BELOW-THE-HOOK LIFTING DEVICE
Engineering Note Cover Page

Lifting Device Numbers:

FNAL Site No.:_____ if applicable Div. Specific No.: 131 if applicable Asset No. _____ if applicable

ASME B30.20 Group: (check one)
- ˅ Group I Structural and Mechanical Lifting Devices
- ˅ Group II Vacuum Lifting Devices
- ˅ Group III Magnets, Close Proximity Operated
- ˅ Group IV Magnets, Remote Operated

Device Name or Description: LUGS FOR RAILROAD CAR

Device was: (check all applicable)
- ˅ Purchased from a Commercial Lifting Device Manufacturer
  mfg. name: _____
- ˅ Designed and Built at Fermilab
- ˅ Designed by Fermilab and Built by a Vendor
  Assy drawing number: _____
- ˅ Provided by a User or Other Laboratory
- ˅ Other. Describe: _____

Engineering Note Prepared by: T FANG Date: 10/11/01

Engineering Note Reviewed by: J. KILMER Date: 10/11/01

Lifting Device Data:

Capacity: 100,000

Fixture Weight: _____

Service: ˅ normal ˅ heavy ˅ severe (refer to B30.20 for definitions)

Duty Cycle: _____ 8, 16 or 24 hour rating (applicable to groups III, and IV)

Inspections Frequency: _____

Rated Load Test by FNAL (if applicable): Date: _____ Load: NOT APPLICABLE

˅ Check if Load Test was by Vendor and attach the certificate.

Satisfactory Load Test Witnessed by: _____

Signature (of Load Test Witness): _____

Notes or Special Information:

THESE LUGS ARE WELDED TO THE CAR. IT IS NOT POSSIBLE TO LOAD TEST THEM PRIOR TO USE.

FERMILAB
ENGINEERING NOTE

SECTION	PROJECT	SERIAL-CATEGORY	PAGE
	1		1

SUBJECT

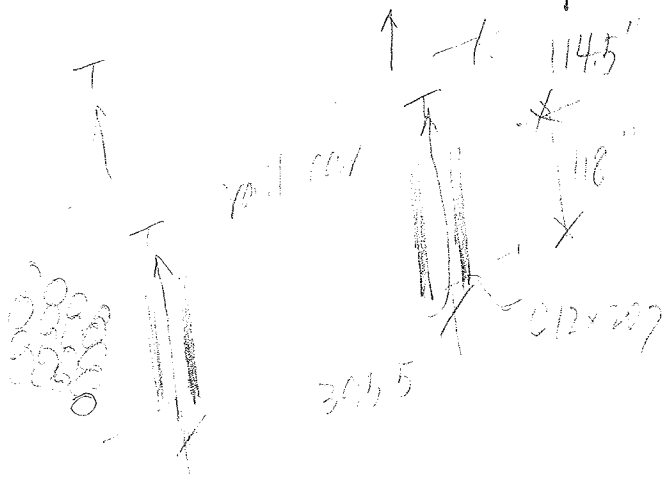
Rail Car Relocation Lifting Lug Design

NAME INGRID FANG

DATE 10-10-2001 REVISION DATE

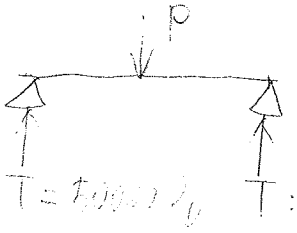
Upon investigation of the 100 ton rail car noticed that the cylindrical tubes were designed to be supported by the two ends. See the photo. below. The ends are supported by C12x20.7 channels through a ½" build up plate.

Assume the pick up points locate at the channels on each ends, then the pick up load T is



