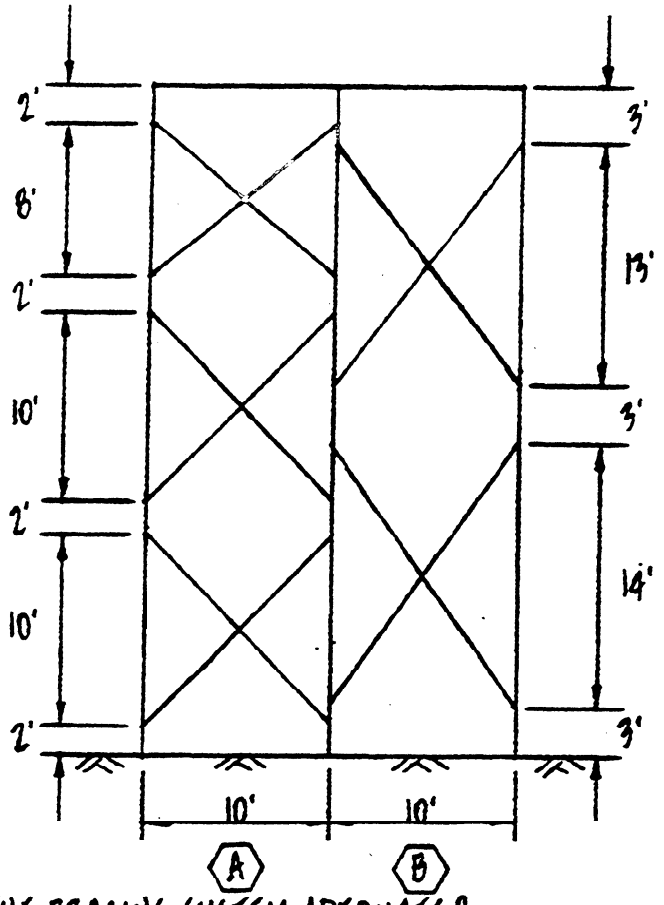
EXAMPLE NO. 6
ADEQUACY OF DIAGONAL BRACING
MULTI-TIERED FRAMED BENTS



2% DEAD LOAD = 3500 #
WIND LOAD = 3200 #

POSTS: 12 x 12 ROUGH

DIAGONAL BRACES: 2 x 8 S4S

CONNECTORS:
BRACE TO POST 1-3/4" ϕ BOL
INTERSECTION OF BRACE 1-3/4" ϕ BOL
ALL BOLTS IN SINGLE SHEAR

IS THE BRACING SYSTEM ADEQUATE?

ANALYZE THE TOP TIER OF BRACING IN (A)

1. DETERMINE THE STRENGTH OF THE CONNECTION BETWEEN BRACE AND POST

CHECK BOLT CAPACITY IN THE SIDE MEMBER. FROM SECT 4-3.02 OF FW MANUAL, ENTE CHART FOR A MEMBER SIZE = 2 x THICKNESS OF SIDE MEMBER.

2 x 1.5" = 3.0" P = 2630 # x 0.75 FOR SINGLE SHEAR = 1973 #

CHECK BOLT CAPACITY IN THE MAIN MEMBER. FROM SECT. 4-3.02 OF FW MANUAL, EN CHART FOR A MEMBER SIZE = 12"

P = 2860 # Q = 1640 #

CHECK BOLT CAPACITY IN MAIN MEMBER (CONT.)

USE HANKINSON'S FORMULA:

$$R = \frac{PQ}{P\sin^2\theta + Q\cos^2\theta} \qquad \theta = \tan^{-1}\frac{10}{8} = 51.3^\circ \quad \sin^2 51.3^\circ = 0.61 \quad \cos^2 51.3^\circ = 0.39$$

$$R = \frac{2860(1640)}{2860(0.61) + 1640(0.39)} = 1961\# \times 0.75 = \underline{1475\#}$$

FOR SINGLE SHEAR

$1475\# < 1973\#$ ∴ MAIN MEMBER CONTROLS CONNECTION CAPACITY

SINCE THE 2% DEAD LOAD CONTROLS THE HORIZONTAL DESIGN FORCE, APPLY 1.25 LOAD DURATION FACTOR AS PER SECT. 4-3.06 OF FW MANUAL.

