## OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT
### CALCULATION COVER SHEET

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<th>MSR 9/25/00</th>
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<td>Strengthening of Trench Cover Plates for Switchgear Building</td>
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<tr>
<td>Michael S. Ruben</td>
<td>Sean A. Fargo</td>
<td>Michael S. Ruben</td>
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### Revision History

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AP-3.12.Q.1

Rev. 06/30/1999
1. Purpose

The objective of this calculation is to strengthen the existing trench cover plates of the Electrical Switchgear Building (BLDG 5010) of the Exploratory Studies Facility. A remodeling effort will change the portion of the facility that has the trenches for electrical cables to a craft/shop area. The users of the building will be using a forklift in this area (Clark CGP 30 forklift with a capacity of 3 tons). The trench covers require strengthening to support the wheel loads from the forklift. The output of this calculation will be sketches revising the floor plate details of DWG YMP-025-1-7007-ST103, Rev 02. (Details 4 and 5)

The Development Plan for this analysis is: “Complete the ESF Electrical Switchgear Building,” BABB000000-01717-4800-00040, Rev 00.

2. Method

Hand calculations will be used in this analysis. There will be no use of computer analysis.

3. Assumptions

1. The existing floor plate is mild steel conforming to ASTM A 36.
2. Existing expansion anchors fastening W6 beam seats to trench walls have ultimate tension capacity of 18,000 pounds and ultimate shear capacity of 19,200 pounds. (Hilti Kwik-bolt II ¼" diameter X 7 inches long with 4-3/4" embedment and 4,000 psi concrete.)

4. Use of Computer Software and Models

There is no computer software used in this analysis.

5. Calculation

See Attachment I

6. Results

See sketches for changes to floor plates in Attachment I.

7. References


2. Elowson, J. 2000. "Wheel Load." E-mail from J. Elowson (NHMH) to M. Ruben, June 7, 2000, with attachment. ACC: MOL.20000628.0427.


8. **Attachments**

Attachment I Calculations
ATTACHMENT I

Calculations
Assume $F_y = 36$ ksi (ASTM A36)

From J.F. Elowson, Las Vegas Clark Forklift Representative

A Clark CGP 30 Forklift W/ 5 ton capacity

will have a maximum front upright load

of 6700 lb [Elowson, John 2000, Ref 2]

Assume Impact Factor of 1.25 & Assume Concentrated Load

$P = 1.25 \times 6700 = 8375$ lb

$M_q = \frac{Pl}{4} = \frac{8375 \times 36}{4}$

$M_q = 75375$ ft-lb

$\Delta \frac{P}{2} = 36"$

$R = \frac{8375}{2} \approx 4200$ ft

$\Delta$

$\Delta = \frac{P}{4} \times 64"$

$\theta = \frac{P}{4} \times 64"$

$\Sigma M_{d} = \frac{1}{2} \times 64 \times 2.125 + 1 \times 1$

$\Sigma M_{d} = 16 \times 1$

$x = 2.059$
CALCULATIONS and SKETCHES

TRENCH COVER IN SWITCHGEAR BLD-6

$B A B 0 0 0 0 0 - 0 1 7 7 - 0 2 1 0 - 0 2 5 5 R F U 0 0$

\[ I_1 = \frac{64 \times 0.25^3}{12} = 0.0833 \text{ in}^4 \quad A_1 = \frac{64 \times 1}{4} = 16 \text{ in}^2 \]

\[ I_2 = \frac{0.25 \times 2^3}{12} \cdot 2 = 0.333 \text{ in}^4 \quad A_2 = 2 \times 0.25 \times 2 = 1 \text{ in}^2 \]

\[ I_{xx} = 0.0833 + 16 \times \left[ \frac{2.125 - 2.059}{2} \right]^2 + 0.333 + 1 \times \left[ \frac{2.059 - 1}{2} \right]^2 = 1.607 \text{ in}^2 \]

\[ S_{x, \text{bot}} = \frac{I_{x}}{C} = \frac{1.607}{2.059} = 0.78 \text{ in}^3 \]

\[ S_{x, \text{top}} = \frac{I_{x}}{C} = \frac{1.607}{0.191} = 8.414 \text{ in}^4 \]

\[ f_b = \frac{63000}{0.78} = 80,769 \text{ psi} > 7.6 \times 36,000 = 21,600 \text{ psi} \]

Add 2 FB $\frac{1}{4} \times 2$ STIFFENERS TO UNDERSIDE OF PC SPANNING IN SAME DIRECTION.