$4T = 100 \text{ ton} \quad T = 25 \text{ ton} = 50000 \text{ lbs}$

— CHECK THE PLATE FOR BENDING STRESS



$P = 2T = 2 \times 50000 \text{ lb}$

$= 100{,}000 \text{ lb}$

$$M_{max} = \frac{Pl}{4} = \frac{100000 \times 114.5}{4} = 2850 \text{ kip·in}$$

$$f_{bx} = \frac{M_{max}}{S_x} = \frac{2850}{\frac{1}{6} \times (1\frac{1}{2}) \times (118-12-6)^2} = 3.42 \text{ ksi}$$

$$F_{bx} = \frac{1}{3} F_y = \frac{1}{3} \times 36 = 12 \text{ ksi}$$

$f_{bx} < F_{bx}$ OK

— CHECK THE CHANNEL UNDER THE TENSION

$f_t = \frac{P}{A}$ where $P = T = 50000$ lbs

$A = 6.09 \text{ in}^2$ for C12x20.7

$$f_t = \frac{50000}{6.09} = 8.2 \text{ ksi}$$

$$F_t = \frac{1}{3} F_y = \frac{1}{3} \times 36 = 12 \text{ ksi}$$

$f_t < F_t$ OK

— CHECK THE CONNECTION UNDER SHEAR.

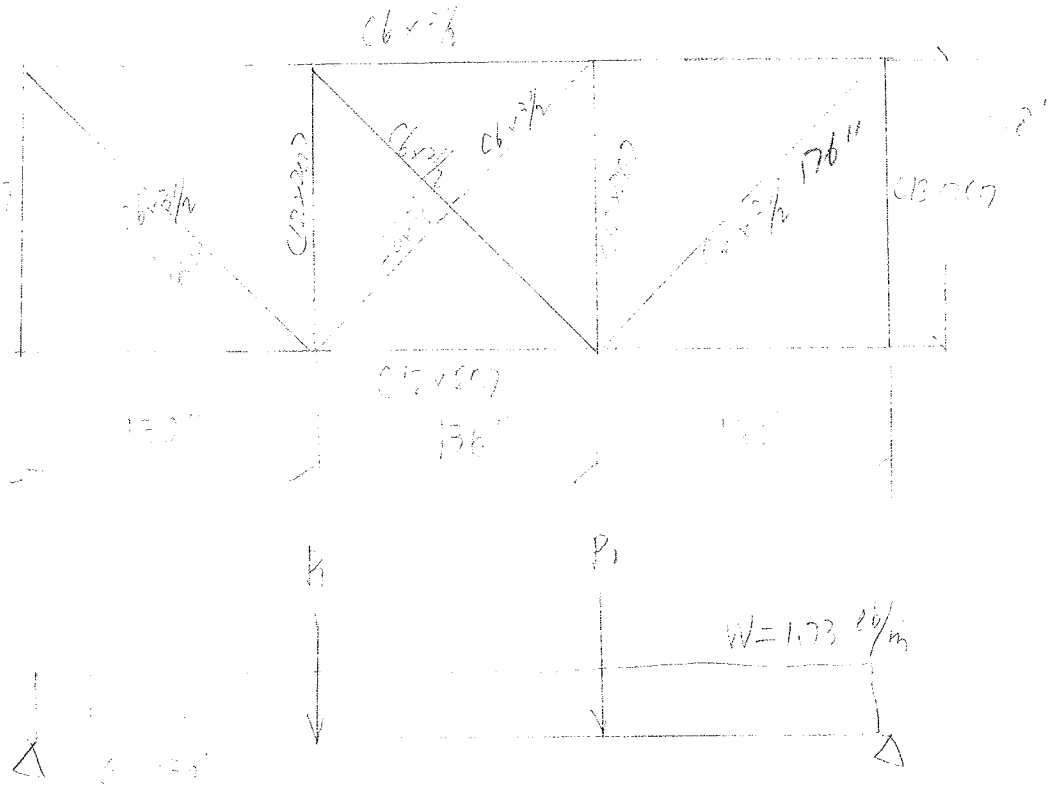
There are total of 44 Rivets 5/8" on the channel. The actual shear on each rivets is

$44 R_v = 50000$ $R_v = 1.136$ kips

From AISC, ASD, page 4-5, knowing the allowable load for Rivets 5/8" is 5.4 kips.

