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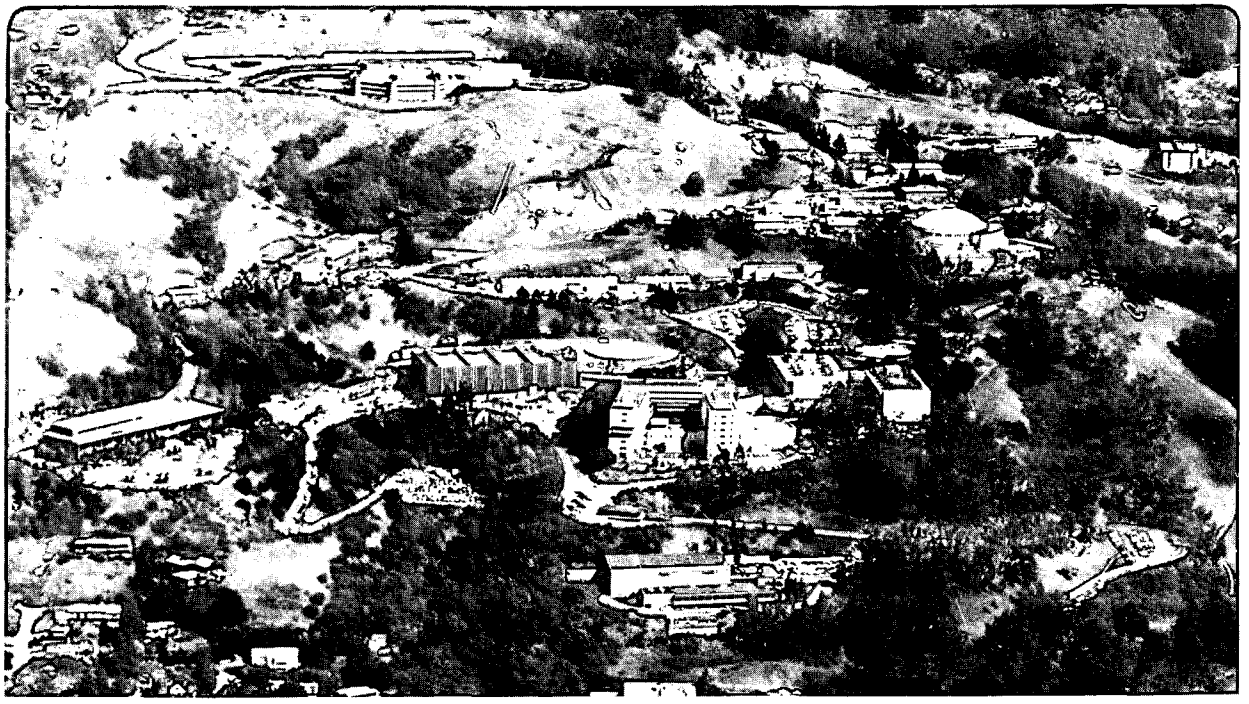


