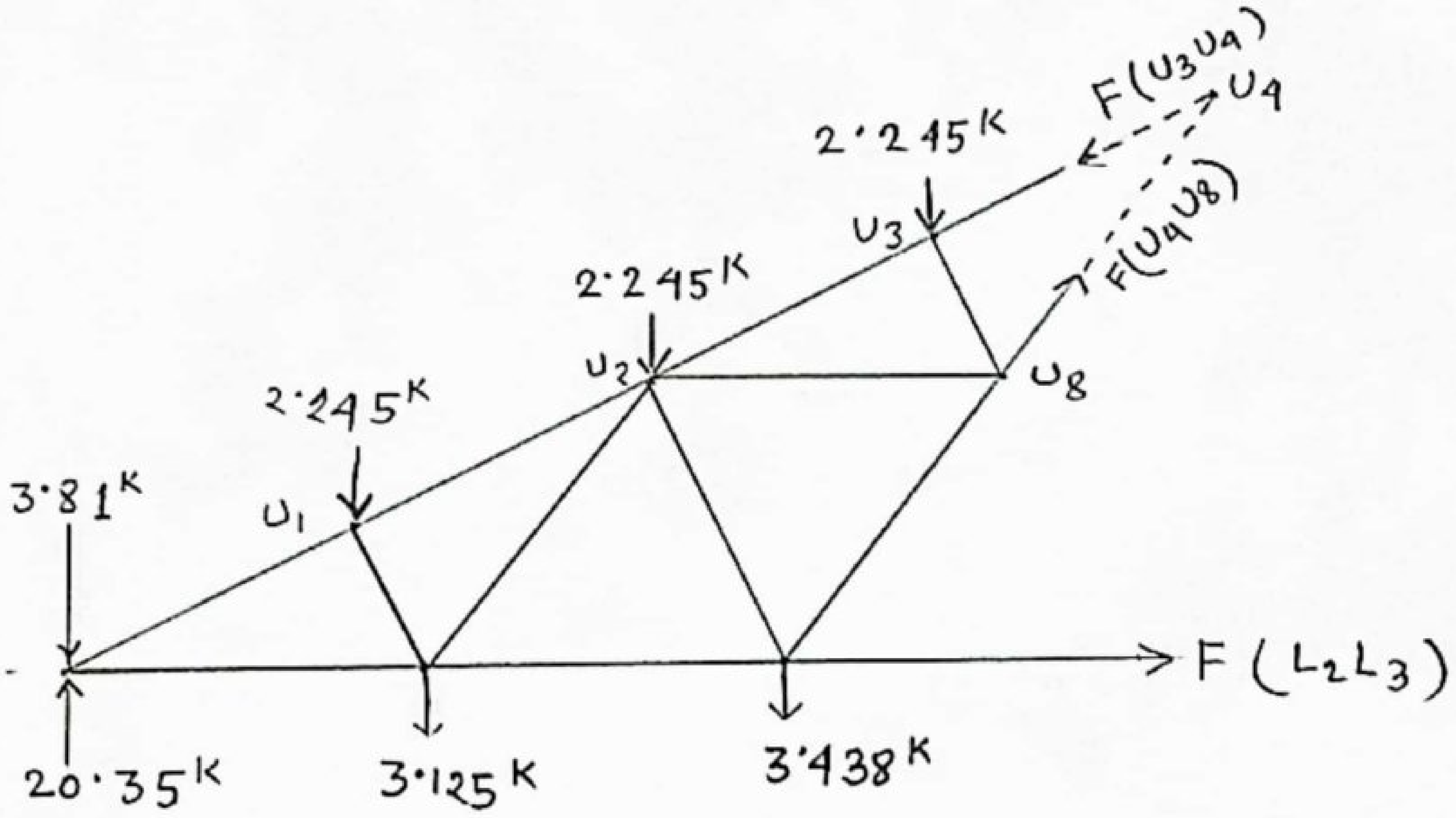

Figure 7.8 : section 1-1

consider the left portion of the section 1-1,

$\sum M_{U_4} = 0$

$\Rightarrow F_{L_2L_3} \times 25.75 = \{(20.35 - 3.81) \times 51.50\} - 2.245 \times 38.625$

$- 2.245 \times 25.75 - 2.245 \times 12.875 - 3.125 \times 35.4$

$- 3.438 \times 19.30$

$\Rightarrow$ $\boxed{F_{L_2L_3} = 19.54 \text{ kips}}$ (T)

$\Sigma F_x = 0$

$\Rightarrow F_{U_3U_4} \cos 26.56 = F_{L_2L_3} + F_{U_4U_8} \cos 53.10$

$\Rightarrow F_{U_3U_4} = 21.85 + 0.6712\, F_{U_4U_8}$ ——— (1)

$\Sigma F_y = 0$

$3.25 + F_{U_4U_8} \sin 53.10 = F_{U_3U_4} \sin 26.56°$

$\Rightarrow 3.25 + 0.7996\, F_{U_4U_8} = 0.4471(21.85 + 0.6712\, F_{U_4U_8})$

$\Rightarrow$ $F_{U_4U_8} = 13.05$ kips (T)

From eqtn (1) $F_{U_3U_4} = 21.85 + 0.6712 \times 13.05$

$\therefore$ $F_{U_3U_4} = 30.611$ kips (C)

consider the joint L_3,

$\Sigma F_x = 0$

$\Rightarrow$ $F_{L_3L_4} = 19.54$ kips (T)

$\Sigma F_y = 0$

$\Rightarrow$ $F_{L_3U_4} = 3.751$ kips (T)

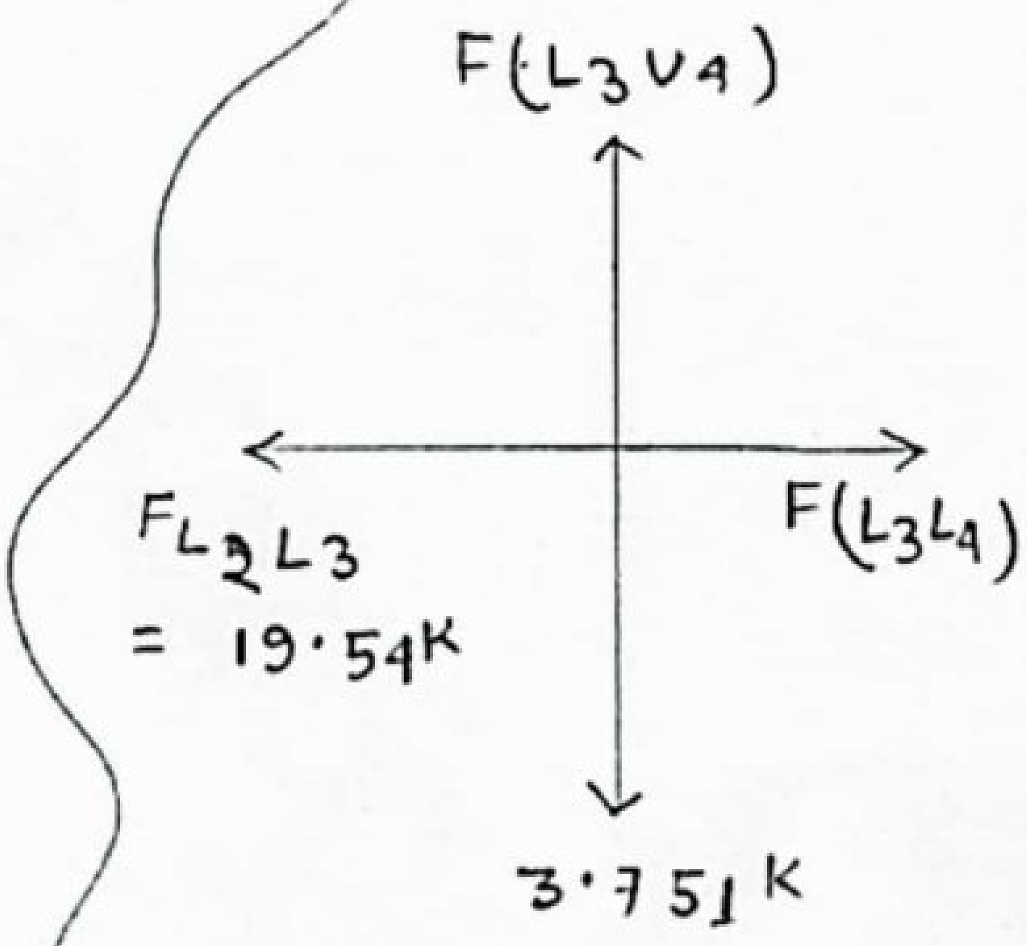

Figure 7.9: Joint L_3

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consider the joint U_3,

$\Sigma F_x = 0$

$\Rightarrow F_{U_2U_3} = F_{U_3U_4} + 2.245 \cos 63.44^\circ$

$\therefore$ $F_{U_3U_4} = 31.61$ kips (c)

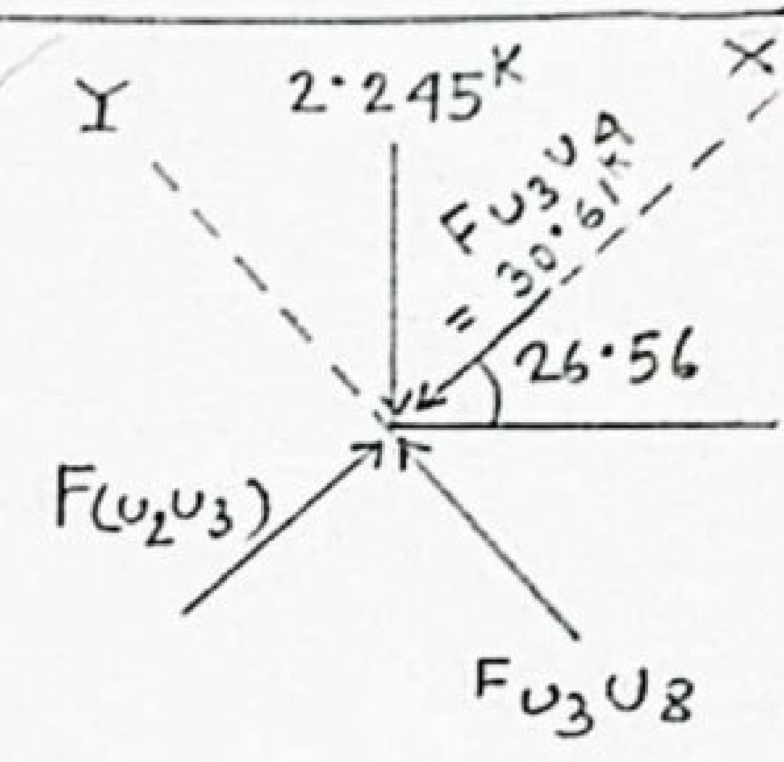

Figure 7.10: Joint U_3

$\Sigma F_y = 0$

$\Rightarrow F_{U_3U_8} = 2.245 \sin 63.44^\circ$

$\therefore$ $F_{U_3U_8} = 2.008$ kips (c)

consider the joint L_2,

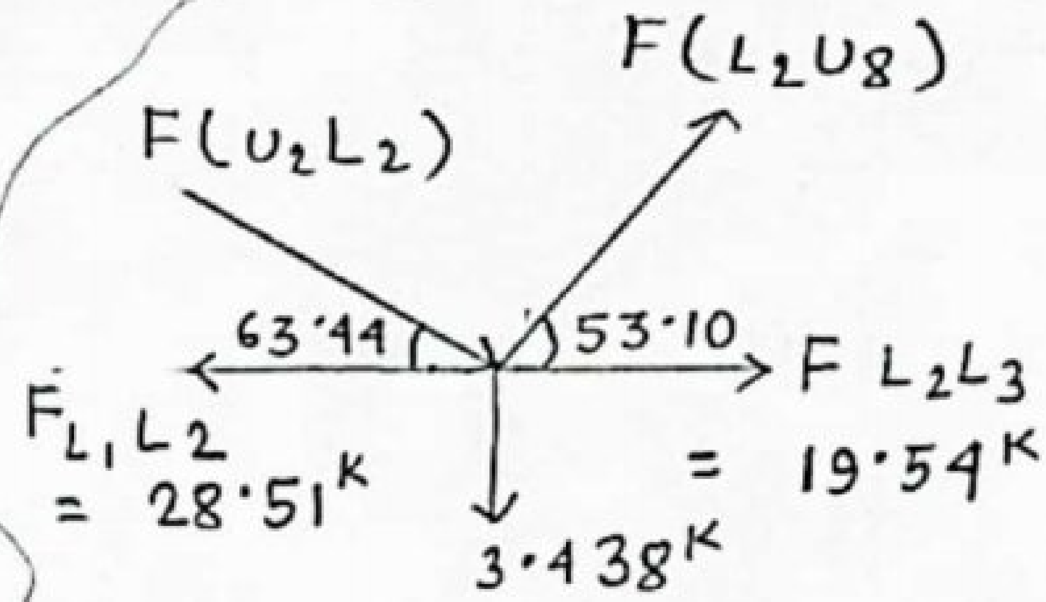

Figure 7.11: Joint L_2

$\Sigma F_y = 0$

$\Rightarrow 3.438 + F_{U_2L_2} \sin 63.44$

$= F_{L_2U_8} \sin 53.10$

$\Rightarrow F_{L_2U_8} = 4.299 + 1.1185 F_{U_2L_2}$ ——— (2)

$\Sigma F_x = 0$

$\Rightarrow 28.51 - 19.54 - F_{U_2L_2} \cos 63.44 = F_{L_2U_8} \cos 53.10^\circ$

$\Rightarrow 8.97 - 0.44713 \, F_{U_2L_2} = 0.6 \, F_{L_2U_8}$

$\Rightarrow 8.97 - 0.44713 \, F_{U_2L_2} = 0.6 (4.299 + 1.1185 \, F_{U_2L_2})$

$\Rightarrow 1.11823 \, F_{U_2L_2} = 6.3906$

$\therefore$ $F_{U_2L_2} = 5.715$ kips (c)

From equation ②

$$F_{L_2U_8} = 4.299 + 1.1185 \times 5.715$$

$$\therefore \boxed{F_{L_2U_8} = 10.69 \text{ kips}} \ (T)$$

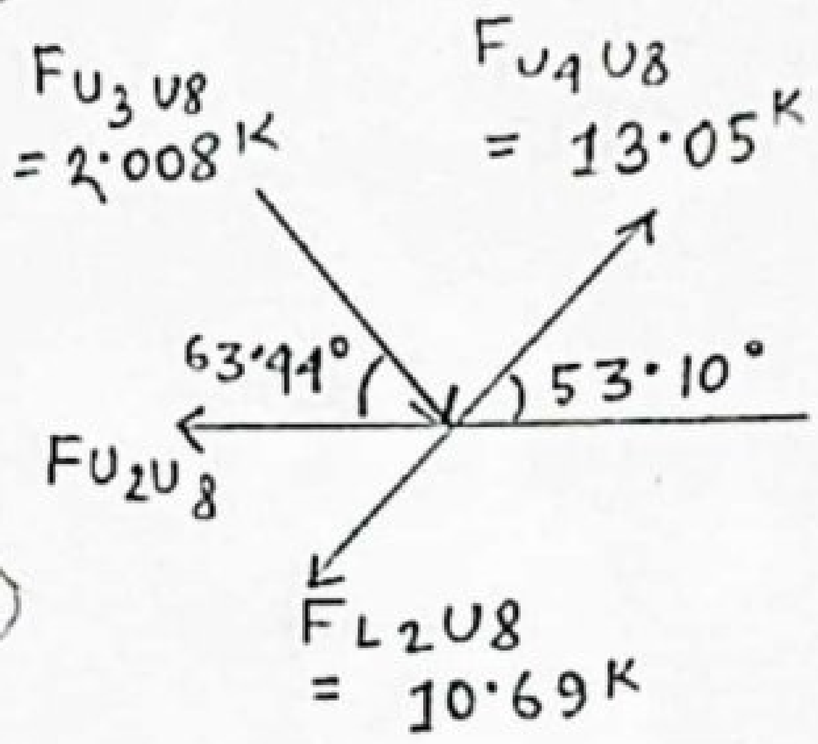

Figure 7.12: Joint U_8

consider the joint U_8,

$$\Sigma F_x = 0$$

$$F_{U_2U_8} = 13.05 \cos 53.10° + 2.008 \cos 63.44° - 10.69 \cos 53.10°$$

$$\Rightarrow \boxed{F_{U_2U_8} = 2.315 \text{ kips}} \ (T)$$

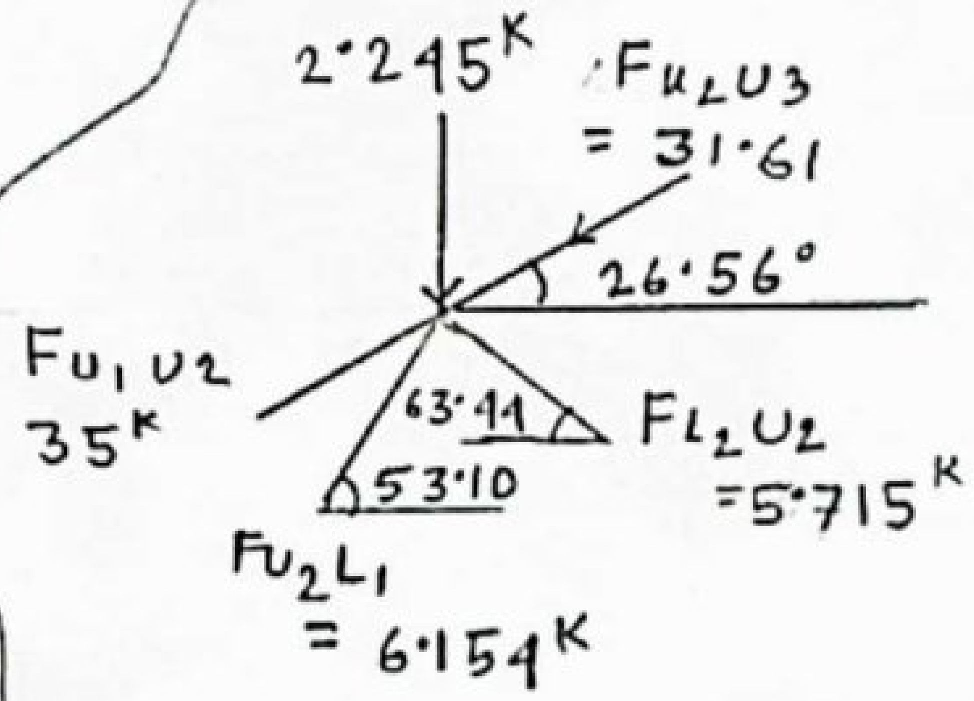

Figure 7.13: Joint U_2

consider the joint U_2 (For check)

$$\Rightarrow \Sigma F_x = 36 \cos 26.56° + 2.315 - 31.61 \cos 26.56° - 5.715 \cos 63.44° - 6.154 \sin 53.10°$$

$$= 0 \text{ kips} \quad \text{(Check)}$$

$$\Sigma F_y = 36 \sin 26.56° - 31.61 \sin 26.56° + 5.715 \sin 63.44° - 2.245 - 6.154 \sin 53.10°$$

$$= 0 \text{ kips} \quad \text{(Check)}$$

The left & right portion of the truss is equal. Hence the force of the member of the right portion of the section 1-1 is equal to the force on member of the left portion of that section.

Table 7·1: Member Stresses due to dead load

Member	Length in ft.	Stress in kips	
		Compression	Tension
$L_0 L_1$	16·09	–	33·10
$L_1 L_2$	16·09	–	28·51
$L_2 L_3$	19·31	–	19·54
$L_3 L_4$	19·31	–	19·54
$L_4 L_5$	16·09	–	28·51
$L_5 L_6$	16·09	–	33·10
$L_0 U_1$	14·39	37	–
$U_1 U_2$	14·39	36	–
$U_2 U_3$	14·39	31·61	–
$U_3 U_4$	14·39	30·611	–
$U_4 U_5$	14·39	30·611	–
$U_5 U_6$	14·39	31·61	–
$U_6 U_7$	14·39	36	–
$U_7 L_6$	14·39	37	–
$U_1 L_1$	7·19	2·008	–

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Member	Length in ft.	Stress in kips	
		Compression	Tension
U_2L_2	14·39	5·715	—
L_3U_4	25·75	—	3·751
L_4U_6	14·39	5·715	—
L_5U_7	7·19	2·008	—
L_5U_6	16·09	—	6·154
U_9L_4	16·09	—	10·69
L_2U_8	16·09	—	10·69
L_1U_2	16·09	—	6·154
U_2U_8	16·09	—	2·315
U_3U_8	7·19	2·008	—
U_4U_8	16·09	—	13·05
U_4U_9	16·09	—	13·05
U_5U_9	7·19	2·008	—
U_6U_9	16·09	—	2·315

7·3 Live Load Analysis:

Calculation of Dutchmen wind effect:

Normal Load, P_n = 37·90 lb/ft²

Bay distance = Spacing of truss
= 14·41 ft

Spacing of Purlin = 14·395 ft

Area of the Panel = Spacing of truss × Spacing of purlin
= (14·41 × 14·395) ft²
= 279·41 sq-ft

∴ Load on Joints (Upper Chord)

Load = Area of Panel × P_n
= (279·41 × 37·90) lb
= 10589·639 lb
= 10·59 kips

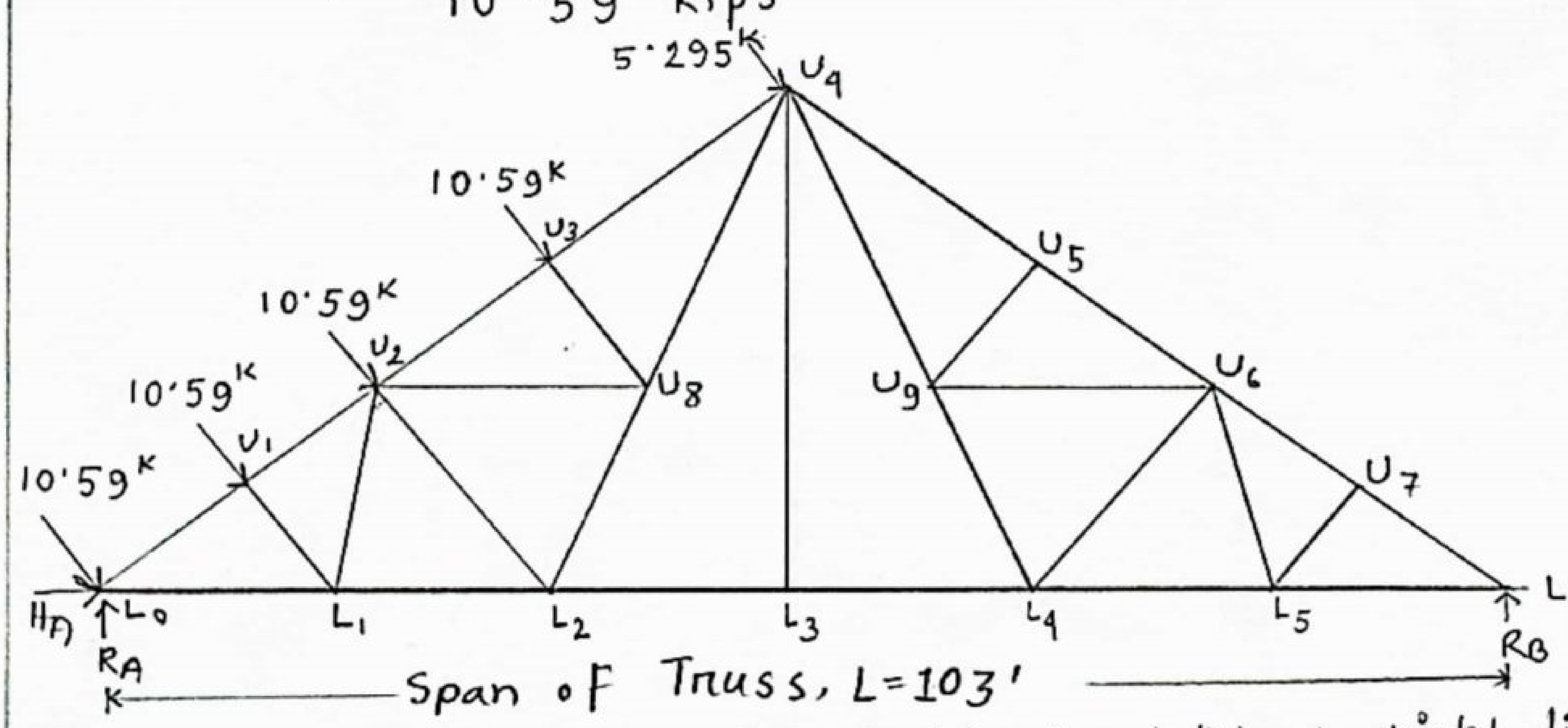

Figure 7·14: Fink type Roof Truss (Showing left to right live Load)

$\Sigma M_B = 0$ [considering figure 7·14]

$\Rightarrow 10{\cdot}59 \cos 26{\cdot}56° \times (103 + 90{\cdot}13 + 77{\cdot}26 + 64{\cdot}386)$
$+ 5{\cdot}295 \cos 26{\cdot}56° \times 51{\cdot}50 - 10{\cdot}59 \sin 26{\cdot}56° (6{\cdot}43 +$
$12{\cdot}87 + 19{\cdot}31) - 5{\cdot}295 \times \sin 26{\cdot}56° \times 25{\cdot}75$
$- R_A \times 103 = 0$

$\Rightarrow R_A = 30{\cdot}78$ kips $(\uparrow)$

$\Sigma F_y = 0 \quad \therefore R_B = 11{\cdot}84$ kips $(\uparrow)$

$\Sigma F_x = 0$

$\Rightarrow 10{\cdot}59 \sin 26{\cdot}56 \times 4 + 5{\cdot}295 \times \sin 26{\cdot}56 + H_A = 0$

$\therefore H_A = 21{\cdot}308$ kips $(\leftarrow)$

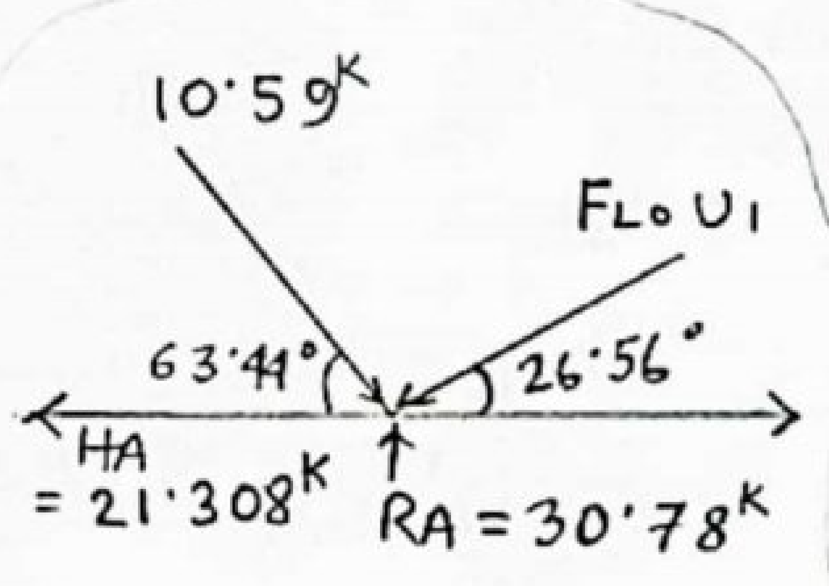

Figure 7·15: Joint L_o

Consider joint L_o,

$\Sigma F_y = 0$

$\Rightarrow R_A - F_{L_oU_1} \cos 63{\cdot}44° - 10{\cdot}59 \cos 26{\cdot}56° = 0$

$\Rightarrow$ $\boxed{F_{L_oU_1} = 47{\cdot}66 \text{ kips (C)}}$

$\Sigma F_x = 0 \Rightarrow H_A + F_{L_oU_1} \cos 26{\cdot}56° - 10{\cdot}59 \cos 63{\cdot}44°$
$- F_{L_oL_1} = 0$