Therefore, the safety factor is $\frac{5.4}{1.136} = 4.75$

— CHECK THE BOTTOM MEMBER OF THE TRUSS



Where $P_1 = W_{(bottom)} + W_{(vertical)} + W_{(diagonal)}$

$= 18 \times \frac{12.5}{12} + 20.7 \times \frac{11.5}{12} + (18 \times \frac{12}{12}) = 732$ lbs

$P_4 = P_1 = 732$ lb

$W = \frac{W_{(bottom)}}{L} = \frac{(20.7 \times 3.85/12)}{20.5} = 1.73$ lb/in

$$M_{max} = \frac{wl^2}{8} + Pa$$

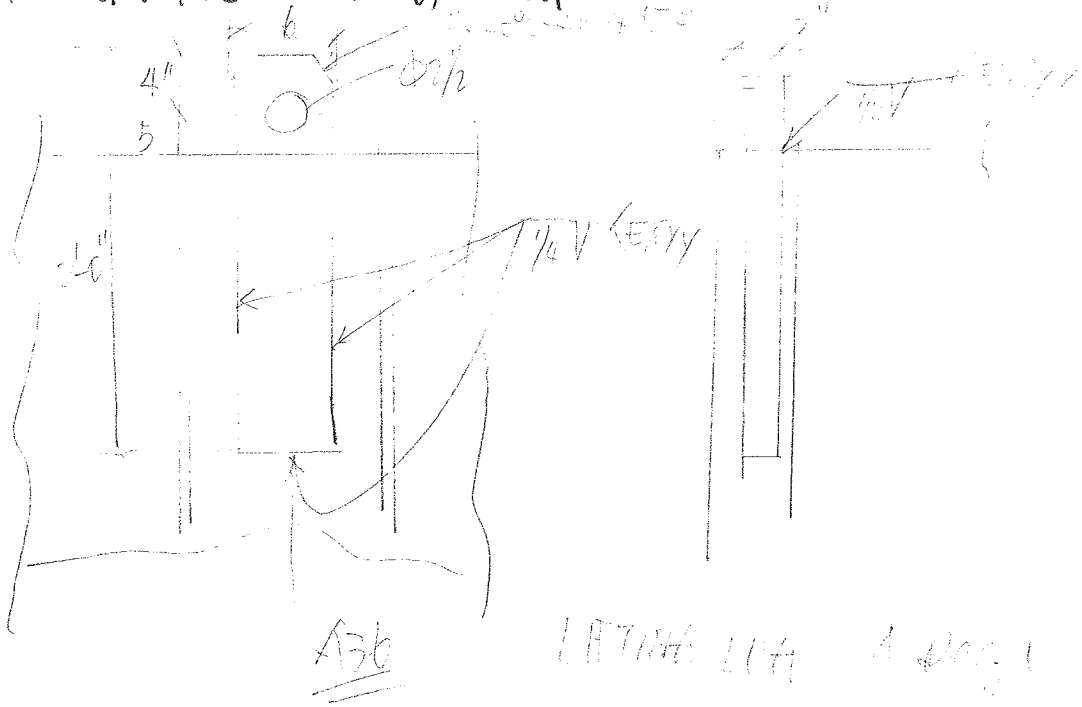
$$= \frac{1.73 \times 395^2}{8} + 732 \times 130 = 128900 \text{ lb-in}$$

$$f_{bx} = \frac{M_{max}}{S_x} = \frac{128900}{21.5} = 5.995 \text{ ksi}$$

$$F_{bx} = \frac{1}{3} F_y = \frac{1}{3} \times 36 = 12 \text{ ksi}$$

$$f_{bx} < F_{bx} \quad \underline{\text{OK}}$$

— DESIGN THE LIFTING LUG

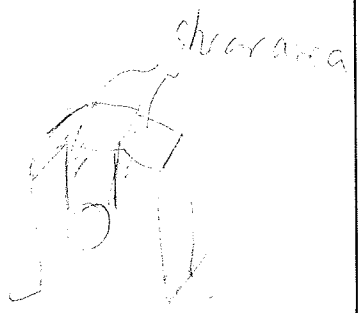


A36

○ CHECK THE LUG UNDER TENSION

$f_t = \frac{F}{A}$ where $F = 50000$ lb $\quad A = (6 - 2\frac{1}{2}) \times 2 = 7$ in^2

$= \frac{50000}{7} = 7.14$ ksi



$F_t = \frac{1}{3} F_y = \frac{1}{3} \times 36 = 12$ ksi

$f_t \leq F_t$ OK

○ CHECK THE LUG UNDER SHEAR

$f_v = \frac{F_v}{A}$ where $F = 50000$ lb $\quad A = [4 - (2\frac{1}{2})/2] \times 2$

