Fermilab

Revision 1.0

1/21/1999

Particle Physics Division

Engineering and Technical Teams

Mechanical Support Engineering Note

Number: MD-ENG-03-010

Date: 5/20/03

Project: E907

Project Internal Reference:

Title: EMCAL SUPPORT CART

Author(s): JIM KILMER

Reviewer(s): [signature]

Key Words:

Abstract/Summary:

THIS NOTE DOCUMENTS CALCULATIONS FOR THE EMCAL BASE SUPPORT CART. NOTE THAT IT DOES NOT COVER THE FRAME BOLTED TO IT AT ALL. THE UPPER FRAME IS BEING DESIGNED AND FABRICATED BY THE UNIVERSITY OF MICHIGAN.

Applicable Codes:

AISC MANUAL OF STEEL CONSTRUCTION 9th EDITION

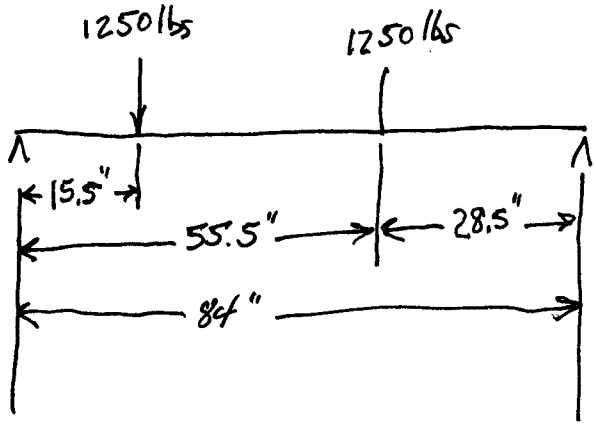
FERMILAB ENGINEERING NOTE	SECTION	PROJECT	SERIAL-CATEGORY	PAGE
				1

SUBJECT	NAME	
DESIGN OF EMCAL CART FOR E-907	DATE	REVISION DATE

LOAD IS 4500 lbs ESTIMATED. USE 5000 FOR CART DESIGN

ASSUME 1" PLATE CONTRIBUTES NOTHING FOR BENDING.

OUTER RAILS 5"x5"x 3/8" STRUCTURAL TUBING $A = 6.58 in^2$, $S = 9.11 in^3$



USE CASE 10 OF AISC MANUAL pg 2-299

$P = 1250 lbs$ $\ell = 84 in$ $a = 15.5 in$ $b = 28.5 in$

$$R_1 = \frac{P}{\ell}(\ell - a + b) = \frac{1250 lbs}{84 in}(84 in - 15.5 in + 28.5 in) = 1443.45 lbs$$

$$R_2 = \frac{P}{\ell}(\ell - b + a) = \frac{(1250 lbs)}{84 in}(84 in - 28.5 in + 15.5 in) = 1056.55 lbs$$

CHECK $R_1 + R_2 = 1443.45 + 1056.55 = 2500 lbs = 2P \Rightarrow$ CHECK OK!

$$M_1 = R_1 a = (1443.45 lbs)(15.5 in) = 2.24 \times 10^4 \text{ lb-in}$$

$$M_2 = R_2 b = (1056.55 lbs)(28.5 in) = 3.01 \times 10^4 \text{ lb-in}$$

$$\text{MAX } \sigma = \frac{M_2}{S} = \frac{3.01 \times 10^4 \text{ lb-in}}{9.11} = 3300 PSI$$

$\Rightarrow$ BENDING OF RAILS FINE.

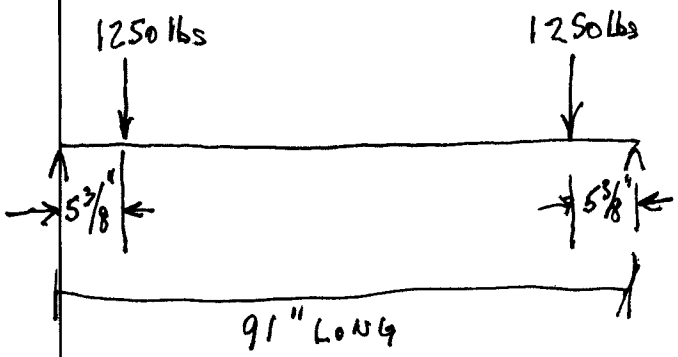
NOTE THAT 5" X 5" X 3/16" SQUARE TUBING HAS $S = 5.36 in^3$

FOR THAT $MAX\ \sigma = \frac{M_z}{S} = \frac{3.01 \times 10^4\ lb\text{-}in}{5.36 in^3} = 5615\ psi$

FOR BENDING USE 1/3 OF F_y = 46KSI/3 = 15,333 PSI

THEREFORE WE CAN USE EITHER 3/8 OR 3/16 WALL. WE HAVE BOTH IN THE STOCK PILE & WILL USE ~~THE~~ THE 3/8" WALL FIRST UNTILE IT RUNS OUT.

