

**BELOW-THE-HOOK LIFTING DEVICE**  
**Engineering Note Cover Page**

Lifting Device Numbers:

FNAL Site No.: \_\_\_\_\_ Div. Specific No.: 142 Asset No. \_\_\_\_\_  
if applicable if applicable if applicable

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

Device Name or Description: GREEN BLOCK LIFTING FIXTURE

Device was:  Purchased from a Commercial Lifting Device Manufacturer  
mfg. name: \_\_\_\_\_

(check all applicable)  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: Zhijing Tang Date: 7/11/03

Engineering Note Reviewed by: SEE NEXT PAGE Date: \_\_\_\_\_

Lifting Device Data:

Capacity: 20000 lbs

Fixture Weight: 500 lbs

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: \_\_\_\_\_

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

Satisfactory Load Test Witnessed by: [Signature]

Signature (of Load Test Witness): Nina  
Chris Aden

Notes or Special Information:

Mechanical Support Department  
Engineering Note

NUMBER: MSD EN – 142 /2003

DATE: July 11, 2003

TITLE: Analysis of the Green Block Lifting Fixture

AUTHOR: Zhijing Tang

REVIEWED BY: *Ang Lee*

DATE REVIEWED: *July 14, 2003*

KEY WORDS: Numi, Green block, Lifting Fixture, Tongs, Chains, Brackets

SUMMARY:

The green blocks in Numi project have dimensions 52X52X26 inches, and weighs about 20,000 lbs. Two pairs of tongs are designed by Jim Kilmer to lift the green blocks. The finite element analysis of the tongs is done by Bob Wands. This engineering note just put all the relevant documents together for future reference.

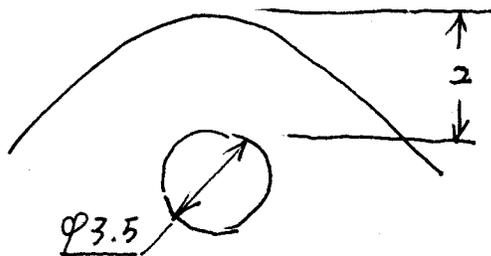
TABLE OF CONTENTS:

Content	Page
1. Analysis of the lifting brackets.....	1
2. Calculation of the frictional coefficient.....	2
3. Finite Element Analysis of Tongs (Bob Wands) .....	4
4. Green block dimensions (Jim Kilmer) .....	9
5. Vendor test and analysis report of T-1 steel .....	10
6. McMarster catalog for chains .....	13
7. Drawings .....	16

## Bracket # 1 (DRWG 406868)

The thickness is 1"

The load is 20,000 lbs



For bearing

$$\text{Area} = 3.5 \times 1 = 3.5 \text{ in}^2$$

$$\text{stress } \sigma = \frac{20000}{3.5} = 5714 \text{ psi}$$

For tearing

$$\text{Area} = 2 \times 2 \times 1 = 4 \text{ in}^2$$

$$\text{stress } \tau = \frac{20000}{4} = 5000 \text{ psi}$$

The material is ASTM A36, which has yield stress of  $\sigma_y = 36 \text{ ksi}$

From above calculation, this hole will be OK.

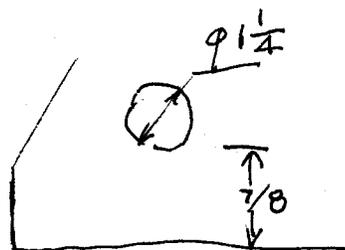
## Bracket # 2 (DRWG 406869)

thickness is 1 in

$$\text{bearing Area} = 1.25 \text{ in}^2$$

$$\text{Load} = 5000 \text{ lb}$$

$$\text{stress } \sigma = 4000 \text{ psi}$$



$$\text{tearing area} = 2 \times \frac{7}{8} \times 1 = \frac{7}{4} \text{ in}^2$$

$$\text{stress } \tau = 2857 \text{ psi} \quad \text{OK!}$$

$$F_h = W \cdot \tan \theta$$

moment from top

$$(W \sin \varphi + F_h \cos \varphi) l_1$$

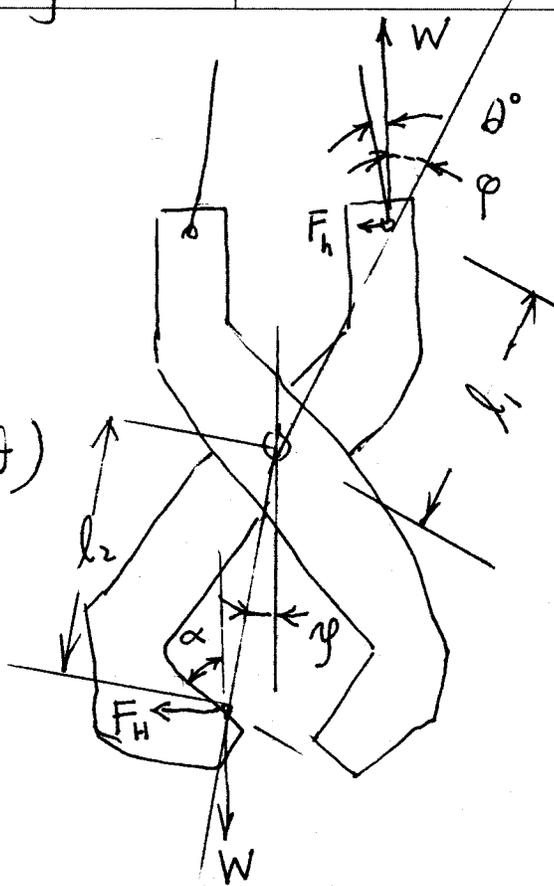
$$= W l_1 (\sin \varphi + \cos \varphi \tan \theta)$$

moment from bottom

$$W \sin \varphi l_2 - F_H \cos \varphi l_2$$

$$= W l_2 (\sin \varphi - \eta \cos \varphi)$$

$$\eta = F_H / W$$



For equilibrium, total moment should be zero

$$\frac{l_1}{l_2} (\sin \varphi + \cos \varphi \tan \theta) + (\sin \varphi - \eta \cos \varphi) = 0$$

From DRWG 406181, We measured

$$\theta = 6.5^\circ, \quad \varphi = 27.5^\circ, \quad \psi = 24^\circ$$

$$\frac{l_1}{l_2} = 0.755, \quad \text{equation becomes}$$

$$0.755 (0.462 + 0.887 \times 0.114) + 0.407 - \eta (0.914) = 0$$

$$\eta = 0.910$$

The angle between grasping surface & vertical is  $\alpha = 35^\circ$ . the normal & tangential forces are

$$F_N = W \sin \alpha + F_H \cos \alpha = W (\sin \alpha + 0.910 \cos \alpha) \\ = 1.319 W$$

$$F_T = W \cos \alpha - F_H \sin \alpha = W (\cos \alpha - 0.910 \sin \alpha) \\ = 0.297 W$$

For no-slippery grasping, the friction coefficient must be

$$f_r \geq \frac{0.297}{1.319} = 0.225.$$

For steel on steel surface.  $f_r = 0.39 > 0.225$ .

(Mark's standard Handbook for Mechanical Engineers. 9th edition Pg 3-25)

Load limit for chains are 17,000 lbs  
the actual load is 5,000 lbs.

maximum bending stress in bracket # 1

$$M = 10,000 \times 13 = 130,000 \text{ lb-in}$$

$$I = \frac{1}{12} \times (13.5)^3 = 205 \text{ in}^4$$

$$c = 13.5 / 2 = 6.75 \text{ in}$$

$$\sigma = \frac{M c}{I} = 4,267 \text{ psi}$$

November 28, 2001

## Stress Analysis of Lifting Tongs Final Design

Bob Wands

### Introduction and Summary

The tong material and geometry have been finalized. T-1 steel ( $S_y > 100$  ksi per vendor testing) will be used. This report presents the results of the final stress analysis, in which a single lifting tong pair is subjected to a 20,000 lb load.

Results show that the maximum primary stress in the tong is 26.3 ksi, which is less than  $1/3 S_y = 33.3$  ksi. Pin stresses are a maximum of 6.8 ksi, also below the allowable for the Grade 8 bolt material used for the pin.

### Geometry

The analysis is based on the tong geometry given in Drwg # 8875.126-MD-406176.

### Material and Allowable Stress

The tongs are made from A514 T-1 steel, with a tested yield strength greater than 100 ksi. For this analysis, maximum allowable normal stress is limited to  $S_y/3 = 33.3$  ksi. Maximum shear stress is limited to  $S_y/6 = 16.6$  ksi.

The pin will be a Grade 8 shoulder bolt, 1.5 in. diameter.  $S_y$  is much greater than 100 ksi for this material, so for simplicity the same allowables will be applied to the pin as have been applied to the tong.

### Finite Element Model

The finite element model is shown in Fig. 1. It consists of 4000 8-node brick elements. Loads totaling 20 kips are applied on the tong jaws. Constraints are applied at the holes at the top of each tong. Contact elements are used between the pin and the tong jaws to produce a joint with zero frictional resistance to torque, and capable of developing whatever compressive contact is necessary to resist the shear and bending forces.

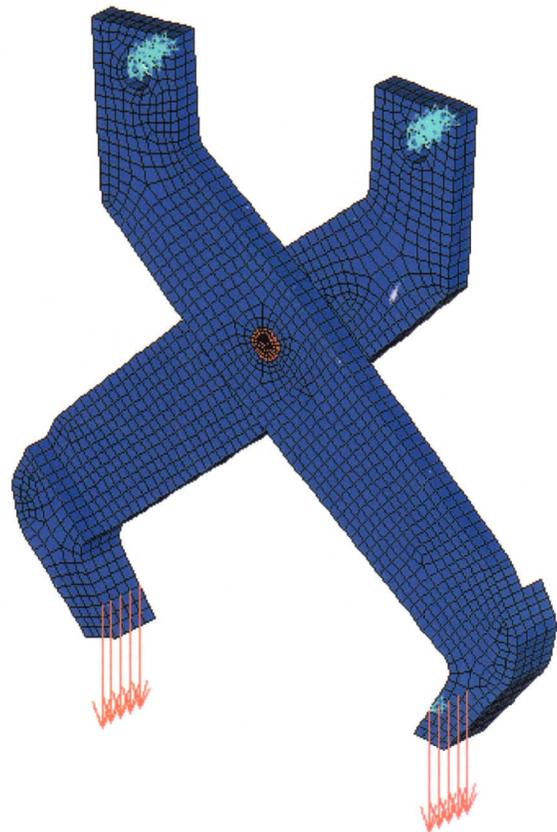


Figure 1. Finite Element Model

## **Results**

### **Stresses in Tongs**

Three critical sections were evaluated. These are shown in Fig. 2. The FE results were used to determine the forces and moments on the three sections. The forces and moments are output in the natural coordinates of the section; i.e., x-axis parallel to the line defining the section.

Table I gives the properties of each section. Table II gives the forces and moments each section.

