

# Lawrence Berkeley National Laboratory

## Recent Work

**Title**

POLE TIP CARRIAGE

**Permalink**

<https://escholarship.org/uc/item/00m0338z>

**Author**

Peters, Craig.

**Publication Date**

1979-11-01



# Lawrence Berkeley Laboratory

UNIVERSITY OF CALIFORNIA

## Engineering & Technical Services Division

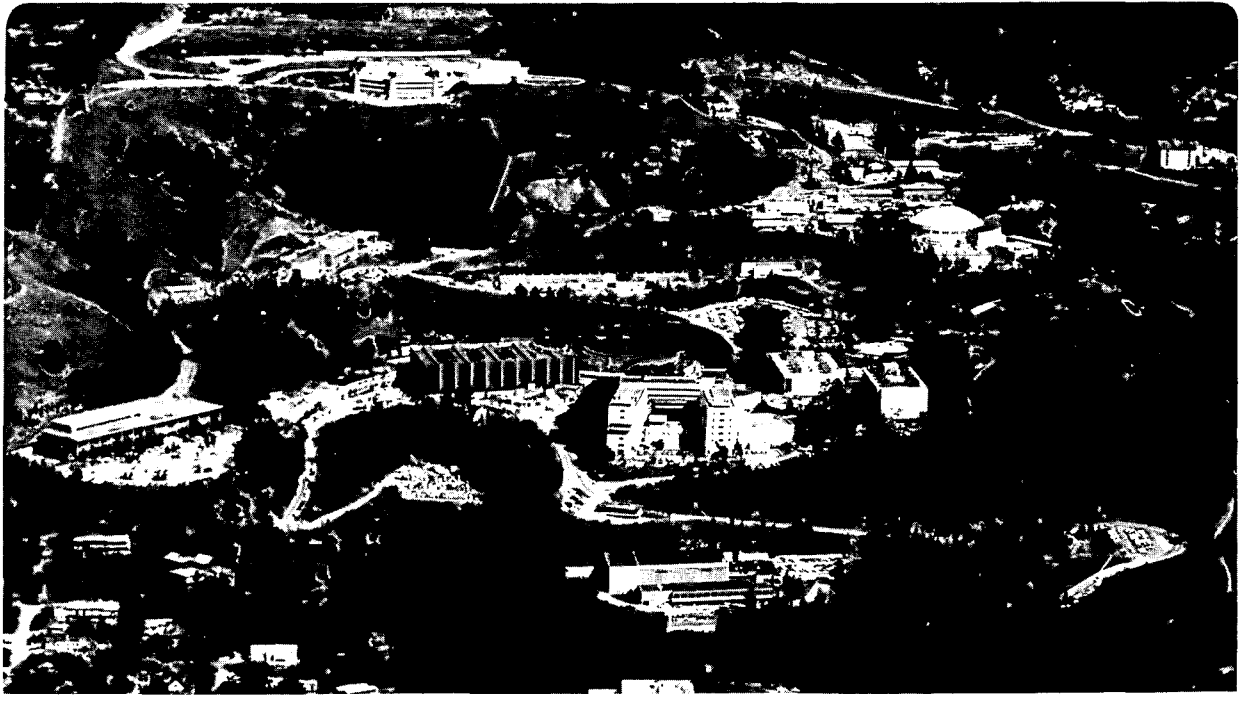
RECEIVED  
LAWRENCE  
BERKELEY LABORATORY

MAR 20 1981

LIBRARY AND  
DOCUMENTS SECTION

**For Reference**

Not to be taken from this room



LBID-361 c.1

## **DISCLAIMER**

This document was prepared as an account of work sponsored by the United States Government. While this document is believed to contain correct information, neither the United States Government nor any agency thereof, nor the Regents of the University of California, nor any of their employees, makes any warranty, express or implied, or assumes any legal responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by its trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof, or the Regents of the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof or the Regents of the University of California.

LAWRENCE RADIATION LABORATORY - UNIVERSITY OF CALIFORNIA		CODE	SERIAL	PAGE
<b>ENGINEERING NOTE</b>		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.

# ENGINEERING NOTE

P40200

M5436

2 OF 11

AUTHOR

DEPARTMENT

LOCATION

DATE

C. PETERS

MECH. ENGR.

