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TEXAS UTILITIES GENERATING COMPANY
2001 BRYAN TOWER · DALLAS, TEXAS 75201

July 30, 1979
TXX-3022

R. J. GARY
EXECUTIVE VICE PRESIDENT
AND GENERAL MANAGER

Mr. Karl V. Seyfrit, Director
U. S. Nuclear Regulatory Commission
Region IV
611 Ryan Plaza Dr., Suite 1000
Arlington, Texas 76012

RIV
Docket No. 50-445/IE Bulletin 79-02,R1
50-446/IE Bulletin 79-02,R1

COMANCHE PEAK STEAM ELECTRIC STATION
1981-83 2300 MW INSTALLATION
RESPONSE TO NRC
IE BULLETIN 79-02, REVISION 1
FILE NO: 10115

Dear Mr. Seyfrit:

Attached is our response to IE Bulletin 79-02, Revision 1 addressing the additional requirement that we submit a description of our analytical models used to verify that pipe support baseplate flexibility is accounted for in the calculation of anchor bolt loads.

Attached is ITT Grinnell's Engineering Standard ES-13 used for sizing holddown bolts. This procedure accounts for baseplate flexibility and is used in the original pipe support design. This procedure is valid for baseplates with symetric bolt patterns.

Also attached is ITT Grinnell's procedure for sizing holddown bolts when field conditions require an unsymetrical bolt pattern. This procedure also assumes the plate to be flexible.

As previously reported, NPS was conducting a finite element analysis which would allow them to incorporate baseplate flexibility into their structural analysis techniques.

The procedure developed as a result of this analysis is attached.

In many cases the NPS procedure is overly conservative. Additional analysis is being performed which may ultimately reduce this conservatism. Until such time as justification exists, the attached procedure will be used.

If you have any further questions, please advise.

Very truly yours,

R. J. Gary

RJG:dla
Attachments
cc: (See attached sheet)

1202 053

7910230535

cc: United States Nuclear Regulatory Commission
Office of Inspection and Enforcement
Division of Reactor Construction Inspection
Washington, D. C. 20555

1202 054

PROCEDURE FOR SIZING HOLD DOWN BOLTS

ENGINEERING STANDARD NO. 13

1202 055

I.T.T. GRINNELL CORP. , PIPE HANGER DIVISION			
ENGINEERING STANDARDS			
FOR INTERNAL USE ONLY		REV. C	DATE: 2/1/77
	APP'D [illegible]		PAGE 1 OF 5

