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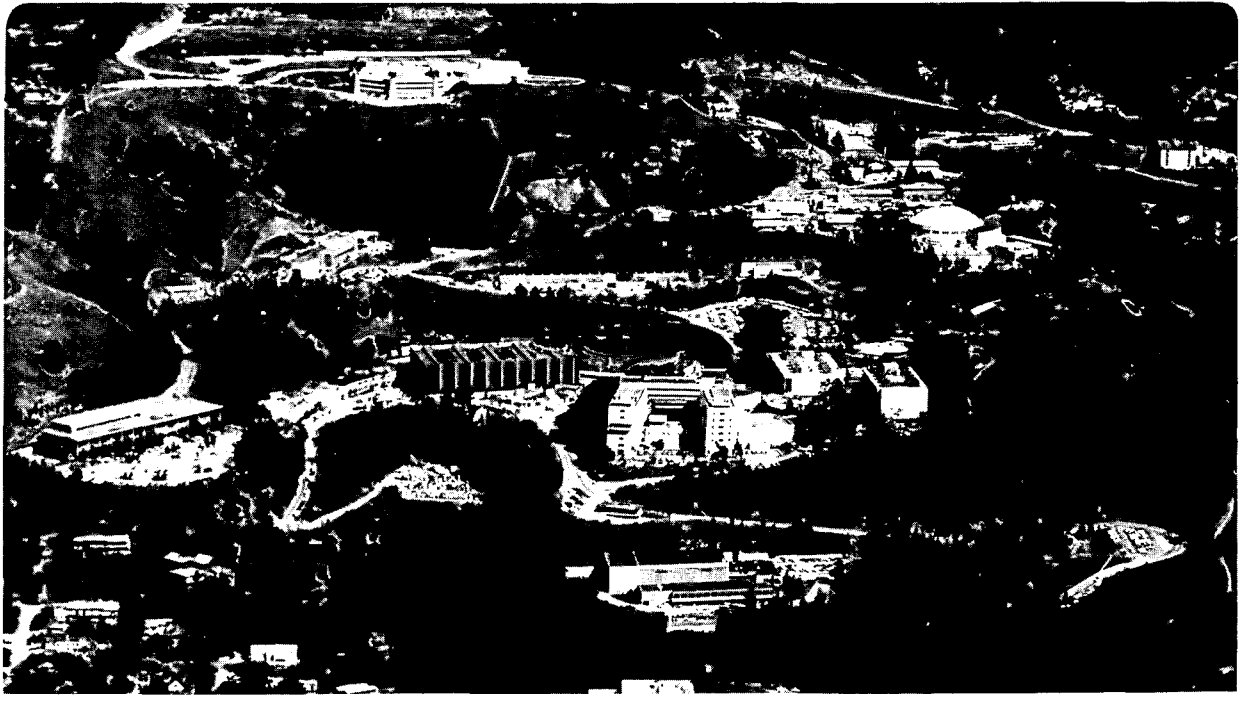
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LAWRENCE RADIATION LABORATORY - UNIVERSITY OF CALIFORNIA		CODE	SERIAL	PAGE
ENGINEERING NOTE		P40200	M5436 A	1 of 11
AUTHOR	DEPARTMENT	LOCATION	DATE	
C. PETERS	MECH. ENGR.	LBL	11-20-79	
PROGRAM - PROJECT - JOB				
PEP-4				
MAGNET CORE				
TITLE				
POLE TIP CARRIAGE				

THE PURPOSE OF THIS NOTE IS TO DETERMINE STRESSES AND SAFETY FACTORS WITHIN MEMBERS AND JOINTS OF THE POLE TIP CARRIAGE UNDER STATIC LOADS AND UNDER EARTHQUAKE LOAD CONDITIONS.

REV "A" 2-23-81 P. Pungar

ADDED OVERTURNING CALCULATIONS AND TIE DOWN REQUIREMENTS FOR A .7g EARTHQUAKE.

WITHOUT TIE DOWN THE ACCELERATION ".g" AT WHICH ONE SET OF ROLLERS WOULD START TO LIFT IS:

DIRECTION OF FORCE (SEE PAGE 2)

	<u>FRONT</u>	<u>BACK</u>	<u>SIDE</u>
CARRIAGE & POLE TIP ASSY	.28g	.50g	.46g
CARRIAGE & POLE TIP ASSY + CONCRETE BLOCK	.32g	.50g	.49g

IF THE CARRIAGE IS RESTRAINED AGAINST A .7g EARTHQUAKE THE BOLTS HOLDING PART 1969914 "CARRIAGE ROLLER OUTER SLEEVE" TO THE FRAME HAVE TO BE SAE G75. THE BOLTS SHOULD BE CHECKED AND REPLACED IF REQUIRED.