$\therefore$ $\boxed{F_{L_oL_1} = 59{\cdot}20 \text{ kips (T)}}$

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consider the joint U_1,

$\Sigma F_x = 0$

$\Rightarrow \quad F_{U_1U_2} - F_{L_0U_1} = 0$

$\therefore \quad \boxed{F_{U_1U_2} = 47.66 \text{ kips (C)}}$

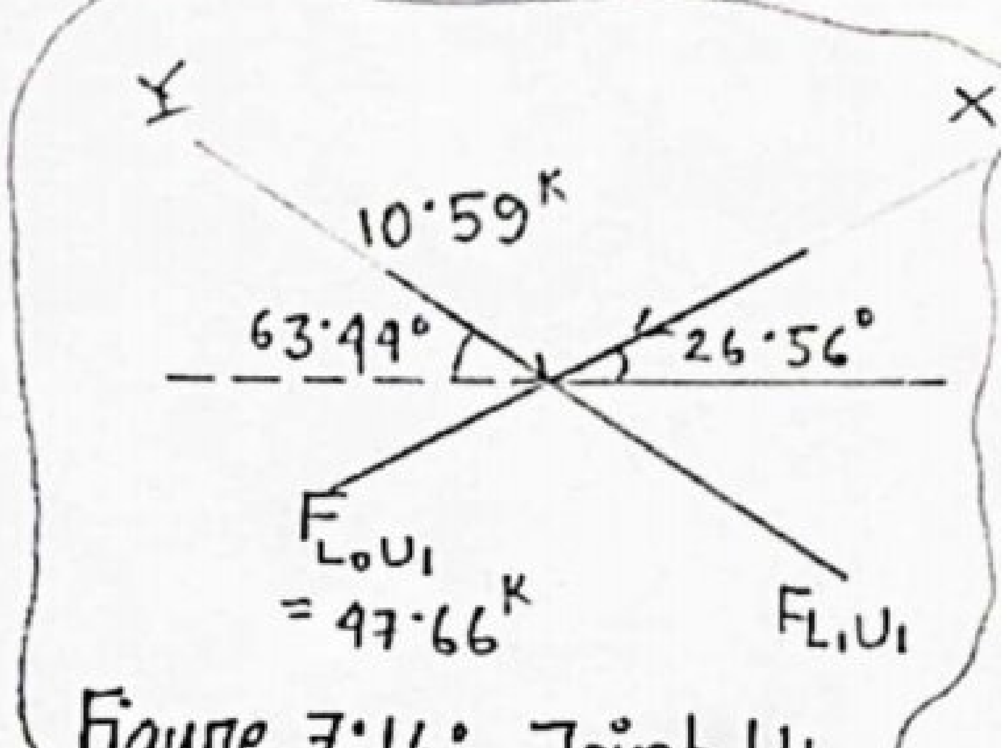

Figure 7.16: Joint U1

$\Sigma F_y = 0$

$\Rightarrow \quad \boxed{F_{L_1U_1} = 10.59 \text{ kips (C)}}$

consider Joint L_1,

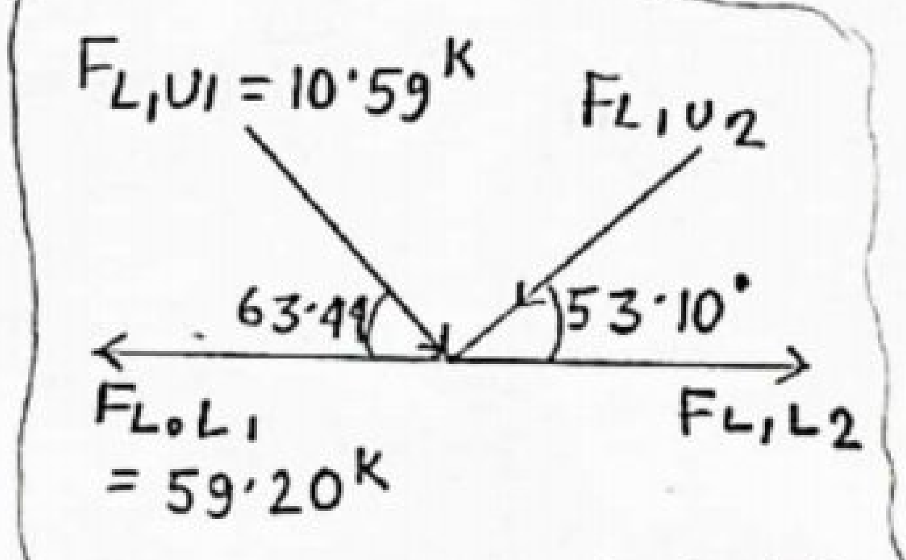

Figure 7.17: Joint L1

$\Sigma F_y = 0$

$\Rightarrow \quad F_{L_1U_2} \sin 53.10° - F_{L_1U_1} \sin 63.44° = 0$

$\therefore \quad \boxed{F_{L_1U_2} = 11.84 \text{ kips (T)}}$

$\Sigma F_x = 0$

$\Rightarrow \quad F_{L_1L_2} - F_{L_0L_1} + F_{L_1U_2} \cos 53.10° + F_{L_1U_1} \cos 63.44° = 0$

$\therefore \quad \boxed{F_{L_1L_2} = 47.36 \text{ kips (T)}}$

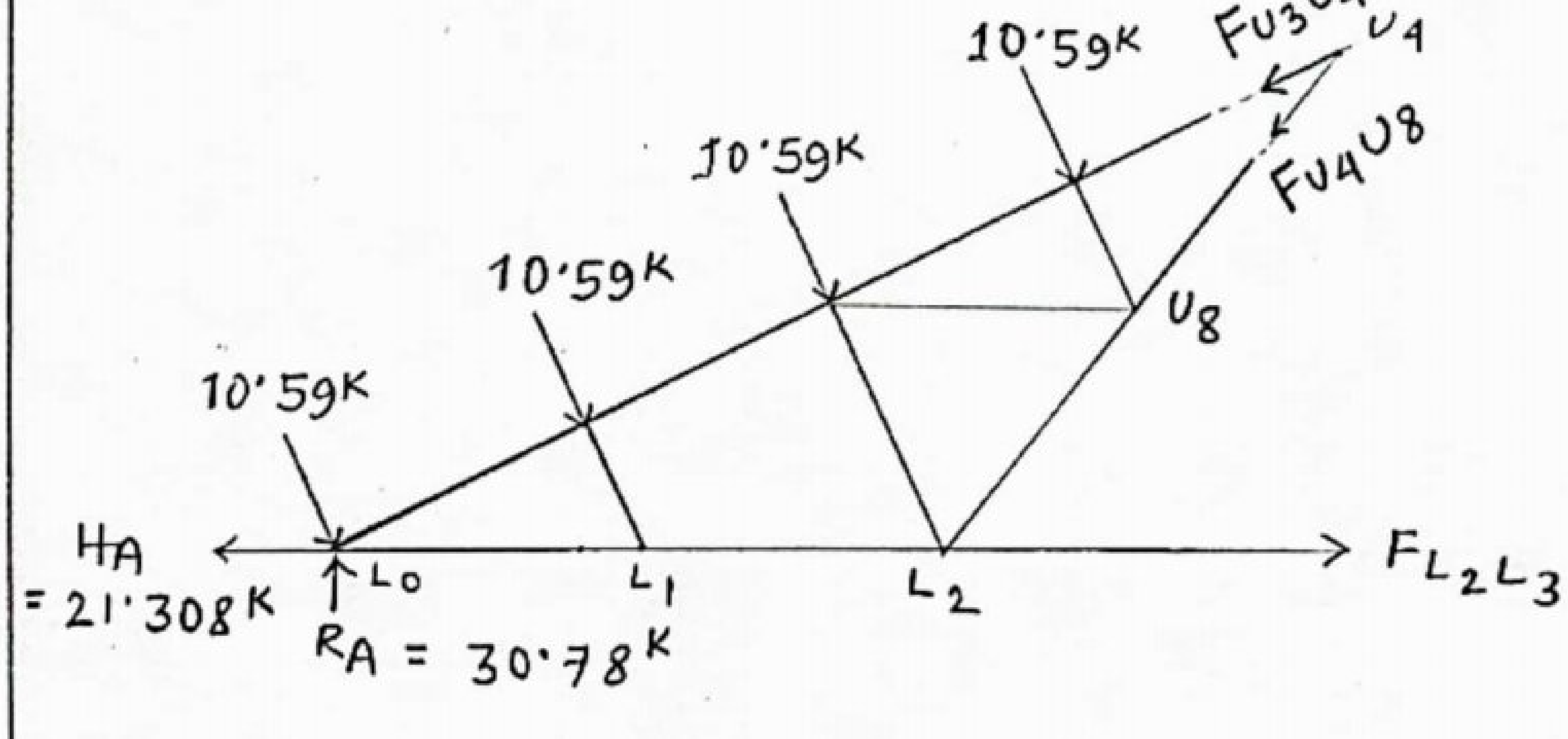

Figure 7.18: Section 1-1

$\Sigma M_{U_4} = 0$ [considering Figure 7.18]

$\Rightarrow (30.78 - 10.59 \cos 26.56) \times 51.50 + 21.308 \times 25.75$

$- 10.59 \cos 26.56° \times (51.50 + 38.63 + 25.75 + 12.89)$

$- 10.59 \times \sin 26.56° \times (25.75 + 19.32 + 12.88 + 6.44)$

$- F_{L_2L_3} \times 25.75 = 0$

$\Rightarrow$ $\boxed{F_{L_2L_3} = 23.67 \text{ kips (T)}}$

$\Sigma F_x = 0$

$\Rightarrow 4 \times 10.59 \times \sin 26.56 - H_A + F_{L_2L_3} + F_{U_4U_8} \cos 53.10$

$- F_{U_3U_4} \cos 26.56 = 0$

$\Rightarrow 21.313 + 0.60042 \; F_{U_4U_8} = 0.8945 \; F_{U_3U_4}$

$\Rightarrow \quad F_{U_3U_4} = 23.83 + 0.67 \; F_{U_4U_8}$ ——— (3)

$\Sigma F_y = 0$

$\Rightarrow 4 \times 10.59 \cos 26.56 - R_A - F_{U_4U_8} \sin 10° + F_{U_3U_8} \cos 63.44° = 0$

$\Rightarrow \quad \sin 53.10° \times F_{U_4U_8} = 7.11 + F_{U_3U_8} \cos 63.44°$

$\Rightarrow \quad F_{U_4U_8} = 8.891 + 0.559 \; F_{U_3U_4}$ ——— (4)

From equation (3) & (4)

$F_{U_3U_4} = 23.83 + 0.67 (8.891 + 0.559 F_{U_3U_4})$

$\Rightarrow$ $\boxed{F_{U_3U_4} = 47.65 \text{ kips (C)}}$

From eqtn (4) $\rightarrow$ $\boxed{F_{U_4U_8} = 35.52 \text{ kips (T)}}$

consider joint U_8,

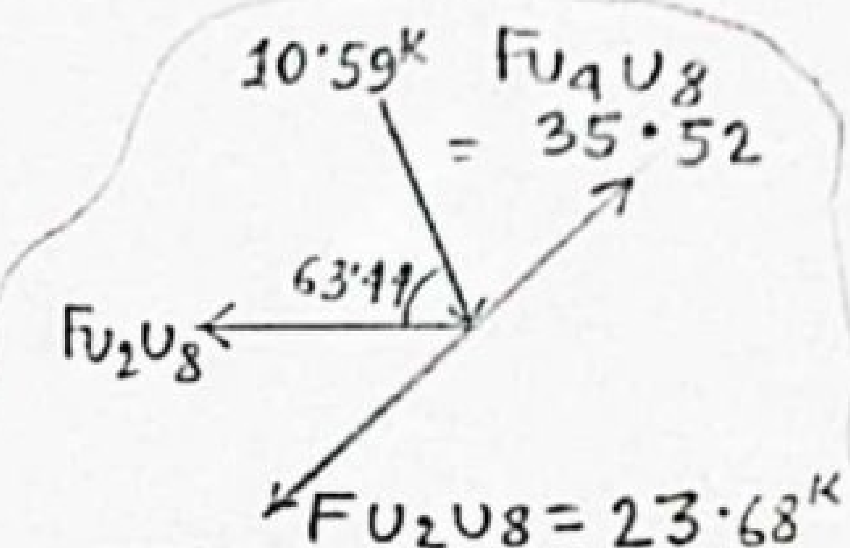

Figure 7.22: Joint U_8

$\Sigma F_x = 0$

$$\Rightarrow F_{U_2U_8} - F_{U_4U_8} \cos 53.10^\circ - 10.59 \cos 63.44^\circ + F_{L_2U_8} \cos 53.10^\circ = 0$$

$$\Rightarrow \boxed{F_{U_2U_8} = 11.84 \text{ kips (T)}}$$

consider joint L_6,

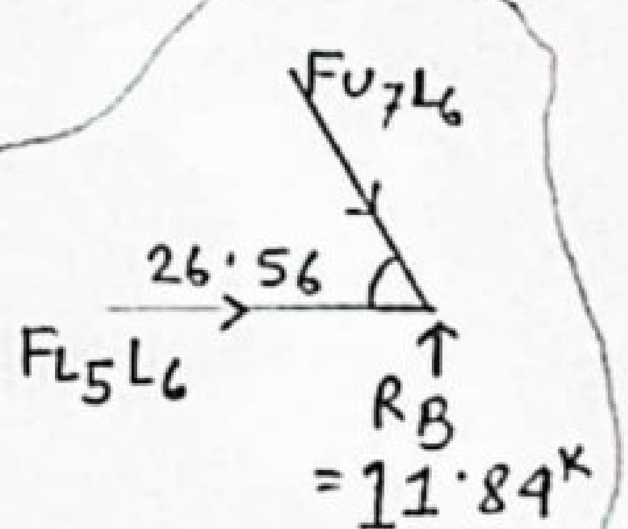

Figure 7.23: Joint L_6

$\Sigma F_y = 0$

$$\Rightarrow F_{U_7L_6} \sin 26.56^\circ - R_B = 0$$

$$\therefore \boxed{F_{U_7L_6} = 26.47 \text{ kips (c)}}$$

$\Sigma F_x = 0$

$$\Rightarrow F_{L_5L_6} + F_{U_7L_6} \cos 26.56^\circ = 0$$

$$\therefore \boxed{F_{L_5L_6} = 23.68 \text{ kips (T)}}$$

consider joint U_7,

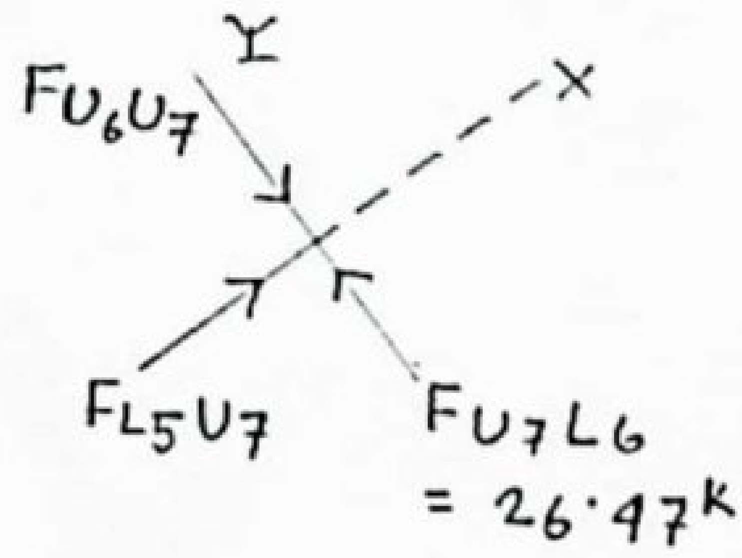

Figure 7.24: Joint U_7

$\Sigma F_x = 0 \Rightarrow \boxed{F_{L_5U_7} = 0 \text{ kips}}$

$\Sigma F_y = 0 \Rightarrow F_{U_7U_6} - F_{U_7L_6} = 0$

$$\boxed{F_{U_7U_7} = 26.47 \text{ kips (C)}}$$

consider joint L_5,

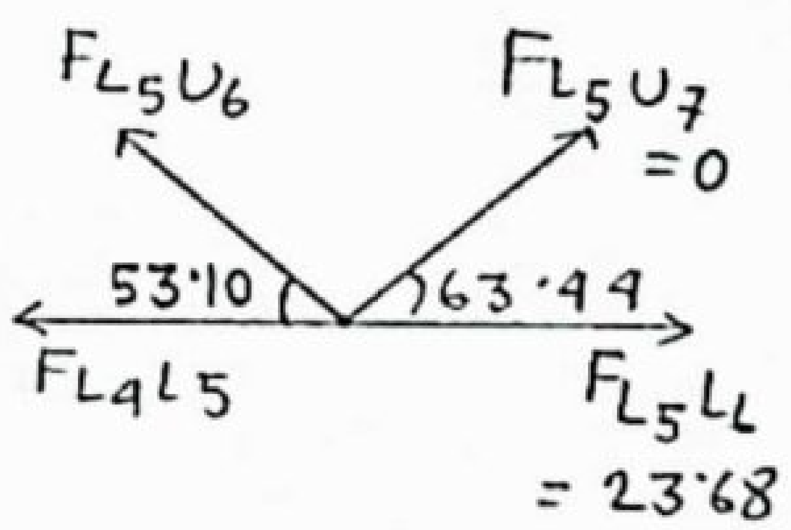

Figure 7.25: Joint L_5

$\Sigma F_y = 0$

$$\Rightarrow F_{L_5U_6} \sin 53.10^\circ + F_{L_5U_7} \sin 63.44^\circ = 0$$

$$\Rightarrow \boxed{F_{L_5U_6} = 0 \text{ kips}}$$

consider the joint L_3

$\Sigma F_y = 0 \Rightarrow$ $\boxed{F_{L_3U_4} = 0^K}$

$\Sigma F_x = 0 \Rightarrow F_{L_2L_3} - F_{L_3L_4} = 0$

$\therefore$ $\boxed{F_{L_3L_4} = 23.67^K \,(T)}$

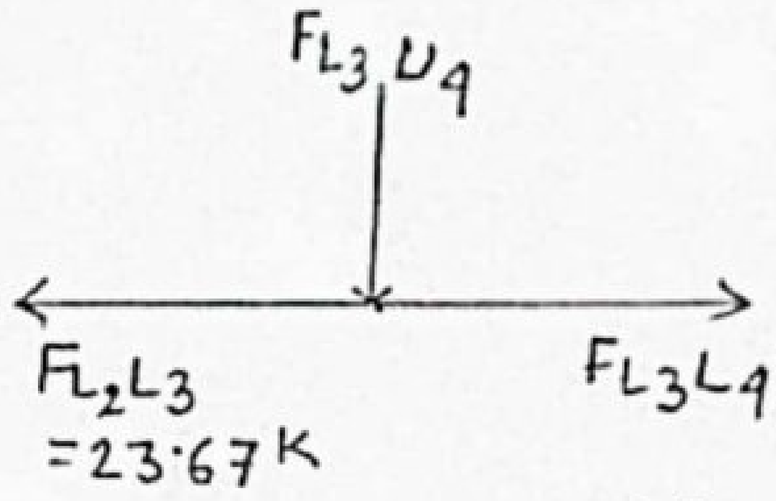

Figure 7·19: Joint L_3

consider joint L_3

$\Sigma F_y = 0$

$\Rightarrow F_{L_3U_4} - F_{U_2U_3} = 0$

$\therefore$ $\boxed{F_{U_2U_3} = 47.65 \text{ kips } (c)}$

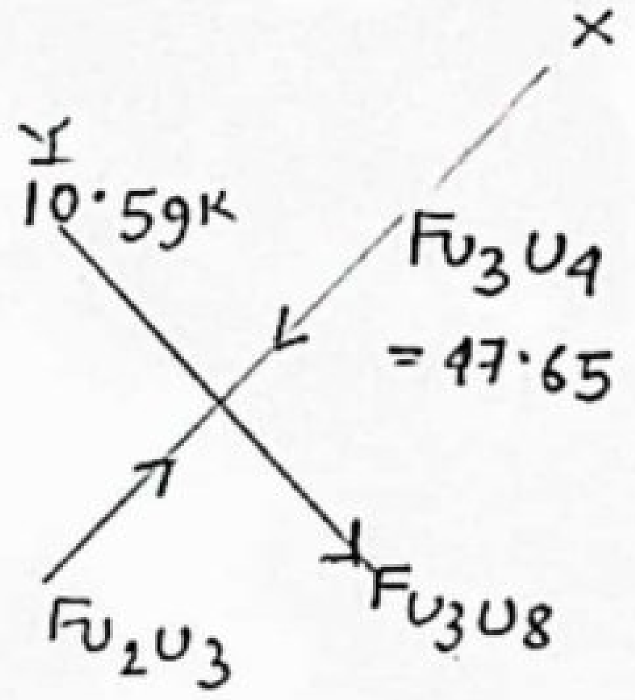

Figure 7·20: Joint U_3

$\Sigma F_y = 0$

$\Rightarrow F_{U_3U_8} - 10.59 = 0$

$\therefore$ $\boxed{F_{U_3U_8} = 10.59 \text{ kips } (c)}$

consider joint L_2

$\Sigma F_y = 0$

$\Rightarrow F_{U_2L_2} \cos 26.56° - F_{L_2U_8} \sin 53.10 = 0$

$\therefore \quad F_{L_2U_8} = 1.1185 \; F_{U_2L_2}$ —— (5)

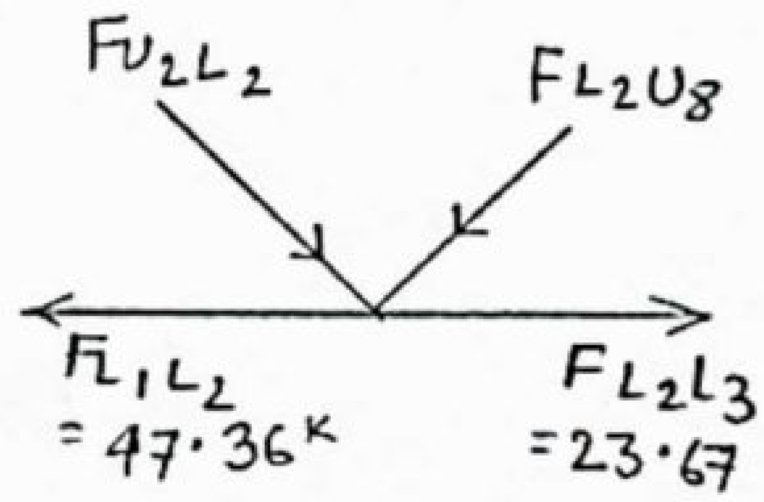

Figure 7·21: Joint L_2

$\Sigma F_x = 0 \Rightarrow F_{U_2L_2} \cos 63.44° + F_{L_2U_8} \cos 53.10° - F_{L_2L_3} = 0$

$\Rightarrow F_{U_2L_2} \cos 63.44° + \cos 53.10 (1.1185 \, F_{U_2L_2}) = 23.67$

$\therefore$ $\boxed{F_{U_2L_2} = 21.18^K \;\; (c)}$

From eqtn (5) $\rightarrow$ $\boxed{F_{L_2U_8} = 23.68 \text{ kips } (T)}$

$\Sigma F_x = 0 \Rightarrow$ $F_{L_4L_5} = 23{\cdot}68$ kips (T)

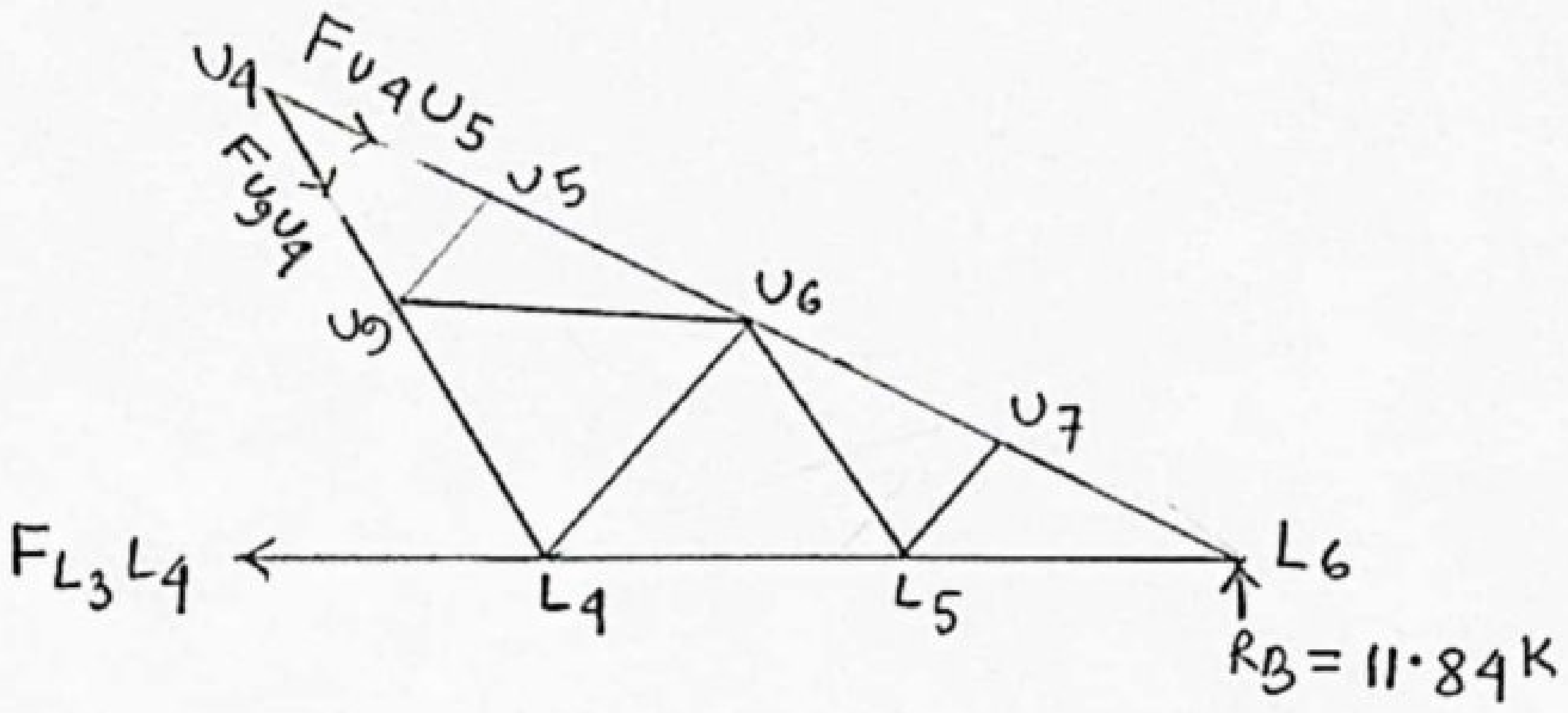

Figure 7·26: section 2-2

Consider section 2-2

$\Sigma M_{U_4} = 0$ (considering figure 7·26)

$\Rightarrow R_B \times 51{\cdot}5 - F_{L_3L_4} \times 25{\cdot}75 = 0$

$F_{L_3L_4} = 23{\cdot}67$ kips (T)

$\Sigma F_x = 0$

$\Rightarrow F_{U_4U_5} \cos 26{\cdot}56^\circ - L_3L_4 - F_{U_9U_4} \cos 53{\cdot}10^\circ = 0$

$F_{U_4U_5} = 26{\cdot}48 + 0{\cdot}67\, F_{U_9U_4}$ —— ⑥

$\Sigma F_y = 0$

$\Rightarrow R_B + F_{U_9U_4} \sin 53{\cdot}10^\circ - F_{U_4U_5} \cos 63{\cdot}44^\circ = 0$

$\Rightarrow 11{\cdot}84 + F_{U_9U_4} \sin 53{\cdot}10^\circ - \cos 63{\cdot}44^\circ (26{\cdot}48 + 0{\cdot}67 F_{U_9U_4}) = 0$

$\Rightarrow$ $F_{U_9U_4} = 0$ kips

from equation ⑥ $\rightarrow$ $F_{U_4U_5} = 26{\cdot}48$ kips (c) consider joint L4,

$\Sigma F_y = 0$

$\Rightarrow F_{L_4U_9} \sin 53.10 - F_{L_4U_9} \sin 63.44 = 0$

$\Rightarrow F_{L_4U_6} = 0.894 F_{L_4U_9}$ — ⑦

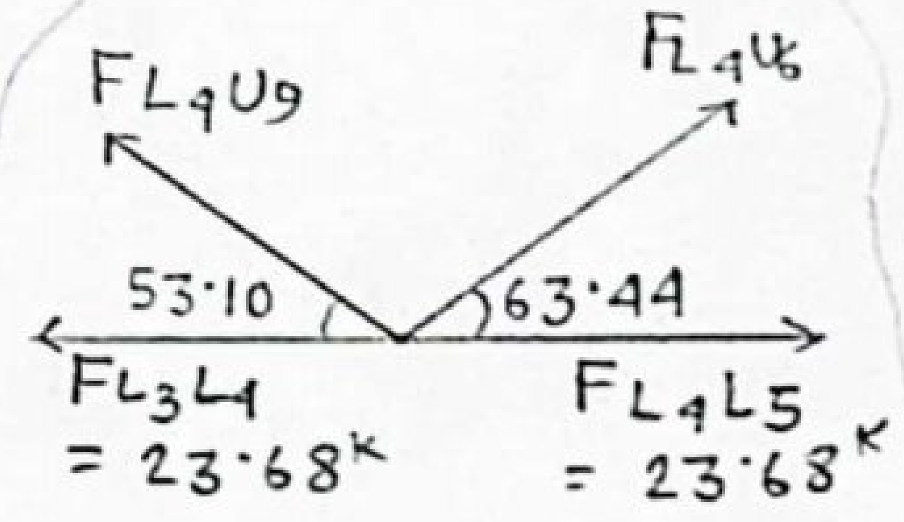

Figure 7.27 : Joint L4

$\Sigma F_x = 0$

$\Rightarrow F_{L_3L_4} - F_{L_4L_5} + F_{L_4U_9} \cos 53.10 - F_{L_4U_6} \cos 63.44 = 0$

$\Rightarrow$ $\boxed{F_{L_4U_9} = 0 \text{ kips}}$

From equation ⑦ $\rightarrow$ $\boxed{F_{L_4U_6} = 0 \text{ kips}}$

consider the joint U9.