SUPPLEMENT 1 TO ENGINEERING STANDARD NO. 13 REV. C

1. Note that in the formulas on page 5, the force should be in pounds.

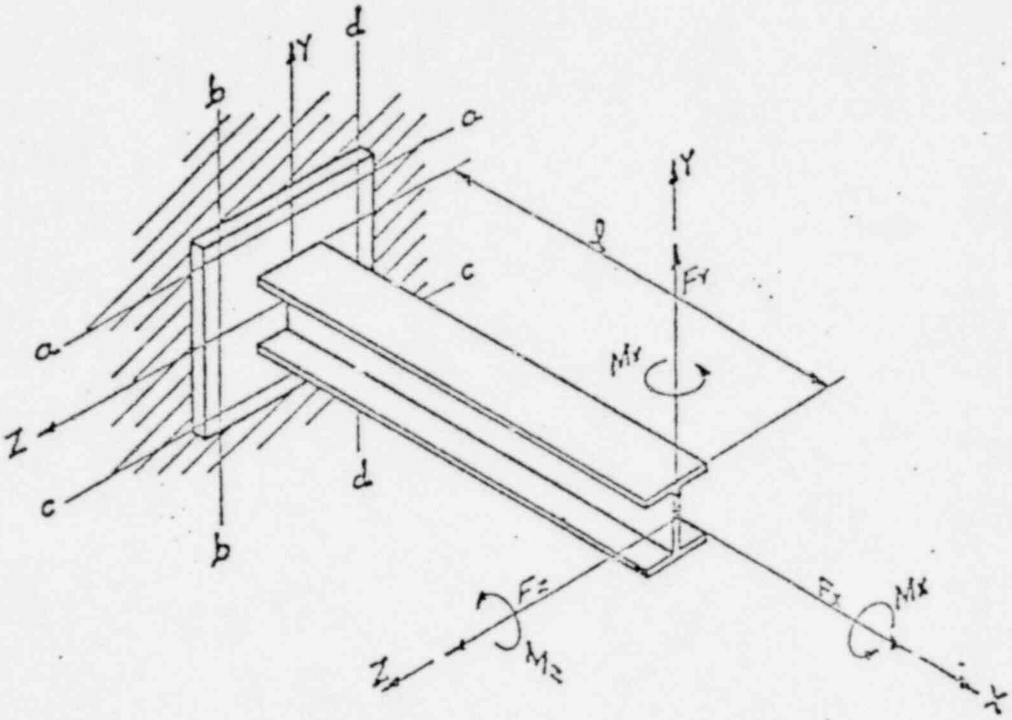
1202 056

I.T.T. GRINNELL CORP. PIPE HANGER DIVISION

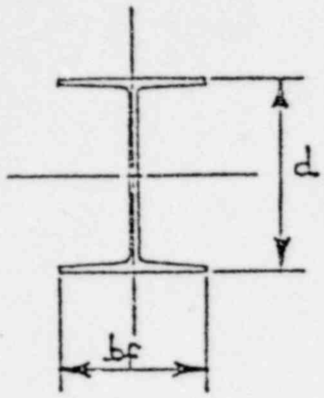
ENGINEERING STANDARDS ADDITIONAL INFORMATION SHEET

FOR INTERNAL USE ONLY	APP'D. [illegible]	DATE 2/1/78	PAGE 1 OF 1

PROCEDURE FOR SIZING HOLD DOWN BOLTS FOR WALL OR BASE PLATE



1202 057

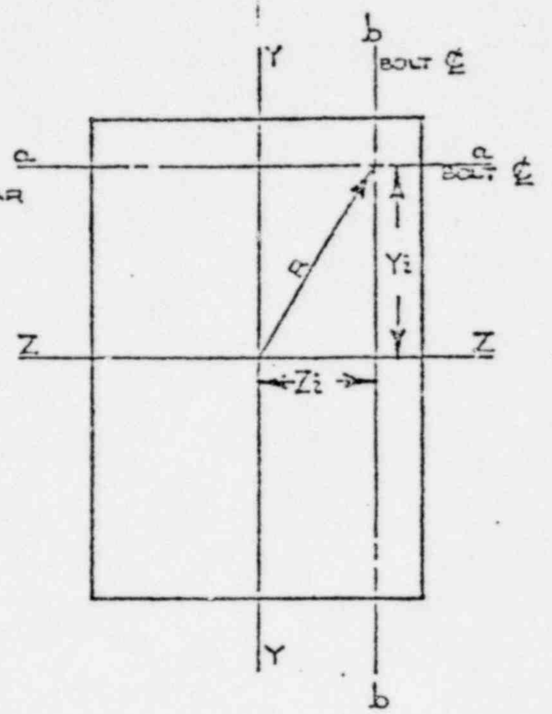


⊥ = PERPENDICULAR

Y_i = ⊥ DISTANCE FROM Z AXIS TO BOLT

Z_i = ⊥ DISTANCE FROM Y AXIS TO BOLT

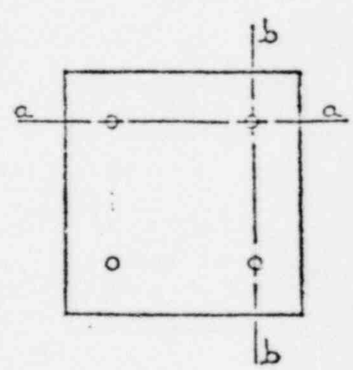
$$R = \sqrt{Z_i^2 + Y_i^2}$$



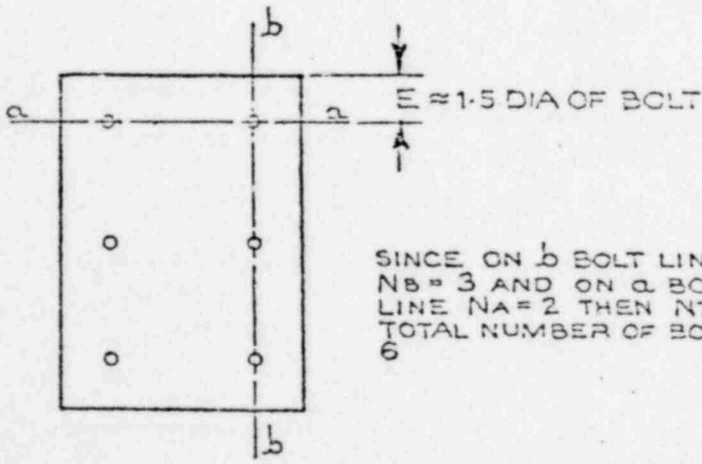
NA = NUMBER OF BOLTS ON BOLT ℄ a - a

NB = NUMBER OF BOLTS ON BOLT ℄ b - b

NT = TOTAL NUMBER OF BOLTS ON PLATE



NA = 2
NB = 2
NT = 4



SINCE ON b BOLT LINE NB = 3 AND ON a BOLT LINE NA = 2 THEN NT = TOTAL NUMBER OF BOLTS = 6

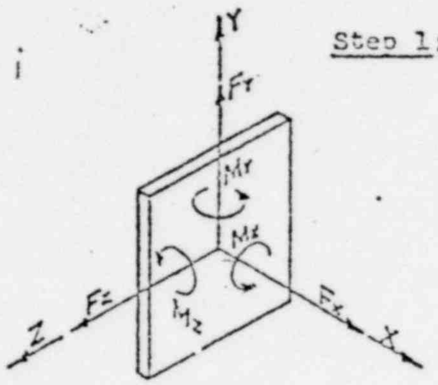
1202 058

POOR ORIGINAL

$$Z = Z_{\ell} + \frac{bf}{2}$$

$$Y = Y_{\ell} + \frac{d}{2}$$

A) If all forces and moments are known on the plate (from computer program STRUDL)



Step 1: $F1 = Fx$ if $Fx > 0.0$; if $Fx \leq 0.0$, $F1 = 0.0$ — Normal Force

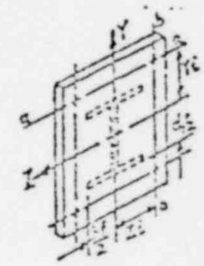
$F2 = \frac{Mz}{Y}$ — Normal Force

$F3 = \frac{My}{Z}$ — Normal Force

$F4 = \frac{Mx}{R} = \frac{Mx}{\sqrt{Z_{\ell}^2 + Y_{\ell}^2}}$ — Shear Force

$F5 = Fy$ — Shear Force

$F6 = Fz$ — Shear Force



$$(Ft)_{Normal} = \frac{|F1|}{Nt} + \frac{|F2|}{Na} + \frac{|F3|}{Nb} \text{ per bolt}$$

$$(Ft)_{Shear} = \frac{(F4 + F5 + F6)}{Nt} \text{ per bolt}$$

Step 2: For concrete fasteners only (for bolts see (B) Step 2)

Check pull-out

$$\text{Pull-out} = \sqrt{(Ft)^2_{Normal} + (Ft)^2_{Shear}} \quad \text{(per bolt)}$$

Pull-out calculated must be $\leq$ pull-out per manufacturer

B) If forces and moments are given at the end of the beam

Step 1: Transfer all forces and moments to the plate

$$F1 = \frac{(My)}{Z} - \frac{(Fz)(\ell)}{Z} = \frac{1}{Z}\left[My - (Fz)\ell \right] \quad \text{Normal Force}$$

$$F2 = \frac{(Mz)}{Y} + \frac{(Fy)(\ell)}{Y} = \frac{1}{Y}\left[Mz + (Fy)\ell \right] \quad \text{Normal Force}$$

$F3 = Fx$ if $Fx > 0.0$, if $Fx \leq 0.0$ $F3 = 0.0$ — Normal Force

$F4 = \frac{Mx}{R} = \frac{Mx}{\sqrt{Z_{\ell}^2 + Y_{\ell}^2}}$ $F5 = Fz$ $F6 = Fy$ — Shear Forces

POOR ORIGINAL

1202 059

BY DEP DATE 9/29/79 SUBJECT .... SHEET NO 1 OF ......

