Fermilab

Particle Physics Division

Mechanical Department Engineering Note

Number: MD-ENG-502 Date: 11/5/2013

Project: MicroBooNE

Project Internal Reference:

Title: MicroBooNE Feedthrough platform addition

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Reviewer(s):

Key Words:

Abstract/Summary:
This note documents the calculations for the splice joints and I-beam to span across a gap left by the contractor in the MicroBooNE feedthrough platform. Without this change there is one feedthrough in the middle of the cryostat that is completely unreachable.

Applicable Codes:

AISC Manual of Steel Construction, ninth edition.

Intermediate Deck lower extension
Jim Kilmer
11/1/2013

The MicroBooNE experiment has an Intermediate deck placed over the top of the cryostat which supports the condensers, main cryostat relief valves and the readout racks. The feedthrough ports on the cryostat are accessed by a small hanging platform underneath the intermediate deck. To get to this lower platform decking sections are removed. At the center of this lower deck the manufacturer did not complete the center part as requested. Hence there is one feedthrough port that can't be reached. This note describes the modfications to the lower platform to allow access to the middle feedthrough. Below is a picture of the area in question.

The small gap on the far side of the platform makes room for the support column. On the near side the 35.25 inch gap is where an additional I-beam needs to be mounted so the deck grating can be installed. See drawing 3974.110-MD-497254 attached. First calculate the total load assuming 150 lb/ft^2.

$$P := 3 \cdot ft \cdot 3 \cdot ft \cdot 150 \frac{lb}{ft^2}$$

$$psi := \frac{lb}{in^2}$$

$P = 1.35 \times 10^3 \cdot lb$ Use 1500 lb to account for grating

The existing I-beams in the picture are W12 by 40 I-beams with the following properties:

$bf := 8.005in$ $tw := 0.295in$ $tf := 0.515$

$d := 11.94in$ $T := 9.5in$

The bridging I-beam is a W8 by 31 I-beam with the following properties:

$bf := 7.995in$ $tw := 0.285 \cdot in$ $tf := 0.435 \cdot in$

$d := 8.00 \cdot in$ $T := 6.125 \cdot in$

Use a 6"wide by 1/2" thick bar to make connecting joints for the I-beam ot I-beam connection. Make the connectors 10" long and weld the two of them to the W8 by 31 section on both ends. Use 1/4" welds on the three sides as shown in the print

$L := 5 \cdot in + 5 \cdot in + 6 \cdot in = 16 \cdot in$ Length of weld

$t := 0.25 \cdot in \cdot .707 = 0.177 \cdot in$ Throat of weld

$Aw := L \cdot t = 2.828 \cdot in^2$ Area of weld using E70 welding rod

$$fshear := \frac{P}{Aw} = 477.369 \cdot psi$$

$Fshear := 70000 \cdot psi \cdot 0.3 = 2.1 \times 10^4 \cdot psi$ From Table J2.5, pg 5-70 for fillet welds

Weld strength is OK

The bar must take the load in shear as well.

$A := 0.5 \cdot in \cdot 6 \cdot in = 3 \cdot in^2$

$$fshearbar := \frac{P}{A} = 450 \cdot psi$$

Since the bar is of unknown origin use a very low Fy of 20000 psi.

$Fshearbar := 20000 \cdot psi \cdot 0.4 = 8 \times 10^3 \cdot psi$

This bar is OK for the load in shear.

The bolts on each connecting bar are 3/4 - 10 UNC. Per Section J3 page 5-75 of the AISC code the spacing of the holes is 2.5 inches or greater than three times the diameter of the bolts. Also for the 3/4" bolts the edge distance is 1.75" minimum which is greater than the minimum requried in Table J3.5 on page 5-76 of 1.25".

$$Abearing := .5\cdot in \cdot .75\cdot in = 0.375\cdot in^2$$

Assume that only one of the two bolts suports the entire load

$$fbearing := \frac{P}{Abearing} = 3.6 \times 10^3 \cdot psi$$

Since we don't know the origin of the steel in the bar and have decided to call it an Fy of 20 Ksi use that and the properties of A36 steel to find and ultimate stress Fu of the bar.

$$Fu := \frac{20000\cdot psi}{36000\cdot psi} \cdot 58000\cdot psi = 3.222 \times 10^4 \cdot psi$$

$$Fbearing := 1.2Fu = 3.867 \times 10^4 \cdot psi$$

Since fbearing is << than Fbearing this stress is OK.