DISCLAIMER

AUTHOR C. PETERS | DEPARTMENT MECH. ENGR. | LOCATION LBL | DATE 2-26-80

PROGRAM — PROJECT — JOB
PEP- 4

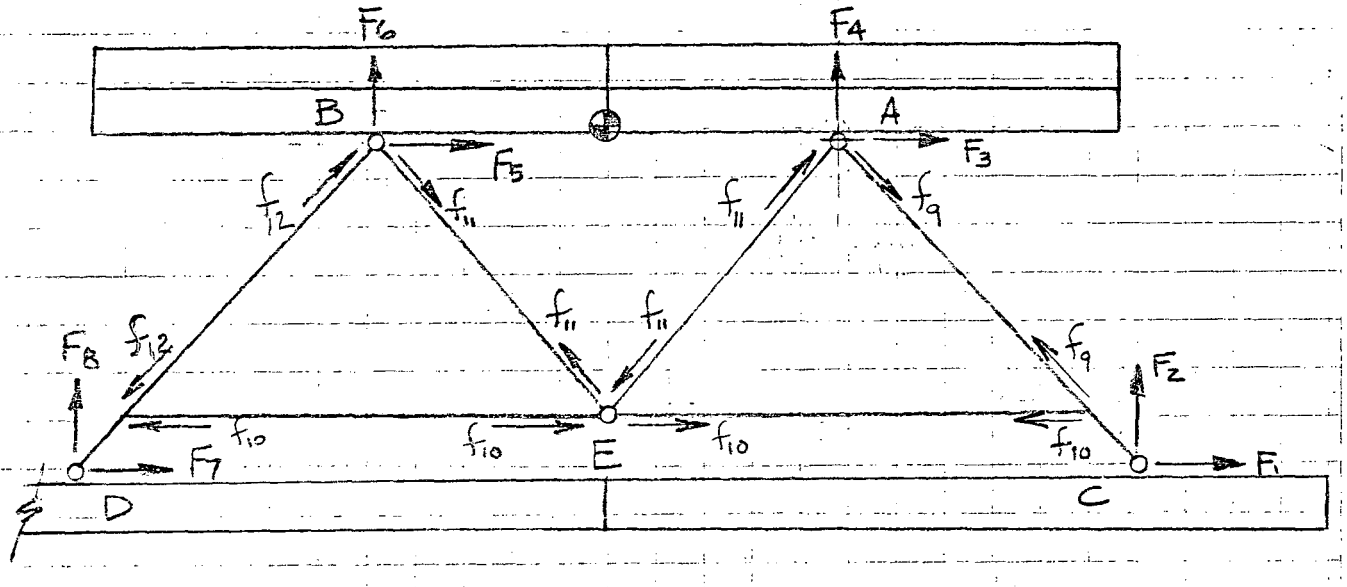
MAGNET CORE

TITLE
POLE TIP ASSEMBLY SEISMIC BRACING

THE PURPOSE OF THIS NOTE IS TO DETERMINE STRESSES AND SAFETY FACTORS WITHIN MEMBERS OF THE POLE TIP ASSEMBLY SEISMIC BRACING UNDER EARTHQUAKE LOAD CONDITIONS. THESE BRACES MUST BE ABLE TO WITHSTAND FORCES RESULTING FROM THE HORIZONTAL ACCELERATION OF THE POLE TIP ASSEMBLY. VERTICAL ACCELERATION IS TAKEN CARE OF BY THE POLE TIP POSITIONING MECHANISM.

THREE HORIZONTAL DIRECTIONS OF GROUND ACCELERATION ARE CONSIDERED. FOR EACH CASE, RESULTANT LOADS AND SAFETY FACTORS WITHIN THE MEMBERS ARE DETERMINED. PAGE 4 SHOWS THE THREE CASES OF GROUND ACCELERATION AND THE FORCE DIAGRAM UPON WHICH CALCULATIONS ARE BASED. DETAILED CALCULATIONS FOR ONE CASE ARE SHOWN. CALCULATION RESULTS FOR ALL CASES ARE TABULATED ON PAGE 7.

REV "A" ADDED CHECK ON BRACE ATTACHMENT PAGES 8 & 9. FOR JOINT "E" HAVE TO USE SOCKET HEAD SHOULDER SCREW SEE PAGE 9
P. Pryor
2-27-81