LBL

11-20-79

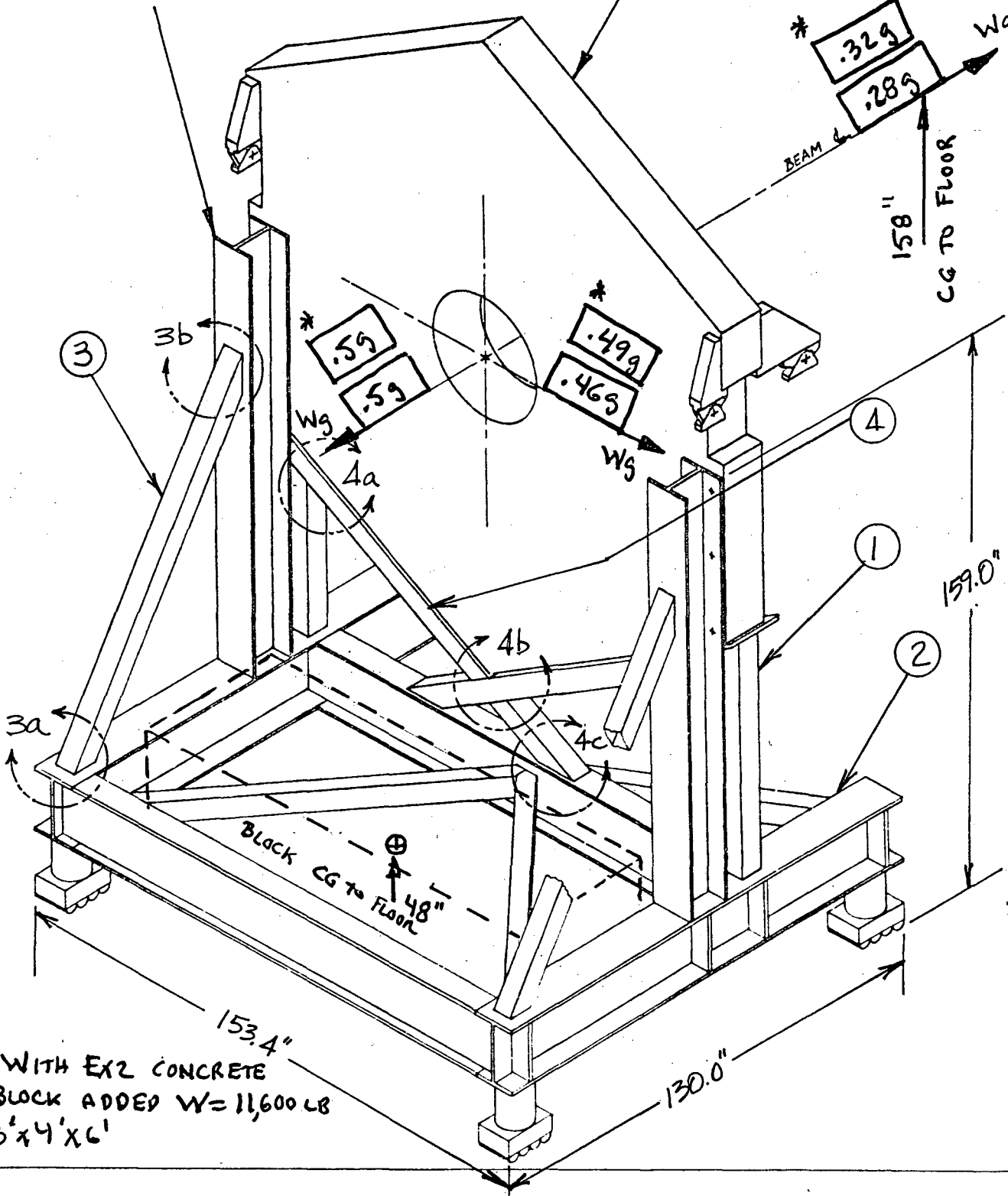
PROGRAM - PROJECT - JOB

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'

**ENGINEERING NOTE**

PA 0200

M5436

3 OF 11

AUTHOR

C. PETERS

DEPARTMENT

MECH. ENGR.

