5-1995

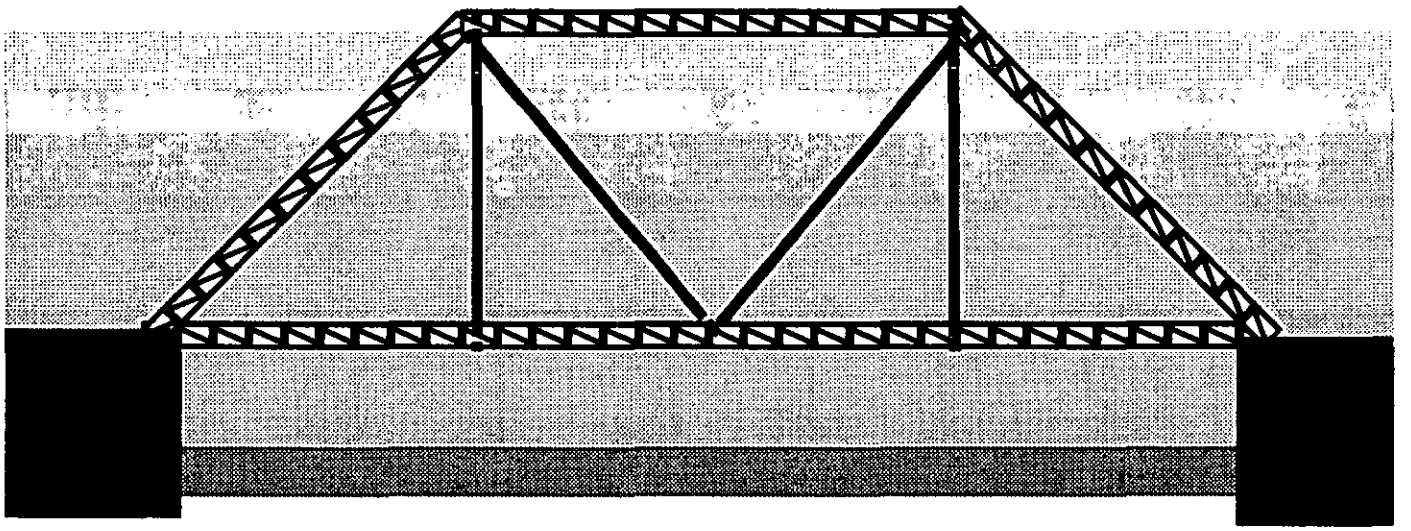
# Final Specification Report for the AISC Steel Bridge Design for the AISC Bridge-Building Competition c/o Egyptian Associates

Derek A. Peebles

# FINAL SPECIFICATION REPORT
FOR

# THE AISC
# STEEL BRIDGE
# DESIGN

FOR
## AISC BRIDGE-BUILDING COMPETITION
## c/o EGYPTIAN ASSOCIATES



PREPARED
BY


## SALUKI ENGINEERING COMPANY
## GROUP VI


EA REFERENCE NO. BRIDGE06.S95
SEC REFERENCE NO. DES.06.S95

APRIL 26, 1995

May 5, 1995

Dr. Williams:

With this letter, you will find the completed design report for my Honors Thesis Project. As I have mentioned, the design was undertaken by myself and two other senior engineering students, under the supervision of an advisor.

To give you a little background about the nature of bridge design, it was preformed with the intention of entering the bridge in the 1996 AISC (American Institute of Steel Construction) Steel Bridge Competition. The regional and national competitions are sponsored annually by AISC, giving civil engineering students an opportunity to apply their text book knowledge with the design and construction of a 1:10 scale steel bridge. The rules of the competition are quite extensive and meant to replicate the challenges of an actual bridge project. I have included a copy of the 1995 rules in the back pocket of the design notebook.

The Southern Illinois University at Carbondale Chapter of The American Society of Civil Engineers (ASCE) has participated in the bridge competition for three years running, becoming more competitive with each passing year. This past year the chapter's bridge won in the category of lightest bridge at the Regional competition held at Kansas State University. We have incorporated lessons learned from the past bridge designs and believe that this currently completed design has the necessary compromise between weight, stiffness, and speed of assembly, to enable it to win in the overall category at next year's competition.

I must mention that this report is a summary of the design procedure which will be followed by the team of ASCE members who will fabricate the bridge in the Fall of 1995. For this reason, it does not include the large bulk of calculations and other work which resulted in the final design.

As a final note, I wish to thank you and everyone else who has contributed their time and energy into making the Honors Program at SIUC such success. It has truly enriched my experiences at SIUC. In particular, I cannot say enough about the lecture series. The speakers which you have scheduled have been a constant source of new ideas and inspiration to me and I know many others. I will miss them when I leave SIUC. Keep up the good work and again thank you.

Sincerely,

Derek Peebles

Derek Peebles

Saluki Engineering Company
1200 South Illinois Avenue
Carbondale, IL 62901
April 26, 1995

Kay Purcell
Manager of Projects
Egyptian Associates
1000 Douglas Drive
Carbondale, IL 62901-6603

Subject: Final Report for design of steel bridge
Project No: BRIDGE06.S95
SEC No: DES06.S95

Dear Mrs. Purcell:

This letter is to inform you that the eleven week study and design of the AISC Steel Bridge has been completed as contracted. Saluki Engineering Company hereby submits the AISC Steel Bridge design specification report to Egyptian Associates at 12:00 pm on April 26, 1995.

Saluki Engineering Company would like to thank you for the opportunity to work on this design project. If you have any questions regarding this report, please contact the project manager, Sarah Ohler, at (618) 529-4252.

Sincerely,

Bill DeBridge
Vice President
Saluki Engineering Company

# SECTION A

## TABLE OF CONTENTS


| | page |
|---|---|
| I. Title Page (RD) | A-1 |
| II. Table of Contents (SO*,DP,RD) | A-2,A-3,A-4,A-5 |
| III. Executive Summary (SO) | A-6 |
| IV. Capital Cost Summary (SO) | A-7,A-8,A-9 |
| V. Critical Path Schedule Diagram (DP*,SO,RD) | A-10,A-11,A-12,A-13 |
| VI. Introduction / Project Description (RD) | A-14 |
| VII. Equipment List/ Materials List (DP) | A-15(A), A-15(B) |
| VIII. Numbering System for Bridge (RD) | A-16 |
| IX. Plot Plan (DP) | A-17,A-18,A-19 |
| X. Design Basis (SO) | A-20 |
| XI. Section B: Member Design (DP) | B-1 to B-13 |
| XII. Section C: Connection Design (RD) | C-1 to C-18 |
| XIII. Section D: Fabrication Process(SO) | D-1 to D-16 |
| XIV. Appendix A: Final Computer Analysis (DP) | E-1 to E-9 |
| XV. Appendix B: USG Funding Procedure (SO) | E-10,E-11 |
| XVI. Appendix C: Vendor Backup (SO) | E12 to E-28 |
| XVII. Appendix D: Combined Bibliography (DP) | E29,E30 |

## TABLE OF CONTENTS


| | page |
|---|---|
| I. Table of Contents | B-1 |
| II. Introduction | B-2 |
| III. Technical Discussion | B-3–B-6 |
| IV. Material List | B-7 |
| V. Cost Summary | B-8 |

VI. Drawings

| Number | Name | Member Numbers | |
|---|---|---|---|
| 101 | Bottom Chord | 1,4,13,16 | B-9 |
| 102 | Bottom Chord | 2,3,14,15 | B-10 |
| 103 | Top Chord | 7,8,19,20 | B-11 |
| 104 | Top Chord | 9,10,21,22 | B-12 |

| | |
|---|---|
| VII.Bibliography | B-13 |

# TABLE OF CONTENTS


| | | Page No. |
|---|---|---|
| I. | Table of Contents | C-1 |
| II. | Introduction | C-2 |
| III. | Technical Discussion | C-3, C-4, C-5 |
| IV. | Assembly Process | C-6, C-7 |
| V. | Material List | C-8 |
| VI. | Cost List | C-9 |
| VII. | Drawings | |

| Number | Name | Joint Number | |
|---|---|---|---|
| 201 | Full Bridge (3-D) | all | C-10 |
| 202 | Member and Joint Numbers | all | C-11 |
| 203 | Dimensioned Bridge | all | C-12 |
| 204 | Bottom End Connections | 1, 5, 9, 13 | C-13 |
| 205 | Bottom Inner Connections | 2, 4, 10, 12 | C-14 |
| 206 | Bottom Center Connections | 3, 11 | C-15 |
| 207 | Top Outer Connections | 6, 8, 14, 15 | C-16 |
| 208 | Top Center Connection | 7 | C-17 |

| | | |
|---|---|---|
| VIII. | Bibliography | C-18 |

# TABLE OF CONTENTS


| | page |
|---|---|
| I. Table of Contents | D-1 |
| II. Introduction | D-2 |
| III. Technical Discussion | D-3, D-4, D-5 |
| IV. Material List | D-6 |
| V. Equipment List | D-7 |
| VI. Costing Summary | D-8, D-9 |

VII. Drawings

| Number | Name | Member Number | |
|---|---|---|---|
| 301 | Hinged Rods | 37, 38 | D-10 |
| 302 | Hinged Rods | 5, 6, 17, 18 | D-11 |
| 303 | Hinged Rods | 11, 12, 23, 24 | D-12 |
| 304 | Lateral Bracing | 35, 36 | D-13 |
| 305 | Lateral Bracing | 25, 26 | D-14 |
| 306 | Lateral Bracing | 27, 28, 29, 30, 31, 32, 33, 34 | D-15 |

VIII. Bibliography D-16

## EXECUTIVE SUMMARY

The Steel Bridge has been completed in accordance with the request for proposal received on January 31, 1995 from Egyptian Associates. Included in the report is a detailed drawing of each member and each connection, a fabrication sequence, an assembly sequence, a final analysis of the design, a cost summary, and a critical path schedule and PERT chart.

The bridge for the 1996 AISC National Steel Bridge Competition has been designed for stiffness, lightness, construction speed, aesthetics, efficiency, and economy. Its height and basic structural design encompass the stiffness aspect. The economy and lightness are due to the type of steel members used. Hinged members allow for the efficiency and speed in construction. Aesthetics were incorporated into the design and painting of the bridge.

The bridge will cost $494.22 in steel, if nothing is donated, and $835.34 in labor, if no time is volunteered. It will take 37 hours to fabricate for a 4 person crew, weigh approximately 125 lbs., and be able to be assembled in about 3 minutes. Volunteer time from members of ASCE will be used in fabrication and assembly processes.

# CAPITAL COST SUMMARY

**Materials:**

**Vendors:**
TVH = True Value Hardware
M-C = McMaster - Carr Supply Company

Structural Steel Tubing:

| Type | Length | Quantity | Cost/each | Vendor |
|---|---|---|---|---|
| 1/2" x 1/2" x 0.049 | 3' | 3 | $2.95 | TVH |
| 5/8" x 5/8" x 0.049 | 6' | 8 | $6.90 | TVH |
| 1" x 1" x 0.049 | 6' | 8 | $10.69 | TVH |
| 11/4" x 1 1/4" x 0.049 | 6' | 8 | $12.59 | TVH |
| 1 1/4" x 1 1/4" x 0.083 | 6' | 1 | $13.79 | TVH |
| 1 1/2" x 1 1/2" x 0.109 | 3' | 1 | $12.18 | M-C |

Round UNC, class 2 Threaded Steel Rods:

| Type | Length | Quantity | Cost/each | Vendor |
|---|---|---|---|---|
| 1/4" | 3' | 8 | $0.96 | TVH |
| 1/4" | 6' | 4 | $1.92 | TVH |
| 3/8" | 6' | 2 | $1.20 | TVH |

Hook and Eye Steel Turnbuckles (UNC, class 2 threads):

| Bolt Diameter | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1/4" | 8 | $4.92 | M-C |
| 3/8" | 2 | $6.87 | M-C |

Dent Ring Pins:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1/4" x 1 3/4" | 40 | $2.00 | TVH |

## CAPITAL COST SUMMARY (continued)

Elevator Bolts:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1/4" x 2" | 20 | $0.32 | TVH |

Eye Bolts:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 3/8" x 1 1/4" | 9 | $1.11 | M-C |

Angle:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1" x 1" x 1/8" x 5' | 1 | $22.03 | M-C |

Acetone:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| generic | 2 | $2.29/pint | TVH |

Primer:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| X-O Rust | 2 | $3.28/pint | TVH |

Paint:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| Spray Enamel | 4 | $1.09/12oz | TVH |

Hinges:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1" loose pin | 8 | $2.55/2 | TVH |

## CAPITAL SUMMARY COST (continued)

Lubricant:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| WD-40 | 2 | $1.49/6oz | TVH |

**TOTAL MATERIALS COST = $494.22**

**Labor and equipment:**
(Means Building Construction Cost Data)
Cutting:

$12.95/hour * 6 hours + $20/day * 1 day = $97.70

Cleaning:

$5.45/hour * 1.5 hours = $8.18

Drilling:

$12.95/hour * 6 hours + $20/day * 1 day = $97.70

Welding:

$37.88/hour * 14.5 hours = $549.26

Painting:
brush:

6 hours * $8.45/hr = $50.70

spray:

4 hours * $7.95/hr = $31.80

**TOTAL LABOR AND EQUIPMENT COSTS = $835.34**

**TOTAL COST = $1,329.56**

# DESCRIPTION OF ACTIVITY CODES

| Activity Code Name | Description | Duration (hrs) |
|---|---|---|
| A | Order the steel members and parts | 14 |
| B | Locate pick-up truck to pick up the steel | 2 |
| C | Secure permission and ID badges to use the workshop | 2 |
| D | Secure a welder for later in the fabrication | 3 |
| E | Pick up the steel | 3 |
| F | Measure and cut the steel to specified sizes | 24 |
| G | File the rough edges and wipe steel with cloth for safety and for a clean fit | 2 |
| H | Tack weld the connections, unless the connections are too awkward to fit the drill press. | 22 |
| I | Drill the holes. Align the connections while drilling. | 22 |
| J | File the edges of the holes for a good bolt or pin fit | 2 |
| K | Replace the tack welds with a strong, permanent weld | 36 |
| L | Assemble the bridge to check for any needed adjustments | 8 |
| M | Clean the entire bridge with acetone | 4 |
| N | Coat the bridge with primer | 16 |
| O | Paint the bridge while it is together to avoid any unwanted thickness on members needing to fit into sleeves | 16 |
| P | Stencil the school name on the bottom chord members | 8 |
| Q | Practice assembly several times to optimize the process | 20 |
| R | Assemble the bridge at the 1995 AISC Steel Bridge Competition | 8 |

# SCHEDULE TO FABRICATE THE BRIDGE

| Activity Code Name | Predecessor Activity | Duration (hrs) |
|---|---|---|
| A | ---------- | 14 |
| B | ---------- | 2 |
| C | ---------- | 2 |
| D | ---------- | 3 |
| E | A, B | 3 |
| F | C, E | 24 |
| G | F | 2 |
| H | D, G | 22 |
| I | H | 22 |
| J | I | 2 |
| K | I | 36 |
| L | J, K | 8 |
| M | L | 4 |
| N | M | 16 |
| O | N | 16 |
| P | O | 8 |
| Q | L | 20 |
| R | P, Q | 8 |

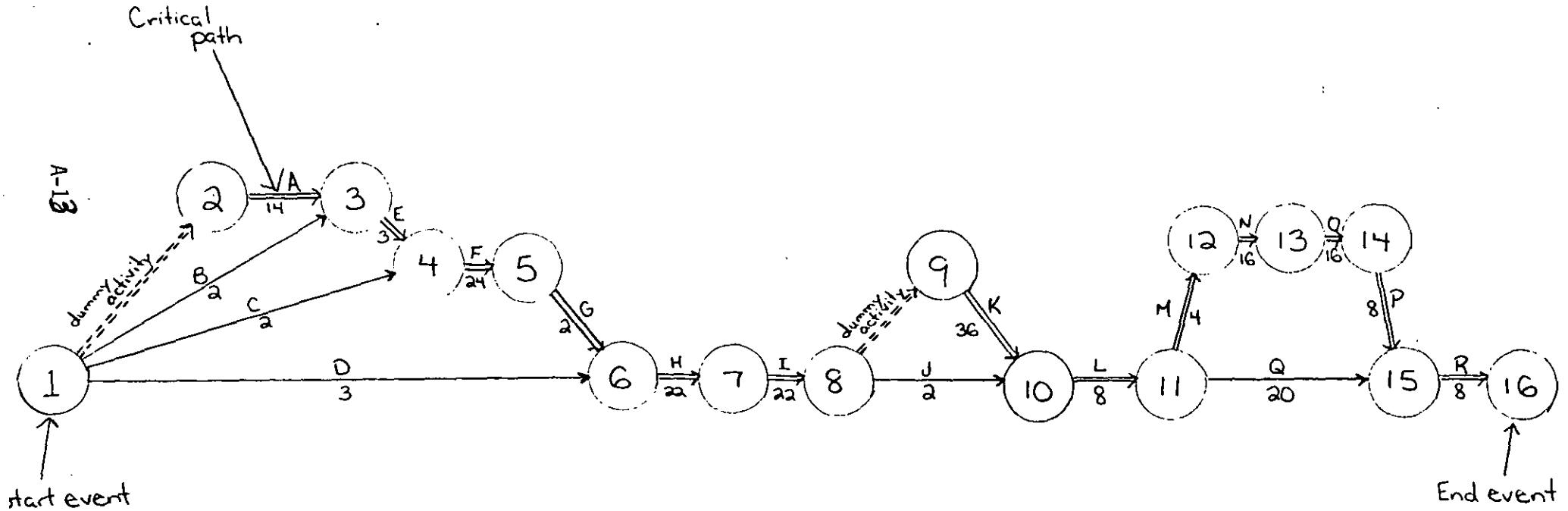
# CRITICAL PATH ANALYSIS

| Successor Event | Predecessor Event | te (hrs) | Te (hrs) | Tl (hrs) | Slack (hrs) |
|---|---|---|---|---|---|
| (END) 16 | 15 | 8 | 183 | 183 | 0 |
| 15 | 14 | 8 | 175 | 175 | 0 |
| 15 | 11 | 20 | 151 | 175 | 24 |
| 14 | 13 | 16 | 167 | 167 | 0 |
| 13 | 12 | 16 | 151 | 151 | 0 |
| 12 | 11 | 4 | 135 | 135 | 0 |
| 11 | 10 | 8 | 131 | 131 | 0 |
| 10 | 9 | 36 | 123 | 123 | 0 |
| 10 | 8 | 2 | 89 | 123 | 34 |
| 9 | 8 | 0 | 87 | 87 | 0 |
| 8 | 7 | 22 | 87 | 87 | 0 |
| 7 | 6 | 22 | 65 | 65 | 0 |
| 6 | 5 | 2 | 43 | 43 | 0 |
| 6 | 1 | 3 | 3 | 43 | 40 |
| 5 | 4 | 24 | 41 | 41 | 0 |
| 4 | 3 | 3 | 17 | 17 | 0 |
| 4 | 1 | 2 | 2 | 17 | 15 |
| 3 | 2 | 14 | 14 | 14 | 0 |
| 3 | 1 | 2 | 2 | 14 | 12 |
| 2 | 1 (START) | 0 | 0 | 0 | 0 |

*Every event is on the critical path

# PERT/CPM NETWORK






Critical Path: 1-2-3-4-5-6-7-8-9-10-11-12-13-14-15-16

* Denoted on network by double arrow, ⟹

## INTRODUCTION

The objective of this project was to design a bridge according to the standards for durability, constructability, usability, strength and serviceability. This design has been carried out in accordance with the rules provided by the American Institute of Steel Construction.

## PROJECT DESCRIPTION

The members and connections of the bridge have been designed for strength and ease in assembly according to the AISC guidelines. The fabrication and materials have been studies to ensure the most economical process.

## EQUIPMENT LIST

All of the needed equipment is available in the SIUC workshop located on the ground floor of Engineering Building D. The equipment in the workshop is as follows:

1) Delta Milwaukee drill press
   Model # MD 6X110 CW (1/3 hp)

2) Emerson 7" horizontal metal cutting band saw
   Model # 10-1720T

3) Enco vertical band saw
   Model # 165-1551

4) Tri-star 6" electric bench grinder

5) Arc welder

6) Power hand drill

7) Assorted hand files

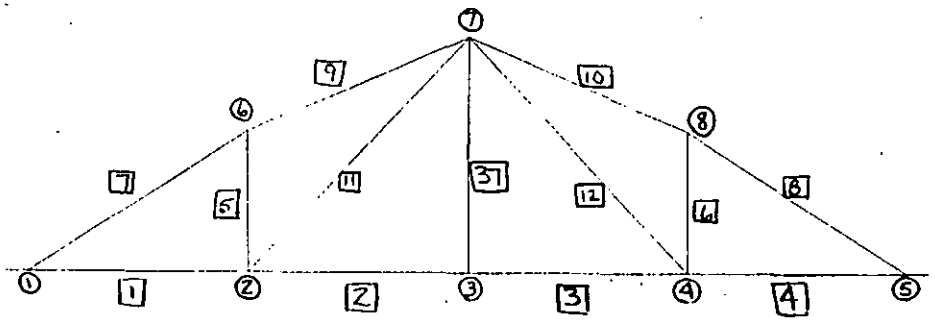
8) Safety glasses

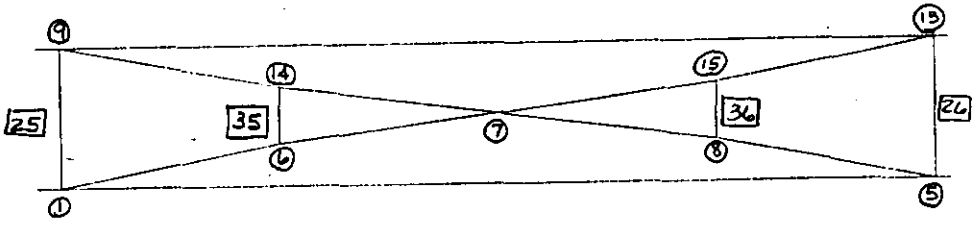
Note: John Hester is in charge of the workshop and permission must be obtained from him before any work begins. Also, identification cards must be obtained for those students who will be working on the bridge in the workshop during the weekends.

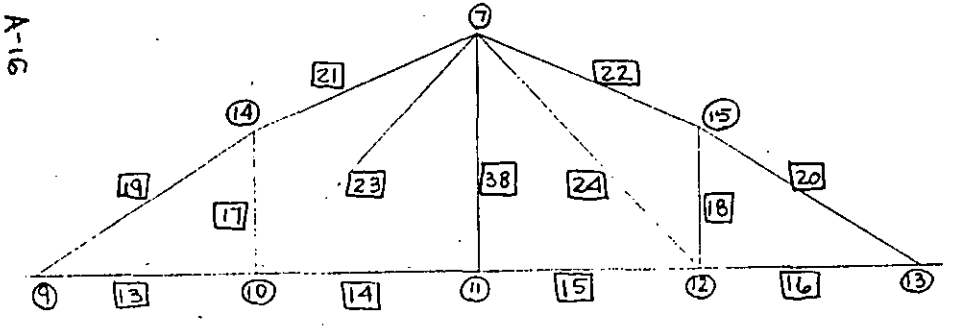
# MATERIALS LIST

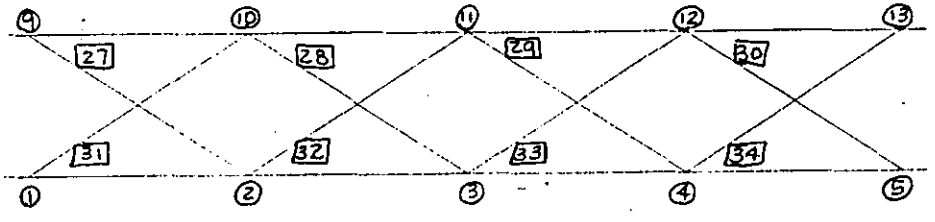
| ITEM | DIMENSIONS | QTY | LINEAR INCHES* | DESIRED STRENGTH |
|---|---|---|---|---|
| Structural Steel Tubing (Members 25, 26) | 1/2" x 1/2" x 0.049" | 2 | 36.0 | Fy = 36 ksi |
| Structural Steel Tubing (Members 35, 36) | 1/2" x 1/2" x 0.049" | 2 | 14.4 | Fy = 36 ksi |
| Structural Steel Tubing (Members 27-34) | 5/8" x 5/8" x 0.049" | 8 | 64.9 | Fy = 36 ksi |
| Structural Steel Tubing (Members 7, 8, 19, 20) | 1" x 1" x 0.049" | 4 | 65.8 | Fy = 36 ksi |
| Structural Steel Tubing (Members 9, 10, 21, 22) | 1" x 1" x 0.049" | 4 | 59.5 | Fy = 36 ksi |
| Structural Steel Tubing (Members 1, 4, 13, 16) | 1 1/4" x 1 1/4" x 0.049" | 4 | 60.0 | Fy = 36 ksi |
| Structural Steel Tubing (Members 2, 3, 14, 15) | 1 1/4" x 1 1/4" x 0.049" | 4 | 54.0 | Fy = 36 ksi |
| Structural Steel Tubing (Connections) | 1 1/4" x 1 1/4" x 0.083" | 1 | 72.0 | Fy = 36 ksi |
| Structural Steel Tubing (Connections) | 1 1/2" x 1 1/2" x 0.109" | 1 | 24.0 | Fy = 36 ksi |
| Round Threaded Steel Rods (Members 5, 6, 17, 18) | 1/4" diam | 4 | 36.0 | Fy = 36 ksi |
| Round Threaded Steel Rods (Members 11, 12, 23, 24) | 1/4" diam | 4 | 82.4 | Fy = 36 ksi |
| Round Threaded Steel Rods (Members 37, 38) | 3/8" diam | 2 | 60.0 | Fy = 36 ksi |
| Steel Turnbuckles | 1/4" threading | 4 | -------- | 325 lb (T) |
| Steel Turnbuckles | 1/4" threading | 4 | -------- | 225 lb (T) |
| Steel Turnbuckles | 3/8" threading | 2 | -------- | 1000 lb (T) |
| Angle | 1" x 1" x 1/8" | 1 | 60.0 | ---------- |
| Dent Ring Pins | 1/4" x 1 3/4" | 40 | -------- | ---------- |
| Elevator Bolts | 1/4" x 2" | 20 | -------- | ---------- |
| Eye Bolts | 3/8" x 1 1/4" | 9 | -------- | 1400 lb |
| Loose hinges | 1" | 8 | -------- | ---------- |
| Containers of Acetone | 1 pint | 2 | -------- | ---------- |
| X-O Rust Primer | 1 pint | 2 | -------- | ---------- |
| Spray Paint (Enamel) | 12 ounces | 4 | -------- | ---------- |
| WD-40 Lubricant | 6 ounces | 2 | -------- | ---------- |

*These are the exact member lengths. When ordering when cutting the steel, some extra length should be added. It is easy to cut off extra but nearly impossible to lengthen a member which is too short.