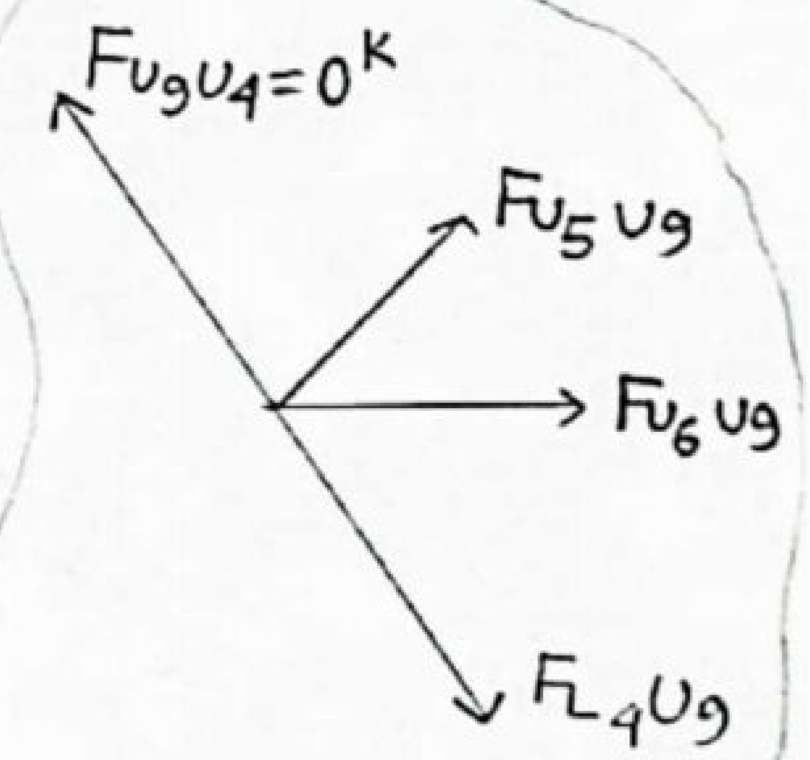

Figure 7.28: Joint U9

$\Sigma F_y = 0$ $\therefore$ $\boxed{F_{U_5U_9} = 0 \text{ kips}}$

$\Sigma F_x = 0$ $\therefore$ $\boxed{F_{U_6U_9} = 0 \text{ kips}}$

Table 7·2: Member Stresses due to Live Load (From Left to right)

Member	Member Length (ft)	Stress in kips	
		Compression	Tension
$L_0 L_1$	16·09	-	59·20
$L_1 L_2$	16·09	-	47·36
$L_2 L_3$	19·31	-	23·67
$L_3 L_4$	19·31	-	23·67
$L_4 L_5$	16·09	-	23·68
$L_5 L_6$	16·09	-	23·68
$L_0 U_1$	14·39	47·66	-
$U_1 U_2$	14·39	47·66	-
$U_2 U_3$	14·39	47·65	-
$U_3 U_4$	14·39	47·65	-
$U_4 U_5$	14·39	26·48	-
$U_5 U_6$	14·39	26·48	-
$U_6 U_7$	14·39	26·47	-
$U_7 L_6$	14·39	26·47	-
$U_1 L_1$	7·19	10·59	-

Member	Member Length (ft)	Stress in kips	
		Compression	Tension
U_2L_2	14·39	21·18	–
L_3U_4	25·75	–	0
L_4U_6	14·39	0	–
L_5U_7	7·19	0	–
L_5U_6	16·09	–	0
U_9L_4	16·09	–	0
L_2U_8	16·09	–	23·68
L_1U_2	16·09	–	11·84
U_2U_8	16·09	–	11·84
U_3U_8	7·19	10·59	–
U_4U_8	16·09	–	35·52
U_4U_9	16·09	0	–
U_5U_9	7·19	0	–
U_6U_9	16·09	0	–

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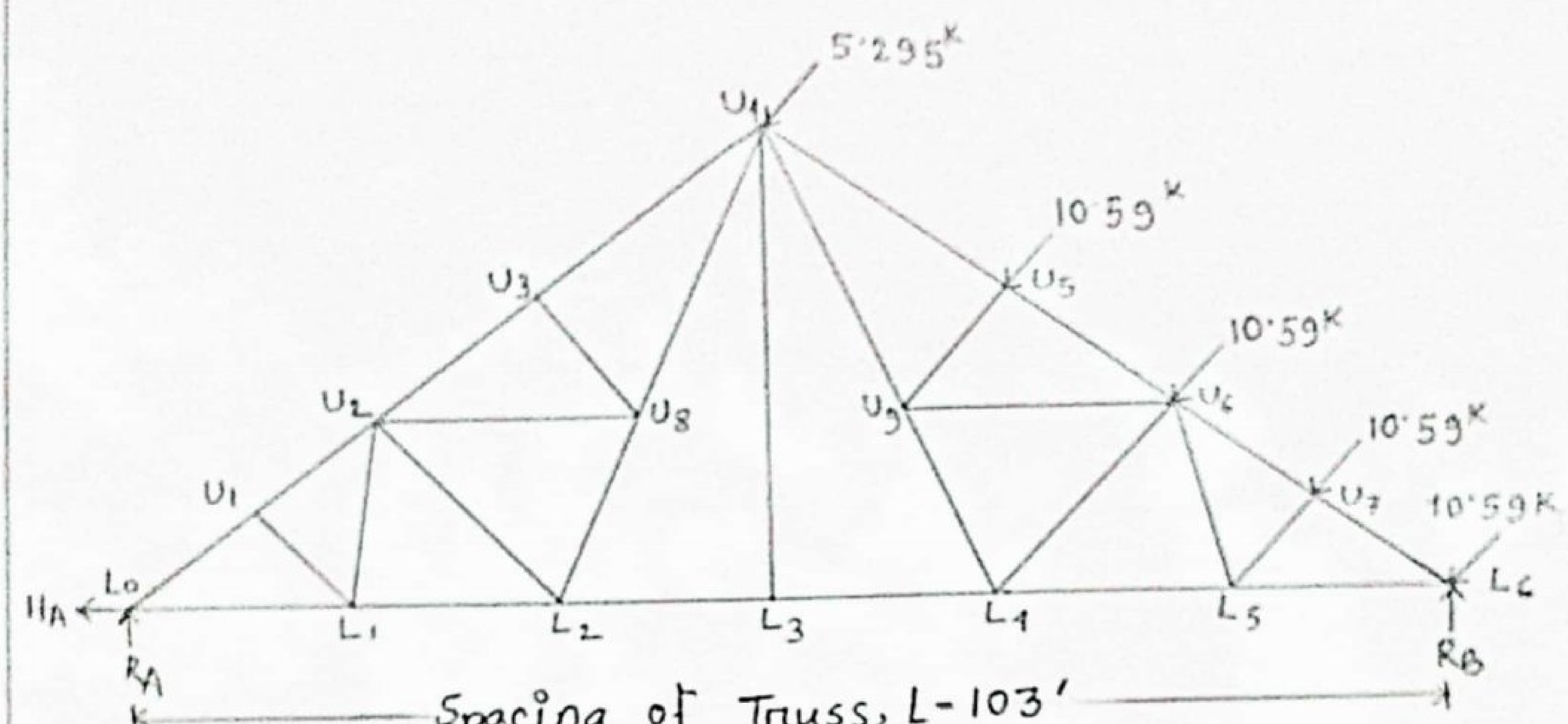

Figure 7.29: Fink type Roof Truss (Showing right to left Live Load)

$\Sigma M_B = 0$ [considering figure 7.29]

$\Rightarrow R_A \times 103 - 10.59 \cos 26.56° \times (12.87 + 25.75 + 38.61)$

$- 5.295 \times \cos 26.56° \times 51.50 - 10.59 \sin 26.56 \times (6.44 + 12.87 + 19.31)$

$- 5.295 \sin 26.56 \times 25.75 = 0$

$\Rightarrow R_A = 11.84$ kips $(\uparrow)$

$\Sigma F_y = 0 \Rightarrow R_B = 30.78$ kips $(\uparrow)$

$\Sigma F_x = 0 \Rightarrow H_A = 21.308$ kips $(\leftarrow)$

Table 7·03: Member stresses due to Live Load (From right to Left)

Member	Member Length (ft)	Stress in Kips	
		Compression	Tension
L_0L_1	16·09	–	2·37
L_1L_2	16·09	–	2·37
L_2L_3	19·31	–	2·37
L_3L_4	19·31	–	2·37
L_4L_5	16·09	–	26·05
L_5L_6	16·09	–	37·89
L_0U_1	14·39	26·47	–
U_1U_2	14·39	26·47	–
U_2U_3	14·39	26·48	–
U_3U_4	14·39	26·47	–
U_4U_5	14·39	47·66	–
U_5U_6	14·39	47·66	–
U_6U_7	14·39	47·66	–
U_7L_6	14·39	47·66	–
U_1L_1	7·19	0	–

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Member	Member Length (ft)	Stress in kips	
		Compression	Tension
U_2L_2	14·39	0	–
L_3U_4	25·75	0	–
L_4U_6	14·39	21·18	–
L_5U_7	7·19	10·59	–
L_5U_6	16·09	–	11·84
U_9L_4	16·09	–	23·68
L_2U_8	16·09	–	0
L_1U_2	16·09	–	0
U_2U_8	16·09	–	0
U_3U_8	7·19	0	–
U_4U_8	16·09	–	0
U_4U_9	16·09	–	35·52
U_5U_9	7·19	10·59	–
U_6U_9	16·09	11·84	–

7·4 Wind Load As Recommended in the ASCE Final Report:

ASCE Recommendation

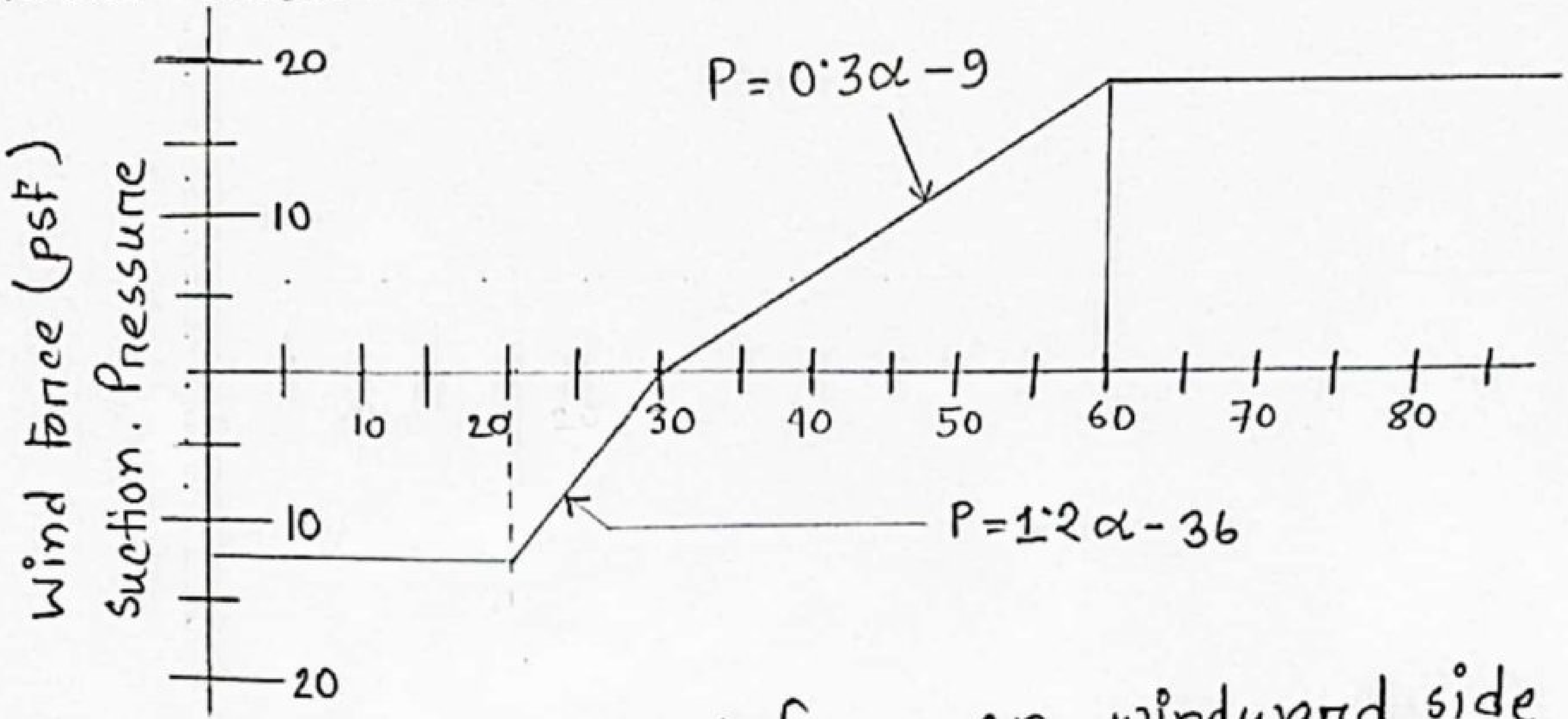

Figure 7·30: External force on windward side

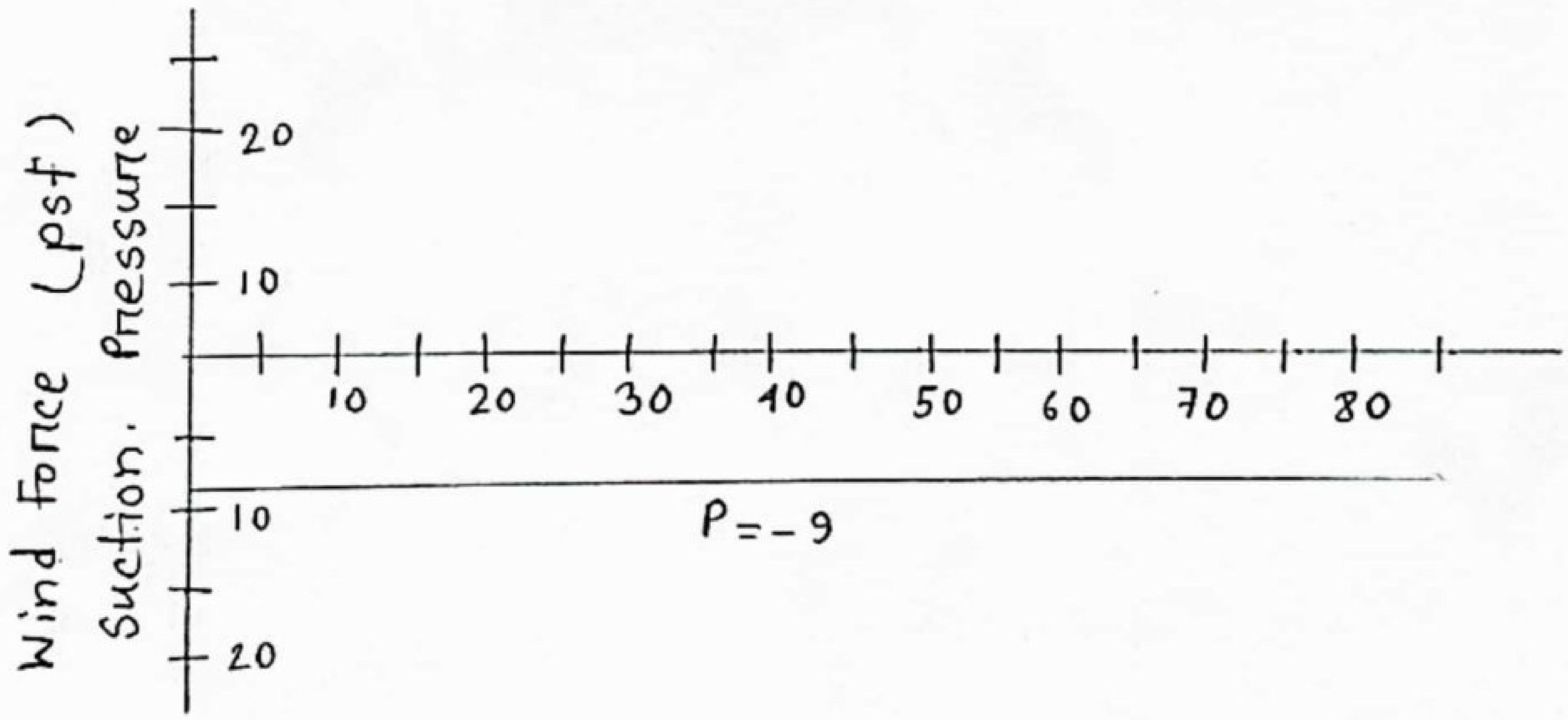

Figure : 7·31: External force on leeward side.

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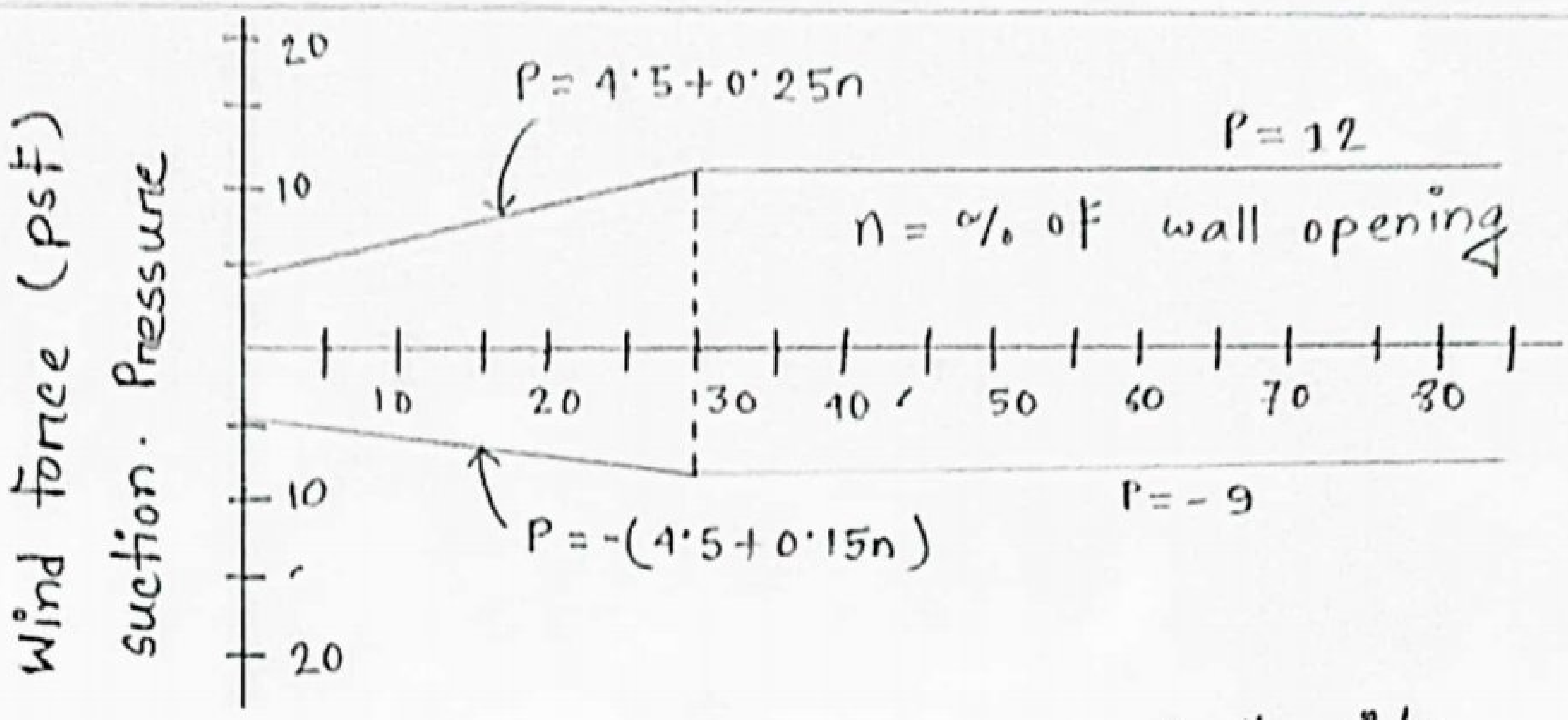

Figure 7·32: External force on both side

Calculation of wind load on the roof of the truss (Wind from Left to Right):

External force + Internal Pressure

Let use assume 30% of all opening

$\alpha = 26'56°$

The External force → Windward side

$P = 1'2\alpha - 36 = 1'2 \times 26'56 - 36$

$= -4'128$ psf (suction)

External force → Leeward side

$P = -9$ psf (suction)

Internal force (Both side)

$P = 12$ psf (pressure)

Internal force (Both side)

$P = -9$ psf (suction)

Let us take,

Inward panel load = (+ve)

Outward panel load = (-ve)

External force + Internal Pressure

ⓐ Wind panel Load →

Windward side = $(-4.128 - 12) \times$ Area of Panel

$= (-16.128 \times 279.41)$ lb

$= 4506.32$ lb

$= -4.50$ kips

ⓑ Wind panel Load →

Leeward side $= (-9 - 12) \times$ Area of Panel

$= (-21 \times 279.41)$ lb

$= -5867.61$ lb

$= -5.87$ kips

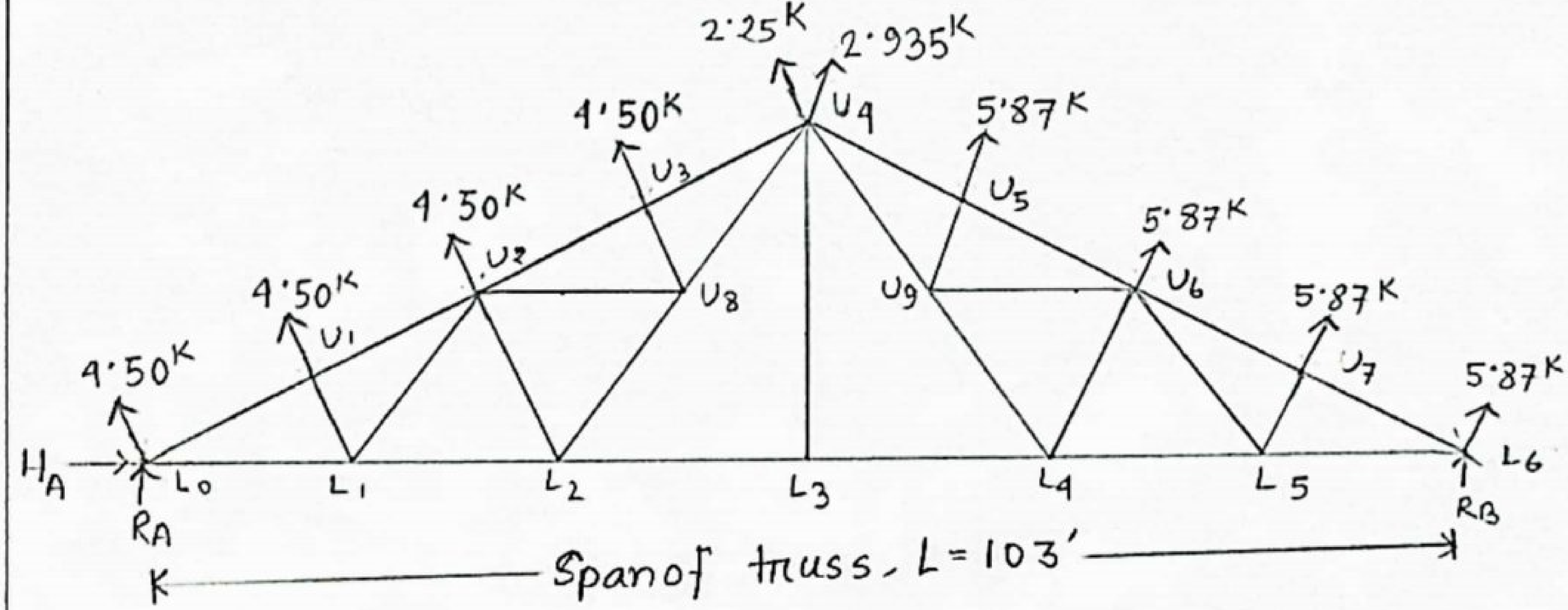

Figure 7·33: Fink type roof truss (Showing External Force + Internal pressure) Left

Table 7.4: Member Stress due to External Force + Internal Pressure, Left

Member	Member length	Stress in kips	
		Compression	Tension
L_0L_1	16.09	17.19	–
L_1L_2	16.09	12.16	–
L_2L_3	19.31	2.11	–
L_3L_4	19.31	2.11	–
L_4L_5	16.09	15.23	–
L_5L_6	16.09	21.79	–
L_0U_1	14.39	–	24.54
U_1U_2	14.39	–	24.55
U_2U_3	14.39	–	24.55
U_3U_4	14.39	–	24.55
U_4U_5	14.39	–	13.21
U_5U_6	14.39	–	13.22
U_6U_7	14.39	–	27.29
U_7L_6	14.39	–	27.29
U_1L_1	7.19	–	4.49

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Member	Member Length	Stress in kips	
		Compression	Tension
U_2L_2	14.39	–	8.98
L_3U_4	25.75	–	0
L_4U_6	14.39	–	11.72
L_5U_7	7.19	–	5.86
L_5U_6	16.09	6.56	–
U_9L_4	16.09	13.11	–
L_2U_8	16.09	10.05	–
L_1U_2	16.09	5.02	–
U_2U_8	16.09	5.03	–
U_3U_8	7.19	–	4.49
U_4U_8	16.09	15.08	–
U_4U_9	16.09	–	1.27
U_5U_9	7.19	–	5.86
U_6U_9	16.09	–	6.02

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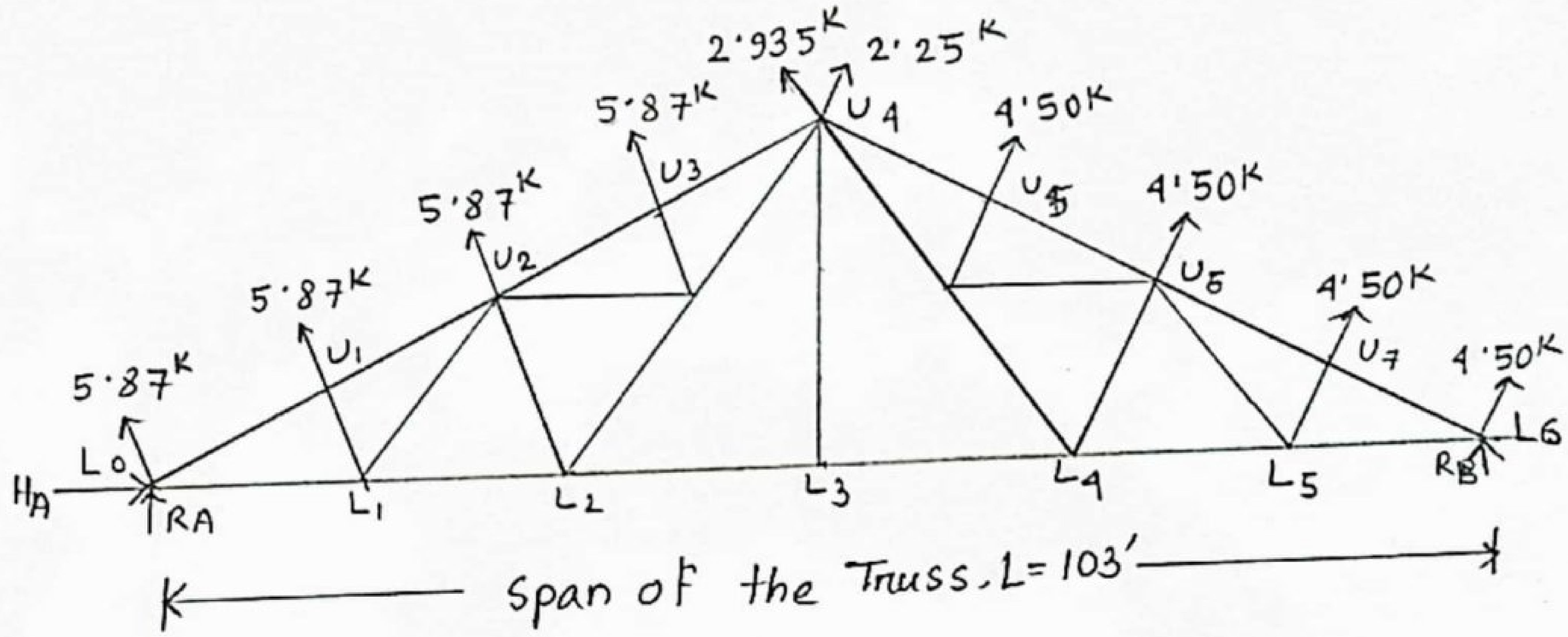

Figure 7·34: Fink type Roof Truss (Showing External Force + Internal Pressure), Right

Table 7.5: Member Stress due to External force + Internal Pressure, Right

Member	Member length (ft)	Stress in kips	
		Compression	Tension
L_0L_1	16.09	35.02	–
L_1L_2	16.09	28.19	–
L_2L_3	19.31	14.52	–
L_3L_4	19.31	14.52	–
L_4L_5	16.09	24.58	–
L_5L_6	16.09	29.60	–
L_0U_1	14.39	–	39.01
U_1U_2	14.39	–	38.90
U_2U_3	14.39	–	38.77
U_3U_4	14.39	–	38.64
U_4U_5	14.39	–	24.55
U_5U_6	14.39	–	24.55
U_6U_7	14.39	–	35.35
U_7L_6	14.39	–	35.35
U_1L_1	7.19	–	6.10

