Title
POLE TIP CARRIAGE

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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  R. Rogers

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)

<table>
<thead>
<tr>
<th>Front</th>
<th>Back</th>
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<tr>
<td>.28g</td>
<td>.50g</td>
<td>.46g</td>
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<tr>
<td>.32g</td>
<td>.50g</td>
<td>.49g</td>
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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 6-5. THE BOLTS SHOULD BE CHECKED AND REPLACED IF REQUIRED.
POLE TIP CARRIAGE

POLE TIP ASSY.
TYP. ASSY. W.T. = 121,000 LBS.

WITH EX2 CONCRETE
BLOK ADDED W = 11,600 LBS
3' x 4' x 6'
I) Static Load Conditions

ITEM 1

60.5 kips

6" x 6" x ½" STL Tube

Max. Allowable Axial Load
(KL = G' & 46ksi Yield) =

269 kips

(Ryerson Data)

Factor of Safety = \[ \frac{269}{60.5} \] = 4.29

ITEM 2

WF 16" x 105 lbs.

605 kips

\[ \sigma_b = \frac{Mc}{I} \]

\[ I = 1850 \text{ in}^4 \]

\[ M = 1789 \text{ in-kip} \]

\[ c = 9 \text{ in} \]

\[ \sigma_b = \frac{8705 \text{ psi}}{ \text{in} } \]
II. EARTHQUAKE LOAD CONDITIONS

TWO CASES:

- CASE A
- CASE B

GROUND ACCELERATION RELATIVE TO CARRIAGE.

CARRIAGE PLAN VIEW

CASE A:

ITEM 3: 6" x 6" x 1/2" STL. TUBE.

FORCE DUE TO ACCEL. = 58 kips

COMPRESSIVE FORCE IN TUBE = \[
\frac{58 \text{ kips}}{\cos 60^\circ}
\] = 116 kips

MAX. ALLOWABLE AXIAL LOAD ( \( KL = 10' \) & 40 ksi YIELD) = 248 kips (RYESELON DATA)

FACTOR OF SAFETY = \[
\frac{248}{116} = 2.14
\]
Joint A

110 kip (tension when accel. is opposite as shown Pg. 4)

\[ \text{length of weld} = 2(9.2 + 4.6 + 6.4) = 47.6 \text{ in} \]

\[ \text{force on weld} = \frac{110 \text{ kip}}{47.6 \text{ in}} = 2.34 \text{ kip/in} \]

\[ \text{reqd. weld size} = \frac{2.34}{9.6} \geq 0.25 \text{ in (AWS)} \]

\[ \text{factor of safety} = \frac{50}{0.25} = 2.00 \]

Joint B

\[ \text{length of weld} = 2(14.5 + 5.6 + 4.6) = 63.2 \text{ in} \]

\[ \text{force on weld} = \frac{110 \text{ kip}}{63.2 \text{ in}} = 1.73 \text{ kip/in} \]

\[ \text{reqd. weld size} = \frac{1.73}{9.6} \geq 0.19 \]

\[ \text{factor of safety} = \frac{50}{0.19} = 2.62 \]
**CASE B:**

\[ F_1 = M_{A,y} \]
\[ F_4 - F_2 = (0.7)(120.5) = 84.3 \text{ KIP} \]
\[ M_3 = 0.7(120.5)(60) = 5109 \text{ KIFP} \]

**ASSUME** \( F_2 = 0 \)

\[ F_4 = 84.3 \text{ KIP} \]

**ITEM 1**

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

**MAX. ALLOWABLE AXIAL LOAD**

\( KL = 6' \) & 46 KSI (YIELD) = 269 KIPS (RYERSON DATA)

**FACTOR OF SAFETY**

\[ \frac{269}{96.1} = 2.79 \]

**ITEM 2**

WF 18" x 105 LBS

\[ F_1 = 96.1 \text{ KIPS} \]

\[ \sigma_b = \frac{M C}{I} \]

\[ M = 2842 \text{ KIFP} \]

\[ C = 9 \text{ IN} \]

\[ I = 1850 \text{ IN}^4 \]

\[ \sigma_b = 13,827 \text{ PSI} \]
ITEM 4  6" x 6" x ½" STL. TUBE

TENSION FORCE IN TUBE = \( \frac{84.3}{\cos 30\degree} = 97.3 \text{ kip} \)
(When accel. opposite shown)

WELD LENGTH = (7.5 + 6.9 + 9) = 41 in

FORCE ON WELD = \( \frac{97.3 \text{ kip}}{41 \text{ in}} \)

REOR. WELD SIZE = \( \frac{2.37}{\frac{9}{16}} \) = .25 in

97.3 kip  Factor of safety = \( \frac{50}{25} \) = 2.0

WELD LENGTH = (6 + 6 + 5 + 3) = 40 in

FORCE ON WELD = \( \frac{97.3 \text{ kip}}{40 \text{ in}} \)