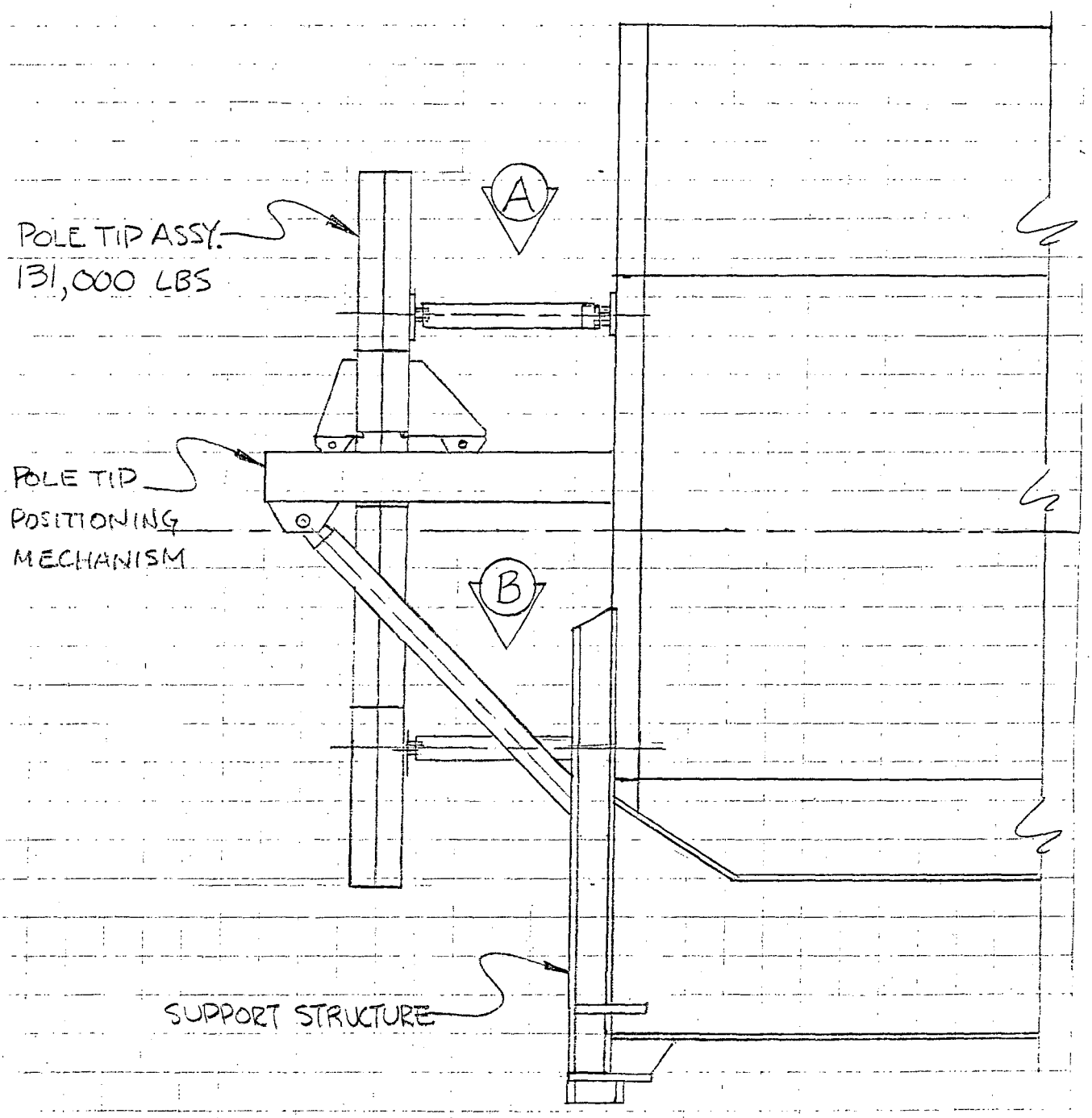


CASE I .7G →

CASE II .7G ↑

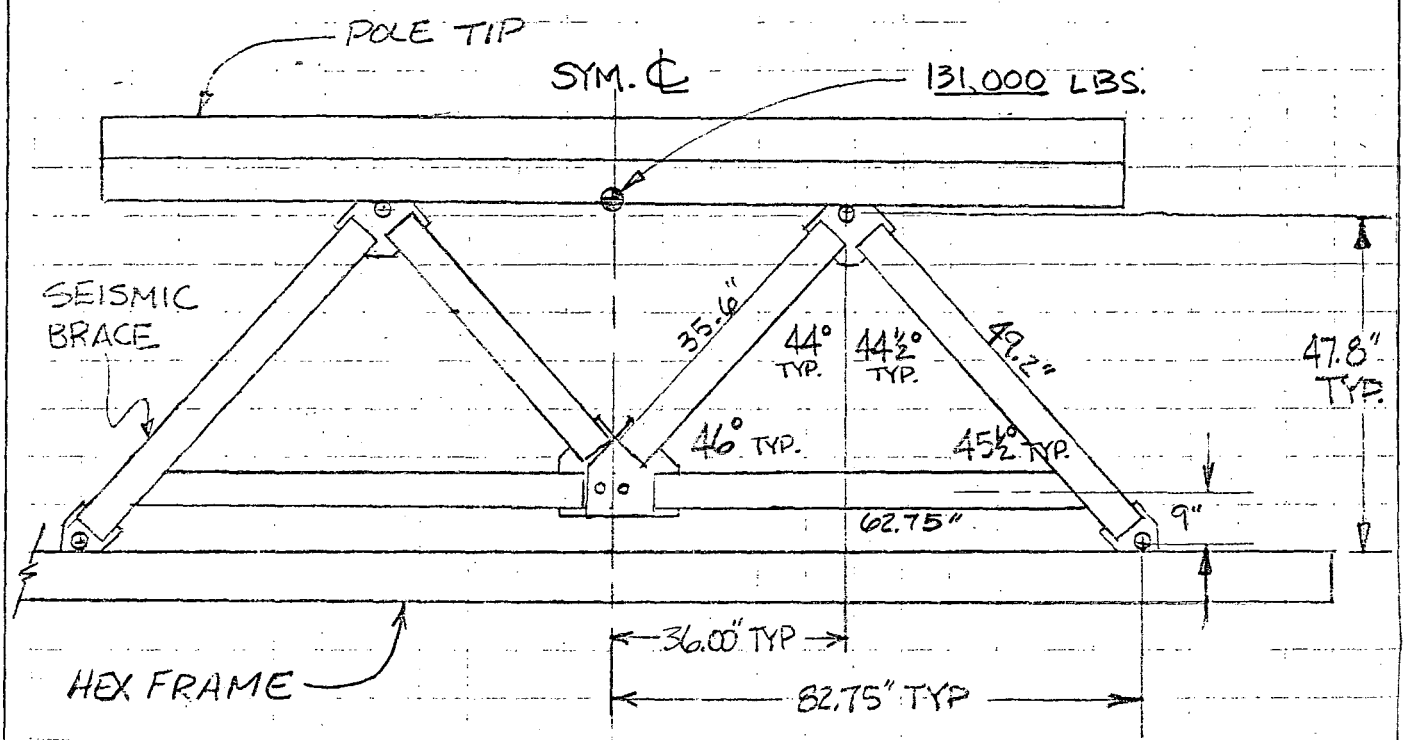
CASE III .7G ↖

} THREE CASES OF GROUND ACCELERATION RELATIVE TO STRUCTURE ABOVE.