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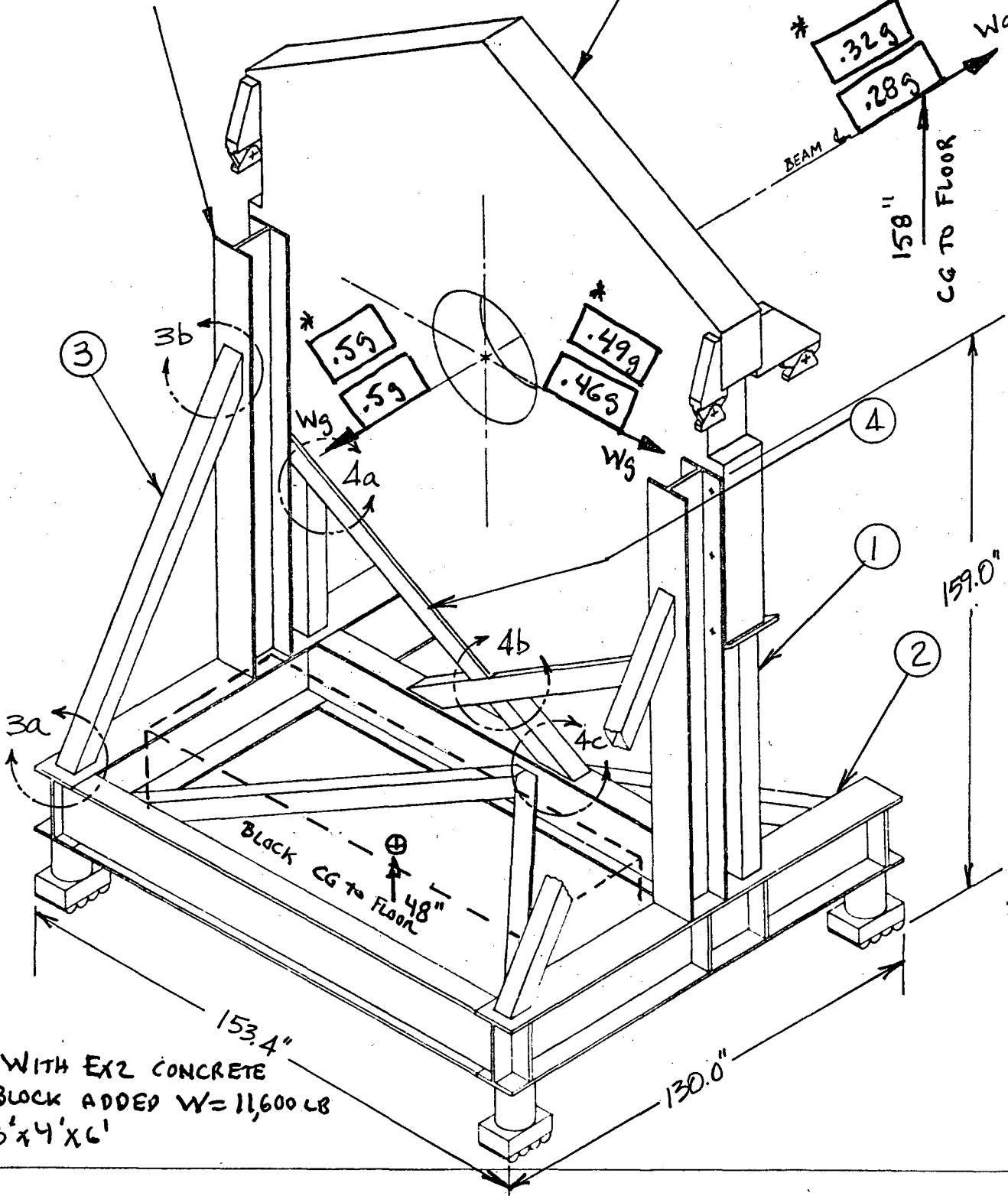
PROGRAM - PROJECT - JOB

TITLE

POLE TIP CARRIAGE

POLE TIP ASSY.

TYP. ASSY. WT. = 121,000 LBS.



* WITH EX2 CONCRETE
 BLOCK ADDED W=11,600 LB
 3'x4'x6'

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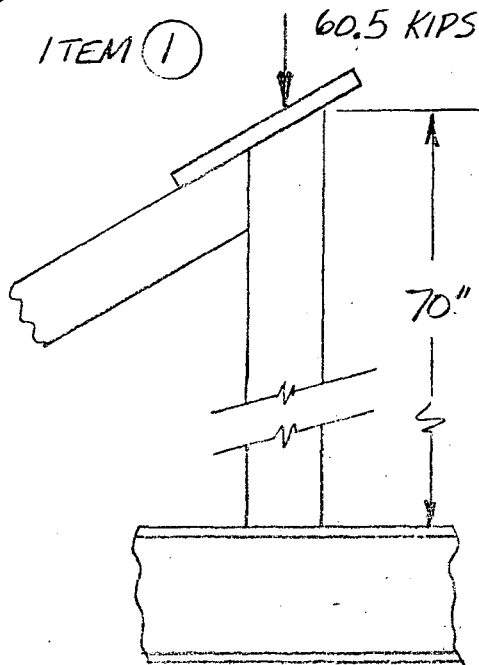
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PROGRAM - PROJECT - JOB

TITLE

I) STATIC LOAD CONDITIONS

6" x 6" x 1/2" STL. TUBE

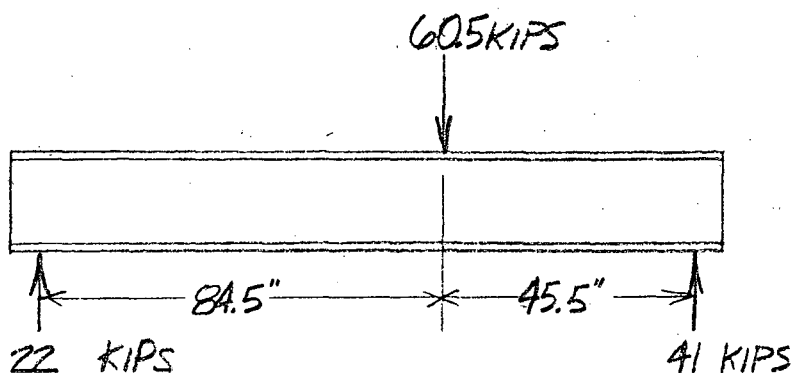
MAX. ALLOWABLE AXIAL LOAD
(KL = 6' & 46 KSI YIELD) =