STRENGTH OF CONNECTION = 1.25 × 1475 = $\underline{1844\#}$

2. DETERMINE THE STRENGTH OF THE DIAGONAL BRACES IN TENSION

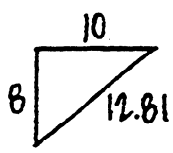
USE NET AREA OF MEMBER - $1.5''(1.25'' - 0.81'') = 9.66\ IN^2$

$F_T = 1200\ PSI\ (9.66\ IN^2) = \underline{\underline{11592\#}}$

3. DETERMINE THE STRENGTH VALUE OF THE TENSION MEMBERS.

$11592\# > 1844\#$ ∴ CONNECTION CONTROLS TENSION

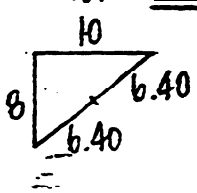
4. CALCULATE THE HORIZONTAL COMPONENT OF THE STRENGTH VALUE FOR THE TENSION MEMBER.



$$T = 1844 \times \frac{10}{12.81} = 1440\#$$

5. DETERMINE THE STRENGTH OF THE DIAGONAL BRACES IN COMPRESSION

CONNECTION = $\underline{1844\#}$ FROM ABOVE



BY INSPECTION, THE 3/4" BOLT AT THE INTERSECTION OF THE BRACES WILL TAKE MORE THAN 250# PERPENDICULAR TO THE BRACES, SO THE UNSUPPORTED LENGTH OF THE COMPRESSION MEMBER = 6.40'

5. CONTINUED

$$\frac{480000}{(L/d)^2} = \frac{480000}{(6.40 \times 12/1.5)^2} = 183.1 \text{ PSI}$$

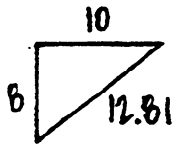
$$183.1 \text{ PSI } (1.5 \times 1.25) = \underline{1991\#}$$

6. DETERMINE THE STRENGTH VALUE OF THE COMPRESSION MEMBERS

$1844\# < 1991\#$ ∴ CONNECTION CONTROLS COMPRESSION

ALLOW ½ THEORETICAL FOR COMPRESSION VALUE. $\frac{1}{2}(1844) = 922\#$

7. CALCULATE THE HORIZONTAL COMPONENT OF THE STRENGTH VALUE FOR THE COMPRESSION MEMBER



$$C = 922 \times \frac{10}{12.81} = 720\#$$

8. CALCULATE THE TOTAL RESISTING CAPACITY OF THE TOP TIER OF BRACING

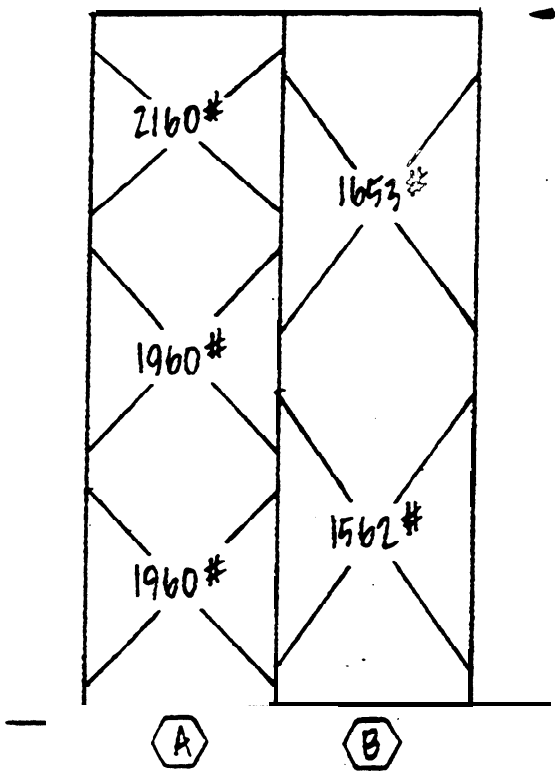
$$\text{TOTAL} = C + T = 720\# + 1440\# = 2160\#$$

ANALYZE REMAINING TIERS IN (A) AND (B)