A-16

| Rev | Date | By | Purpose |
|---|---|---|---|
| 3 | 4/07 | RLD | Modified Members |
| 2 | 3/22 | RLD | Changed Height |
| 1 | 3/08 | RLD | Original |

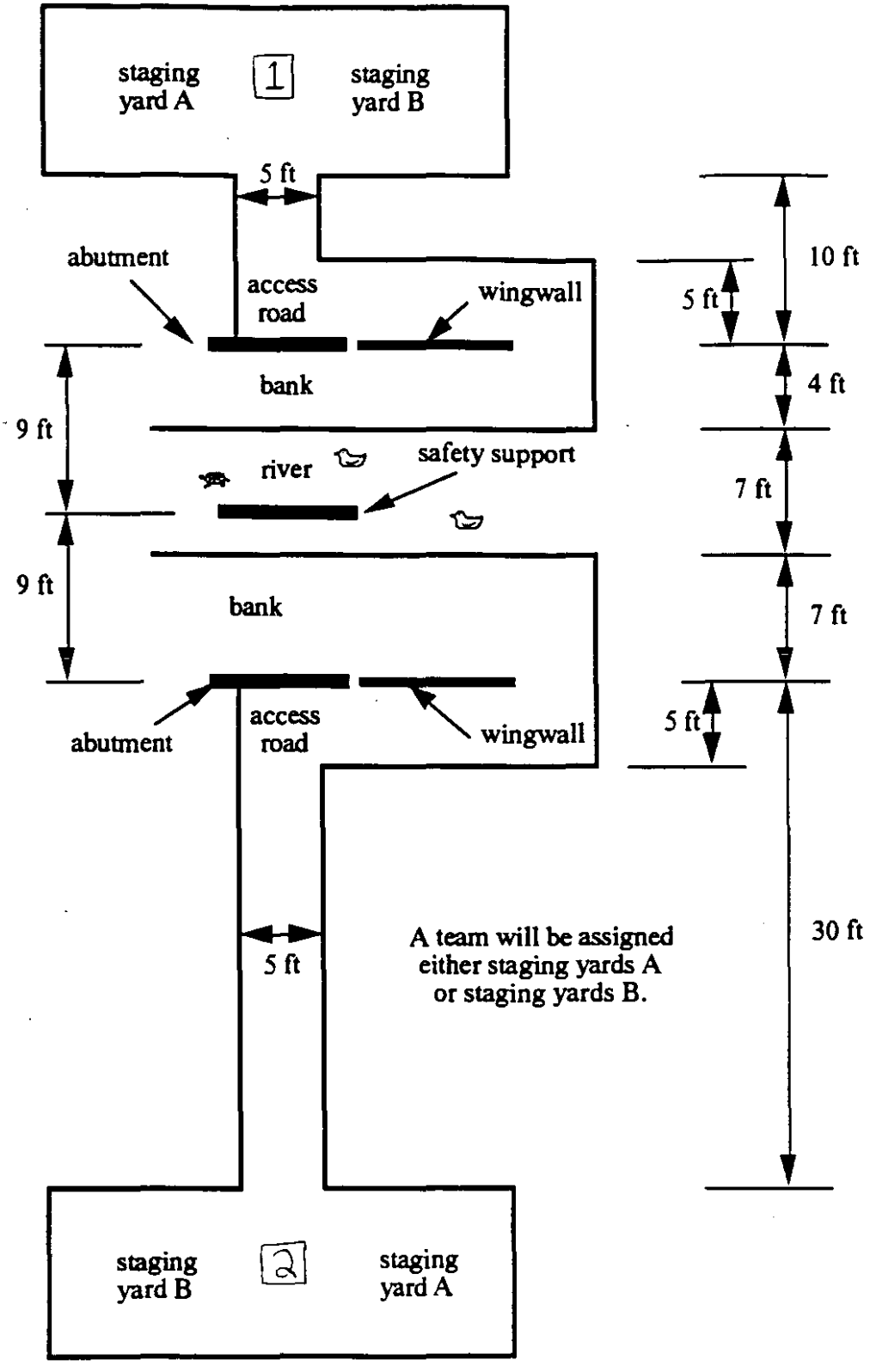
**SALUKI ENGINEERING COMPANY**

**Team #6** **SEC Reference #DES.06.S95**

| | |
|---|---|
| **Client:** Egyptian Associates | **EA Reference #:** BRIDGE06.S95 |

**Title:** Member and Joint Numbers

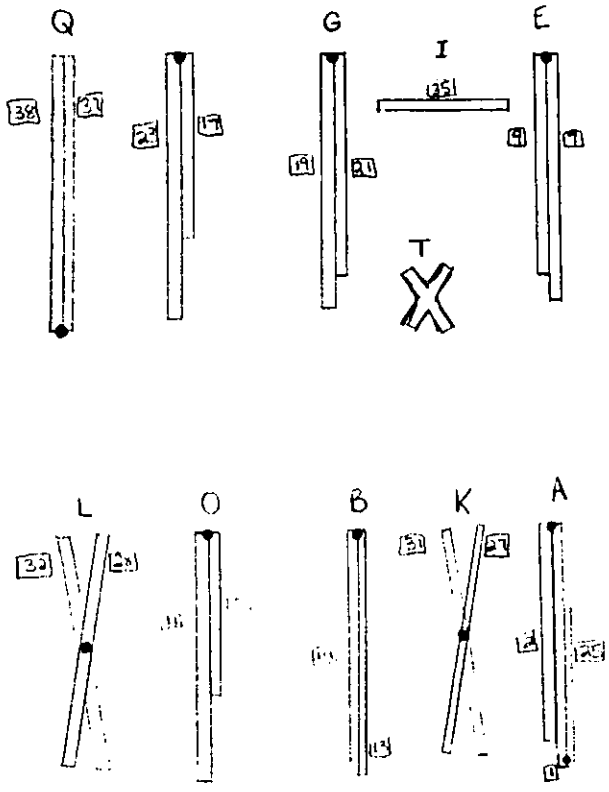
| | | | |
|---|---|---|---|
| **Drawn by:** | Rachel Davis | **Scale:** | 1"=2' |
| **Date:** 4/24/95 | **Drawing Number:** 001 | **Rev.** | 3 |


staging yard A
1
staging yard B
5 ft
abutment
access road
wingwall
bank
9 ft
river
safety support
9 ft
bank
abutment
access road
wingwall
5 ft
A team will be assigned either staging yards A or staging yards B.
staging yard B
2
staging yard A
10 ft
5 ft
4 ft
7 ft
7 ft
5 ft
30 ft

Site Plan

# COMPETITION STAGING YARD SET-UP

## STAGING YARD 1 (SHORT TIE)




← Assuming Staging Yard 'A' will be used

5ft
TO ABUTMENTS

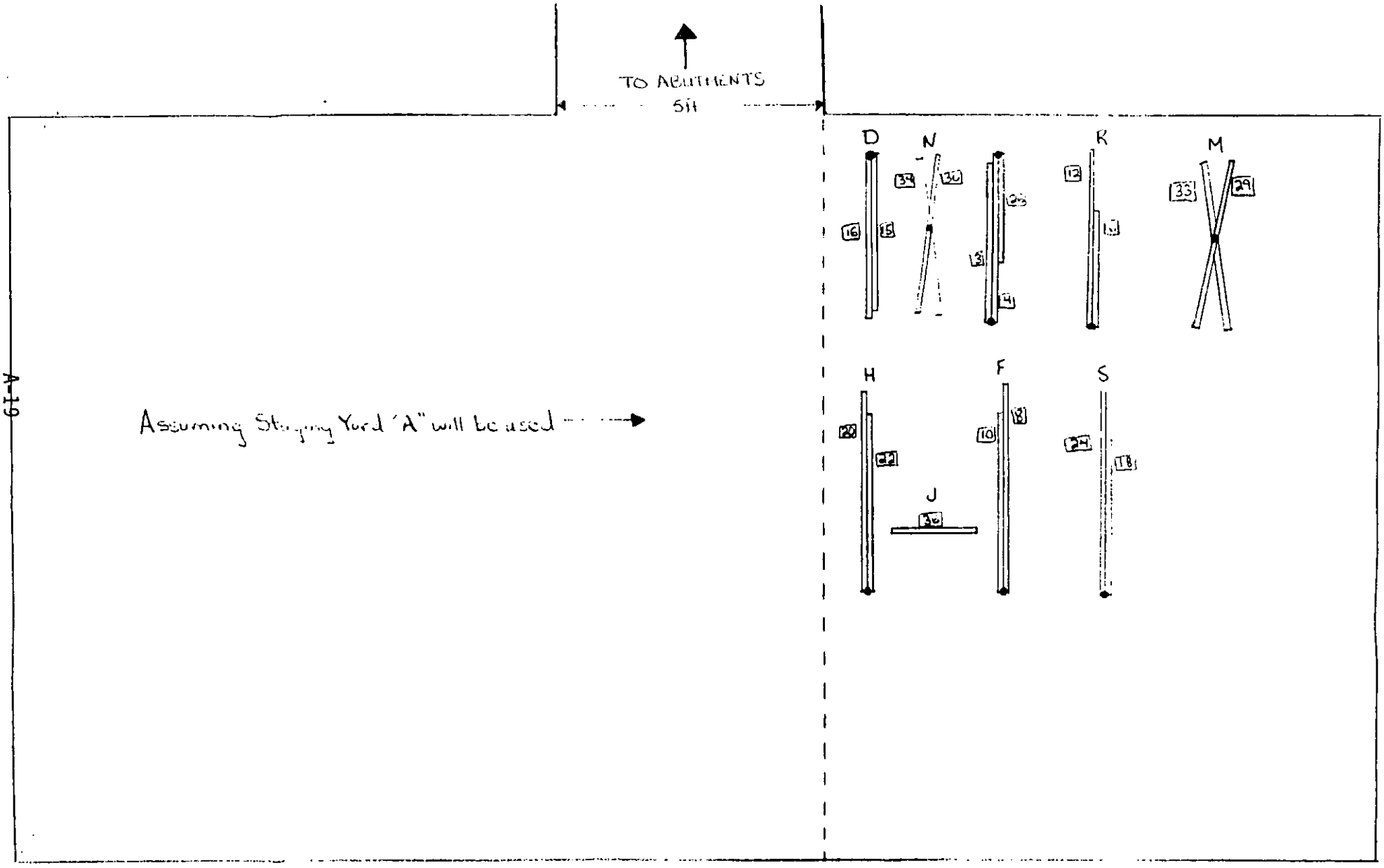
A-18

* Not to scale, staging yard size subject to vary
This drawing is intended to show only the relative positions of the members

• denotes hinge at this point

# COMPETITION STAGING YARD SET-UP

## STAGING YARD 2 (LONG SIDE)




* Not to scale ... subject to vary

● - denotes ... at this point.

# BASIS OF DESIGN

The following documents and standards have served as the basis for the Saluki Engineering Company eleven week design study of the AISC steel bridge:

**Documents:**

| | |
|---|---|
| I. Request for Proposal from Egyptian Associates | January 31, 1995 |
| A. Project Definition | January 31, 1995 |
| B. Additional Requirements | January 31, 1995 |
| II. Saluki Engineering Proposal | February 13, 1995 |
| III. Transmittal Letter | February 13, 1995 |
| IV. Saluki Engineering Progress Report | March 21, 1995 |

**Standards:**

| | |
|---|---|
| I. Saluki Engineering Company Standards | January 17, 1995 |
| II. American Institute of Steel Construction Standards | 1986 |

# SECTION B

## TABLE OF CONTENTS

page

I. Table of Contents B-1

II. Introduction B-2

III. Technical Discussion B-3–B-6

IV. Material List B-7

V. Cost Summary B-8

VI. Drawings

| Number | Name | Member Numbers | |
|---|---|---|---|
| 101 | Bottom Chord | 1,4,13,16 | B-9 |
| 102 | Bottom Chord | 2,3,14,15 | B-10 |
| 103 | Top Chord | 7,8,19,20 | B-11 |
| 104 | Top Chord | 9,10,21,22 | B-12 |

VII.Bibliography B-13

# INTRODUCTION

The design of the steel members of the bridge is a process of compromise. In competition, the major categories in determining which bridge wins overall, are the weight of the bridge, the deflection of the bridge, and the speed of construction of the bridge. While the speed of construction is mostly a result of the connection design, the weight of the bridge and the deflection of the bridge are very much dependent upon the member design.

The compromise lies in the sizing of the members. Of course the deflection of the bridge could be minimized by the use of over-sized, over-designed members, however, the bridge will suffer in the category of weight. At the other extreme, very small members could used in order to minimize the weight of the bridge, however, the bridge will suffer in the category of deflection and may possibly even fail. An efficient design of the members must be pursued so that the bridge will perform well in both the categories of weight and deflection.

# TECHNICAL DISCUSSION

The members of the bridge are to be a combination of square tubing and threaded rods. In all there will be four different cross-sections of square tubing used and two different diameters of threaded rods.

## BOTTOM CHORD MEMBERS

The bottom chord members will be 1 1/4 inch square tubing with a wall thickness of 0.049 inches. These members are detailed in drawings 101 and 102 of this section.

In the design of the bottom chord, which is subjected to a combination of bending and tensile forces, both I-beams and square tubing were investigated. I-beams, although very strong in bending, lack resistance to torsion due to their open faces. In addition, it was discovered that the acquisition of I-beams small enough for the bridge would be very difficult and most likely prohibitively expensive. The investigation of square tubing yielded more promising results. Square tubing has considerable strength in bending, although less than I-beams for the same area. However, square tubing has the advantage of significant torsional strength due to the closed faces of the cross-section. And, perhaps more important, square tubing is readily available in sizes all the way down to 1/2 inch square, which would allow the freedom to design for the most efficient members possible. For these reasons, square tubing was selected for the bottom chord members.

## TOP CHORD MEMBERS

The top chord members will be 1 inch square tubing with a wall thickness of 0.049 inches. These members are detailed in drawings 103 and 104 of this section.

**TOP CHORD MEMBERS CONT...**

In the design of the top chord, which will be subjected to compressive forces, square tubing was selected from the beginning. The selection was motivated by the efficiency of square tubing when subjected to compression. The only more efficient member type under compression is circular tubing, but circular tubing complicated the connections of the bridge. The efficiency of square tubing is a result of the nearly equal radius of gyration in all directions which provides for a nearly equal resistance to buckling in all directions. The member is only as strong as its weakest axis and so members which are unsymmetrical contain wasted material in their strong axis.

The aim in designing the cross-section was to have the mass as far away from the axial center of the tube as possible. This is because the radius of gyration and hence buckling resistance for a given cross-sectional area increases as the moment of inertia of the cross-section increases. So, whereas 3/4 inch square tubing could have been selected to resist the compressive load, the members would have been much thicker and therefore much heavier than the 1 inch square members which were selected.

## LATERAL BRACING MEMBERS

The diagonal lateral bracing members will be 5/8 inch square tubing with a wall thickness of 0.049 inches. The remaining lateral bracing will be 1/2 inch square tubing.

The forces in the lateral bracings are relatively small, with no member being subjected to an axial force of even 200 lbs. However, the force in any given lateral bracing may be either tension or compression depending upon which side the 100 lb lateral test load. The compression state will dominate and so all of the members were designed for the compression loading and hence, square tubing was employed for the same reasons outlined in the "Top Chord Members" explanation above.

*See Section D for drawings and additional specifications on lateral bracing.

## WEB MEMBERS

The web members will be 1/4 inch diameter threaded rods and 3/8 inch diameter threaded rods.

In order to significantly reduce the overall weight of the bridge, a truss pattern in which all of the web members are in tension was carefully chosen. Since tensile forces tend to straighten the member, buckling is not a concern and thus the members can be made very small and light.

To carry the tensile force in the web members we had the option of using cables or rods. The concern with cables was excessive stretching, and since deflection is a major concern in the competitiveness of the bridge, we ruled out the use of cables. Instead, we sacrificed some lightness in the bridge in order to gain considerable stiffness with the use of rods. Threaded rods were called for so that turnbuckles could be incorporated at one of the connections of each rod. This will ensure the tight fit of the rods and the rigidity of the bridge as a whole.

*See Section D for drawings and additional specifications on web members.

## FINAL ANALYSIS OF BRIDGE FOR FORCES AND DEFLECTIONS

The final analysis of the bridge for the forces and deflections was performed by computer.

Dr. Aslam Kassimali's structural analysis computer program was used in order to determine the forces in each member of the bridge when the bridge was either subjected to the 2500 lb vertical loading test or the 100 lb lateral loading test. The bridge was analyzed as a truss, which includes the assumptions that all of the loading occurs at the joints and that the axial centroid of the members meet at a single point at the joints. In order to accommodate the assumption of loading only at the joints, the distributed loading of 2500 lb along with an assumed bridge weight of 150

**FORCES AND DEFLECTIONS CONT...**

lb was applied as a downward 662.5 lb loading at each of joints 3 and 11, and a downward 331.3 lb loading at each of joints 2, 4, 10, and 12. As for the 100 lb lateral loading test, no modeling was needed since it is actually applied as a point load at the joint during competition.

There were difficulties in using the structural analysis computer program in order to analyze for the deflections in the bridge as a result of these two loading tests. These difficulties lay in the fact that our bridge contains members of 6 different cross-sections and the program would only accept four different cross-sections. As a result the method of virtual work was employed along with the assistance of a spreadsheet. This method revealed a vertical deflection of 0.109 in at the center of the bridge due to the 2500 lb vertical load test, and a lateral deflection of 0.019 in at the center of the bridge due to the 100 lb lateral load test. These are very promising results and bodes well for the competitiveness of the bridge.

*See the appendices of this report for the detailed results of the computer analysis and the virtual work method.

# MEMBER MATERIALS LIST

| ITEM | DIMENSIONS | QTY | LINEAR INCHES* | DESIRED STRENGTH |
|---|---|---|---|---|
| Structural Steel Tubing (Members 7, 8, 19, 20) | 1" x 1" x 0.049" | 4 | 65.8 | Fy = 36 ksi |
| Structural Steel Tubing (Members 9, 10, 21, 22) | 1" x 1" x 0.049" | 4 | 59.5 | Fy = 36 ksi |
| Structural Steel Tubing (Members 1, 4, 13, 16) | 1 1/4" x 1 1/4" x 0.049" | 4 | 60.0 | Fy = 36 ksi |
| Structural Steel Tubing (Members 2, 3, 14, 15) | 1 1/4" x 1 1/4" x 0.049" | 4 | 54.0 | Fy = 36 ksi |

*These are the exact member lengths. When ordering and cutting the steel, some extra length should be added. It is easy to cut off extra but nearly impossible to lengthen a member which is too short.

## COSTING SUMMARY

**Materials:**

Structural Steel Tubing:

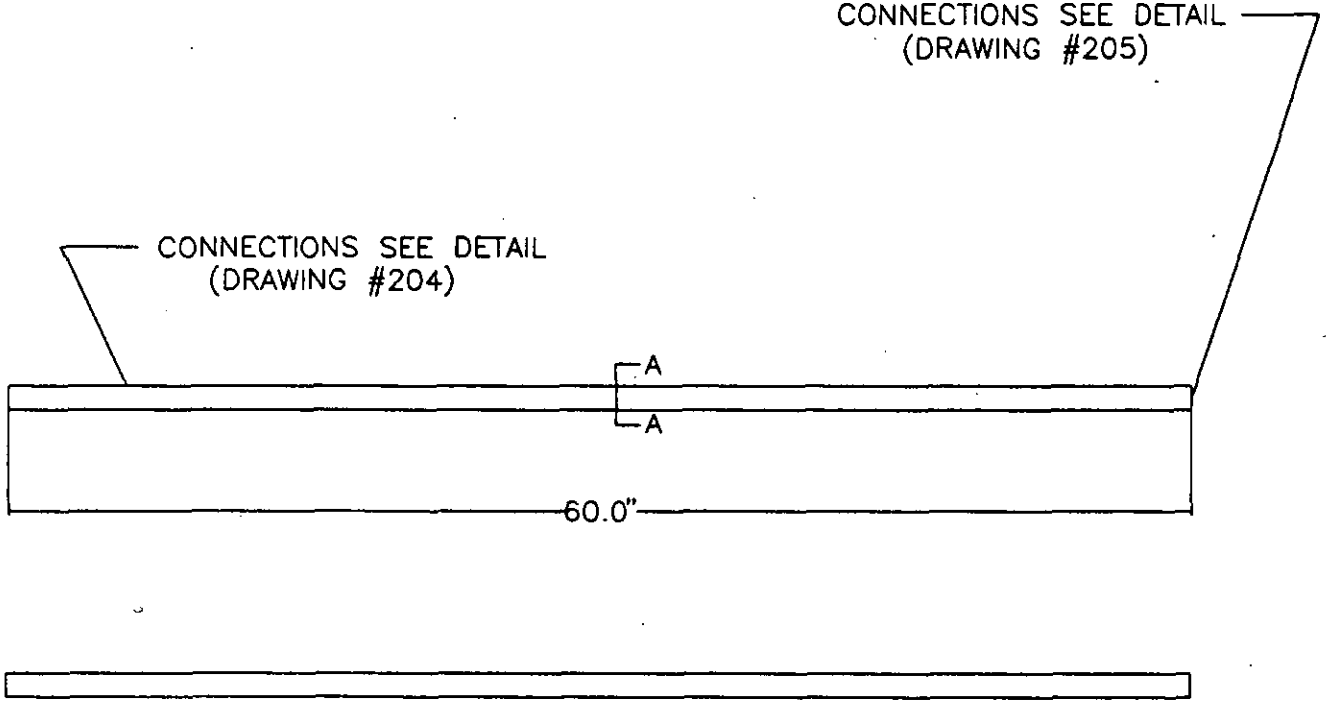
**Vendors:**
TVH = True Value Hardware
M-C = McMaster - Carr Supply Company

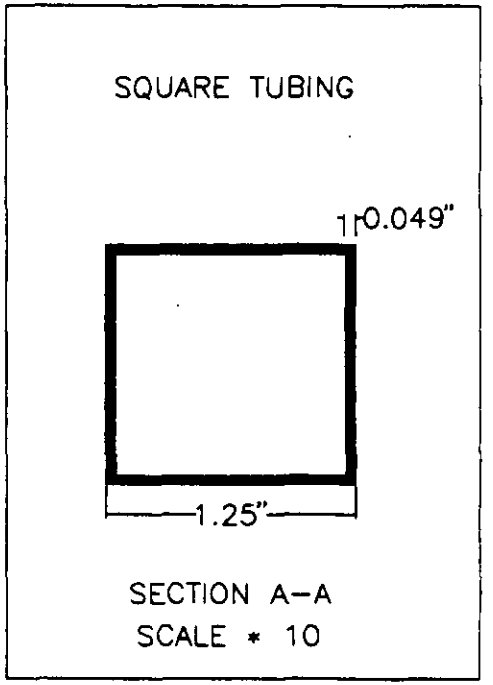
| Type | Length | Quantity | Cost/each | Vendor |
|---|---|---|---|---|
| 1" x 1" x 0.049" | 6' | 8 | $10.69 | TVH |
| 1 1/4" x 1 1/4" x 0.049 | 6' | 8 | $12.59 | TVH |

**Labor and Equipment:**

*Since all sections are interdependent this is covered in the Team Section only.

**Total Materials Cost = $186.24**




0 2.5 5 10

| Rev | Date | By | Purpose |
|---|---|---|---|
| 3 | | | |
| 2 | | | |
| 1 | | | |

SALUKI ENGINEERING COMPANY

Team #6 SEC Reference #DES.06.S95

Client: Egyptian Associates

EA Reference #: BRIDGE06.S95

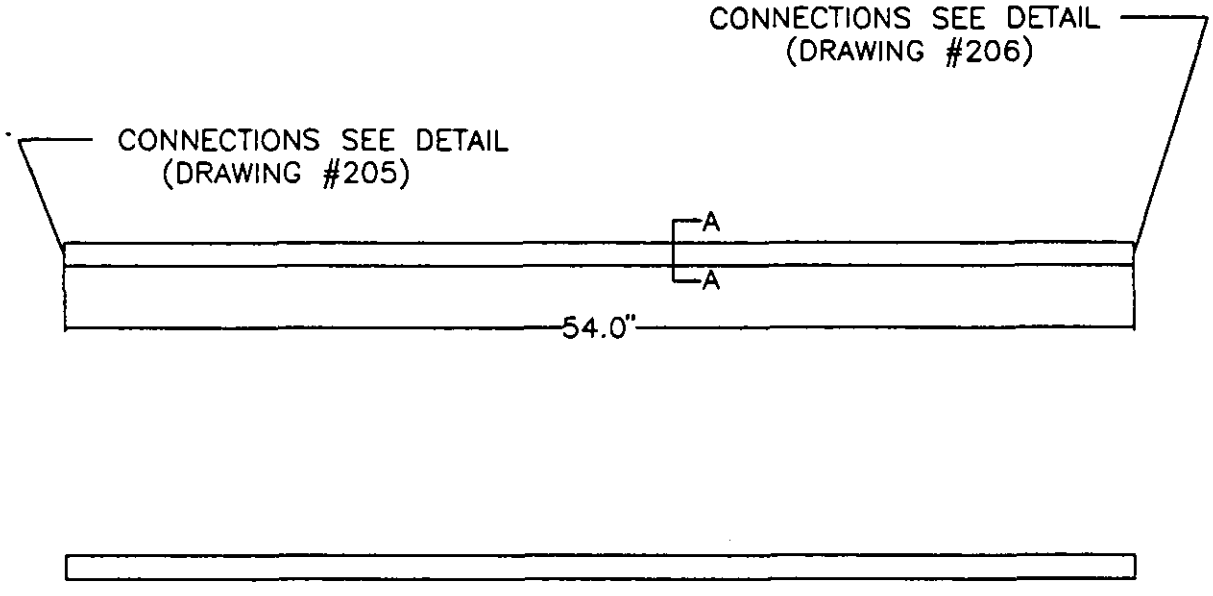
Title: BOTTOM CHORD MEMBERS 1,4,13,16

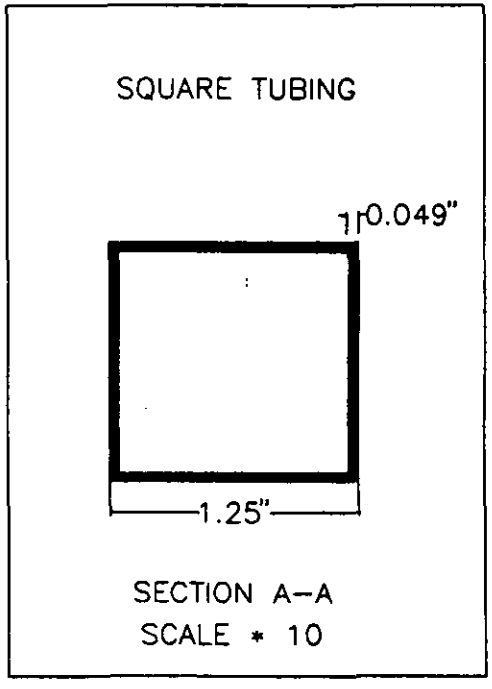
Drawn by: DEREK PEEBLES Scale: 1:1

Date: 4/17/95

Drawing Number: 101

Rev 0




0 2.5 5 10

B-10

| Rev | Date | By | Purpose |
|---|---|---|---|
| 3 | | | |
| 2 | | | |
| 1 | | | |