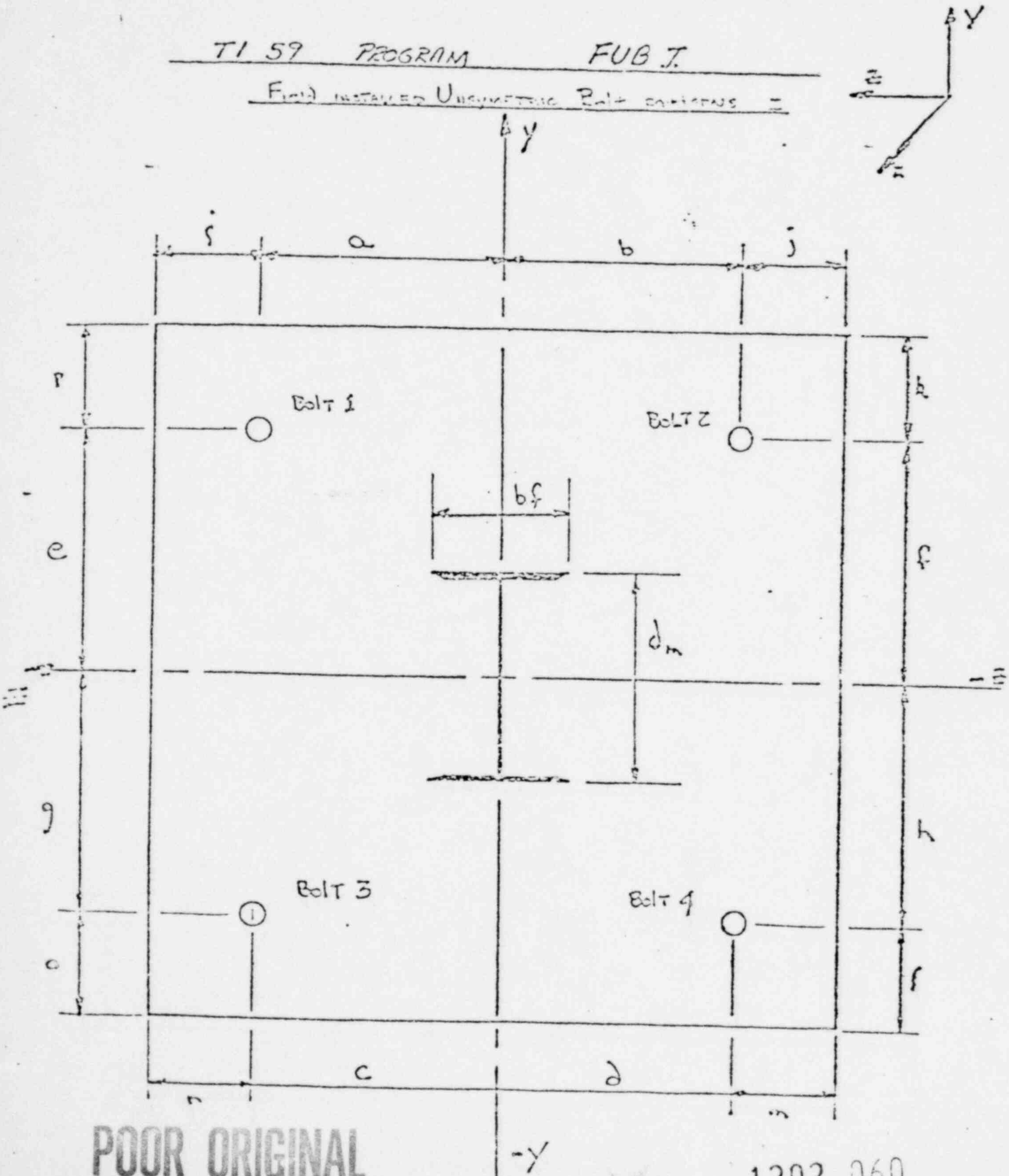
CHKD BY .... DATE .... CUSTOMER Texas Utilities SYSTEM ....

PROJECT Comanche Peak PROJECT NO CM-TC

UN SYMETRIC BOLT PATTERN EVALUATION

TI 59 PROGRAM FUB I

Field installed Unsymmetric Bolt patterns



POOR ORIGINAL

1202 060

REWRITING EQUATION 12

$$F_{T1_x} = F_x / L_1 \left(\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \frac{1}{L_4}\right)$$

$$F_{T2_x} = F_x / L_2 \left(\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \frac{1}{L_4}\right)$$

$$F_{T3_x} = F_x / L_3 \left(\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \frac{1}{4}\right)$$

$$F_{T4_x} = F_x / L_3 \left(\frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \frac{1}{L_4}\right)$$

POOR ORIGINAL

PULL OUT DUE TO M_z

When M_z is a negative value Bolts 1 & 2 ARE subjected TO PULL OUT

① $F_{TN\bar{M}_z} = FAC_{N\bar{M}_z}\left(FP_{\bar{M}_z}\right)$

Refer to equations 3, 5 & 6 OF F_x SECTION

② $FAC_{N\bar{M}_z} = \dfrac{L_1 + L_2}{L_N}$

③ $FAC_{1\bar{M}_z} = \dfrac{L_1 + L_2}{L_1}$; ④ $FAC_{2\bar{M}_z} = \dfrac{L_1 + L_2}{L_2}$

⑤ $FP_{\bar{M}_z} = |M_z| \Big/ FAC_{1\bar{M}_z}\left(e + \partial m/2\right) + FAC_{2\bar{M}_z}\left(f + \partial m/2\right)$

⑥ $F_{T1\bar{M}_z} = \dfrac{L_1 + L_2}{L_N}\left(\dfrac{|M_z|}{\frac{L_1+L_2}{L_1}\left(e + \frac{\partial m}{2}\right) + \quad ''}\right)$

1202 061

Rewriting equation 6

$$F_{T1\bar{M}_z} = |M_z| \Big/ \left[\frac{1}{L_1}\left(e + \frac{\partial m}{2}\right) + \frac{1}{L_2}\left(f + \frac{\partial m}{2}\right)\right] L_1$$

$$F_{T2\bar{M}_z} = |M_z| \Big/ \left[\frac{1}{L_1}\left(e + \frac{\partial m}{2}\right) + \frac{1}{L_2}\left(f + \frac{\partial m}{2}\right)\right] L_2$$

REWRITING EQUATION 12

$$F_{T1_x} = Fx \Big/ L_1\left(\frac{1}{L_1}+\frac{1}{L_2}+\frac{1}{L_3}+\frac{1}{L_4}\right)$$

$$F_{T2_x} = Fx \Big/ L_2\left(\frac{1}{L_1}+\frac{1}{L_2}+\frac{1}{L_3}+\frac{1}{L_4}\right)$$

$$F_{T3_x} = Fx \Big/ L_3\left(\frac{1}{L_1}+\frac{1}{L_2}+\frac{1}{L_3}+\frac{1}{4}\right)$$

$$F_{T4_x} = Fx \Big/ L_3\left(\frac{1}{L_1}+\frac{1}{L_2}+\frac{1}{L_3}+\frac{1}{L_4}\right)$$

POOR ORIGINAL

PULLOUT DUE TO MZ

WHEN MZ IS A NEGATIVE VALUE BOLTS 1 & 2 ARE SUBJECTED TO PULL OUT

Refer to equations 3, 5 & 6 of Fx section

① $F_{T_N \bar{M}_z} = FAC_{N \bar{M}_z}\left(FP_{\bar{M}_z}\right)$

② $FAC_{N \bar{M}_z} = \dfrac{L_1+L_2}{L_N}$ ③ $FAC_{1_{\bar{M}_z}} = \dfrac{L_1+L_2}{L_1}$; ④ $FAC_{2_{\bar{M}_z}} = \dfrac{L_1+L_2}{L_2}$