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Members	Member Length (ft)	Stress in kips	
		Compression	Tension
U_2L_2	14·39	–	12·21
L_3U_4	25·75	–	0
L_4U_6	14·39	–	8·89
L_5U_7	7·19	–	4·49
L_5U_6	16·09	5·02	–
U_9L_4	16·09	10·05	–
L_2U_8	16·09	13·66	–
L_1U_2	16·09	6·83	–
U_2U_8	16·09	6·84	–
U_3U_8	7·19	–	6·10
U_4U_8	16·09	20·50	–
U_4U_9	16·09	–	1·00
U_5U_9	7·19	–	4·49
U_6U_9	16·09	–	4·63

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External Force + Internal Suction:

ⓐ Wind Panel Load →

Windward sid = $(-4.128 - 9) \times$ Area of Panel

$= (4.872 \times 279.41)$ lb

$= 1361.28$ lb $= 1.36$ kips

ⓑ Wind· panel Load →

Leeward side = 0 kips

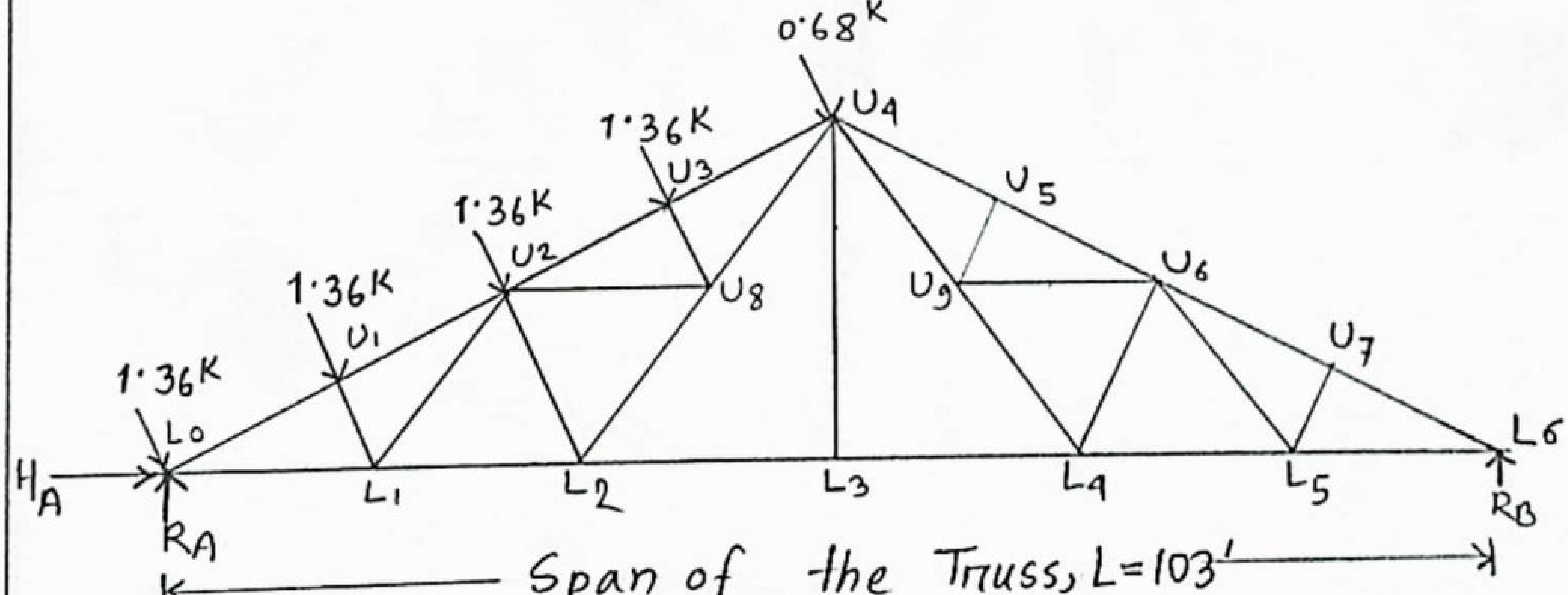

Figure: 7.35: Fink type Roof Truss (Showing- External force + internal Suction), Left

Table 7·6: Member Stress due to External force + Internal suction, Left

Member	Member Length	Stress in kips	
		Compression	Tension
L_0L_1	16·09	–	7·62
L_1L_2	16·09	–	6·10
L_2L_3	19·31	–	3·05
L_3L_4	19·31	–	3·05
L_4L_5	16·09	–	3·05
L_5L_6	16·09	–	3·05
L_0U_1	14·39	6·13	–
U_1U_2	14·39	6·14	–
U_2U_3	14·39	6·14	–
U_3U_4	14·39	6·14	–
U_4U_5	14·39	3·40	–
U_5U_6	14·39	3·40	–
U_6U_7	14·39	3·41	–
U_7L_6	14·39	3·41	–
U_1L_1	7·19	1·36	–

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Member	Member Length (ft)	Stress in kips	
		Compression	Tension
U_2L_2	14·39	2·72	–
L_3U_4	25·75	–	0
L_4U_6	14·39	0	–
L_5U_7	7·19	0	–
L_5U_6	16·09	–	0
U_9L_4	16·09	–	0
L_2U_2	16·09	–	3·04
L_1U_2	16·09	–	1·52
U_2U_8	16·09	–	1·52
U_3U_8	7·19	1·36	–
U_4U_8	16·09	–	4·57
U_4U_9	16·09	–	0
U_5U_9	7·19	0	–
U_6U_9	16·09	–	0

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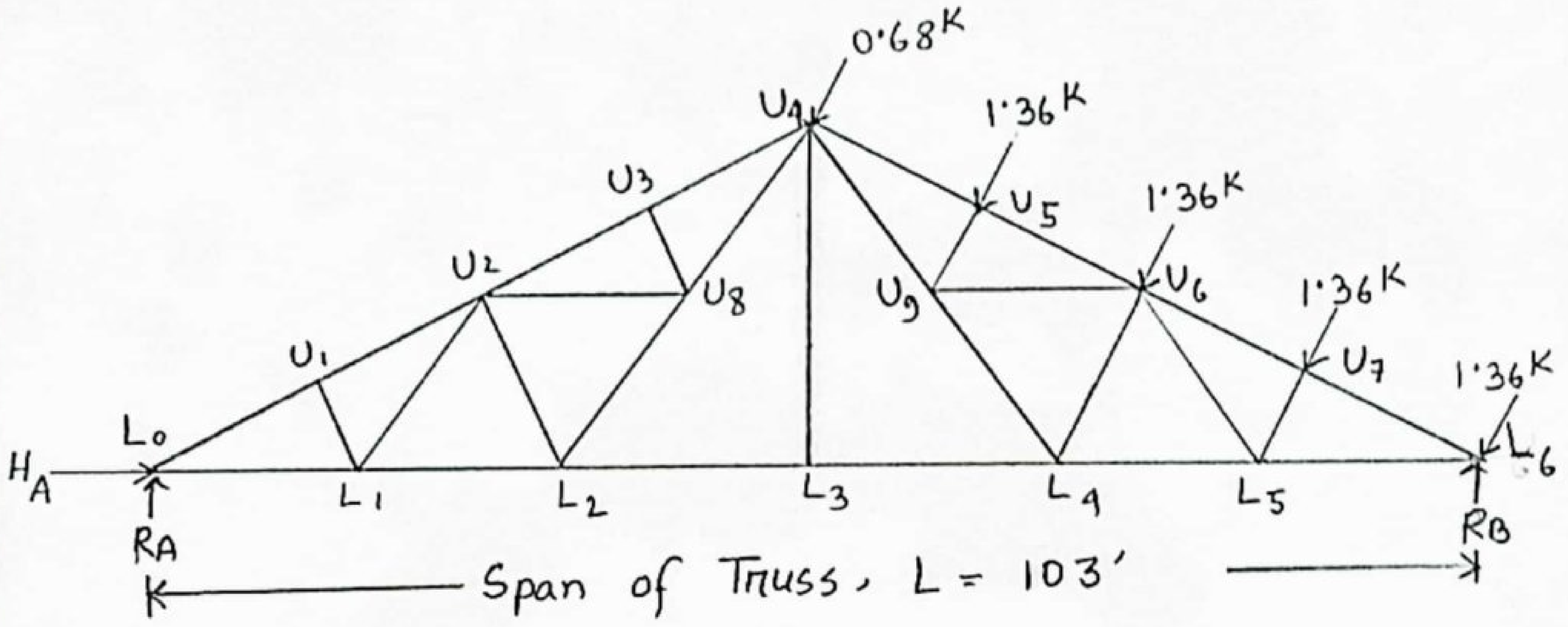

Figure 7·36 : Fink type roof truss (showing External force + Internal Suction), Right

Table 7.5: Member stress due to External force + Internal suction, Right

Member	Member Length	Stress in kips	
		Compression	Tension
L_0L_1	16.09	-	0.305
L_1L_2	16.09	-	0.305
L_2L_3	19.31	-	0.305
L_3L_4	19.31	-	0.305
L_4L_5	16.09	-	3.35
L_5L_6	16.09	-	4.88
L_0U_1	14.39	3.41	-
U_1U_2	14.39	3.41	-
U_2U_3	14.39	3.40	-
U_3U_4	14.39	3.40	-
U_4U_5	14.39	2.86	-
U_5U_6	14.39	2.86	-
U_6U_7	14.39	6.13	-
U_7L_6	14.39	6.13	-
U_1L_1	7.19	0	-

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Member	Member Length	Stress in kips	
		Compression	Tension
U_2L_2	14·39	0	–
L_3U_4	25·75	–	0
L_4U_6	14·39	2·72	–
L_5U_7	7·19	1·36	–
L_5U_6	16·09	–	1·52
U_9L_4	16·09	–	3·04
L_2U_8	16·09	–	0
L_1U_2	16·09	–	0
U_2U_8	16·09	0	–
U_3U_8	7·19	0	–
U_4U_8	16·09	0	–
U_4U_9	16·09	0·304	–
U_5U_9	7·19	1·36	–
U_6U_9	16·09	1·40	–

7.5 Design Stress Chart for different Members:

Table 7.8: Desing Stress Chart

Members	Member Length (Ft)	Dead Load (kips)	Stress due to Wind Load (kips)							
			Dutchmen wind force		External force + Internal Pressure		External force + Internal suction		Design Stress	
			Left	Right	Left	Right	Left	Right	Tension	Compression
L_0L_1	16.09	33.10	59.20	2.37	-17.19	-35.02	7.62	0.305	92.30	1.92
L_1L_2	16.09	28.51	47.36	2.37	-12.16	-28.19	6.10	0.305	75.87	0.32
L_2L_3	19.31	19.54	23.67	2.37	-2.11	-14.52	3.05	0.305	43.21	5.02
L_3L_4	19.31	19.54	23.67	2.37	-2.11	-14.52	3.05	0.305	43.21	5.02
L_4L_5	16.09	28.51	23.68	26.05	-15.23	-24.58	3.05	3.35	54.56	3.93
L_5L_6	16.09	33.10	23.68	37.89	-21.79	-29.60	3.05	4.88	80.00	3.50
L_0U_1	14.39	-37	-47.66	-26.47	24.54	39.01	-6.13	-3.41	2.01	84.66
U_1U_2	14.39	-36	-47.66	-26.47	24.55	38.90	-6.14	-3.41	2.90	83.66
U_2U_3	14.39	-31.61	-47.65	-26.48	24.55	38.77	-6.14	-3.04	7.16	79.26
U_3U_4	14.39	-31.611	-47.65	-26.47	24.55	38.64	-6.14	-3.04	7.03	79.26
U_4U_5	14.39	-30.611	-26.48	-47.66	13.21	24.55	-3.40	-2.86	5.06	78.27
U_5U_6	14.39	-30.61	-26.48	-47.66	13.22	24.55	-3.40	-2.86	6.06	78.27
U_6U_7	14.39	-36	-26.47	-47.66	27.29	35.35	-3.41	-6.13	0.65	83.66
U_7L_6	14.39	-37	-26.47	-47.66	27.29	35.35	-3.41	-6.13	1.65	84.66

Members	Member Length (ft)	Dead load (kips)	Wind Load Stress (kips): Dutchmen Wind force		External force + Internal pressure		External force + Internal suction		Design Stress	
			Left	Right	left	Right	left	Right	Tension	Compression
U_1L_1	7.19	-2.008	-10.59	0	4.49	6.10	-1.36	0	4.09	12.60
U_2L_2	14.39	-5.715	-21.18	0	8.98	12.21	-2.72	0	6.50	26.90
L_3U_4	25.75	3.751	0	0	0	0	0	0	3.75	3.75
L_4U_6	14.39	-5.715	0	-21.18	11.72	8.98	0	2.72	6.005	26.90
L_5U_7	7.19	-2.008	0	-10.59	5.86	4.49	0	1.36	3.85	12.60
L_5U_6	16.09	6.154	0	11.84	-6.56	-5.02	0	1.52	18	0.41
U_3L_4	16.09	10.69	0	23.68	-13.11	-10.05	0	3.04	34.37	2.42
L_2U_8	16.09	10.69	23.68	0	-10.05	-13.66	3.04	0	34.37	2.97
L_1U_2	16.09	6.154	11.84	0	-5.02	-6.83	1.52	0	18	0.68
U_2U_8	16.09	2.315	11.84	0	-5.03	-6.84	1.52	0	14.16	9.53
U_3U_8	7.19	-2.008	-10.59	0	4.49	6.10	-1.36	0	4.09	12.60
U_4U_8	16.09	13.05	35.52	0	-15.08	-20.50	4.57	0	48.57	7.45
U_4U_9	16.09	13.05	0	35.51	1.27	1.00	0	-8.304	48.57	12.45
U_5U_9	7.19	-2.008	0	-10.59	5.86	4.49	0	-1.36	3.85	12.60
U_6U_9	16.09	2.315	0	-11.84	6.02	4.63	0	-1.40	8.34	9.53

Scanned with CamScanner

1700099

7·6 Element of Equal Angle

Table 7·9: Element of equal angle

Size (inch)	Thickness (inch)	Wt. per ft. (lb)	Area ($in.^2$)	Axis → X-X r (in.)
L8×8	9/8	56·9	16·7	2·42
	1	51·0	15·0	2·44
	7/8	45·0	13·2	2·45
	3/4	38·9	11·4	2·47
	5/8	32·7	9·61	2·49
	9/16	29·6	8·68	2·50
	1/2	26·4	7·75	2·50
L 6×6	1	37·4	11·0	1·80
	7/8	33·1	9·73	1·81
	3/4	28·7	8·44	1·83
	5/8	24·2	7·11	1·84
	9/16	21·9	6·43	1·85
	1/2	19·6	5·75	1·86
	7/16	17·2	5·06	1·87
	3/8	14·9	4·36	1·88
	5/16	12·4	3·65	1·89
L 5×5	7/8	27·2	7·98	1·49
	3/4	23·6	6·94	1·51
	5/8	20·0	5·86	1·52
	1/2	16·2	4·75	1·54
	7/16	14·3	4·18	1·55
	3/8	12·3	3·61	1·56
	5/16	10·3	3·03	1·57

Size (inch)	Thickness (inch)	Wt. per ft. (lb)	Area (inch²)	Axis X-X r (in.)
$L\ 3\frac{1}{2} \times 3\frac{1}{2}$	1/2	11·1	3·25	1·06
	7/16	9·8	2·87	1·07
	3/8	8·5	2·48	1·07
	5/16	7·2	2·09	1·08
	1/4	5·8	1·69	1·09
L 3×3	1/2	9·4	2·75	0·898
	7/16	8·3	2·43	0·905
	3/8	7·2	2·11	0·913
	5/16	6·1	1·78	0·922
	1/4	4·9	1·44	0·930
	3/16	3·71	1·09	0·939
$L\ 2\frac{1}{2} \times 2\frac{1}{2}$	1/2	7·7	2·25	0·739
	3/8	5·9	1·73	0·753
	5/16	5·0	1·46	0·761
	1/4	4·1	1·19	0·769
	3/16	3·07	0·902	0·778
L 2×2	3/8	4·7	1·36	0·594
	5/16	3·92	1·15	0·601
	1/4	3·19	0·938	0·609
	3/16	2·44	0·715	0·617
	1/8	1·65	0·484	0·626

7.7 Design of Tension Member :

(a) Allowable Tensile stress = 20 ksi

(b) Two members of equal angles as shown in figure 7.37 below :

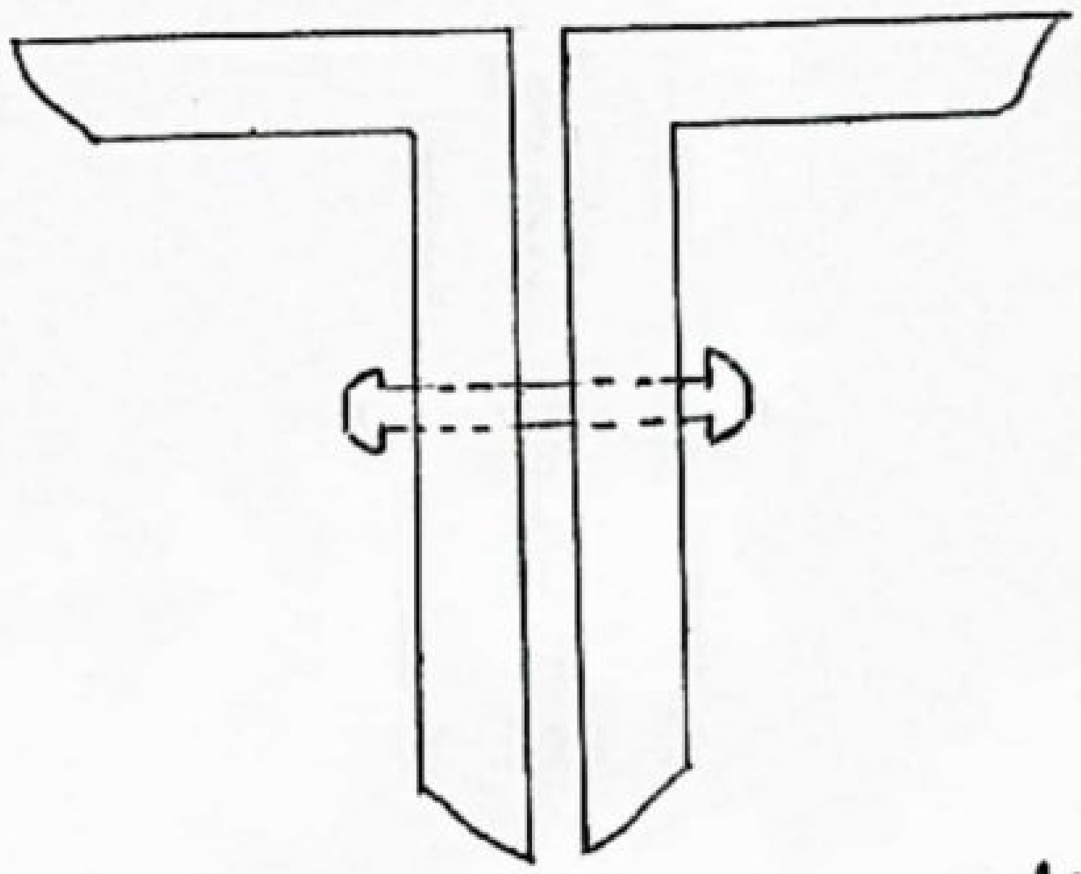

Figure 7.37 : Two members of equal angles

(c) Using 3/4 inch ϕ rivet with minimum clearance $= \frac{1}{16}''$

i.e, diameter of rivet hole $= \left(\frac{3}{4} + \frac{1}{16}\right)$ inch

$= \frac{13}{16}$ inch

(d) Slender ratio ≤ 240

Member L_0L_1

(a) Length of the member = 16.09 ft

(b) Design stress (Tension) = 92.30 kips

(c) Net area required for two angle $= \frac{92.30}{20}$

$= 4.615 \ in^2$

(d) Net area for an angle $= \frac{4.615}{2} = 2.31 \ in^2$

(e) Let us supply $(3'' \times 3'' \times \frac{1}{2}'')$ of gross area $= 2.75 \ in^2$

(f) Net area = $2.75 - (\frac{13}{16} \times \frac{1}{2}) = 2.34 \, in^2$

(g) Slender ratio = $\frac{l}{r} = \frac{16.09 \times 12}{0.898} = 215.01 \angle 240$

Hence supplied section = $[3'' \times 3'' \times \frac{1}{2}'']$

Member L_1L_2

(a) Length of member = 16.09 ft

(b) Design stress (Tension) = 75.87 ft

(c) Net area required for two angle = $\frac{75.87}{20} \, in^2$
$= 3.794 \, in^2$

(d) Net area for an angle = $\frac{3.794}{2} = 1.897 \, in^2$

(e) Let us supply $(3'' \times 3'' \times \frac{1}{2}'')$ of gross area = $2.75 in^2$

(f) Net area = $2.75 - (\frac{13}{16} \times \frac{1}{2}) = 2.34 \, in^2$

(g) Slender ratio = $l/r = \frac{16.09 \times 12}{0.898} = 215.01 \angle 240$

Hence supplied section ⇒ $[3'' \times 3'' \times \frac{1}{2}'']$

Member L_2L_3 & L_3L_4

(a) Length of member = 19.31 ft

(b) Design stress (Tension) = 43.21 kips

(c) Net area required for two angle = $\frac{43.21}{20} \, in^2$
$= 2.161 \, in^2$

(d) Net area for an angle = $\frac{2.161}{2} = 1.081 \, in^2$

(e) Let us supply $(3\frac{1}{2}'' \times 3\frac{1}{2}'' \times \frac{1}{4}'')$ of gross area = $1.69 in^2$

(f) Net area = $1.69 - \left(\frac{13}{16} \times \frac{1}{4}\right) = 1.49 \text{ in}^2$

(g) Slender ratio = $\frac{l}{r} = \frac{19.31 \times 12}{1.09} = 212.59 < 240$

Hence Supplied section ⇒ $\left[3\frac{1}{2}'' \times 3\frac{1}{2}'' \times \frac{1}{4}''\right]$

Member L_4L_5

(a) Length of member = 16.09 ft

(b) Design stress (Tension) = 54.56 kips

(c) Net area required for two angle = $\frac{54.56}{20} \text{ in}^2$

= 2.728 in^2

(d) Net area for an angle = $\frac{2.728}{2} = 1.364 \text{ in}^2$

(e) Let us supply $(3'' \times 3'' \times \frac{1}{2}'')$ of gross area = 2.75in^2

(f) Net area = $2.75 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 2.34 \text{ in}^2$

(g) Slender ratio = $\frac{l}{r} = \frac{16.09 \times 12}{0.898} = 215.01 < 240$

Hence supplied section ⇒ $\left[3'' \times 3'' \times \frac{1}{2}''\right]$

Member L_5L_6

(a) Length of member = 16.09 ft

(b) Design stress (Tension) = 80 kips

(c) Net area required for two angle = $\frac{80}{20} \text{ in}^2$

= 4 in^2

(d) Net are required for an angle = $\frac{4}{2} = 2 \text{ in}^2$

(e) Let us supply $\left(3'' \times 3'' \times \frac{1}{2}''\right)$ of gross area

= 2.75 in^2

(f) Net area $= 2.75 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 2.34 \text{ in}^2$

(g) Slender ratio $= \frac{L}{r} = \frac{16.09 \times 12}{0.898} = 215.01 < 240$

Hence supplied section $\Rightarrow \left[3'' \times 3'' \times \frac{1}{2}''\right]$

Member L_0U_1

(a) Length of member = 14.39 ft

(b) Design stress (tension) = 2.01 kips

(c) Net area required for two angle $= \frac{2.01}{20} \text{ in}^2$
$= 0.101 \text{ in}^2$

(d) Net area for an angle $= \frac{0.101}{2} = 0.051 \text{ in}^2$

(e) Let us supply $\left(2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right)$ of gross area $= 2.25 \text{ in}^2$

(f) Net area $= 2.25 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 1.844 \text{ in}^2$

(g) Slender ratio $= \frac{l}{r} = \frac{14.39 \times 12}{0.739} = 233.67 < 240$

Hence supplied section $\Rightarrow \left[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right]$

Member U_1U_2

(a) Length of member = 14.39 ft

(b) Design Stress (Tension) = 2.90 kips

(c) Net area required for two angle $= \frac{2.90}{20} \text{ in}^2$
$= 0.145 \text{ in}^2$

(d) Net area for an angle $= \frac{0.145}{2} = 0.073 \text{ in}^2$

(e) Let us supply $\left(2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right)$ of gross area
$= 2.25 \text{ in}^2$

(f) Net area $= 2.25 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 1.844 \text{ in}^2$

(g) Slender ratio $= \frac{L}{r} = \frac{14.39 \times 12}{0.739} = 233.67 < 240$

Hence supplied section $\Rightarrow \left[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right]$

Member U_2U_3

(a) Length of member = 14.39 ft

(b) Design stress (Tension) = 7.16 kips

(c) Net area required for two angle $= \frac{7.16}{20} \text{ in}^2$
$= 0.358 \text{ in}^2$

(d) Net area for an angle $= \frac{0.358}{2} = 0.179 \text{ in}^2$

(e) Let us supply $\left(2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right)$ of gross area
$= 2.25 \text{ in}^2$

(f) Net area $= 2.25 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 1.844 \text{ in}^2$

(g) Slender ratio $= l/r = \frac{14.39 \times 12}{0.739} = 233.67 < 240$

Hence supplied section $\Rightarrow \left[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right]$

Member U_3U_4

(a) Member Length = 14.39 ft

(b) Design stress (Tension) = 7.03 kips

(c) Net area required for two angle $= \frac{7.03}{20} \text{ in}^2$
$= 0.352 \text{ in}^2$

(d) Net area for an angle $= 0.176 \text{ in}^2$

(e) Let us supply $\left(2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right)$ of gross area
$= 2.25 \text{ in}^2$

(f) Net area $= 2.25 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 1.844 \text{ in}^2$

(g) Slender ratio $= l/r = \frac{14.39 \times 12}{0.739} = 233.67 < 240$

Hence supplied section ⇒ $\left[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right]$

Member U_4U_5 & U_5U_6

(a) Length of member = 14.39 ft

(b) Design Stress (Tension) = 6.06 kips

(c) Net area required for two angles $= \frac{6.06}{20} \text{ in}^2$

$= 0.303 \text{ in}^2$

(d) Net area required an angle $= \frac{0.303}{2} = 0.152 \text{ in}^2$

(e) Let us supply $\left(2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right)$ of gross area $= 2.25 \text{ in}^2$

(f) Net area $= 2.25 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 1.844 \text{ in}^2$

(g) Slender ratio $= l/r = \frac{14.39 \times 12}{0.739} = 233.67 < 240$

Hence supplied section ⇒ $\left[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right]$

Member U_6U_7

(a) Length of Member = 14.39 ft

(b) Design Stress (Tension) = 0.65 kips

(c) Net area required for two angles $= \frac{0.65}{20} \text{ in}^2$

$= 0.033 \text{ in}^2$

(d) Net area required for an angle $= \frac{0.033}{2} \text{ in}^2 =$

$= 0.0165 \text{ in}^2$

(e) Let us supply $\left(2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right)$ of gross area $= 2.25 \text{ in}^2$

(f) Net area = $2.25 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 1.844 \text{ in}^2$

(g) Slender ratio = $\frac{l}{r} = \frac{14.39 \times 12}{0.739} = 233.67 < 240$

Hence supplied section ⇒ $\left[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right]$

Member U_7L_6

(a) Length of member = 14.39 ft

(b) Design stress (Tension) = 1.65 kips

(c) Net area required for two angles = $\frac{1.65}{20} \text{ in}^2$
$= 0.083 \text{ in}^2$

(d) Net area required for an angle = $\frac{0.083}{2} = 0.042 \text{ in}^2$

(e) Let us supply $\left(2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right)$ of gross area = 2.25 in^2

(f) Net area = $2.25 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 1.844 \text{ in}^2$

(g) Slender ratio = $l/r = \frac{14.39 \times 12}{0.739} = 233.67 < 240$

Hence section ⇒ $\left[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}''\right]$

Member U_1L_1

(a) Length of Member = 7.19 ft

(b) Design stress (Tension) = 4.09 kips

(c) Net area required for two angles = $\frac{4.09}{20} \text{ in}^2$
$= 0.205 \text{ in}^2$

(d) Net area for an angle = $\frac{0.205}{2} \text{ in}^2 = 0.103 \text{ in}^2$

(e) Let us supply $\left(2'' \times 2'' \times \frac{3}{8}''\right)$ of gross area = 1.36 in^2

(f) Net area = $1.36 - \left(\frac{13}{16} \times \frac{3}{8}\right) = 1.055 \text{ in}^2$

(g) Slender ratio = $l/r = \frac{7.19 \times 12}{0.594} = 145.25 < 240$

Hence supplied section ⇒ $[2'' \times 2'' \times \frac{3}{8}'']$

Member U_2L_2

(a) Length of member = 14.39 ft

(b) Design stress (Tension) = 6.50 ft

(c) Net area required for two angle = $\frac{6.50}{20}$ in^2

$= 0.325$ in^2

(d) Net area for an angle = $\frac{0.325}{2}$ in^2 = 0.163 in^2

(e) Let us supply $(2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}'')$ of gross area = 2.25 in^2

