



Particle Physics Division

Mechanical Department Engineering Note

Number: MD-ENG-494

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Project: MicroBooNE

Project Internal Reference:

Title: MicroBooNE Relay Rack Lifting Fixture

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Key Words: MicroBooNE Relay Rack Lifting Fixture

Abstract/Summary:

This Below-the Hook lifting device will be used to position relay racks for the MicroBooNE experiment. Each rack will be assembled in one of these lifting fixtures that will remain with the rack until decommissioning. These calculations, along with the included load test, prove that this device meets or exceeds the requirements of the cited codes and can safely carry the intended loads.

The load test was performed at Lab F with a test load of 1000 pounds. This test load is 1.25 times the fixture design load of 800 pounds. The load was left in place for 15 minutes and no visible deformation or cracking was noted either during or after the test.

Applicable Codes:

Manual of Steel Construction, ASD, Ninth Edition, American Institute of Steel Construction, Inc. 1989

Design of Below-the-Hook Lifting Devices, ASME BTH -1-2005, American Society of Mechanical Engineers, 2006

RELAY RACK LOAD = 800#

LIFTING FIXTURE LOAD:

2 x 2 x 1/4" ANGLES

$$2(36)(3.19/12) = 19.1\#$$

$$2(24)(3.19/12) = 12.8\#$$

$$\underline{31.9\#}$$

31.9

2 x 1/4" BAR

$$2(2 \times 0.25)(20)(490/1728) = 5.67\#$$

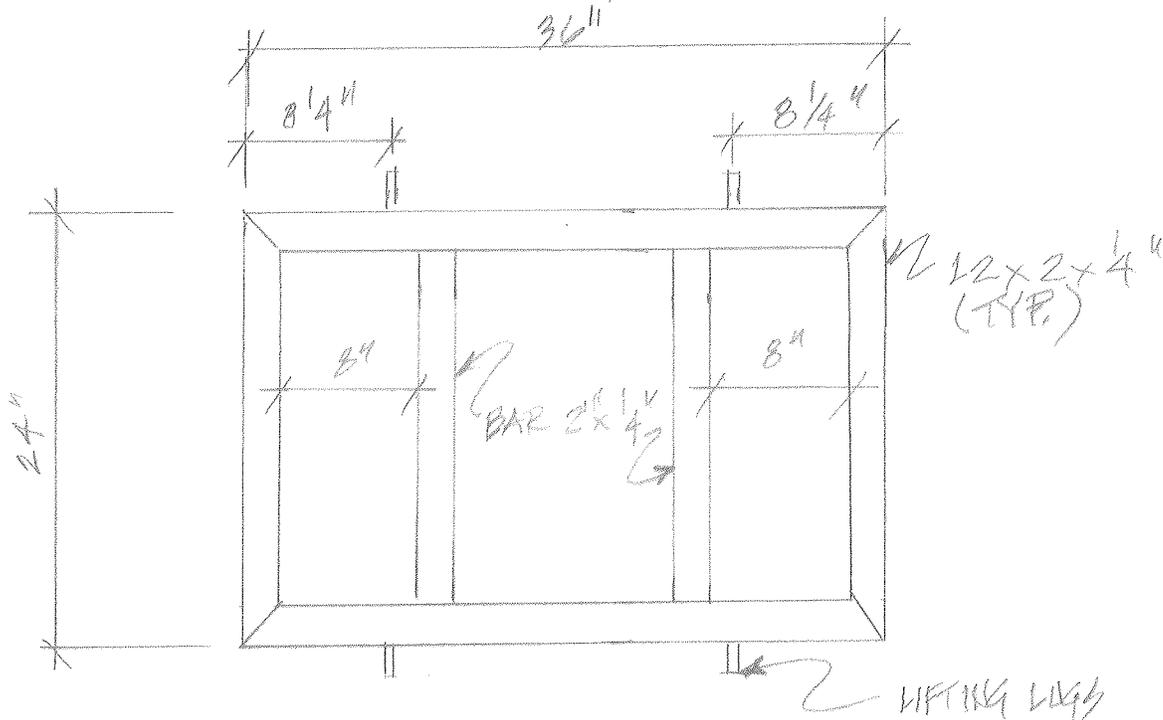
$$\text{WGS } 4(2 \times 4 \times 0.5)(490/1728) = \underline{4.54\#}$$