⑤ $FP_{\bar{M}_z} = |M_z| \Big/ FAC_{1_{\bar{M}_z}}\left(e+\partial_m/2\right) + FAC_{2_{\bar{M}_z}}\left(f+\partial_m/2\right)$

⑥ $F_{T_1 \bar{M}_z} = \dfrac{L_1+L_2}{L_N}\left(\dfrac{|M_z|}{\frac{L_1+L_2}{L_1}\left((e+\frac{\partial_m}{2}\right) + \dots}\right)$

REWRITING EQUATION 6

1202 062

$$F_{T_{1_{\bar{M}_z}}} = |M_z| \Big/ \left[\frac{1}{L_1}\left(e+\frac{\partial_m}{2}\right)+\frac{1}{L_2}\left(f+\frac{\partial_m}{2}\right)\right] L_1$$

$$F_{T_{2_{\bar{M}_z}}} = |M_z| \Big/ \left[\frac{1}{L_1}\left(e+\frac{\partial_m}{2}\right)+\frac{1}{L_2}\left(f+\frac{\partial_m}{2}\right)\right] L_2$$

Pull out due to Mz cont'd

when Mz is a positive number bolts 3 & 4 are subjected to pullout

The basic equations for Mz negative hold true

$$F_{T_3\,M_z^+} = M_z \Big/ \left[\frac{1}{L_3}\left(g + \frac{d_m}{2}\right) + \frac{1}{L_4}\left(h + \frac{d_m}{2}\right)\right] L_3$$

$$F_{T_4\,M_z^+} = M_z \Big/ \left[\frac{1}{L_3}\left(g + \frac{d_m}{2}\right) + \frac{1}{L_4}\left(h + \frac{d_m}{2}\right)\right] L_4$$

Pull out due to My

When My is negative bolts 2 & 4 are subjected

When My is a positive bolts 1 & 3 are subjected

Similar results are obtained as in the Mz equations

$$F_{T_1\,M_y^+} = M_y \Big/ \left[\frac{1}{L_1}\left(a + \frac{b_f}{2}\right) + \frac{1}{L_3}\left(c + \frac{b_f}{2}\right)\right] L_1$$

$$F_{T_2\,M_y^-} = |M_y| \Big/ \left[\frac{1}{L_2}\left(b + \frac{b_f}{2}\right) + \frac{1}{L_4}\left(d + \frac{b_f}{2}\right)\right] L_2$$

$$F_{T_3\,M_y^+} = M_y \Big/ \left[\frac{1}{L_1}\left(a + \frac{b_f}{2}\right) + \frac{1}{L_3}\left(c + \frac{b_f}{2}\right)\right] L_3$$

$$F_{T_4\,M_y^-} = |M_y| \Big/ \left[\frac{1}{L_2}\left(b + \frac{b_f}{2}\right) + \frac{1}{L_4}\left(d + \frac{b_f}{2}\right)\right] L_4$$

1202 063

TOTAL Pull ON A SEISMIC RESTRAINT subjected To ± LOADS will equal The sum of $\boxed{F_{TH_x} + F_{TH\pm M_x} + F_{TH\pm M_y}}$

IF UNIDIRECTIONAL LOADINGS (That is of eather + or −) exist, Pull outs FOR − Fx Need NOT Be Considered and The Bolts NOT effected by the moment sign (+ or −) will also be equal to 0

POOR ORIGINAL

SHEAR EVALUATION

The computation for shear values must consider the eccentricity between the ℄ of welded attachment and shear center as a Function of Bolt Area & Distances between Bolts.

The shears on each Bolt due to Fz & Fy will be considered as $\frac{(F)(A_N)}{A_{TOTAL}}$

1202 064

But in addition a moment (eccentricity x F) must

For ease of writing, the Following Terms Shall Be established

POOR ORIGINAL

e_Y = ECCENTRICITY $\bar{Y}$

e_Z = ECCENTRICITY $\bar{Z}$

FA_N = shear on N Due To Pure Fz Load

FB_N = shear ON N Due To Pure Fy Load

FC_N = shear ON N Due To $(e_Y F_Z)$ moment

FD_N = shear ON N Due To $(e_Z F_Y)$ moment

FE_N = shear ON N Due To Mx moment

$FA_1 = F_Z A_1 / \Sigma A$

$FA_2 = F_Z A_2 / \Sigma A$

$FA_3 = F_Z A_3 / \Sigma A$

$FA_4 = F_Z A_4 / \Sigma A$

$\Sigma A = A_1 + A_2 + A_3 + A_4$

$FB_1 = F_Y A_1 / \Sigma A$

$FB_2 = F_Y A_2 / \Sigma A$

$FB_3 = F_Y A_3 / \Sigma A$

$FB_4 = F_Y A_4 / \Sigma A$

1202 065

Calculation of e_y & e_z

$$e_y = \frac{A_1 e + A_2 f - A_3 g - A_4 h}{\Sigma A}$$

$$e_z = \frac{A_1 a - A_2 b + A_3 c - A_4 d}{\Sigma A}$$

F_N = Load on Bolt (shear)
C_N = Proportionality constant
r_N = Distance from CG of pattern to Bolt
Fe = applied moment (ie $F_z \times e_y$)