NOW LOOK AT CROSS BEAMS



$P = 1250\ lbs$
$l = 91"$
$a = 5\ 3/8"$

USE CASE 9 OF AISC MANUAL Pg 2-298

$M_{MAX} = Pa = (1250\ lbs)(5.375\ in)$

$= 6718\ lb\text{-}in$

FOR CROSS PIECES USE 5" X 5" X 3/16" SQUARE TUBE

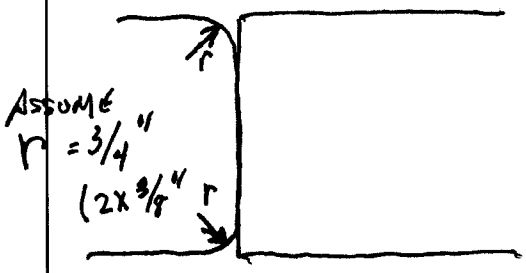
THEN $MAX\ \sigma = \frac{M}{S} = \frac{6718\ lb\ in}{5.36 in^3}$

$= 1253\ PSI$

THIS IS AN ACCEPABLE BENDING STRESS.

CHECK CONNECTION WELDS ON THE BEAMS.
FOR THIS USE THE FOLLOWING

WELDS ARE 1/4" FILLET WELDS AT CORNERS



THEN

$$t = \frac{.25\,in}{\sqrt{2}} = .177\,in$$

$$l = 5\,in - 1.5\,in = 3.5\,in$$

$$A_{WELD} = 2 \times .177\,in \times 3.5\,in = 1.237$$

FROM PREVIOUS CALCULATION CASE 9

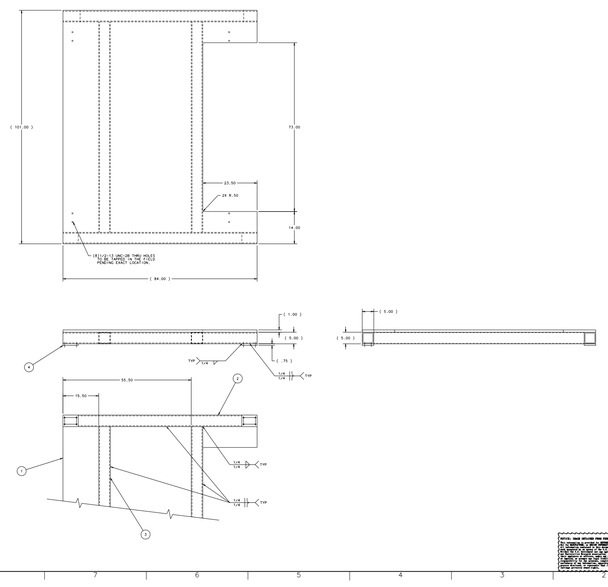
SHEAR $V = P = 1250\,lbs$

THEN WELD SHEAR $\sigma = \frac{V}{A} = \frac{1250\,lbs}{1.237\,in^2} \simeq 1000\,PSI$

∴ THIS SHEAR STRESS IS FINE USING EITHER E60 OR E70 ROD

WELDS HOLDING THE 1" PLATE IN PLACE DO NOT SEE TENSILE OR SHEAR FORCES.

REV.	DESCRIPTION	DRAWN / APPROVED	DATE / DATE



4	MD-421156	CASTER MOUNTING PLATE	A
3	CONC.	PIPE STRUCTURAL STEEL TUBING 8 X 8 X 5/8 WALL X 51.00 LG	2
2	CONC.	PIPE STRUCTURAL STEEL TUBING 8 X 8 X 5/8 WALL X 56.00 LG	2
1	CONC.	PLATE STRUCTURAL STEEL 4 X 8 X 1/2 LG	1
ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES			
DRAWN	J.LAMER		27-MAY-2021
CHECKED	M.TRUE		27-MAY-2021
APPROVED	J.LAMER		27-MAY-2021
MATERIAL	SEE PARTS LIST ABOVE		
FINISH			
DO NOT SCALE DRAWING			
DO NOT REMOVE THIS BORDER			