(f) Net area = $2.25 - (\frac{13}{16} \times \frac{1}{2}) = 1.844$ in^2

(g) Slender ratio = $\frac{l}{r} = \frac{14.39 \times 12}{0.739} = 233.67$

Hence supplied section = $[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}'']$

Member L_3U_4

(a) Length of member = 25.75 ft

(b) Design stress (Tension) = 3.75 kips

(c) Net area required for two angle = $\frac{3.75}{20}$ ~~kips~~

$= 0.1875$ in^2

(d) Net area for an angle = $\frac{0.1875}{2} = 0.093$ in^2

(e) Let us apply $(5'' \times 5'' \times \frac{7}{8}'')$ of gross area = 7.98 in^2

(f) Net area $= 7.98 - (\frac{13}{16} \times \frac{7}{8}) = 7.27$ in^2

(g) Slender ratio = $\frac{L}{r} = \frac{25.75 \times 12}{1.49} = 207.38 < 240$

Hence supplied Section ⇒ $[5'' \times 5'' \times \frac{7}{8}'']$

Member L_4U_6

(a) Length of member = 14·39 ft

(b) Design stress (Tension) = 6·005 kips

(c) Net area required for two angles = $\frac{6.005}{20}$ in^2
= 0·301 in^2

(d) Net area for an angle = $\frac{0.301}{2}$ = 0·151 in^2

(e) Let us supply $(2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}'')$ of gross area = 2·25 in^2

(f) Net area = $2.25 - (\frac{13}{16} \times \frac{1}{2})$ = 1·844 in^2

(g) Slender ratio = $\frac{l}{r} = \frac{14.39 \times 12}{0.739}$ = 233·67 ∠ 240

Hence supplied section ⇒ $[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}'']$

Member U_5U_9 and L_5U_7:

(a) Length of member = 7·19 ft

(b) Design stress (Tension) = 3·85 kips

(c) Net area for ~~an~~ two angles = $\frac{3.85}{20}$ in^2 = 0·193 in^2

(d) Net area for an angle = $\frac{0.193}{2}$ in^2 = 0·097 in^2

(e) Let us supply $(2'' \times 2'' \times \frac{3}{8}'')$ of gross area = 1·36 in^2

(f) Net area = $1.36 - (\frac{13}{16} \times \frac{3}{8})$ = 1·055 in^2

(g) Slender ratio = $\frac{l}{r} = \frac{7.19 \times 12}{0.594}$ = 145·25 ∠ 240

Hence supplied section $[2'' \times 2'' \times \frac{3}{8}'']$

Member L_5U_6 and L_1U_2

(a) Length of member = 16·09 ft

(b) Design stress (tension) = 18 kips

(c) Net area required for two angles $= \frac{18 \cdot 00}{20}$ in^2
$= 0 \cdot 90$ in^2

(d) Net area for an angle $= \frac{0 \cdot 90}{2} = 0 \cdot 45$ in^2

(e) Let us supply $(3'' \times 3'' \times \frac{1}{2}'')$ of gross area = 2·75 in^2

(f) Net area $= 2 \cdot 75 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 2 \cdot 34$ in^2

(g) Slender ratio $= \frac{l}{r} = \frac{16 \cdot 09 \times 12}{0 \cdot 898} = 215 \cdot 01 \angle 240$

Hence Supplied section $\Rightarrow [3'' \times 3'' \times \frac{1}{2}'']$

Member U_9L_4 & L_2U_8

(a) Length of member = 16·09 ft

(b) Design stress (Tension) = 34·37 kips

(c) Net area required for two angles $\frac{34 \cdot 37}{20}$ in^2
$= 1 \cdot 719$ in^2

(d) Net area for an angle $= \frac{1 \cdot 719}{2}$ in^2
$= 0 \cdot 860$ in^2

(e) Let us supply $(3'' \times 3'' \times \frac{1}{2}'')$ of gross area = 2·75 in^2

(f) Net area $= 2 \cdot 75 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 2 \cdot 34$ in^2

(g) Slender ratio $= \frac{l}{r} = \frac{16 \cdot 09 \times 12}{0 \cdot 898} = 215 \cdot 01 \angle 240$

Hence supplied section $\Rightarrow [3'' \times 3'' \times \frac{1}{2}'']$

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Member U_2U_8

(a) Length of the member = 16.09 ft

(b) Design stress (tension) = 14.16 kips

(c) Net area required for two angles = $\frac{14.16}{20}$ in^2

= 0.708 in^2

(d) Net area required for an angle = $\frac{0.708}{2}$ = 0.354 in^2

(e) Let us supply $(3'' \times 3'' \times \frac{1}{2}'')$ of gross area = 2.75 in^2

(f) Net area = $2.75 - \left(\frac{13}{16} \times \frac{1}{2}\right)$ = 2.34 in^2

(g) Slender ratio = $\frac{l}{r} = \frac{16.09 \times 12}{0.898}$ = 215.01 < 240

Hence supplied section ⇒ $[3'' \times 3'' \times \frac{1}{2}'']$

Member U_3U_8

(a) Length of the member = 7.19 ft

(b) Design stress (tension) = 4.092 kips

(c) Net area required for two angles = $\frac{4.092}{20}$ in^2

= 0.205 in^2

(d) Net area for an angle = $\frac{0.205}{2}$ = 0.103 in^2

(e) Let us supply $(2'' \times 2'' \times \frac{3}{8}'')$ of gross area = 1.36 in^2

(f) Net area = $1.36 - \left(\frac{13}{16} \times \frac{3}{8}\right)$ = 1.055 in^2

(g) Slender ratio = $\frac{l}{r} = \frac{7.19 \times 12}{0.594}$ = 145.25 < 240

Hence supplied section ⇒ $[2'' \times 2'' \times \frac{3}{8}'']$

Member $U_4 U_8$

(a) Length of the member $= 16{\cdot}09$ ft

(b) Design Stress (Tension) $= 48{\cdot}57$ kips

(c) Net area required for two angles $= \frac{48{\cdot}57}{20}$ in^2

$= 2{\cdot}429$ in^2

(d) Net area for an angle $= 1{\cdot}215$ in^2

(e) Let us supply $[3'' \times 3'' \times \frac{1}{2}'']$ for a gross area $= 2{\cdot}75$ in

(f) Net area $= 2{\cdot}75 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 2{\cdot}34$ in^2

(g) Slender ratio $= \frac{l}{r} = \frac{16{\cdot}09 \times 12}{0{\cdot}898} = 215{\cdot}01 \angle 240$

Hence supplied section $\Rightarrow [3'' \times 3'' \times \frac{1}{2}'']$

Member $U_4 U_9$

(a) Length of the member $= 16{\cdot}09$ ft

(b) Design stress (Tension) $= 45{\cdot}57$ kips

(c) Net area required for two angles $= \frac{45{\cdot}57}{20}$ in^2

$= 2{\cdot}279$ in^2

(d) Net area for an angle $= \frac{2{\cdot}279}{2} = 1{\cdot}139$ in^2

(e) Let us supply $(3'' \times 3'' \times \frac{1}{2}'')$ of gross area $= 2{\cdot}75$ in^2

(f) Net area $= (2{\cdot}75) - \left(\frac{13}{16} \times \frac{1}{2}\right) = 2{\cdot}34$ in^2

(g) Slender ratio $= l/r = \frac{16{\cdot}09 \times 12}{0{\cdot}898} = 215{\cdot}01 \angle 240$

Hence supplied section $\Rightarrow [3'' \times 3'' \times \frac{1}{2}'']$

Member U_6U_9

(a) Member length = 16·09 ft

(b) Design stress (tension) = 8·34 kips

(c) Net area required for two angles = $\frac{8 \cdot 34}{20}$ ~~kips~~
= 0·417 in^2

(d) Net area for an angle = $\frac{0 \cdot 417}{2}$ = 0·209 in^2

(e) Let us supply $[3'' \times 3'' \times \frac{1}{2}'']$ of gross area = 2·75 in^2

(f) Net area = $2 \cdot 75 - \left(\frac{13}{16} \times \frac{1}{2}\right) = 2 \cdot 34$ in^2

(g) Slender ratio = $l/r = \frac{16 \cdot 09 \times 12}{0 \cdot 898} = 215 \cdot 01 < 240$

Hence supplied section ⇒ $[3'' \times 3'' \times \frac{1}{2}'']$

7·8 Design for Compression Member

(a) Allowable Compressive Stress = 11 ksi

(b) Two member of equal angles as shown in figure 7·38 below

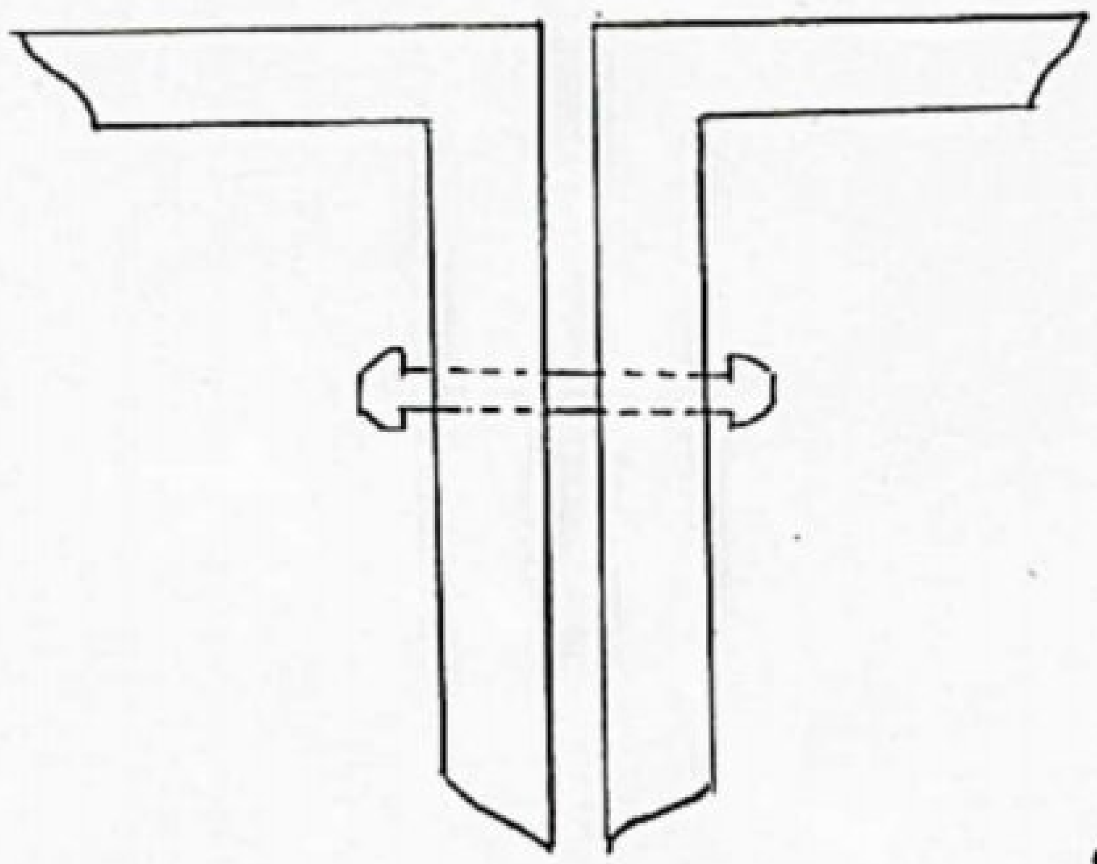

Figure 7·38 : Two members of equal angles

(c) Using $\frac{3}{4}$ in. ϕ rivet with minimum clearance = $\frac{1}{16}$ in.

i.e., diameter of rivet hole = $\left(\frac{3}{4}+\frac{1}{16}\right)$in. = $\frac{13}{16}$ inch

(d) Slender ratio ≤ 120

Member L_oL_1

(a) Length of member = 16·09 Ft

(b) Design stress (Compression) = 1·92 kips

(c) Net area required for two angles = $\frac{1.92}{11}$ = 0·175 in²

(d) Net area for an angle = $\frac{0.175}{2}$ = 0·0873 in²

(e) Let us supply $\left(6'' \times 6'' \times \frac{5}{16}''\right)$ of gross area = 3·65 in²

(f) Net area = $3.65 - \left(\frac{13}{16} \times \frac{5}{16}\right)$ = 3·306 in²

(g) Slender ratio = $\frac{l}{r} = \frac{16.09 \times 12}{1.89}$ = 102·16 ∠ 120

Hence supplied section ⇒ $\left[6'' \times 6'' \times \frac{5}{16}''\right]$

Scanned with CamScanner

Member L_1L_2

ⓐ Length of member = 16·09 ft

ⓑ Design stress (Compression) = 0·32 kips

ⓒ Net area required for two angles = $\frac{0.32}{11} = 0.029 in^2$

ⓓ Net area for an angle = $\frac{0.029}{2} = 0.0145 in^2$

ⓔ Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ of gross area = $3.65 in^2$

ⓕ Net area = $3.65 - (\frac{13}{16} \times \frac{5}{16}) = 3.306 in^2$

ⓖ Slender ratio = $\frac{l}{r} = \frac{16.09 \times 12}{1.89} = 102.16 < 120$

∴ Hence Supplied Section $[6'' \times 6'' \times 5/16'']$

Member L_2L_3 & L_3L_4

ⓐ Length of member = 19·31 ft

ⓑ Design stress (Compression) = 5·02 kips

ⓒ Net area required for two angles = $\frac{5.02}{11} in^2$
$= 0.456 in^2$

ⓓ Net area for an angle = $\frac{0.456}{2} = 0.228 in^2$

ⓔ Let us supply $(8'' \times 8'' \times \frac{1}{2}'')$ of gross area = $7.75 in^2$

ⓕ Net area = $7.75 - (\frac{13}{16} \times \frac{1}{2}) = 7.344 in^2$

ⓖ Slender ratio = $\frac{l}{r} = \frac{19.31 \times 12}{2.50} = 92.688 in^2$

Hence supplied section ⇒ $[8'' \times 8'' \times \frac{1}{2}'']$

1700099

Member L_4L_5

(a) Length of member = 16.09 ft

(b) Design stress (compression) = 3.93 kips

(c) Net area required for two angles = $\frac{3.93}{11}$ in^2

= 0.357 in^2

(d) Net area for an angle = $\frac{0.357}{2}$ = 0.179 in^2

(e) Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ of gross area = 3.65 in^2

(f) Net area = $3.65 - (\frac{13}{16} \times \frac{5}{16}) = 3.306$ in^2

(g) Slender ratio = $\frac{16.09 \times 12}{1.89} = 102.16 < 120$

Hence supplied section ⇒ $[6'' \times 6'' \times \frac{5}{16}'']$

Member L_5L_6

(a) Length of member = 16.09 ft

(b) Design stress (Compression) = 3.50 kips

(c) Net area required for two angles = $\frac{3.50}{11}$ = 0.318 in^2

(d) Net area for an angle = $\frac{0.318}{2}$ in^2 = 0.159 in^2

(e) Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ for gross area = 3.65 in^2

(f) Net area = $3.65 - (\frac{13}{16} \times \frac{5}{16}) = 3.306$ in^2

(g) Slender ratio = l/r = $\frac{16.09 \times 12}{1.89}$

= $102.16 < 120$

∴ Hence supplied section ⇒ $[6'' \times 6'' \times \frac{5}{16}'']$

1700099

Member L_0U_1 & U_7L_6

ⓐ Length of member = 14·39 ft

ⓑ Design stress (compression) = 84·66 kips

ⓒ Net area required for two angles = $\frac{84.66}{11}$ in^2
= 7·70 in^2

ⓓ Net area for an angle = $\frac{7.70}{2}$ = 3·85 in^2

ⓔ Let us supply $(5'' \times 5'' \times \frac{3}{4}'')$ of gross area = 6·94 in^2

ⓕ Net area = $6.94 - \left(\frac{13}{16} \times \frac{3}{4}\right) = 6.33$ in^2

ⓖ Slender ratio = $\frac{l}{r} = \frac{14.39 \times 12}{1.51} = 118.65 < 120$

Hence supplied section ⇒ $[5'' \times 5'' \times \frac{3}{4}'']$

Member U_1U_2 & U_6U_7

ⓐ Length of member = 14·39 ft

ⓑ Design stress (compression) = 83·66 kips

ⓒ Net area required for two angles = $\frac{83.66}{11}$ in^2
= 7·605 in^2

ⓓ Net area for an angle = $\frac{7.605}{2}$ = 3·803 in^2

ⓔ Let us supply $[5'' \times 5'' \times \frac{3}{4}'']$ of gross area = 6·94 in^2

ⓕ Net area = $6.94 - \left(\frac{13}{16} \times \frac{3}{4}\right) = 6.33$ in^2

ⓖ Slender ratio = $\frac{l}{r} = \frac{14.39 \times 12}{1.51} = 118.65 < 120$

Hence supplied section ⇒ $[5'' \times 5'' \times \frac{3}{4}'']$

Member U_2U_3 & U_3U_4

ⓐ Length of the member = 14·39 ft

ⓑ Design stress (Compression) - 79·26 kips

ⓒ Net area required for two angles = $\frac{79.26}{11}$ in^2

$= 7.205\ in^2$

ⓓ Net area for an angle = $\frac{7.205}{2}$ = $3.603\ in^2$

ⓔ Let us supply $(5'' \times 5'' \times \frac{3}{4}'')$ of gross area = $6.94\ in^2$

ⓕ Net area = $6.94 - \left(\frac{13}{16} \times \frac{3}{4}\right) = 6.33\ in^2$

ⓖ Slender ratio = $\frac{l}{r} = \frac{14.39 \times 12}{1.51} = 118.65 \angle 120$

Hence supplied section => $[5'' \times 5'' \times \frac{3}{4}'']$

Member U_4U_5 & U_5U_6

ⓐ Length of member = 14·39 ft

ⓑ Design stress (Compression) = 78·27 kips

ⓒ Net area required for two angles = $\frac{78.27}{11}$ in^2

$= 7.115\ in^2$

ⓓ Net area for an angle = $\frac{7.115}{2}$ = $3.558\ in^2$

ⓔ Let us supply $(5'' \times 5'' \times \frac{3}{4}'')$ of gross area = $6.94\ in^2$

ⓕ Net area = $6.94 - \left(\frac{13}{16} \times \frac{3}{4}\right) = 6.33\ in^2$

ⓖ Slender ratio = $l/r = \frac{14.39 \times 12}{1.51} = 118.65 \angle 120$

Hence supplied section $[5'' \times 5'' \times \frac{3}{4}'']$

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Member U_1L_1, U_3U_8 & U_5U_9, L_5U_7

(a) Length of the member = 7·19 in²

(b) Design stress (compression) = 12·60 kips

(c) Net area required for two angles = $\frac{12 \cdot 60}{11}$ in²
$= 1 \cdot 145$ in²

(d) Net area for an angle = $\frac{1 \cdot 145}{2} = 0 \cdot 573$ in²

(e) Let us supply $(2\frac{1}{2} \times 2\frac{1}{2} \times \frac{1}{2})$ of gross area = 2·25 in²

(f) Net area = $2 \cdot 25 - (\frac{13}{16} \times \frac{1}{2}) = 1 \cdot 844$ in²

(g) Slender ratio = $\frac{l}{r} = \frac{7 \cdot 19 \times 12}{0 \cdot 739} = 116 \cdot 75 \angle 120$

Hence supplied section => $[2\frac{1}{2}'' \times 2\frac{1}{2}'' \times \frac{1}{2}'']$

Member U_2L_2 & L_4U_6

(a) Length of member = 14·39 ft

(b) Design stress (compression) = 26·90 kips

(c) Net area required for two angle = $\frac{26 \cdot 90}{11}$ in²
$= 2 \cdot 445$ in²

(d) Net area for an angle = $\frac{2 \cdot 445}{2} = 1 \cdot 223$ in²

(e) Let us supply $[5'' \times 5'' \times \frac{3}{4}'']$ of gross area = 6·94 in²

(f) Net area = $6 \cdot 94 - (\frac{13}{16} \times \frac{3}{4}) = 6 \cdot 33$ in²

(g) Slender ratio = $l/r = \frac{14 \cdot 39 \times 12}{1 \cdot 51} = 118 \cdot 65 \angle 120$

Hence supplied section => $[5'' \times 5'' \times \frac{3}{4}'']$

Member L_3U_1

(a) Length of member = 25·75 ft

(b) Design stress (compression) = 3·75 kips

(c) Net area required for two angles $= \frac{3.75}{11}$ in^2

$= 0.341$ in^2

(d) Net area for an angle = 0·170 in^2

(e) Let us supply $(8'' \times 4'' \times \frac{9}{16}'')$ of gross area = 6·43 in^2

(f) Net area $= 6.43 - \left(\frac{13}{16} \times \frac{9}{16}\right) = 5.97$ in^2

(g) Slender ratio $= \frac{l}{r} = \frac{25.75 \times 12}{2.58} = 119.77 \angle 120$

Hence supplied section => $[8'' \times 4'' \times \frac{9}{16}'']$

Member L_5U_6

(a) Length of member = 16·09 ft

(b) Design stress (compression) = 0·41 kips

(c) Net area required for two angles $= \frac{0.41}{11}$ in^2

$= 0.037$ in^2

(d) Net area for an angle $= \frac{0.037}{2} = 0.0186$ in^2

(e) Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ of gross area = 3·65 in^2

(f) Net area $= 3.65 - \left(\frac{13}{16} \times \frac{5}{16}\right) = 3.306$ in^2

(g) Slender ratio $= l/r = \frac{16.09 \times 12}{1.89} = 102.16 \angle 120$

Hence supplied section => $[6'' \times 6'' \times \frac{5}{16}'']$

Member U_9L_1

(a) Length of member = 16·09 ft

(b) Design stress (compression) = 2·42 kips

(c) Net area required for two angle $= \frac{2.42}{11} = 0.22 \text{ in}^2$

(d) Net area for an angle $= \frac{0.22}{2} = 0.11 \text{ in}^2$

(e) Let us supply $[6'' \times 6'' \times \frac{5}{16}'']$ of gross area = 3·65 in²

(f) Net area $= 3.65 - \left(\frac{13}{16} \times \frac{5}{16}\right) = 3.306 \text{ in}^2$

(g) Slender ratio $= l/r = \frac{16.09 \times 12}{1.89} = 102.16 < 120$

Hence supplied section $\Rightarrow [6'' \times 6'' \times \frac{5}{16}'']$

Member L_2U_8

(a) Length of member = 16·09 ft

(b) Design stress (compression) = 2·97 kips

(c) Net area required for two angles $= \frac{2.97}{11} \text{ in}^2$
$= 0.27 \text{ in}^2$

(d) Net area for an angle $= \frac{0.27}{2} = 0.135 \text{ in}^2$

(e) Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ of gross area
$= 3.65 \text{ in}^2$

(f) Net area $= 3.65 - \left(\frac{13}{16} \times \frac{5}{16}\right) = 3.306 \text{ in}^2$

(g) Slender ratio $= l/r = \frac{16.09 \times 12}{1.89} = 102.16 < 120$

Hence supplied section $\Rightarrow [6'' \times 6'' \times \frac{5}{16}'']$

Member L_1U_2

(a) Length of member = 16·09 ft

(b) Design stress (Compression) = 0·68 kips

(c) Net area required for two angles = $\frac{0.68}{11}$ in^2
= 0·0618 in^2

(d) Net area for an angle = $\frac{0.0618}{2}$ = 0·0309 in^2

(e) Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ of gross area = 3·65 in^2

(f) Net area = $3.65 - (\frac{13}{16} \times \frac{5}{16})$ = 3·306 in^2

(g) Slender ratio = $l/r = \frac{16.09 \times 12}{1.89} = 102.16 < 120$

Hence supplied section => $[6'' \times 6'' \times \frac{5}{16}'']$

Member U_2U_8

(a) Length of member = 16·09 ft

(b) Design stress (compression) = 4·53 kips

(c) Net area required for two angles = $\frac{4.53}{11}$ in^2
= 0·412 in^2

(d) Net area for an angle = $\frac{0.412}{2}$ = 0·206 in^2

(e) Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ of gross area
= 3·65 in^2

(f) Net area = $3.65 - (\frac{13}{16} \times \frac{5}{16})$ = 3·306 in^2

(g) Slender ratio = $l/r = \frac{16.09 \times 12}{1.89} = 102.16 < 120$

Hence supplied section => $[6'' \times 6'' \times \frac{5}{16}'']$

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Member U_4U_8

(a) Length of member = 16·09 ft

(b) Design stress (compression) = 7·45 kips

(c) Net area required for two angles = $\frac{7.45}{11}$ in^2
= 0·677 in^2

(d) Net area for an angle = $\frac{0.677}{2}$ = 0·3386 in^2

(e) Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ of gross area
= 3·65 in^2

(f) Net area = $3.65 - \left(\frac{13}{16} \times \frac{5}{16}\right) = 3.306$ in^2

(g) Slender ratio = $l/r = \frac{16.09 \times 12}{1.89} = 102.16 < 120$

Hence supplied section ⇒ $[6'' \times 6'' \times \frac{5}{16}'']$

Member U_4U_9

(a) Length of member = 16·09 ft

(b) Design stress (compression) = 12·75 kips

(c) Net area required for two angles = $\frac{12.75}{11}$
= 1·159 in^2

(d) Net area for an angle = $\frac{1.159}{2}$ = 0·580 in^2

(e) Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ of gross area
= 3·65 in^2

(f) Net area = $3.65 - \left(\frac{13}{16} \times \frac{5}{16}\right) = 3.306$ in^2

(g) Slender ratio = $l/r = \frac{16.09 \times 12}{1.89} = 102.16 < 120$

Hence supplied section ⇒ $[6'' \times 6'' \times \frac{5}{16}'']$

Member $U_6 U_9$

(a) Length of member = 16·09 ft

(b) Design stress (compression) = 9·53 in²

(c) Net area required for two angle $= \frac{9.53}{11}$ in²

$= 0.866$ in²

(d) Net area for an angle $= \frac{0.866}{2}$ in²

$= 0.433$ in²

(e) Let us supply $(6'' \times 6'' \times \frac{5}{16}'')$ of gross area

$= 3.65$ in²

(f) Net area $= 3.65 - (\frac{13}{16} \times \frac{5}{16}) = 3.306$ in²

(g) Slender ratio $= l/r = \frac{16.09 \times 12}{1.89} = 102.16 < 120$

Hence supplied section $\Rightarrow [6'' \times 6'' \times \frac{5}{16}'']$

7·9 Design of Rivet

Assumptions:

(a) Allowable Shear stress = 15 ksi (Single Shear)

(b) Allowable Shear Stress = 30 ksi (Double Shear)

(c) Allowable bear stress = 40 ksi (Double Bear)

(d) Size of gusset plate = $\frac{7}{16}''$ (Thickness)

(e) Size of rivet = $\frac{3}{4}''\phi$

(f) Minimum rivet number = 2

Rivet Value

(a) For shear $= \left\{ \frac{\pi}{4} \times \left(\frac{3}{4}\right)^2 \times 30 \right\}$ kips

$= 13.25$ kips

(b) For Bear $= \left[\left(\frac{7}{16} \times \frac{3}{4} \right) \times 40 \right]$ kips

$= 13.125$ kips

∴ Therefore design rivet value = 13·125 kips per rivet

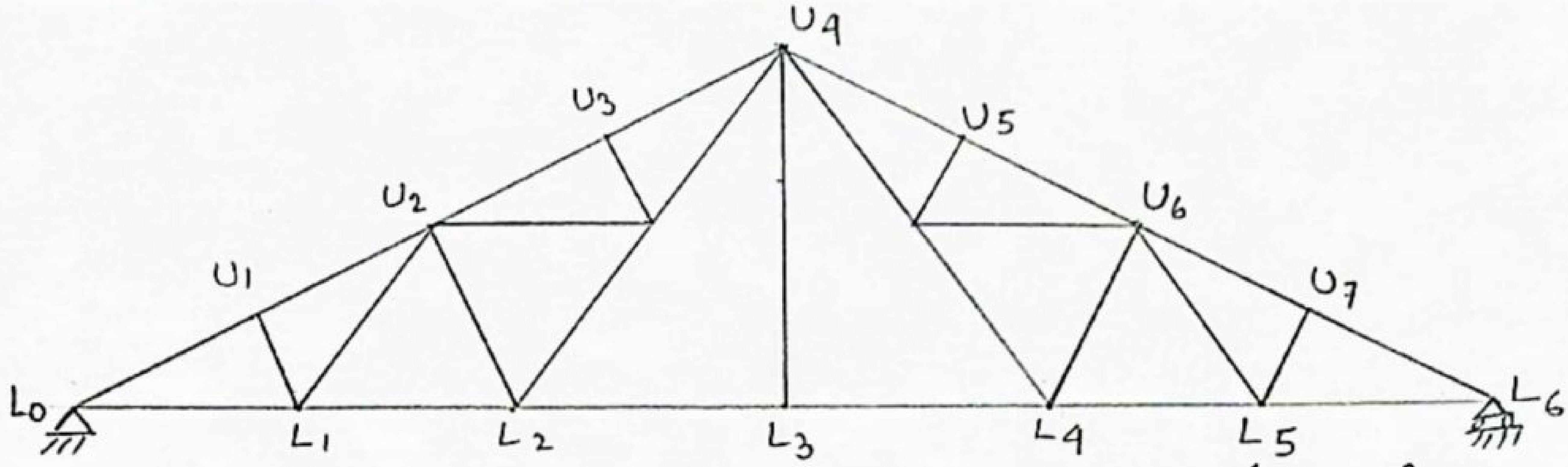

Figure 7·39: Fink type roof truss (Showing different Joints)