The W10 by 40 I-beam is known to be A36 steel with a minimum Fu of 58 KSI and a web that is thinner than the splice plate.

$$Abear := 0.350\cdot in \cdot .75\cdot in = 0.262\cdot in^2$$

$$fbear := \frac{P}{Abear} = 5.143 \times 10^3 \cdot psi$$

$$Fbear := 1.2\cdot 58000\cdot psi = 6.96 \times 10^4 \cdot psi$$

Since fbear is << than Fbear the I-beam web is OK in bearing.

The bolts to be used on the splices are 2.5" long 3/4" -10 UNC Grade 8 bolts which are much better than A325 structural bolts. Use Table 1-D page 4-5 for the shear allowed on a bolt. The bolts are threaded all the way so for an A325 bolt with a bearing connection and shear plane through the threads an allowable load of 9.3 KIPS is given for a single bolt. The platform total load supported by the four bolts is only 1500 pounds. The bolts are more than adequate for this load.

The connection plates must handle the shear in a plane through the center of the bolt holes.

$Width := 6in - 2 \cdot 0.875 \cdot in = 4.25\,in$

$T := .5in$

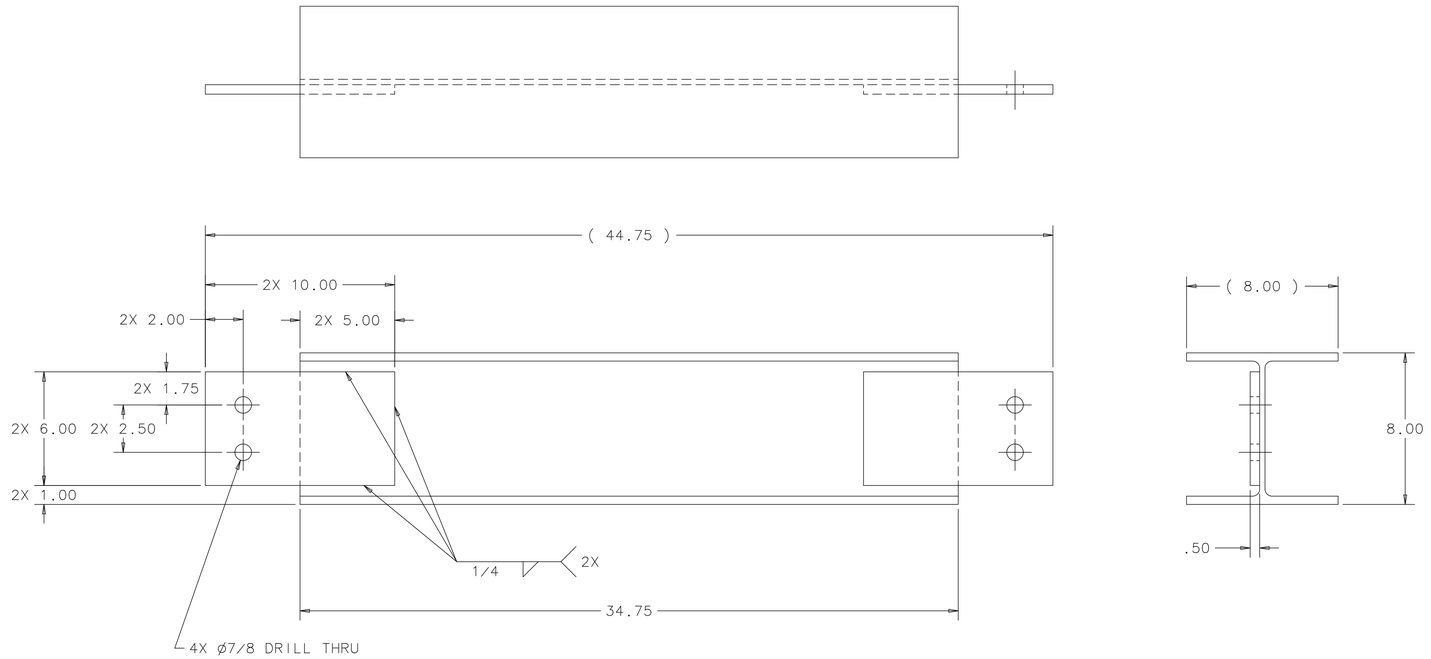
$A := Width \cdot T = 2.125\,in^2$