LOCATION

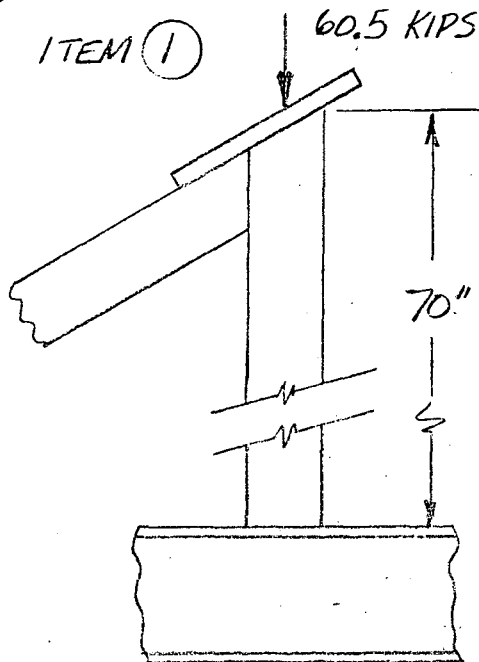
LBL

DATE

11-20-79

PROGRAM - PROJECT - JOB

TITLE

I) STATIC LOAD CONDITIONS

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

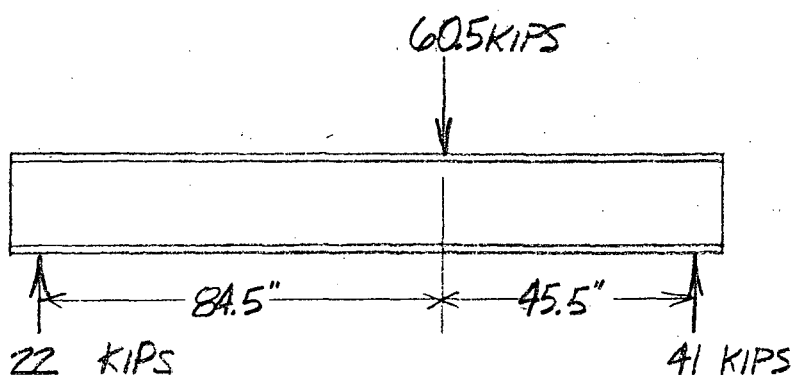
MAX. ALLOWABLE AXIAL LOAD  
(KL = 6' & 46 KSI YIELD) =

269 KIPS  
(RYERSON DATA)

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

$$= \boxed{4.29}$$

ITEM ② W F 18" X 105 LBS.



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

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

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

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

**ENGINEERING NOTE**

P40200

M5436

4 OF 11

AUTHOR

C. PETERS

DEPARTMENT

MECH. ENGR.

LOCATION

LBL

DATE

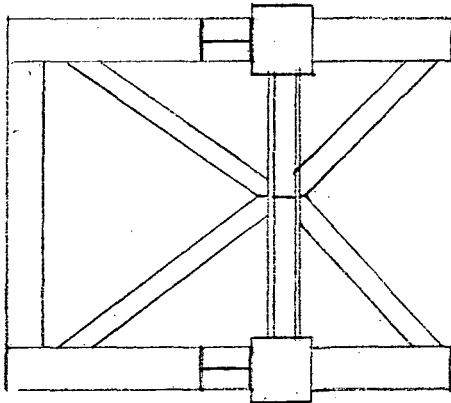
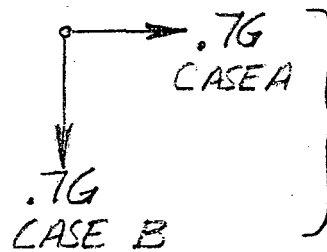
11-20-79

PROGRAM - PROJECT - JOB

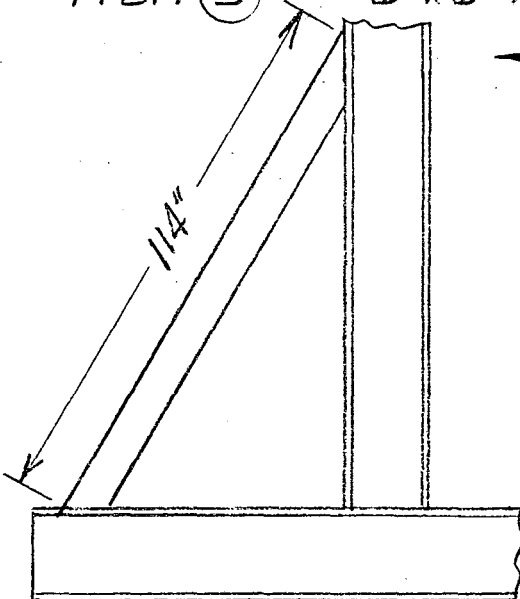
TITLE

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)

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

**ENGINEERING NOTE**

P40200

M5436

5 of 11

AUTHOR

C. PETERS

DEPARTMENT

MECH. ENGR.

LOCATION

LBL

DATE

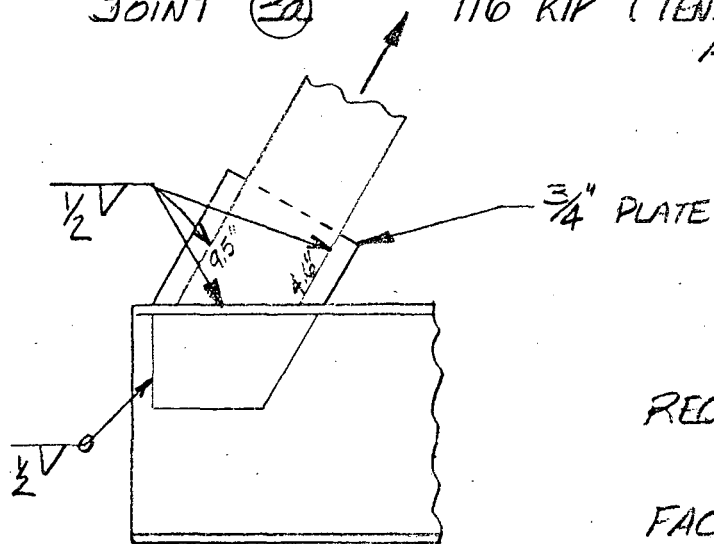
11-20-79

PROGRAM - PROJECT - JOB

TITLE

JOINT (3a)