SALUKI ENGINEERING COMPANY

Team #6 SEC Reference #DES.06.S95

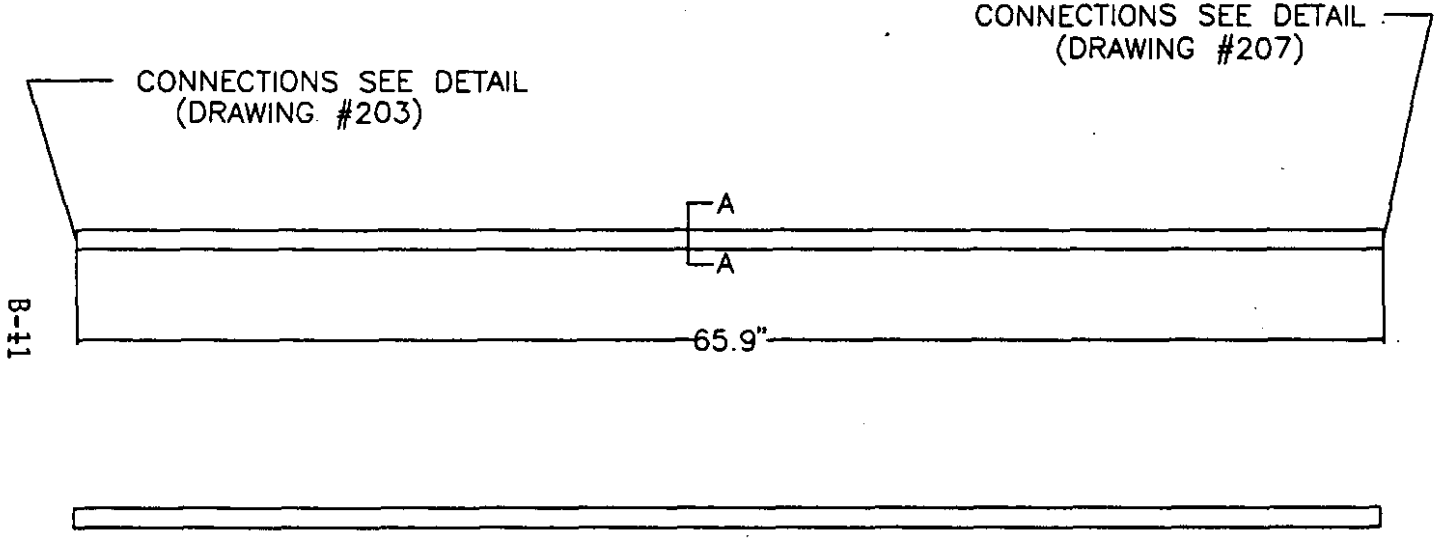
Client: Egyptian Associates

EA Reference #: BRIDGE06.S95

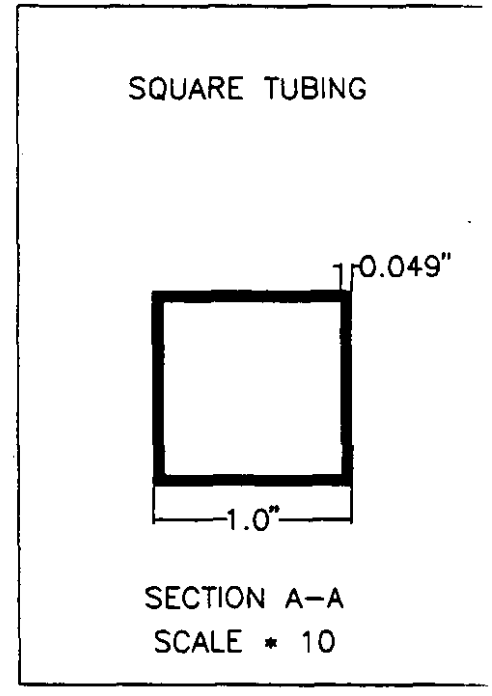
Title: BOTTOM CHORD MEMBERS 2,3,14,15

Drawn by: DEREK PEEBLES Scale: 1:10

Date: 4/17/95 Drawing Number: 102 Rev. 0




B-11

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| | | | |
|---|---|---|---|
| 3 | | | |
| 2 | | | |
| 1 | | | |
| Rev | Date | By | Purpose |

SALUKI ENGINEERING COMPANY

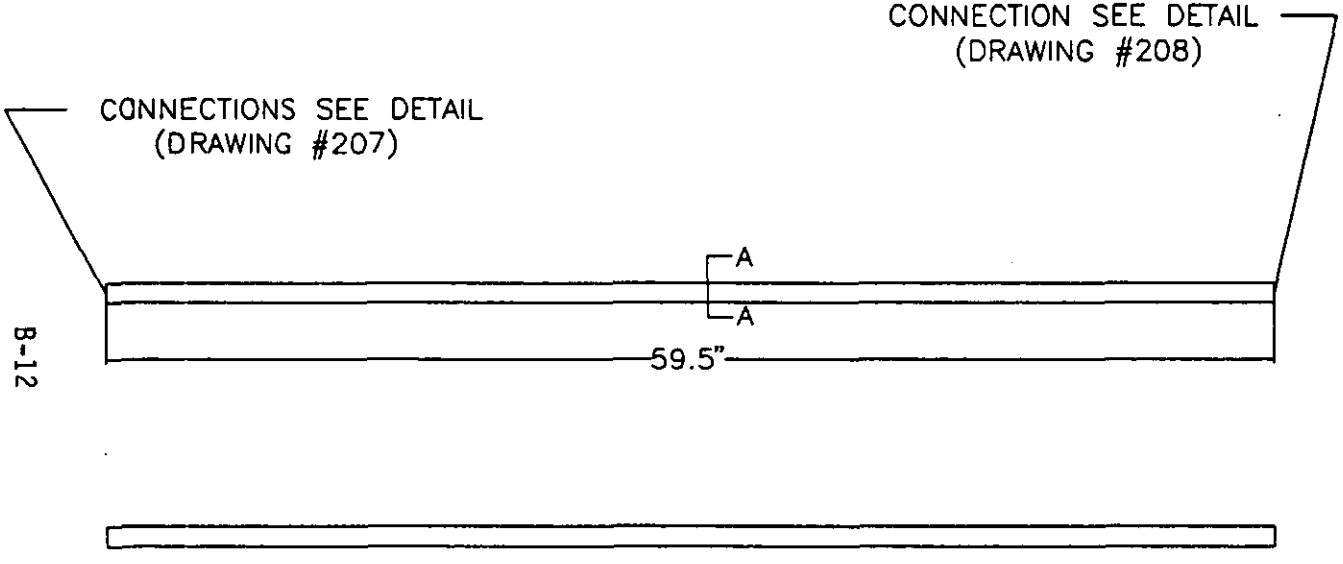
Team #6 SEC Reference #DES.06.S95

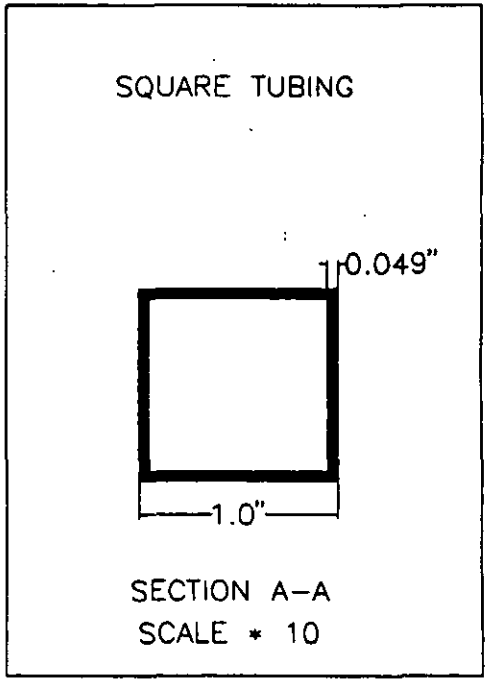
| Client: | EA Reference #: |
|---|---|
| Egyptian Associates | BRIDGE06.S95 |

Title: TOP CHORD MEMBERS 7,8,19,20

Drawn by: DEREK PEEBLES Scale: 1:10

| Date: | Drawing Number: | Rev. |
|---|---|---|
| 4/17/95 | 103 | 0 |




B-12

0 2.5 5 10

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| 3 | | | |
| 2 | | | |
| 1 | | | |
| Rev | Date | By | Purpose |

| | |
|---|---|
| SALUKI ENGINEERING COMPANY | |
| Team #6 | SEC Reference #DES.06.S95 |
| Client: Egyptian Associates | EA Reference #: BRIDGE06.S95 |
| Title: TOP CHORD MEMBERS 9,10,21,22 | |
| Drawn by: DEREK PEEBLES | Scale: 1 : 10 |
| Date: | Drawing Number: 104 Rev. |

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# SECTION C

# TABLE OF CONTENTS


| | | Page No. |
|---|---|---|
| I. | Table of Contents | C-1 |
| II. | Introduction | C-2 |
| III. | Technical Discussion | C-3, C-4, C-5 |
| IV. | Assembly Process | C-6, C-7 |
| V. | Material List | C-8 |
| VI. | Cost List | C-9 |
| VII. | Drawings | |

| Number | Name | Joint Number | |
|---|---|---|---|
| 201 | Full Bridge (3-D) | all | C-10 |
| 202 | Member and Joint Numbers | all | C-11 |
| 203 | Dimensioned Bridge | all | C-12 |
| 204 | Bottom End Connections | 1, 5, 9, 13 | C-13 |
| 205 | Bottom Inner Connections | 2, 4, 10, 12 | C-14 |
| 206 | Bottom Center Connections | 3, 11 | C-15 |
| 207 | Top Outer Connections | 6, 8, 14, 15 | C-16 |
| 208 | Top Center Connection | 7 | C-17 |

| | | |
|---|---|---|
| VIII. | Bibliography | C-18 |

## INTRODUCTION

This section contains the design of the bridge member connections as well as the assembly process of the final bridge for the AISC Bridge-Building Competition. The design of the connections is important in order to limit the deflection of the assembled bridge and to make the assembly time a minimum. The compression connections will be steel tube sleeves to hold the member in place. The tension connections will be connected with hooks and eyes. Other connections, such as those with little load, torsional loads, or alternating loads will be pinned or welded.

The assembly process is important in the design of the entire bridge. AISC rules limit the size and weight of the members, the time of assembly , and the number of preassembled members. The recommended assembly process will use four team members to assemble the bridge in approximately three minutes. It will also give a logical order the assembly to keep organization and to maximize the use of time by each team member.

# TECHNICAL DISCUSSION

Connections:

Joints 1, 5, 9, 13

These connections consist of a 7-in. section of 1-1/4" x 1-1/4" x 0.083" square tubing welded to the top of the end bottom chord member at the angle of the upper chord member. The inside face of the sleeve will be removed to allow the member to slide in easily. There will be a 3-in. section of 1" x 1" x 1/8" angle welded to the inside of the end bottom chord member. The end lateral member will be pinned to the angle so that it will be able to fold into the angle. This member will be connected to the angle at one joint and pinned during assembly to the angle at the opposite joint. There will also be a hole for the crossed lateral member to be attached with an elevator bolt. (See Drawing #202 for locations and Drawing #204 for details.)

Joints 2, 4, 10, 12

These connections consist of two bottom chord members hinged at the bottom of the members with a 1-in. hinge. A 6-in. section of 1" x 1" x 1/8" angle will be welded to the inside of the bottom chord member. There will be two holes to pin the members in place to the angle when unfolded. There will also be two holes for the crossed lateral members to be connected. A hook, taken from the turnbuckle, will be welded to the bottom chord member to attach the rings to the rods. (See Drawing #202 for locations and Drawing #205 for details.)

Joints 3, 11

These connections consist of an 8-in. section of 1-1/2" x 1-1/2" x 0.109" square tubing welded to one of the center bottom chord members. There will be a 6-in. section of 1" x 1" x 1/8" angle welded to the inside of the tubing. There will be holes for pinning the bottom chord members in place inside the sleeve and for the crossed lateral members to be connected. There will also be a hook, taken from the turnbuckle, to connect the rings welded to the rods. (See Drawing #202 for locations and Drawing #206 for details.)

Joints 6, 8, 14, 15

These connections will consist of two sleeves of 1-1/4" x 1-1/4" x 0.083" square tubing welded at the angle of the top chord members. The bottom of the sleeves will be open in order to place onto the upper chord members. The sleeves will be welded to the upper lateral member. The two upper chord members will be hinged to allow folding before the competition. There will be two holes for pins in each sleeve and a hook, taken from the turnbuckle, welded to the inside of the sleeves. (See Drawing #202 for locations and Drawing #207 for Details.)

Joint 7

This connection will consist of four 1-1/4" x 1-1/4" x 0.083" square tubing sleeves welded together at the angles of the top chord members. A hook, taken from the turnbuckle, will be welded underneath. There will be two holes in each sleeve to hold the upper chord members in place. (See Drawing #202 for locations and Drawing #208 for Details.)

Due to the length of members 11, 12, 23, and 24, two rings must be welded to the rods at the mid-section to create a hinge, which will keep the length of the member under the specified 66 inches.

The assembly process has been designed for a four-person team. This seemed to work the best in the last four competitions. The bridge should be able to be assembled in about three minutes, which would result in a winning construction speed score in the last four competitions. For more details on the assembly process, see pages C-6 and C-7.

## ASSEMBLY PROCESS

| Preassembled Members*: | Assembly Letter: |
|---|---|
| 1, 2, 25 | A |
| 13, 14 | B |
| 3, 4, 26 | C |
| 15, 16 | D |
| 7, 9 | E |
| 8, 10 | F |
| 19, 21 | G |
| 20, 22 | H |
| 35 | I |
| 36 | J |
| 27, 31 | K |
| 28, 32 | L |
| 29, 33 | M |
| 30, 34 | N |
| 5, 11 | O |
| 17, 23 | P |
| 37, 38 | Q |
| 6, 12 | R |
| 18, 24 | S |
| Connection Sleeve (Joint #7) | T |

*Refer to Drawing #202 for location of members and joints

## ASSEMBLY PROCESS (Continued)

| Staging Yard (Short Side): | Staging Yard (Long Side): |
|---|---|
| Team Members: TM1, TM2 | Team Members: TM3, TM4 |
| Assembly Members: | Assembly Members: |
| A, B, E, G, I, K, L, O, P, Q, T | C, D, F, H, J, M, N, R, S |
| TIMED ASSEMBLY PROCEDURE: | |
| TM1 and TM2 unfold A, B, K, connect and carry to abutments | TM3 and TM4 unfold C, D, N, connect and carry to abutments |
| TM1 connects B, D at joint #11<br>TM2 carries E, G, I, T to abutments | TM3 connects A, C at joint #3<br>TM4 carries F, H, J to abutments |
| TM1 and TM2 unfold E, G, connect E, G, I, T, and slip into sleeves at joints #9, #10 (do not pin bottom chord) | TM3 and TM4 unfold F, H, connect F, H, J assembly to T, slip into sleeves at joints #5, #13 (do not pin to bottom chord) |
| TM1 carries O, then Q, then L to abutments<br>TM2 carries P, connects P, O<br>TM1 and TM2 connect Q, L | TM3 carries R, then M<br>TM4 carries S, connects S, R<br>TM3 connects M |
| TM1 and TM2 connect rods to bottom chord (slip E, G out of bottom sleeve to hook bottom connections, then replace and pin) | TM3 and TM4 connect rods to bottom chord (slip F, H out of bottom sleeve to hook bottom connections, then replace and pin) |
| TM1 and TM2 make any needed adjustments and return to staging yard | TM3 and TM4 make any needed adjustments, then return to staging yard |

# CONNECTION MATERIALS LIST

| ITEM | DIMENSIONS | QTY | LINEAR INCHES | DESIRED STRENGTH |
|---|---|---|---|---|
| Structural Steel Tubing (Connections) | 1 1/4" x 1 1/4" x 0.083" | 1 | 72.0 | Fy = 36 ksi |
| Structural Steel Tubing (Connections) | 1 1/4" x 1 1/4" x 0.109" | 1 | 24.0 | Fy = 36 ksi |
| Angle | 1" x 1" x 1/8" | 1 | 60.0 | ---------- |
| Dent Ring Pins | 1/4" x 1 3/4" | 40 | ------- | ---------- |
| Elevator Bolts | 1/4" x 2" | 20 | ------- | ---------- |
| Eye Bolts | 3/8" x 1 1/4" | 9 | ------- | 1400 lb |
| Loose Hinges | 1" | 8 | ------- | ---------- |

## COSTING SUMMARY

**Materials:**

**Vendors:**
TVH = True Value Hardware
M-C = McMaster Carr Supply Company

Structural Steel Tubing:

| Type | Length | Quantity | Cost/each | Vendor |
|---|---|---|---|---|
| 1 1/4" x 1 1/4" x 0.083 | 6' | 1 | $13.79 | TVH |
| 1 1/2" x 1 1/2" x 0.109 | 3' | 1 | $12.18 | M-C |

Dent Ring Pin:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1/4" x 1 3/4" | 40 | $2.00 | TVH |

Elevator Bolts:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1/4" x 2" | 20 | $0.32 | TVH |

Eye Bolts:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 3/8" x 1 1/4" | 9 | $1.11 | M-C |

Angle:

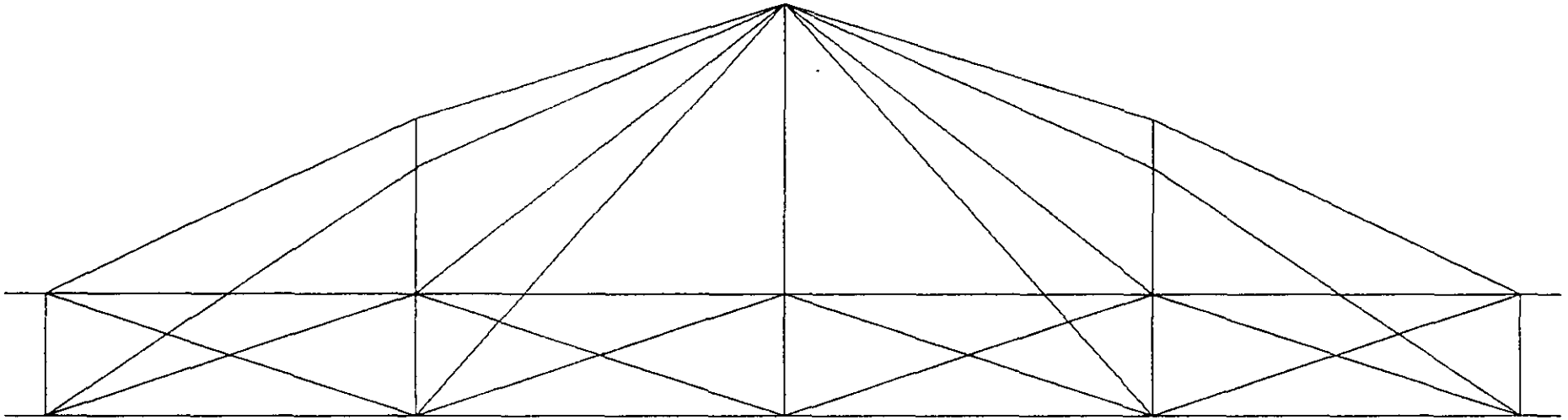
| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1" x 1" x 1/8" x 5' | 1 | $22.03 | M-C |

Hinges:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1" loose pin | 8 | $2.55/2 | TVH |

**Labor and Equipment:**
*Since all sections are interdependent this is covered in the Team Section only.

**Total Materials Cost = $154.59**



C-10

| Rev | Date | By | Purpose |
|---|---|---|---|
| 3 | 4/07 | RLD | Modified Members |
| 2 | 3/22 | RLD | Changed Height |
| 1 | 3/08 | RLD | Original |

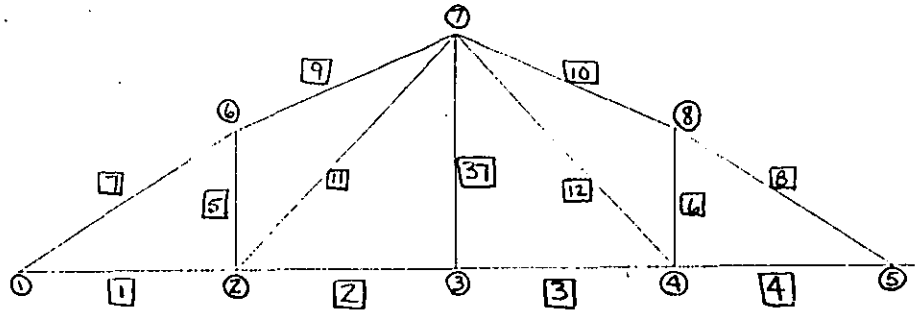
**SALUKI ENGINEERING COMPANY**

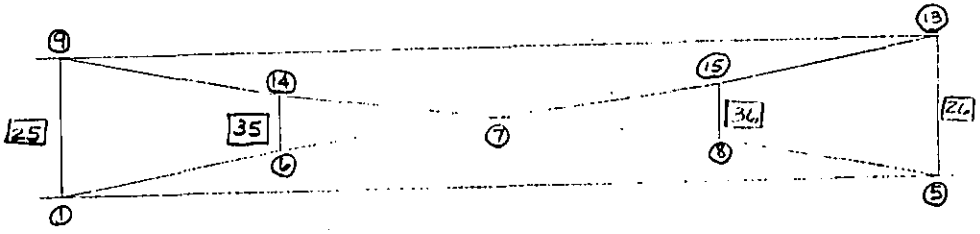
**Team #6** **SEC Reference #DES.06.S95**

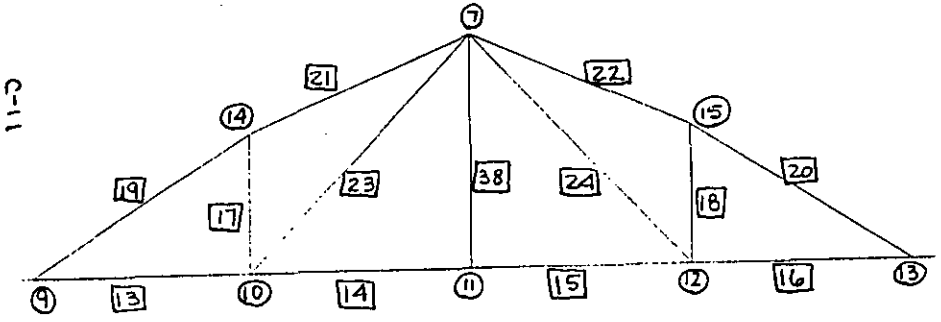
| | |
|---|---|
| **Client:** Egyptian Associates | **EA Reference #:** BRIDGE06.S95 |

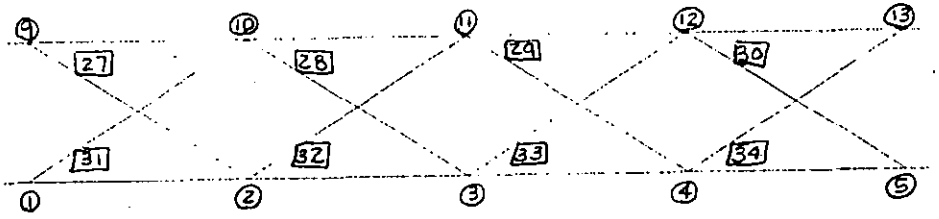
**Title:** Full Bridge (3-D)

| | | | |
|---|---|---|---|
| **Drawn by:** | Rachel Davis | **Scale:** | 1"=2' |
| **Date:** 4/24/95 | **Drawing Number:** 201 | **Rev.** | 3 |









| | | | |
|---|---|---|---|
| 3 | 4/07 | RLD | Modified Members |
| 2 | 3/22 | RLD | Changed Height |
| 1 | 3/08 | RLD | Original |
| **Rev** | **Date** | **By** | **Purpose** |

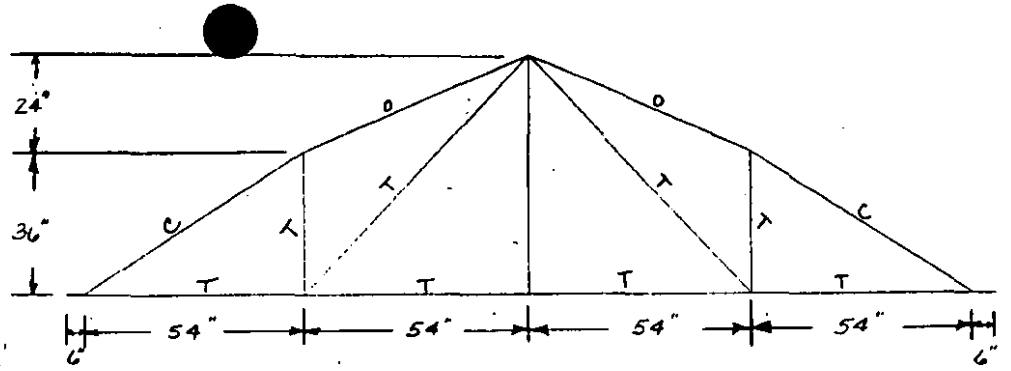
**SALUKI ENGINEERING COMPANY**

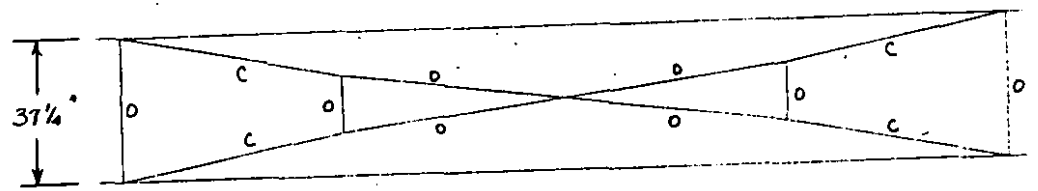
**Team #6** **SEC Reference #DES.06.S95**

| | |
|---|---|
| **Client:** Egyptian Associates | **EA Reference #:** BRIDGE06.S95 |

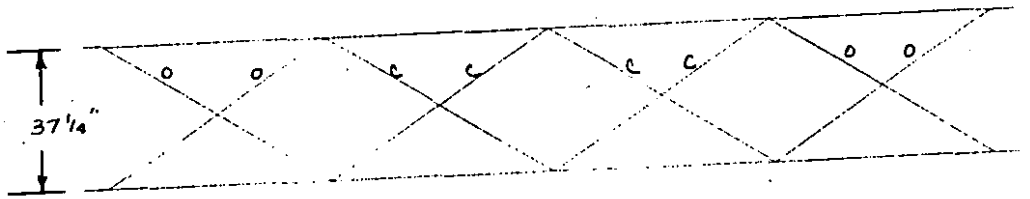
**Title:** Member and Joint Numbers

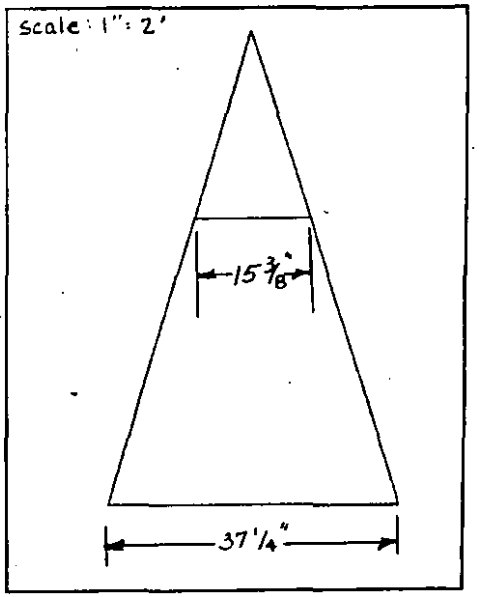
| | | | |
|---|---|---|---|
| **Drawn by:** Rachel Davis | | **Scale:** | 1"=2' |
| **Date:** 4/24/95 | **Drawing Number:** 202 | | **Rev.** 3 |




C-2




| Rev | Date | By | Purpose |
|---|---|---|---|
| 3 | 4/07 | RLD | Modified Members |
| 2 | 3/22 | RLD | Changed Height |
| 1 | 3/08 | RLD | Original |