\[ \frac{D}{U} \quad \frac{U}{U_1} \quad \frac{U}{U_2} \]

\[ \frac{I_1 = 0.0833 \text{ in}^4 \quad I_2 = 4 \times \frac{0.25 \times 2^3}{12} = 0.6667 \text{ in}^4 }{A_1 = 16 \text{ in}^2 \quad A_2 = 4 \times 0.25 \times 2 = 2 \text{ in}^2 } \]

\[ \frac{2 \times \frac{\text{Ad}}{A} = \frac{16 \times 2.125 + 2 \times 1}{16 + 2} = 2.00 }{ } \]

\[ I_{xx} = 0.0833 + 16 \times \left[ \frac{2.125 - 2.00}{2} \right]^2 + 0.6667 + 2 \times \left[ \frac{2 - 1}{2} \right]^2 = 3.000 \]

\[ S_{x, \text{bot}} = \frac{3.000}{2.00} = 1.5 \quad S_{x, \text{top}} = \frac{3.000}{2.5} = 1.200 \]
Add 23 x 2 x 3/8 W/LLV at end of plate near support to help reduce local yielding of plate.

\[ f_b = \frac{63,000}{1.50} = 42,000 \text{ psi} > 21,600 \text{ psi} \]

\[ I_0 = 6A \times \frac{2.5}{12} = 0.0833 \text{ in}^4 \]

\[ I_0 = 2 \times \frac{2.5 \times 2}{12} = 0.33 \text{ in}^4 \]

\[ A_0 = 6A \times \frac{1}{4} = 1.6 \text{ in}^2 \]

\[ A_0 = 2 \times (2.5 \times 2) = 1 \text{ in}^2 \]

\[ I_5 = 2 \times 1.53 = 3.06 \text{ in}^4 \]

\[ A_5 = 2 \times 1.73 = 3.46 \text{ in}^2 \]

\[ A_0 = 16 + 1 + 3.46 = 2.87 \text{ in} \]

\[ I_{XX} = 0.0933 + 16(3.125 - 2.87)^2 + 0.333 + 1(2.87 - 2) + 3.06 + 3.46(2.87 + 1.98) \]

\[ I_{XX} = 8.14 \text{ in}^4 \]

\[ S_X = \frac{8.14}{2.87} = 2.83 \text{ in}^3 \text{ bottom of 3 x 2} \]

\[ S_X = \frac{8.14}{1.87} = 4.35 \text{ in}^3 \text{ bottom of FB 1/4 x 2} \]

\[ f_b = \frac{7537.5}{2.83} = 26,634 \text{ psi} \]

\[ V = \frac{V_0}{I} = \frac{480 \times 16(2.125 - 1.873)}{8.133} = 2082 \text{ psi} \]
Assume \( \frac{3}{16}" \) weld using E70XX electrode

\[
70 \times 3 \times \frac{1}{16} = 13\frac{1}{2} \times \frac{1}{16} \text{ or } 3\frac{3}{8} \times \frac{1}{16}
\]

\[
\text{Min } L = 1\frac{1}{2}'' \text{ use } 2'' \text{ long filler welds } @ 8'' \text{ staggered on side}
\]

\[
\text{Effective } 2'' @ 4\%
\]

\[
\text{wt of } 2\times2\times\frac{3}{8} = 5.9 \times \frac{1}{4} \times (3+3+5+5) \times 5.9 = 94.4
\]
REVISE DETAIL 4 DRING YMD - 015 - 1 - 7007 - ST103 - REV 2 AS FOLLOWS:
(BABBA 000 - 0117 - 2100 - 03703 - 02)

SEE DET 1 FOR LOCATION

HOLE DRILL 1/2" Ø HOLE THRU 2 X 3

TRIM 2 ½" TO ALLOW CONTINUOUS
2 X 3 EA SIDE (TYP 4 PLACES)

1/4" ø

1'-4 15/16" 4 TOTAL
2'-4 15/16" 3 TOTAL
2'-11 15/16" 48 TOTAL

3" TYP

ANTI-SKID
COATING

2 1/16"

3/16

2-8

2-8

TYP 5'-0" WIDE TRENCH COVER
FLUOR DANIEL
CALCULATIONS and SKETCHES

TRENCH COVER IN SWITCHGEAR BLDG

BA6000000-01717-0210-00155 REV.00

REVISE DETAIL 5 DWG YMP-025-1-7007-ST103 REV 2 AS FOLLOWS
(BAG8AA000-01717-2100-03703-02)

FABRICATE TO FIT 4'-0" MAXIMUM

1/2" Ø HOLE TYP

1/4" R

ANTI-COATI

2-1/2" TYP

1/4" R

REPLACE EXISTING FB 1/4 X 2
L3 X 2 X 3/8 LLY (5 PIECES REQ'D)