$$10.2$$

$$\frac{10.2}{42.11\#}$$

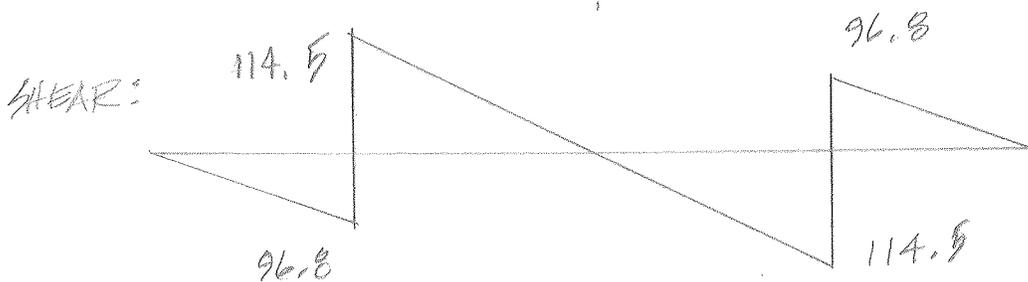
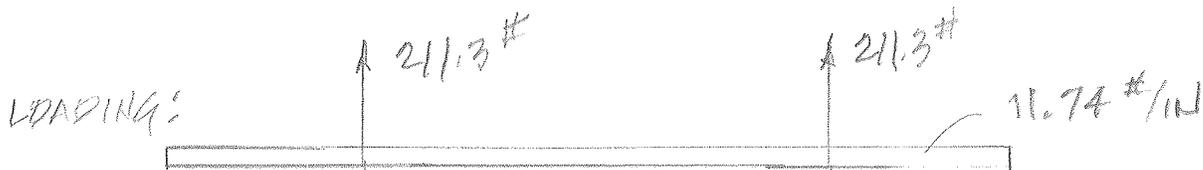
SAY 45# TOTAL

$$\text{LOAD @ EA. WLG} = (800 + 45) / 4 = 211.3\#$$



TOP VIEW

LONG SIDE BEAMS:



L2x2x1/4 PROPERTIES:
AREA = 0.932 in²
S = 0.247 in³

$$M_{MAX} = 96.8 (8.25) / 2 = 399.3 \text{ FT-IN}$$

$$f_b = M/S = 399.3 / 0.247 = 1617 \text{ PSI}$$

SINCE THIS IS BELOW THE HOOK LIFTING DEVICE,
 $F_b = F_y / 3 = 36 / 3 = 12 \text{ KSI} = 12,000 \text{ PSI}$

$$12,000 \text{ PSI} > 1617 \text{ PSI}, \text{ BENDING OK}$$

APPROX TOTAL LOAD TRANSFERRED TO ANGLES BY 2"x1/4" BARS:

$$A_{BAR} = 2(0.25) = 0.5 \text{ IN}^2 \quad \text{SHEAR} = 211.3 / 0.5 = 422.6 \text{ PSI}$$

$$422.6 \text{ PSI} < 12,000 \text{ PSI}, \text{ SHEAR OK}$$

WELDS FOR EACH LIFTING LEG:

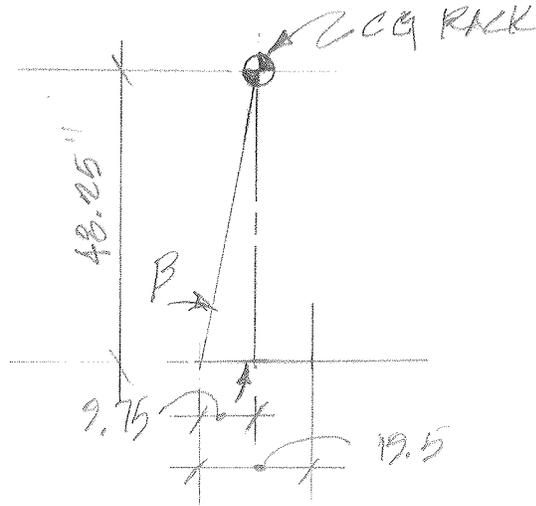
$$\text{ALLOW. LOAD FOR 2" OF 3/16" WELD} = 2(0.3)(3/16)(1707)(70) = 5.6 \text{ K} = 5,600 \text{ \#}$$

EACH BAR WELDED BOTH SIDES

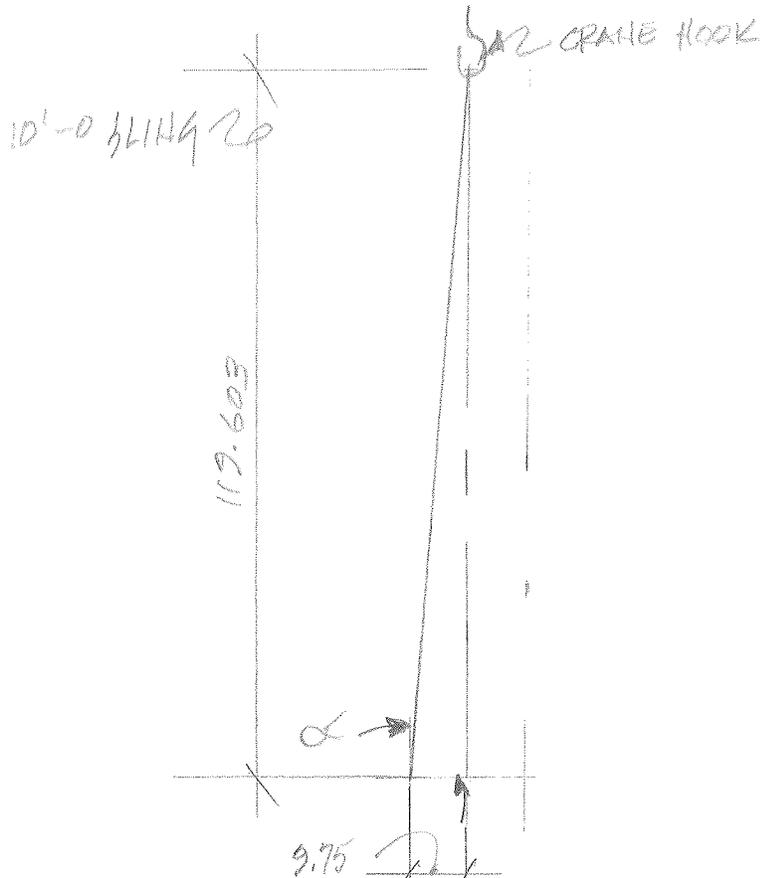
$$P_{ALLOW} = 5,600 \times 2 = 11,200 \text{ \#} > 211.3 \text{ \#} \text{ OK}$$

STABILITY:

SLING LENGTH = 10'-0" LONG
 RELAY RACK = 3'-0" HIGH
 MASSIVE C.G. OF RACK = 4'-0" FROM BASE



$$L\beta = \tan^{-1} \frac{48.25}{9.75} = 78.6^\circ$$



$$L\alpha = \tan^{-1} \frac{119.603}{9.75} = 85.3^\circ$$

$L\alpha > L\beta \therefore$ LIFT IS SAFE FOR OVERTURNING.



CARDINAL
1000 LBS

WRIGHT BELT
CHIPPING HOPPER



CARDINAL
1000 LBS

SELF
HOPPER