Joint L_o

Number of rivet,

For member $L_oL_1 = \frac{\text{Load}}{\text{Rivet Value}} = \frac{92\cdot30}{13\cdot125}$

$= 7\cdot032$

≈ 8

For member $L_oU_1 = \frac{\text{Load}}{\text{Rivet Value}} = \frac{84\cdot66}{13\cdot125}$

$= 6\cdot45 \approx 7$

Joint L_1

Number of rivet,

For member $L_oL_1 = 8$

For member $L_1L_2 = \frac{\text{Load}}{\text{Rivet value}} = \frac{75\cdot87}{13\cdot125}$

$= 5\cdot781$

≈ 6

For member $U_1L_1 = \frac{\text{Load}}{\text{Rivet value}} = \frac{12\cdot60}{13\cdot125}$

$= 0\cdot96 \approx 1 \longrightarrow 2$

(Minimum number of rivet = 2)

For member $L_1U_2 = \frac{\text{Load}}{\text{Rivet value}} = \frac{18}{13.125}$

$= 1.371$

≈ 2

Joint L_2

Number of rivet,

For member $L_1L_2 = 6$

For member $L_2L_3 = \frac{\text{Load}}{\text{rivet value}} = \frac{43.21}{13.125}$

$= 3.29 \approx 4$

For member $L_2U_2 = \frac{\text{Load}}{\text{rivet value}} = \frac{26.90}{13.125}$

$= 2.049 \approx 3$

For member $L_2U_8 = \frac{\text{Load}}{\text{Rivet value}} = \frac{34.37}{13.125}$

$= 2.62 \approx 3$

Joint L_3

Number of rivet,

For member $L_2L_3 = 4$

For member $L_3L_4 = \frac{\text{Load}}{\text{Rivet Value}} = \frac{43.2}{13.125}$

$= 3.29 \approx 4$

For member $L_3U_4 = \frac{\text{Load}}{\text{rivet value}}$

$= \frac{3.75}{13.125}$

$= 0.285 \approx 1 \rightarrow 2$

(Minimum number of rivet = 2)

Joint L_4

Number of rivet,

For member $L_3L_4 = 4$

For member $L_4L_5 = \frac{\text{Load}}{\text{Rivet Value}} = \frac{54.56}{13.125}$

$= 4.157 \approx 5$

For member $U_9L_4 = \frac{\text{Load}}{\text{Rivet value}} = \frac{34.37}{13.125}$

$= 2.62 \approx 3$

For member $L_4U_6 = \frac{\text{Load}}{\text{Rivet value}} = \frac{26.90}{13.125}$

$= 2.05 \approx 3$

Joint L_5

For member $L_5L_6 = \frac{\text{Load}}{\text{Rivet value}} = \frac{80}{13.125}$

$= 6.10 \approx 7$

For member $L_4L_5 = 5$

For member $L_5U_6 = \frac{\text{Load}}{\text{Rivet value}} = \frac{18}{13.125}$

$= 1.37 \approx 2$

For member $L_5U_7 = \frac{\text{Load}}{\text{Rivet value}} = \frac{12.60}{13.125}$

$= 0.91 \approx 1 \longrightarrow 2$

(minimum number of Rivet = 2)

Joint L_6

Number of Rivet,

For member $L_5L_6 = 7$

For member $U_7L_6 = \frac{Load}{Rivet\ Value} = \frac{84.66}{13.125}$

$= 6.45 \approx 7$

Joint U_1

Number of rivet,

For member $L_0U_1 = 7$

For member $U_1L_1 = 2$

For member. $U_1U_2 = \frac{Load}{Rivet\ value} = \frac{83.66}{13.125}$

$= 6.37 \approx 7$

Joint U_2

Number of rivet,

For member $U_1U_2 = 7$

For member $U_2L_1 = 2$

For member, $U_2L_2 = 3$

For member $U_2U_8 = \frac{Load}{Rivet\ Value} = \frac{14.16}{13.125}$

$= 1.08 \approx 2$

For member $U_2U_3 = \frac{Load}{Rivet\ Value} = \frac{79.26}{13.125}$

$= 6.039 \approx 7$

Joint U_3

Number of rivet,

For member $U_2U_3 = 7$

For member $U_3U_8 = \frac{Load}{Rivet\ value} = \frac{12.60}{13.125}$

$= 0.96 \approx 1 \rightarrow 2$

For member, $U_3U_4 = \frac{\text{Load}}{\text{Rivet Value}} = \frac{79.26}{13.125}$

$= 6.04 \approx 7$

Joint U_4

Number of Rivets,

For member, $U_3U_4 = 7$

For member, $L_3U_4 = 2$

For member, $U_4U_8 = \frac{\text{Load}}{\text{Rivet value}} = \frac{48.57}{13.125}$

$= 3.70 \approx 4$

for member $U_4U_9 = \frac{\text{Load}}{\text{Rivet value}} = \frac{48.57}{13.125}$

$= 3.70 \approx 4$

For member $U_4U_5 = \frac{\text{Load}}{\text{Rivet Value}} = \frac{78.27}{13.125}$

$= 5.96 \approx 6$

Joint U_5

Number of rivets,

for member $U_4U_5 = 6$

For member $U_5U_9 = \frac{\text{Load}}{\text{Rivet value}} = \frac{12.60}{13.125}$

$= 0.96 \approx 1 \longrightarrow 2$

For member, $U_5U_6 = \frac{\text{Load}}{\text{Rivet value}} = \frac{78.27}{13.125}$

$= 5.96 \approx 6$

Joint U_6

Number of rivets,

For member $U_5U_6 = 6$

For member $L_4U_6 = 3$

For member $L_5U_6 = 2$

For member, $U_6U_7 = \frac{\text{Load}}{\text{Rivet value}} = \frac{83.66}{13.125}$

$= 6.37 \approx 7$

For member, $U_6U_9 = \frac{\text{Load}}{\text{rivet value}} = \frac{9.53}{13.125}$

$= 0.726 \approx 1 \rightarrow 2$

(minimum number of rivet = 2)