**SALUKI ENGINEERING COMPANY**

**Team #6** **SEC Reference #DES.06.S95**

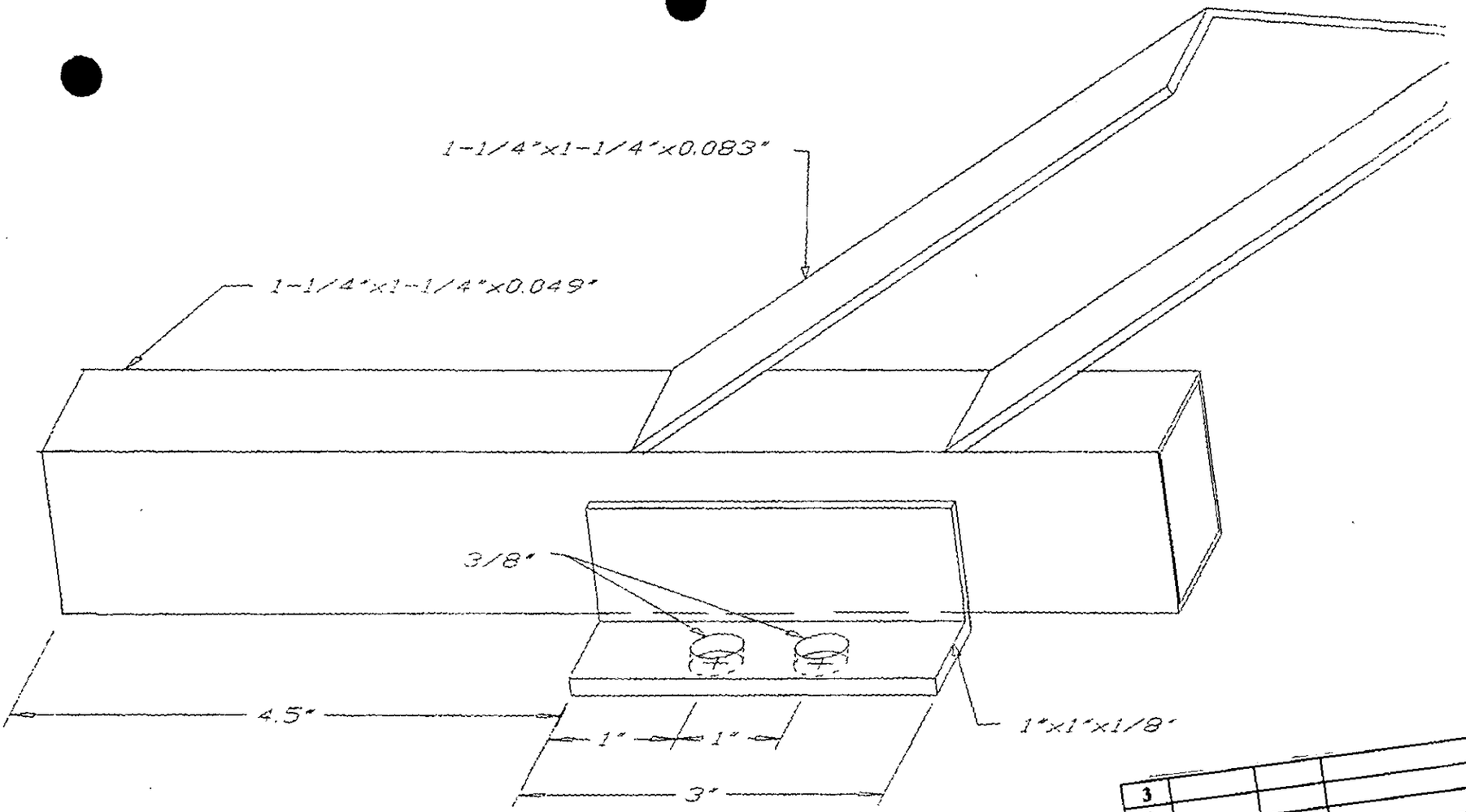
**Client:** Egyptian Associates

**EA Reference #:** BRIDGE06.S95

**Title:** Dimensioned Bridge

**Drawn by:** Rachel Davis **Scale:** 1"=2'

**Date:** 4/24/95 **Drawing Number:** 203 **Rev.** 3




| Rev | Date | By | Purpose |
|---|---|---|---|
| 3 | | | |
| 2 | | | |
| 1 | | | |

SALUKI ENGINEERING COMPANY

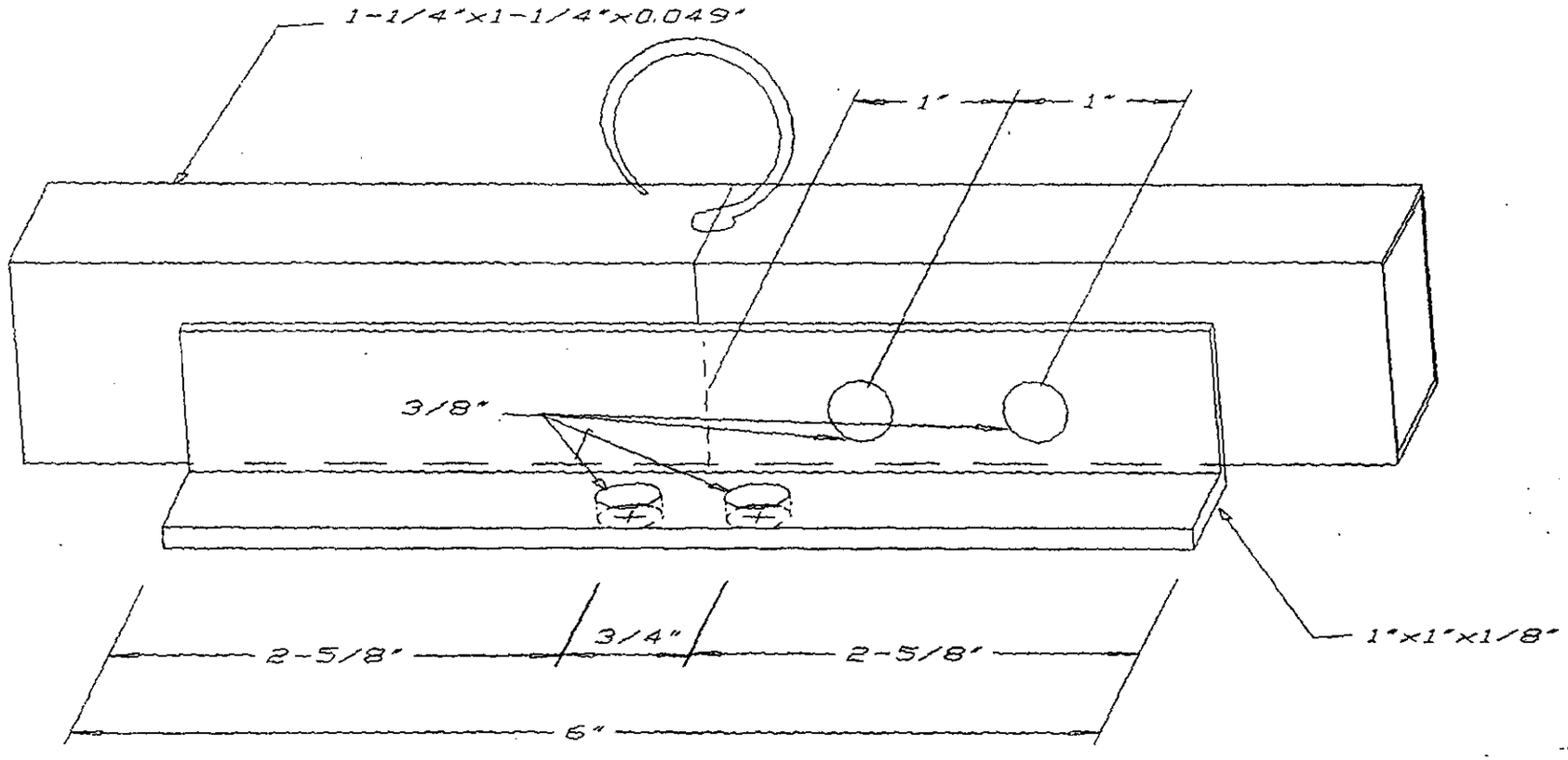
Team #6 — SEC Reference #DES.06.S95

Client: Egyptian Associates — EA Reference #: BRIDGE06.S95

Title: Bottom End Connections (Joints #1,5, 9, 13)

Drawn by: Rachel Davis — Scale: 1"=1"

Date: 4/24/95 — Drawing Number: 204 — Rev. 0

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| 3 | | | |
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SALUKI ENGINEERING COMPANY

Team #6 SEC Reference #DES.06.S95

Client: Egyptian Associates

EA Reference #: BRIDGE06.S95

Title: Bottom Inner Connections (Joints #2, 4, 10, 12)

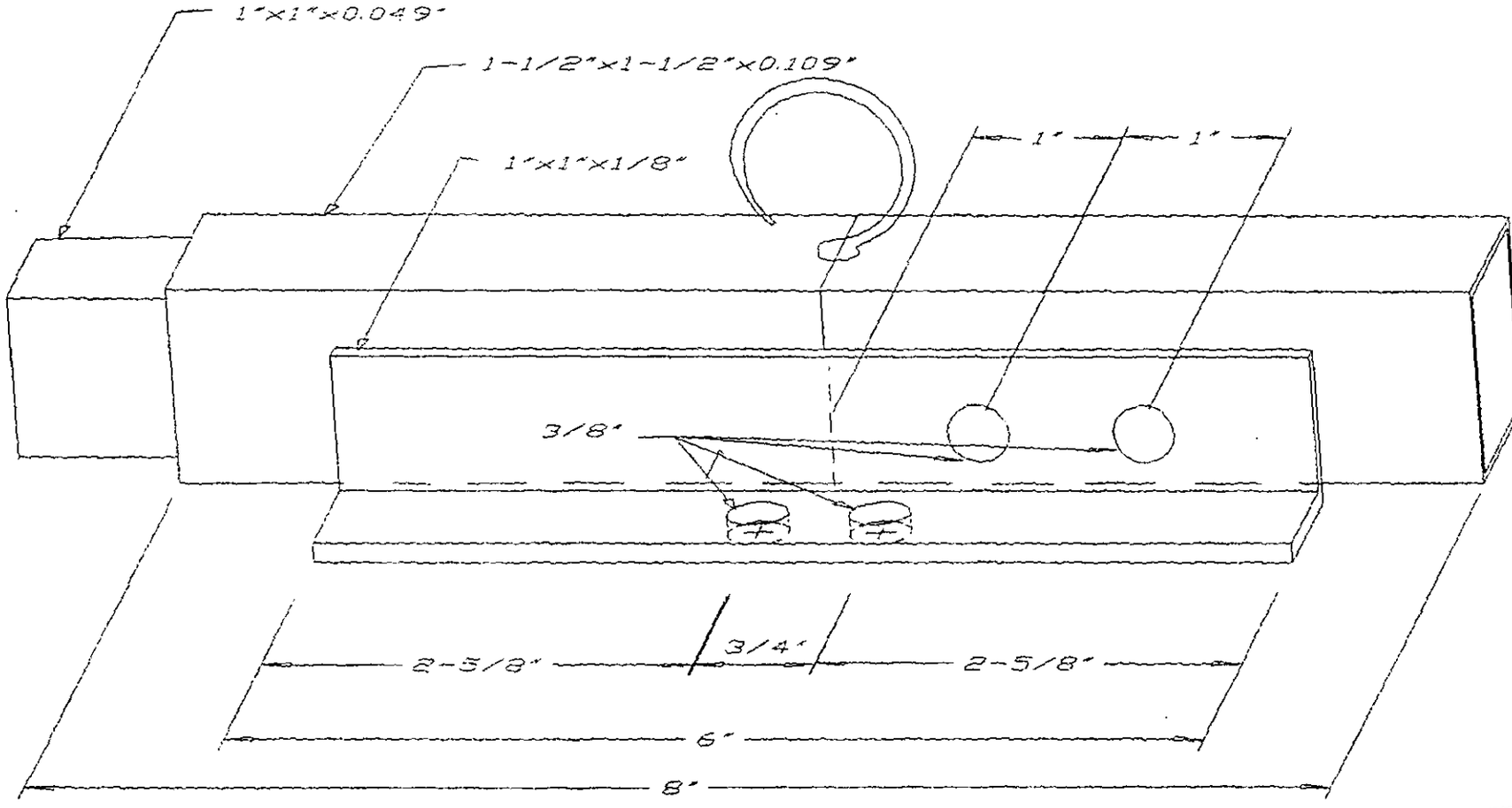
Drawn by: Rachel Davis

Scale: 1"=

Date: 4/24/95

Drawing Number: 205

Re 0




| Rev | Date | By | Purpose |
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SALUKI ENGINEERING COMPANY

Team #6 SEC Reference #DES.06.S95

Client: Egyptian Associates

EA Reference #: BRIDGE06.S95

Title: Bottom Center Connections (Joints #3, 11)

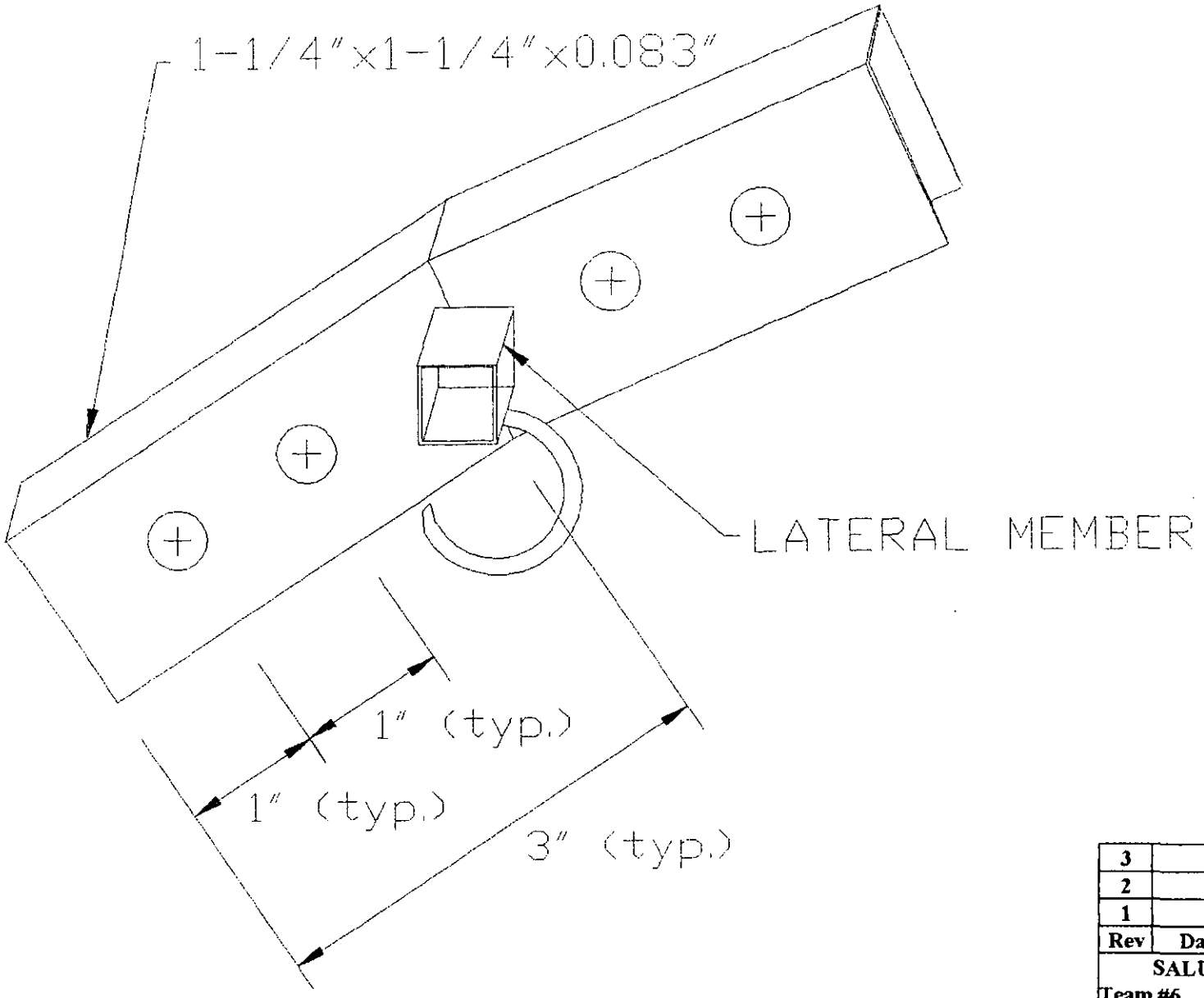
Drawn by: Rachel Davis

Scale: 1"=1"

Date: 4/25/95

Drawing Number: 206

Rev. 0

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| 1 | | | |
| **Rev** | **Date** | **By** | **Purpose** |

**SALUKI ENGINEERING COMPANY**

**Team #6** **SEC Reference #DES.06.S95**

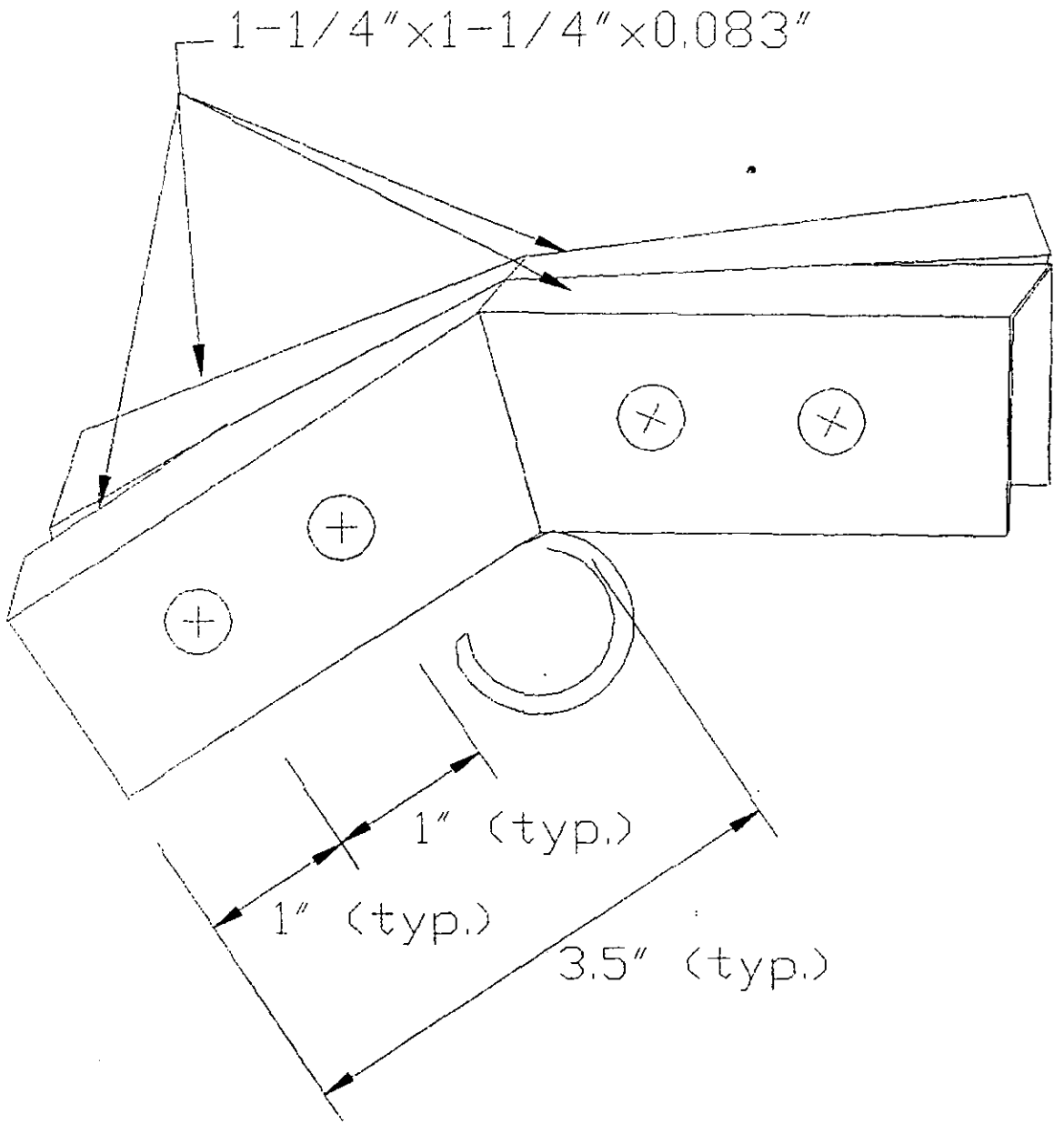
**Client:** **Egyptian Associates**

**EA Reference #:** **BRIDGE06.S95**

**Title:** Top Outer Connections (Joints #6, 8, 14, 15)

**Drawn by:** Rachel Davis **Scale:** 1" = 1"

**Date:** 4/25/95 **Drawing Number:** 207 **Rev** 0

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| Rev | Date | By | Purpose |

**SALUKI ENGINEERING COMPANY**

**Team #6** **SEC Reference #DES.06.S95**

| | |
|---|---|
| **Client:** Egyptian Associates | **EA Reference #:** BRIDGE06.S95 |

**Title:** Top Center Connection (Joint #7)

| | | | |
|---|---|---|---|
| **Drawn by:** | Rachel Davis | **Scale:** | 1"=1 |
| **Date:** 4/25/95 | **Drawing Number:** a08 | | **Rev** 0 |

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# SECTION D

# TABLE OF CONTENTS


| | page |
|---|---|
| I. Table of Contents | D-1 |
| II. Introduction | D-2 |
| III. Technical Discussion | D-3, D-4, D-5 |
| IV. Material List | D-6 |
| V. Equipment List | D-7 |
| VI. Costing Summary | D-8, D-9 |

VII. Drawings

| Number | Name | Member Number | |
|---|---|---|---|
| 301 | Hinged Rods | 37, 38 | D-10 |
| 302 | Hinged Rods | 5, 6, 17, 18 | D-11 |
| 303 | Hinged Rods | 11, 12, 23, 24 | D-12 |
| 304 | Lateral Bracing | 35, 36 | D-13 |
| 305 | Lateral Bracing | 25, 26 | D-14 |
| 306 | Lateral Bracing | 27, 28, 29, 30, 31, 32, 33, 34 | D-15 |

VIII. Bibliography D-16

# INTRODUCTION

The fabrication process is an important step in the design of the steel bridge. Each step of the process has many important decisions which need to be made at the time of fabrication. These decisions will effect the actual duration of fabrication and the quality of the bridge. The decisions will range from which connections to tack before drilling to what is best fit for the connections. Welding, cutting the steel, and drilling the holes require more time than the other steps in the process and are the most important.

The vendors will effect the fabrication process. Availability of the materials at the time of fabrication and when the materials are received could cause changes in the process. Funding will also have an effect on the process duration.

Sizing and drawings of lateral members and web members are also included in this section. The lateral members are designed to take the 100 lb lateral test and help with the stability in the other tests. The web members are in tension when taking the load for the vertical load tests. All members are taken into account in the fabrication process.

## TECHNICAL DISCUSSION

Fabrication Process:

The fabrication process consists of 11 steps taking approximately 37 hours. Time is to be volunteered by the members of the Southern Illinois University American Society of Civil Engineers to accomplish these steps. The estimate is for a 4 member crew. The crew number can be increased on some steps such as painting the bridge and cleaning the bridge, but other steps would be more trouble with more people involved. The times are subject to change as directed by the Chairman of the Bridge Committee, ASCE, SIUC.

Steps:

1. Cut the steel into the specified sizes and file the rough edges.(6 hours)
2. Clean the steel with shop cloths.(0.5 hours)
3. Tack weld the connections that are to be welded, unless the connections are too awkward to fit the drill press.(5.5 hours)
4. Drill the holes. Align the connections while drilling. File any drilled holes which may have rough edges.(6 hours)
5. Weld a strong weld in place of the tack weld.(9 hours)
6. Clean the members as welded together with acetone.(1 hour)
7. Assemble the bridge a few times to see how everything fits together.(2 hours)
8. Coat the bridge with primer.(4 hours)
9. Paint the bridge while it is together to avoid any extra unwanted thickness in member connections.(4 hours)
10. Stencil the school name on the bottom chord members after the primary paint is on.. (2 hours)
11. Practice the assembly process.(as directed by the Bridge Committee Chairman)

## TECHNICAL DISCUSSION (continued)

Funding:

There is more than one way to receive funding for the bridge. The first is through the Civil Engineering Department. Procedure is to talk to the chairman, Dr. Sami, to see if funding is available. The next procedure is to politely ask from vendors and private parties for donations in return for displaying their company name at the competition. Some professors and some involved people have privately donated to help fund the bridge in past years. Vendors have also donated materials in past years. The last way to fund the bridge is through the Undergraduate Student Government. This procedure must be done during the school year (appendix B). Any of these methods are acceptable, and if they do not work ASCE will fund the bridge with its own finances.

Design of Lateral Members:

The lateral members were designed to withstand a 100 lb load for the lateral test, a 500 lb load plus the weight of the bridge for the first vertical test, and a 2500 lb load plus the weight of the bridge for the final test. A factor of safety was also used when analyzing the member reactions. The members were designed to be tubular steel due to the compression forces which they can develop along with the tensile forces. Members 25 and 26 are 36" long and are 1/2" square tubular steel with a thickness of 0.049" (Drawing 305). Members 35 and 36 are 14.4" long. Although they carry virtually no load, they have the same thickness as members 25 and 26 for symmetry purposes, and are used for stability (Drawing 304). Members 27 through 34 are approximately 64.9" long, with angles on each end to fit the connections. These members are 0.625" square tubing and are all hinged in the middle with a 0.25" bolt (Drawing 306). Each lateral member is to be cut and drilled according to the fabrication process (Section D) and connected as specified in the connection specification (Section C).

* for additional discussion on lateral bracing see Section B.

## TECHNICAL DISCUSSION (continued)

Design of Web Members:

The web members were designed to help with stability during the 100 lb lateral load test, withstand a 500 lb load plus the weight of the bridge for the first vertical test, and withstand a 2500 lb load plus the weight of the bridge for the final test. During the analysis the deflection of the members and the bridge was kept to a minimum. A factor of safety was also used when analyzing the member reactions. The members were designed to be threaded steel rods with turnbuckles. Rods were found to be lighter than tubing, but only strong in tension. Since the web members only experience tensile forces we determined to use rods. The turnbuckles are present so the rods can be put into place then tightened for a good fit. Members 37 and 38 are 60" long and have a diameter of 0.375" (Drawing 301). Members 5, 6, 17, 18 are 36" long and have a diameter of 0.25" (Drawing 302). Members 11, 12, 23, 24 are 82.7" long with a hinge in the middle and have a diameter of 0.25" (Drawing 303). Each rod has a turn buckle included in its length which will be used to make the length exact. The rods will be hinged together as specified in the connection specification (Section C).

* for additional discussion on web members see Section B.

# MEMBER MATERIALS LIST

| ITEM | DIMENSIONS | QTY | LINEAR INCHES* | DESIRED STRENGTH |
|---|---|---|---|---|
| Structural Steel Tubing (Members 25, 26) | 1/2" x 1/2" x 0.049" | 2 | 36.0 | Fy = 36 ksi |
| Structural Steel Tubing (Members 35, 36) | 1/2" x 1/2" x 0.049" | 2 | 14.4 | Fy = 36 ksi |
| Structural Steel Tubing (Members 27-34) | 5/8" x 5/8" x 0.049" | 8 | 64.9 | Fy = 36 ksi |
| Round Threaded Steel Rods (Members 5, 6, 17, 18) | 1/4" diam | 4 | 36.0 | Fy = 36 ksi |
| Round Threaded Steel Rods (Members 11, 12, 23, 24) | 1/4" diam | 4 | 82.4 | Fy = 36 ksi |
| Round Threaded Steel Rods (Members 37, 38) | 3/8" diam | 2 | 60.0 | Fy = 36 ksi |
| Steel Turnbuckles | 1/4" threading | 4 | ------- | 325 lb (T) |
| Steel Turnbuckles | 1/4" threading | 4 | ------- | 225 lb (T) |
| Steel Turnbuckles | 3/8" threading | 2 | ------- | 1000 lb (T) |

*These are the exact member lengths. When ordering when cutting the steel, some extra length should be added. It is easy to cut off extra but nearly impossible to lengthen a member which is too short.

## EQUIPMENT LIST

All of the needed equipment is available in the SIUC workshop located on the ground floor of Engineering Building D. The equipment in the workshop is as follows:

1) Delta Milwaukee drill press
   Model # MD 6X110 CW (1/3 hp)

2) Emerson 7" horizontal metal cutting band saw
   Model # 10-1720T

3) Enco vertical band saw
   Model # 165-1551

4) Tri-star 6" electric bench grinder

5) Arc welder

6) Power hand drill

7) Assorted hand files

8) Safety glasses

Note: John Hester is in charge of the workshop and permission must be obtained from him before any work begins. Also, identification cards must be obtained for those students who will be working on the bridge in the workshop during the weekends.