$$F_1 = C r_1 \; ; \; F_2 = C r_2 \; ; \; F_3 = C r_3 \; ; \; F_4 = C r_4$$

moment $Fe = F_1 r_1 + F_2 r_2 + F_3 r_3 + F_4 r_4$

$$Fe = C\left(r_1^2 + r_2^2 + r_3^2 + r_4^2\right)$$

$$C = \frac{FE}{r_1^2 + r_2^2 + r_3^2 + r_4^2}$$

$r_1^2 = (a \mp e_z)^2 + (e \mp e_y)^2$ ± dependent on location of e_y & e_z

$r_2^2 = (b \mp e_z)^2 + (f \pm e_y)^2$

$r_3^2 = (c \pm e_z)^2 \; (g \pm e_y)^2$

$r_4^2 = (D \pm e_z)^2 \; (h \pm e_y)^2$

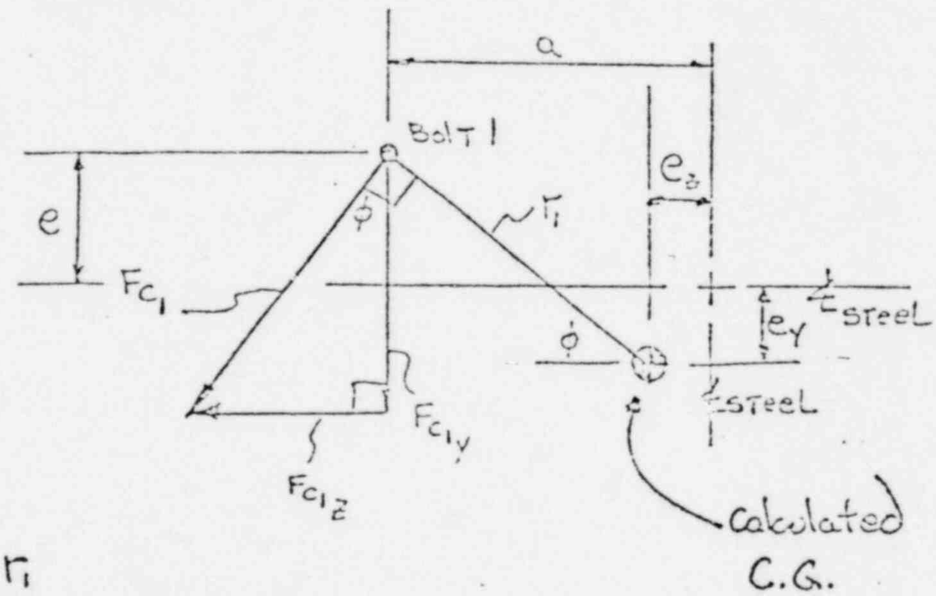
$$C_Y = \frac{F_Y e_Z}{r_1^2 + r_2^2 + r_3^2 + r_4^2} \; +$$

$$C_Z = \frac{F_Z e_Y}{r_1^2 + r_2^2 + r_3^2 + r_4^2}$$

EQUATIONS FOR F_{C_N} & F_{D_N}

all shears are to be resolved into Z & Y coordinates for the addition of vectors at conclusion.

By similar triangles



$$\frac{F_{C_{1Z}}}{F_{C_1}} = \frac{e + e_Y}{r_1}$$

$$F_{C_{1Z}} = \frac{(e+e_Y)(F_{C_1})}{r_1}$$

$F_{C_1} = C r_1$ $\qquad F_{C_{1Z}} = C_Z r_1$

$F_{C_{1Z}} = (e \pm e_Y)(C_Z)$	$F_{C_{1Y}} = (a \pm e_Z)(C_Z)$
$F_{C_{2Z}} = (f \pm e_Y)(C_Z)$	$F_{C_{2Y}} = (b \pm e_Z)(C_Z)$
$F_{C_{3Z}} = (g \pm e_Y)(C_Z)$	$F_{C_{3Y}} = (c \pm e_Z)(C_Z)$
$F_{C_{4Z}} = (h \pm e_Y)(C_Z)$	$F_{C_{4Y}} = (d \pm e_Z)(C_Z)$

1202 067

Based on these methods the equations for Fd_N can be derived

POOR ORIGINAL

$Fd_{1z} = (e \pm e_y)(C_y)$	$Fd_{1y} = (a \pm e_z)(C_y)$
$Fd_{2z} = (f \pm e_y)(C_y)$	$Fd_{2y} = (b \pm e_z)(C_y)$
$Fd_{3z} = (g \pm e_y)(C_y)$	$Fd_{3y} = (c \pm e_z)(C_y)$
$Fd_{4z} = (h \pm e_y)(C_y)$	$Fd_{4y} = (d \pm e_z)(C_y)$

Equations for F_{e_x} & F_{e_y} due to M_x

M_x is about ⊄ welded attachment

$$\tau_1 A_1 R_1 + \tau_2 A_2 R_2 + \tau_3 A_3 R_3 + \tau_4 A_4 R_4 = T = M_x$$

$$\frac{\tau_1}{R_1} = \frac{\tau_2}{R_2} = \frac{\tau_3}{R_3} = \frac{\tau_4}{R_4}$$

$$\tau_1 A_1 R_1 + \frac{\tau_1 R_2^2 A_2}{R_1} + \frac{\tau_1 R_3^2 A_3}{R_1} + \frac{\tau_1 R_4^2 A_4}{R_1} = M_x$$

$$\tau = \frac{F}{A} \qquad \tau_1 = \frac{F_{e_1}}{A_1}$$

$$A_1 R_1^2 + A_2 R_2^2 + A_3 R_3^2 + A_4 R_4^2 = K$$

1202 068

$F_{E_1} = M_x A_1 R_1 / K$ $R_1 = (a^2 + e^2)$

$F_{E_2} = M_x A_2 R_2 / K$ $R_2 =$

$F_{E_3} = M_x A_3 R_3 / K$ $R_3 =$

$F_{E_4} = M_x A_4 R_4 / K$ $R_4 =$

By the same similar triangle method Previously used will be applied

$$\frac{F_{E_1 z_E}}{F_{E_1}} = \frac{e}{r_1} \qquad F_{E_1 z} = \frac{(e)(M_x)(A_1)}{K}$$

$$F_{E_1 y} = \frac{(a)(M_x)(A_1)}{K}$$

$F_{E_1 z} = (e)(M_x)(A_1)/K$	$F_{E_1 y} = (a)(M_x)(A_1)/K$
$F_{E_2 z} = (f)(M_x)(A_2)/K$	$F_{E_2 y} = (b)(M_x)(A_1)/K$
$F_{E_3 z} = (g)(M_x)(A_3)/K$	$F_{E_3 y} = (c)(M_x)(A_1)/K$
$F_{E_4 z} = (h)(M_x)(A_3)/K$	$F_{E_4 y} = (d)(M_x)(A_1)/K$

TOTAL Shear values

$$F_{S1} = \sqrt{\left[F_{A_1} + F_{C_{1z}} + F_{D_{1z}} + F_{E_{1z}}\right]^2 + \left[F_{B_{1y}} + F_{C_{1y}} + F_{D_{1y}} + F_{E_{1y}}\right]^2}$$

$$F_{S2} = \sqrt{\left[F_{A_2} + F_{C_{2z}} + F_{D_{2z}} + F_{E_{2z}}\right]^2 + \left[F_{B_{2y}} + F_{C_{2y}} + F_{D_{2y}} + F_{E_{2y}}\right]^2}$$

ETC

To calculate shear values using ES-14 with a symetric Bolt Pattern the Results obtained From this analysis will Be less than ES-14 Results.

Bolts shall be sized using normal interaction curves.