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



LENGTH OF WELD =

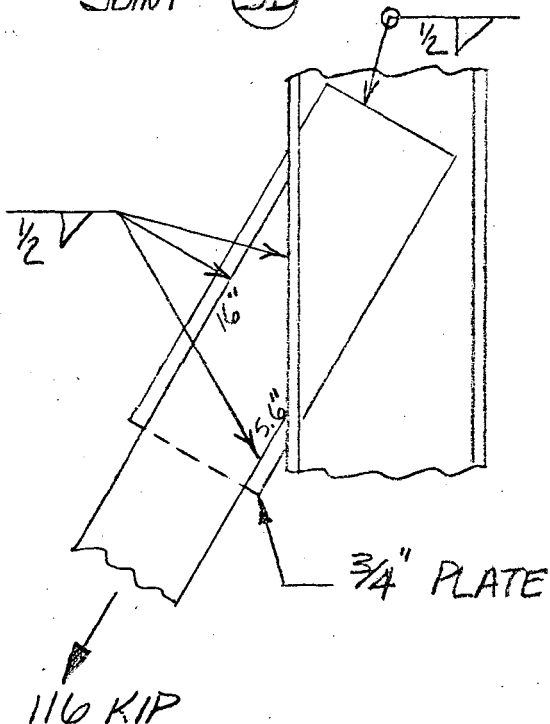
$$2(9.2 + 4.6 + 6 + 4) = 47.6 \text{ IN}$$

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

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

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

JOINT (3b)



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

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

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

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



**ENGINEERING NOTE**

P4 0200

M5436

6 of 11

AUTHOR

C. PETERS

DEPARTMENT

MECH. ENGR.

LOCATION

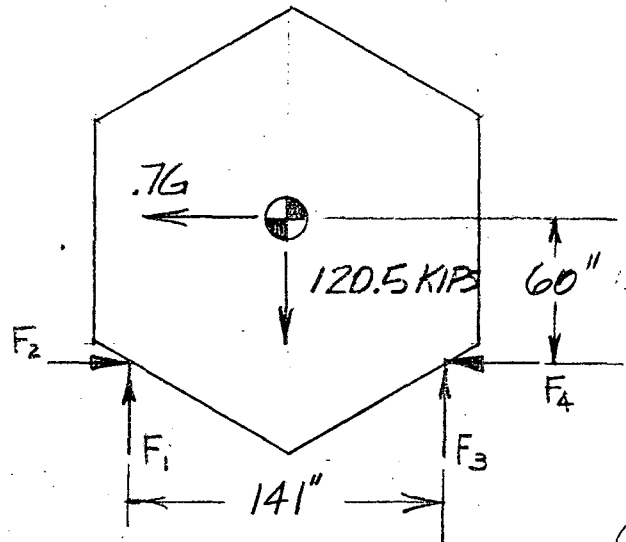
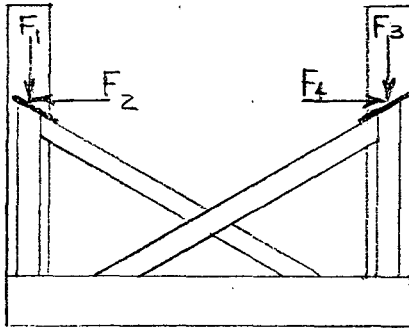
LBL

DATE

11-20-79

PROGRAM - PROJECT - JOB

TITLE

CASE B:

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

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

ASSUME  $F_2 \sim 0$ 

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

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

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

$$\sum M = \sum \bar{I} \bar{a} + M \bar{a} d$$

$$\sum M_{34}:$$

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

$$- (120.5)(0.7)(60)$$

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

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

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

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

$$\sigma_b = MC/I \quad M = 2842 \text{ KIP-IN}$$

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

$$I = 1850 \text{ IN}^4$$

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



$$34.9 \text{ KIPS} \quad 84.5" \quad 45.5" \quad 65.1 \text{ KIP}$$

## ENGINEERING NOTE

P4 0200

M5436

7 of 11

AUTHOR

C. PETERS

DEPARTMENT

MECH. ENGR.