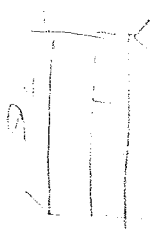
$= 5.5$ in^2

$= \frac{50000}{5.5} = 9.09$ ksi

$F_v = \frac{1}{3} F_y = \frac{1}{3} \times 36 = 12$ ksi

$f_v < F_v$ OK

○ CHECK THE LUG UNDER BENDING



$M_{max} = 10\% \times T \times 9'' = 10\% \times 50000 \times 9$

$= 45000$ lb-in

$S = \frac{1}{6} ab^2 = \frac{1}{6} \times 6 \times 2^2 = 4$ in^3

$f_{bx} = \frac{M}{S} = \frac{45000}{4} = 11.25$ ksi

$F_{bx} = \frac{1}{3} F_y = \frac{1}{3} \times 36 = 12$ ksi

$f_{bx} < F_{bx}$ OK

② CHECK THE BEARING

$f_p = \frac{F}{A}$ where $F = 50000$ lbs $A = 2\frac{1}{2} \times 2 = 5$ in^2

$= \frac{50000}{5} = 10$ ksi

$F_p = \frac{1}{3} F_y = \frac{1}{3} \times 36 = 12$ ksi

$f_p < F_p$ OK

③ DESIGN THE WELDS

According to AISC, ASD, Table J2.5 page 5-70, Row 9, for fillet weld. 1/4", the allowable load is

$0.707 \times 1/4 \times 12 = 2.12$ kip/in.

the weld length for 50000 lb load is

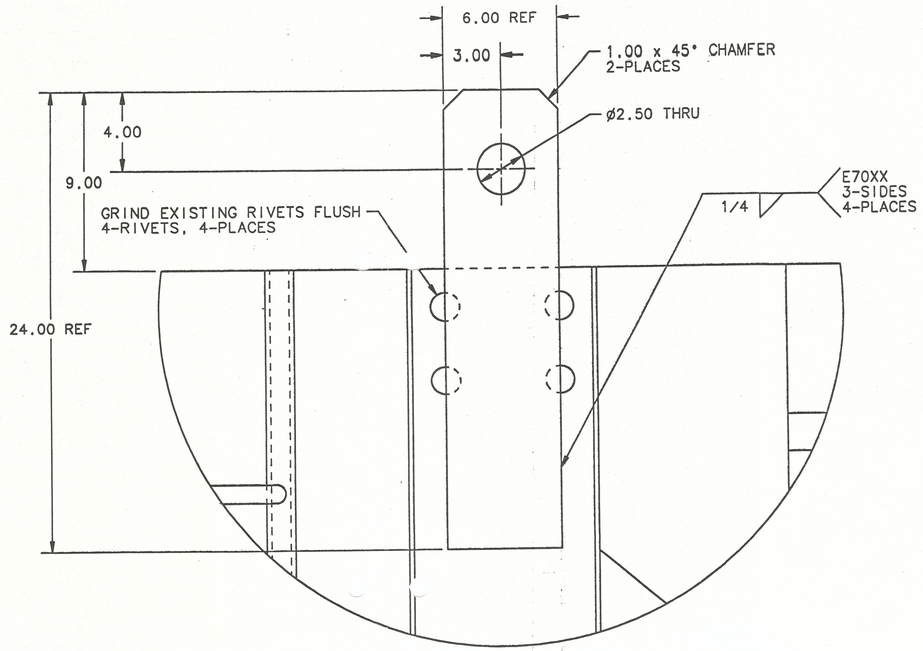
$\frac{50 \text{ kip}}{2.12} = 23$ in.

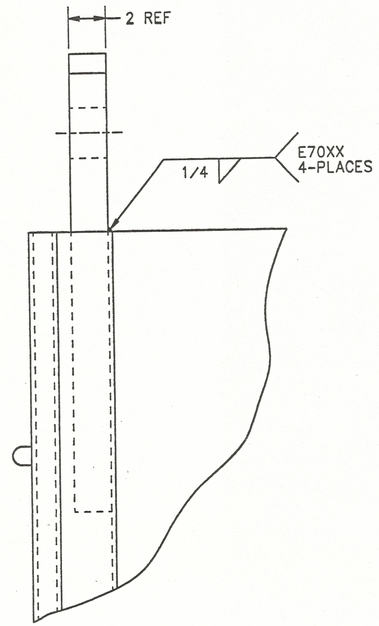
The actual weld length is 42 in.