269 KIPS
(RYERSON DATA)

$$\text{FACTOR OF SAFETY} = \frac{269}{60.5}$$

$$= \boxed{4.29}$$

ITEM ② W F 18" X 105 LBS.



$$J_b = MC/I \quad I = 1850 \text{ IN}^4$$

$$M = 1789 \text{ IN-KIP}$$

$$C = 9 \text{ IN}$$

$$J_b = \boxed{8,705 \text{ PSI}}$$

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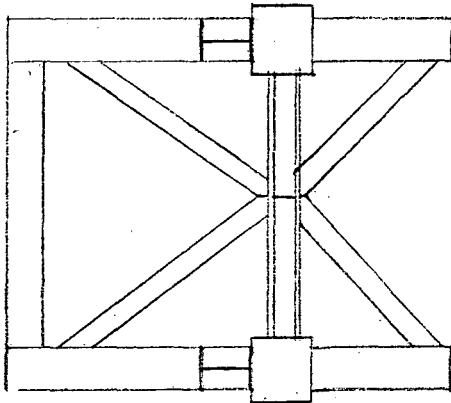
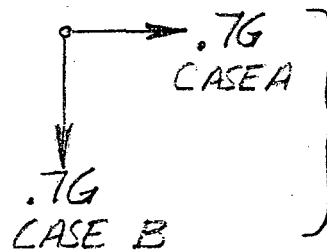
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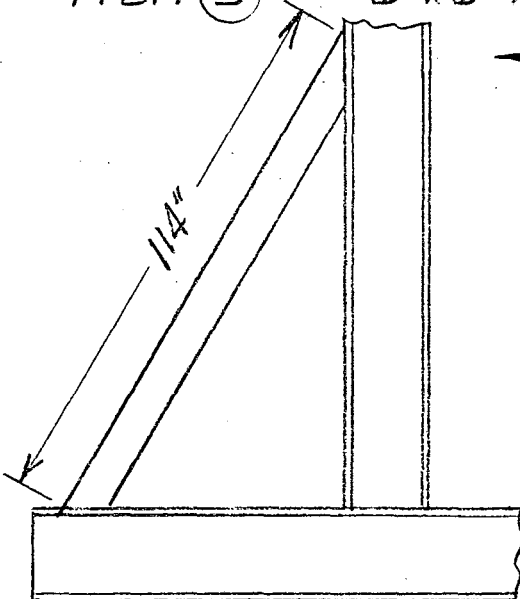
TITLE

II. EARTHQUAKE LOAD CONDITIONS

TWO CASES:

CARRIAGE PLAN VIEWGROUND
ACCELERATION
RELATIVE TO
CARRIAGE.CASE A:

ITEM ③ 6" x 6" x 1/2" STL. TUBE.



← FORCE DUE TO ACCEL. = 58 KIPS

$$\text{COMPRESSIVE FORCE IN TUBE} = \frac{58 \text{ KIPS}}{\cos 60^\circ} = 116 \text{ KIPS}$$

MAX. ALLOWABLE AXIAL LOAD
($KL = 10'$ & 46 KSI YIELD) = 248 KIPS
(RYERSON DATA)

$$\text{FACTOR OF SAFETY} = \frac{248}{116} = \boxed{2.14}$$

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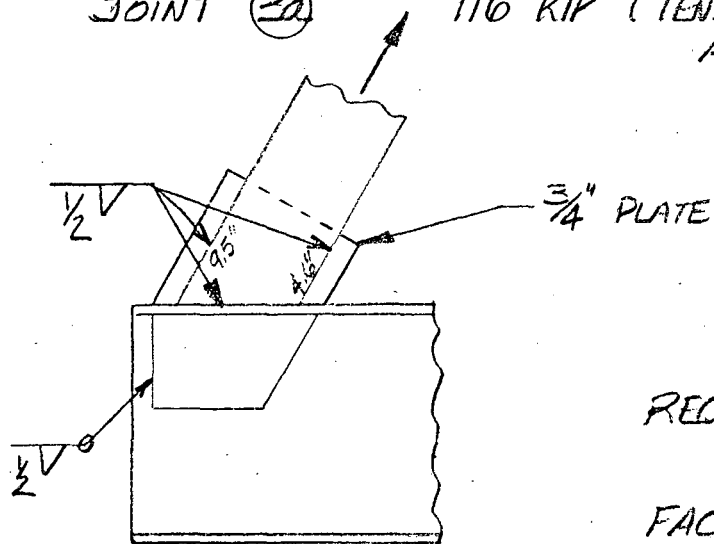
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JOINT (3a)