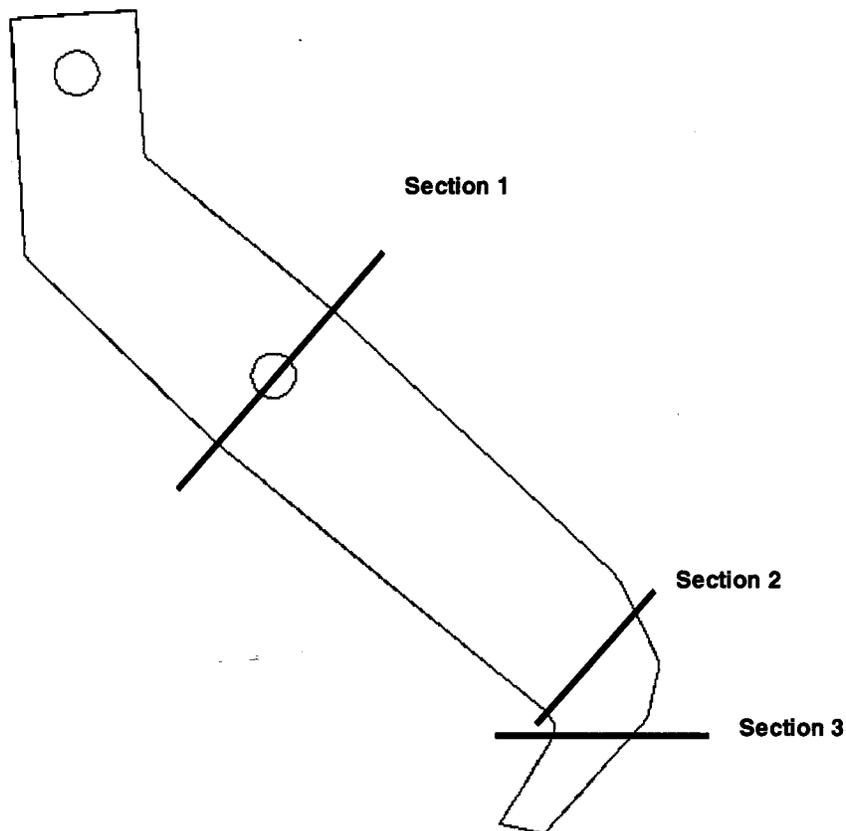
The resulting stresses were calculated from the section property and force information. These stresses are:

$P_m$  = primary membrane ( $f_y/A$ )

$P_b$  = primary bending ( $Mc/I$ , about the two bending axes  $x$  and  $z$ )

Shear = shear stress due to in-plane forces ( $f_x$  and  $f_z$ )

The total normal stress was found by summing the membrane and bending stresses. These stresses are summarized in Table III. All stresses are below the allowables.



**Figure 2. Sections for Stress Evaluation**

**Table I. Properties of Sections**

	<b>Width (in)</b>	<b>Thickness (in)</b>	<b>Area (in<sup>2</sup>)</b>	<b>I<sub>zz</sub> (in<sup>4</sup>)</b>	<b>c<sub>z</sub> (in)</b>	<b>I<sub>xx</sub> (in<sup>4</sup>)</b>	<b>c<sub>x</sub> (in)</b>
<b>Section 1</b>	<b>6.0</b>	<b>1.25</b>	<b>7.5</b>	<b>22.15</b>	<b>3</b>	<b>0.73</b>	<b>0.63</b>
<b>Section 2</b>	<b>4.5</b>	<b>1.25</b>	<b>5.63</b>	<b>9.49</b>	<b>2.25</b>	<b>0.73</b>	<b>0.63</b>
<b>Section 3</b>	<b>2.7</b>	<b>2.50</b>	<b>6.75</b>	<b>4.10</b>	<b>1.35</b>	<b>3.52</b>	<b>1.25</b>

**Table II. Forces and Moments on Sections**

	<b>F<sub>x</sub> (lbs)</b>	<b>F<sub>y</sub> (lbs)</b>	<b>F<sub>z</sub> (lbs)</b>	<b>M<sub>x</sub> (in-lbs)</b>	<b>M<sub>y</sub> (in-lbs)</b>	<b>M<sub>z</sub> (in-lbs)</b>
<b>Section 1</b>	<b>3333</b>	<b>-21486</b>	<b>-393</b>	<b>16839</b>	<b>6088</b>	<b>84913</b>
<b>Section 2</b>	<b>7071</b>	<b>7071</b>	<b>393</b>	<b>3872</b>	<b>-2576</b>	<b>-23301</b>
<b>Section 3</b>	<b>0</b>	<b>-10000</b>	<b>-393</b>	<b>891</b>	<b>-1046</b>	<b>26603</b>

**Table III. Stresses on Sections  
(all stresses in psi)**

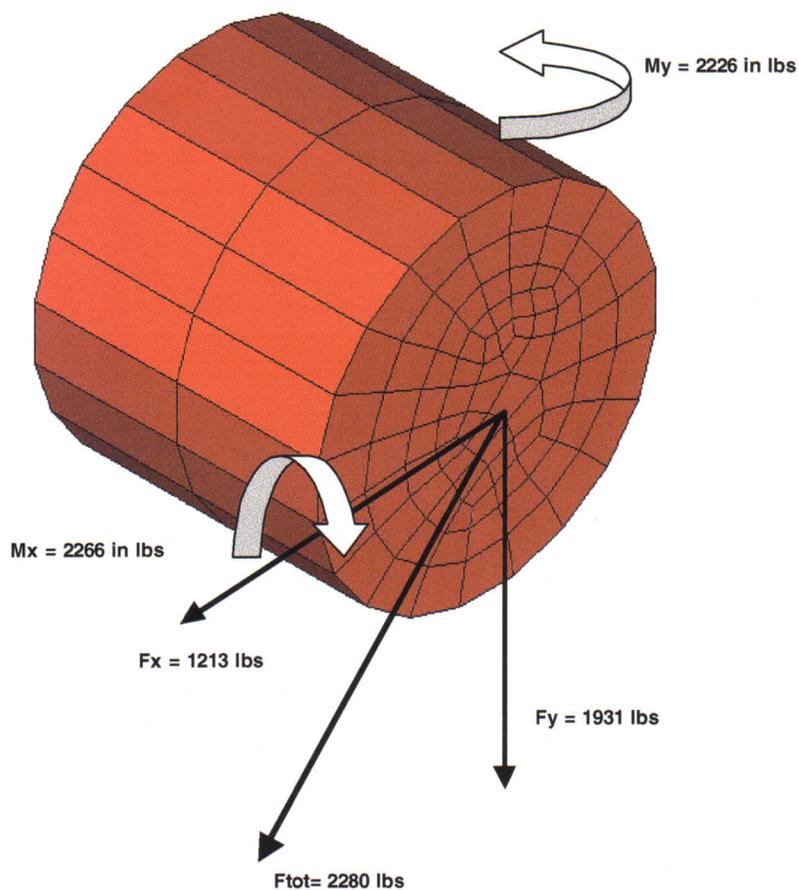
	<b>P<sub>m</sub></b>	<b>P<sub>b</sub> - Z</b>	<b>P<sub>b</sub> - X</b>	<b>Sum of Bending Stresses</b>	<b>Total Normal Stress</b>	<b>Shear</b>
<b>Section 1</b>	<b>444</b>	<b>11501</b>	<b>14369</b>	<b>25870</b>	<b>26315</b>	<b>447</b>
<b>Section 2</b>	<b>1257</b>	<b>5523</b>	<b>3304</b>	<b>8827</b>	<b>10084</b>	<b>1259</b>
<b>Section 3</b>	<b>0</b>	<b>8758</b>	<b>316</b>	<b>9075</b>	<b>9075</b>	<b>58</b>

### Pin

The bending and shear forces on the pin were extracted from the FEA at the pin mid-length. These are shown in Fig. 3.

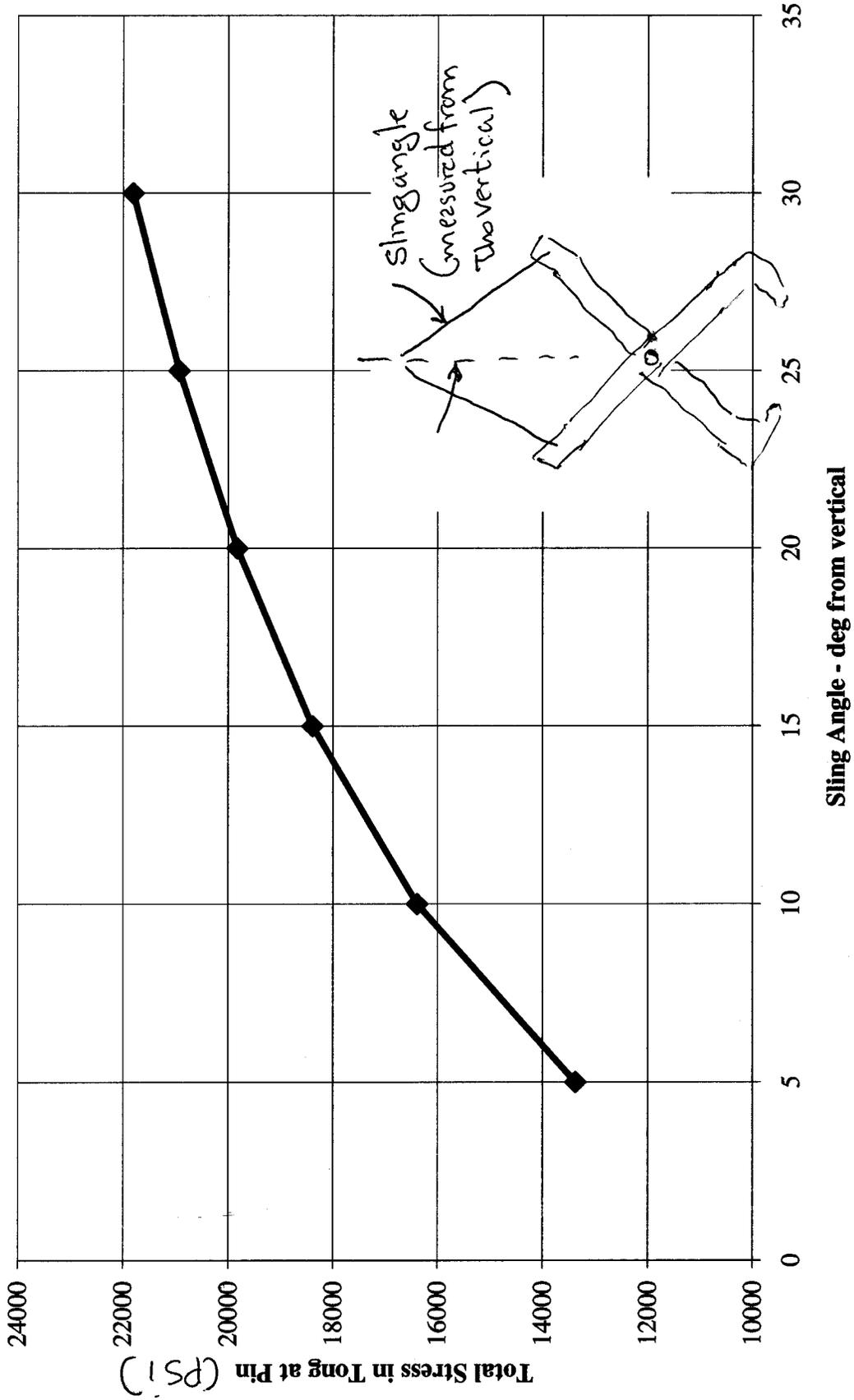
For a 1.5 inch pin,  $A = 1.76 \text{ in}^2$ ,  $I = 0.248 \text{ in}^4$ . The shear stress is then  $2280/1.76 = 1295 \text{ psi}$ . The bending stresses about the x and y axes are 6838 and 6718 psi, respectively. (Because the cross section is circular, the bending stresses do not add as they did in the case of the rectangular tong sections)

All pin stresses are well below the allowable stress.



