OFFICE OF CIVILIAN RADIOACTIVE WASTE MANAGEMENT

CALCULATION COVER SHEET

1. QA: N/A ^{MSR} 9/19/00 ^{MSR}
 Page: 1 Of: 43 ^{MSR}

2. Calculation Title

Strengthening of Trench Cover Plates for Switchgear Building

MOL.20001011.0002

3. Document Identifier (including Revision Number)

BAB000000-01717-0210-00155 Rev 00

4. Total Attachments

1

5. Attachment Numbers – Number of pages in each

1-10

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9. Remarks

Editorial correction to title on 9/25/00 MSR

Revision History

10. Revision No.	11. Description of Revision

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 ¾" 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

1. AISC (American Institute of Steel Construction) 1989. *Manual of Steel Construction, Allowable Stress Design*. 9th Edition. Chicago, Illinois: American Institute of Steel Construction. TIC: 205770.
2. Elowson, J. 2000. "Wheel Load." E-mail from J. Elowson (NHMH) to M. Ruben, June 7, 2000, with attachment. ACC: MOL.20000628.0427.
3. Hilti. 1999. Hilti Product Technical Guide/2000. 59-71. Tulsa, Oklahoma: Hilti, Inc. TIC: 248425.

4. YMP (Yucca Mountain Site Characterization Project) 1994a. *Exploratory Studies Facility, Package 1A Electrical Switchgear Bldg 5010, FDN Sections & Details*. YMP-025-1-7007-ST103 Rev. 2. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.19950626.0208.

5. YMP 1994b. *Exploratory Studies Facility, Package 1A Electrical Switchgear Bldg 5010, Floor Slab & FDN Plan*. YMP-025-1-7007-ST101 Rev. 3. Las Vegas, Nevada: Yucca Mountain Site Characterization Office. ACC: MOL.19950626.0206.

6. CRWMS M&O 1995. *Add Standard Detail 9, Optional Removable Floor Beam*. BCP-02-95-0171. Las Vegas, Nevada: CRWMS-M&O. ACC: MOL.19960513.0344.

8. Attachments

Attachment I Calculations

ATTACHMENT I

Calculations

TRENCH COVER IN SWITCHGEAR BLDG

BAB000000-01717-0210-00155 REV 00

INVESTIGATE EXISTING SWITCHGEAR BLDG FLOOR PLATE

BAB000000-01717-2100
- 03703-01

REF 4.]

Assume $F_y = 36 \text{ ksi}$ (ASTM A36)

FROM J.F. ELOWSON, LAS VEGAS CLARK FORKLIFT REPRESENTATIVE
A CLARK CGP 30 FORKLIFT W/ 3 TON CAPACITY
WILL HAVE A MAXIMUM FRONT WHEEL LOAD
OF 6700 # [ELOWSON, JOHN 2000, REF 2]

ASSUME IMPACT FACTOR OF 1.25 & ASSUME CONCENTRATED LOAD

$$1.25 \times 6700 = 8375 \text{ \#}$$

$$M_c = \frac{PL}{4} = \frac{8375 \times 36}{4}$$

$$M_c = 75375 \text{ \#}$$

$$\frac{\sum Ad}{A} = \frac{1/4 \times 64 \times 2.125 + 1 \times 1}{16 \times 1}$$

$$\bar{x} = 2.059$$

TRENCH COVER IN SWITCHGEAR PLDG

BAB000000-01717-0210-00155 REV 00

$$I_{\text{①}} = \frac{64 * 0.25^3}{12} = 0.0833 \text{ in}^4 \quad A_{\text{①}} = 64 * \frac{1}{4} = 16 \text{ in}^2$$

$$I_{\text{②}} = \frac{0.25 * 2^3}{12} * 2 = 0.333 \text{ in}^4 \quad A_{\text{②}} = 2 * .25 * 2 = 1 \text{ in}^2$$

$$I_{xx} = 0.0833 + 16 * [2.125 - 2.059]^2 + 0.333 + 1 * [2.059 - 1]^2 = 1.607 \text{ in}^4$$

$$S_{x \text{ Bot}} = \frac{I}{c} = \frac{1.607}{2.059} = 0.78 \text{ in}^3$$

$$S_{x \text{ Top}} = \frac{I}{c} = \frac{1.607}{0.191} = 8.414 \text{ in}^3$$

$$f_b = \frac{63000}{0.78} = 80,769 \text{ psi} > 0.6 * 36,000 = 21,600 \text{ psi}$$