LOCATION

LBL

DATE

11-20-79

PROGRAM - PROJECT - JOB

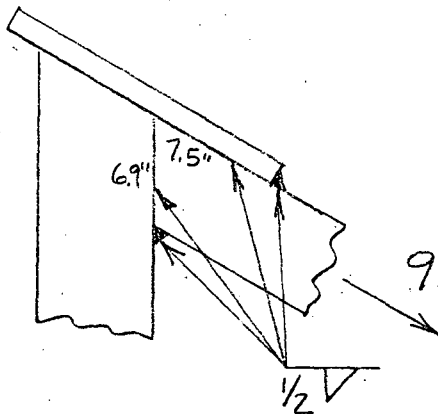
TITLE

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)



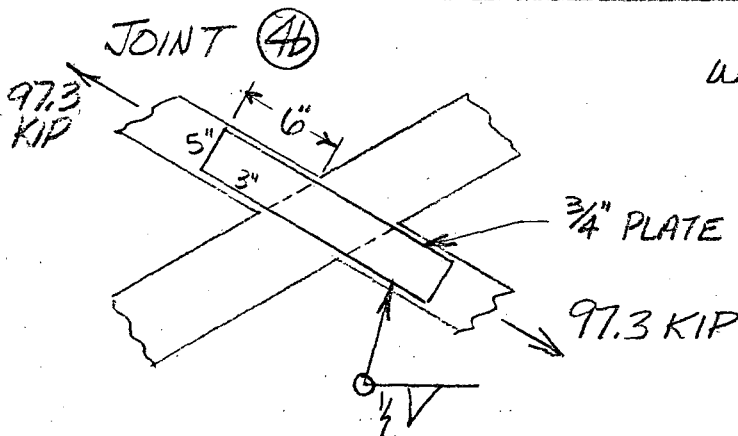
$$\text{WELD LENGTH} = (7.5 + 6.9 + 7.5) \times 2 = 41 \text{ IN.}$$

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

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

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

JOINT (B)



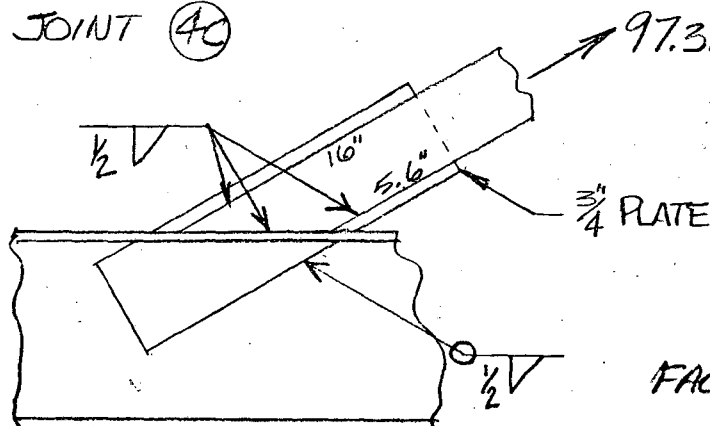
$$\text{WELD LENGTH} = (6 + 6 + 5 + 3) \times 2 = 40 \text{ IN.}$$

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

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

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

JOINT (C)