Joint U_7

Number of rivets

For member $U_6U_7 = 7$

For member $L_5U_7 = 2$

For member, $U_7L_6 = 7$

Joint U_8

Number of rivet,

For member $U_3U_8 = 2$

For member $U_2U_8 = 2$

For member, $L_2U_8 = 3$

For member $U_4U_8 = 4$

Joint U_9

Number of Rivet for,

Member U_5U_9 = 2

Member U_6U_9 = 2

Member U_9L_4 = 3

Member U_4U_9 = 4

Joint L_0

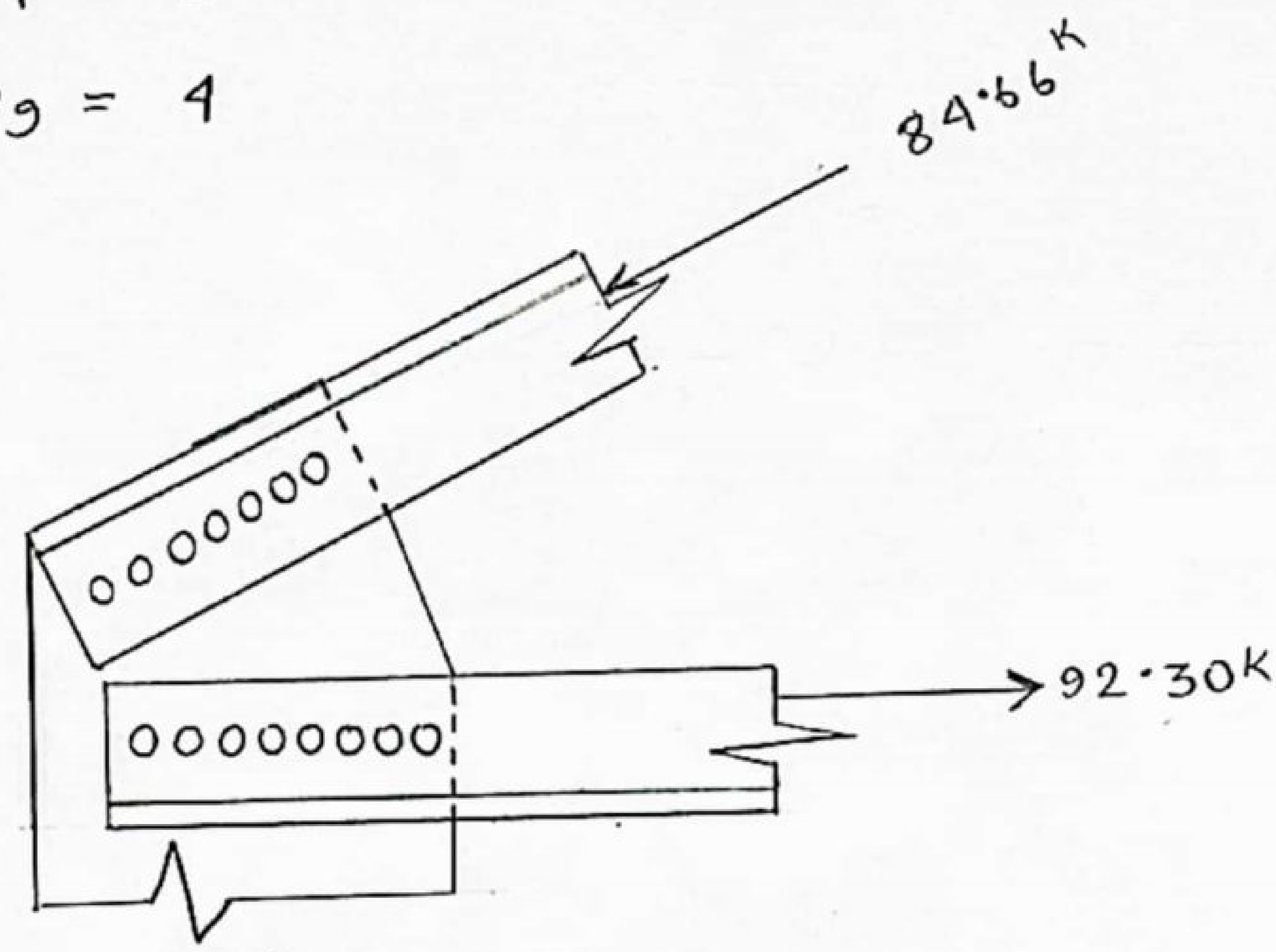

Figure 7.40: Joint L_0

Joint L_1

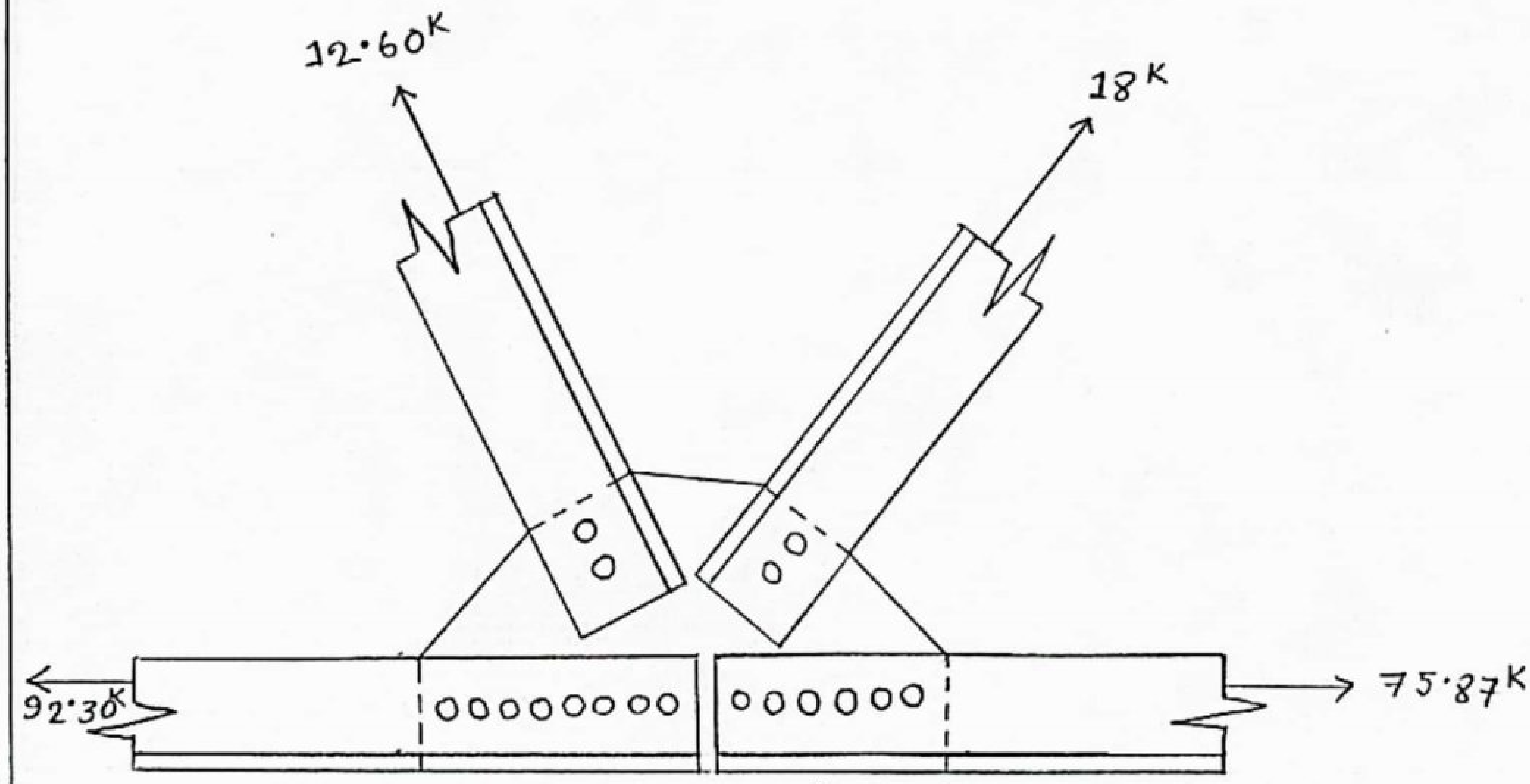

Figure 7.41: Joint L_1

Joint L_2

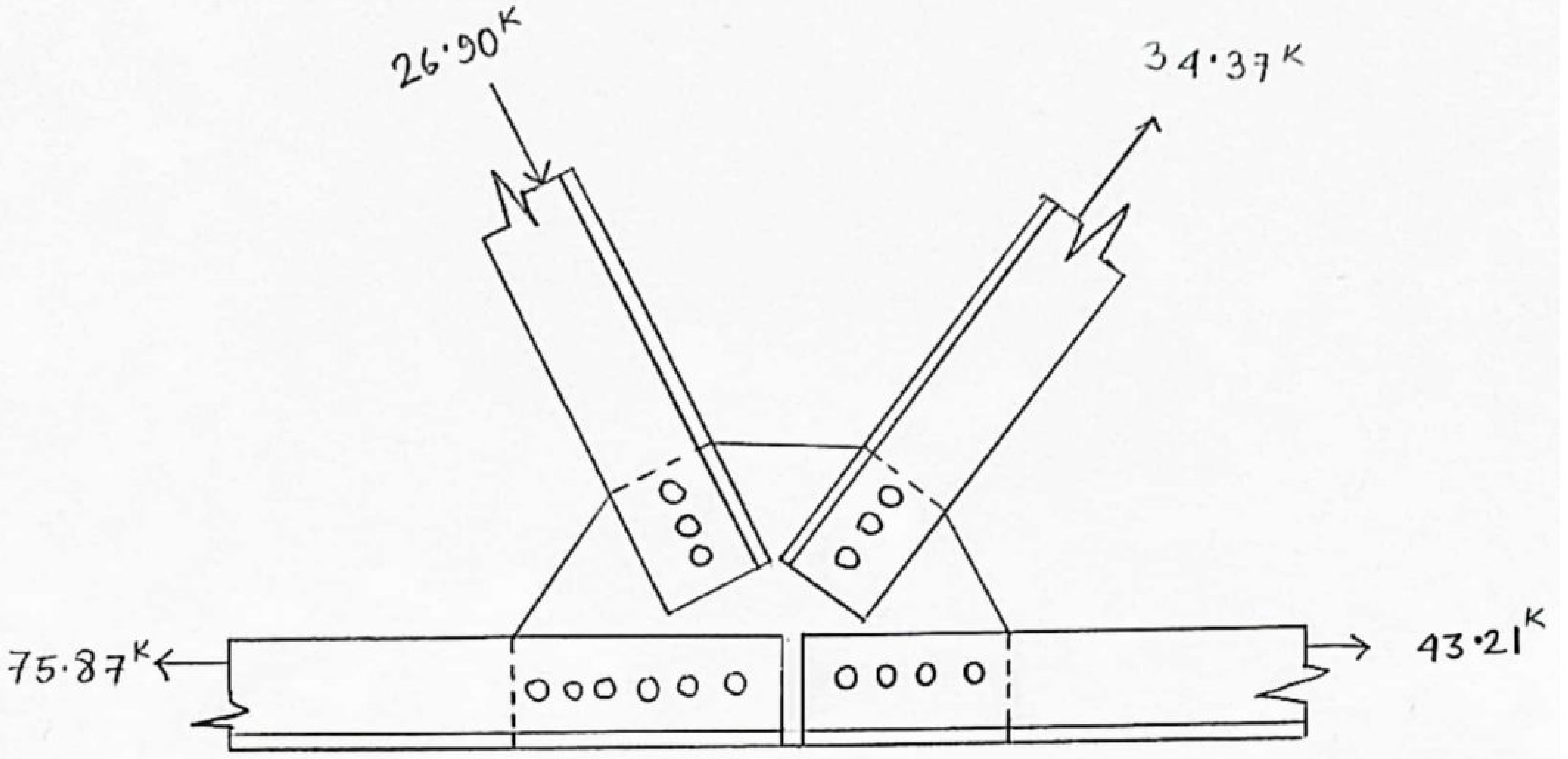

figure 7·42: Joint L_2

Joint L_3

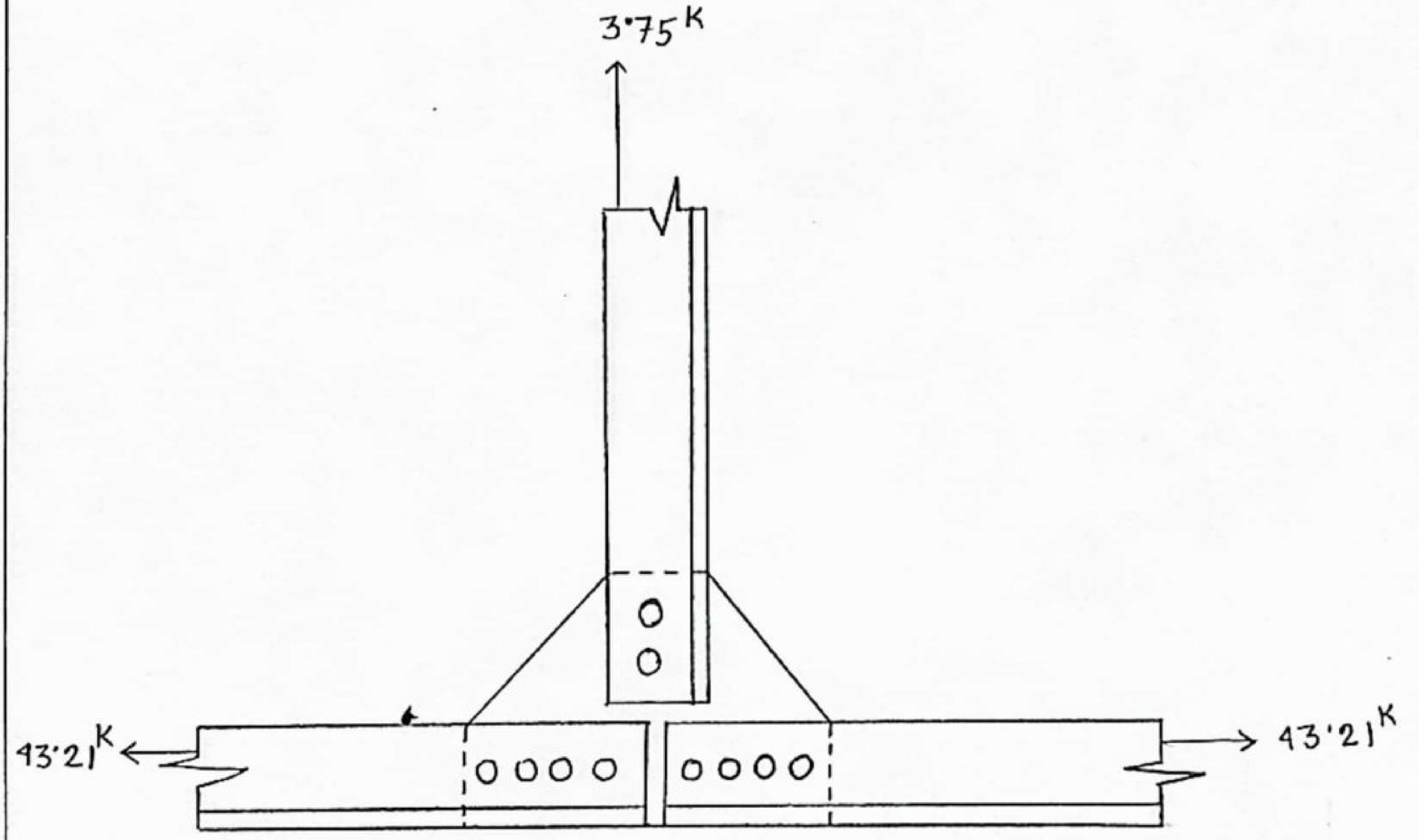

Figure 7·43: Joint L_3

Joint L_4

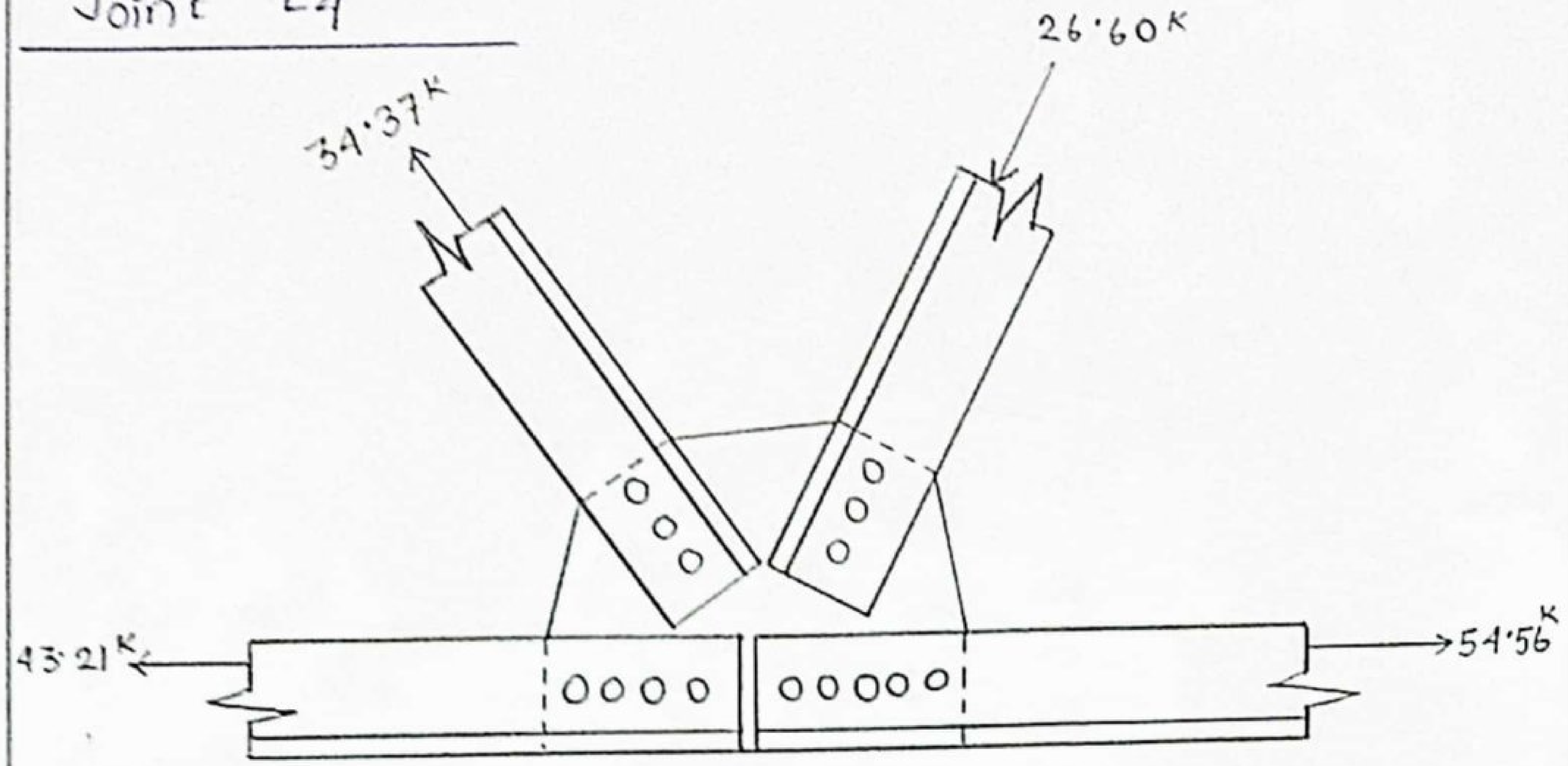

Figure 7.44: Joint L_4

Joint L_5

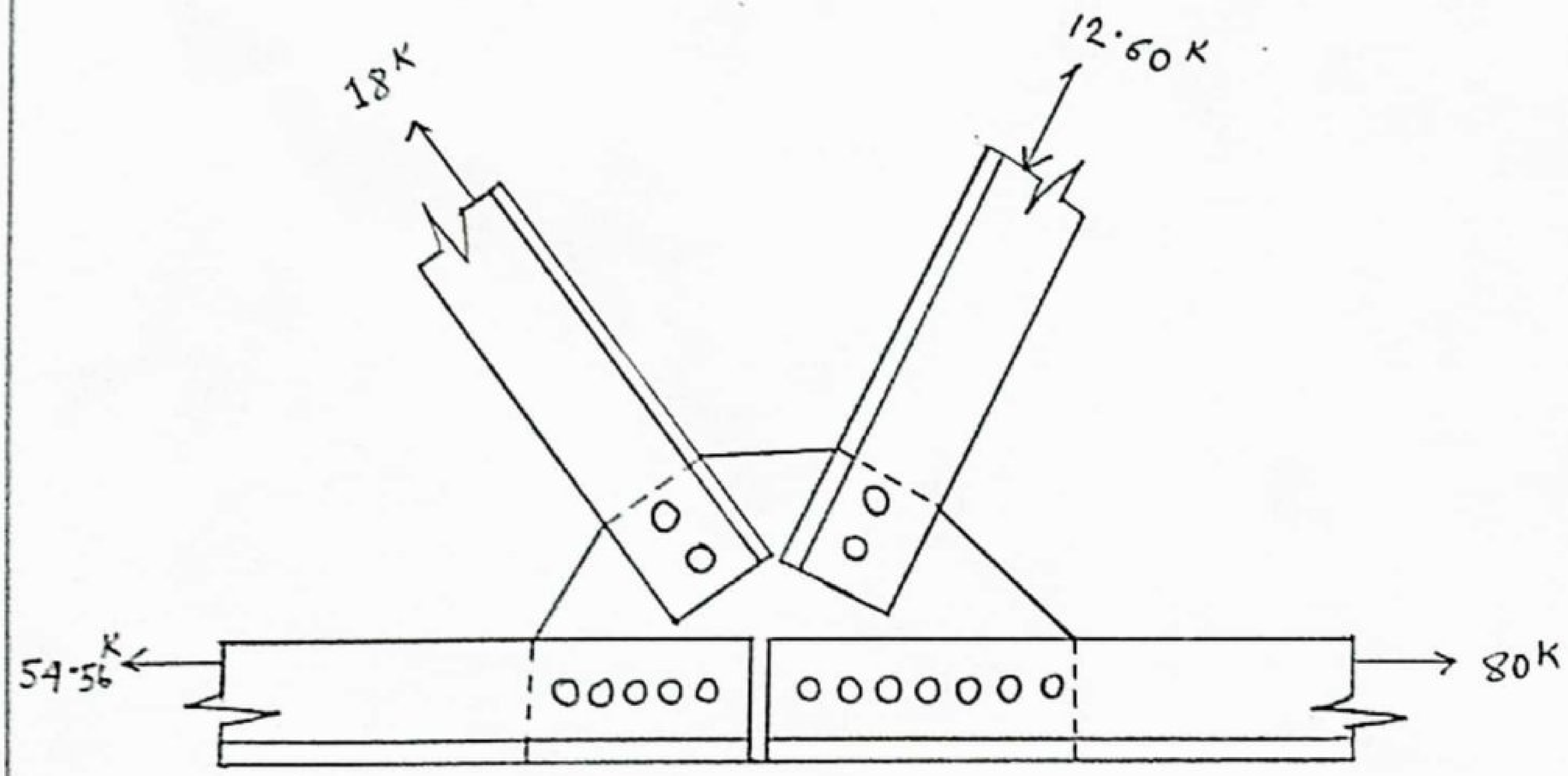

Figure 7.45: Joint L_5

Joint L_6

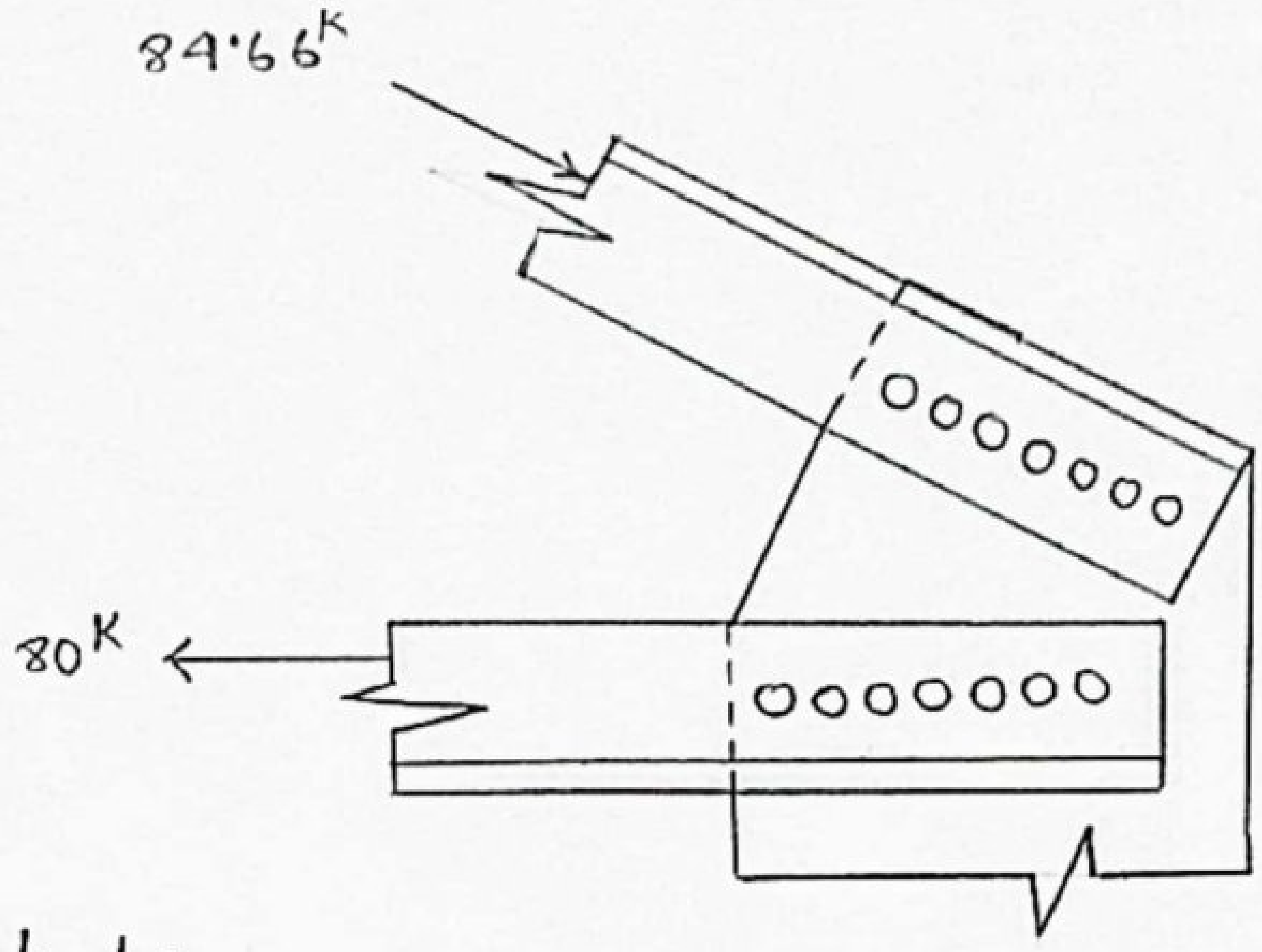

Figure 7.46: Joint L_6

Joint U_1

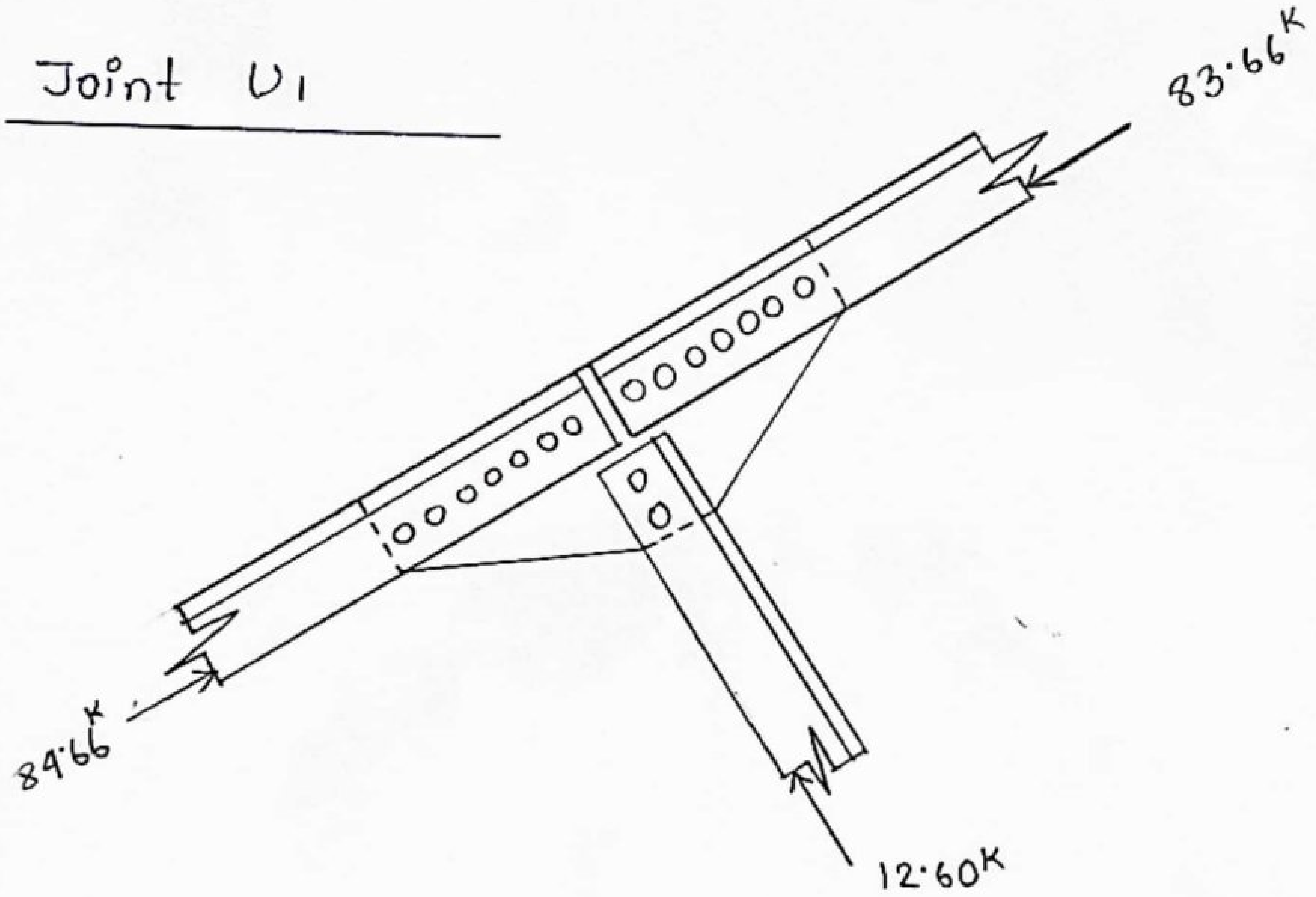

Figure 7.47: Joint U_1

Joint U_2

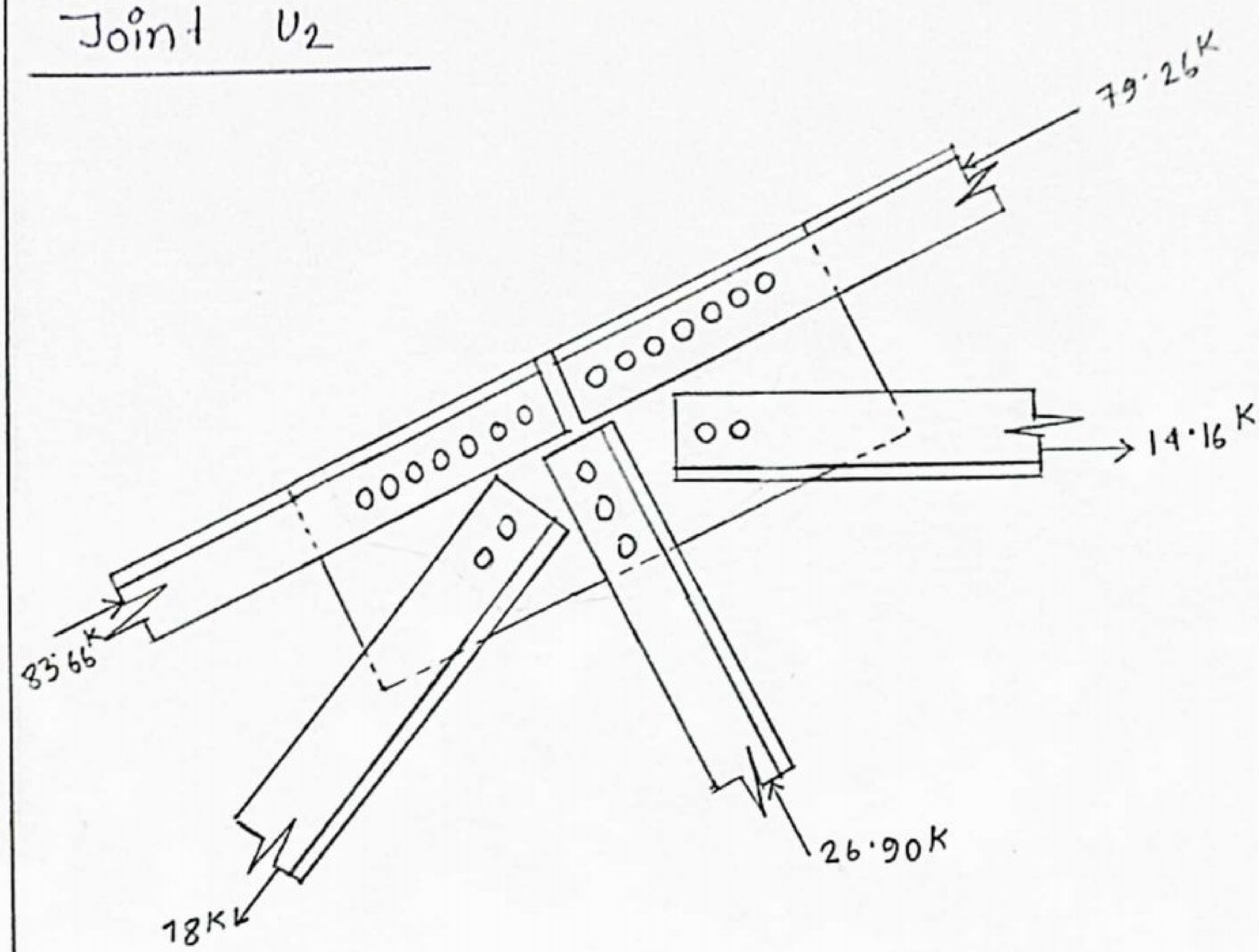

Figure 7.48: Joint U_2

Joint U_3

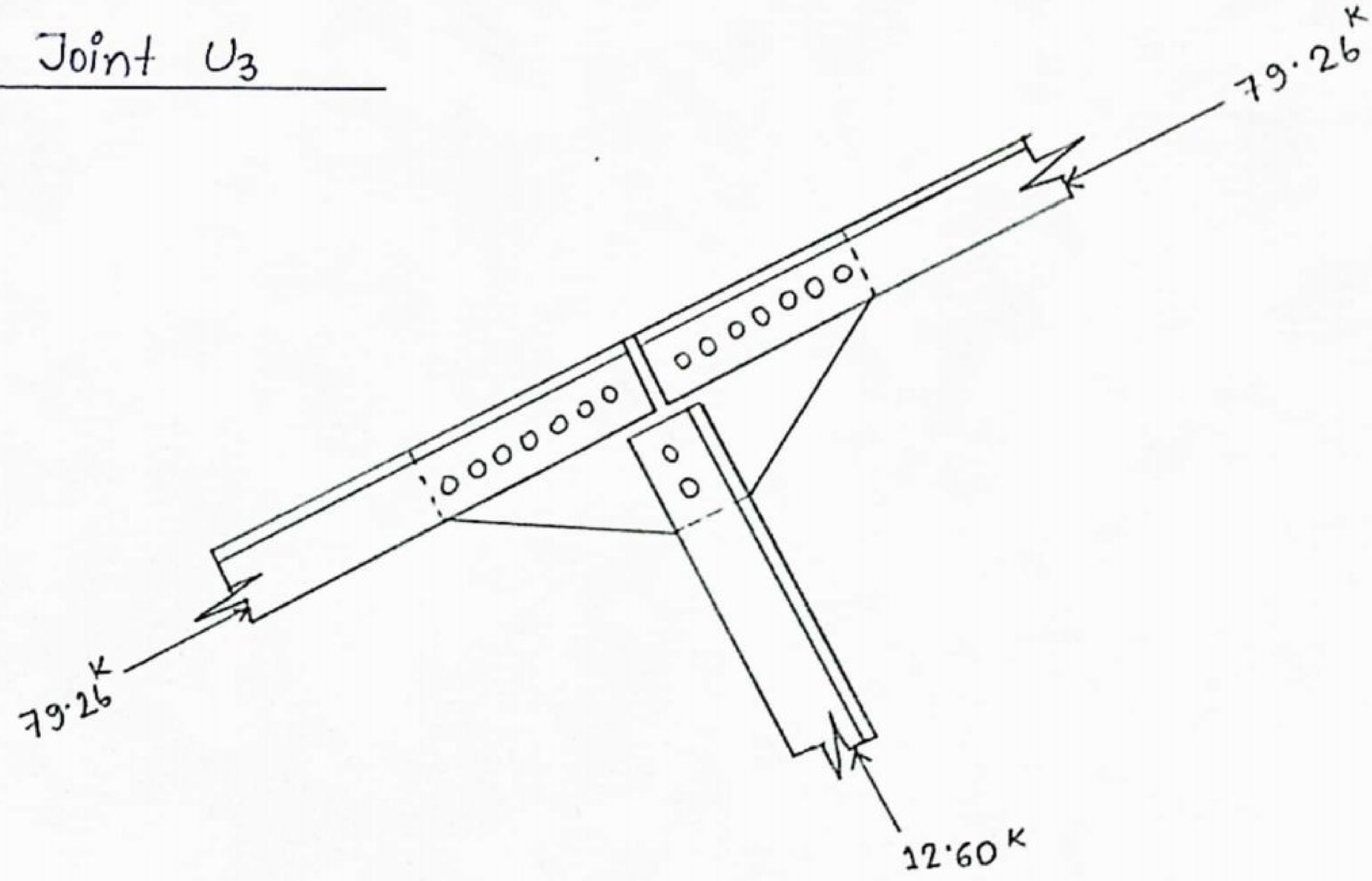

Figure 7.49: Joint U_3

Joint U4

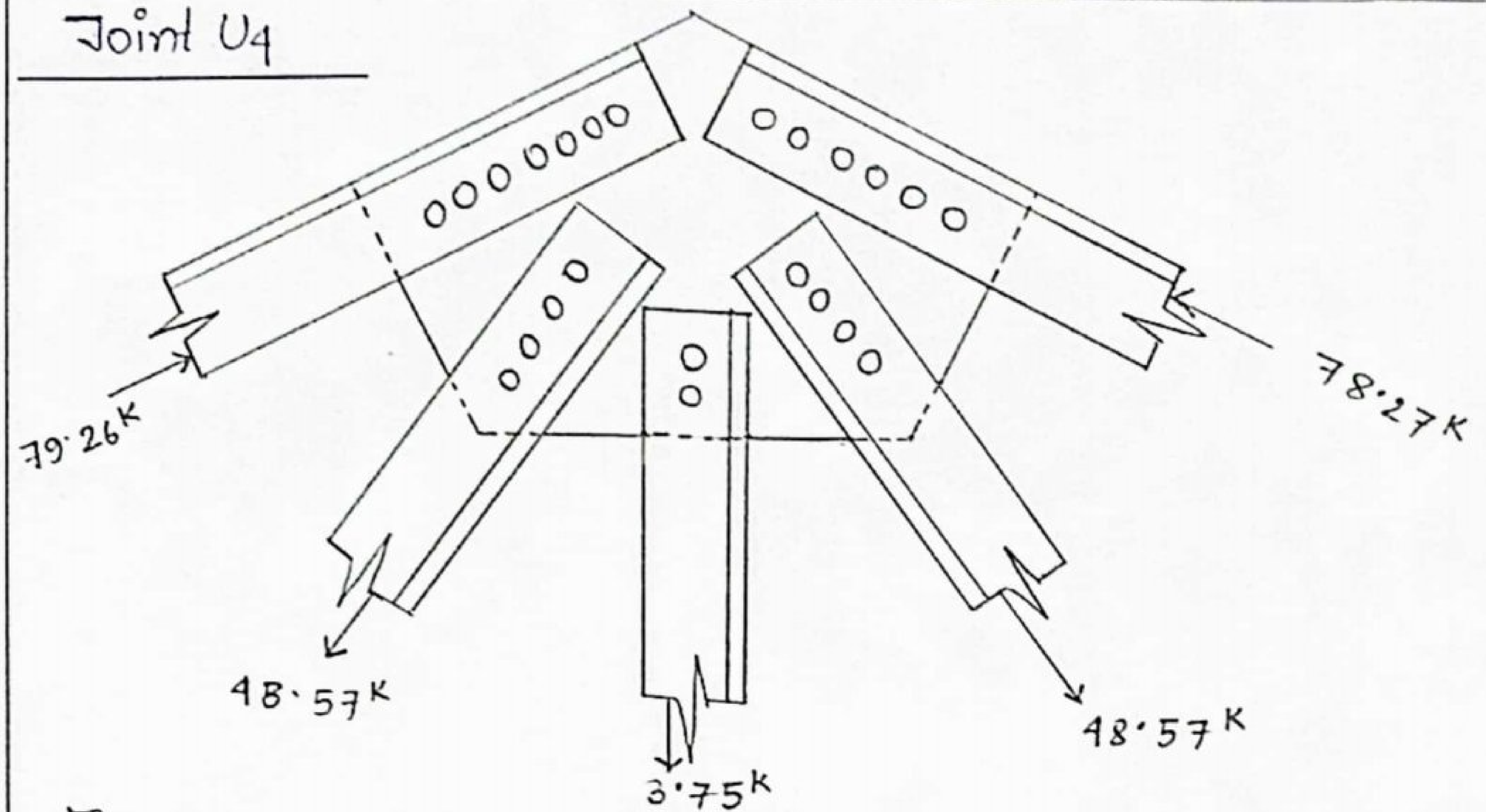

Figure 7.50: Joint U4

Joint U5

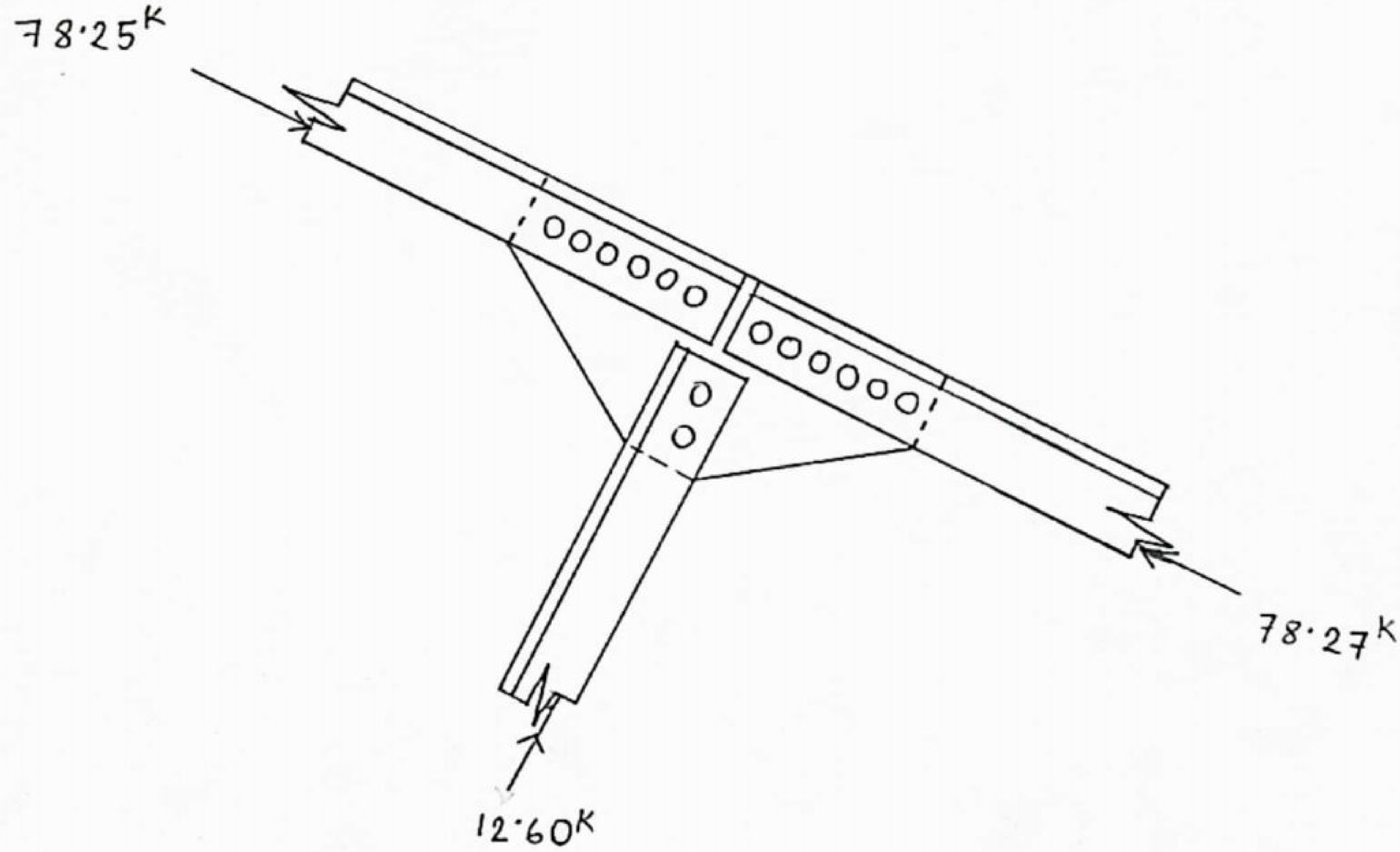

Figure 7.51: Joint U5

Joint U6

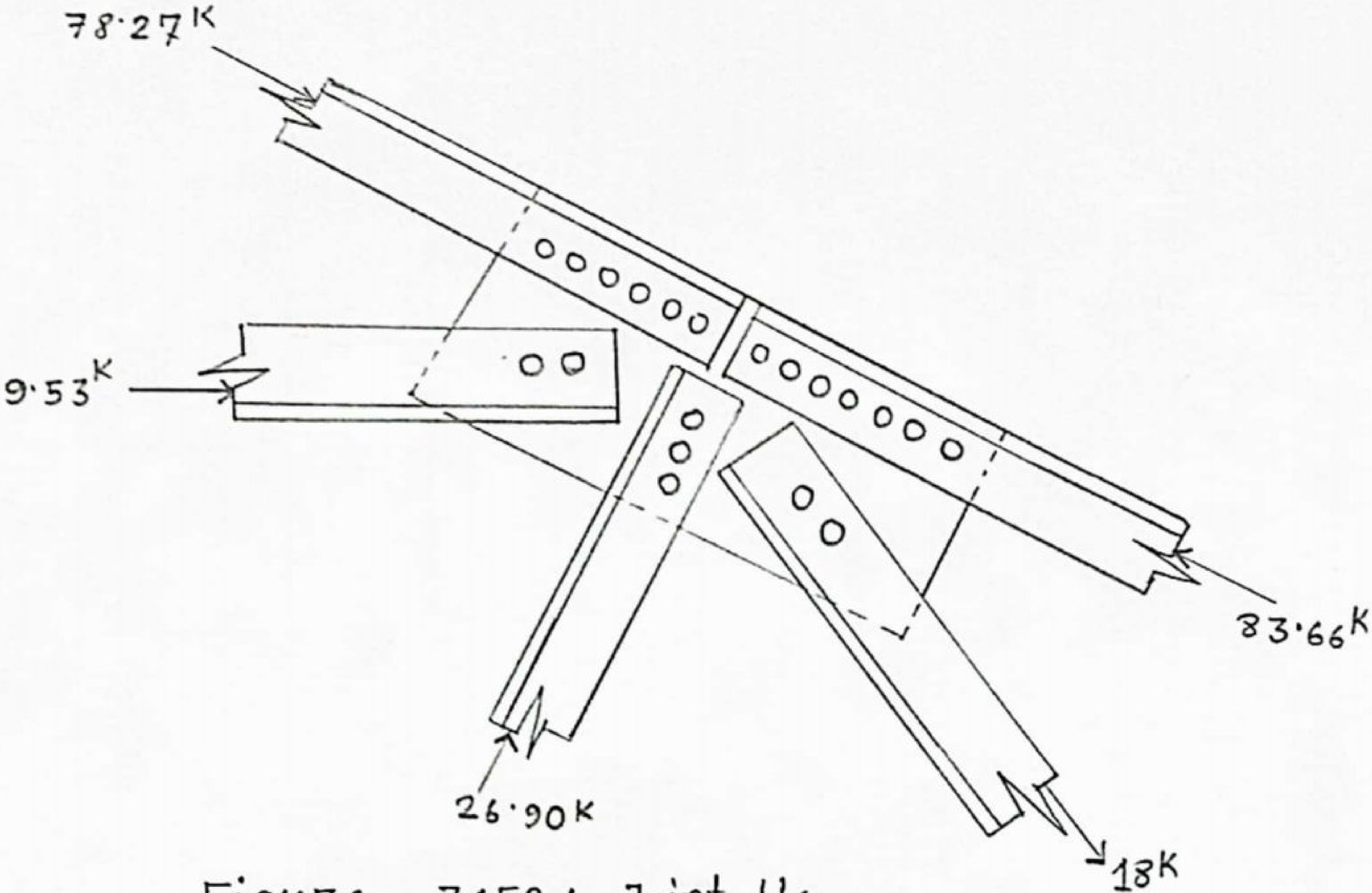

Figure 7.52: Joint U6

Joint U7

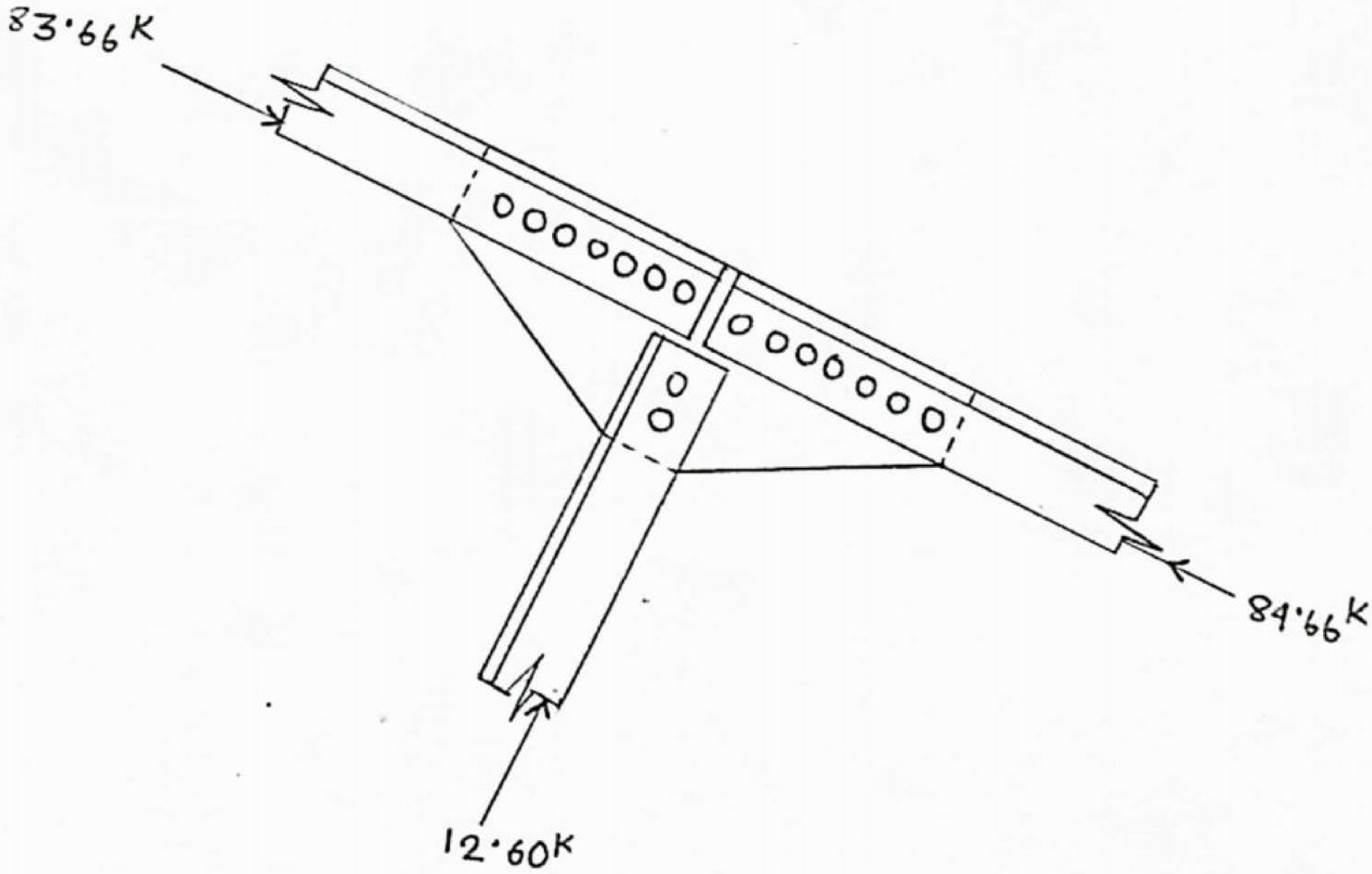

Figure 7.53: Joint U7

Joint U8

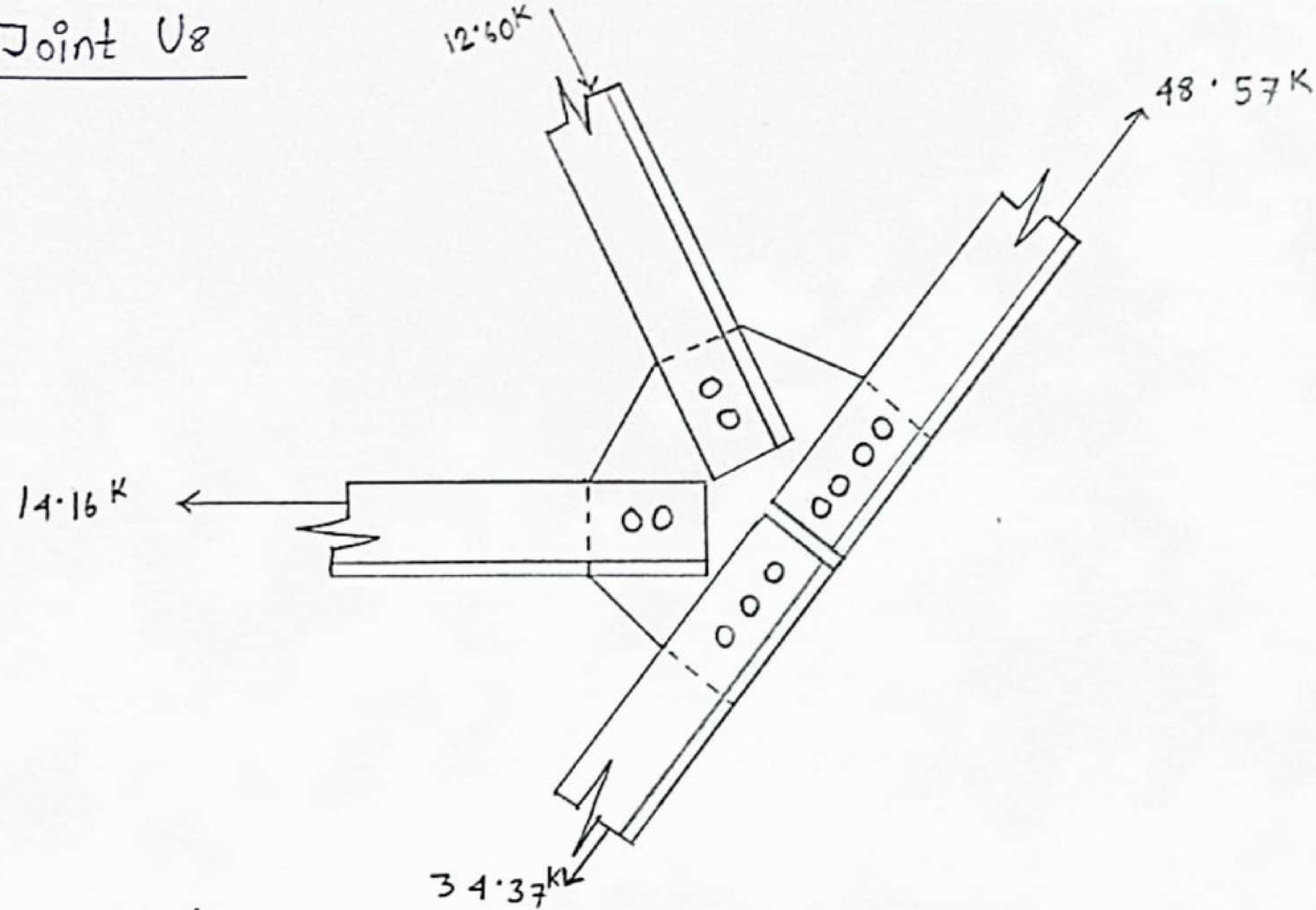

Figure :7.54 : Joint U8

Joint U9

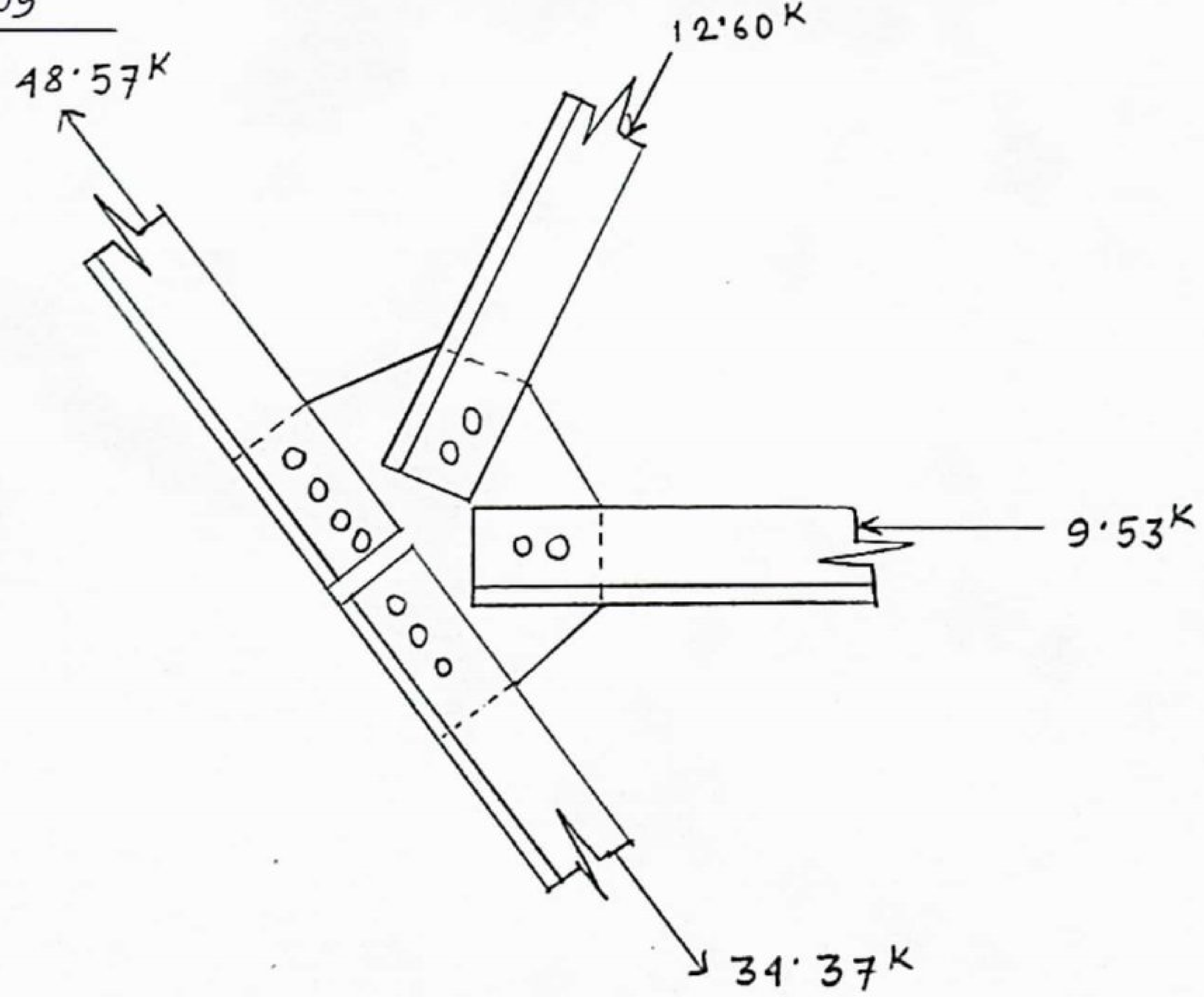

Figure 7.54 : Joint U9

⑤ (External Force + Internal Pressure), Right :

R_A = 22.09 kips (Downward)

R_B = 19.64 kips (Downward)

H_A = 2.745 kips (Rightward)

⑥ (External force + Internal suction), Left :

R_A = 3.965 kips (Upward)

R_B = 1.525 kips (upward)

H_A = 2.745 kips (Leftward)

⑦ (External Force + Internal suction), Right :

R_A = 1.525 kips (Upward)

R_B = 3.965 kips (upward)

H_A = 2.745 kips (Rightward)

(ii) Design of Shoe Angle :

(a) Let us consider the size of shoe angle is $(3'' \times 3'' \times \frac{3}{8}'')$

(b) The length of equal angle = 10"

(c) Size of rive = $\frac{3}{4}'' \phi$

(d) Allowable shearing stress = 15 ksi (assumed)

(e) Allowable bearing stress = 40 ksi (assumed)

(f) Rivet value for bearing = $\left(\frac{7}{16} \times \frac{3}{4} \times 40\right)$ kips

= 13·125 kips

(g) Rivet value for shearing = $\frac{\pi}{4} \times \left(\frac{3}{4}\right)^2 \times (2 \times 15)$

= 13·25 kips

(h) Design rivet value = 13·125 kips

(i) Vertical reaction = (Dead Load Reaction + Maximum Live Load Reaction)

= (20·35 + 30·78) kips

= 51·13 kips

(J) Horizontal Reaction = 21·308 kips

(k) Design Reaction = $\sqrt{(51 \cdot 13)^2 + (21 \cdot 308)^2}$ kips

= 55·39 kips

No. of rivet between gusset plate and shoe angle = $\frac{\text{Design Reaction}}{\text{Rivet Design value}}$