1202 070

JOB NO. ____________

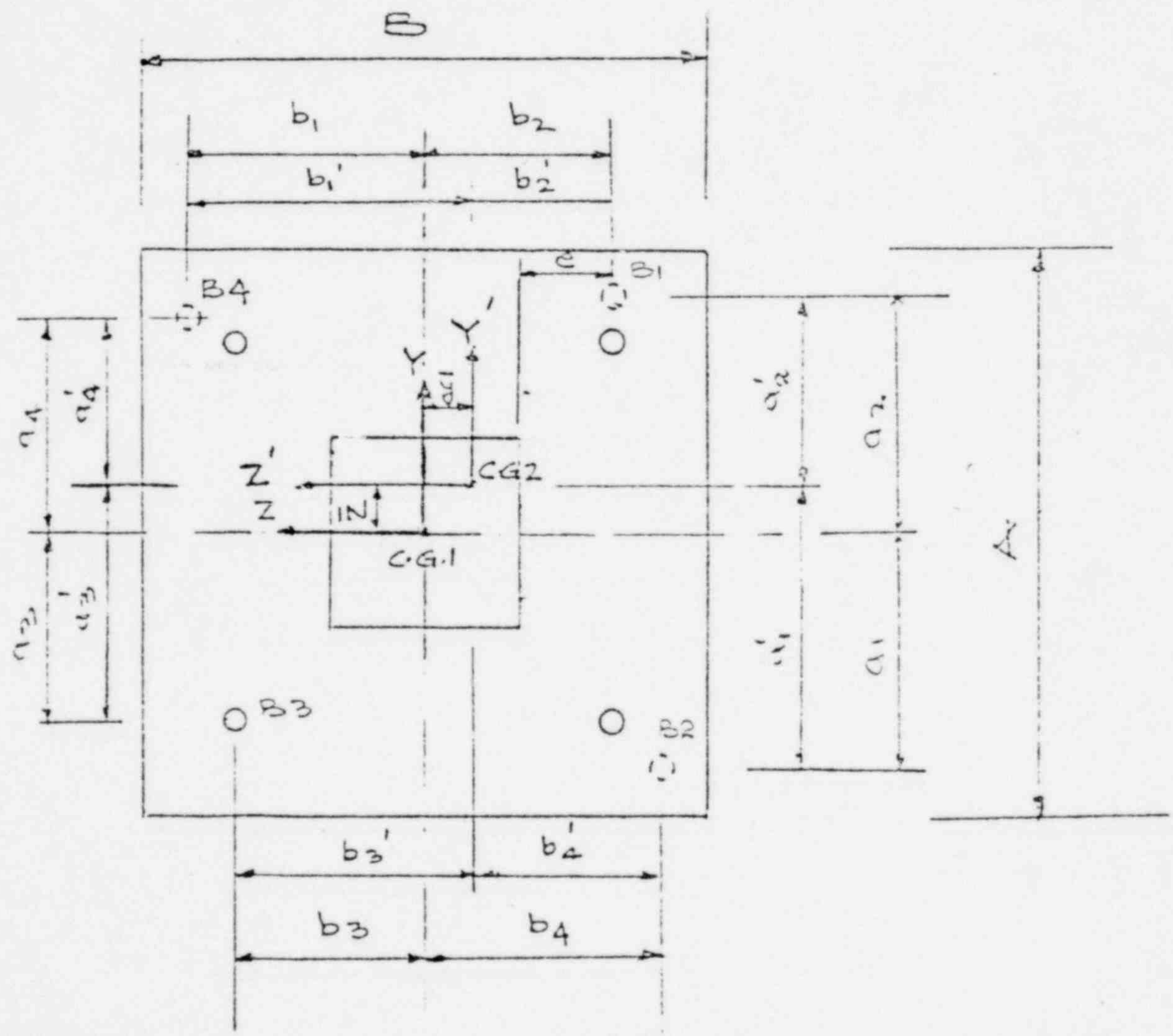
SHEET 1 OF ______

CLIENT/PROJECT TUSI | COMANCHE PEAK UNITS 1&2 ENGR. CC DATE 5-7-79

SUBJECT PROCEDURE FOR CALCULATING BOLT PULLOUT AND PLATE DESIGN CHK'D TS DATE 5-9-79

POOR ORIGINAL

TO CALCULATE BOLT PULLOUT IN CASE OF ECCENTRIC BOLT PATTERN



O DESIGN BOLT POSITION

◌ ACTUAL FIELD CONDITION

CG1 ORIGINAL CENTER OF GRAVITY OF BOLT SYSTEM

CG2 NEW CENTER OF GRAVITY OF BOLT SYSTEM (FIELD COND.)