**Figure 3. Forces on Pin at Mid-length**

# Total Stress in Tong as Function of Sling Angle





FERMILAB  
ENGINEERING NOTE

SECTION

PROJECT

SERIAL-CATEGORY

PAGE

9

SUBJECT

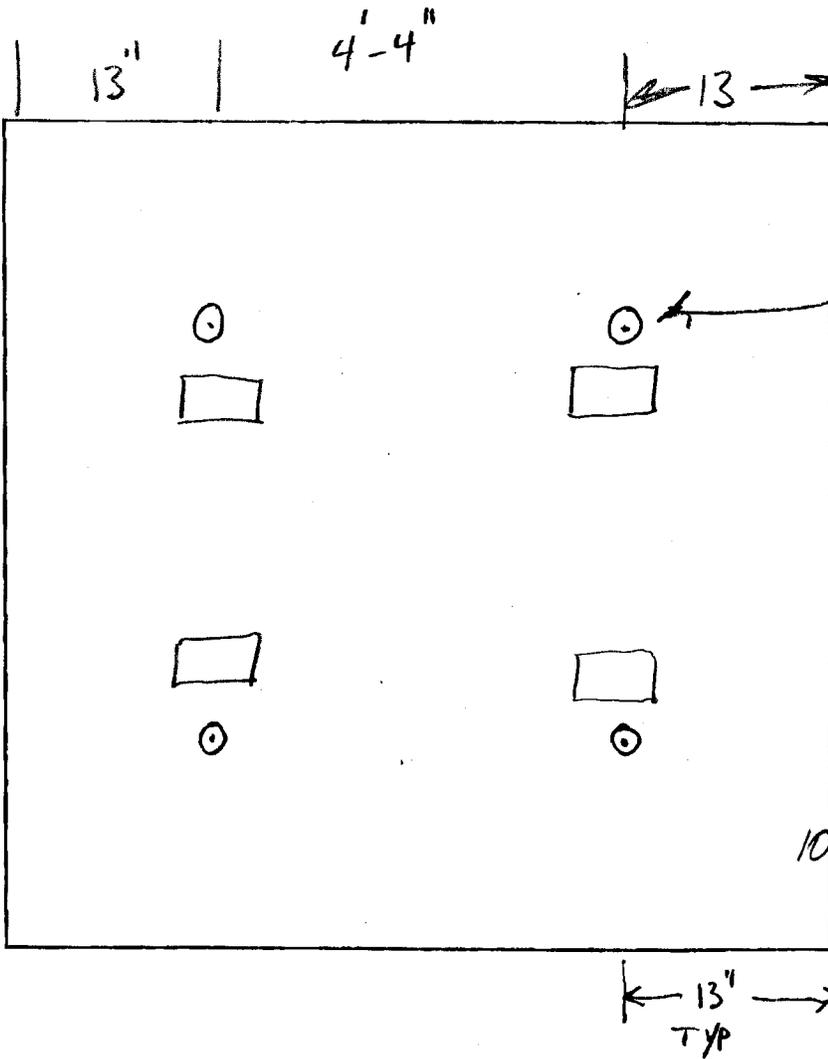
GREEN BLOCK HOLE PATTERN

NAME

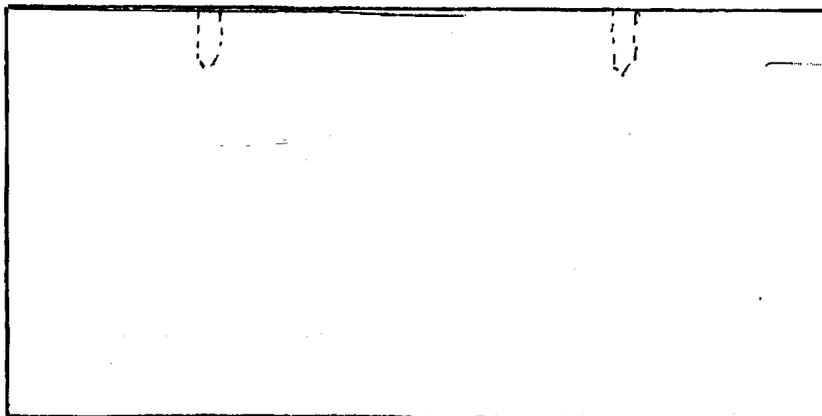
JIM KILMER

DATE

REVISION DATE



HOLES DRILLED  
D-TAPPED FOR 1/4"-8 UNF



TAP 3" DEEP



Ryerson Number: E1 454846 01 01 001  
Territory: 1  
Load: OT  
Item Number: 01

R Y E R S O N T U L L  
Material Certification

To: FERMI NATIONAL LAB - PRO CARD  
C/O JOSEPH T RYERSON & SON  
P O BOX 8000  
CHICAGO IL 60608

Your Order Number                      Order Date  
PRN 11764                                      04/26/2001

Item Description  
PLT T1 TYPE A/EQUIV A514 GRB 1-1/4 x 96 x 3 FT 0

Single / Multiple Heat Number  
821M12260

Slab / Coil Number (if applicable)  
S22299

Item Instructions  
SEND CERTS WITH SHIPMENT  
CERTIFIED

Part Number (if applicable)                      Item Mark Instruction (if applicable)

A survey of our material sources has indicated that neither mercury nor radioactive substances is introduced into their products, or is used in any of their processes. While we make no independent tests for mercury or radiation, there is nothing in Ryerson's system, which could be expected to introduce contamination of either type.

This document certifies that the material described above was shipped on your order and that the attached data is a true copy of the test report furnished by the producer with said material.

05/21/2001

  
\_\_\_\_\_  
Authorized Agent of RYERSON TULL

DELIVERY RECEIPT

PAGE 01

12

ILL FERNI NATIONAL LAB - PRO CARD  
TO C/O JOSEPH T RYERSON & SON  
P O BOX 8006  
CHICAGO IL 60608  
RAIL STATION 306 JERILYN SNYDER

DELV RECI # 01-174908  
SHIP DATE 05/22/01  
CUST ACCT # 2672365-00



ILL FERNI NAT'L LAB - PRO CARD  
TO RECEIVING DEPT/PRN 11764  
KIRK & WILSON RD  
MARIETTA IL 60510  
(630)840-3711

LOAD NORTH ITEMS 1  
TRAILER ID 45175 FOB D  
TRACTOR ID 91834 SHIP TERMS PPD  
CARRIER USFL BOND

EST ORDER	REFERENCE	DESCRIPTION	QUANTITY	
			SHIPPED	U/M
IN 11764	454846 01 01 001	PLT TI TYPE A/EQUIV AS14 GRB	1.243	LBS
	PR	1-1/4 x 96 x 3 FT 0	1	PC
	DATE 04/26/01	GREEN-PINK-ORANGE	1	BDL
	TR WITH SHIPMENT	HEAT# 821M12260 /522299		
	RESREP # 594 EXT. 7908	** ITEM BUNDLED WITH OTHERS ON LOAD **		
		MASTER BDL # ARAD		

INSTRUCTIONS: RECUG HRS: 8:00AM - 4:30PM

RECEIVED BY

*[Signature]*

DATE

*5/22/01*

AST PAGE

Please refer to page 662 for information

**Some Information About Chain**

**Measuring Chain**—Some of the weldless chain includes actual size illustrations. For other types of chain, use the diagram at left as a general measuring guideline.

**Work Load Limit**—The maximum safe load which can be applied to a straight length of new chain in an even and direct fashion. **Work Load** should never be exceeded. Work Load Limits may be reduced by any of the following: jerking, lifting, and pulling at an angle; applying load at an accelerated rate; twisting, weathering, corrosion, age, and high temperatures.

**Selecting Chain and Attachments**—Hooks, rings, shackles, swivels, and other attachments must be compatible with the chain in terms of type, grade, and size. **Remember the Work Load Limit for any assembly is the lowest Work Load Limit for the chain or for any of the component items in the assembly.**

**Chain Inspection**—Frequent link-by-link inspections are extremely important. If defective links are found, the must be removed from service.

**Overhead Lifting**—Only chains listed on this page used for overhead lifting.

**Standard Finish**—No additional finishes applied to the chain. It may also be called bright, self-colored, or shot-peened chain.

**Galvanized Chain**—Zinc is applied by dipping in a molten bath (Hot Galvanizing) or by a cold mechanical process (Cold Galvanizing).

**Plated Chain**—An finish that is applied by either dipping or electroplating. Plating improves corrosion resistance and may also be used to improve the appearance of the chain.

**Coated Chain**—A nylon or polyester coating is applied, which provides easier handling and identification.

**Heat Treating**—Makes the outer layer of steel harder. It has greater resistance to cutting and abrasion, but is less ductile.



The strongest chain we offer—available in standard finish and super-galvanized finish. Super galvanized offers corrosion protection that lasts up to 10 times longer than ordinary galvanized finishes. All chain is heat treated.

Trade Size, In.	Actual Material Dia., mm	Nom. Inside Link Size, Lg.	Wd.	Per Foot	
				1-49	50-Up
3/16 (T/S)	5	0.197"	0.295"	2,200	2,000
1/8	7	0.276"	0.374"	4,300	3,900
5/16	8	0.315"	0.425"	5,500	5,000
3/8	10	0.394"	0.531"	8,800	8,000
1/2	13	0.512"	0.689"	15,000	13,500
5/8	16	0.630"	0.846"	22,600	20,600
3/4	19	0.748"	1.008"	31,600	28,600
7/8	22	0.866"	1.161"	42,600	38,600

**Welded Chain—For Lifting**

**Grade 100 Maximum Strength Alloy Steel Chain**

Standard lengths are 5, 10, 25, 50, and 100 ft. Work load limits are stated at room temperature. Work load limits are reduced in heat. Do not use in temperatures greater than 300° F.

Trade Size, In.	Actual Material Dia., mm	Nom. Inside Link Size, Lg.	Wd.	Per Foot	
				1-49	50-Up
3/16	5	0.197"	0.295"	2,200	2,000
1/8	7	0.276"	0.374"	4,300	3,900
5/16	8	0.315"	0.425"	5,500	5,000
3/8	10	0.394"	0.531"	8,800	8,000
1/2	13	0.512"	0.689"	15,000	13,500
5/8	16	0.630"	0.846"	22,600	20,600
3/4	19	0.748"	1.008"	31,600	28,600
7/8	22	0.866"	1.161"	42,600	38,600

**Grade 80 High Strength Alloy Steel Chain**

The most common for overhead lifting. Great for slings, magnets, pulling piles, heavy duty towing, and drag-lines requiring high strength and wear resistance. Chain is heat treated and has a standard finish. Standard lengths are 5, 10, 25, 50, and 100 ft. Work load limits are stated at room temperature. Work load limits are reduced in heat. Do not use in temperatures greater than 350° F.

Trade Size, In.	Actual Material Dia., mm	Nom. Inside Link Size, Lg.	Wd.	Per Foot	
				1-49	50-Up
3/16	5	0.197"	0.295"	2,200	2,000
1/8	7	0.276"	0.374"	4,300	3,900
5/16	8	0.315"	0.425"	5,500	5,000
3/8	10	0.394"	0.531"	8,800	8,000
1/2	13	0.512"	0.689"	15,000	13,500
5/8	16	0.630"	0.846"	22,600	20,600
3/4	19	0.748"	1.008"	31,600	28,600
7/8	22	0.866"	1.161"	42,600	38,600

**Grade 80 Cold-Galvanized Alloy Steel Chain**

Similar to Grade 80 high strength alloy steel chain above, but with a mechanical cold-galvanized finish that provides corrosion protection without reducing the work load limit. Ideal for use in salt water. Chain is heat treated. Cold galvanizing meets ASTM specification B 464 and MIL-C-16180A.

Standard lengths are 5, 10, 25, 50, and 100 ft. Work load limits are stated at room temperature. Work load limit is reduced in heat. Do not use in temperatures greater than 200° F.

Trade Size, In.	Actual Material Dia., mm	Nom. Inside Link Size, Lg.	Wd.	Per Foot	
				1-49	50-Up
3/16	5	0.197"	0.295"	2,200	2,000
1/8	7	0.276"	0.374"	4,300	3,900
5/16	8	0.315"	0.425"	5,500	5,000
3/8	10	0.394"	0.531"	8,800	8,000
1/2	13	0.512"	0.689"	15,000	13,500
5/8	16	0.630"	0.846"	22,600	20,600
3/4	19	0.748"	1.008"	31,600	28,600
7/8	22	0.866"	1.161"	42,600	38,600

**Grade 60 Alloy Steel Chain**

Designed for more ductility than Grade 80, chain is excellent for heavy overhead lifting in steel mills, foundries, and for other rugged industrial applications. Chain has a standard finish. Standard lengths are 5, 10, 25, 50, and 100 ft. Work load limits are stated in heat. Do not use in temperatures greater than 500° F.

Trade Size, In.	Actual Material Dia., mm	Nom. Inside Link Size, Lg.	Wd.	Per Foot	
				1-49	50-Up
3/16	5	0.197"	0.295"	2,200	2,000
1/8	7	0.276"	0.374"	4,300	3,900
5/16	8	0.315"	0.425"	5,500	5,000
3/8	10	0.394"	0.531"	8,800	8,000
1/2	13	0.512"	0.689"	15,000	13,500
5/8	16	0.630"	0.846"	22,600	20,600
3/4	19	0.748"	1.008"	31,600	28,600
7/8	22	0.866"	1.161"	42,600	38,600

**Grade 50 Type 316L(Ti) Stainless Steel Chain**

Resistant to rust, acid, and salt water, it also resists pitting—even in phosphoric and most acidic solutions. Chain is not heat treated. Standard lengths are 5, 10, 25, 50, and 100 ft. Work load limits are stated at room temperature. Work load limits are reduced in heat. Do not use in temperatures greater than 750° F.