$= \frac{55 \cdot 39}{13 \cdot 125}$

$= 4 \cdot 22 \approx 5$

Therefor, 5 Rivets will be used between gusset plate and shoe angle and with base plate.

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7·11 Design of Base Plate:

Given, $f_c' = 2000$ Psi

(a) Allowable bearing preassure, B.P. $= 0.25 f_c'$

$= (0.25 \times 2000)$ psi

$= 500$ psi

(b) Area required to resist total reaction

$$= \frac{\text{Design Reaction}}{\text{Bearing Pressure}}$$

$$= \frac{55.39 \times 1000}{500} \text{ in}^2$$

$$= 110.78 \text{ in}^2$$

∴ The width $= \frac{\text{Area}}{10''} = \frac{110.78}{10}$ inch

$= 11.078$ inch $\cong 12$ inch

∴ The tentative size of base plate $= (12'' \times 10'')$

Minimum width required for base plate

$$= \frac{7}{16} + 2 \times (3 + 1.5 + 1.5)$$

$$= 12.4375''$$

$$\approx 13''$$

Scanned with CamScanner

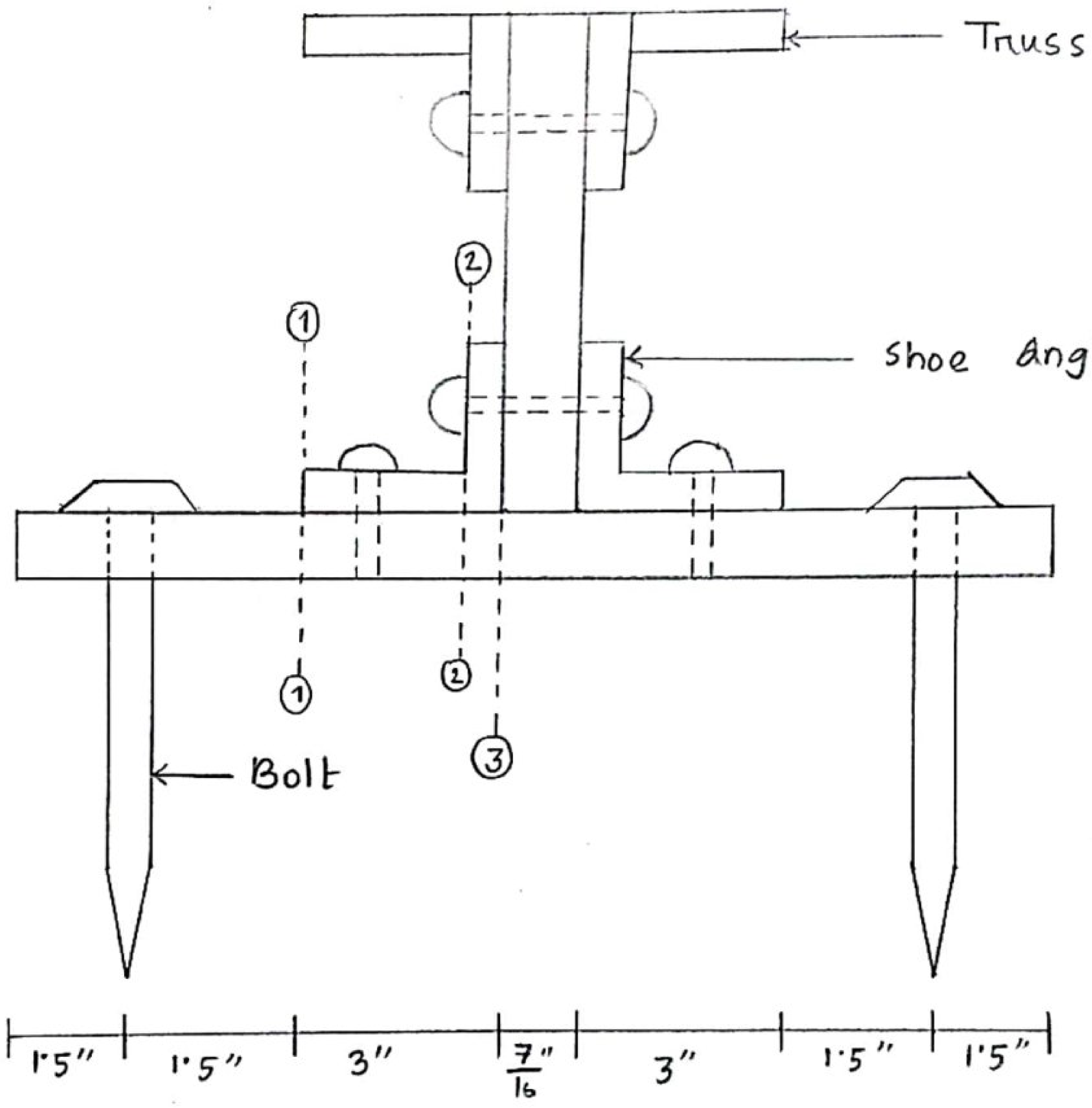

Figure 7·55: (Base Plate, Showing Truss, Shoe Angle & Bolt)

Hence the design of base plate = (13" × 10")

$$\text{Intensity of Pressure} = \frac{\text{Design Reaction}}{\text{Area}}$$

$$= \frac{55.39}{13 \times 10}$$

$$= 0.4261 \text{ ksi}$$

Bending moment at section 1-1, 2-2 & 3-3:

$$M_{1-1} = \frac{(3)^2}{2} \times 0.4261 = 1.9175 \text{ kip-in}$$

$$M_{2-2} = \frac{(5.625)^2}{2} \times 0.4261 = 6.741 \text{ kip-in}$$

$$M_{3-3} = \frac{(6)^2}{2} \times 0.4261 = 7.67 \text{ kip-in}$$

Thickness of base plate:

We know,

$$\sigma = \frac{MC}{I} = \frac{M \times \frac{t}{2}}{b \times \frac{t^3}{12}} = \frac{6M}{bt^2}$$

From section 1-1,

$$20 = \frac{6 \times 1.9175}{13 \times t^2}$$

$$\therefore t = 0.21 \text{ inch}$$

From section 2-2,

$$20 = \frac{6 \times 6.741}{13 \times t^2}$$

$$\therefore t = 0.394 \text{ inch}$$

From section 3-3,

$$20 = \frac{6 \times 7.67}{13 \times t^2}$$

$$\therefore t = 0.421 \text{ inch}$$

7.12 Design of Anchor bolt

Given data,

Bond Stress, $u = 160$ psi

Max (-ve) Reaction = Max (-ve) − Dead Load

$= 22.09 - 20.35$

$= 1.74$ kips

Dia of bolt assumed = 1"

Length of anchor bolt, L:

$$u = \frac{P}{A} \quad \text{or} \quad u = \frac{P}{\pi \times d \times L}$$

$$\therefore \quad L = \frac{P}{\pi \times d \times u} = \frac{1.74 \times 1000}{\pi \times 1 \times 160}$$

$\therefore \quad L = 3.46$ inch

$$\text{Effective Length} = \frac{L}{4} = \frac{L}{4}$$

$= 0.865$ inch

$$\text{Total length of bolt} = \frac{3}{8} + 0.421 + 0.865$$

$= 2.036$ inch

$\approx 3"$

7·13 Design Plate

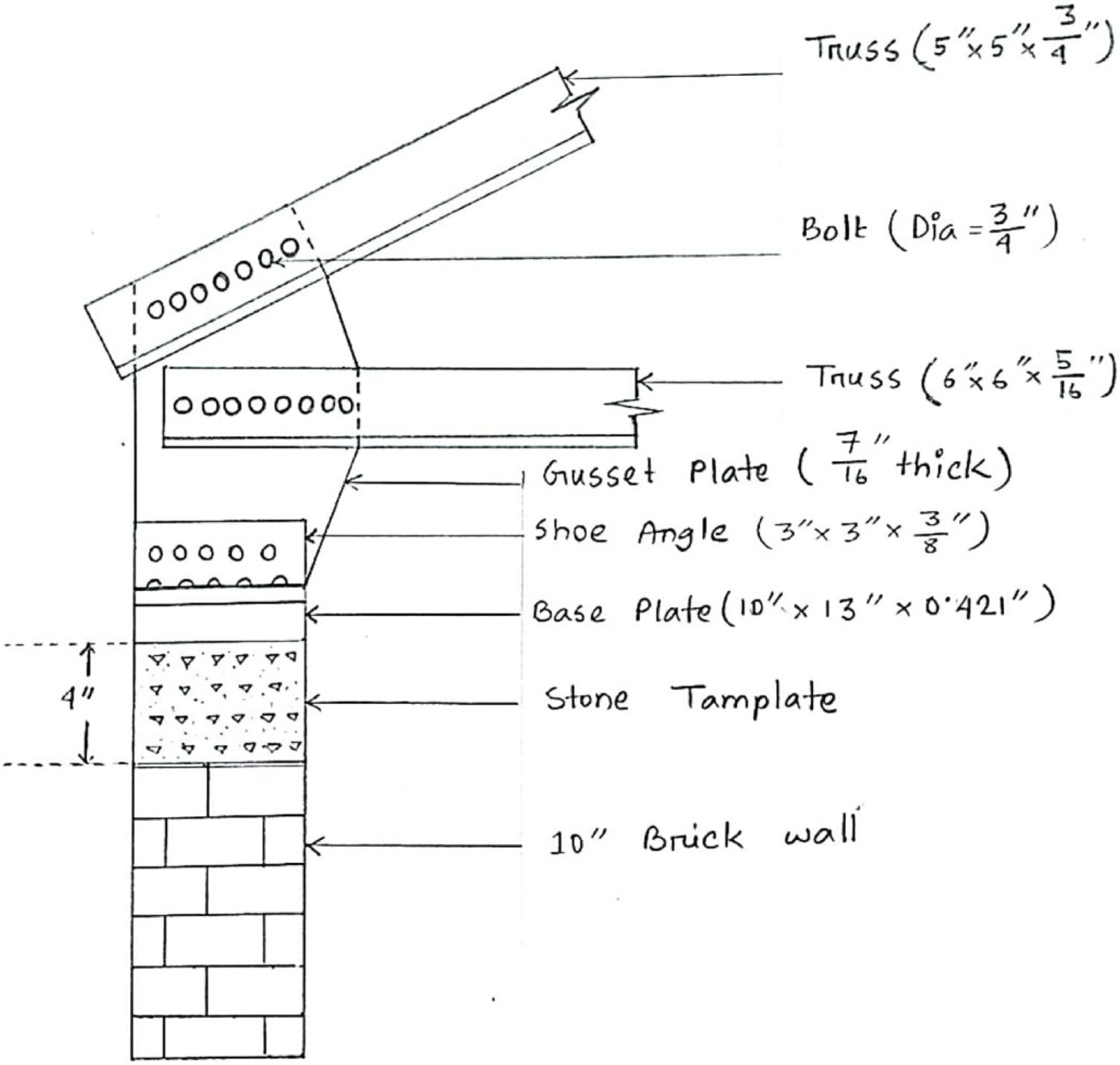

Figure 7·56: Support condition (Showing Truss, Gusset Plate, Shoe angle, Base Plate)

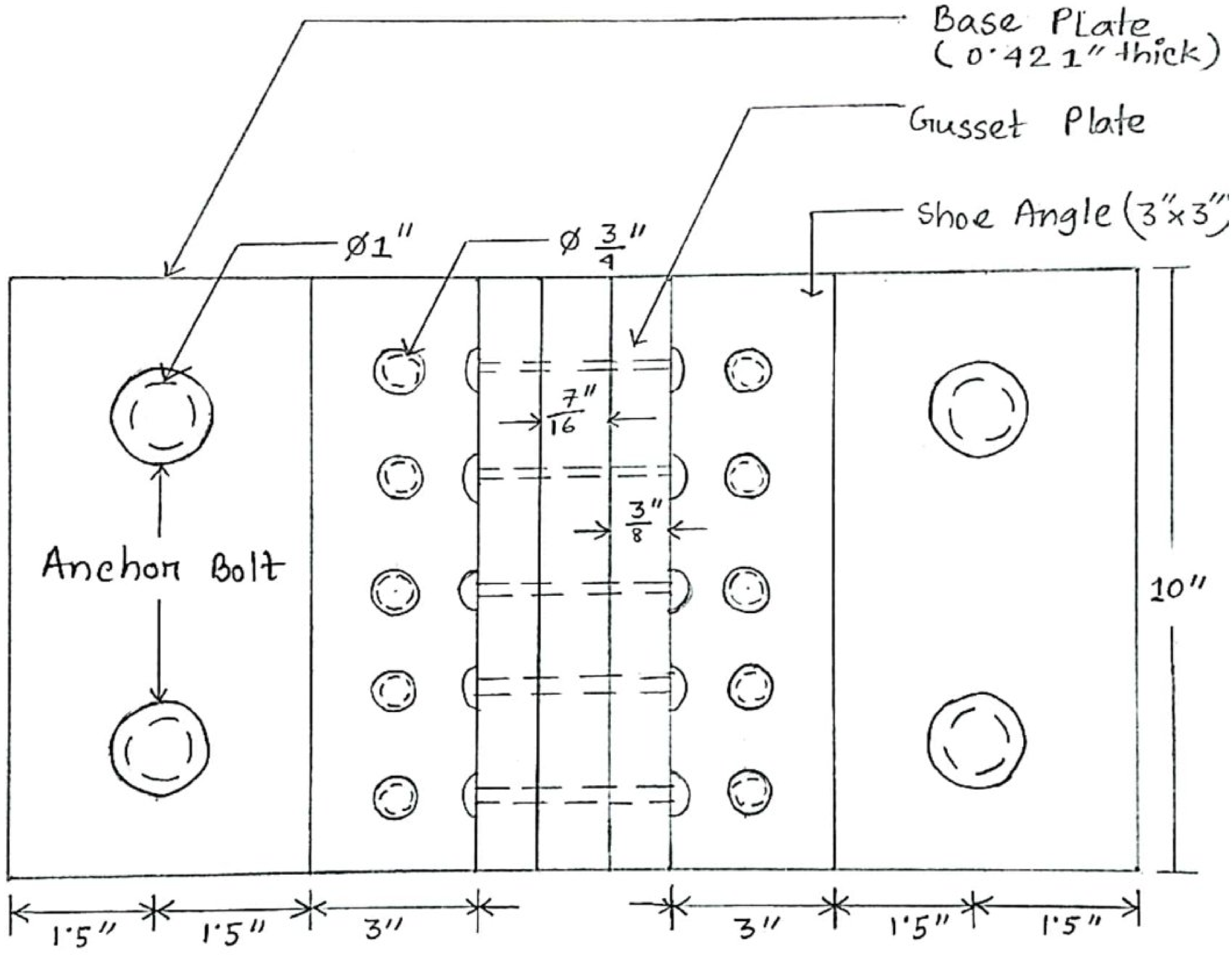

Figure 7·57: Hinge Support (Showing Base Plate, Shoe Angle, Gusset Plate)

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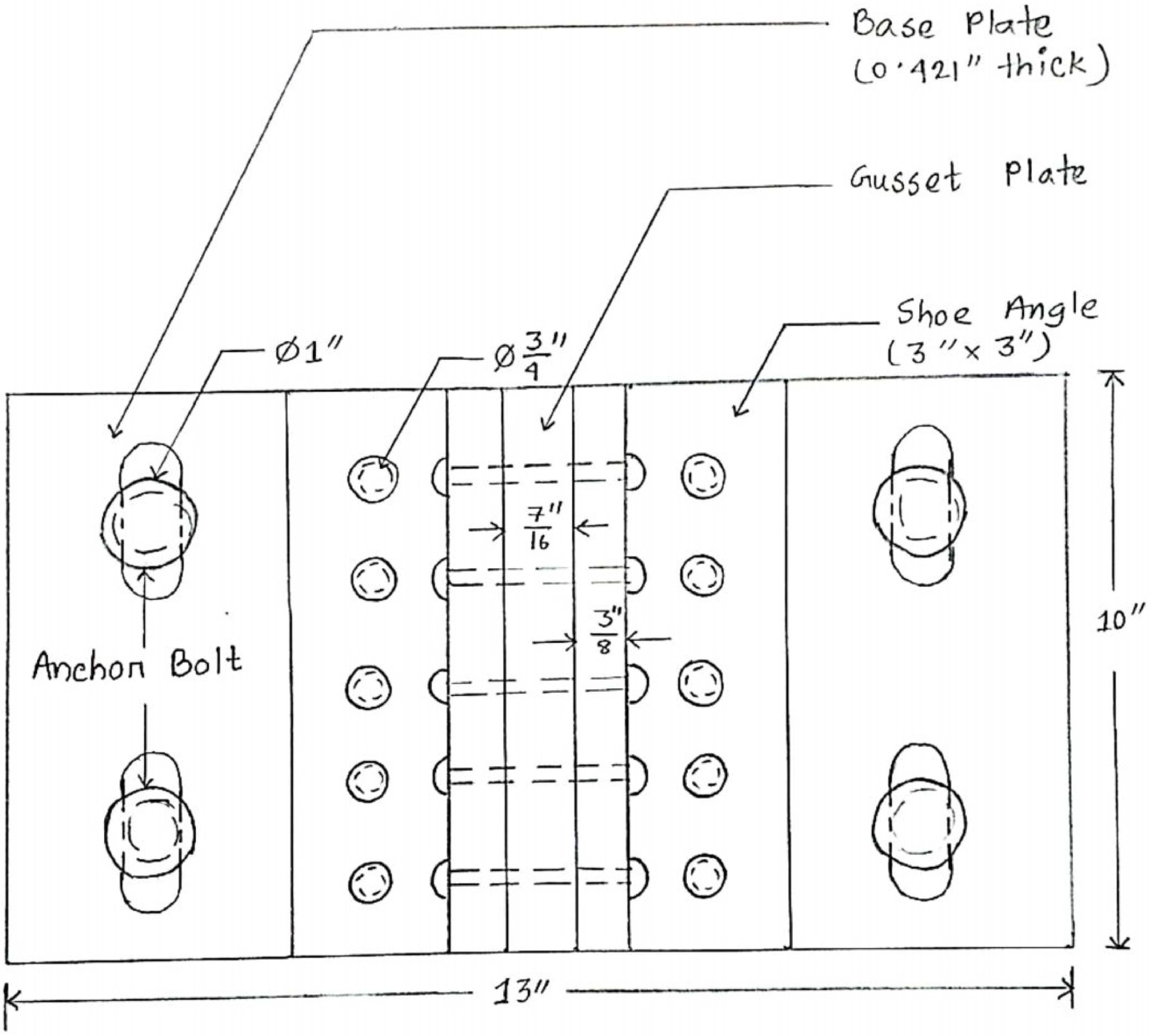

Figure 7·58: Roller Support (Showing Base Plate, Shoe Angle, Gusset plate)