1202 071

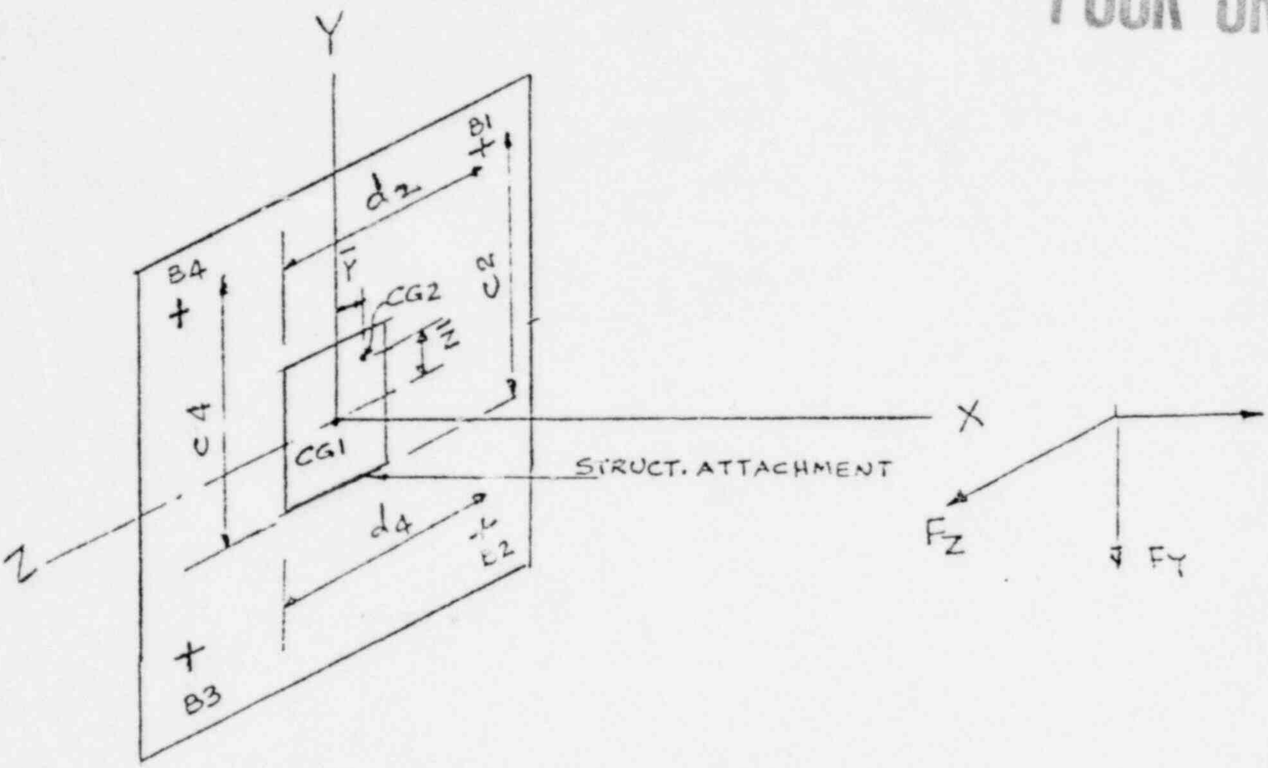
JOB NO. ______

SHEET 2 OF ______

CLIENT/PROJECT TUSI / COMMANCHE PEAK UNITS 1 & 2 ENGR. C.C. DATE 5-7-79

SUBJECT PROCEDURE FOR CALCULATING BOLT PULL OUT AND PLATE DESIGN CHK'D TS DATE 5-9-79

POOR ORIGINAL



EXTERNAL FORCES F_x, F_Y, F_Z, M_x, M_Y, M_Z

FORCES ON PLATE F_x F_Y F_Z, M_x M_Y M_Z

FORCES F_x, M_Y M_Z INDUCES PULL ON BOLTS
FORCES F_Y F_Z, M_x INDUCES SHEAR ON BOLTS.

ASSUME B1 IS THE HIGHEST STRESSED BOLT IN THE SYSTEM.

1202 072

JOB NO.

SHEET 3 OF

CLIENT/PROJECT TUSI COMMANCHE PEAK UNITS 1 & 2 ENGR. CC DATE 5-7-79

SUBJECT PROCEDURE FOR CALCULATING BOLT PULLOUT AND PLATE DESIGN CHK'D TB DATE 5-9-79

STEP ① TO FIND CG2
TAKE MOMENT @ B2

$$\bar{Z} = \frac{(a_1+a_2)+(a_1-a_3)+(a_1-a_3+a_3+a_4)}{4} - a_1$$

STEP ② CALCULATE BOLT DISTANCE FROM CG2

$$a_1' = a_1+\bar{Z}$$
$$a_2' = a_2-\bar{Z}$$

$$a_3' = a_3+\bar{Z}$$
$$a_4' = a_4-\bar{Z}$$

STEP ③ FIND I_{ZZ}

$$I_{ZZ} = (a_1')^2+(a_2')^2+(a_3')^2+(a_4')^2$$

STEP ④ FOLLOW EXACTLY SAME PROCEDURE TO FIND I_{YY}

$$I_{YY} = (b_1')^2+(b_2')^2+(b_3')^2+(b_4')^2$$

1202 073

STEP ⑤ TO FIND MAXIMUM PULLOUT IN THE BOLT @ B1

$$P_T = 4\left\{\frac{F_x}{4} + \frac{(M_Y+F_x\cdot\bar{Y})}{d_2 \text{ OR } d_4} + \frac{(M_Z+F_x\cdot\bar{Z})}{c_2 \text{ OR } c_4}\right\}$$

WHICHEVER IS SMALLER   WHICHEVER IS SMALLER

CLIENT/PROJECT TUSI | COMMANCHE PEAK UNITS 1 & 2 ENGR. CC DATE 5-7-79
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POOR ORIGINAL

STEP ⑥ TO FIND V_Y & V_Z SHEAR IN BOLT (IN THIS CASE @ B1)

$$V_Y = \frac{F_Y}{4} + \frac{(M_X \pm F_Z \cdot \bar{Z} \pm F_Y \cdot \bar{Y})\, b_2'}{I_{ZZ} + I_{yy}}$$

$$V_Z = \frac{F_Z}{4} + \frac{(M_X \pm F_Z \cdot \bar{Z} \pm F_Y \cdot \bar{Y})\, a_2'}{I_{ZZ} + I_{yy}}$$

$$V_R = \sqrt{V_Y^2 + V_Z^2}$$

STEP ⑦

$$\frac{P_T}{P} + \frac{V_R}{V} < 1.0$$

P = ALLOWABLE PULLOUT LOAD ON BOLT
V = ALLOWABLE SHEAR ON BOLT

STEP 8 CHECK PLATE THICKNESS

$$t = \sqrt{\frac{2 \times P \times e \times 6}{F_{bYC} \times A}}$$

F_{bYC} = ALLOWABLE COMP. STRESS DUE TO BENDING ABOUT MINOR AXIS. SEE CHART SDS: NF 12.1

1202 074

JOB NO. ______

SHEET 5 OF ______

nps

CLIENT/PROJECT TUSI | COMMANCHE PEAK UNITS 1 & 2 ENGR. C.C. DATE 5-7-79

SUBJECT PROCEDURE FOR CALCULATING BOLT PULLOUT AND PLATE DESIGN CHK'D. T.B. DATE 5-9-79

CONCLUSION

PRELIMINARY ANALYSIS BY COMPUTERS INDICATE THAT, THE ABOVE PROCEDURE MAY SAFELY BE ADOPTED TO FIND PULLOUT FORCE IN BOLT AND TO DESIGN PLATE THICKNESS. HOWEVER STRUCTURAL DESIGN DEPARTMENT IS FURTHER INVESTIGATING THE EFFECT OF THE LOAD FACTOR AND FLEXIBILITY OF PLATE BY FINITE ELEMENT ANALYSIS METHOD USING COMPUTERS. THE RESULTS OF WHICH ARE NOT AVAILABLE AT PRESENT TIME.