116 KIP (TENSION WHEN ACCEL. IS OPPOSITE AS SHOWN PG. 4)



LENGTH OF WELD =

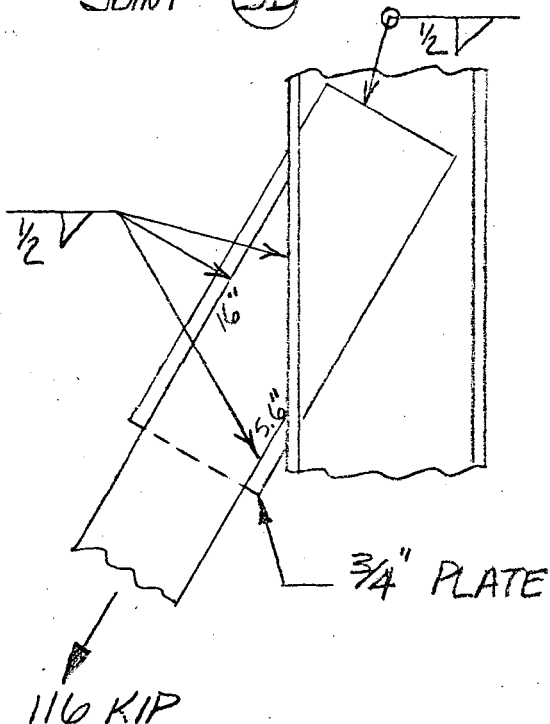
$$2(9.2 + 4.6 + 6 + 4) = 47.6 \text{ IN}$$

$$\begin{aligned} \text{FORCE ON WELD} &= \frac{116 \text{ KIP}}{47.6 \text{ IN}} \\ &= 2.43 \frac{\text{KIP}}{\text{IN}} \end{aligned}$$

$$\text{REQD. WELD SIZE} = \frac{2.43}{9.6} = .25 \text{ IN} \quad \leftarrow \text{(ANS)}$$

$$\text{FACTOR OF SAFETY} = \frac{.50}{.25} = \boxed{2.00}$$

JOINT (3b)



$$\begin{aligned} \text{LENGTH OF WELD} &= 2(16 + 5.6 + 4 + 6) \\ &= 63.2 \text{ IN} \end{aligned}$$

$$\begin{aligned} \text{FORCE ON WELD} &= \frac{116 \text{ KIP}}{63.2 \text{ IN}} \\ &= 1.83 \text{ KIP/IN} \end{aligned}$$

$$\text{REQD. WELD SIZE} = \frac{1.83}{9.6} = .19$$

$$\text{FACTOR OF SAFETY} = \frac{.50}{.19} = \boxed{2.62}$$

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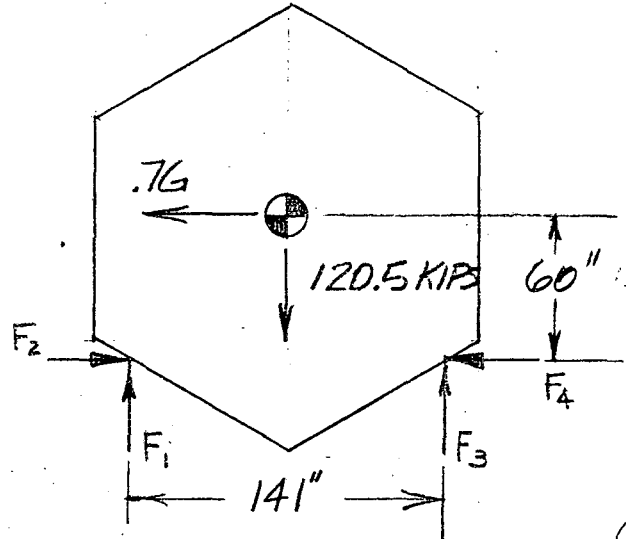
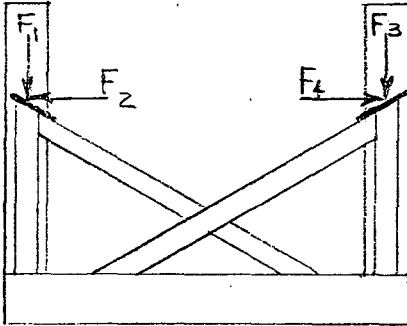
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PROGRAM - PROJECT - JOB

TITLE

CASE B:

$$\sum F_x = \text{max}$$

$$F_4 - F_2 = (0.7)(120.5) \\ = 84.3 \text{ KIP}$$

ASSUME $F_2 \sim 0$

$$F_4 = 84.3 \text{ KIPS}$$

$$\sum F_y = \text{max}$$

$$F_1 + F_3 = 120.5 \text{ KIPS}$$

$$\sum M = \sum \bar{I}_d + M_{ad}$$

$$\sum M_{34}:$$

$$(F_1)(141) - \frac{(120.5)(141)}{2} \\ - (120.5)(0.7)(60)$$

$$F_1 = 96.1 \text{ KIPS}$$

$$F_2 = 24.9 \text{ KIPS}$$

ITEM (1)

6" x 6" x 1/2" STL. TUBE

MAX. ALLOWABLE AXIAL LOAD

$$(KL = 6' @ 46 \text{ KSI YIELD}) = 269 \text{ KIPS (RYERSON DATA)}$$

$$\text{FACTOR OF SAFETY} = \frac{269}{F_1} = \boxed{2.79}$$

ITEM (2)

WF 18" x 105 LBS

$$F_1 = 96.1 \text{ KIPS}$$

$$\sigma_b = MC/I \quad M = 2842 \text{ KIP-IN} \\ C = 9 \text{ IN} \\ I = 1850 \text{ IN}^4$$

$$\sigma_b = \boxed{13,827 \text{ PSI}}$$



$$34.9 \text{ KIPS} \quad \quad \quad 65.1 \text{ KIP}$$

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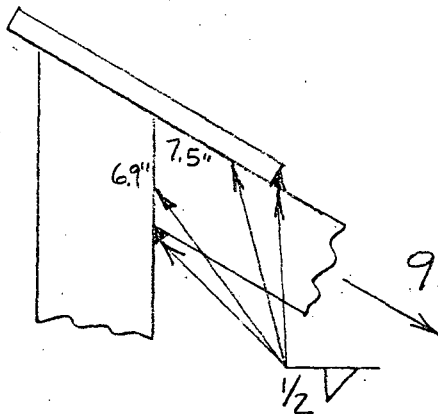
TITLE