Trade Size, In.	Actual Material Dia., mm	Nom. Inside Link Size, Lg.	Wd.	Per Foot	
				1-24	25-Up
3/16	5	0.197"	0.295"	1,100	0,38
1/8	7	0.276"	0.374"	2,200	0,74
5/16	8	0.315"	0.425"	3,300	1,10
3/8	10	0.394"	0.531"	4,400	1,48
1/2	13	0.512"	0.689"	7,100	2,55

**Grade 70 High Strength Steel Transport Chain**

Use this heat treated chain for load-binding, towing, and logging jobs. It's stronger than Grade 40 High Test and Grade 30 Proof Coil chain. Meets D.O.T. CFR 49, 393.102 for load securement. Zinc-plated chain color is gold for easy recognition. Limits are reduced in heat.

Trade Size, In.	Actual Material Dia., mm	Nom. Inside Link Size, Lg.	Wd.	Per Foot	
				1-49	50-Up
3/16	7	0.279"	0.50"	3,150	3,383T91
1/8	8	0.335"	0.60"	4,700	3,963T92
5/16	10	0.401"	0.70"	6,000	3,663T93
3/8	13	0.525"	0.81"	11,300	3,363T95
1/2	17	0.701"	1.05"	3,150	3,412T72
5/8	20	0.886"	1.36"	6,600	3,412T74
3/4	24	1.071"	1.70"	11,300	3,412T76
7/8	28	1.256"	2.04"	3,150	3,424T74
1	32	1.441"	2.38"	4,700	3,424T76
1 1/8	36	1.626"	2.72"	6,000	3,424T78
1 1/4	40	1.811"	3.06"	7,300	3,424T80
1 1/2	44	2.001"	3.40"	8,600	3,424T82
1 3/4	48	2.191"	3.74"	9,900	3,424T84
2	52	2.381"	4.08"	11,200	3,424T86
2 1/4	56	2.571"	4.42"	12,500	3,424T88
2 1/2	60	2.761"	4.76"	13,800	3,424T90
2 3/4	64	2.951"	5.10"	15,100	3,424T92
3	68	3.141"	5.44"	16,400	3,424T94
3 1/4	72	3.331"	5.78"	17,700	3,424T96
3 1/2	76	3.521"	6.12"	19,000	3,424T98
3 3/4	80	3.711"	6.46"	20,300	3,424T100
4	84	3.901"	6.80"	21,600	3,424T102
4 1/4	88	4.091"	7.14"	22,900	3,424T104
4 1/2	92	4.281"	7.48"	24,200	3,424T106
4 3/4	96	4.471"	7.82"	25,500	3,424T108
5	100	4.661"	8.16"	26,800	3,424T110

**Grade 40 High Test Steel Binding Chain**

Often used for load binding, tie-downs, demolition, and tow chain, this chain is stronger than Grade 30 Proof Coil chain. Also known as Grade 43 chain, it is made from medium-carbon steel and is not heat treated. Standard lengths are 5, 10, 25, 50, and 100 ft. Work load limits are stated at room temperature. Work load limits are reduced in heat.

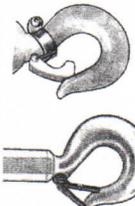
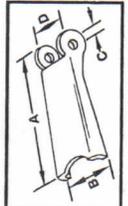
Trade Size, In.	Actual Material Dia., mm	Nom. Inside Link Size, Lg.	Wd.	Per Foot	
				1-49	50-Up
3/16	7	0.279"	0.50"	2,600	3,588T14
1/8	8	0.335"	0.60"	3,900	3,588T16
5/16	10	0.401"	0.70"	5,400	3,588T18
3/8	13	0.525"	0.81"	9,200	3,588T20
1/2	17	0.701"	1.05"	11,500	3,588T22
5/8	20	0.886"	1.36"	16,200	3,588T24
3/4	24	1.071"	1.70"	2,600	3,588T26
7/8	28	1.256"	2.04"	2,600	3,588T28
1	32	1.441"	2.38"	2,600	3,588T30
1 1/8	36	1.626"	2.72"	2,600	3,588T32
1 1/4	40	1.811"	3.06"	2,600	3,588T34
1 1/2	44	2.001"	3.40"	2,600	3,588T36
1 3/4	48	2.191"	3.74"	2,600	3,588T38
2	52	2.381"	4.08"	2,600	3,588T40
2 1/4	56	2.571"	4.42"	2,600	3,588T42
2 1/2	60	2.761"	4.76"	2,600	3,588T44
2 3/4	64	2.951"	5.10"	2,600	3,588T46
3	68	3.141"	5.44"	2,600	3,588T48
3 1/4	72	3.331"	5.78"	2,600	3,588T50
3 1/2	76	3.521"	6.12"	2,600	3,588T52
3 3/4	80	3.711"	6.46"	2,600	3,588T54
4	84	3.901"	6.80"	2,600	3,588T56
4 1/4	88	4.091"	7.14"	2,600	3,588T58
4 1/2	92	4.281"	7.48"	2,600	3,588T60
4 3/4	96	4.471"	7.82"	2,600	3,588T62
5	100	4.661"	8.16"	2,600	3,588T64

**Grade 30 General Purpose Proof Coil Steel Chain**

Excellent for applications that don't require the higher strength of Grade 40 or Grade 70. Use for tailgate chain, tow chains, tie down chains, logging chains, pipe line hangers, and guardrail chain. Made of low-carbon steel; not heat treated. Poly-coated chain color is green. Cold galvanized chain has a smooth zinc finish that provides excellent corrosion protection. Great for nailing, logging, and binding applications. Cold meets ASTM B 454 and MIL-C-1562A specifications. Standard lengths are 5, 10, 25, 50, and 100 ft. Work load limits are stated at room temperature. Work load limits are reduced in heat.

Trade Size, In.	Actual Material Dia., mm	Nom. Inside Link Size, Lg.	Wd.	Per Foot	
				1-49	50-Up
3/16	4	0.162"	0.27"	375	3,592T12
1/8	5	0.213"	0.40"	800	3,592T14
5/16	7	0.279"	0.45"	1,300	3,592T16
3/8	8	0.335"	0.49"	1,900	3,592T18
1/2	10	0.401"	0.60"	2,650	3,592T20
5/8	13	0.525"	0.81"	4,500	3,592T22
3/4	16	0.656"	1.02"	6,900	3,592T24
7/8	20	0.781"	1.22"	10,600	3,592T26
1	24	0.906"	1.42"	15,300	3,592T28
1 1/8	28	1.031"	1.62"	21,000	3,592T30
1 1/4	32	1.156"	1.82"	26,700	3,592T32
1 1/2	36	1.281"	2.02"	32,400	3,592T34
1 3/4	40	1.406"	2.22"	38,100	3,592T36
2	44	1.531"	2.42"	43,800	3,592T38
2 1/4	48	1.656"	2.62"	49,500	3,592T40
2 1/2	52	1.781"	2.82"	55,200	3,592T42
2 3/4	56	1.906"	3.02"	60,900	3,592T44
3	60	2.031"	3.22"	66,600	3,592T46
3 1/4	64	2.156"	3.42"	72,300	3,592T48
3 1/2	68	2.281"	3.62"	78,000	3,592T50
3 3/4	72	2.406"	3.82"	83,700	3,592T52
4	76	2.531"	4.02"	89,400	3,592T54
4 1/4	80	2.656"	4.22"	95,100	3,592T56
4 1/2	84	2.781"	4.42"	100,800	3,592T58
4 3/4	88	2.906"	4.62"	106,500	3,592T60
5	92	3.031"	4.82"	112,200	3,592T62
5 1/4</					

# Hook Latches & Chain Connectors



Attach stainless steel latches to plain hooks. SNAP LATCH—Standard hook latch. Consists of a latch, spring, latch bolt, and self-locking nut. Snap latches are not for use with Crosby 320N style hooks.

For Hook (Tons)

Carbon Steel	A	B	C	D
1/4"	1.44"	0.59"	0.16"	0.38"
1/2"	1.60"	0.59"	0.16"	0.38"
3/4"	1.84"	0.82"	0.19"	0.47"
1"	2.41"	1.00"	0.17"	0.56"
1 1/2"	2.97"	1.20"	0.20"	0.58"
2"	3.66"	1.50"	0.27"	0.59"
2 1/2"	4.94"	1.90"	0.39"	0.83"
3"	5.88"	2.56"	0.52"	0.94"
3 1/2"	6.50"	3.00"	0.39"	2.19"
4"	7.88"	4.12"	0.52"	3.31"
4 1/2"	8.44"	4.12"	0.52"	3.31"

## DOUBLE-ACTION LATCHES

Each	A	B	C	D
\$12.24	2.97"	1.21"	0.20"	0.38"
8944T12	3.66"	1.50"	0.27"	0.59"
8944T19	4.94"	1.90"	0.39"	0.83"
8944T23	5.88"	2.56"	0.52"	0.94"
8944T28	6.50"	3.00"	0.39"	2.19"
8944T31	7.88"	4.12"	0.52"	3.31"

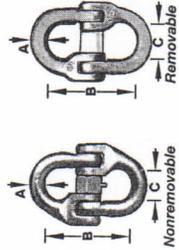
## CLAMP LATCHES

Hook Neck Size	Hook Throat Size	Each
1/8"-2"	3"	3544T19
2 1/8"-2 1/2"	3 1/2"	3544T39
2 3/8"-2 3/4"	3 1/2"	3544T41
2 1/2"-2 3/4"	3 3/4"	3544T42
2 3/4"-2 3/4"	4"	3544T43
3"-3 1/4"	4 1/2"	3544T44

## Alloy-Steel Chain Connectors

Use Grade 100 connectors with Grade 100 chain and components only. Grade 80 connectors should be used with Grade 80 chain and components only.

Chain Size	Standard Finish		Galvanized Finish	
	1-5	6-UP	1-5	6-UP
3/16" (7/32)	2,200	\$12.22	3,358T51	\$14.05
1/4" (1/4)	4,300	\$12.22	3,358T52	\$16.20
5/16"	5,500	\$15.11	3,358T53	\$17.39
3/8"	8,800	\$15.82	3,358T54	\$20.64
1/2"	15,000	\$26.57	3,358T55	\$30.07
5/8"	22,600	\$35.80	3,358T56	\$41.17
3/4"	31,600	\$42.69	3,358T57	\$50.58
7/8"	42,600	\$52.69	3,358T58	\$61.58
Grade 80—Nonremovable				
3/16" (7/32)	2,200	\$10.89	3,358T71	\$12.52
1/4" (1/4)	4,300	\$10.89	3,358T72	\$14.76
5/16"	5,500	\$13.63	3,358T73	\$15.86
3/8"	8,800	\$15.82	3,358T74	\$18.83
1/2"	15,000	\$26.57	3,358T75	\$30.07
5/8"	22,600	\$35.80	3,358T76	\$41.17
3/4"	31,600	\$42.69	3,358T77	\$50.58
7/8"	42,600	\$52.69	3,358T78	\$61.58
Grade 80—Removable				
3/16" (7/32)	2,100	\$10.48	3,358T13	\$11.40
1/4" (1/4)	4,300	\$10.48	3,358T14	\$12.75
5/16"	5,500	\$12.15	3,358T15	\$13.58
3/8"	8,800	\$15.11	3,358T16	\$22.51
1/2"	12,000	\$26.70	3,358T17	\$28.54
5/8"	18,100	\$39.96	3,358T18	\$40.62
3/4"	28,300	\$49.04	3,358T19	\$60.75
7/8"	34,200	\$65.97	3,358T20	\$81.19



Attach hooks, rings, master links, and other end fittings to steel chain or wire rope. Connectors are made of heat-treated, forged alloy steel.

Standard Finish is plain, uncoated steel. Super Galvanized Finish provides up to 10 times more corrosion resistance than standard galvanizing.

NONREMOVABLE CONNECTORS—True security in a mechanical coupling link. Once attached, link must be burned or cut off. Links cannot be disassembled with a punch and hammer.

REMOVABLE CONNECTORS—Fast assembly without special tools or skills. Parts can be used over and over before replacement is necessary.