REOR. WELD SIZE = \( \frac{2.43}{\frac{9}{16}} \) = .25 in

97.3 kip  Factor of safety = \( \frac{50}{25} \) = 2.0

WELD LENGTH = 2(16 + 5.6 + 6.4) = 63.2 in

FORCE ON WELD = \( \frac{97.3 \text{ kip}}{63.2 \text{ in}} \) = 1.54 kip/in

REOR. WELD SIZE = \( \frac{1.54}{\frac{9}{16}} \) = .16 in

97.3 kips  Factor of safety = \( \frac{50}{.16} \) = 3.12
For pole tip assy CG location see Eng Note MS 267

Pole tip assy WT = W = 130 k
Carriage WT = WF = 8.0 k

Check overturning in worst direction

\[ \sum M_\text{around } R_B \]

Check \( \delta \) for overturning \( R_B = 0 \)

\[ \begin{align*}
130 \times (9) &+ 8 \times (3) \times 57.5 - 8 \times (59.5) - 130 \times (53 - 11.2) = 0 \\
\delta &= \frac{8 \times (59.5) + 130 \times (41.8)}{130 \times (158) + 8 \times (57.5)} = \frac{5910}{21006} = 0.28 \\
\end{align*} \]

Hold down force required at \( R_B \) for \( \delta = 0.7 \)

\[ \begin{align*}
R_B (119) + 21000(1.7) - 5910 &= 0 \\
R_B &= \frac{-21000(1.7) + 5910}{119} = \frac{-8790 \text{ k.l.}}{119} = 74 \text{ k} \\
\text{Hold down force each corner} &= \frac{74}{2} = \frac{74}{2} = 37 \text{ k} = P \\
\text{Shear at each corner} &= \left( \frac{130 + 8}{4} \right) \cdot 7 = \frac{96.6 \text{ k}}{4} = 24.1 \text{ k}
\end{align*} \]
CHECK OVERTURNING IN OTHER DIRECTIONS.

FORCE TOWARDS BACK

\[ g = \frac{130(77.2) + 8(59.5)}{130(158) + 8(57.5)} = \frac{10512}{21000} = 0.50 \]

FORCE SIDEWAYS

\[ g = \frac{130 + 8}{70.75} = \frac{138}{21000} = 0.0066 \]

NO CONCRETE BLOCK.

FORCE TOWARDS FRONT

\[ g = \frac{130(418) + 8(59.5) + 11.6(89)}{130(158) + 8(57.5) + 11.6(48)} = \frac{6940}{21560} = 0.32 \]

FORCE SIDEWAYS

\[ g = \frac{130 + 8 + 11.6}{70.75} = \frac{149.6}{21560} = 0.0069 \]

WITH EX2 BLOCK W=11.6k 3'x4'x6'

FORCE TOWARDS BACK

\[ g = \frac{130(77.2) + 8(59.5) + 11.6(30)}{21560} = \frac{10860}{21560} = 0.50 \]

FORCE SIDEWAYS

\[ g = \frac{130 + 8 + 11.6}{70.75} = \frac{149.6}{21560} = 0.0069 \]
TOWARDS INSIDE OF FRAME

\[ F = W(q) \]

POLE TIP \&

\[ M = 48K \times 8.5 = 408 \text{ kN} \]

\[ S = \frac{1}{\sigma} = \frac{29.3}{325} = 0.09 \]

\[ T = \frac{M}{S} = \frac{408 \text{ kN}}{121.1 \text{ kN}} = 3.37 \text{ kN} \]

\[ \sigma_{YIELD} = 75 \text{ ksi} \]

D.O.M. TUBE

CHECK ATTACHMENT BOLTS

\[ F = \frac{48K \times 8.5}{10.75} = 38K \]

\[ \sigma = \frac{38K}{60} = 62 \text{ ksi} \]

GALV. 1-3/4" UNC BOLT

Proof Load = 76 kN
HILTI DROP IN ANCHORS HDI 3/4, 3/4 IN BOLT
ULTIMATE CAPACITY IN 4000 PSI CONCRETE

\[ \text{Pullout} = P_u = 16.03 \text{ K} \]
\[ \text{Shear} = S_u = 17.6 \text{ K} \]

From McMackin P.J. "HEADED STEEL ANCHORS UNDER COMBINED LOADING" AISC ENG JOURNAL 2nd QUARTER 1973

For combined loading,

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

UPLIFT ON REAR STOP
\[ \frac{37 \text{ K}}{4 \text{ BOLTS}} = 9.25 \text{ K} \]

SHEAR ON FRONT STOP
\[ \frac{96.6 \text{ K}}{2} = 48.3 \text{ K/STOP} \]
\[ \frac{48.5 \text{ K}}{4 \text{ BOLTS}} = 12 \text{ K} \]
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