ITEM (A) 6" x 6" x 1/2" STL. TUBE

$$\text{TENSION FORCE IN TUBE} = \frac{84.3}{\cos 30^\circ} = 97.3 \text{ KIP}$$

(WHEN ACCEL. OPPOSITE SHOWN)

JOINT (A)



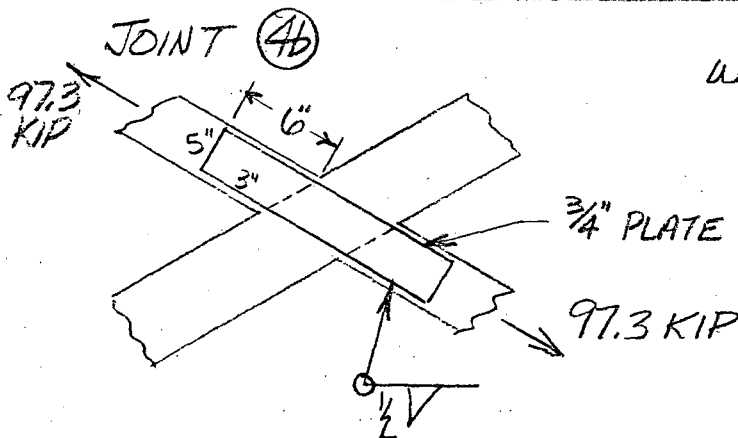
$$\text{WELD LENGTH} = (7.5 + 6.9 + 7.5) \times 2 = 41 \text{ IN.}$$

$$\text{FORCE ON WELD} = \frac{97.3 \text{ KIPS}}{41 \text{ IN}} = 2.37 \frac{\text{KIP}}{\text{IN}}$$

$$\text{REQD. WELD SIZE} = \frac{2.37}{9.6} = .25 \text{ IN}$$

$$\text{FACTOR OF SAFETY} = \frac{.50}{.25} = 2.0$$

JOINT (B)



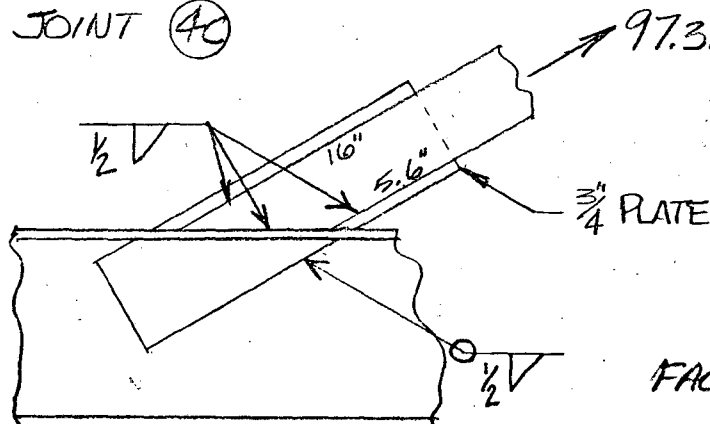
$$\text{WELD LENGTH} = (6 + 6 + 5 + 3) \times 2 = 40 \text{ IN.}$$

$$\text{FORCE ON WELD} = \frac{97.3 \text{ KIP}}{40 \text{ IN}} = 2.43 \frac{\text{KIP}}{\text{IN}}$$

$$\text{REQD. WELD SIZE} = \frac{2.43}{9.6} = .25 \text{ IN}$$

$$\text{FACTOR OF SAFETY} = \frac{.50}{.25} = 2.0$$

JOINT (C)



$$\text{WELD LENGTH} = 2(16 + 5.6 + 6) = 63.2 \text{ IN.}$$

$$\text{FORCE ON WELD} = \frac{97.3 \text{ KIP}}{63.2 \text{ IN}} = 1.54 \text{ KIP/IN}$$