Grade 80 Alloy Steel Chain Couplers

Grade 80 Alloy Steel Master and Half Links

Chain Size	Work Load Limit, Lbs.★	Each
3/16" (7/32)	3,500	3697T81
1/4" (1/4)	7,100	3697T82
5/16"	12,000	3697T83
3/8"	16,100	3697T84
1/2"	28,300	3697T85
5/8"	35,000	3697T86
3/4"	42,600	3697T87
7/8"	52,600	3697T88



"Two-in-one" unit eliminates the need for separate coupling link and master link. Links let you assemble chain rings right on the job. Great for chain and wire rope. Forged and heat-treated. Grade 80 alloy steel is painted yellow. To apply, remove pin joining sections and insert smaller section through chain link or around wire rope. Replace pin to join sections and connect.

# Chain Connectors

Use Standard and Wide Jaw units for connecting links. Use Delta-shaped units for thimbles, bulky fittings, and combination chain and rope connectors. Square connectors skip strap material for thimbles, bulky fittings, and combination chain and rope connectors. Square connectors skip strap material for thimbles, bulky fittings, and combination chain and rope connectors.

Chain Connector Information

Threaded Chain Connectors

Delta-Shaped Threaded Chain Connectors

Pear-Shaped Threaded Chain Connectors

Square Threaded Strap Connectors

Quick Connectors

Stock Dia.	Zinc-Plated Steel		Type 316 Stainless Steel	
	Std. Qty.	Each Pkg.	Std. Qty.	Each Pkg.
1/8"	50	\$0.70	120	\$2.28
9/32"	50	0.71	176	2.40
3/8"	50	0.71	240	2.98
1/2"	50	0.71	300	3.58
5/8"	50	0.71	360	4.18
3/4"	50	0.71	420	4.78
7/8"	50	0.71	480	5.38
1"	50	0.71	540	5.98
1 1/8"	50	0.71	600	6.58
1 1/4"	50	0.71	660	7.18
1 3/8"	50	0.71	720	7.78
1 1/2"	50	0.71	780	8.38
1 3/4"	50	0.71	840	8.98
1 7/8"	50	0.71	900	9.58
2"	50	0.71	960	10.18
2 1/8"	50	0.71	1,020	10.78
2 1/4"	50	0.71	1,080	11.38
2 3/8"	50	0.71	1,140	11.98
2 1/2"	50	0.71	1,200	12.58
2 5/8"	50	0.71	1,260	13.18
2 3/4"	50	0.71	1,320	13.78
2 7/8"	50	0.71	1,380	14.38
3"	50	0.71	1,440	14.98
3 1/8"	50	0.71	1,500	15.58
3 1/4"	50	0.71	1,560	16.18
3 3/8"	50	0.71	1,620	16.78
3 1/2"	50	0.71	1,680	17.38
3 5/8"	50	0.71	1,740	17.98
3 3/4"	50	0.71	1,800	18.58
3 7/8"	50	0.71	1,860	19.18
4"	50	0.71	1,920	19.78
4 1/8"	50	0.71	1,980	20.38
4 1/4"	50	0.71	2,040	20.98
4 3/8"	50	0.71	2,100	21.58
4 1/2"	50	0.71	2,160	22.18
4 5/8"	50	0.71	2,220	22.78
4 3/4"	50	0.71	2,280	23.38
4 7/8"	50	0.71	2,340	23.98
5"	50	0.71	2,400	24.58

Stock Dia.	Zinc-Plated Steel		Type 316 Stainless Steel	
	Std. Qty.	Each Pkg.	Std. Qty.	Each Pkg.
1/8"	50	\$0.70	120	\$2.28
9/32"	50	0.71	176	2.40
3/8"	50	0.71	240	2.98
1/2"	50	0.71	300	3.58
5/8"	50	0.71	360	4.18
3/4"	50	0.71	420	4.78
7/8"	50	0.71	480	5.38
1"	50	0.71	540	5.98
1 1/8"	50	0.71	600	6.58
1 1/4"	50	0.71	660	7.18
1 3/8"	50	0.71	720	7.78
1 1/2"	50	0.71	780	8.38
1 3/4"	50	0.71	840	8.98
1 7/8"	50	0.71	900	9.58
2"	50	0.71	960	10.18
2 1/8"	50	0.71	1,020	10.78
2 1/4"	50	0.71	1,080	11.38
2 3/8"	50	0.71	1,140	11.98
2 1/2"	50	0.71	1,200	12.58
2 5/8"	50	0.71	1,260	13.18
2 3/4"	50	0.71	1,320	13.78
2 7/8"	50	0.71	1,380	14.38
3"	50	0.71	1,440	14.98
3 1/8"	50	0.71	1,500	15.58
3 1/4"	50	0.71	1,560	16.18
3 3/8"	50	0.71	1,620	16.78
3 1/2"	50	0.71	1,680	17.38
3 5/8"	50	0.71	1,740	17.98
3 3/4"	50	0.71	1,800	18.58
3 7/8"	50	0.71	1,860	19.18
4"	50	0.71	1,920	19.78
4 1/8"	50	0.71	1,980	20.38
4 1/4"	50	0.71	2,040	20.98
4 3/8"	50	0.71	2,100	21.58
4 1/2"	50	0.71	2,160	22.18
4 5/8"	50	0.71	2,220	22.78
4 3/4"	50	0.71	2,280	23.38
4 7/8"	50	0.71	2,340	23.98
5"	50	0.71	2,400	24.58

Stock Dia.	Zinc-Plated Steel		Type 316 Stainless Steel	
	Std. Qty.	Each Pkg.	Std. Qty.	Each Pkg.
1/8"	50	\$0.70	120	\$2.28
9/32"	50	0.71	176	2.40
3/8"	50	0.71	240	2.98
1/2"	50	0.71	300	3.58
5/8"	50	0.71	360	4.18
3/4"	50	0.71	420	4.78
7/8"	50	0.71	480	5.38
1"	50	0.71	540	5.98
1 1/8"	50	0.71	600	6.58
1 1/4"	50	0.71	660	7.18
1 3/8"	50	0.71	720	7.78
1 1/2"	50	0.71	780	8.38
1 3/4"	50	0.71	840	8.98
1 7/8"	50	0.71	900	9.58
2"	50	0.71	960	10.18
2 1/8"	50	0.71	1,020	10.78
2 1/4"	50	0.71	1,080	11.38
2 3/8"	50	0.71	1,140	11.98
2 1/2"	50	0.71	1,200	12.58
2 5/8"	50	0.71	1,260	13.18
2 3/4"	50	0.71	1,320	13.78
2 7/8"	50	0.71	1,380	14.38
3"	50	0.71	1,440	14.98
3 1/8"	50	0.71	1,500	15.58
3 1/4"	50	0.71	1,560	16.18
3 3/8"	50	0.71	1,620	16.78
3 1/2"	50	0.71	1,680	17.38
3 5/8"	50	0.71	1,740	17.98
3 3/4"	50	0.71	1,800	18.58
3 7/8"	50	0.71	1,860	19.18
4"	50	0.71	1,920	19.78
4 1/8"	50	0.71	1,980	20.38
4 1/4"	50	0.71	2,040	20.98
4 3/8"	50	0.71	2,100	21.58
4 1/2"	50	0.71	2,160	22.18
4 5/8"	50	0.71	2,220	22.78
4 3/4"	50	0.71	2,280	23.38
4 7/8"	50	0.71	2,340	23.98
5"	50	0.71	2,400	24.58

Stock Dia.	Zinc-Plated Steel		Type 316 Stainless Steel	
	Std. Qty.	Each Pkg.	Std. Qty.	Each Pkg.

# Anchor & Twisted Shackles

**Shackle Information**  
 movement of rigging chain lines. This reduces chain wear and prevents kinking and fouling.  
**Twisted**—Spiral design accommodates two-plane movement.  
**Shackles come with one of three pin styles:**  
**SCREW PINS**—Shackles with captive screw pins need no special tools to assemble. Slip a screwdriver blade or hand punch through pin eye and tighten. **CAUTION: Screw pin shackles should not be used where load shifting might unscrew the shackle pin.**  
**BOLT PINS**—Also known as safety shackles. Bolt pins with threaded ends accommodate nuts as well as locking cotter pins.  
**LOOSE PINS**—Unthreaded pins are locked with cotter pins except Type 316 stainless steel.



**Anchor Shackle with Bolt Pin**  
 Anchor Shackle with Loose Pin  
 Twisted Shackle with Screw Pin

Stock Dia.	Screw Pins			Loose Pins		
	A	B	C	Work Load Limit, Lbs.*	Each Bkn. Pkg.	Full Pkg.
3/8"	1 1/2"	1 1/4"	1 1/2"	6,500	8966T51	\$13.60
1/2"	1 3/4"	1 1/2"	1 3/4"	10,000	8966T52	19.09
5/8"	1 7/8"	1 3/4"	1 7/8"	14,000	8966T53	28.59
3/4"	2"	1 7/8"	2"	19,000	8966T54	30.05
7/8"	2 1/8"	2"	2 1/8"	25,000	8966T55	40.11
1"	2 3/8"	2 1/8"	2 3/8"	42,000	8966T56	60.80
1 1/4"	3 1/8"	2 3/8"	3 1/8"	80,000	8966T57	105.33
1 1/2"	3 3/8"	3 1/8"	3 3/8"	100,000	8966T58	147.79
2"	4 1/8"	3 3/8"	4 1/8"	100,000	8966T59	247.08

**GALVANIZED ALLOY STEEL ANCHOR SHACKLE**

Stock Dia.	A	B	C	Work Load Limit, Lbs.*	Each Bkn. Pkg.	Full Pkg.
3/8"	1 1/2"	1 1/4"	1 1/2"	666	3568T44	\$2.42
1/2"	1 3/4"	1 1/2"	1 3/4"	1,000	3568T45	2.73
5/8"	1 7/8"	1 3/4"	1 7/8"	1,500	3568T46	3.38
3/4"	2"	1 7/8"	2"	2,000	3568T47	3.76
7/8"	2 1/8"	2"	2 1/8"	3,000	3568T48	4.06
1"	2 3/8"	2 1/8"	2 3/8"	4,000	3568T49	4.46
1 1/4"	3 1/8"	2 3/8"	3 1/8"	6,500	3568T50	7.27
1 1/2"	3 3/8"	3 1/8"	3 3/8"	9,000	3568T51	9.27
2"	4 1/8"	3 3/8"	4 1/8"	13,000	3568T52	13.92
2 1/2"	5 1/8"	4 1/8"	5 1/8"	17,000	3568T53	17.76
3"	6 1/8"	5 1/8"	6 1/8"	19,000	3568T54	20.57
3 1/2"	7 1/8"	6 1/8"	7 1/8"	24,000	3568T55	42.59
4"	8 1/8"	7 1/8"	8 1/8"	28,000	3568T56	46.57
4 1/2"	9 1/8"	8 1/8"	9 1/8"	34,000	3568T57	43.69
5"	10 1/8"	9 1/8"	10 1/8"	50,000	3568T58	84.98
5 1/2"	11 1/8"	10 1/8"	11 1/8"	50,000	3568T59	147.79
6"	12 1/8"	11 1/8"	12 1/8"	70,000	3568T60	168.69

**TYPE 316 STAINLESS STEEL ANCHOR SHACKLE**

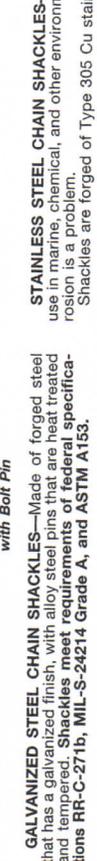
Stock Dia.	A	B	C	Work Load Limit, Lbs.*	Each Bkn. Pkg.	Full Pkg.
3/8"	1 1/2"	1 1/4"	1 1/2"	450	3860T51	\$30.22
1/2"	1 3/4"	1 1/2"	1 3/4"	650	3860T52	32.63
5/8"	1 7/8"	1 3/4"	1 7/8"	1,000	3860T53	37.03
3/4"	2"	1 7/8"	2"	1,375	3860T54	39.81
7/8"	2 1/8"	2"	2 1/8"	1,990	3860T55	46.81
1"	2 3/8"	2 1/8"	2 3/8"	3,000	3860T56	60.48
1 1/4"	3 1/8"	2 3/8"	3 1/8"	4,475	3860T57	102.70
1 1/2"	3 3/8"	3 1/8"	3 3/8"	6,000	3860T58	135.62
2"	4 1/8"	3 3/8"	4 1/8"	7,950	3860T59	179.40