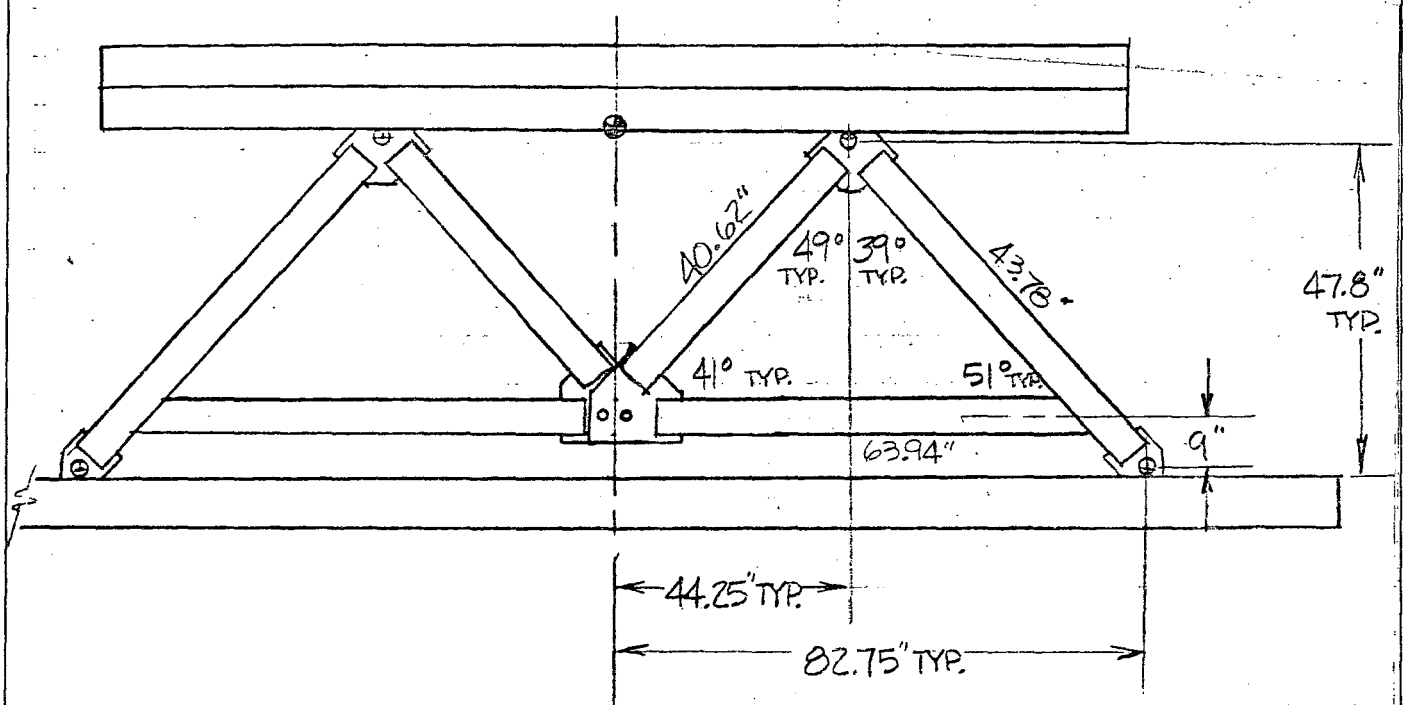


SUPPORT STRUCTURE AND POLE TIP ASSEMBLY.

SIDE ELEVATION VIEW



VIEW A - UPPER SEISMIC BRACE



VIEW B - LOWER SEISMIC BRACE

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CASE I UPPER BRACE

ON POLE TIP $\Sigma F_H = MA = 131{,}000 \text{ LB} \times .7G$
$= 88 \text{ K}$

FORCE OF POLE TIP ON BRACE $= \frac{88K}{2} = 44 \text{ KIP.}$

$F_3 + F_5 = -44 \text{ K}$

BY COMPARING FORCES AT JOINT A & B,

$F_3 = F_5 = \frac{-44}{2} = \boxed{-22 \text{ K}}$

$\Sigma F_V = MA = 0 \quad \therefore \quad F_4 + F_6 = 0$
$\Sigma M_{CG} = 0 \quad \therefore \quad \boxed{F_4 = F_6 = 0}$

ON BRACE $\Sigma F_H = 0 \quad \therefore \quad F_1 + F_7 + F_3 + F_5 = 0$
$F_1 + F_7 = 44 \text{ K}$

$\Sigma F_V = 0 \quad \therefore \quad F_4 + F_6 + F_2 + F_8 = 0$
$F_2 + F_8 = 0$

$\Sigma M_D = 0 \quad \therefore \quad F_2(87.75)(2) = (47.6)(F_3 + F_5)$

$\boxed{F_2 = -12.7 \text{ K}}$
$\boxed{F_8 = +12.7 \text{ K}}$

$\Sigma f_A = 0 \therefore \quad f_{11}(\cos 44°) + F_4 = (\cos 44\tfrac{1}{2}°) f_9$
$.719 f_{11} = .713 f_9, \quad f_{11} = .992 f_9$
$f_{11}(\sin 44°) + f_9(\sin 44\tfrac{1}{2}°) + F_3 = 0$
$\therefore (.694)(.992 f_9) + f_9(.701) = 22K$
$\boxed{f_9 = 15.83 \text{ K}}$
$\therefore f_{11} = .992(15.83) = \boxed{15.71 \text{ K}}$

$\Sigma f_B = 0 \therefore f_{11}(\cos 44°) = F_6 + f_{12}(\cos 44\tfrac{1}{2}°)$
$f_{11}(.719) = f_{12}(.713), \quad f_{12} = \boxed{15.83 \text{ K}}$

$\Sigma f_E = 0 \therefore f_{10} = (\cos 46°) f_{11} = (.695)(15.71) = \boxed{10.92 \text{ K}}$

$\Sigma F_c = 0 \therefore \quad F_1 = f_{10} + (\cos 45\tfrac{1}{2}^\circ) f_9 = 10.92 + (.701)(15.83)$

$F_1 = \boxed{22.01\ k}$

$F_7 = 44 - F_1 = \boxed{21.99\ k}$

ALLOWABLE AXIAL LOADING.

MEMBER	MAX. ALLOWABLE (FROM RYERSON DATA BK, P. 198)	SAFETY FACTOR (OVER ALLOWABLE)
AE - 4" SQ. TUBE	136K	8.7
AC - "	132K	8.3
EC - "	127K	11.6

WELD STRESSES - ALL WELDED JOINTS CONSIST OF AT LEAST 20" OF 3/8" FILLET WELD.

$\text{MAX. WELD STRESS} = \frac{\text{MAX LOAD.}}{\text{AREA}} = \frac{f_{11}}{\text{AREA}} = \frac{15.83\ k}{20" \times 3/8"}$

$= 1{,}266\ \text{PSI}$

$\text{SAFETY FACTOR} = \frac{\text{ALLOWABLE}}{\text{MAX. STRESS}} = \frac{9{,}200}{1{,}266} = \boxed{7.3}$

BENDING STRESS - MAX OCCURS AT JOINT OF MEMBERS AC AND EC.