TRIM L3 X 2 AS REQ'D

TYP 3'-0" WIDE TRENCH

FORM E50
INVESTIGATE EXISTING EXPANSION ANCHORS FASTENED W/6 BEAM

SEAT

REF: HILTI, 2000 PAGES 51-67 REF 3

$P_e = 4000 \text{psi}$  BAB000-01717-2100-03701-03

Dwg YAP-025-1-7007-ST101 REV 3 REF

3/4" x 7" LONG, $W = 4\frac{\text{3}}{4}$ EMBED

& 6" SPACING

LOAD ADJUSTMENT FACTOR = 0.78

ANCHOR WORKING LOAD ALLOWABLES

$T = 4800 \#$

$V = 5120 \#$

ALLOWABLE SHEAR /2 BOLTS

$= 2 \times 5120 \times 0.78$

$= 7800 \#$

CHECK TENSION $T = 6700 \times 1.5" \times \frac{1}{1.50"/\text{in}}$

$T = 6700 \#$

2 BOLT TENSION CAPACITY $= 4800 \times 2 \times 0.78$ $= 7500$

CHECK COMBINED LOADS

$\left(\frac{T}{T_a}\right)^{\frac{5}{3}} + \left(\frac{V}{V_a}\right)^{\frac{5}{3}} = \left(\frac{6700}{4800}\right)^{\frac{5}{3}} + \left(\frac{6700}{7500}\right)^{\frac{5}{3}} = 1.57 \text{ NG}$

$> 1.00$
INVESTIGATE "Fixes" THAT WILL STRENGTHEN BEAM SUPPORT

OPTION 1. ADD CLIP ANGLE WELD TO CONTINUOUS ANGLE & BOLT TO W16 BEAM

ASSUME NEW BOLT TAKES ALL TENSION PREVENTING ROTATION ABOUT TOE OF EXISTING SCAFF ANGLE

\[ \text{Moment} = 6700 \times 1.5 = 10050 \text{ lb-ft} \]

\[ \text{Bolt Load} = \frac{10050}{1.5+4} = 1827 \text{ lb} \]

\[ \text{Assume New Bolt Also Takes } \frac{1}{2} \text{ Shear Load} \]

\[ \frac{6700}{2} = 3350 \text{ lb} \]

Resultant on New Bolt = \( \sqrt{1827^2 + 3350^2} \approx 3816 \text{ lb} \)

USE 3/4" A307 BOLT SINGLE SHEAR CAPACITY = 4400 lb TABLE I-D

REF: also steel manual 7th Edition

CHECK 3/8" FIELD WELD

\[ 21000 \times \frac{3}{16} \times 0.707 = 2783 \frac{3}{11} \text{ lb} \]

USE 2" WELD EA SIDE

\[ 4 \times 2783 \frac{3}{11} = 11,132 \text{ lb} \] OK
REMAINING LOAD OF 3350# ON EXISTING BEAM SEAT
WITH NEW BOLT ASSUMING ALL TENSION, EXPANSION
ANCHORS SET ONLY SHEAR

SHEAR CAPACITY OF 2 BOLTS = 8000# > 3350#

FIELD DEVIATION REPORT 96/026 S DATED 11/28/95
REPORTED THAT 23 SEATS WERE PlACED WITH
5½" ANCHORS NOT THE SPECIFIED 7" ANCHORS

ASSUMING MIN. EMBRD OF 3¼” ALLOWABLE WORKING
LOAD FOR ONE 3¼” X 5½” LONG HILTI Kwik Bolt II
IS 4140# [REF HILTI 1996 PAGE 60]

WITH SHEAR ONLY, ONE ANCHOR HAS SUFFICIENT
CAPACITY FOR 3350#

CONCLUSION: ADDING NEW 3½” BOLT TO BEAM W/E BY
TRANSFERRING LOAD TO CONTINUOUS EMBEDDED
ANCHOR WILL ALLOW USE OF EXISTING
BEAM SEATS & THOSE IDENTIFIED WITH
MODIFICATIONS IN FDB 96/026 S
INVESTIGATE "FIXES" THAT WILL STRENGTHEN BEAM SUPPORT

OPTION 2 REPLACE EXISTING 2.3 X 3 SEAT WITH 2.5 X 3 TO INCREASE MOMENT ARM BETWEEN & EXPANSION ANCHORS & COMPRESSION BLOCK.

\[ T = \frac{6700 \times 1.5 \times 1}{[1.5 + 2]} = 2872 \text{ ft} \]

CHECK COMBINED LOADS

\[ \left( \frac{6700}{8000} \right) + \left( \frac{2872}{7500} \right)^{\frac{5}{3}} = 0.95 < 1.0 \]

OK

REMOVABLE REPLACING EXISTING 2.3 X 3 WITH 2.5 X 3 X 3/8 X 0.8" LLW CHECK COMBINED LOAD

CONCLUSION: REMOVING & REPLACING EXISTING SEAT 2.3 X 3 WITH 2.5 X 3 X 3/8 WILL REDUCE TENSION IN EXPANSION ANCHORS. UNDER THE COMBINED LOAD THE SUPPORT WILL WORK. HOWEVER, THE IDENTIFIED SEATS IN FDR 96/0265S WILL REQUIRE ADDITIONAL STRENGTHENING ON A CASE BY CASE BASIS DEPENDING UPON INSPECTION AS BUILDING EACH MODIFIED SUPPORT.