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

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

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

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

## ENGINEERING NOTE

CODE

P40200

SERIAL

M5436A

PAGE

8 OF 11

AUTHOR

P. PURGALIS

DEPARTMENT

MECH ENG

LOCATION

BERKELEY

DATE

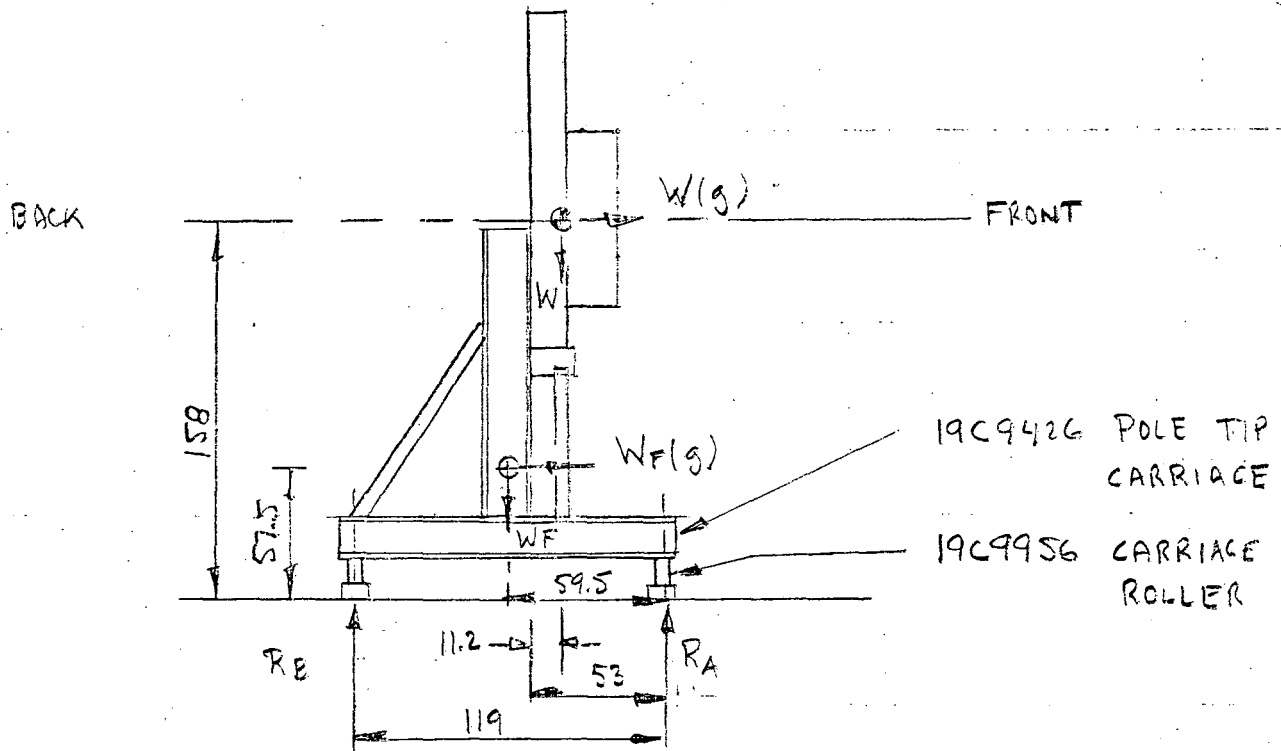
2-23-81



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  $g = .7$

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

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

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

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

**ENGINEERING NOTE**

P40200