JOB NO. ______

SHEET 6 OF ______

CLIENT/PROJECT TUSI | COMANCHE PEAK UNITS 1 & 2 ENGR. C.C DATE 5-7-79

SUBJECT EXAMPLE CHK'D TB DATE 5-9-79

EXTERNAL FORCES

$F_x = 1500^{\#}$

$F_Y = 800^{\#}$

$F_Z = 900^{\#}$

$M_X = 2000^{\#}$-inch

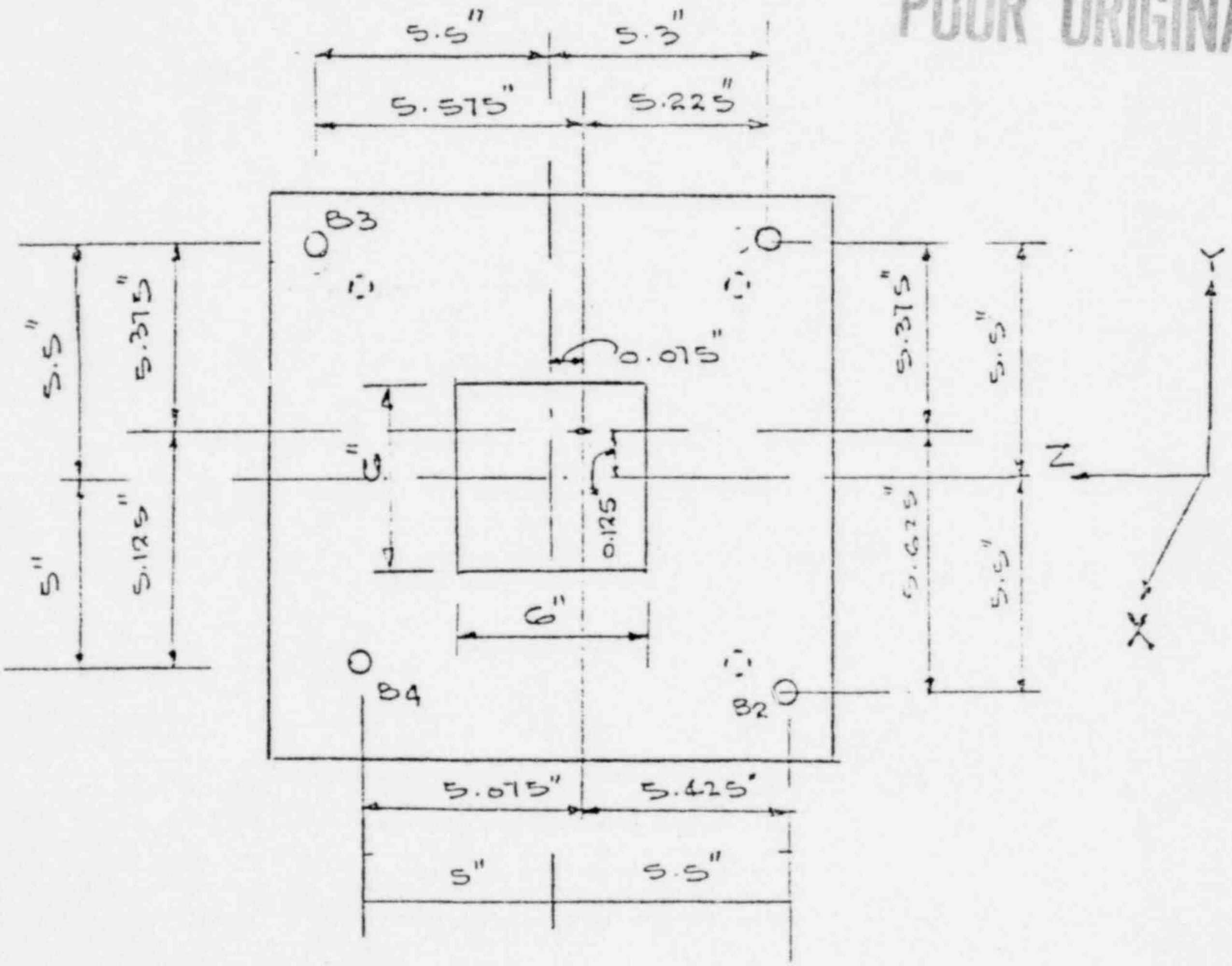
$M_Y = -1000^{\#}$-inch

$M_Z = -1500^{\#}$-inch

4 - $\frac{3}{4}$" ¢ HILTI KWIK BOLT WITH 5" EMBEDMENT

$\frac{3}{4}$" x 14" x 1'-2"

POOR ORIGINAL



1202 076

JOB NO. ______

SHEET 8 OF ______

CLIENT/PROJECT TUSI | COMANCHE PEAK UNITS 1 & 2 ENGR. C.C. DATE 5-7-79

SUBJECT EXAMPLE CHK'D. TB DATE 5-9-79

POOR ORIGINAL

STEP (5)

$$P_T : 4\left[\frac{1500}{.4} + \left(\frac{1000 + 1500 \times 0.075}{8.3}\right) + \frac{1500 + 1500 \times 0.125}{8.8}\right\}$$

$$= 2267^{\#}$$

STEP (6)

$$V_Y = \frac{800}{4} + \frac{(2000 - 900 \times 0.125 + 800 \times 0.075)\,5.225}{115.69 + 113.57}$$

$$200 + 45 = 245^{\#}$$

$$V_Z = \frac{900}{4} + \left(\frac{2000 - 900 \times 0.125 + 800 \times 0.075}{115.69 + 113.57}\right)5.37$$

$$= 225 + 46 = 271^{\#}$$

$$V_R = \sqrt{245^2 + 271^2} = 366^{\#}$$

STEP (7)

$$\frac{2267}{4110} + \frac{366}{4270} = 0.64 < 1.0 \quad \text{O.K.}$$

1202 077

JOB NO. ______

SHEET 9 OF ______

CLIENT/PROJECT TUSI | COMANCHE PEAK UNITS 1 & 2 ENGR. C.C. DATE 5-7-79

SUBJECT EXAMPLE. CHK'D T.B. DATE 5.9.79

STEP 8

$$t = \sqrt{\frac{2 \times 2267 \times 2.3 \times 6}{24600 \times 14}} = 0.43''$$

$\frac{3}{4}''$ THICK $\mathcal{P}$ O.K.

JOB NO. ______

SHEET 7 OF ______

CLIENT/PROJECT TUSI | COMANCHE PEAK UNITS 1&2 ENGR. CC DATE 5-7-79

SUBJECT EXAMPLE CHK'D. TB DATE 5-9-79

STEP ①

$$\bar{Z} = \frac{(5.5+5.5)+(5.5-5)+(5.5-5+5+5.5)}{4} - 5.5$$

$$= 0.125''$$

STEP ②

$$a_1' = 5.5 + 0.125 = 5.625''$$

$$a_2' = 5.5 - 0.125 = 5.375''$$

$$a_3' = 5.0 + 0.125 = 5.125''$$

$$a_4' = 5.5 - 0.125 = 5.375''$$

STEP ③

$$I_{ZZ} = \frac{5.625^2 + 5.375^2 + 5.125^2 + 5.375^2}{4}$$

$$= 115.69^{in^4}$$

STEP ④ (A)

$$\bar{Y} = \frac{(5.5+5.3)+(5.5-5.0)+(5.5-5+5+5.5)}{4}$$

$$= 5.575 - 5.5 = 0.075''$$

(B)

$$b_1' = 5.5 + 0.075 = 5.575''$$

$$b_2' = 5.3 - 0.075 = 5.225''$$

$$b_3' = 5.0 + 0.075 = 5.075''$$

$$b_4' = 5.5 - 0.075 = 5.425''$$

(C)

$$I_{YY} = 5.575^2 + 5.225^2 + 5.075^2 + 5.425^2$$

$$= 113.57^{in^4}$$

1202 079