## COSTING SUMMARY

**Materials:**

**Vendors:**
TVH = True Value Hardware
M-C = McMaster - Carr Supply Company

Structural Steel Tubing:

| Type | Length | Quantity | Cost/each | Vendor |
|---|---|---|---|---|
| 1/2" x 1/2" x 0.049 | 3' | 3 | $2.95 | TVH |
| 5/8" x 5/8" x 0.049 | 6' | 8 | $6.90 | TVH |

Round UNC, class 2 Threaded Steel Rods:

| Type | Length | Quantity | Cost/each | Vendor |
|---|---|---|---|---|
| 1/4" | 3' | 8 | $0.96 | TVH |
| 1/4" | 6' | 4 | $1.92 | TVH |
| 3/8" | 6' | 2 | $1.20 | TVH |

Hook and Eye Steel Turnbuckles (UNC, class 2 threads):

| Bolt Diameter | Quantity | Cost/each | Vendor |
|---|---|---|---|
| 1/4" | 8 | $4.92 | M-C |
| 3/8" | 2 | $6.87 | M-C |

Acetone:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| generic | 2 | $2.29/pint | TVH |

Primer:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| X-O Rust | 2 | $3.28/pint | TVH |

## COSTING SUMMARY (continued)

Paint:

| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| Spray Enamel | 4 | $1.09/12oz | TVH |

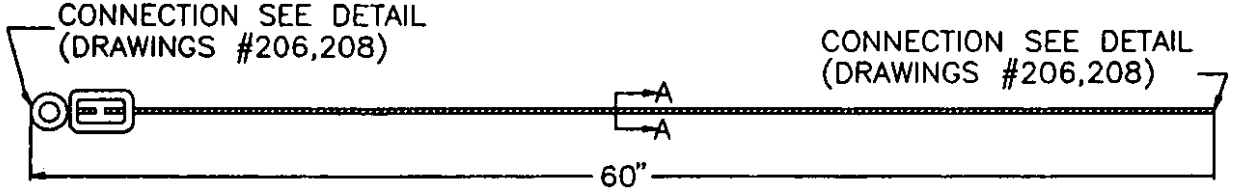
Lubricant:

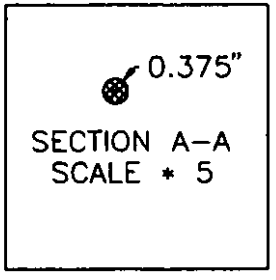
| Type | Quantity | Cost/each | Vendor |
|---|---|---|---|
| WD-40 | 2 | $1.49/6oz | TVH |

**Labor and Equipment:**

* Since all sections are interdependent this is covered in the Team Section only.

**Total Materials Cost = $153.39**




B-10

0 2.5 5 10

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| 3 | | | |
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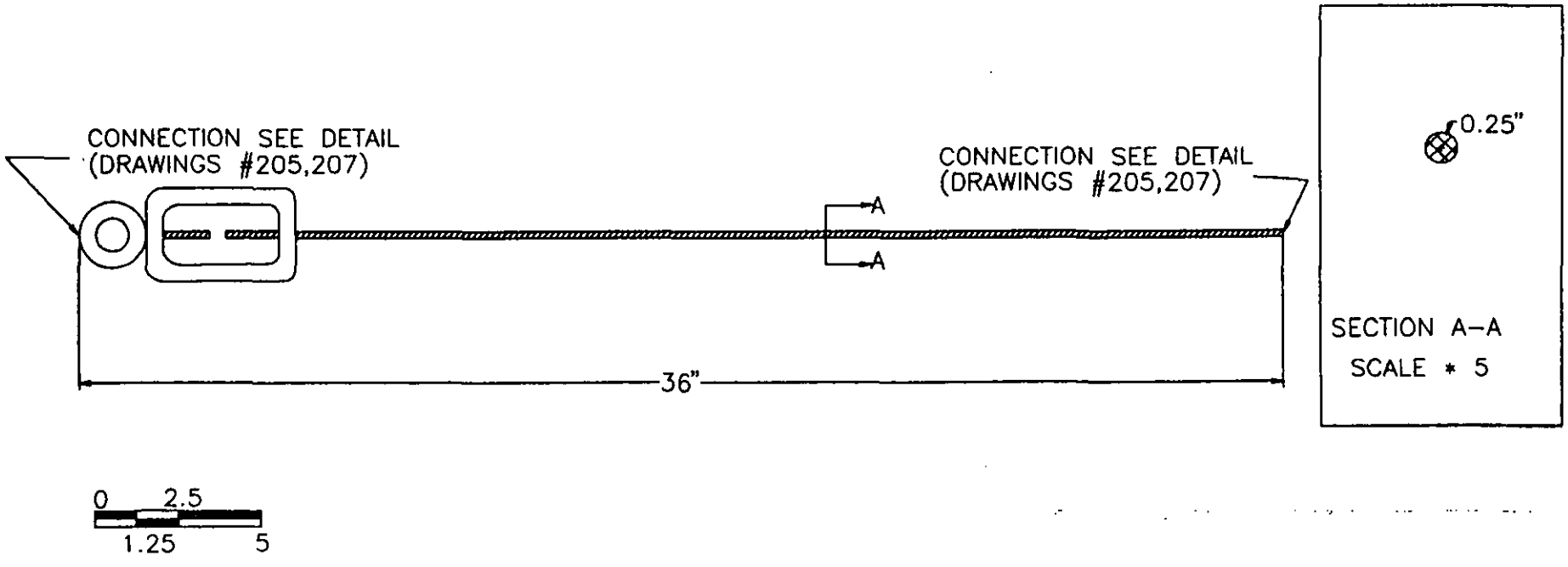
| 1 | 4-19 | SO | Corrections |
| Rev | Date | By | Purpose |

SALUKI ENGINEERING COMPANY

Team #6 SEC Reference #DES.06.S95

| | |
|---|---|
| Client: Egyptian Associates | EA Reference #: BRIDGE06.S95 |
| Title: Hinged Rods 37,38 | |
| Drawn by: Sarah E Ohler | Scale: 1 : 10 |
| Date: 4-15-95 | Drawing Number: 301 |
| Rev. 0 | |




D-11

| Rev | Date | By | Purpose |
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| 3 | | | |
| 2 | 4-19 | SO | Corrections |
| 1 | 4-15 | SO | Corrections |

SALUKI ENGINEERING COMPANY

Team #6 SEC Reference #DES.06.S95

Client: Egyptian Associates

EA Reference #: BRIDGE06.S95

Title: Hinged Rods 5,6,17,18

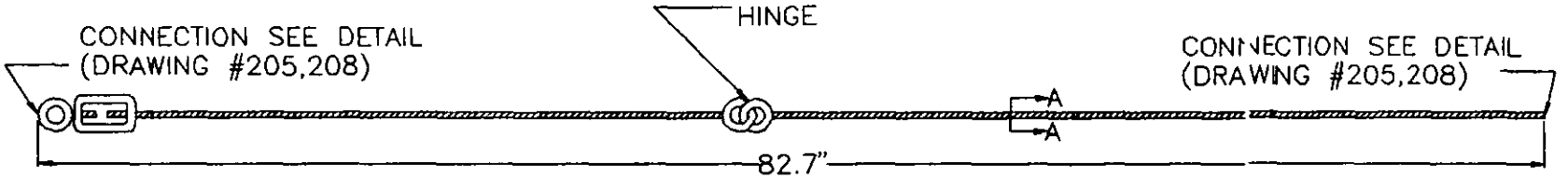
Drawn by: Sarah E. Ohler

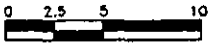
Scale: 1:5

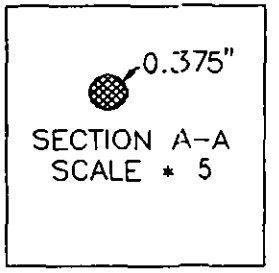
Date: 4-8 -95

Drawing Number: 302

Rev. 0

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| Rev | Date | By | Purpose |

**SALUKI ENGINEERING COMPANY**

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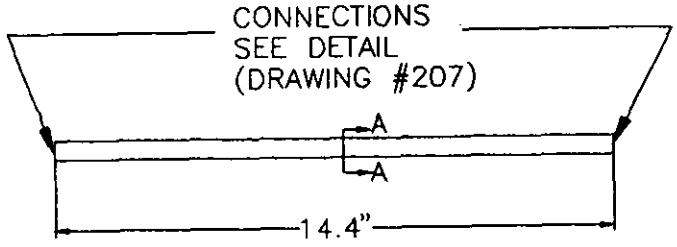
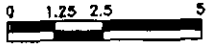
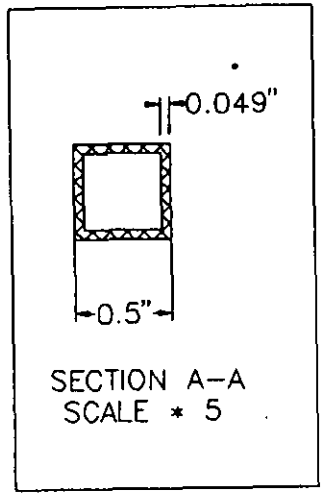
|---|---|
| Team #6 SEC Reference #DES.06.S95 | |
| Client: Egyptian Associates | EA Reference #: BRIDGE06.S95 |
| Title: Hinged Rods 11,12,23,24 | |
| Drawn by: Sarah E. Ohler | Scale: 1:10 |
| Date: 4-8-95 | Drawing Number: 303 Rev. 0 |

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| 2 | | | |
| 1 | 4-15 | SO | Corrections |
| Rev | Date | By | Purpose |

**SALUKI ENGINEERING COMPANY**

**Team #6** **SEC Reference #DES.06.S95**

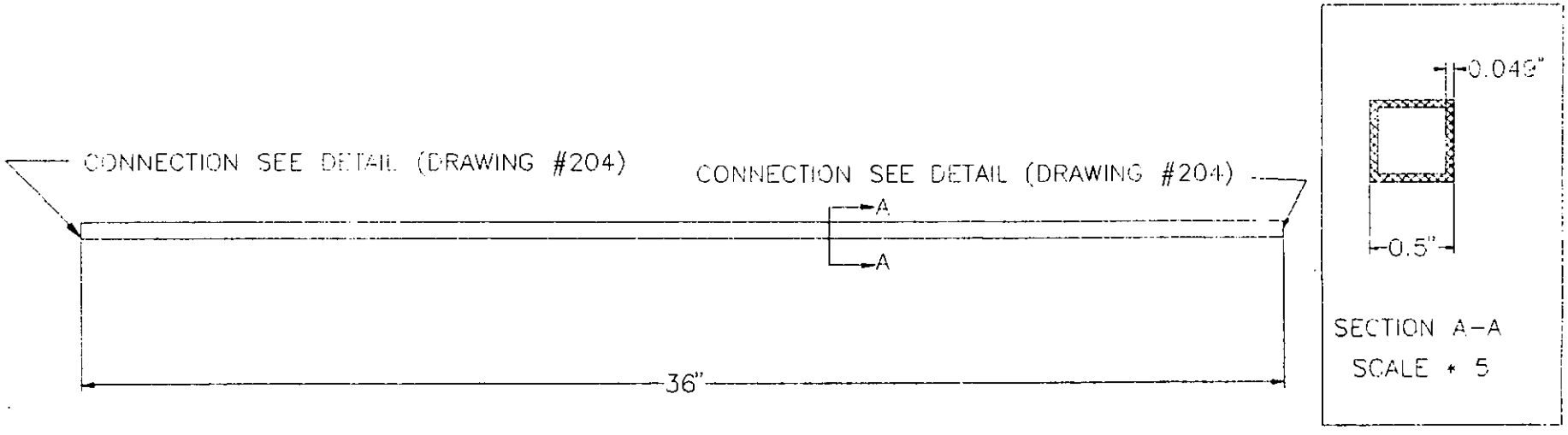
**Client:** Egyptian Associates

**EA Reference #:** BRIDGE06.S95

**Title:** Lateral Bracing 35,36

**Drawn by:** Sarah E. Ohler **Scale:** 1:5

**Date:** 4-8-95 **Drawing Number:** 304 **Rev.** 0

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D-14

| | | | |
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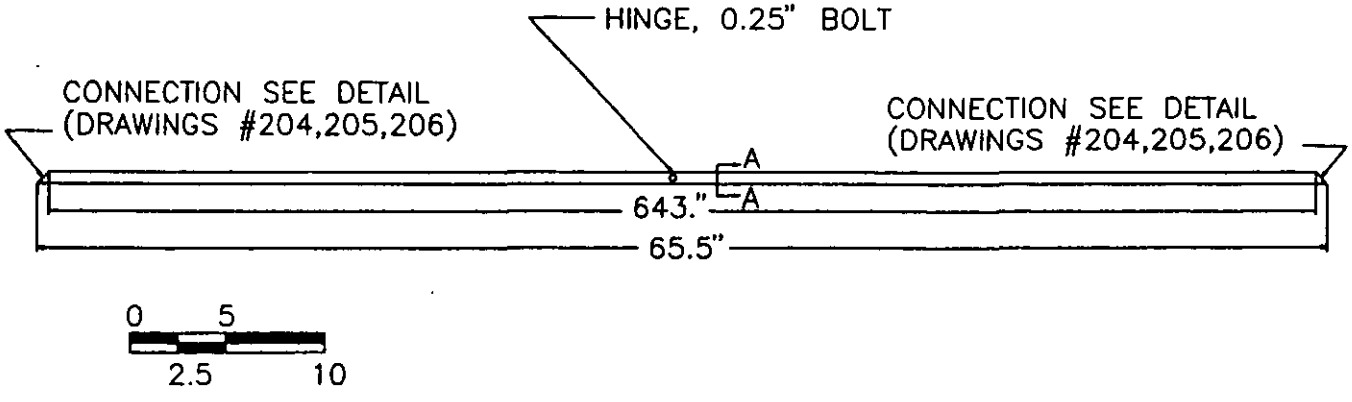
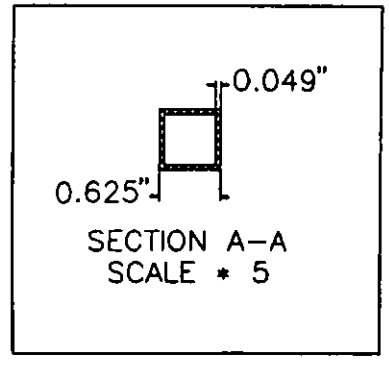
| 2 | 4-8 | SO | Corrections |
| 1 | 4-4 | SO | Corrections |
| **Rev** | **Date** | **By** | **Purpose** |

**SALUKI ENGINEERING COMPANY**

**Team #6** **SEC Reference #DES.06.S95**

| | |
|---|---|
| **Client:** Egyptian Associates | **EA Reference #:** BRIDGE06.S95 |
| **Title:** Lateral Bracing 25,26 | |
| **Drawn by:** Sarah E. Ohler | **Scale:** 1:5 |
| **Date:** 4-3-95 | **Drawing Number:** 305 **Rev.** 0 |




D-15

| Rev | Date | By | Purpose |
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| 2 | 4-15 | SO | Corrections |
| 1 | 4-8 | SO | Corrections |

SALUKI ENGINEERING COMPANY

Team #6 SEC Reference #DES.06.S95

Client: Egyptian Associates

EA Reference #: BRIDGE06.S95

Title: Lateral Bracing 27,28,29,30, 31,32,33,34

Drawn by: Sarah E. Ohler

Scale: 1:10

Date: 4-4-95

Drawing Number: 306

Rev. 0

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# SECTION E

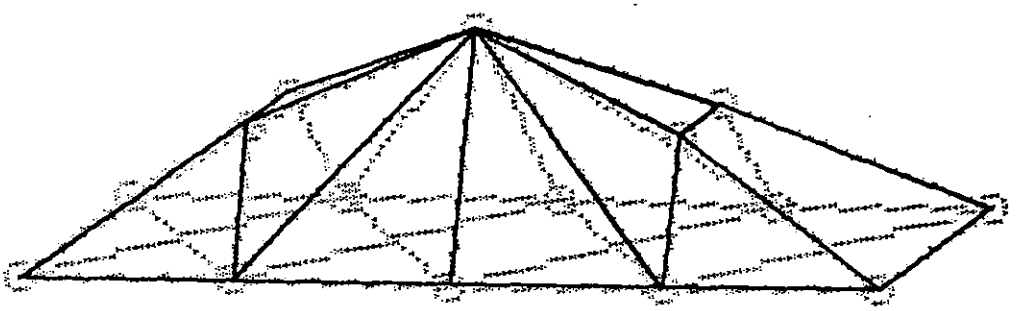
# Appendix A:

# Final Computer Analysis

```
**********************
* Computer Software  *
*       for          *
* STRUCTURAL ANALYSIS *
*       by           *
*   Aslam Kassimali  *
**********************
```

## General Structural Data

Project Title : THE TRUSS
Structure Type : Space Truss
Number of Joints : 15
Number of Members : 38
Number of Material Property Sets (E) : 1
Number of Cross-Sectional Property Sets (A & I) : 1



## Joint Coordinates

| Joint No. | X Coordinate | Y Coordinate | Z Coordinate |
|---|---|---|---|
| 1 | +0.0000E+00 | +0.0000E+00 | +0.0000E+00 |
| 2 | +5.4000E+01 | +0.0000E+00 | +0.0000E+00 |
| 3 | +1.0800E+02 | +0.0000E+00 | +0.0000E+00 |
| 4 | +1.6200E+02 | +0.0000E+00 | +0.0000E+00 |
| 5 | +2.1600E+02 | +0.0000E+00 | +0.0000E+00 |
| 6 | +5.4000E+01 | +3.6000E+01 | +1.0800E+01 |
| 7 | +1.0800E+02 | +6.0000E+01 | +1.8000E+01 |
| 8 | +1.6200E+02 | +3.6000E+01 | +1.0800E+01 |
| 9 | +0.0000E+00 | +0.0000E+00 | +3.6000E+01 |
| 10 | +5.4000E+01 | +0.0000E+00 | +3.6000E+01 |
| 11 | +1.0800E+02 | +0.0000E+00 | +3.6000E+01 |
| 12 | +1.6200E+02 | +0.0000E+00 | +3.6000E+01 |
| 13 | +2.1600E+02 | +0.0000E+00 | +3.6000E+01 |
| 14 | +5.4000E+01 | +3.6000E+01 | +2.5200E+01 |
| 15 | +1.6200E+02 | +3.6000E+01 | +2.5200E+01 |

## Supports

| Joint No. | X Restraint | Y Restraint | Z Restraint |
|---|---|---|---|
| 1 | Yes | Yes | Yes |
| 5 | No | Yes | No |
| 9 | Yes | Yes | Yes |
| 13 | No | Yes | No |

## Member Data

| Member No. | Beginning Joint | End Joint | Material No. | Cross-Sectional Property No. |
|---|---|---|---|---|
| 1 | 1 | 2 | 1 | 1 |
| 2 | 2 | 3 | 1 | 1 |
| 3 | 3 | 4 | 1 | 1 |
| 4 | 4 | 5 | 1 | 1 |
| 5 | 2 | 6 | 1 | 1 |
| 6 | 4 | 8 | 1 | 1 |
| 7 | 1 | 6 | 1 | 1 |
| 8 | 5 | 8 | 1 | 1 |
| 9 | 6 | 7 | 1 | 1 |
| 10 | 8 | 7 | 1 | 1 |
| 11 | 2 | 7 | 1 | 1 |
| 12 | 4 | 7 | 1 | 1 |
| 13 | 9 | 10 | 1 | 1 |
| 14 | 10 | 11 | 1 | 1 |
| 15 | 11 | 12 | 1 | 1 |
| 16 | 12 | 13 | 1 | 1 |
| 17 | 10 | 14 | 1 | 1 |
| 18 | 12 | 15 | 1 | 1 |
| 19 | 9 | 14 | 1 | 1 |
| 20 | 13 | 15 | 1 | 1 |
| 21 | 14 | 7 | 1 | 1 |
| 22 | 15 | 7 | 1 | 1 |
| 23 | 10 | 7 | 1 | 1 |
| 24 | 12 | 7 | 1 | 1 |
| 25 | 1 | 9 | 1 | 1 |
| 26 | 5 | 13 | 1 | 1 |
| 27 | 2 | 9 | 1 | 1 |
| 28 | 3 | 10 | 1 | 1 |
| 29 | 4 | 11 | 1 | 1 |
| 30 | 5 | 12 | 1 | 1 |
| 31 | 1 | 10 | 1 | 1 |
| 32 | 2 | 11 | 1 | 1 |
| 33 | 3 | 12 | 1 | 1 |
| 34 | 4 | 13 | 1 | 1 |
| 35 | 14 | 6 | 1 | 1 |
| 36 | 15 | 8 | 1 | 1 |
| 37 | 3 | 7 | 1 | 1 |
| 38 | 11 | 7 | 1 | 1 |

# 2500 lb Vertical Test Load

## Joint Loads

| Joint No. | X Force | Y Force | Z Force |
|---|---|---|---|
| 2 | +0.0000E+00 | -3.3125E+02 | +0.0000E+00 |
| 3 | +0.0000E+00 | -6.6250E+02 | +0.0000E+00 |
| 4 | +0.0000E+00 | -3.3125E+02 | +0.0000E+00 |
| 10 | +0.0000E+00 | -3.3125E+02 | +0.0000E+00 |
| 11 | +0.0000E+00 | -6.6250E+02 | +0.0000E+00 |
| 12 | +0.0000E+00 | -3.3125E+02 | +0.0000E+00 |

## Member Axial Forces

Note: Positive values are compressive forces

| Member No. | Axial Force |
|---|---|
| 1 | -9.9773E+02 |
| 2 | -1.0395E+03 |
| 3 | -1.0474E+03 |
| 4 | -9.8977E+02 |
| 5 | -2.3056E+02 |
| 6 | -2.3056E+02 |
| 7 | +1.2108E+03 |
| 8 | +1.2108E+03 |
| 9 | +1.0955E+03 |
| 10 | +1.0955E+03 |
| 11 | -1.5220E+02 |
| 12 | -1.5220E+02 |
| 13 | -9.9773E+02 |
| 14 | -1.0395E+03 |
| 15 | -1.0474E+03 |
| 16 | -9.8977E+02 |
| 17 | -2.3056E+02 |
| 18 | -2.3055E+02 |
| 19 | +1.2108E+03 |
| 20 | +1.2108E+03 |
| 21 | +1.0955E+03 |
| 22 | +1.0955E+03 |
| 23 | -1.5220E+02 |
| 24 | -1.5220E+02 |
| 25 | +0.0000E+00 |
| 26 | -1.9610E+02 |
| 27 | +4.7864E+00 |
| 28 | +1.7437E+02 |
| 29 | +1.8394E+02 |
| 30 | -4.7847E+00 |
| 31 | +4.7856E+00 |
| 32 | +1.7436E+02 |
| 33 | +1.8394E+02 |
| 34 | -4.7853E+00 |
| 35 | +8.2057E-04 |
| 36 | +4.1028E-04 |
| 37 | -6.9167E+02 |
| 38 | -6.9167E+02 |

# 100 lb Lateral Test Load

## Joint Loads

| Joint No. | X Force | Y Force | Z Force |
|---|---|---|---|
| 3 | +0.0000E+00 | +0.0000E+00 | +1.0000E+02 |

## Member Axial Forces

Note: Positive values are compressive forces

| Member No. | Axial Force |
|---|---|
| 1 | -1.6561E+02 |
| 2 | -1.0383E+02 |
| 3 | -4.6172E+01 |
| 4 | +1.5600E+01 |
| 5 | +7.0922E+00 |
| 6 | -7.0922E+00 |
| 7 | -3.7245E+01 |
| 8 | +3.7245E+01 |
| 9 | -3.3699E+01 |
| 10 | +3.3700E+01 |
| 11 | -9.3636E+00 |
| 12 | +9.3635E+00 |
| 13 | +2.4161E+02 |
| 14 | +2.7833E+01 |
| 15 | -2.7826E+01 |
| 16 | +5.8398E+01 |
| 17 | -7.0923E+00 |
| 18 | +7.0921E+00 |
| 19 | +3.7245E+01 |
| 20 | -3.7244E+01 |
| 21 | +3.3700E+01 |
| 22 | -3.3699E+01 |
| 23 | +9.3637E+00 |
| 24 | -9.3637E+00 |
| 25 | +0.0000E+00 |
| 26 | +2.4666E+01 |
| 27 | +3.3447E+01 |
| 28 | +1.2479E+02 |
| 29 | +3.3447E+01 |
| 30 | -5.5489E+01 |
| 31 | -1.2479E+02 |
| 32 | -3.3447E+01 |
| 33 | +5.5488E+01 |
| 34 | -3.3447E+01 |
| 35 | +0.0000E+00 |
| 36 | -2.5643E-05 |
| 37 | +3.8363E-05 |
| 38 | +2.0584E-05 |

# Virtual Forces: Vertical

## Joint Loads

| Joint No. | X Force | Y Force | Z Force |
|---|---|---|---|
| 3 | +0.0000E+00 | -1.0000E+00 | +0.0000E+00 |

## Member Axial Forces

Note: Positive values are compressive forces

| Member No. | Axial Force |
|---|---|
| 1 | -5.2501E-01 |
| 2 | -6.7501E-01 |
| 3 | -6.7500E-01 |
| 4 | -5.2500E-01 |
| 5 | -1.7401E-01 |
| 6 | -1.7401E-01 |
| 7 | +9.1378E-01 |
| 8 | +9.1378E-01 |
| 9 | +8.2681E-01 |
| 10 | +8.2681E-01 |
| 11 | +2.2973E-01 |
| 12 | +2.2973E-01 |
| 13 | +8.8546E-06 |
| 14 | -4.4999E-01 |
| 15 | -4.5000E-01 |
| 16 | +1.9232E-06 |
| 17 | -2.6616E-07 |
| 18 | +4.1317E-07 |
| 19 | +1.1913E-06 |
| 20 | -1.4816E-06 |
| 21 | +1.1711E-06 |
| 22 | -1.2519E-06 |
| 23 | +1.9475E-07 |
| 24 | -5.0287E-07 |
| 25 | +0.0000E+00 |
| 26 | -1.2821E-06 |
| 27 | +1.6747E-06 |
| 28 | +2.7042E-01 |
| 29 | +1.3999E-06 |
| 30 | -2.7042E-01 |
| 31 | -2.7042E-01 |
| 32 | -1.1782E-06 |
| 33 | +2.7041E-01 |
| 34 | -1.4319E-06 |
| 35 | +1.0017E-07 |
| 36 | +7.5125E-08 |
| 37 | -1.0440E+00 |
| 38 | +3.6000E-08 |

# Virtual Forces: Lateral

## Joint Loads

| Joint No. | X Force | Y Force | Z Force |
|---|---|---|---|
| 3 | +0.0000E+00 | +0.0000E+00 | +1.0000E+00 |

## Member Axial Forces

Note: Positive values are compressive forces

| Member No. | Axial Force |
|---|---|
| 1 | -1.6561E+00 |
| 2 | -1.0383E+00 |
| 3 | -4.6172E-01 |
| 4 | +1.5600E-01 |
| 5 | +7.0922E-02 |
| 6 | -7.0922E-02 |
| 7 | -3.7245E-01 |
| 8 | +3.7245E-01 |
| 9 | -3.3699E-01 |
| 10 | +3.3700E-01 |
| 11 | -9.3636E-02 |
| 12 | +9.3635E-02 |
| 13 | +2.4161E+00 |
| 14 | +2.7833E-01 |
| 15 | -2.7826E-01 |
| 16 | +5.8398E-01 |
| 17 | -7.0923E-02 |
| 18 | +7.0921E-02 |
| 19 | +3.7245E-01 |
| 20 | -3.7244E-01 |
| 21 | +3.3700E-01 |
| 22 | -3.3699E-01 |
| 23 | +9.3637E-02 |
| 24 | -9.3638E-02 |
| 25 | +0.0000E+00 |
| 26 | +2.4666E-01 |
| 27 | +3.3447E-01 |
| 28 | +1.2479E+00 |
| 29 | +3.3447E-01 |
| 30 | -5.5488E-01 |
| 31 | -1.2479E+00 |
| 32 | -3.3447E-01 |
| 33 | +5.5488E-01 |
| 34 | -3.3447E-01 |
| 35 | -4.0067E-07 |
| 36 | -2.0033E-07 |
| 37 | +2.1610E-07 |
| 38 | +5.2073E-07 |