$$\text{REQD. WELD SIZE} = \frac{1.54}{9.6} = .16 \text{ IN}$$

$$\text{FACTOR OF SAFETY} = \frac{.50}{.16} = 3.12$$

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P. PURGALIS

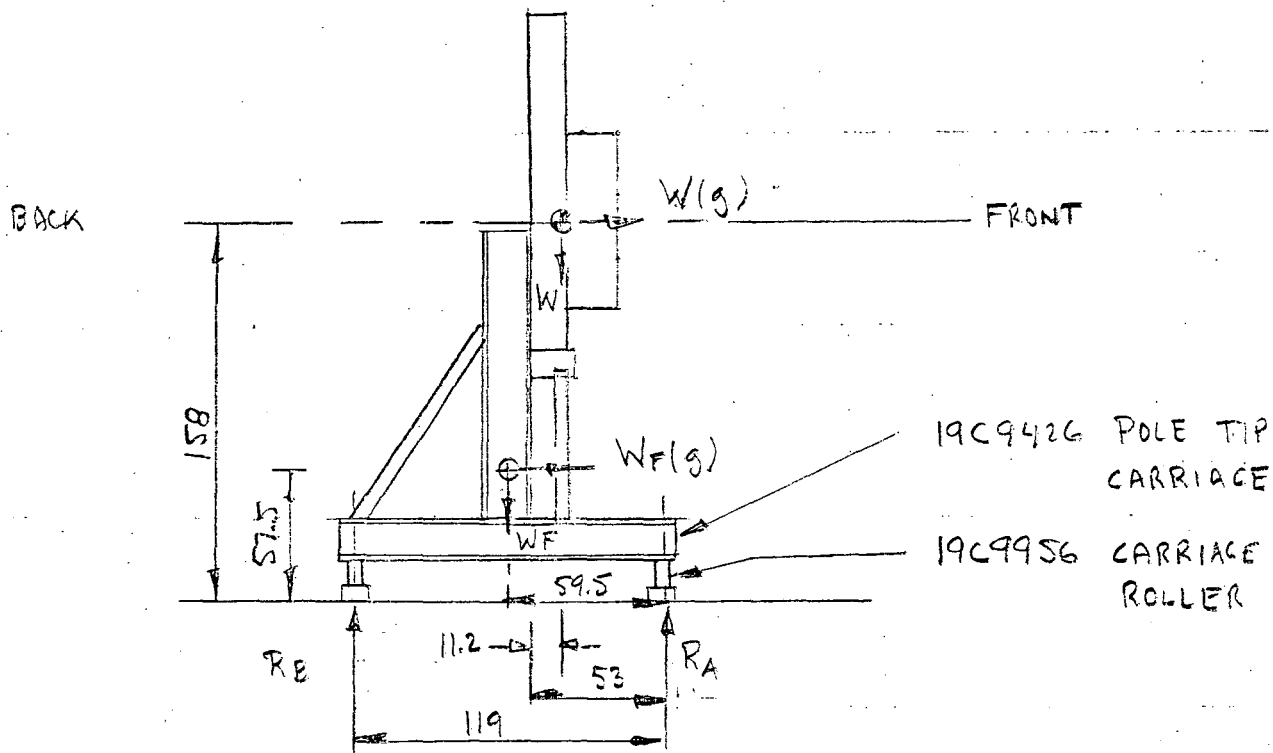
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FOR POLE TIP ASSY CG LOCATION SEE ENG NOTE M5267

POLE TIP ASSY WT = $W = 130\text{K}$ CARRIAGE WT = $W_F = 8.0\text{K}$ CHECK OVERTURNING IN WORST DIRECTION $\sum M$ AROUND R_A CHECK g FOR OVERTURNING $R_B = 0$

$$130\text{K}(g) 158 + 8\text{K}(g) 57.5 - 8\text{K}(59.5) - 130\text{K}(53 - 11.2) = 0$$

$$g = \frac{8(59.5) + 130(41.8)}{130(158) + 8(57.5)} = \frac{5910}{21000} = \boxed{.28}$$

HOLD DOWN FORCE REQUIRED AT R_B FOR $g = .7$

$$R_B(119) + 21000(.7) - 5910 = 0$$

$$R_B = \frac{-21000(.7) + 5910}{119} = \frac{8790\text{K-IN}}{119\text{IN}} = 74\text{K}$$

$$\text{HOLD DOWN FORCE EACH CORNER} = \frac{74}{2} = \boxed{37\text{K}} = P$$

$$\text{SHEAR AT EACH CORNER } S = \left(\frac{130+8}{4}\right) \cdot .7 = \frac{96.6\text{K}}{4} = \boxed{24.1\text{K}}$$

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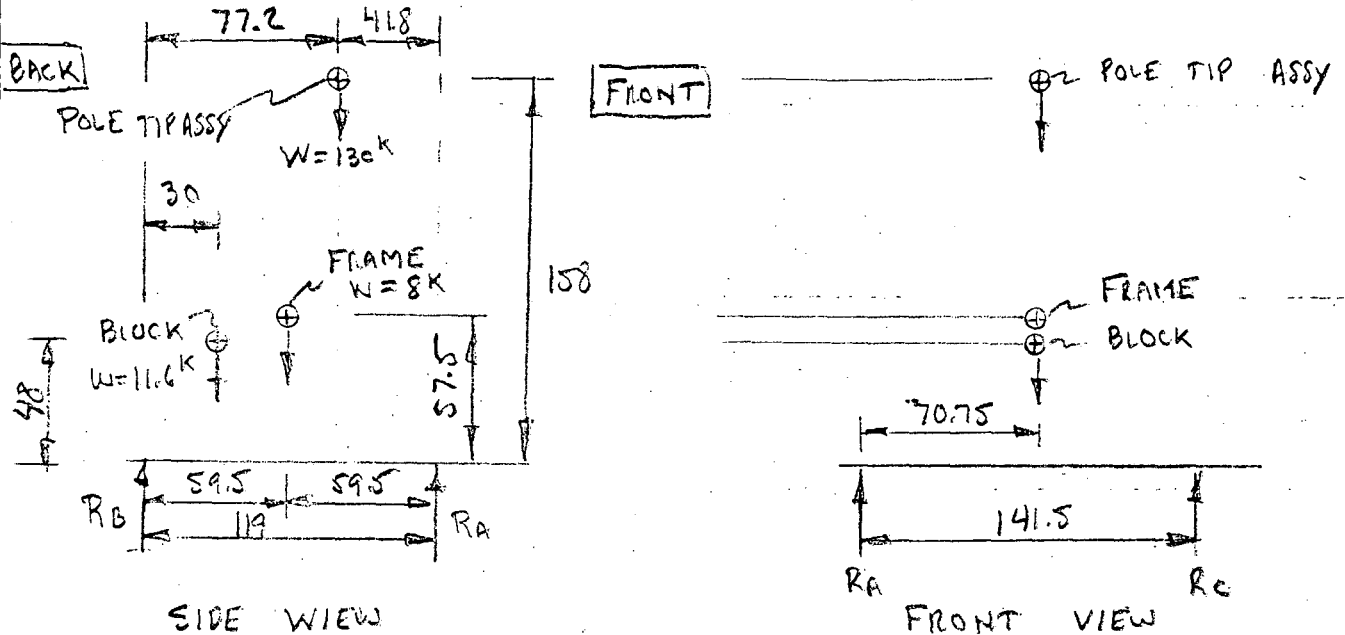
P. PURCALIS