The safety factor is $\frac{42}{23} = 1.8$.

In conclusion, the design as sketch is adequate.

REV.	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE

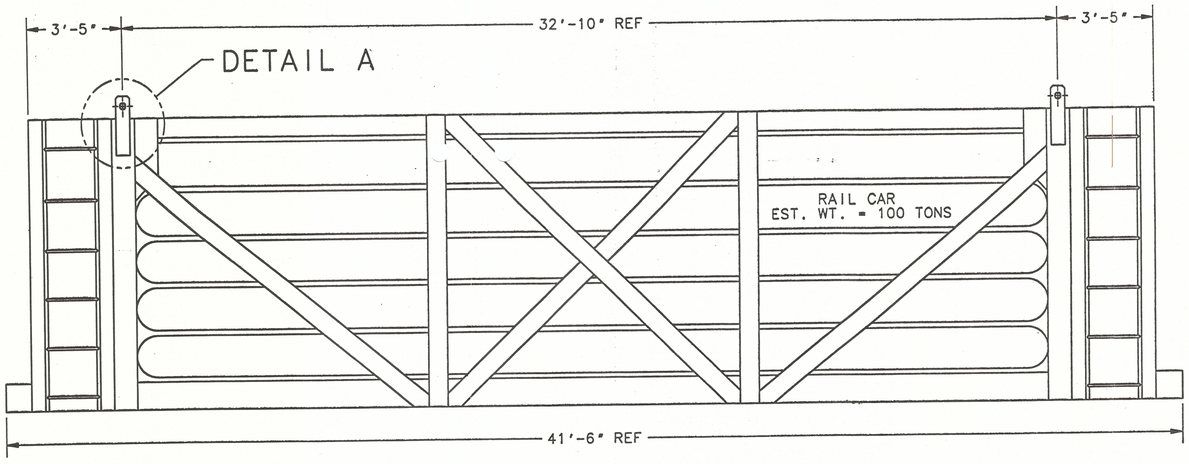


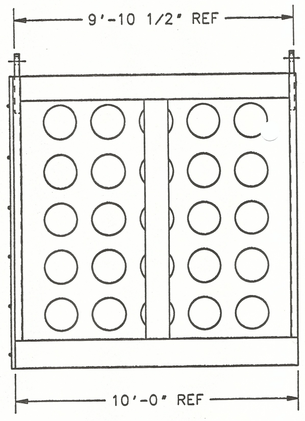


DETAIL A

SCALE: 1/4

LIFTING LUG
SEE ITEM 1





BUDGET CODE
AWN

OCT 2001
APPROVED
FOR
Fabrication

ITEM NO.	PART NO.	DESCRIPTION OR SIZE	QTY. REQ.
1	COML	PLATE, 2 x 6.00 x 24.00 CARBON STEEL ASTM A36	4

PARTS LIST

UNLESS OTHERWISE SPECIFIED				
.XX	.XXX	ANGLES	ORIGINATOR	INGRID FANG 10-11-01
±.06	± ———	± 1°	DRAWN	B. CYKO 10-11-01
			CHECKED	10-11-01
			APPROVED	Fang 10-11-01

1. BREAK ALL SHARP EDGES .015 MAX.
2. DO NOT SCALE DRWG.
3. DIMENSIONING IN ACCORD WITH ANSI Y14.5M-1982 STD'S.
4. ALL DIMENSIONS ARE IN INCHES.

250 MAX. ALL MACHINED SURFACES

USED ON

MATERIAL SEE ABOVE

FERMI NATIONAL ACCELERATOR LABORATORY
UNITED STATES DEPARTMENT OF ENERGY

PPD/MECHANICAL DEPARTMENT
RAIL CAR RELOCATION
LIFTING LUG DETAIL

SCALE	DRAWING NUMBER	SHEET NO.	REV.
3/8"=1'-0" AS NOTED	9210.300-MD-397659	1 OF 1	