Determination of Bridge Deflection by the Virtual Work Method
2500 lb vertical test load

| Member | Length, L (in) | Area, A (in^2) | Force, F (lb) | Virtual Force Fv (lb) | Fv(FL/A) (lb^2/in) |
|---|---|---|---|---|---|
| 1 | 60.0 | 0.2354 | 998 | 5.25E-01 | 133547.2 |
| 2 | 54.0 | 0.2354 | 1040 | 6.75E-01 | 161036.5 |
| 3 | 54.0 | 0.2354 | 1047 | 6.75E-01 | 162120.4 |
| 4 | 60.0 | 0.2354 | 990 | 5.25E-01 | 132476.6 |
| 5 | 36.0 | 0.0276 | 231 | 1.74E-01 | 52427.0 |
| 6 | 36.0 | 0.0276 | 231 | 1.74E-01 | 52427.0 |
| 7 | 65.8 | 0.1864 | -1211 | -9.14E-01 | 390724.2 |
| 8 | 65.8 | 0.1864 | -1211 | -9.14E-01 | 390724.2 |
| 9 | 55.1 | 0.1864 | -1096 | -8.27E-01 | 267930.3 |
| 10 | 55.1 | 0.1864 | -1096 | -8.27E-01 | 267930.3 |
| 11 | 65.3 | 0.0884 | 152 | -2.30E-01 | -25824.5 |
| 12 | 65.3 | 0.0884 | 152 | -2.30E-01 | -25824.5 |
| 13 | 60.0 | 0.2354 | 998 | -8.85E-06 | -2.3 |
| 14 | 54.0 | 0.2354 | 1040 | 4.50E-01 | 107357.7 |
| 15 | 54.0 | 0.2354 | 1047 | 4.50E-01 | 108080.3 |
| 16 | 60.0 | 0.2354 | 990 | -1.92E-06 | -0.5 |
| 17 | 36.0 | 0.0276 | 231 | 2.66E-07 | 0.1 |
| 18 | 36.0 | 0.0276 | 231 | -4.13E-07 | -0.1 |
| 19 | 65.8 | 0.1864 | -1211 | -1.17E-06 | 0.5 |
| 20 | 65.8 | 0.1864 | -1211 | 1.48E-06 | -0.6 |
| 21 | 55.1 | 0.1864 | -1096 | -1.17E-06 | 0.4 |
| 22 | 55.1 | 0.1864 | -1096 | 1.25E-06 | -0.4 |
| 23 | 65.3 | 0.0884 | 1522 | -1.95E-07 | -0.2 |
| 24 | 65.3 | 0.0884 | 1522 | 5.03E-07 | 0.6 |
| 25 | 36.0 | 0.0884 | 0 | 0.00E+00 | 0.0 |
| 26 | 36.0 | 0.0884 | 196 | 1.28E-06 | 0.1 |
| 27 | 64.9 | 0.1129 | -5 | -1.67E-06 | 0.0 |
| 28 | 64.9 | 0.1129 | -174 | -2.70E-01 | 27006.2 |
| 29 | 64.9 | 0.1129 | -184 | -1.40E-06 | 0.1 |
| 30 | 64.9 | 0.1129 | 5 | 2.70E-01 | 776.0 |
| 31 | 64.9 | 0.1129 | -5 | 2.70E-01 | -776.0 |
| 32 | 64.9 | 0.1129 | -174 | 1.18E-06 | -0.1 |
| 33 | 64.9 | 0.1129 | -184 | -2.70E-01 | 28558.3 |
| 34 | 64.9 | 0.1129 | 5 | 1.43E-06 | 0.0 |
| 35 | 14.4 | 0.0884 | 0 | -1.00E-07 | 0.0 |
| 36 | 14.4 | 0.0884 | 0 | -7.50E-08 | 0.0 |
| 37 | 62.6 | 0.0491 | 692 | 1.04E+00 | 917555.4 |
| 38 | 62.7 | 0.0491 | 692 | -3.60E-08 | -0.0 |
| Total | ----- | ----- | ----- | ----- | 3148249.9 |

Deflection = (3, 148, 249.9)/(29.0E06) = 0.109

Vertical Deflection of joint 3 = 0.109 in

Determination of Bridge Deflection by the Virtual Work Method
100 lb lateral test load

| Member | Length, L (in) | Area, A (in^2) | Force, F (lb) | Virtual Force Fv (lb) | Fv(FL/A) (lb^2/in) |
|---|---|---|---|---|---|
| 1 | 60.0 | 0.2354 | 166 | 1.66E+00 | 70236.2 |
| 2 | 54.0 | 0.2354 | 104 | 1.04E+00 | 24811.6 |
| 3 | 54.0 | 0.2354 | 46 | 4.62E-01 | 4875.1 |
| 4 | 60.0 | 0.2354 | -16 | -1.56E-01 | 636.2 |
| 5 | 36.0 | 0.0276 | -7 | -7.09E-02 | 647.3 |
| 6 | 36.0 | 0.0276 | 7 | 7.09E-02 | 647.3 |
| 7 | 65.8 | 0.1864 | 37 | 3.72E-01 | 4858.8 |
| 8 | 65.8 | 0.1864 | -37 | -3.72E-01 | 4858.8 |
| 9 | 55.1 | 0.1864 | 34 | 3.37E-01 | 3387.0 |
| 10 | 55.1 | 0.1864 | -34 | -3.37E-01 | 3387.0 |
| 11 | 65.3 | 0.0884 | 9 | 9.36E-02 | 622.3 |
| 12 | 65.3 | 0.0884 | -9 | -9.36E-02 | 622.3 |
| 13 | 60.0 | 0.2354 | -242 | -2.42E+00 | 149271.0 |
| 14 | 54.0 | 0.2354 | -28 | -2.78E-01 | 1785.6 |
| 15 | 54.0 | 0.2354 | 28 | 2.78E-01 | 1785.6 |
| 16 | 60.0 | 0.2354 | -58 | -5.84E-01 | 8633.5 |
| 17 | 36.0 | 0.0276 | 7 | 7.09E-02 | 647.3 |
| 18 | 36.0 | 0.0276 | -7 | -7.09E-02 | 647.3 |
| 19 | 65.8 | 0.1864 | -37 | -3.72E-01 | 4858.8 |
| 20 | 65.8 | 0.1864 | 37 | 3.72E-01 | 4858.8 |
| 21 | 55.1 | 0.1864 | -34 | -3.37E-01 | 3387.0 |
| 22 | 55.1 | 0.1864 | 34 | 3.37E-01 | 3387.0 |
| 23 | 65.3 | 0.0884 | -9 | -9.36E-02 | 622.3 |
| 24 | 65.3 | 0.0884 | 9 | 9.36E-02 | 622.3 |
| 25 | 36.0 | 0.0884 | 0 | 0.00E+00 | 0.0 |
| 26 | 36.0 | 0.0884 | -25 | -2.47E-01 | 2514.7 |
| 27 | 64.9 | 0.1129 | -33 | -3.34E-01 | 6335.9 |
| 28 | 64.9 | 0.1129 | -125 | -1.25E+00 | 89819.5 |
| 29 | 64.9 | 0.1129 | -33 | -3.34E-01 | 6335.9 |
| 30 | 64.9 | 0.1129 | 55 | 5.55E-01 | 17547.1 |
| 31 | 64.9 | 0.1129 | 125 | 1.25E+00 | 89819.5 |
| 32 | 64.9 | 0.1129 | 33 | 3.34E-01 | 6335.9 |
| 33 | 64.9 | 0.1129 | -55 | -5.55E-01 | 17547.1 |
| 34 | 64.9 | 0.1129 | 33 | 3.34E-01 | 6335.9 |
| 35 | 14.4 | 0.0884 | 0 | 4.01E-07 | 0.0 |
| 36 | 14.4 | 0.0884 | 0 | 2.00E-07 | 0.0 |
| 37 | 62.6 | 0.0491 | 0 | -2.16E-07 | 0.0 |
| 38 | 62.7 | 0.0491 | 0 | -5.21E-07 | 0.0 |
| Total | ----- | ----- | ----- | ----- | 542688.1 |

Deflection = (542, 688.1)/(29.0E06) = 0.019

Lateral Deflection of joint 3 = 0.019 in

# Appendix B:

# USG Funding Procedure

# USG General Funding

Funding Guidelines for Allocating Student Activity Fees

The following criteria shall be established as the official Finance Committee Policy in determining funding recommendations to the SIUC Student Senate.

1) The activity shall meet all State and University regulations regarding the event and its funding by USG.

2) The majority of the members of the organizations must be undergraduates, or be a program of interest to undergraduates. (Interest to students is to be determined by the Finance Committee or recommendations from the Senate members.)

3) The activity should be of a nature that would be available to all students, not just those belonging to that organization. (Priority given to members.)

4) The amount of students participating in the activity should be proportionate to the size of the group, in order to merit the funding request.

5) A high degree of student control of the activity is essential in the programming, planning, and implementation of the event.

6) The past accountability of the organization:
   a. organization's past programming
   b. involvement of students in the organization
   c. degree of success programs have had in the past

The considerations will be based on an "After Action Report" submitted by the organization to the Finance Committee within 14 days of the event funded.

7) The activity should relate to past activities of the organization to the goals and objectives of the organization as stated in its constitution.

Group Requirements for Funding Consideration

1) Groups must be Registered Student Organizations (RSO's)as defined by the Office of Student Development.

2) The RSO must be in good standing as defined by the Office of Student Development.

3) The RSO must be in good standing as defined by Undergraduate Student Government.
   a. USG must have a current copy of the RSO's constitution.
   b. USG must have a current membership list including phone numbers.
   c. USG must have a current list of officers including phone numbers.
   d. USG must have an After Action report from the RSO's last funded event.

4) The RSO must have a fiscal advisor located within the Office of Student Development.

Travel

Monies will be allocated for travel where members of the organization will:

1) Represent SIUC and thereby enhance the prestige of the University by proper actions of that organization.

2) In the event that an organization is allocated monies, a memorandum summarizing aspects of the program and knowledge gained is to be submitted to the USG Finance Committee within 14 days upon returning to SIUC. Along with an "After Action Report" which can be obtained from Steve Harris in the Office of Student Development.

Noncompliance with any of the above regulations will be taken into consideration by the Finance Committee for future funding requests.

Transportation

Transportation shall not exceed 50% per event and must be channeled through SIUC Travel whenever possible.

Lodging

Funding for lodging shall not exceed $30.00 per room per night, nor exceed one week's duration.

Registration

Registration funding shall not exceed 25% of cost. Honorariums shall not exceed 25% of cost.

Conditions for General Funding

1) General Funding includes only one-time events such as trips, speakers, rallies, or new programs.

2) RSO's are eligible for a maximum of $1,000 per RSO per semester.

3) RSO's must have independently raised 50% or more of the amount for which they are asking. First requests for General Funding without fundraising may be given a maximum of $200 if the need is shown.

4) RSO's must show verification of the independently raised monies.

5) RSO's may request funding no more than 2 times per semester.

6) Priority One RSO's may not receive General Funding.

Items That Will Not Be Funded

1) Food and beverages
2) Charitable contributions
3) No funding "after the fact" (if the Finance Committee has already met.)
4) Prizes
5) Advertising not for a specific scheduled event that qualifies for General Funding.
6) Any items to be budgeted out of Yearly Fee Allocations.

Exceptions to theses guidelines may be granted depending on the request, even if it meets the aforementioned guidelines. Any exceptions to the aforementioned guidelines will be granted only in special circumstances when approved by the Finance Committee and a majority of the members present at the regular Student Senate meeting. Special considerations and/or exceptions to the aforementioned guidelines must be agreed on by 2/3 of the Finance Committee. In addition, an expressed written explanation for the special consideration and/or exception must accompany the Bill to Fund before the regular Student Senate meeting.

# Appendix C:

# Vendor Backup

**True Value Hardware**
**Vendor Backup**

All three group members went to True Value Hardware in the Murdale Shopping Center and wrote down prices for the materials needed. These items listed below are the prices current and materials available as of April 23, 1995.

Structural Steel Tubing:

| Type | Length | Cost/each |
|---|---|---|
| 1/2" x 1/2" x 0.049 | 3' | $2.95 |
| 5/8" x 5/8" x 0.049 | 6' | $6.90 |
| 1" x 1" x 0.049 | 6' | $10.69 |
| 11/4" x 1 1/4" x 0.049 | 6' | $12.59 |
| 1 1/4" x 1 1/4" x 0.083 | 6' | $13.79 |

Round UNC, class 2 Threaded Steel Rods:

| Type | Length | Cost/each |
|---|---|---|
| 1/4" | 3' | $0.96 |
| 1/4" | 6' | $1.92 |
| 3/8" | 6' | $1.20 |

Dent Ring Pins:

| Type | Cost/each |
|---|---|
| 1/4" x 1 3/4" | $2.00 |

Elevator Bolts:

| Type | Cost/each |
|---|---|
| 1/4" x 2" | $0.32 |

Acetone:

| Type | Cost/each |
|---|---|
| generic | $2.29/pint |

**True Value Hardware**
**Vendor Backup (continued)**

Primer:

| Type | Cost/each |
|---|---|
| X-O Rust | $3.28/pint |

Paint:

| Type | Cost/each |
|---|---|
| Spray Enamel | $1.09/12oz |

Lubricant:

| Type | Cost/each |
|---|---|
| WD-40 | $1.49/6oz |

Hinges:

| Type | Cost/each |
|---|---|
| 1" loose pin | $2.55/2 |

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ıd sizes. Castings can be supplied rough

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promptly quoted.

## Bars

es long.

| NET EACH | Size, In. | No. | NET EACH |
|---|---|---|---|
| .. $111.69 | 1½ x8 | ..8923K35.. | $172.00 |
| .. 46.92 | 2 x2½ | ..8923K38.. | 71.48 |
| .. 56.00 | 2 x3 | ..8923K39.. | 80.48 |
| .. 64.77 | 2 x3½ | ..8923K41.. | 93.85 |
| .. 78.31 | 2 x4 | ..8923K42.. | 107.26 |
| .. 84.92 | 2 x4½ | ..8923K43.. | 120.62 |
| .. 96.00 | 2 x5 | ..8923K44.. | 125.23 |
| .. 105.08 | 2 x6 | ..8923K45.. | 138.46 |
| .. 125.23 | 2 x7 | ..8923K46.. | 163.08 |
| .. 149.69 | 2 x8 | ..8923K47.. | 187.54 |

## Bars

| NET EACH | Dia. In. | No. | NET EACH |
|---|---|---|---|
| | | 72" Length | |
| ... $69.23 | 2¾ | .....8909K58.. | $105.08 |
| ... 82.77 | 3 | .....8909K59.. | 119.38 |
| ... 89.38 | 3¼ | .....8909K61.. | 136.31 |
| ... 98.15 | 3½ | .....8909K62.. | 146.46 |
| ...120.62 | 3¾ | .....8909K63.. | 169.85 |
| ...136.31 | 4 | .....8909K64.. | 186.46 |
| ...156.31 | 4¼ | .....8909K65.. | 209.85 |
| ...176.46 | 4½ | .....8909K66.. | 234.62 |
| ...194.46 | 4¾ | .....8909K67.. | 261.38 |
| ...209.85 | 5 | .....8909K68.. | 288.15 |
| ...259.23 | 5½ | .....8909K69.. | 350.77 |
| ...301.69 | 6 | .....8909K71.. | 400.00 |
| ...[illegible].92 | 6½ | .....8909K72.. | 442.31 |
| | 7 | .....8909K73.. | 531.69 |
| ...362.62 | 7½ | .....8909K74.. | 598.77 |
| ... 75.85 | 8 | .....8909K75.. | 688.00 |
| ... 89.38 | | | |

## Bars

| NET EACH | O.D. In. | I.D. In. | No. | NET EACH |
|---|---|---|---|---|
| ..$114.92 | 7 | ...3 | ..8929K26.. | $195.00 |
| .. 93.92 | 7 | ...4½ | ..8929K27.. | 146.77 |
| .. 129.42 | 8 | ...3 | ..8929K31.. | 257.10 |
| .. 98.55 | 8 | ...5 | ..8929K32.. | 188.83 |
| .. 137.90 | | | | |
| .. 107.42 | | | | |

## gular Plates

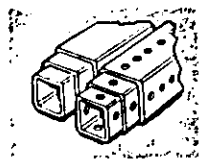
| NET EACH | Lgth. In. | Thick. In. | No. | NET EACH |
|---|---|---|---|---|
| ..$123.25 | 12 | ...2½ | ..8925K37.. | $135.50 |
| .. 160.00 | 14 | ...2½ | ..8925K38.. | 153.83 |
| .. 111.00 | 18 | ...2½ | ..8925K39.. | 196.67 |
| .. 123.25 | 24 | ...2½ | ..8925K41.. | 251.75 |
| .. 160.00 | | | | |
| .. 207.08 | | | | |

## ;es

| NET EACH | Dia. In. | No. | NET EACH |
|---|---|---|---|
| . $68.88 | 16 | .....8926K44.. | $210.48 |
| . 92.07 | 18 | .....8926K45.. | 260.97 |
| . 116.42 | 20 | .....8926K65.. | 316.69 |
| . 144.03 | | 4" Thick | |
| . 177.90 | 9 | .....8926K51.. | $103.79 |
| . 217.58 | 10 | .....8926K52.. | 124.31 |
| | 12 | .....8926K54.. | 171.98 |
| . $ 80.60 | 14 | .....8926K55.. | 227.41 |
| . 96.03 | 16 | .....8926K56.. | 275.48 |
| . 132.16 | 18 | .....8926K57.. | 342.98 |
| . 175.86 | 20 | .....8926K67.. | 422.50 |

STER-CARR

## Telescopic Square Steel Tubing



**Each size telescopes smoothly into the next larger size for the entire length of the tubing.** Ideal for stands, racks, supports and related structural uses. Corner welded square tubing of tough 12 gauge steel in mill uncoated finish. Available with or without perforations. Perforations are 7/16" diameter. Supplied in 20-ft. to 24-ft. random lengths.

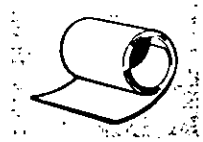
| Size In. | Without Perforations No. | NET EACH | With Perforations No. | NET EACH |
|---|---|---|---|---|
| 1½ x1½ | .....8883K11..... | $81.17 | 8883K21..... | $104.00 |
| 1¾ x1¾ | .....8883K12..... | 91.41 | 8883K22..... | 114.06 |
| 2 x2 | .....8883K13..... | 101.64 | 8883K23..... | 124.19 |
| 2¼ x2¼ | .....8883K14..... | 112.03 | 8883K24..... | 134.38 |

## Drawn-Over Mandrel (D.O.M.) Carbon Steel Tubing

**Uniform wall thickness tubing offers fine finish, straightness and close tolerances.** Made from 1020 steel (up to .125 wall) and 1026 steel (walls over .125). Meets ASTM A513, Type 5 and QQ-T-830. **Furnished in random 17' to 24' lengths only.**

| O.D. x Wall | No. | NET EACH | O.D. x Wall | No. | NET EACH |
|---|---|---|---|---|---|
| ¼"x.028.. | 9027K11.. | $28.17 | ⅞"x.065.. | 9027K22.. | $33.50 |
| ⅜"x.028.. | 9027K12.. | 28.04 | ⅞"x.125.. | 9027K23.. | 54.81 |
| ⅜"x.035.. | 9027K13.. | 22.07 | 1" x.065.. | 9027K24.. | 36.57 |
| ⅜"x.065.. | 9027K14.. | 32.46 | 1" x.125.. | 9027K25.. | 57.20 |
| ½"x.035.. | 9027K15.. | 23.75 | 1¼"x.065.. | 9027K26.. | 46.02 |
| ½"x.065.. | 9027K16.. | 29.16 | 1¼"x.095.. | 9027K27.. | 59.45 |
| ⅝"x.065.. | 9027K17.. | 29.10 | 1½"x.250.. | 9027K28.. | 139.20 |
| ⅝"x.125.. | 9027K18.. | 53.83 | 1½"x.312.. | 9027K29.. | 167.60 |
| ¾"x.065.. | 9027K19.. | 35.03 | 2" x.125.. | 9027K31.. | 90.40 |
| ¾"x.125.. | 9027K21.. | 51.00 | 2" x.375.. | 9027K32.. | 260.20 |

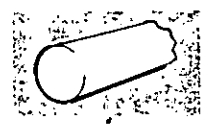
## Galvanized Seamless Roll Valley and Flashing



**Used for all types of general sheet metal work.** Standard roll is 50 feet long, .0135" thick. **Supplied in full roll only.**

| Roll Width Inches | No. | NET PER ROLL |
|---|---|---|
| 8 | .....9118K22.... | $40.60 |
| 12 | .....9118K23.... | 61.20 |
| 20 | .....9118K24.... | 127.50 |
| 24 | .....9118K25.... | 151.50 |

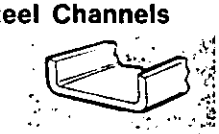
## Zinc Plated Steel Rounds



**Cold drawn 1010 steel.** Flats and angles also available. Prices upon request. **Supplied in standard 36" lengths only.**

| Dia. In. | No. | NET PER BAR | Dia. In. | No. | NET PER BAR |
|---|---|---|---|---|---|
| ¼ | .....9120K11.... | $0.88 | 7/16 | .....9120K14.... | $2.10 |
| 5/16 | .....9120K12.... | 1.18 | ½ | .....9120K15.... | 2.54 |
| ⅜ | .....9120K13.... | 1.58 | ⅝ | .....9120K16.... | 3.86 |
| | | | ¾ | .....9120K17.... | 5.40 |

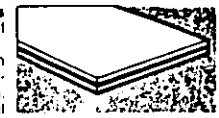
## Hot Rolled Carbon Steel Channels



**Easily welded and machined hot rolled mild steel channels.** Used to build framework, runners, bumpers and as structural and reinforcing members. **Supplied in standard 20 foot lengths only.**

| Size, In. Base | Sides | No. | NET EACH |
|---|---|---|---|
| 1/8 INCH THICK | | | |
| ¾ | ...⅜.. | 9015K14.. | $20.35 |
| 1 | ...⅜.. | 9015K16.. | 35.36 |
| 1 | ...½.. | 9015K17.. | 41.82 |
| 1¼ | ...½.. | 9015K18.. | $27.87 |
| 1½ | ...½.. | 9015K19.. | 34.73 |
| 2 | ...½.. | 9015K24.. | 71.98 |
| 3/16 INCH THICK | | | |
| 2 | ..1 .. | 9015K26.. | $54.91 |

## Composite Steel Sheets



**Fully damped composite metal is used for both structural and acoustical applications.**

Widely used as a structural element in equipment construction. Free from resonance and coincidence phenomena. Insulates against airborne sound. Useful as a noise barrier as well as a vibration-free structural element.

**Features a laminated sandwich-type construction.** Inner material is a specially compounded viscoelastic material for optimal structural and acoustic-dampening properties. Outer layers consist of low carbon cold-rolled electrogalvanized steel.

**Note:** Other types of steels, aluminum, and laminates of dissimilar metals are available. Specify 8998K999, sheet and composite thickness desired, **Prices on Request.**

Material can be sheared, bent, stamped, and welded using standard production methods (for minor modifications). Damps efficiently throughout a temperature range of 40° to 150°F. Will withstand paint over temperatures of up to 300°F.

SHEET SIZE: 48" x 96".

| Nominal Thickness Inches | No. | NET EACH |
|---|---|---|
| .020/.010/.020 .050 | 8998K31..... | $143.40 |
| .030/.010/.030 - .070 | 8998K32..... | 161.16 |
| .040/.010/.040 - .090 | 8998K33..... | 208.29 |
| .050/.010/.050 - .110 | 8998K34..... | 228.65 |
| .060/.010/.060 - .130 | 8998K35..... | 275.20 |
| .080/.010/.080 - .170 | 8998K36..... | 356.07 |
| .020/.010/.040 - .070 | 8998K37..... | 168.15 |
| .020/.010/.060 - .090 | 8998K38..... | 208.29 |
| .020/.010/.080 - .110 | 8998K39..... | 242.04 |
| .040/.010/.060 - .110 | 8998K41..... | 242.04 |
| .040/.010/.080 - .130 | 8998K42..... | 282.18 |

## Carbon Steel Flats—1018

**A cold drawn Grade 1018 widely used for economical cold forming and welded fabrication. Can be case hardened. Furnished in 10' to 12' random lengths only. Also available in cut lengths . . . prices on request.**

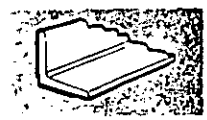
| Size In. | No. | NET EACH | Size In. | No. | NET EACH |
|---|---|---|---|---|---|
| 1/16x1 | .....9109K11... | $14.67 | ¼x3 | .....9109K15... | $52.68 |
| 1/16x2 | .....9109K12... | 28.18 | ⅜x2 | .....9109K16... | 53.17 |
| ¼x1 | .....9109K13... | 18.79 | ½x2 | .....9109K17... | 66.91 |
| ¼x2 | .....9109K14... | 36.45 | ½x3 | .....9109K18... | 99.96 |

## Hot Rolled Carbon Steel Rounds

**Low carbon hot rolled steel best suited for general production and repair. Easily welded, machined or formed. Not recommended for forging or heat treating. Furnished in standard 20 foot lengths only.**

| Dia., In. | No. | NET EACH |
|---|---|---|
| ¼ | .....9010K11..... | $ 4.16 |
| ⅜ | .....9010K12..... | 8.90 |
| ½ | .....9010K13..... | 15.56 |
| ¾ | .....9010K15..... | 33.49 |
| 1 | .....9010K17..... | 59.54 |

## Hot Rolled Carbon Steel Angles



**One of the handiest shapes for general plant maintenance and repair work.** Easily cut, welded or machined. Ideal for special benches, shelving, bracing or structural work. **Supplied in full 20 foot lengths only.**

| Size, Inches | No. | NET EACH | Size, Inches | No. | NET EACH |
|---|---|---|---|---|---|
| 1/8 INCH THICK | | | 3/16 INCH THICK | | |
| ¾x ¾ | 9017K12 | $15.62 | 2 x1½ | 9017K26 | $49.64 |
| 1 x1 | 9017K14 | 18.63 | 2 x2 | 9017K28 | 54.41 |
| 1¼x1¼ | 9017K17 | 23.31 | 2½x1½ | 9017K31 | 62.26 |
| 1½x1½ | 9017K18 | 28.33 | 2½x2 | 9017K32 | 62.52 |
| 1¾x1¾ | 9017K22 | 33.41 | 1/4 INCH THICK | | |
| 2 x2 | 9017K27 | 37.92 | 1 x1 | 9017K16 | $33.48 |
| 3/16 INCH THICK | | | 1½x1½ | 9017K41 | 51.71 |
| 1½x1½ | 9017K19 | $40.14 | 2 x2 | 9017K29 | 70.18 |
| 1¾x1¾ | 9017K23 | 47.35 | 2½x2 | 9017K33 | 81.57 |
| 2 x1¼ | 9017K24 | 51.71 | 2½x2½ | 9017K35 | 90.34 |

# Drop Forged Eyebolts

PLAIN PATTERN

Blank

Threaded

Threaded with Nut

## Drop Forged Steel Eyebolts

Heat treated after forging for strength and toughness. Self-colored finish. Threaded eyebolts have fully threaded shanks with Unified National Coarse (UNC) Class 2 threads.

See safety recommendations regarding load limits on page 343.