Add 2 FB 1/4 x 2 STIFFENERS TO UNDERSIDE OF TC SPANNING IN SAME DIRECTION

$$I_{\text{①}} = 0.0833 \text{ in}^4$$

$$A_{\text{①}} = 16 \text{ in}^2$$

$$I_{\text{②}} = 4 * \frac{0.25 * 2^3}{12} = 0.6667 \text{ in}^4$$

$$A_{\text{②}} = 4 * .25 * 2 = 2 \text{ in}^2$$

$$\frac{\sum A d}{A} = \frac{16 * 2.125 + 2 * 1}{16 + 2} = 2.00$$

$$I_{xx} = 0.0833 + 16 * [2.125 - 2.00]^2 + 0.6667 + 2 * [2 - 1]^2 = 3.000$$

$$S_{x \text{ Bot}} = \frac{3.000}{2.00} = 1.5$$

$$S_{x \text{ Top}} = \frac{3.00}{.25} = 12.00$$

TRENCH COVER IN SWITCHGEAR BLDG

BAB000000-01717-0210-00155 REV 00

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

Add L3x2x3/8 w/ LLV AT END OF PLATE NEAR SUPPORT TO HELP REDUCE LOCAL YIELDING OF PLATE

$$I_{(1)} = \frac{64 \times .25^3}{12} = 0.0883 \text{ in}^4$$

$$I_{(2)} = 2 \times \frac{.25 \times 2^3}{12} = 0.333 \text{ in}^4$$

$$A_{(1)} = 64 \times 1/4 = 16 \text{ in}^2$$

$$A_2 = 2 \times .25 \times 2 = 1 \text{ in}^2$$

$$I_{(3)} = 2 \times 1.53 = 3.06 \text{ in}^4$$

$$A_{(3)} = 2 \times 1.73 = 3.46 \text{ in}^2$$

[AISC 1989-P1-50 REF 1]

$$\bar{X} = \frac{\sum Ad}{A} = \frac{(16 \times 3.125) + (1 \times 2) + 3.46 \times 1.96}{16 + 1 + 3.46} = 2.87 \text{ in}$$

$$I_{xx} = 0.0833 + 16(3.125 - 2.87)^2 + 0.333 + 1(2.87 - 2)^2 + 3.06 + 3.46(2.87 - 1.96)^2$$

$$I_{xx} = 8.14 \text{ in}^4$$

$$S_x = \frac{8.14}{2.87} = 2.83 \text{ in}^3 \text{ BOTTOM OF L3x2}$$

$$S_x = \frac{8.14}{1.87} = 4.35 \text{ in}^3 \text{ BOTTOM OF FB 1/4 x 2}$$

$$f_b = \frac{75375}{2.83} = 26,634 \text{ psi}$$

STRENGTHEN PLATE w/ L2x3x3/8

SAY OK w/ CONSERVATIVE AROUND PERIMETER LOAD ASSUMPTIONS

$$V = \frac{VQ}{I} = \frac{4200 \times 16 \times (2.125 - 1.873)}{8.133} = 2082 \text{ #/in}$$

TRENCH COVER IN SWITCHGEAR BLDG

BAB000000-01717-0210-00155 REV 00

Assume $\frac{3}{16}$ " WELD USING E70XX ELECTRODE

$$70 \times .3 \times \frac{1}{16} = 1312 \#/\text{in}/\frac{1}{16} \quad \text{OR} \quad 3936 \#/\text{in}/\frac{1}{16}$$

MIN L = $1\frac{1}{2}$ " USE 2" LONG FILLET WELDS @ 8" STAGGERED FA SIDE

EFFECTIVE $2 @ 4\%$

$$7872 \# @ 4\%$$

$$1968 \#/\text{in} \approx 2082 \#$$

WT OF $L3 \times 2 \times \frac{3}{8}$ 5.9 #/ft $(3+3+5+5) \times 5.9 = 94.4 \#$

TRENCH COVER IN SWITCHGEAR BLDG

BAB000000-01717-0210-00155 REV 00

REVISE DETAIL ④ DWG YMP-025-1-7007-ST103 REV 2 AS FOLLOWS:
(BABBA000-01717-2100-03703-02)

TYP 5'-0" WIDE TRENCH COVER

TRENCH COVER IN SWITCHGEAR BLDG

BAB000000-01717-0210-0065 REV 00

REVISE DETAIL ⑤ DWG YHP-025-1-7007-ST103 REV 2 AS FOLLOWS
(BABBA000-01717-2100-03703-02)

TYP 3'-0" WIDE TRENCH

TRENCH COVER IN SWITCHGEAR BLDG

BAB000000-01717-0210-00155 REV 00

INVESTIGATE EXISTING EXPANSION ANCHORS FASTENING W6 BEAM SEAT

REF: HILTI, 2000 PAGES 51-67 REF 3

$f'_c = 4000 \text{ psi}$ BABBA000-01717-2100-03701-03

DWG YMP-025-1-7007-ST101 REV 3 REF

$3/4" \phi \times 7" \text{ LONG w/ } 4 3/4" \text{ EMBED}$
 $\Sigma 6" \text{ SPACING}$