**TYPE 304 STAINLESS STEEL TWISTED SHACKLE**

Stock Dia.	A	B	C	Work Load Limit, Lbs.*	Each Bkn. Pkg.	Full Pkg.
3/8"	1 1/2"	1 1/4"	1 1/2"	450	3569T34	\$20.78
1/2"	1 3/4"	1 1/2"	1 3/4"	650	3569T35	22.67
5/8"	1 7/8"	1 3/4"	1 7/8"	1,000	3569T36	26.80
3/4"	2"	1 7/8"	2"	1,375	3569T37	28.82
7/8"	2 1/8"	2"	2 1/8"	1,990	3569T38	32.63
1"	2 3/8"	2 1/8"	2 3/8"	3,000	3569T39	36.94
1 1/4"	3 1/8"	2 3/8"	3 1/8"	4,475	3569T40	41.38
1 1/2"	3 3/8"	3 1/8"	3 3/8"	6,000	3569T41	54.83
2"	4 1/8"	3 3/8"	4 1/8"	7,950	3569T42	73.50

# Chain Sha

**Steel and Stainless Steel**  
**Chain Shackles with Loose Pin**  
**Chain Shackles with Bolt Pin**  
**Chain Shackles with Screw Pin**  
**Long Sha with Self-Loc (No Cotter Pin)**



**Anchor Shackle with Bolt Pin**  
**Anchor Shackle with Loose Pin**  
**Twisted Shackle with Screw Pin**

**GALVANIZED STEEL CHAIN SHACKLES**—Made of forged steel that has a galvanized finish with alloy steel pins that are heat treated and tempered. Shackles meet requirements of Federal specifications RR-C-271b, MIL-S-24214 Grade A, and ASTM A153. Shackles are forged of Type 305 Cu stain

Stock Dia.	With Screw Pin			With Bolt Pin		
	A	B	C	Work Load Limit, Lbs.*	Each Bkn. Pkg.	Full Pkg.
3/8"	1 1/2"	1 1/4"	1 1/2"	1,000	3560T44	\$2.93
1/2"	1 3/4"	1 1/2"	1 3/4"	1,500	3560T45	2.86
5/8"	1 7/8"	1 3/4"	1 7/8"	2,000	3560T46	3.26
3/4"	2"	1 7/8"	2"	3,000	3560T47	3.44
7/8"	2 1/8"	2"	2 1/8"	4,000	3560T48	4.20
1"	2 3/8"	2 1/8"	2 3/8"	6,500	3560T49	5.53
1 1/4"	3 1/8"	2 3/8"	3 1/8"	10,000	3560T50	9.42
1 1/2"	3 3/8"	3 1/8"	3 3/8"	13,000	3560T51	12.90
2"	4 1/8"	3 3/8"	4 1/8"	19,000	3560T52	23.77
2 1/2"	5 1/8"	4 1/8"	5 1/8"	24,000	3560T53	42.86
3"	6 1/8"	5 1/8"	6 1/8"	28,000	3560T54	48.81
3 1/2"	7 1/8"	6 1/8"	7 1/8"	34,000	3560T55	63.51
4"	8 1/8"	7 1/8"	8 1/8"	50,000	3560T56	77.88
4 1/2"	9 1/8"	8 1/8"	9 1/8"	70,000	3560T57	118.89
5"	10 1/8"	9 1/8"	10 1/8"	100,000	3560T58	171.37
5 1/2"	11 1/8"	10 1/8"	11 1/8"	100,000	3560T59	315.45

**TYPE 305 Cu STAINLESS STEEL—10 per Package**

Stock Dia.	A	B	C	Work Load Limit, Lbs.*	Each Bkn. Pkg.	Full Pkg.
3/8"	1 1/2"	1 1/4"	1 1/2"	550	3824T41	\$7.56
1/2"	1 3/4"	1 1/2"	1 3/4"	825	3824T42	9.18
5/8"	1 7/8"	1 3/4"	1 7/8"	1,200	3824T43	11.73
3/4"	2"	1 7/8"	2"	1,650	3824T44	14.98
7/8"	2 1/8"	2"	2 1/8"	2,200	3824T45	22.56
1"	2 3/8"	2 1/8"	2 3/8"	3,000	3824T46	34.28

**TYPE 305 Cu STAINLESS STEEL - LONG SHACKLE WITH KEY PIN—10 per Package**

Stock Dia.	A	B	C	Work Load Limit, Lbs.*	Each Bkn. Pkg.	Full Pkg.
3/8"	1 1/2"	1 1/4"	1 1/2"	550	3841T51	\$9.18
1/2"	1 3/4"	1 1/2"	1 3/4"	825	3841T52	10.85
5/8"	1 7/8"	1 3/4"	1 7/8"	1,200	3841T53	14.72
3/4"	2"	1 7/8"	2"	1,650	3841T54	20.37

**Wide Mouth Clevises**

Stock Dia.	A	B	C	Proof Load, Lbs.	Stock Dia.	A	B	C	Proof Load, Lbs.
1"	2 1/8"	1"	2 1/8"	25,000	3/4"	1 1/8"	3/4"	1 1/8"	20,000
1 1/4"	3 1/8"	1 1/4"	3 1/8"	35,000	1/2"	1 1/4"	1/2"	1 1/4"	15,000
1 1/2"	3 3/8"	1 1/2"	3 3/8"	45,000	5/8"	1 3/8"	5/8"	1 3/8"	20,000
2"	4 1/8"	2"	4 1/8"	60,000	3/8"	1 1/8"	3/8"	1 1/8"	10,000

ADDENDUM to Engineering Note MSD EN-142  
"Analysis of the Green Block Lifting Fixture"

During the test of the lifting fixture, some slipperiness was observed. Field measurements turn out that the tongs in service opens up more than was assumed in the analysis (page 2 ~ 3 of the note) which was based on the drawing (8875.126-MD-406181). Some other factors may also contributed to the slipperiness. ex. the weld beads was not grounded.

To prevent the slipperiness, a cross bar is designed to modify the lifting fixture. The analysis is next page, and the schematic is attached. In Pg 95. plot of force in cross bar versus frictional coefficient is presented for  $\alpha = 30^\circ$ .

Assume the angle in Pg 2 is changed to  $\alpha = 30^\circ$ ,  
 See what friction coefficient is required

$$\mu = \frac{F_T}{F_N} = \frac{W \cos \alpha - F_H \sin \alpha}{W \sin \alpha + F_H \cos \alpha} = 0.32$$

still less than what we find from the handbook

Now we assume that the frictional coefficient  $\mu = 0.1$ ,  
 see what force will be required in the cross bar to  
 hold the tongs together without slipping.

$$\mu = 0.1 = \frac{W \cos \alpha - (F_H + F_B) \sin \alpha}{W \sin \alpha + (F_H + F_B) \cos \alpha}$$

We know that  $F_H = 0.91 W$ , We assume  $F_B = \xi W$ ,

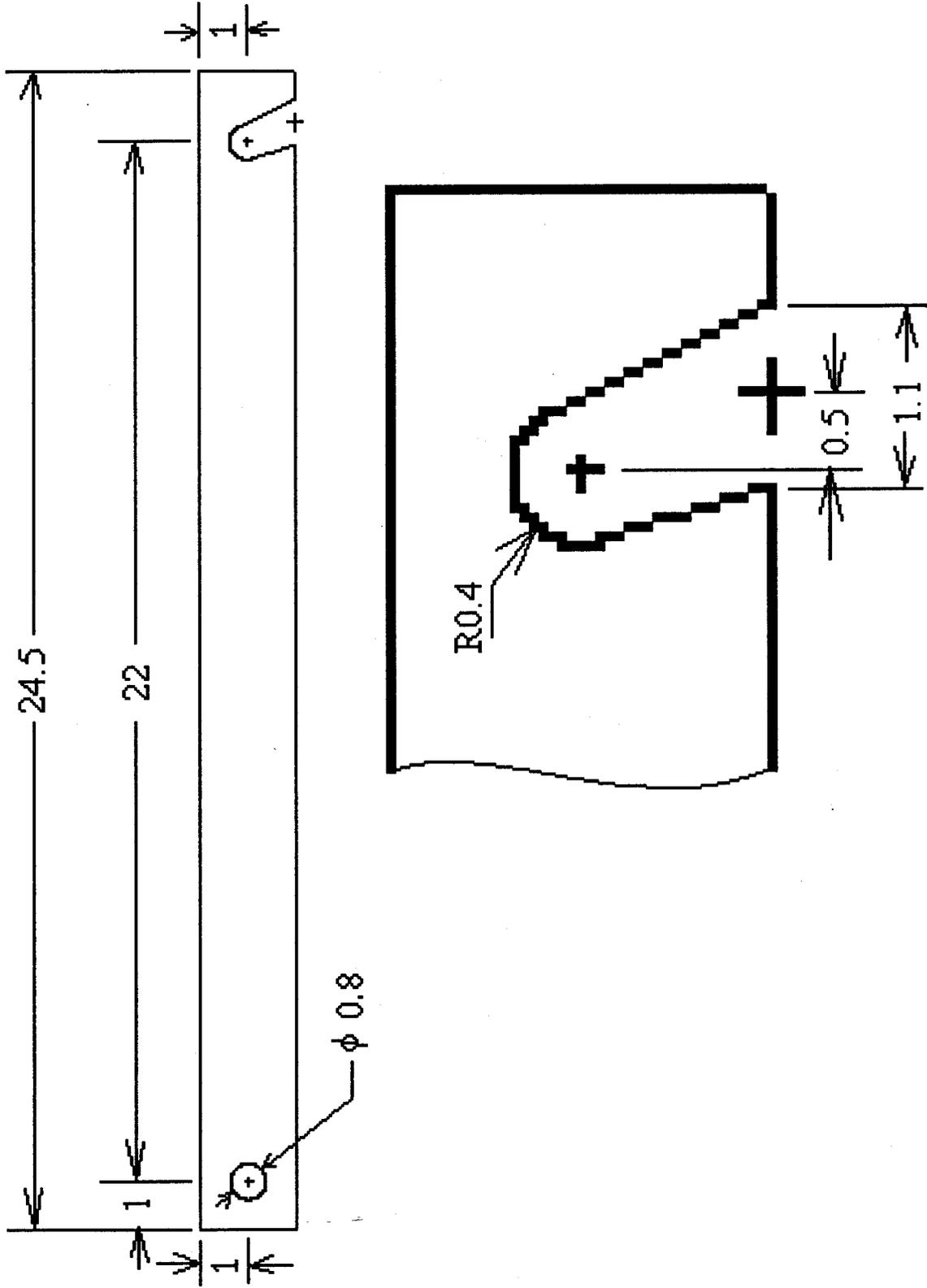
then

$$0.1 = \frac{\cos \alpha - (0.91 + \xi) \sin \alpha}{\sin \alpha + (0.91 + \xi) \cos \alpha}$$