Other sizes and hot galvanized finish eyebolts available—Prices on request. Specify No. 3013T99[illegible] Plain Pattern and No. 3014T999 for Shoulder Pattern, give diameter, length, finish (self-colored or galvani[illegible] and indicate blank or threaded.

| Shank Dia. In. | Shank Lgth. In. | Eye I.D. In. | Work Load Limit Lbs. | Blank Eyebolts Plain No. | Blank Eyebolts Plain NET EACH | Blank Eyebolts Shoulder No. | Blank Eyebolts Shoulder NET EACH | Threaded Eyebolts Plain No. | Threaded Eyebolts Plain NET EACH | Threaded Eyebolts Shoulder No. | Threaded Eyebolts Shoulder NET EA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/4 | 1 | 3/4 | 500 | 3013T11 | $0.92 | 3014T11 | $0.92 | 3013T45 | $1.33 | 3014T45 | $ |
| 5/16 | 1 1/8 | 3/8 | 900 | 3013T12 | 1.08 | 3014T12 | 1.08 | 3013T46 | 1.39 | 3014T46 | |
| 3/8 | 1 1/4 | 1 | 1400 | 3013T13 | 1.11 | 3014T13 | 1.11 | 3013T47 | 1.62 | 3014T47 | |
| 3/8 | 2 1/2 | 1 | 1400 | 3013T71 | 3.18 | 3014T71 | 3.18 | 3013T62 | 5.16 | 3014T62 | |
| 3/8 | 3 | 1 | 1400 | 3013T72 | 3.18 | 3014T72 | 3.18 | 3013T63 | 5.16 | 3014T63 | |
| 7/16 | 1 3/8 | 1 3/32 | 2000 | 3013T14 | 1.28 | 3014T14 | 1.28 | 3013T48 | 1.78 | 3014T48 | |
| 1/2 | 1 1/2 | 1 3/16 | 2600 | 3013T15 | 1.33 | 3014T15 | 1.33 | 3013T49 | 2.01 | 3014T49 | |
| 1/2 | 2 1/2 | 1 3/16 | 2600 | 3013T73 | 3.89 | 3014T73 | 3.89 | 3013T64 | 5.82 | 3014T64 | |
| 1/2 | 3 | 1 3/16 | 2600 | 3013T74 | 3.89 | 3014T74 | 3.89 | 3013T65 | 5.82 | 3014T65 | |
| 9/16 | 1 5/8 | 19/32 | 3000 | 3013T16 | 1.95 | 3014T16 | 1.95 | 3013T51 | 2.63 | 3014T51 | |
| 5/8 | 1 3/4 | 1 3/8 | 4000 | 3013T17 | 2.21 | 3014T17 | 2.21 | 3013T52 | 3.14 | 3014T52 | |
| 5/8 | 2 1/2 | 1 3/8 | 4000 | 3013T75 | 5.98 | 3014T75 | 5.98 | 3013T66 | 8.43 | 3014T66 | |
| 5/8 | 3 | 1 3/8 | 4000 | 3013T76 | 5.98 | 3014T76 | 5.98 | 3013T67 | 8.43 | 3014T67 | |
| 3/4 | 2 | 1 1/2 | 6000 | 3013T18 | 3.06 | 3014T18 | 3.06 | 3013T53 | 4.11 | 3014T53 | |
| 3/4 | 2 1/2 | 1 1/2 | 6000 | 3013T77 | 7.40 | 3014T77 | 7.40 | 3013T68 | 9.87 | 3014T68 | |
| 3/4 | 3 | 1 1/2 | 6000 | 3013T78 | 7.40 | 3014T78 | 7.40 | 3013T69 | 9.87 | 3014T69 | |
| 7/8 | 2 1/4 | 1 11/16 | 7000 | 3013T19 | 4.22 | 3014T19 | 4.22 | 3013T54 | 5.45 | 3014T54 | |
| 1 | 2 1/2 | 1 13/16 | 9000 | 3013T21 | 5.74 | 3014T21 | 5.74 | 3013T55 | 7.41 | 3014T55 | |
| 1 1/8 | 2 3/4 | 2 | 10600 | 3013T22 | 12.07 | 3014T22 | 12.07 | 3013T56 | 13.22 | 3014T56 | |
| 1 1/4 | 3 | 2 3/16 | 15000 | 3013T23 | 13.55 | 3014T23 | 13.55 | 3013T57 | 15.98 | 3014T57 | |
| 1 1/2 | 3 1/2 | 2 1/2 | 19600 | 3013T24 | 25.44 | 3014T24 | 25.44 | 3013T58 | 27.49 | 3014T58 | |
| 1 3/4 | 3 3/4 | 2 7/8 | 28000 | 3013T25 | 41.20 | 3014T25 | 43.50 | 3013T59 | 50.67 | 3014T59 | |
| 2 | 4 | 3 1/4 | 38000 | 3013T26 | 54.97 | 3014T26 | 63.20 | 3013T61 | 67.22 | 3014T61 | |

SHOULDER PATTERN

Blank

Threaded

Threaded with Nut

## Drop Forged Steel Eyebolts with Nuts

### PLAIN PATTERN

Hot galvanized finish. United National Coarse (UNC) Class 2 threads. See safety recommendations on page 343

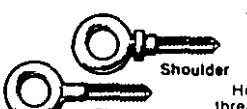
| Shank Lgth., In. | Thread Lgth., In. | No. | NET EACH |
|---|---|---|---|
| **SHANK DIA. 1/4"—EYE I.D. 1/2" 500 LB. WORKING LOAD LIMIT** | | | |
| 2 | 1 1/2 | 3016T14 | $1.64 |
| 3 | 1 1/2 | 3016T15 | 1.64 |
| 4 | 2 | 3016T16 | 1.82 |
| 5 | 2 1/2 | 3016T17 | 2.48 |
| 6 | 3 | 3016T18 | 2.54 |
| **SHANK DIA. 5/16"—EYE I.D. 5/8" 800 LB. WORKING LOAD LIMIT** | | | |
| 2 1/4 | 1 1/2 | 3016T23 | $1.84 |
| 3 1/4 | 1 1/2 | 3016T24 | 2.06 |
| 4 1/4 | 2 1/2 | 3016T26 | 2.06 |
| 5 | 2 1/2 | 3016T27 | 2.54 |
| 6 | 3 | 3016T28 | 2.98 |
| **SHANK DIA. 3/8"—EYE I.D. 3/4" 1200 LB. WORKING LOAD LIMIT** | | | |
| 2 1/2 | 1 1/2 | 3016T32 | 2.10 |
| 3 | 1 1/2 | 3016T33 | 2.30 |
| 4◆ | 1 1/2 | 3016T34 | 2.50 |
| 4 1/4 | 2 | 3016T35 | 2.60 |
| 5 | 2 1/2 | 3016T36 | 2.80 |
| 6 | 3 | 3016T37 | 2.86 |
| 8 | 4 | 3016T38 | 4.12 |
| ◆Working load limit 1040 lbs. | | | |
| **SHANK DIA. 1/2"—EYE I.D. 1" 2200 LB. WORKING LOAD LIMIT** | | | |
| 2 | 1 7/8 | 3016T39 | $2.70 |
| 3 1/4 | 1 1/2 | 3016T42 | 2.70 |
| 4■ | 2 | 3016T43 | 2.80 |
| 4 1/2 | 2 | 3016T44 | 2.86 |
| 6 | 3 | 3016T45 | 3.60 |
| 8 | 4 | 3016T46 | 5.08 |
| **SHANK DIA. 1/2"—EYE I.D. 1" 2200 LB. WORKING LOAD LIMIT (Continued)** | | | |
| 10 | 4 | 3016T47 | $6.42 |
| 12 | 4 | 3016T48 | 6.64 |
| ■Working load limit 1960 lbs. | | | |
| **SHANK DIA. 5/8"—EYE I.D. 1-1/4" 3500 LB. WORKING LOAD LIMIT** | | | |
| 4 1/2 | 2 | 3016T52 | $4.34 |
| 6 | 3 | 3016T53 | 5.04 |
| 8 | 4 | 3016T54 | 8.12 |
| 10 | 4 | 3016T55 | 8.26 |
| 12 | 4 | 3016T56 | 8.30 |
| **SHANK DIA. 3/4"—EYE I.D. 1-1/2" 5200 LB. WORKING LOAD LIMIT** | | | |
| 4 1/2 | 2 1/2 | 3016T62 | $6.40 |
| 6 | 3 | 3016T63 | 6.64 |
| 8 | 4 | 3016T64 | 11.80 |
| **SHANK DIA. 3/4"—EYE I.D. 1-1/2" 5200 LB. WORKING LOAD LIMIT (Continued)** | | | |
| 10 | 4 | 3016T65 | $12.[illegible] |
| 12 | 4 | 3016T66 | 12.[illegible] |
| 15 | 6 | 3016T67 | 13.[illegible] |
| 18 | 6 | 3016T68 | 18.[illegible] |
| **SHANK DIA. 1"—EYE I.D. 2" 9800 LB. WORKING LOAD LIMIT** | | | |
| 6 | 3 | 3016T84 | $15.[illegible] |
| 9 | 4 | 3016T85 | 16.[illegible] |
| 12 | 4 | 3016T87 | 20.[illegible] |
| 18 | 6 | 3016T88 | 23.[illegible] |
| **SHANK DIA. 1-1/4"—EYE I.D. 2-3/16" 13,560 LB. WORKING LOAD LIMIT** | | | |
| 6 | 5 | 3016T89 | $36.[illegible] |
| 8 | 5 | 3016T91 | 37.[illegible] |
| 12 | 4 | 3016T92 | 40.[illegible] |

### SHOULDER PATTERN

| Shank Dia. | Eye I.D. | Work Load Limit, Lbs. | Regular Shank Lgth. | Regular Thread Lgth. | Regular No. | Regular NET EACH | Extra Long Shank Lgth. | Extra Long Thread Lgth. | Extra Long No. | Extra Long NET EAC |
|---|---|---|---|---|---|---|---|---|---|---|
| 1/4" | 1/2" | 500 | 2" | 1 1/2" | 3018T14 | $1.68 | 4" | 2" | 3018T34 | $2.[illegible] |
| 5/16" | 5/8" | 800 | 2 1/4" | 1 1/2" | 3018T15 | 1.90 | 4 1/4" | 2 1/2" | 3018T35 | 2.[illegible] |
| 3/8" | 3/4" | 1200 | 2 1/2" | 1 1/2" | 3018T16 | 2.10 | 4 1/4" | 2" | 3018T36 | 2.[illegible] |
| 1/2" | 1" | 2100 | 3 1/4" | 1 1/2" | 3018T17 | 2.70 | 6" | 3" | 3018T37 | 3.[illegible] |
| 5/8" | 1 1/4" | 3400 | 4" | 2" | 3018T18 | 4.96 | 6" | 3" | 3018T38 | 5.0[illegible] |
| 3/4" | 1 1/2" | 5000 | 4 1/2" | 2 1/2" | 3018T19 | 6.40 | 6" | 3" | 3018T39 | 6.[illegible] |
| 7/8" | 1 3/4" | 7000 | 5" | 2 1/2" | 3018T21 | 9.54 | 8" | 4" | 3018T41 | 13.[illegible] |
| 1" | 2" | 9000 | 6" | 3" | 3018T22 | 16.00 | 9" | 4" | 3018T42 | 17.[illegible] |

## Drop Forged Bronze Shoulder Pattern Eyebolts with Nuts

| Shank Dia. | Shank Lgth. | Thd. Lgth. | Eye I.D. | Work Load Limit | No. | NET EACH |
|---|---|---|---|---|---|---|
| 1/4" | 2" | 1 1/2" | 1/2" | 360 lbs. | 3017T14 | $6.72 |
| 1/4" | 4" | 2 1/2" | 1/2" | 360 lbs. | 3017T15 | 7.54 |
| 5/16" | 2 1/4" | 1 1/2" | 5/8" | 600 lbs. | 3017T16 | 7.54 |
| 5/16" | 4 1/4" | 2 1/2" | 5/8" | 600 lbs. | 3017T17 | 9.22 |
| 3/8" | 2 1/2" | 1 1/2" | 3/4" | 1000 lbs. | 3017T18 | 9.48 |
| 3/8" | 4 1/2" | 2 1/2" | 3/4" | 1000 lbs. | 3017T19 | 10.76 |
| 1/2" | 3 1/4" | 1 1/2" | 1" | 1920 lbs. | 3017T21 | 18.72 |
| 1/2" | 6" | 3" | 1" | 1920 lbs. | 3017T22 | 22.98 |




## Drop Forged Steel Screw Eyebolts

Hot galvanized finish. Cone point with lag screw thread. See safety recommendations regarding working load limits.

| Shank, In. Dia. | Lgth. | Thread Lgth., In. | Eye I.D., In. | Work Load Limit, Lbs. | Plain No. | Shoulder No. | NET EAC |
|---|---|---|---|---|---|---|---|
| 1/4 | 2 | 1 1/2 | 1/2 | 500 | 3021T14 | 3020T14 | $1.5[illegible] |
| 5/16 | 2 1/4 | 1 5/8 | 5/8 | 800 | 3021T15 | 3020T15 | 1.8[illegible] |
| 3/8 | 2 1/2 | 1 3/4 | 3/4 | 1200 | 3021T16 | 3020T16 | 1.9[illegible] |
| 1/2 | 3 1/4 | 2 1/8 | 1 | 2200 | 3021T17 | 3020T17 | 2.6[illegible] |
| 5/8 | 4 | 2 1/2 | 1 1/4 | 3500 | 3021T18 | 3020T18 | 4.5[illegible] |
| 3/4 | 4 1/2 | 3 | 1 1/2 | 5200 | 3021T19 | 3020T19 | 6.7[illegible] |

McMASTER-CARR

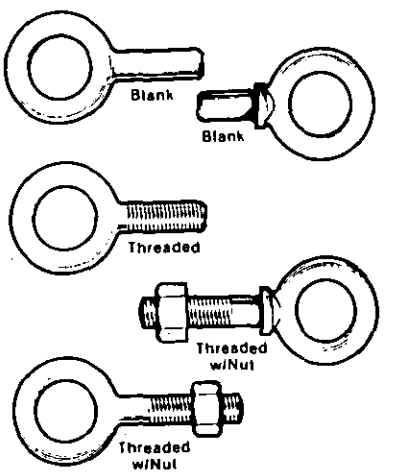
# Drop Forged Eye & Ringbolts

## Eyebolt Safety Recommendations

Load ratings for eyebolts are based on a straight vertical lift. Angular lifts should be avoided as load ratings will be significantly lower. If a situation requires an angular lift, a properly seated shoulder pattern eyebolt must be used. While both plain and shoulder patterns are equally suitable for vertical lifts, shoulder pattern bolts are recommended for use whenever possible.

Due to the many variables that arise in using eyebolts, load limits shown are given as a guide only with no guarantee of actual performance. Never exceed working load limits listed.

PLAIN PATTERN SHOULDER PATTERN




## Drop Forged Stainless Steel Eyebolts

Nonmagnetic 18-8 stainless steel type 304. Threaded eyebolts have Unified National Coarse (UNC) Class 2 threads.

See safety recommendations regarding working load limits.

### Stub Length Plain Pattern

| Shank Dia. | Shank Lgth. In. | Thread Lgth. In. | Eye I.D. In. | Working Load Limit Lbs. | Blank No. | Blank NET EACH | Threaded No. | Threaded NET EACH |
|---|---|---|---|---|---|---|---|---|
| 1/4 | 3/4 | 1/2 | 1/4 | 460 | 8891T12 | $3.92 | 8891T32 | $5.32 |
| 5/16 | 1 7/16 | 7/16 | 5/16 | 780 | 8891T14 | 6.30 | 8891T34 | 7.84 |
| 3/8 | 3/4 | 1/2 | 3/8 | 1160 | 8891T16 | 7.28 | 8891T36 | 8.26 |
| 1/2 | 3/4 | 5/8 | 1 3/16 | 2150 | 8891T18 | 7.56 | 8891T38 | 8.68 |
| 5/8 | 1 | 3/4 | 1 1/4 | 3440 | 8891T21 | 22.26 | 8891T41 | 23.25 |
| 3/4 | 1 | 7/8 | 1 1/2 | 5140 | 8891T23 | 29.68 | 8891T43 | 31.33 |
| 1 | 1 7/16 | 1 1/16 | 1 13/16 | 9370 | 8891T25 | 32.98 | 8891T45 | 34.63 |
| 1 1/4 | 2 | 1 3/8 | 2 3/16 | 15130 | 8891T27 | 69.25 | 8891T47 | 79.15 |

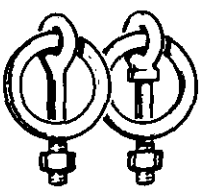
### Plain & Shoulder Pattern

| Shank Dia. | Shank Lgth. In. | Thread Lgth. In. | Eye I.D. In. | Working Load Limit Lbs. | Plain Pattern Blank No. | Plain Pattern Blank NET EACH | Plain Pattern Threaded w/Nut No. | Plain Pattern Threaded w/Nut NET EACH | Shoulder Pattern Blank No. | Shoulder Pattern Blank NET EACH | Shoulder Pattern Threaded w/Nut No. | Shoulder Pattern Threaded w/Nut NET EACH |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1/4 | 2 | 1 1/2 | 1/2 | 460 | 3032T11 | $4.99 | 3032T31 | $6.21 | 3032T21 | $4.99 | 3032T41 | $6.21 |
| 1/4 | 4 | 2 1/2 | 1/2 | 460 | 3032T51 | 6.65 | 3032T57 | 9.10 | 3032T54 | 6.65 | 3032T61 | 9.10 |
| 5/16 | 2 1/4 | 1 1/2 | 5/8 | 780 | 3032T12 | 7.88 | 3032T32 | 10.41 | 3032T22 | 7.88 | 3032T42 | 10.41 |
| 5/16 | 4 1/4 | 2 1/2 | 5/8 | 780 | 3032T52 | 8.14 | 3032T58 | 11.73 | 3032T55 | 8.14 | 3032T62 | 11.73 |
| 3/8 | 2 1/2 | 1 1/2 | 3/4 | 1160 | 3032T13 | 9.01 | 3032T33 | 12.25 | 3032T23 | 9.01 | 3032T43 | 12.25 |
| 3/8 | 4 1/2 | 2 1/2 | 3/4 | 1160 | 3032T53 | 10.59 | 3032T59 | 13.83 | 3032T56 | 10.59 | 3032T63 | 13.83 |
| 1/2 | 3 1/4 | 1 1/2 | 1 | 2150 | 3032T14 | 12.25 | 3032T34 | 14.62 | 3032T24 | 12.25 | 3032T44 | 14.62 |
| 1/2 | 6 | 3 | 1 | 2150 | 3032T15 | 15.48 | 3032T35 | 18.28 | 3032T25 | 15.48 | 3032T45 | 18.28 |
| 5/8 | 4 | 2 | 1 1/4 | 3440 | 3032T16 | 19.83 | 3032T36 | 24.73 | 3032T26 | 19.83 | 3032T46 | 24.73 |
| 3/4 | 4 1/2 | 2 | 1 1/2 | 5140 | 3032T17 | 24.50 | 3032T37 | 33.44 | 3032T27 | 24.50 | 3032T47 | 33.44 |
| 7/8 | 5 | 2 1/2 | 1 3/4 | 7130 | 3032T18 | 36.94 | 3032T38 | 47.06 | 3032T28 | 36.94 | 3032T48 | 47.06 |
| 1 | 6 | 3 | 2 | 9370 | 3032T19 | 52.89 | 3032T39 | 63.49 | 3032T29 | 52.89 | 3032T49 | 63.49 |

## Nut Ringbolts

Drop forged steel, galvanized finish, UNC Class 2 threads. See safety recommendations regarding working load limits.

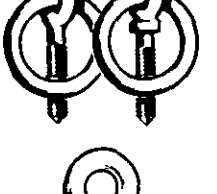
| Shank Dia. | Shank Lgth. | Thread Lgth. | Ring I.D. | Working Load Limit | Plain No. | Plain NET EACH | Shoulder No. | Shoulder NET EACH |
|---|---|---|---|---|---|---|---|---|
| 5/16" | 2 1/4" | 1 1/2" | 2" | 800 lbs. | 3025T15 | $6.27 | 3025T23 | $5.55 |
| 3/8" | 2 1/2" | 1 1/2" | 2" | 1200 lbs. | 3025T16 | 6.46 | 3025T24 | 6.27 |
| 1/2" | 3 1/4" | 1 1/2" | 3" | 2200 lbs. | 3025T17 | 9.50 | 3025T25 | 6.46 |
| 3/4" | 4 1/2" | 2 1/2" | 3" | 5200 lbs. | 3025T19 | 20.33 | 3025T26 | 9.50 |
| 1" | 6" | 3" | 3 3/4" | 9800 lbs. | 3025T22 | 72.77 | 3025T28 | 20.33 |
| | | | | | | | 3025T31 | 72.77 |



## Screw Ringbolts

Drop forged steel, galvanized finish. Lag screw thread with cone points. See safety recommendations regarding working load limits.

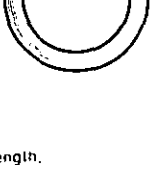
| Shank Dia. | Shank Lgth. | Thread Lgth. | Ring I.D. | Working Load Limit | Plain No. | Plain NET EACH | Shoulder No. | Shoulder NET EACH |
|---|---|---|---|---|---|---|---|---|
| 1/4" | 2" | 1 1/2" | 1 3/4" | 500 lbs. | 3047T42 | $5.23 | 3047T49 | $5.23 |
| 5/16" | 2 1/4" | 1 5/8" | 2" | 800 lbs. | 3047T43 | 5.80 | 3047T51 | 5.80 |
| 3/8" | 2 1/2" | 1 3/4" | 2" | 1200 lbs. | 3047T44 | 6.56 | 3047T52 | 6.56 |
| 1/2" | 3 1/4" | 2 1/8" | 3" | 2200 lbs. | 3047T45 | 9.31 | 3047T53 | 9.31 |
| 5/8" | 4 1/2" | 2 1/2" | 2 3/4" | 3500 lbs. | 3047T46 | 17.67 | 3047T54 | 17.67 |
| 3/4" | 4 1/2" | 3" | 3" | 5200 lbs. | 3047T47 | 22.42 | 3047T55 | 22.42 |
| 1" | 6" | 3 1/2" | 3 3/4" | 9800 lbs. | 3047T48 | 73.15 | 3047T56 | 73.15 |



## Steel Rings

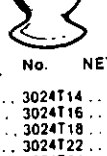
| I.D. | Dia. | Stock Yield Strength Lbs. ■ | No. | NET EACH |
|---|---|---|---|---|
| **GALVANIZED** | | | | |
| 2" | 5/16" | 520 | 3068T15 | $1.18 |
| 2 1/4" | 5/16" | 470 | 3068T16 | 1.48 |
| 2 1/2" | 3/8" | 720 | 3068T17 | 1.91 |
| 3" | 1/2" | 1440 | 3068T22 | 4.51 |
| 4" | 1/2" | 1050 | 3068T23 | 5.18 |
| 4" | 5/8" | 2100 | 3068T25 | 9.31 |
| 5" | 5/8" | 1630 | 3068T26 | 10.51 |
| **NICKEL PLATED WELDED WIRE** | | | | NET/100 |
| 1/2" | 0.177" | | 8894T10 | $10.00 |
| 5/8" | 0.177" | Not | 8894T20 | 11.00 |
| 3/4" | 0.177" | rated | 8894T30 | 11.38 |
| 7/8" | 0.177" | by | 8894T40 | 14.00 |
| 1" | 0.177" | manu- | 8894T50 | 15.50 |
| 1 1/8" | 0.177" | facturer | 8894T60 | 16.25 |
| 1 1/4" | 0.177" | | 8894T70 | 16.75 |

■ Safe load is approximately 50% of yield strength.



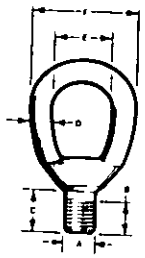
## Forged Pad Eyes

Used for welding onto a variety of machinery, equipment and vehicles. Available in 1035 carbon steel or type 304 polished stainless steel.



| Eye I.D. | Eye O.D. | Shoulder Dia. | Overall Ht. | No. | NET EACH |
|---|---|---|---|---|---|
| **CARBON STEEL** | | | | | |
| 1/4" | 5/8" | 5/8" | 3/4" | 3024T14 | $0.56 |
| 3/8" | 7/8" | 7/8" | 1 31/32" | 3024T16 | .80 |
| 5/8" | 1 1/8" | 1" | 1 5/16" | 3024T18 | 1.14 |
| 3/4" | 1 1/2" | 1 1/16" | 1 3/8" | 3024T22 | 1.14 |
| 1" | 2 1/8" | 1 7/16" | 2 11/32" | 3024T24 | 1.96 |
| 1 1/4" | 2 5/8" | 1 3/4" | 2 3/4" | 3024T26 | 2.90 |
| **304 STAINLESS STEEL** | | | | | |
| 3/4" | 1 3/8" | 2 11/32" | 1 9/16" | 8892T12 | $8.31 |
| 1" | 1 3/4" | 7/8" | 2" | 8892T14 | 10.09 |
| 1 1/4" | 2 1/4" | 1 13/32" | 2 5/8" | 8892T16 | 16.03 |
| 1 1/2" | 2 3/4" | 1 3/8" | 3 1/4" | 8892T18 | 23.00 |

# Hoist Rings & Eyes

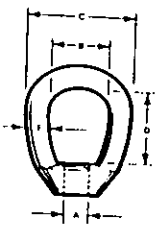


## Drop Forged Lifting Eyes

Forged carbon steel, galvanized finish.

Unified National Coarse (UNC) Class 2A threads.

| Thread Dia., In.(A) | Dimensions, In. B | C | D | E | F | Wo Lim |
|---|---|---|---|---|---|---|
| 5/16 | 1/4 | 11/16 | 1/4 | 3/4 | 1 1/4 | |
| 3/8 | 5/16 | 3/8 | 5/16 | 1 | 1 5/8 | |
| 1/2 | 1/2 | 13/32 | 3/8 | 1 1/4 | 2 | |
| 5/8 | 9/16 | 17/16 | 1/2 | 1 1/2 | 2 1/2 | |
| 3/4 | 5/8 | 121/32 | 5/8 | 1 3/4 | 3 | |
| 7/8 | 13/16 | 1 3/4 | 3/4 | 2 | 3 1/2 | |
| 1 | 1 | 2 1/8 | 7/8 | 2 1/4 | 4 | 1 |
| 1 1/8 | 1 1/16 | 2 5/16 | 1 | 2 1/2 | 4 1/2 | 1 |

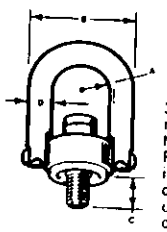


## Drop Forged Eye Nuts

Available in galvanized steel and 18-8 type 303 stainless steel. Tapped with Unified National Coarse (UNC) Class 2-B threads.

**Note:** Loads shown apply to eye nuts only, based on a vertical pull, and not to any connecting bolt or stud.

| Thread Dia., In.(A) | Dimensions, In. B | C | D | E | Work L Limit, l | | |
|---|---|---|---|---|---|---|---|
| **GALVANIZED STEEL** | | | | | | | |
| 1/4 | 3/4 | 1 1/4 | 1 1/16 | 1/4 | 52 | | |
| 5/16 | 3/4 | 1 1/4 | 1 1/16 | 1/4 | 84 | | |
| 3/8 | 1 | 1 5/8 | 1 1/4 | 5/16 | 124 | | |
| 7/16 | 1 1/4 | 2 | 1 1/2 | 3/8 | 170 | | |
| 1/2 | 1 1/4 | 2 | 1 1/2 | 3/8 | 224 | | |
| 5/8 | 1 1/2 | 2 1/2 | 2 | 1/2 | 360 | | |
| 3/4 | 1 3/4 | 3 | 2 3/8 | 5/8 | 520 | | |
| 7/8 | 2 | 3 1/2 | 2 5/8 | 3/4 | 720 | | |
| 1 | 2 1/4 | 4 | 3 1/16 | 7/8 | 1000 | | |
| 1 1/8 | 2 1/4 | 4 | 3 1/16 | 7/8 | 12300 | 3019T24 | 11 |
| 1 1/4 | 2 1/2 | 4 1/2 | 3 1/2 | 1 | 15500 | 3019T25 | 14 |
| 1 1/2 | 3 1/8 | 5 5/8 | 4 | 1 1/4 | 22500 | 3019T27 | 28 |
| 2 | 4 | 7 | 6 1/4 | 1 1/2 | 40000 | 3019T28 | 64 |
| **303 STAINLESS STEEL** | | | | | | | |
| 1/4 | 3/4 | 1 1/4 | 1 1/16 | 1/4 | 460 | 3061T14 | $12 |
| 5/16 | 3/4 | 1 1/4 | 1 1/16 | 1/4 | 780 | 3061T15 | 12 |
| 3/8 | 1 1/4 | 2 | 1 1/2 | 3/8 | 1160 | 3061T17 | 14 |
| 1/2 | 1 1/4 | 2 | 1 1/2 | 3/8 | 2150 | 3061T18 | 14 |
| 5/8 | 1 1/2 | 2 1/2 | 2 | 1/2 | 3440 | 3061T21 | 17 |
| 3/4 | 1 3/4 | 3 | 2 3/8 | 5/8 | 5140 | 3061T23 | 30 |



## Heavy Duty Safety Hoist Rings

Pivots 180° and swivels 360° to compensate for pitch, roll and sway when lifting heavy, unbalanced loads. Reduces risks in lifting, moving and turning heavy machinery, tooling, dies, and other equipment. Alloy steel construction with a corrosion resistant finish. Load ratings are for lifts in any direction.

| Bolt Size | Work Load Limit Lbs. | Thread Torque Ft. Lbs. | Dimensions, In. A | B | C | D | No. | NE EAC |
|---|---|---|---|---|---|---|---|---|
| 5/16"-18 | 800 | 7 | 7/16 | 1 5/8 | 9/16 | 3/8 | 3052T55 | $ 70 |
| 3/8"-16 | 1000 | 12 | 7/16 | 1 3/8 | 9/16 | 3/8 | 3052T56 | 70 |
| 1/2"-13 | 2500 | 28 | 11/16 | 2 1/16 | 1 1/16 | 1/2 | 3052T57 | 85 |
| 5/8"-13 | 2500 | 28 | 7/8 | 3 1/4 | 3/4 | 3/4 | 3052T58 | 85 |
| 5/8"-11 | 4000 | 60 | 7/8 | 3 1/4 | 1 | 3/4 | 3052T59 | 86 |
| 3/4"-10 | 5000 | 100 | 7/8 | 3 1/4 | 1 1/4 | 3/4 | 3052T61 | 86 |
| 3/4"-10 | 5000 | 100 | 7/8 | 3 1/4 | 1 | 3/4 | 3052T62 | 86 |
| 3/4"-10 | 7000 | 100 | 1 13/32 | 4 13/16 | 1 1/2 | 3/4 | 3052T63 | 86 |
| 7/8"-9 | 8000 | 160 | 1 13/32 | 4 13/16 | 1 | 1 | 3052T64 | 185 |
| 1"-8 | 10000 | 230 | 1 13/32 | 4 13/16 | 1 | 1 | 3052T65 | 186 |
| 1"-8 | 10000 | 230 | 1 13/32 | 4 13/16 | 1 1/4 | 1 | 3052T66 | 188 |
| 1 1/4"-7 | 15000 | 470 | 1 3/4 | 6 | 1 7/8 | 1 1/4 | 3052T67 | 188 |
| 2"-4 1/2 | 30000 | 800 | 2 1/4 | 8 | 3 1/8 | 1 3/4 | 3052T68 | 344 |
| 2 1/2"-4 | 50000 | 2100 | 3 | 10 1/2 | 4 1/8 | 2 1/4 | 3052T69 | 528 |
| 3"-4 | 75000 | 4300 | 3 3/4 | 13 | 5 3/8 | 2 3/4 | 3052T71 | 2277 |

## Clevis Eyebolts

Used for heavy lifting operations. Suited for die work and lifting in the construction industry. Rugged shackle pivots on heavy pin; lifting is on a direct plane for smoother motion and stress elimination.