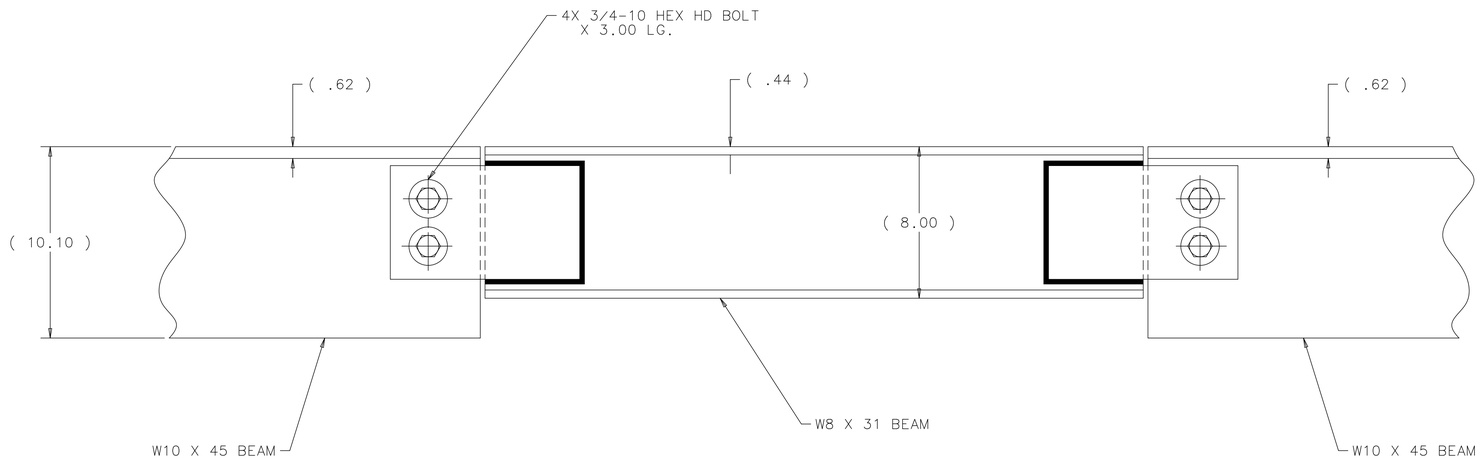
$\sigma shear := \frac{P}{A} = 635.294\,psi$ The shear stress in the reduced area of the plate from the bolt holes

This is well below the allowable stress calculated above as 8000 psi for this unkown steel bar.

This I-beam added to support a small 3 foot by 3 foot section of grating is adequate for the loading.

REV	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE





INSTALLATION LAYOUT

UNLESS OTHERWISE SPECIFIED			ORIGINATOR	J.KILMER	04-NOV-2013
.XX	.XXX	ANGLES	DRAWN	G.SMITH	04-NOV-2013
± .06	± ---	± ---	CHECKED	G.SMITH	04-NOV-2013
			APPROVED	J.KILMER	04-NOV-2013

1. BREAK ALL SHARP EDGES .015 MAX.
2. DO NOT SCALE DRAWING.
3. DIMENSIONS BASED UPON ASME Y14.5M-1994
4. MAX. ALL MACH. SURFACES
5. DRAWING UNITS: U.S. INCH

USED ON

MATERIAL
W8 X 31 STEEL BEAM &
1/2" X 6.00 X 10.00 SREEL PLATE

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

E974-MICROBOONE - INFRASTRUCTURE DECK SUPPORT WELDMENT

SCALE	DRAWING NUMBER	SHEET	REV
1:4	3974.110-MD-497254	1 OF 1	

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