CALCULATIONS ARE SIMILAR TO ABOVE PROCEDURE AND ARE SUMMARIZED ON NEXT PAGE

STEP	DESCRIPTION	(A) MIDDLE TIER = BOTTOM TIER	(B) TOP TIER	(B) BOTTOM TIER
1	BOLT CAP. IN SIDE MEMBER	$P = 2630 \times 0.75 = 1973^{\#}$	$P = 1973^{\#}$	$P = 1973^{\#}$
	BOLT CAP. IN MAIN MEMBER	$P = 2860^{\#}$ $Q = 1640^{\#}$ $\theta = \tan^{-1}\frac{10}{10} = 45°$ $R = 2085 \times 0.75 = 1564^{\#}$	$P = 2860^{\#}$ $Q = 1640^{\#}$ $\theta = \tan^{-1}\frac{10}{13} = 37.6°$ $R = 2243 \times 0.75 = 1682^{\#}$	$P = 2860^{\#}$ $Q = 1640^{\#}$ $\theta = \tan^{-1}\frac{10}{14} = 35.5°$ $R = 2283 \times 0.75 = 1712^{\#}$
	CONTROLLING	$1564^{\#} < 1973^{\#}$ MAIN MEMBER	$1682^{\#} < 1973^{\#}$ MAIN MEMBER	$1712^{\#} < 1973^{\#}$ MAIN MEMBER
	STRENGTH OF CONNECTION	$1.25 \times 1564 = 1955^{\#}$	$1.25 \times 1682 = 2103^{\#}$	$1.25 \times 1712 = 2140^{\#}$
2	STRENGTH OF DIAGONAL BRACE IN TENSION	$1.5(1.25 - 0.81) = 9.66\ IN^2$ $F_T = 1200(9.66) = 11592^{\#}$	AREA $= 9.66\ IN^2$ $F_T = 11592^{\#}$	AREA $= 9.66\ IN^2$ $F_T = 11592^{\#}$
3	STRENGTH OF TENSION MEMBER	$11592^{\#} > 1955^{\#}$ CONNECTION CONTROLS	$11592^{\#} > 2103^{\#}$ CONNECTION CONTROLS	$11592^{\#} > 2140^{\#}$ CONNECTION CONTROLS
4	HORIZ. COMPONENT TENSION MEMBER	$1955 \times \frac{10}{14.14} = \underline{1383^{\#}}$	$2103 \times \frac{10}{16.40} = \underline{1282^{\#}}$	$2140 \times \frac{10}{17.21} = \underline{1243^{\#}}$
5	STRENGTH OF DIAGONAL BRACE IN COMPRESSION	CONNECTION CAP. $= 1955^{\#}$	CONNECTION CAP. $= 2103^{\#}$	CONNECTION CAP. $= 2140^{\#}$
		$\frac{480000}{(7.07 \times 12/1.5)^2} = 150$ PSI $150(1.5 \times 1.25) = 1631^{\#}$	$\frac{480000}{(8.20 \times 12/1.5)^2} = 112$ PSI $112(1.5 \times 1.25) = 1218^{\#}$	$\frac{480000}{(8.60 \times 12/1.5)^2} = 101$ PSI $101(1.5 \times 1.25) = 1098^{\#}$
6	STRENGTH OF COMP. MEMBER	$1631^{\#} < 1955^{\#}$ BRACE CONTROLS $\frac{1}{2} \times 1631 = 816^{\#}$	$1218^{\#} < 2103^{\#}$ BRACE CONTROLS $\frac{1}{2} \times 1218 = 609^{\#}$	$1098^{\#} < 2140^{\#}$ BRACE CONTROLS $\frac{1}{2} \times 1098 = 549^{\#}$
7	HORIZ. COMPONENT COMP. MEMBER	$816 \times \frac{10}{14.14} = \underline{577^{\#}}$	$609 \times \frac{10}{16.40} = \underline{371^{\#}}$	$549 \times \frac{10}{17.21} = \underline{319^{\#}}$
8	TOTAL RESISTING CAPACITY	$577 + 1383 = 1960^{\#}$	$371 + 1282 = 1653^{\#}$	$319^{\#} + 1243^{\#} = 1562^{\#}$

SUMMARY OF RESISTING CAPACITIES



CONTROLLING HORIZONTAL DESIGN FORCE = 2% DEAD LOAD = 3500#

CALCULATE THE TOTAL RESISTING CAPACITY OF THE BENT BRACING

THE TOTAL RESISTING CAPACITY OF THE BENT BRACING = THE SUM OF THE WEAKER PAIR OF BRACES IN (A) & THE WEAKER PAIR OF BRACES IN (B)

TOTAL RESISTING CAPACITY OF BENT BRACING = 1960# + 1562# = 3522#

SINCE 3522# > 3500#, <u>BRACING SYSTEM IS ADEQUATE</u>