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A

CHECK OVERTURNING IN OTHER DIRECTIONSNO CONCRETE BLOCK

← FORCE TOWARDS BACK

+ $\sum M$ AROUND RB

$$g = \frac{130(77.2) + 8(59.5)}{130(158) + 8(57.5)} = \frac{10512}{21000} = \boxed{.50}$$

FORCE SIDEWAYS →

$$g = \frac{(130+8)(70.75)}{21000} = \boxed{.46}$$

WITH EXZ BLOCK W=11.6K 3'x4'x6'

→ F TOWARDS FRONT

+ $\sum M$ AROUND RA

$$g = \frac{130(41.8) + 8(59.5) + 11.6(89)}{130(158) + 8(57.5) + 11.6(48)} = \frac{6940}{21560} = \boxed{.32}$$

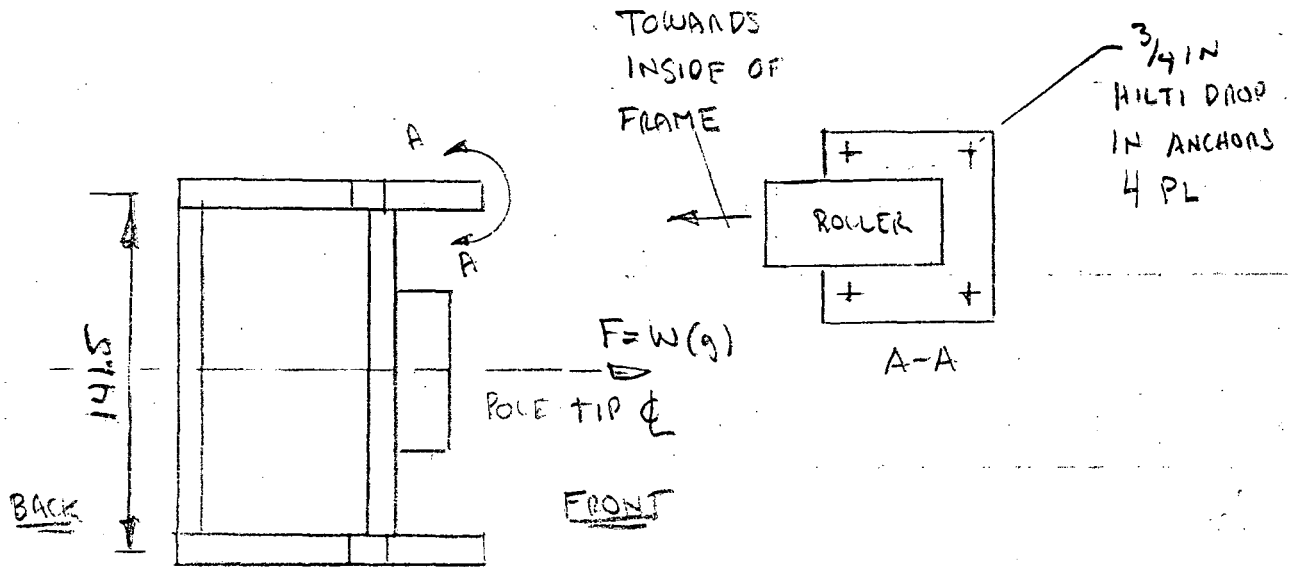
→ FORCE SIDEWAYS

$$g = \frac{(130+8+11.6)(70.75)}{21560} = \boxed{.49}$$

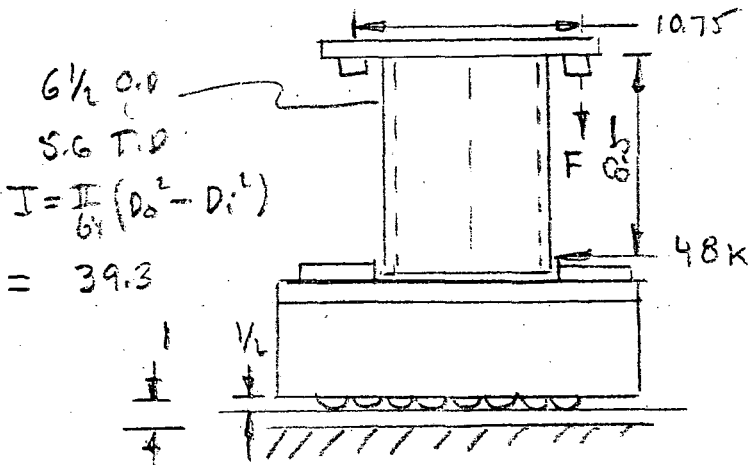
← FORCE TOWARDS BACK

+ $\sum M$ AROUND RB

$$g = \frac{130(77.2) + 8(59.5) + 11.6(30)}{21560} = \frac{10860}{21560} = \boxed{.50}$$



WORST CASE FORCE ALONG POLE TIP ϕ
 FRONT STOPS TAKE ALL SHEAR FORCE
 BACK STOPS TAKE UPLIFT



6 1/2 O.D.
 S.G. T.D.
 $I = \frac{\pi}{64} (D_o^4 - D_i^4)$
 $= 39.3$

$M = 48K \times 8.5 = 408 \text{ KIN}$

$S = \frac{I}{c} = \frac{39.3}{3.25} = 12.09$

$\sigma = \frac{M}{S} = \frac{408 \text{ KIN}}{12.1 \text{ INS}} = 33.7 \text{ KSI}$