solve for  $\xi$ . We get  $\xi = 0.48$

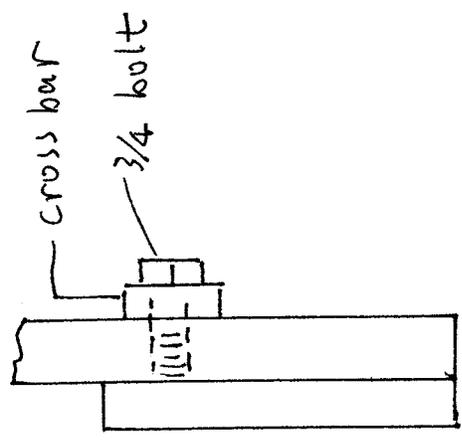
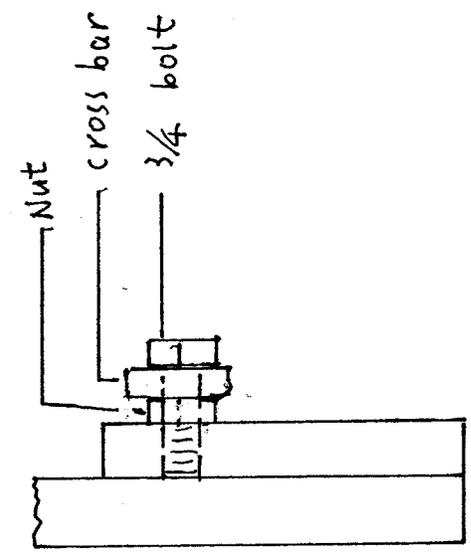
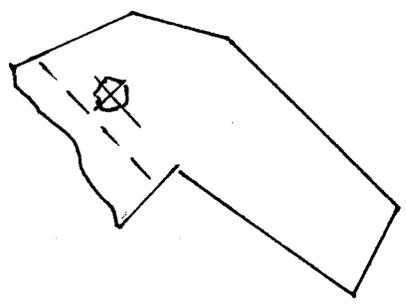
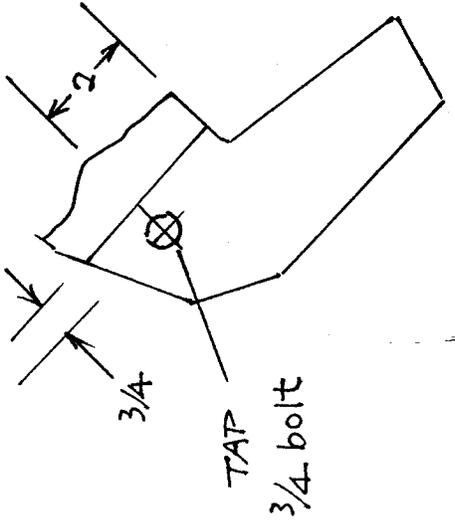
Therefore

$$F_B = \xi W = (0.48)(5000) = 2400 \text{ lbs.}$$

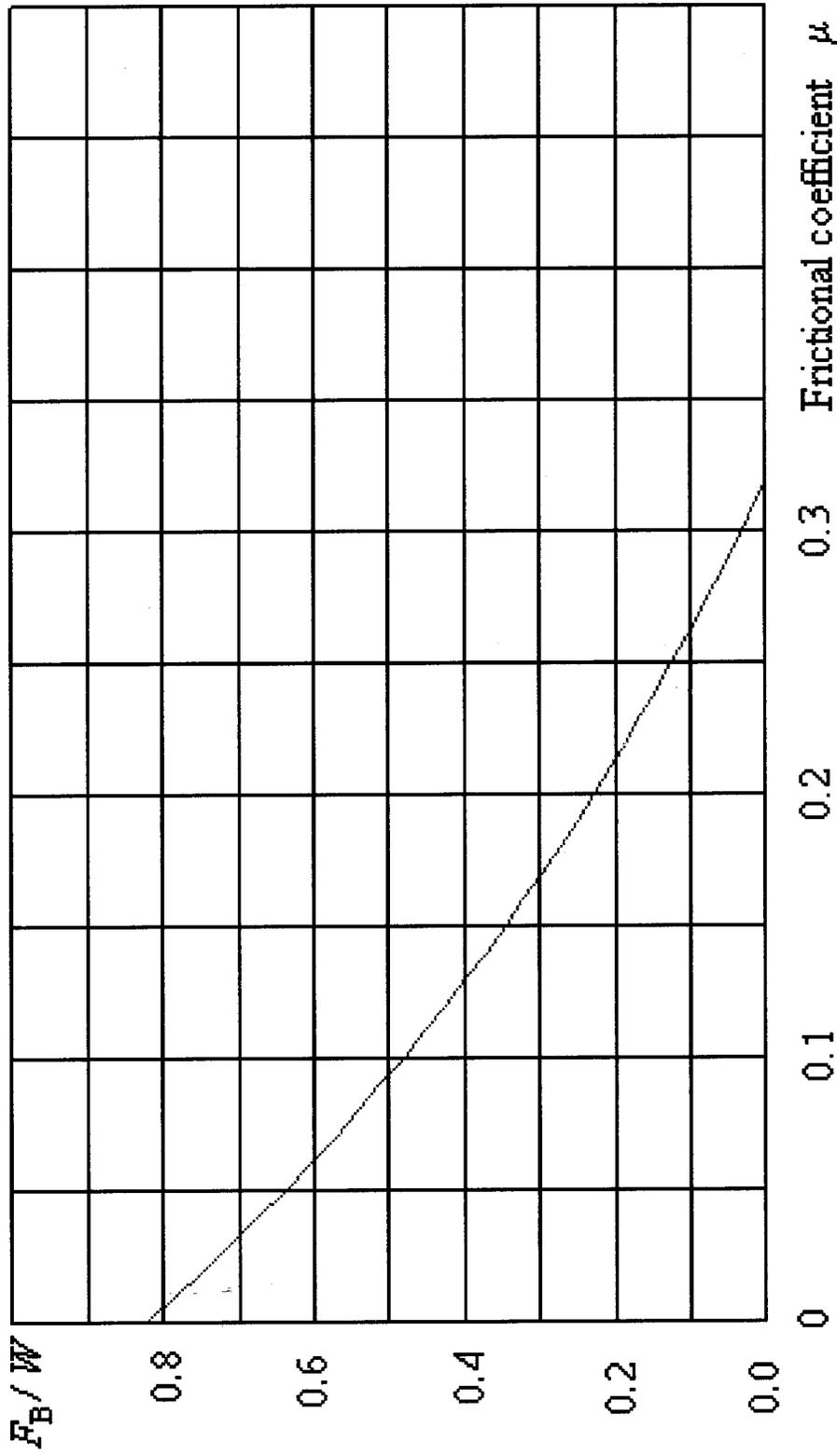


Numi Green Block Lifting Fixture Cross Bar

( )



Force in cross bar versus frictional coefficient

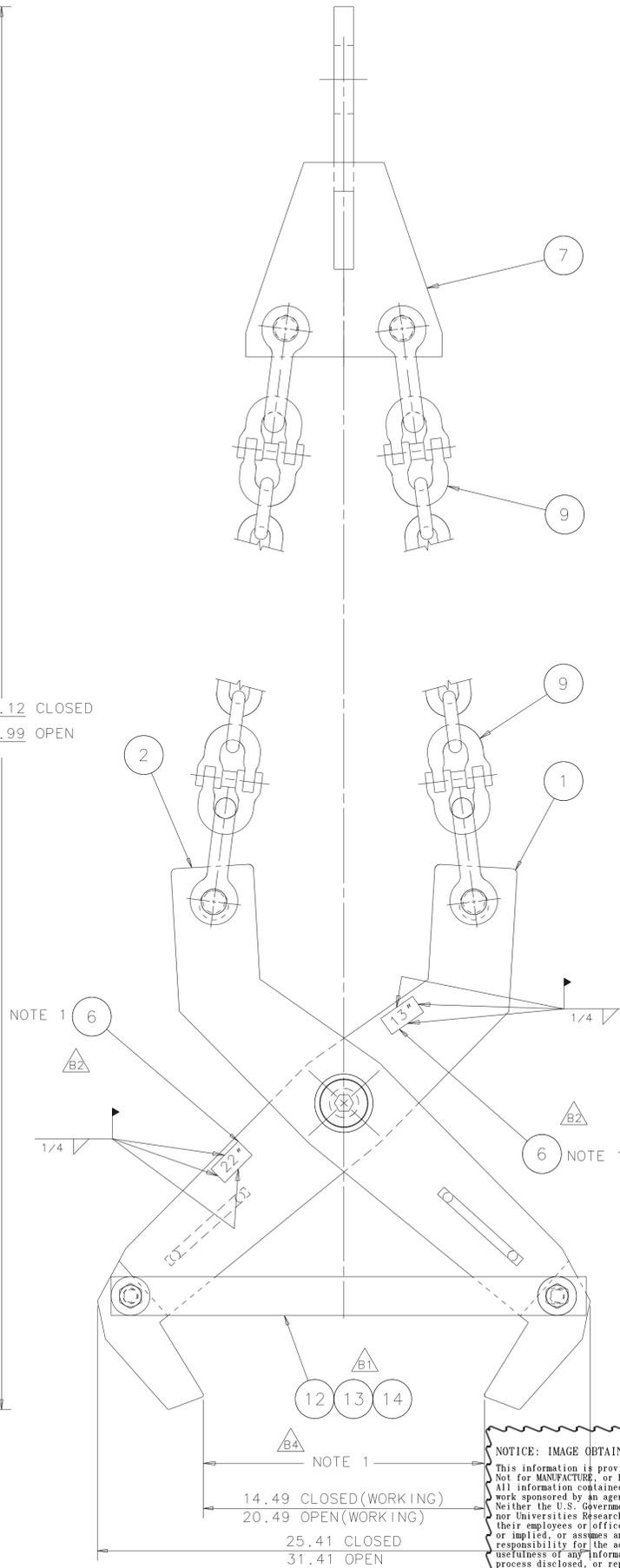
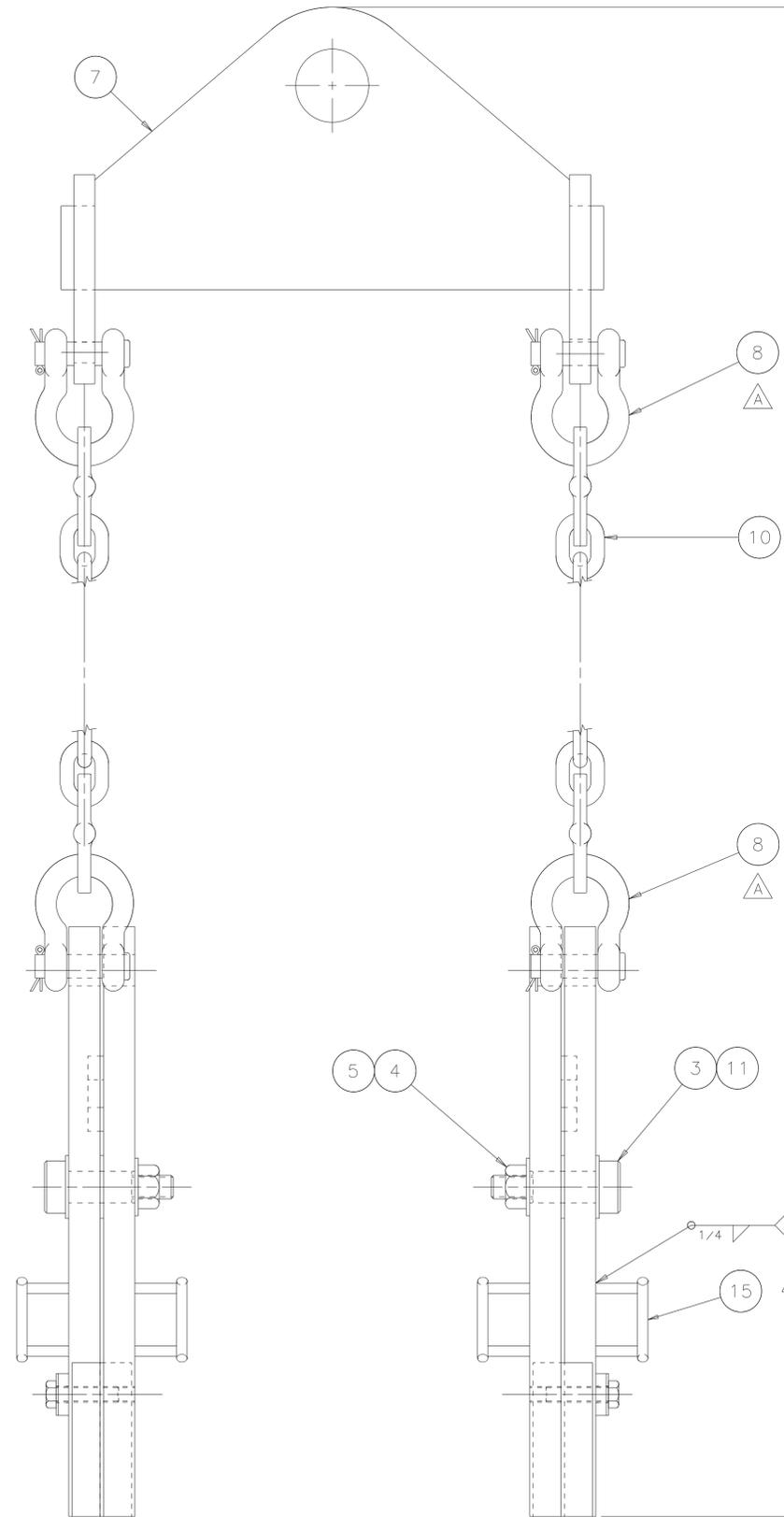


f

(

)