MS436A

9 OF 11

AUTHOR

P. PURCALIS

DEPARTMENT

MECH ENG

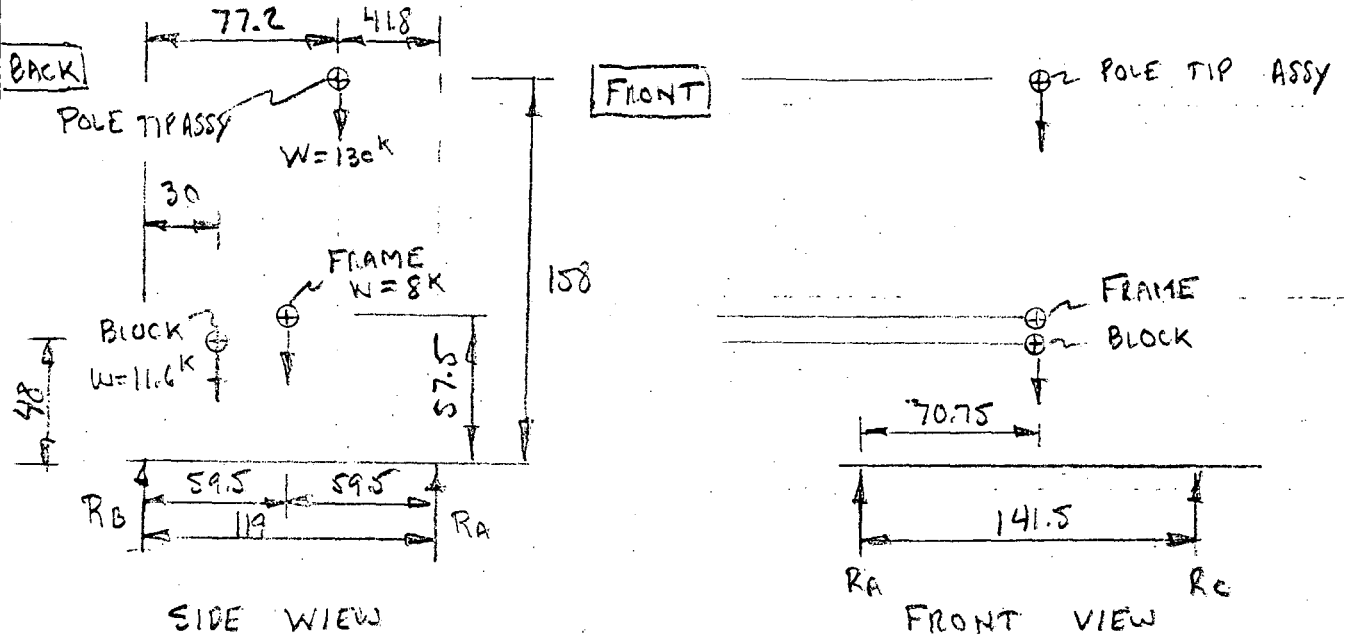
LOCATION

BERKELEY

DATE

2-23-81

A

CHECK OVERTURNING IN OTHER DIRECTIONSNO CONCRETE BLOCK← FORCE TOWARDS BACK $\sum M$  AROUND  $R_B$ 

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

FORCE SIDEWAYS →

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

WITH EX2 BLOCK W=11.6K 3'x4'x6'→ F TOWARDS FRONT $\sum M$  AROUND  $R_A$ 

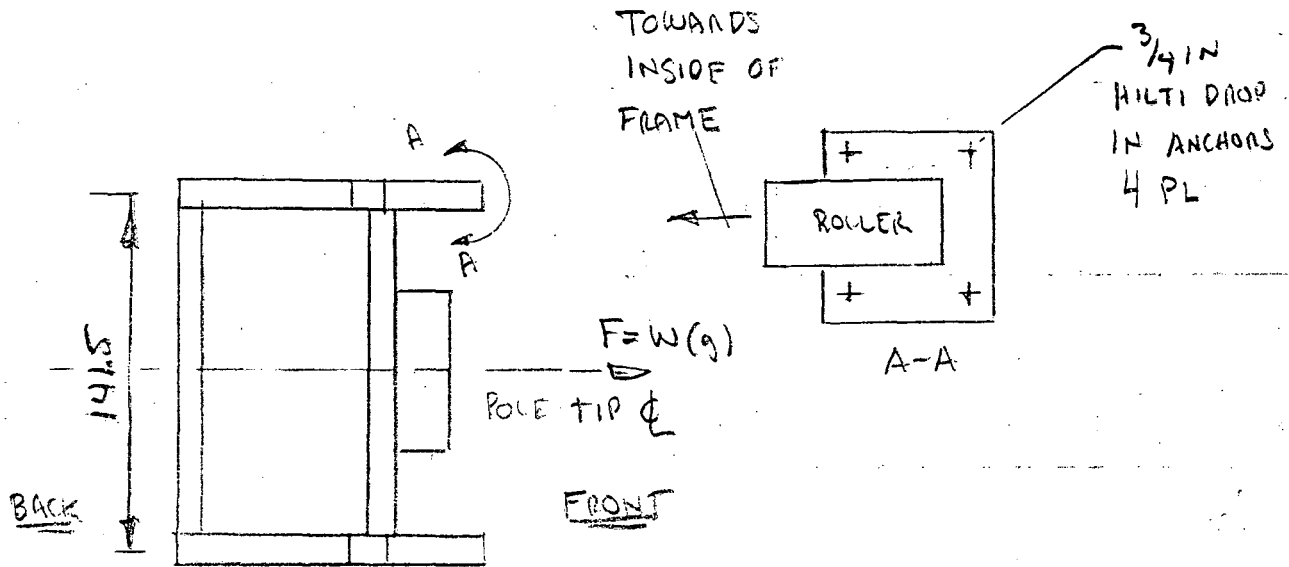
$$g = \frac{130(41.8) + 8(59.5) + 11.6(89)}{130(158) + 8(57.5) + 11.6(48)} = \frac{6940}{21560} = \boxed{.32}$$

→ FORCE SIDEWAYS

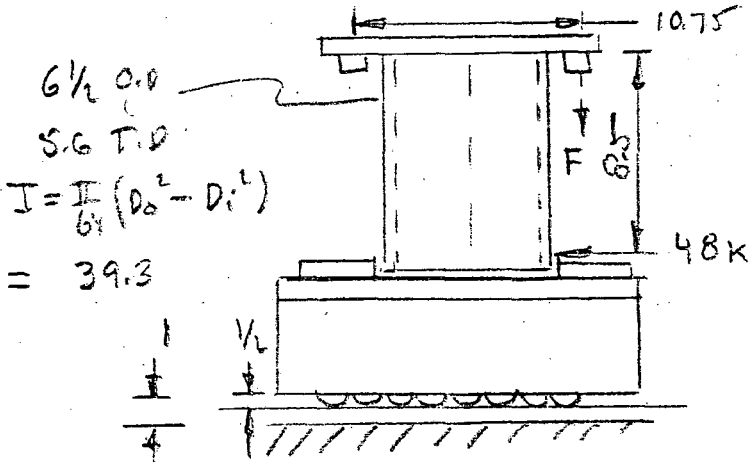
$$g = \frac{(130+8+11.6)70.75}{21560} = \boxed{.49}$$