$\sigma_{\text{YIELD}} = 75 \text{ KSI}$ ← FS = 2.2
 D.O.M TUBE

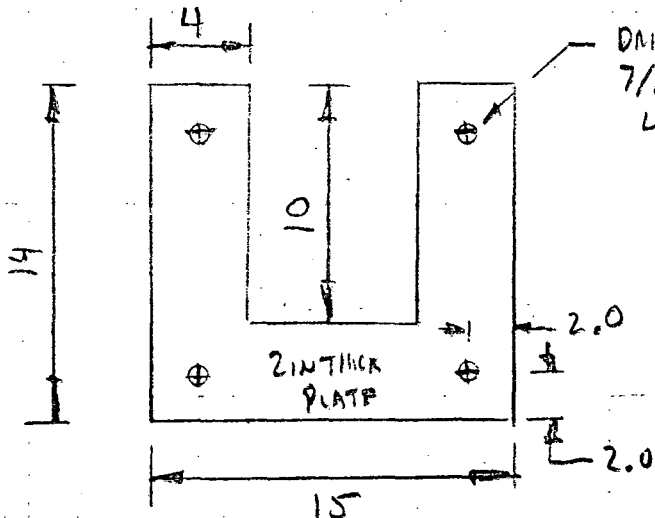
CHECK ATTACHMENT BOLTS

$F = \frac{48K (8.5)}{10.75} = 38K$

$\sigma = \frac{38K}{.606} = 62 \text{ KSI}$ ← FS = 1.25

G.R.S 1-8UNC BOLT

PROOF LOAD = 78 KSI ←



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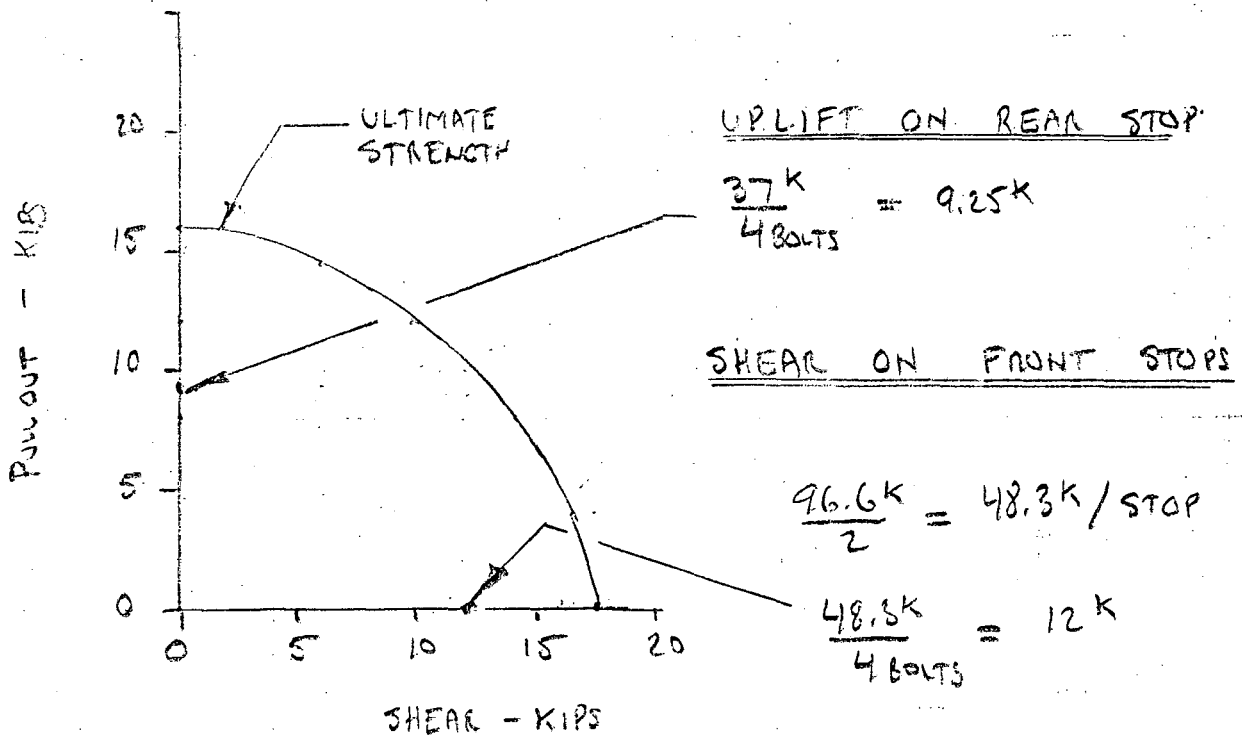
HILTI DROP IN ANCHORS HDI 3/4 3/4 IN BOLT
 ULTIMATE CAPACITY IN 4000 PSI CONCRETE

PULLOUT = $P_u = 16.03 \text{ k}$
 SHEAR = $S_u = 17.6 \text{ k}$ } HILTI CATALOG
 H-3908 4/77

FROM McMACKIN P.2 "HEADED STEEL ANCHORS UNDER COMBINED
 LOADING" AISC ENG JOURNAL 2ND QUARTER 1973

FOR COMBINED LOADING

$$\left(\frac{P}{P_u}\right)^{5/3} + \left(\frac{S}{S_u}\right)^{5/3} \leq 1$$



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