$\sigma_b = \frac{MC}{I} \qquad M = 9"(F_1 + F_2)$

$= 9"(22.0 - 12.7) = 83.7\ \text{K-IN.}$

$C = 2", \quad I = 12\ \text{IN}^4$

$\sigma = \frac{83.7\,(2)}{12} = 13.95\ \text{KSI}$

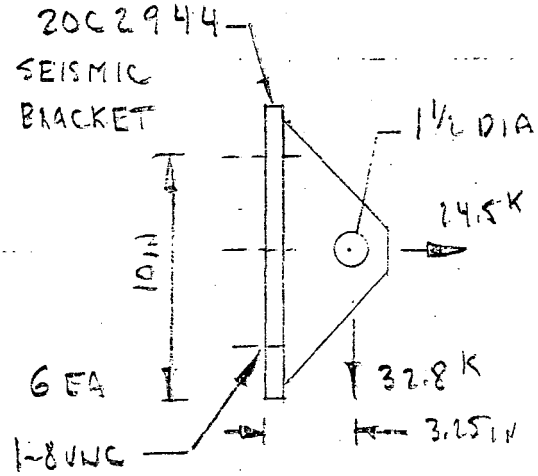
$\text{SAFETY FACTOR} = \frac{55\ \text{KSI ULT}}{13.95\ \text{KSI}} = \boxed{3.9}$

ITEM	CASE I →		CASE II ↑		CASE III ↖	
	UPPER	LOWER	UPPER	LOWER	UPPER	LOWER
EXTERNAL FORCES (KIPS)						
F_1	22.0	22.0	-21.6	-17.8	-32.8	-30.2
F_2	-12.7	-12.7	22.0	22.0	24.5	24.5
F_3	-22.0	-22.0	21.6	17.8	28.7	26.0
F_4	0	0	-22.0	-22.0	-15.5	-15.5
F_5	-22.0	-22.0	-21.6	-17.8	2.4	5.1
F_6	0	0	-22.0	-22.0	-15.5	-15.5
F_7	22.0	22.0	21.6	17.8	-1.7	-.9
F_8	12.7	12.7	22.0	22.0	6.6	6.6
INTERNAL FORCES (KIPS)						
f_9	15.8	14.5	-30.9	-28.3	-34.4	-31.6
f_{10}	10.9	12.9	0	0	-8.7	-10.4
f_{11}	15.7	17.1	0	0	-12.6	-13.8
f_{12}	15.8	14.5	-30.9	-28.3	9.1	8.3
AXIAL LOAD SAFETY FACTOR						
MEMBER AE	8.7	7.7	–	–	10.8	9.6
AC	8.3	9.2	4.3	4.7	3.8	4.2
EC	11.6	9.9	–	–	14.6	12.2
WELD STRESS						
PSI	1,266	1,366	2,400	2,260	2,740	2,525
SAFETY FACTOR	7.3	6.7	3.8	4.1	3.4	3.6
BENDING STRESS						
PSI	13,950	13,950	0	0	12,450	8,565
SAFETY FACTOR	3.9	3.9	–	–	4.4	6.4

PINS AT A, B, C, D

CHECK PIN SHEAR WORST CASE III UPPER

$F_1 = 32.8$ $F_2 = 24.5$ $F = \sqrt{32.8^2 + 24.5^2} = 40.9^K$



PIN 1.5 DIA COLD ROLLED 1018

$F_u = 64$ KSI
$F_y = 54$ KSI

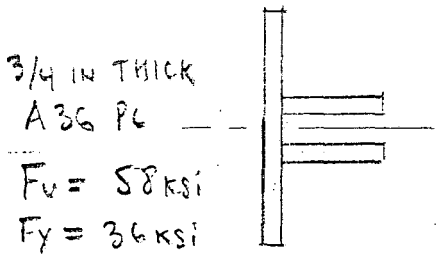
$\tau_u = .6 F_u = .6(64) = 41.6$ KSI

$A = \frac{\pi D^2}{4} = \frac{3.14(1.5)^2}{4} = 1.76 IN^2$

DOUBLE SHEAR

$\tau = \frac{F}{2A} = \frac{40.9^K}{2(1.76)} = 11.6$ KSI

F.S = 3.5



CHECK BOLTS A307 1-8UNC

AISC ALLOWABLE TENSION = 1.33 (19.8) = **26.33 KSI**

" ALLOWABLE SHEAR = 1.33 (10) = **13.3 KSI**

MAX TENSION = $\frac{32.8^K (3.25)}{10} + \frac{24.5^K}{(2)\text{BOLTS}} + \frac{24.5^K}{6\text{ BOLTS}} = 9.3^K$