FOR ADDITIONAL
DETAILS SEE DETAIL 7

LOAD ADJUSTMENT FACTOR = 0.78

ANCHOR WORKING LOAD ALLOWABLES

$$T = 4800 \#$$

$$V = 5120 \#$$

ALLOW SHEAR / 2 BOLTS

$$= 2 \times 5120 \times 0.78$$

$$= 8000 \#$$

REMOVABLE BEAM TRENCH COVER R SECTION

STANDARD DETAIL
NOT TO SCALE

REF: GE 101 S-SK-011 BCP-02-95-0171

REF 6

CHECK TENSION $T = 6700 \times 1.5" \times \frac{1}{1.50"}$ MOMENT ARM BETWEEN TENSION &

$$T = 6700 \#$$

COMPRESSION RESISTING COUPLE

$$2 \text{ BOLT TENSION CAPACITY} = 4800 \times 2 \times 0.78 = 7500$$

CHECK COMBINED LOADS $\left(\frac{T}{T_A}\right)^{5/3} + \left(\frac{V}{V_A}\right)^{5/3} = \left(\frac{6700}{8000}\right)^{5/3} + \left(\frac{6700}{7500}\right)^{5/3} = 1.57 \text{ NG}$
 > 1.00

TRENCH COVER IN SWITCHGEAR BLDG

BAB 000 000-01717-0210-00155 REV 00

INVESTIGATE "FIXES" THAT WILL STRENGTHEN BEAM SUPPORT

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

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

$$\text{MOMENT} = 6700 \times 1.5 = 10050 \text{ \#}$$

$$\text{BOLT LOAD} = \frac{10050}{(1.5 + 4)} = 1827 \text{ \#}$$

REMOVABLE BEAM TRENCH COVER R SECTION

ASSUME NEW BOLT ALSO TAKES $\frac{1}{2}$ SHEAR LOAD $\frac{6700}{2} = 3350 \text{ \#}$

$$\text{RESULTANT ON NEW BOLT} = \sqrt{1827^2 + 3350^2} = 3816 \text{ \#}$$

USE $\frac{3}{4}$ " ϕ A 307 BOLT SINGLE SHEAR CAPACITY = 4400 $\text{\#}$ TABLE I-D
REF: AISC STEEL MANUAL 7TH EDITION

CHECK $\frac{3}{16}$ " FIELD WELD

$$21000 \times \frac{3}{16} \times 0.707 = 2783 \text{ \#/11}$$

USE 2" WELD EA SIDE

$$4 \times 2783 \text{ \#/11} = 11,132 \text{ \# OK}$$

TRENCH COVER IN SWITCHGEAR BLDG

BA8000000-01717-0210-00155 REV 00

REMAINING LOAD OF 3350# ON EXISTING BEAM SEAT
WITH NEW BOLT ASSUMING ALL TENSION, EXPANSION
ANCHORS SEE 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
5 1/2" ANCHORS NOT THE SPECIFIED 7" ANCHORS

ASSUMING MIN. EMBED OF 3 1/4" ALLOWABLE WORKING
LOAD FOR ONE 3/4" ϕ X 5 1/2" LONG HILTI KWIK BOLT II
IS 4140# [REF HILTI 1996 PAGE 61]

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

CONCLUSION: ADDING NEW 3/4" ϕ BOLT TO BEAM WED &
TRANSFERRING LOAD TO CONTINUOUS EMBEDDED
ANGLE WILL ALLOW USE OF EXISTING
BEAM SEATS & THOSE IDENTIFIED WITH
MODIFICATIONS IN FDR 96/026 S

TRENCH COVER IN SWITCHGEAR BLDG

BAB 000 000 - 01717 - 0210 - 00155 REV 00

INVESTIGATE "FIXES" THAT WILL STRENGTHEN BEAM SUPPORT

OPTION 2 REPLACE EXISTING L3x3 SEAT WITH L5x3 TO INCREASE MOMENT ARM BETWEEN EXPANSION ANCHORS & COMPRESSION BLOCK.

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

CHECK COMBINED LOADS

$$\left(\frac{6700}{8000} \right)^{5/3} + \left(\frac{2872}{7500} \right)^{5/3} = 0.95 < 1.0 \text{ OK}$$

REMOVE & REPLACE EXISTING L3x3 w/ L5x3x3/8 x 0'-8" LVL

CONCLUSION: REMOVING & REPLACING EXISTING SEAT L3x3 WITH L5x3x3/8 WILL REDUCE TENSION IN EXPANSION ANCHORS. UNDER THE COMBINED LOAD

THE SUPPORT WILL WORK.

HOWEVER, THE IDENTIFIED SEATS IN FDR 96/0265 WILL REQUIRE ADDITIONAL STRENGTHENING ON A CASE BY CASE BASIS DEPENDING UPON INSPECTION & AS BUILDING EACH MODIFIED SUPPORT