← FORCE TOWARDS BACK $\sum M$  AROUND  $R_B$ 

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



WORST CASE FORCE ALONG POLE TIP  $\phi$   
 FRONT STOPS TAKE ALL SHEAR FORCE  
 BACK STOPS TAKE UPLIFT



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

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

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

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

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

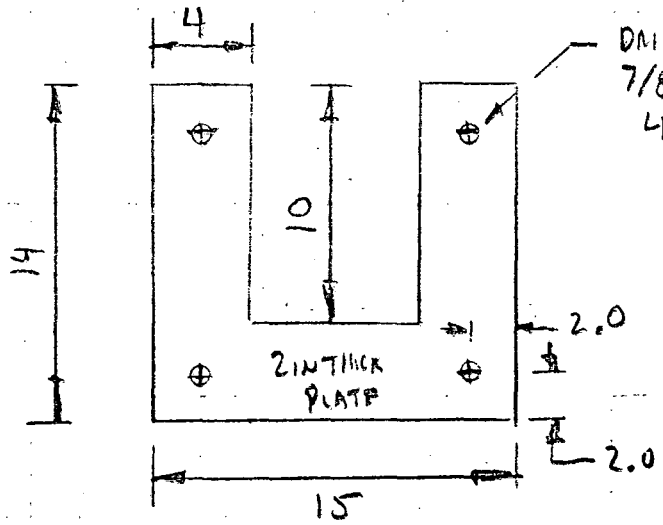
CHECK ATTACHMENT BOLTS

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

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

G.R.S 1-8UNC BOLT

PROOF LOAD = 78 KSI



## ENGINEERING NOTE

P40200

MS436A

11 OF 11

AUTHOR

P. PURGALIS

DEPARTMENT

MECH ENG

LOCATION

BERKELEY

DATE

2-23-81



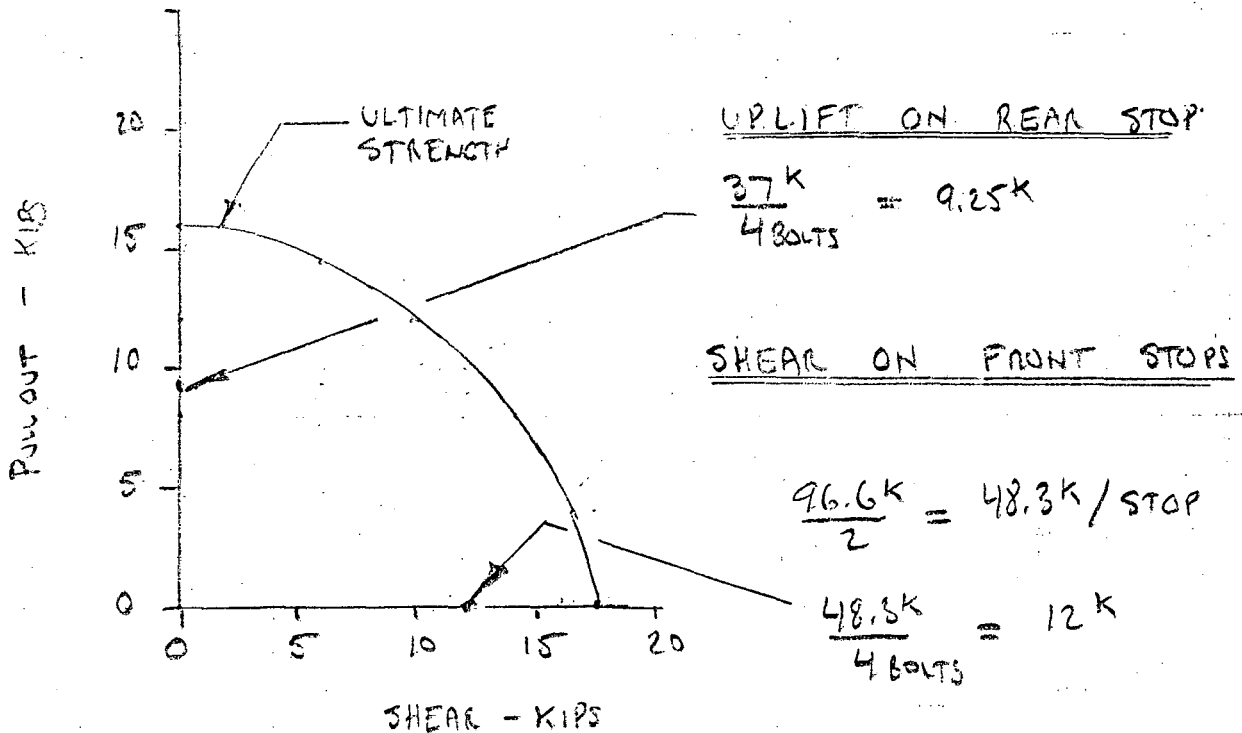
HILTI DROP IN ANCHORS HDI 3/4 3/4 IN BOLT  
 ULTIMATE CAPACITY IN 4000 PSI CONCRETE

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

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



This report was done with support from the Department of Energy. Any conclusions or opinions expressed in this report represent solely those of the author(s) and not necessarily those of The Regents of the University of California, the Lawrence Berkeley Laboratory or the Department of Energy.

Reference to a company or product name does not imply approval or recommendation of the product by the University of California or the U.S. Department of Energy to the exclusion of others that may be suitable.

TECHNICAL INFORMATION DEPARTMENT  
LAWRENCE BERKELEY LABORATORY  
UNIVERSITY OF CALIFORNIA  
BERKELEY, CALIFORNIA 94720