REV	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE
A	REVISED DESCRIPTION FOR ITEM 8 TO MATCH REQUISITION.	B. CYKO J. KILMER	10-03-03 10-05-03
B	1. ADDED ITEM 12 AND ASSOCIATED HARDWARE, CHAIN LENGTH WAS 3 FT. 2. LOCATION OF (ITEM 6) TO BE FIELD WELDED; 3. ADDED ITEM 15; 4. CHANGED NOTE 1 FOR FIELD WELD DIM.; 5. CHANGED QTY. (ITEM 6) 4 WAS 2, MATERIAL SIZE 5/8 X 1 X 2.00 WAS 3/4 X 2 X3.00.	F. McCONOLOGUE/ B. ELLISON  C. NILA	12/04/03  07-DEC-03



ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
15	MB-431611	HANDLE WELDMENT	4
14	COML	HEX HD. CAP SCR. 3/4-10 X 3.00 LG. GRADE 5	4
13	COML	3/4 FLAT WASHER, ALLOY STL.	4
12	MC-431589	SAFETY BAR	2
11	COML	1 1/2 FLAT WASHER, ALLOY STL.	4
10	COML	CHAIN, GRADE 80 ALLOY STEEL, 2 FT. LONG, McMASTER-CARR #3587T17	4
9	COML	CHAIN CONNECTOR FOR 5/8 CHAIN, GRADE 80 ALLOY STL, McMASTER-CARR #3578T17	8
8	COML	SHACKLE w/SAFETY PIN, Ø1", 25K LB. LOAD LIMIT, McMASTER-CARR #8966T55	8
7	MD-406867	INGOT LIFTER ASSEMBLY	1
6	COML	FLAT, 5/8 x 1 x 2.00 LG. A36 STEEL (SAFETY STOPS)	4
5	COML	1 1/8 FLAT WASHER, ALLOY STL.	2
4	COML	NUT 1 1/8-7UNC HX. HD. GRADE 8	2
3	COML	SHOULDER SCREW 5.00 LG. HX. SOC. HD 1 1/2 DIA. SHOULDER, 1 1/8-7UNC THD x 1.50 LG. ALLOY STEEL	2
2	MD-406180	WELDMENT LEFT	2
1	MD-406175	WELDMENT RIGHT	2

PARTS LIST			
UNLESS OTHERWISE SPECIFIED	ORIGINATOR	J. KILMER	30-APR-2002
.XX .XXX ANGLES	DRAWN	V. MAJDANSKI	02-MAY-2002
± --- ± --- ± ---	CHECKED	D. FRIEND	06-JUN-2002
1. BREAK ALL SHARP EDGES .015 MAX.	APPROVED	J. KILMER	06-JUN-2002
2. DO NOT SCALE DRAWING.	USED ON		
3. DIMENSIONS BASED UPON ANS1 Y14.5M-1982	MATERIAL		
4. MAX. ALL MACH. SURFACES 250	SEE PARTS LIST ABOVE		

**FERMI NATIONAL ACCELERATOR LABORATORY**  
UNITED STATES DEPARTMENT OF ENERGY

PPD/MECHANICAL DEPARTMENT  
NUMI, GREEN BLOCK LIFTING FIXTURE  
LIFTING FIXTURE ASSEMBLY

SCALE	DRAWING NUMBER	SHEET	REV
1 : 4	8875.126-MD-406181	1 OF 1	B

CREATED WITH : Ideos11NXSeries GROUP: PPD/MECHANICAL DEPARTMENT

**NOTES**

1. WELD SAFETY STOPS (ITEM 6) TO ITEM 1 BY SETTING JAW OPENINGS TO 13" AND 22" AS SHOWN.

**NOTICE: IMAGE OBTAINED FROM FERMI LAB WEB SITE**  
This information is provided for REFERENCE use only. Not for MANUFACTURE, or DESIGN INFORMATION. All information contained in this document represents work sponsored by an agency of the U.S. Government. Neither the U.S. Government nor any agency thereof, nor Universities Research Association, Inc., nor any of their employees or officers, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product or process disclosed, or represents that its use would not infringe privately owned rights.

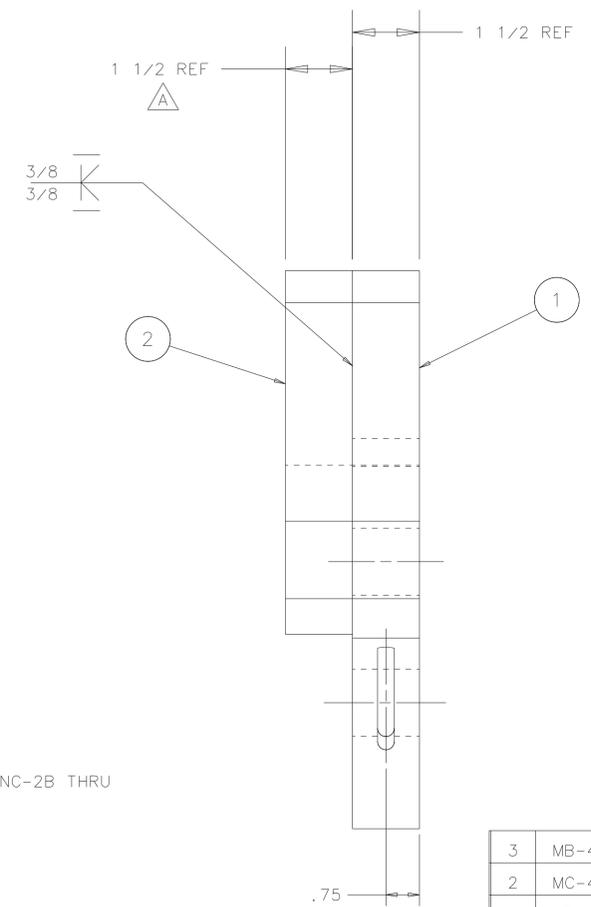
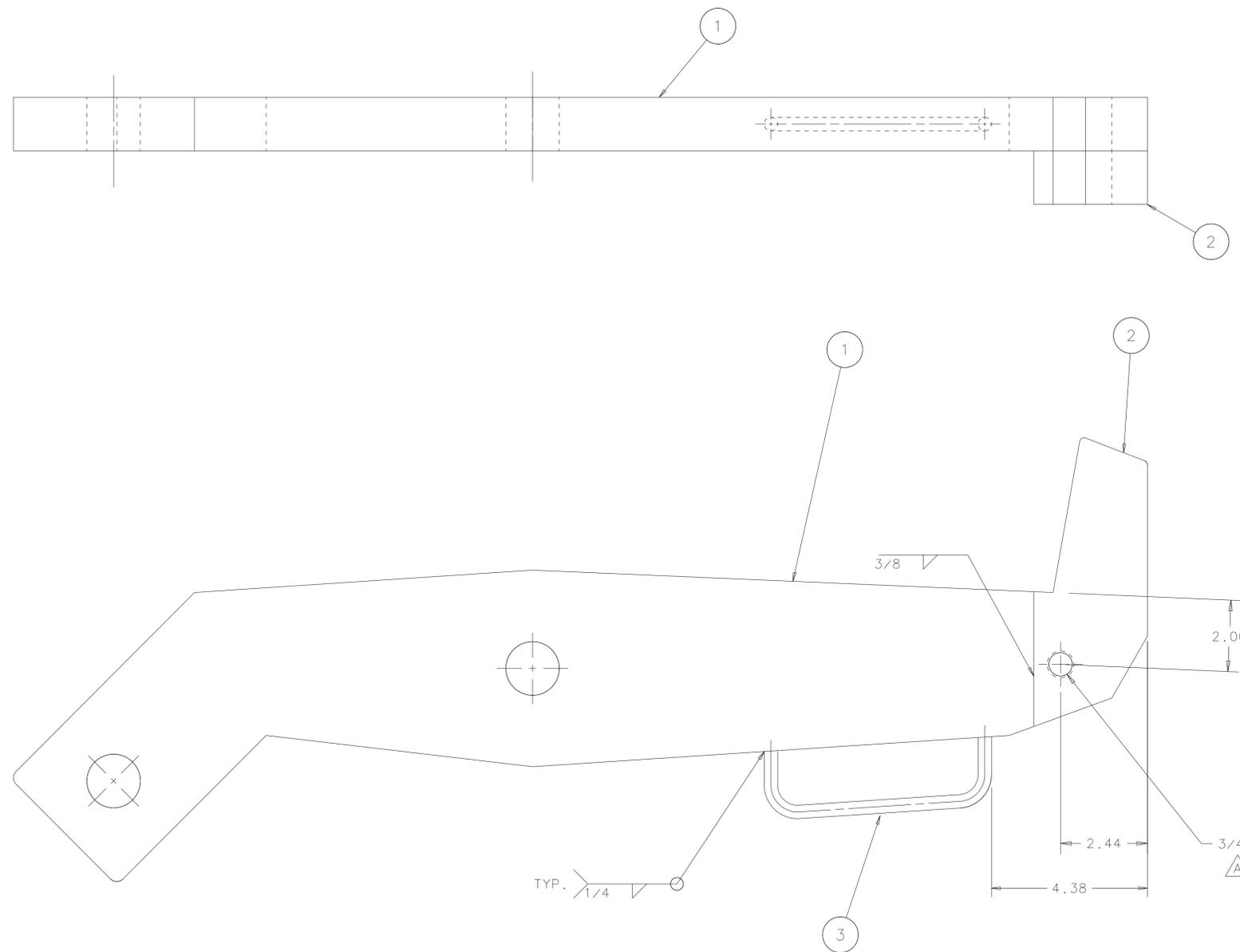
72.12 CLOSED  
73.99 OPEN

NOTE 1

14.49 CLOSED (WORKING)  
20.49 OPEN (WORKING)

25.41 CLOSED  
31.41 OPEN

REV	DESCRIPTION	DRAWN	DATE
		APPROVED	DATE
A	ITEM NO. 2 THICKNESS WAS 1.00, ADDED TAPPED HOLE	F. McCONOLOGUE C. NILA	11-13-03 13-NOV-03



ITEM	PART NO.	DESCRIPTION OR SIZE	QTY.
3	MB-406179	HANDRAIL	1
2	MC-406177	STIFFENER NO.1	1
1	MD-406176	LIFTING BAR	1

PARTS LIST			
UNLESS OTHERWISE SPECIFIED	ORIGINATOR	J. KILMER	30-APR-2002
.XX	.XXX	ANGLES	DRAWN
± .06	± --	± --	V. MAJDANSKI
			D. FRIEND
			04-JUN-2002
1. BREAK ALL SHARP EDGES	APPROVED	J. KILMER	05-JUN-2002
.015 MAX.	USED ON		
2. DO NOT SCALE DRAWING.	MD-406181		
3. DIMENSIONS BASED UPON	MATERIAL		
ANSI Y14.5M-1982	SEE PARTS LIST ABOVE		
4. MAX. ALL MACH. SURFACES			
250			

**FERMI NATIONAL ACCELERATOR LABORATORY**  
UNITED STATES DEPARTMENT OF ENERGY

PPD/MECHANICAL DEPARTMENT  
NUMI, GREEN BLOCK LIFTING FIXTURE  
WELDMENT-RIGHT

SCALE	DRAWING NUMBER	SHEET	REV
1 : 2	8875.126-MD-406175	1 OF 1	A

CREATED WITH : Ideos11NXSeries GROUP: PPD/MECHANICAL DEPARTMENT

NOTICE: IMAGE OBTAINED FROM FERMILAB WEB SITE  
This information is provided for REFERENCE use only.  
Not for MANUFACTURE, or DESIGN INFORMATION.  
All information contained in this document represents  
work sponsored by an agency of the U.S. Government.  
Neither the U.S. Government nor any agency thereof,  
nor Universities Research Association, Inc., nor any of  
their employees or officers, makes any warranty, express  
or implied, or assumes any legal liability or  
responsibility for the accuracy, completeness, or  
usefulness of any information, apparatus, product or  
process disclosed, or represents that its use would not  
infringe privately owned rights.