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

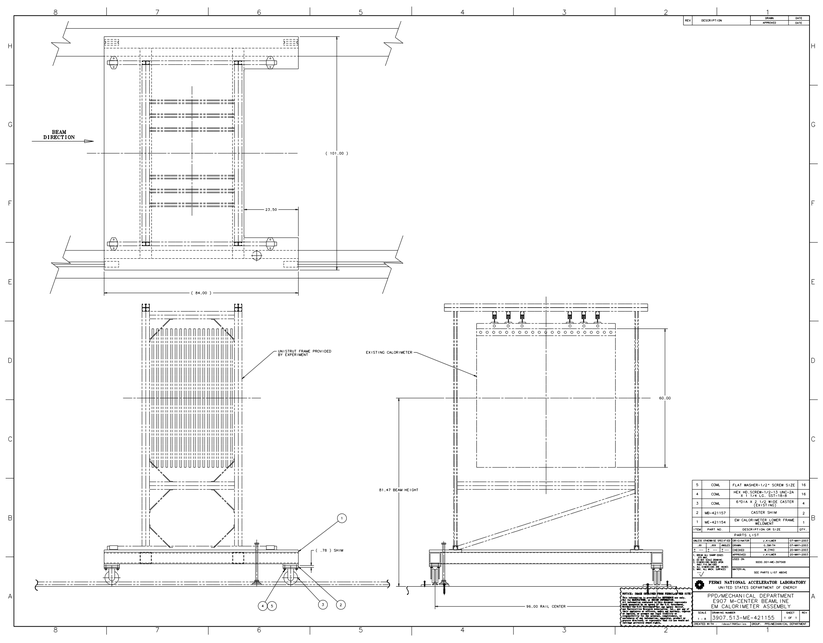
PPD/MECHANICAL DEPARTMENT
MINOS NEAR DETECTOR SEAM
EM CALORIMETER-DASE WELDMENT

SIZE	CONTROL NUMBER	SHEET	REV
D	13907.513-ME-421154	1 OF 1	-

PROJECT NO. | DRAWING NO. 13907 | MECHANICAL TECHNOLOGY

NOTICE: THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF FERMI NATIONAL ACCELERATOR LABORATORY (FERMILAB) AND SUBMITTED FOR YOUR EXCLUSIVE USE IN CONNECTION WITH THE PROJECT OR SERVICE SPECIFIED THEREIN. THEY ARE TO BE RETURNED TO FERMILAB UPON REQUEST. THEY MAY NOT BE REPRODUCED OR DISTRIBUTED TO OTHERS WITHOUT WRITTEN PERMISSION FROM FERMILAB. ALL RIGHTS IN PATENTS, COPYRIGHTS, TRADE SECRETS, OR OTHER INTELLECTUAL PROPERTY RIGHTS ARE RESERVED BY FERMILAB.

REV.	DESCRIPTION	DRAWN / APPROVED	DATE / DATE



5	CONL	FLAT WASHER-1/2" SCREW SIZE	16
4	CONL	HEX HD SCREW-1/2-13 UNC-2A X 1.25 LG PTL	16
3	CONL	STEEL 4" X 2.00 WIDE CASTER (5X10-PAT)	4
2	ME-421157	CASTER SHIM	2
1	ME-421154	EM CALORIMETER LOWER FRAME ASSY	1
ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.

PARTS LIST

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES			
TOLERANCES ON DECIMALS ± .01 ANGLES ± 1°	DRAWN	J.LUCAS	27-MAY-2003
	CHECKED	R.TWIST	27-MAY-2003
	APPROVED	J.LUCAS	27-MAY-2003
	MATERIAL	SEE PARTS LIST ABOVE	
	FINISH		
	DO NOT SCALE DRAWING		
	NEXT ASSY		
	USED ON	SEE PARTS LIST ABOVE	

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

PROJ-MECHANICAL DEPARTMENT
MINOS NEAR DETECTOR
EM-CALORIMETER ASSEMBLY

SIZE	DRAWING NUMBER	REV
D	3597-513-ME-421155	0

SCALE: 1:20 SHEET 1 OF 1

PROPRIETARY INFORMATION: THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION OF FERMI NATIONAL ACCELERATOR LABORATORY. THIS INFORMATION IS PROVIDED TO YOU FOR YOUR USE ONLY. YOU MAY NOT DISTRIBUTE, DISCLOSE OR USE THIS INFORMATION FOR ANY PURPOSE OTHER THAN THE PURPOSE FOR WHICH IT IS PROVIDED. IF YOU DO NOT AGREE TO THESE TERMS, YOU MUST RETURN THIS DOCUMENT TO FERMI NATIONAL ACCELERATOR LABORATORY.