OR $\frac{9.3^K}{.606 IN^2} = \boxed{15.3 \text{ KSI}} = f_t$

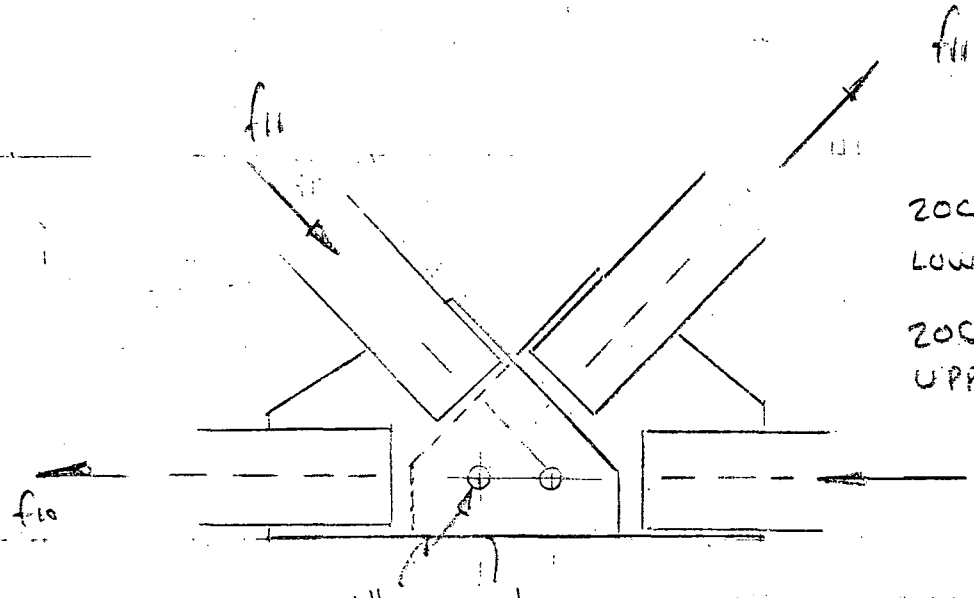
SHEAR = $\frac{32.8^K}{6(.55 IN^2)} = \boxed{10 \text{ KSI}} = f_v$

COMBINING

$$\left(\frac{f_t}{F_t}\right)^2 + \left(\frac{f_v}{F_v}\right)^2 \leq 1$$

$$\left(\frac{15.3}{26.33}\right)^2 + \left(\frac{10}{13.3}\right)^2 = .34 + .56 = .9 < 1 \quad \text{O.K}$$

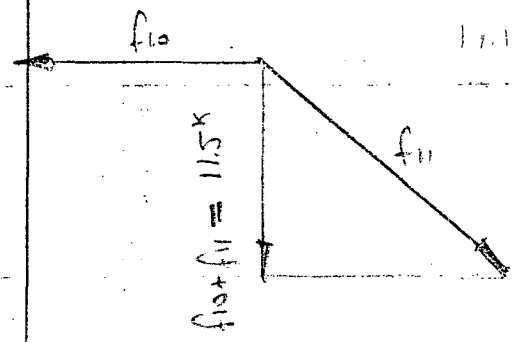
CHECK JOINT E WORST CASE 17.1 K = f_{11}
12.9 = f_{10}



20C2956
LOWER SEISMIC BRACE

20C2966
UPPER SEISMIC BRACE

1" DIA 1 IN THICK PLATE A36
F_u = 58 KSI
F_y = 36 KSI



FOR 1-8 UNC BOLT A = .55 IN²

SHEAR STRESS = $\frac{11.5^K}{.55 IN^2}$ = 20.9 KSI

ALLOWABLE FOR A307 BOLT = 10 KSI

FS = 4.6

SOCKET HEAD SHOULDER SCREW
NOM 1" SHOULDER DIA
SHEAR STRENGTH 96 KSI

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