Made of high quality alloy steel. Unified National Coarse (UNC) threads.

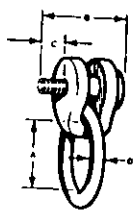
| Shank, In. Dia. | Lgth. | Eye I.D., In. | Length, In. Less Stud | Est. Lift Capacity | No. | NET EACH |
|---|---|---|---|---|---|---|
| 1/2-13 | 1 7/8 | 1 5/32 | 4 1/8 | 1 1/2 tons | 3026T14 | $66.92 |
| 5/8-11 | 2 5/16 | 1 5/16 | 4 7/8 | 2 tons | 3026T15 | 71.67 |
| 3/4-10 | 2 5/8 | 1 13/16 | 5 25/32 | 3 1/4 tons | 3026T16 | 86.25 |
| 7/8-9 | 3 | 2 | 6 19/32 | 4 3/4 tons | 3026T17 | 117.50 |
| 1-8 | 3 3/8 | 2 9/32 | 7 1/16 | 6 1/2 tons | 3026T18 | 142.32 |
| 1 1/4-7 | 4 3/16 | 2 11/16 | 8 1/8 | 8 1/2 tons | 3026T19 | 179.82 |
| 1 1/2-6 | 5 | 3 1/4 | 10 15/16 | 12 tons | 3026T21 | 226.43 |
| 2"-4 1/2 | 6 5/8 | 5 | 16 3/4 | 25 tons | 3026T22 | 420.62 |

## Swivel Lifting Plates

For temporary attachment to steel, wood or construction materials using machine bolt, lag screw or coil bolt. Made of forged steel welded to heavy steel bearing plate. Shackle is forged of 1" diameter stock, and swings on a line through center of bolt.

**Maximum Work Load Limit:** 9000 lbs., except 1 1/2" size, 12,000 lbs.

| Bolt Hole Dia. x Ht. | Plate Size Thk. x W x D | Recommended Minimum Bolt Length | No. | NET EACH |
|---|---|---|---|---|
| 3/4" x 1 3/8" | 1/2" x 2 1/2" x 5" | 4" | 3070T21 | $57.14 |
| 1" x 1 3/8" | 1/2" x 2 1/2" x 5" | 5" | 3070T23 | 59.26 |
| 1 1/2" x 2 1/2" | 1/2" x 3" x 6" | 6" | 3070T25 | 168.42 |

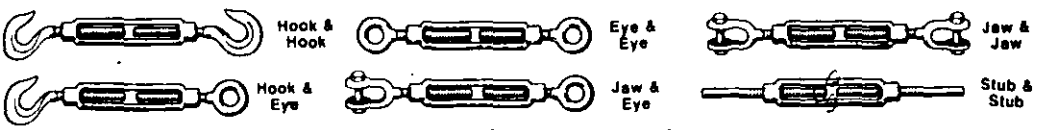


## Swivel Hoist Rings

Well suited for industrial lifting applications—dies, fixtures, molds, machinery. Constructed of alloy steel. Clevis, ring, bushing and cap screw are magnetic particle inspected. Bolts have Unified National Coarse Class 3A threads.

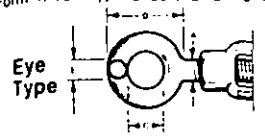
| Bolt Size In. | Work Load Limit, Lbs. | Thread Torque Ft. Lbs. | Dimensions, In. A | B | C | D | No. | NET EACH |
|---|---|---|---|---|---|---|---|---|
| 5/16 | 650 | 3.5 | 2 | 2 1/8 | 5/8 | 1/8 | 8887T62 | $53.77 |
| 3/8 | 800 | 4.5 | 2 | 2 3/8 | 3/4 | 3/8 | 8887T63 | 56.68 |
| 1/2 | 1800 | 15.0 | 3 | 3 3/8 | 1 | 3/8 | 8887T64 | 83.09 |
| 5/8 | 2500 | 25.0 | 3 | 3 5/8 | 1 1/4 | 3/8 | 8887T65 | 85.95 |
| 3/4 | 4100 | 50.0 | 4 | 5 | 1 1/2 | 1 | 8887T66 | 163.92 |
| 1 | 7100 | 90.0 | 4 | 5 3/8 | 2 | 1 | 8887T67 | 187.00 |
| 1 1/4 | 14000 | 150.0 | 6 | 6 7/8 | 2 | 1 1/4 | 8887T68 | 409.00 |
| 1 1/2 | 17200 | 250.0 | 6 | 7 7/8 | 2 1/2 | 1 3/8 | 8887T69 | 455.67 |
| 2 | 29000 | 300.0 | 5 1/4 x 10 1/2 | 10 | 3 1/8 | 1 1/2 | 8887T71 | 646.27 |

# Turnbuckles

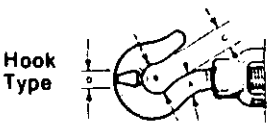



## Drop Forged Steel Turnbuckles

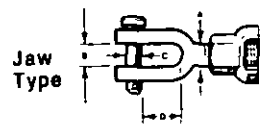
Galvanized finish. Meet Federal Specification FF-T-791b, Type 1, Form 1. Jaw type ends are furnished with round pins and cotter keys. Bolts have Unified National Coarse (UNC) threads, Class 2. **Sizes up to 2¼" available—Prices on Request.**




| Dimensions, In. | | | | Work Load |
|---|---|---|---|---|
| A | C | D | E | Limit, Lbs.◆ |
| ¼ | ½ | 1 | 1/32 | 500 |
| 5/16 | 5/8 | 1 1/4 | 3/32 | 800 |
| 3/8 | 3/4 | 1 1/2 | 1 1/32 | 1200 |
| 1/2 | 1 | 2 | 1 1/16 | 2200 |
| 5/8 | 1 1/4 | 2 5/16 | 1 1/32 | 3500 |
| 3/4 | 1 1/2 | 2 3/4 | 1 3/8 | 5200 |
| 1 | 1 3/4 | 3 1/4 | 1 3/4 | 7000 |
| 1 | 2 | 3 3/4 | 1 7/8 | 9800 |




| Dimensions, In. | | | | Work Load |
|---|---|---|---|---|
| A | B | C | D | Limit, Lbs.◆ |
| 1/4 | 5/16 | 9/32 | 7/32 | 400 |
| 5/16 | 1/2 | 1/2 | 5/16 | 700 |
| 3/8 | 1/2 | 1/2 | 3/8 | 900 |
| 1/2 | 7/8 | 13/16 | 17/32 | 1300 |
| 5/8 | 29/32 | 27/32 | 5/8 | 2200 |
| 3/4 | 1 1/8 | 29/32 | 11/16 | 2700 |
| 7/8 | 1 3/16 | 1 1/16 | 13/16 | 3200 |
| 1 | 1 3/8 | 1 1/4 | 7/8 | 4200 |



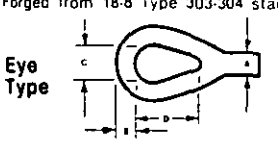

| Dimensions, In. | | | | Work Load |
|---|---|---|---|---|
| A | B | C | D | Limit, Lbs.◆ |
| 1/4 | 3/8 | 1/4 | 21/32 | 500 |
| 5/16 | 15/32 | 1/4 | 3/4 | 800 |
| 3/8 | 1/2 | 5/16 | 27/32 | 1200 |
| 1/2 | 5/8 | 7/16 | 1 1/16 | 2200 |
| 5/8 | 7/8 | 1/2 | 1 13/32 | 3500 |
| 3/4 | 15/16 | 5/8 | 1 17/32 | 5200 |
| 7/8 | 1 5/32 | 3/4 | 1 19/32 | 7000 |
| 1 | 1 3/16 | 7/8 | 1 31/32 | 9800 |

◆Do not exceed working load limit. On hook & eye turnbuckles do not exceed the working load limit shown for the hook end.

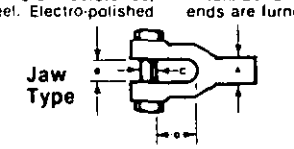
| Bolt Dia. | Take Up | Hook & Hook No. | Hook & Hook NET EACH | Hook & Eye No. | Hook & Eye NET EACH | Eye & Eye No. | Eye & Eye NET EACH | Jaw & Eye No. | Jaw & Eye NET EACH | Jaw & Jaw No. | Jaw & Jaw NET EACH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼" | 4" | 2997T51 | $4.92 | 2998T51 | $4.92 | 2999T51 | $4.92 | 3000T51 | $6.08 | 3001T51 | $7.08 |
| 5/16" | 4½" | 2997T52 | 6.17 | 2998T52 | 6.17 | 2999T52 | 6.17 | 3000T52 | 7.08 | 3001T52 | 8.00 |
| 3/8" | 6" | 2997T53 | 6.87 | 2998T53 | 6.87 | 2999T53 | 6.87 | 3000T53 | 8.17 | 3001T53 | 9.08 |
| 1/2" | 6" | 2997T54 | 7.83 | 2998T54 | 7.83 | 2999T54 | 7.83 | 3000T54 | 8.67 | 3001T54 | 9.67 |
| 1/2" | 9" | 2997T55 | 10.25 | 2998T55 | 10.25 | 2999T55 | 10.25 | 3000T55 | 11.15 | 3001T55 | 12.83 |
| 1/2" | 12" | 2997T56 | 12.33 | 2998T56 | 12.33 | 2999T56 | 12.33 | 3000T56 | 12.83 | 3001T56 | 14.33 |
| 5/8" | 6" | 2997T57 | 9.97 | 2998T57 | 9.97 | 2999T57 | 9.97 | 3000T57 | 11.73 | 3001T57 | 13.55 |
| 5/8" | 9" | 2997T58 | 13.80 | 2998T58 | 13.80 | 2999T58 | 13.80 | 3000T58 | 15.17 | 3001T58 | 17.65 |
| 5/8" | 12" | 2997T59 | 15.28 | 2998T59 | 15.28 | 2999T59 | 15.28 | 3000T59 | 17.08 | 3001T59 | 19.83 |
| ¾" | 6" | 2997T61 | 17.17 | 2998T61 | 17.17 | 2999T61 | 17.17 | 3000T61 | 17.47 | 3001T61 | 18.98 |
| ¾" | 9" | 2997T62 | 19.50 | 2998T62 | 19.50 | 2999T62 | 19.50 | 3000T62 | 19.57 | 3001T62 | 20.98 |
| ¾" | 12" | 2997T63 | 23.10 | 2998T63 | 23.10 | 2999T63 | 23.10 | 3000T63 | 24.58 | 3001T63 | 26.92 |
| ¾" | 18" | 2997T64 | 31.98 | 2998T64 | 31.98 | 2999T64 | 31.98 | 3000T64 | 33.66 | 3001T64 | 37.88 |
| 7/8" | 12" | 2997T65 | 28.42 | 2998T65 | 28.42 | 2999T65 | 28.42 | 3000T65 | 31.40 | 3001T65 | 34.35 |
| 7/8" | 18" | 2997T66 | 41.42 | 2998T66 | 41.42 | 2999T66 | 41.42 | 3000T66 | 45.58 | 3001T66 | 50.46 |
| 1" | 6" | 2997T67 | 31.67 | 2998T67 | 31.67 | 2999T67 | 31.67 | 3000T67 | 33.38 | 3001T67 | 35.87 |
| 1" | 12" | 2997T68 | 34.43 | 2998T68 | 34.43 | 2999T68 | 34.43 | 3000T68 | 37.20 | 3001T68 | 40.07 |
| 1" | 18" | 2997T69 | 52.79 | 2998T69 | 52.79 | 2999T69 | 52.79 | 3000T69 | 58.32 | 3001T69 | 63.97 |
| 1" | 24" | 2997T71 | 62.33 | 2998T71 | 62.33 | 2999T71 | 62.33 | 3000T71 | 63.08 | 3001T71 | 68.83 |
| 1¼" | 12" | 2997T72 | 52.50 | 2998T72 | 52.50 | 2999T72 | 52.50 | 3000T72 | 68.78 | 3001T72 | 75.26 |

## Drop Forged Stainless Steel Turnbuckles

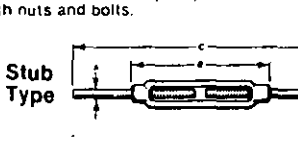
For applications requiring maximum corrosion resistance. Forged from 18-8 Type 303-304 stainless steel. Electro-polished finish. Bolts have Unified National Coarse (UNC) threads. Jaw type ends are furnished with nuts and bolts.




| Dimensions, In. | | | | Work Load |
|---|---|---|---|---|
| A | B | C | D | Limit, Lbs.◆ |
| ¼ | ¼ | ½ | 5/8 | 460 |
| 5/16 | 5/16 | ½ | 3/8 | 780 |
| 3/8 | 11/32 | 9/16 | 15/16 | 1160 |
| ½ | 7/16 | ¾ | 1 1/4 | 2150 |
| 5/8 | ½ | 1 1/4 | 1 15/16 | 3440 |
| ¾ | 5/8 | 1 | 2 1/8 | 5140 |
| 7/8 | 13/16 | 1 3/4 | 2 1/2 | 7130 |
| 1 | 7/8 | 1 1/2 | 2 5/16 | 9370 |




| Dimensions, In. | | | | Work Load |
|---|---|---|---|---|
| A | B | C | D | Limit, Lbs.◆ |
| 1/4 | 3/8 | 1/4 | 5/8 | 460 |
| 5/16 | 1/2 | 1/4 | 3/4 | 780 |
| 3/8 | 9/16 | 5/16 | 27/32 | 1160 |
| 1/2 | 5/8 | 3/8 | 1 1/16 | 2150 |
| 5/8 | 7/8 | 1/2 | 1 3/8 | 3440 |
| 3/4 | 15/16 | 5/8 | 1 1/2 | 5140 |
| 7/8 | 1 1/8 | 3/4 | 1 3/4 | 7130 |
| 1 | 1 1/4 | 7/8 | 2 1/16 | 9370 |




| Dimensions, In. | | | Work Load |
|---|---|---|---|
| A | B | C | Limit, Lbs.◆ |
| 1/4 | 4 3/4 | 9 | 460 |
| 5/16 | 5 7/16 | 10 1/2 | 780 |
| 3/8 | 7 1/8 | 15 | 1160 |
| 1/2 | 7 1/2 | 15 | 2150 |
| 5/8 | 7 7/8 | 16 | 3440 |
| 3/4 | 8 1/4 | 17 | 5140 |
| 7/8 | 8 5/8 | 17 | 7130 |
| 1 | 9 | 18 | 9370 |

◆Do not exceed working load limit.

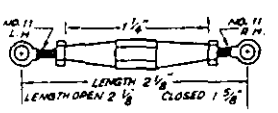
| Bolt Dia. | Take Up | Body Only No. | Body Only NET EACH | Stub & Stub No. | Stub & Stub NET EACH | Eye & Eye No. | Eye & Eye NET EACH | Jaw & Eye No. | Jaw & Eye NET EACH | Jaw & Jaw No. | Jaw & Jaw NET EACH |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ¼" | 4" | 3022T11 | $9.26 | 3022T21 | $19.06 | 3022T31 | $23.33 | 3022T41 | $28.70 | 3022T51 | $32.98 |
| 5/16" | 4½" | 3022T12 | 12.13 | 3022T22 | 23.02 | 3022T32 | 29.56 | 3022T42 | 34.30 | 3022T52 | 38.66 |
| 3/8" | 6" | 3022T13 | 15.94 | 3022T23 | 26.52 | 3022T33 | 34.61 | 3022T43 | 39.51 | 3022T53 | 44.33 |
| 1/2" | 6" | 3022T14 | 20.38 | 3022T24 | 36.71 | 3022T34 | 50.40 | 3022T44 | 54.60 | 3022T54 | 58.80 |
| 5/8" | 6" | 3022T15 | 26.29 | 3022T25 | 47.91 | 3022T35 | 69.69 | 3022T45 | 82.99 | 3022T55 | 95.74 |
| ¾" | 6" | 3022T16 | 38.66 | 3022T26 | 65.02 | 3022T36 | 87.19 | 3022T46 | 105.16 | 3022T56 | 122.66 |
| 7/8" | 6" | 3022T17 | 41.84 | 3022T27 | 103.52 | 3022T37 | — | — | — | — | — |
| 1" | 6" | 3022T18 | 54.21 | 3022T28 | 117.60 | 3022T38 | — | — | — | 3022T58 | 278.91 |

## Miniature Cable Turnbuckle

Nickel plated brass. For use with miniature coated or uncoated cable. Furnished with one left hand one right hand 5-40 thread eyebolt and one left hand and one right hand 5-40 thread eyebolt and one left hand and one right hand nickel plated brass nut.

For cables 3/64" diameter and smaller.

**No. 3435T12**—Pkg. of 5 .....NET/PKG.$32.00




## Swivel Lifting Plates

For temporary attachment to steel, wood or construction materials using machine bolt, lag screw or coil bolt. Made of forged steel welded to heavy steel bearing plate. Shackle is forged of 1" diameter stock, and swings on a line through center of bolt.

**Maximum Work Load Limit:** 9000 lbs., except 1½" size, 12,000 lbs.

| Plate Size Thk. x W x D | Recommended Minimum Bolt Length | No. | NET EACH |
|---|---|---|---|
| ½"x2½"x5" | 4" | 3070T21 | $57.14 |
| ½"x2½"x5" | 5" | 3070T23 | 59.26 |
| ½"x3" x6" | 6" | 3070T25 | 168.42 |

| Dimensions, In. A | B | C | D | No. | NET EACH |
|---|---|---|---|---|---|
| 2 | 2⅛ | ⅝ | ⅛ | 8887T62 | $53.77 |
| 2 | 2⅜ | ¾ | ⅜ | 8887T63 | 56.68 |
| 3 | 3⅜ | 1 | ⅜ | 8887T64 | 83.09 |
| 3 | 3⅝ | 1¼ | ⅜ | 8887T65 | 85.95 |
| 4 | 5 | 1½ | 1 | 8887T66 | 163.92 |
| 4 | 5⅜ | 2 | 1 | 8887T67 | 187.00 |
| 6 | 6⅞ | 2 | 1¼ | 8887T68 | 409.00 |
| 6 | 7⅞ | 2½ | 1⅜ | 8887T69 | 455.67 |
| 5¼ x 10½ | 10 | 3½ | 1½ | 8887T71 | 646.27 |

# Turnbuckles & U-Bolts


## Drop Forged Steel Stub End Turnbuckles

Self-colored finish. Meets Federal Specification FF-T-791b, Type 1, Form 1. Unified National Coarse (UNC) threads. Weldless construction.

| Bolt Dia. In. | Take Up In. | Working Load Limit Lbs. | Body Only No. | Body Only NET EACH | Stub & Stub No. | Stub & Stub NET EACH |
|---|---|---|---|---|---|---|
| ¼ | 4 | 500 | 2995T14 | $2.05 | 2996T14 | $3.80 |
| 5/16 | 4½ | 800 | 2995T15 | 2.66 | 2996T15 | 4.75 |
| ⅜ | 6 | 1200 | 2995T16 | 2.87 | 2996T16 | 5.04 |
| ½ | 6 | 2200 | 2995T17 | 3.49 | 2996T17 | 6.20 |
| ½ | 9 | 2200 | 2995T18 | 5.28 | 2996T18 | 8.38 |
| ½ | 12 | 2200 | 2995T19 | 5.96 | 2996T19 | 10.73 |
| ⅝ | 6 | 3500 | 2995T21 | 3.97 | 2996T21 | 6.98 |
| ⅝ | 9 | 3500 | 2995T22 | 5.76 | 2996T22 | 10.28 |
| ⅝ | 12 | 3500 | 2995T23 | 6.61 | 2996T23 | 11.73 |
| ¾ | 6 | 5200 | 2995T24 | 5.33 | 2996T24 | 9.12 |
| ¾ | 9 | 5200 | 2995T25 | 6.46 | 2996T25 | 11.68 |
| ¾ | 12 | 5200 | 2995T26 | 9.69 | 2996T26 | 16.32 |
| ⅞ | 6 | 7200 | 2995T28 | 6.74 | 2996T28 | 12.07 |
| ⅞ | 12 | 7200 | 2995T29 | 10.45 | 2996T29 | 21.09 |
| 1 | 6 | 10000 | 2995T32 | 7.99 | 2996T32 | 15.01 |
| 1 | 12 | 10000 | 2995T33 | 12.56 | 2996T33 | 22.61 |
| 1¼ | 6 | 15200 | 2995T37 | 14.39 | 2996T37 | 26.87 |
| 1¼ | 12 | 15200 | 2995T38 | 17.80 | 2996T38 | 34.78 |
| 1¼ | 18 | 15200 | 2995T39 | 27.98 | 2996T39 | 53.91 |
| 1½ | 6 | 21400 | 2995T43 | 18.75 | 2996T43 | 37.47 |
| 1½ | 12 | 21400 | 2995T44 | 26.75 | 2996T44 | 49.36 |

## Little Turnbuckles

Zinc plated die cast body. Steel fittings.

| Bolt Dia. | Take Up | O'All Lgth. Closed | Eye& Eye No. | Hook & Eye No. | Hook & Hook No. | NET EACH |
|---|---|---|---|---|---|---|
| 5/32" | 1¼" | 3¼" | 3010T14 | 3010T21 | 3010T27 | $0.63 |
| 3/16" | 1⅝" | 3¾" | 3010T15 | 3010T22 | 3010T28 | .72 |
| ¼" | 2⅜" | 5½" | 3010T17 | 3010T24 | 3010T29 | .96 |
| 5/16" | 2¾" | 6½" | 3010T18 | 3010T25 | 3010T31 | 1.31 |
| ⅜" | 3" | 7½" | 3010T19 | 3010T26 | 3010T32 | 1.67 |

## Aluminum Alloy Turnbuckles

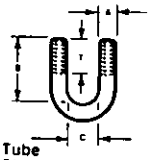
Intended for light duty applications. Cast aluminum body with electrogalvanized steel fittings. Eye fittings not welded. National Coarse Threads. **Package of 10.**

| Bolt Dia. | Length Min. | Length Max. | Eye & Eye No. | Hook & Eye No. | Hook & Hook No. | NET/ PKG. |
|---|---|---|---|---|---|---|
| 8-32 | 3⅜" | 4⅝" | 3003T14 | 3004T14 | 3005T14 | $5.01 |
| 10-24 | 4" | 5⅝" | 3003T15 | 3004T15 | 3005T15 | 5.28 |
| 12-24 | 4½" | 6⅜" | 3003T16 | 3004T16 | 3005T16 | 5.78 |
| ¼"-20 | 5½" | 7⅝" | 3003T17 | 3004T17 | 3005T17 | 6.83 |
| 5/16"-18 | 6¾" | 9¼" | 3003T18 | 3004T18 | 3005T18 | 11.01 |
| ⅜"-16 | 7½" | 10½" | 3003T19 | 3004T19 | 3005T19 | 12.70 |

## Aluminum Wrench-Fit Turnbuckles

Flat sides of body fit wrench. Rust resistant extruded aluminum body meets federal strength test specifications. Eyes and hooks are bent, drawn steel wire. Eyes not welded.

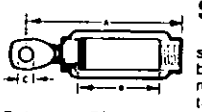
| Bolt Dia. | Take Up | Eye & Eye No. | Eye & Eye NET EACH | Hook & Hook No. | Hook & Hook NET EACH |
|---|---|---|---|---|---|
| 3/16" | 1⅜" | 3038T12 | $0.62 | | |
| ¼" | 2⅛" | 3038T14 | .96 | | |
| 5/16" | 2⅜" | 3038T15 | 1.23 | | |
| ⅜" | 3" | 3038T16 | 1.82 | 3038T36 | $1.82 |



## Copper Plated U-Bolts

Lightweight U-bolt is used for the suspension of stationary copper tubing lines. Copper plated steel. Hex nuts not included.

| Tube Size | Dimensions A | B | C | T | No. | NET EACH |
|---|---|---|---|---|---|---|
| ½" | ¼"-20 | 2¼" | 1 5/16" | 1½" | 8882T17 | $0.90 |
| ¾" | ¼"-20 | 2 21/32" | 1 5/16" | 1¾" | 8882T18 | .98 |
| 1" | ¼"-20 | 2 13/16" | 1⅜" | 1¾" | 8882T19 | 1.01 |
| 1¼" | ¼"-20 | 3⅛" | 1⅜" | 1¾" | 8882T21 | 1.12 |
| 1½" | ¼"-20 | 3¼" | 1¾" | 1 11/16" | 8882T22 | 1.19 |
| 2" | ¼"-20 | 3½" | 2⅛" | 1 11/16" | 8882T23 | 1.26 |



## Short Pattern Turnbuckl

Malleable body short turnbuckle has steel swivel bottom assembly. Turnbuckle has right hand threads for top connecting rod. Black finish. Unified National Coarse (UNC) threads.

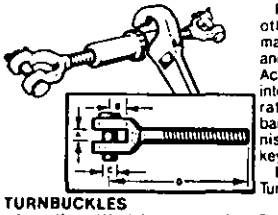
| Bolt Size | Dimensions A | B | C | Max. Work Load Limit | No. | NET EAC 1-11 | EAC 12 |
|---|---|---|---|---|---|---|---|
| ⅜" | 3 7/16" | 1 9/16" | 13/32" | 610 lbs. | 3002T1 | $1.38 | $1. |
| ½" | 3 7/16" | 1 9/16" | 13/32" | 710 lbs. | 3002T2 | 1.70 | 1. |
| ⅝" | 4⅞" | 2⅛" | ½" | 710 lbs. | 3002T3 | 2.87 | 2. |
| ¾" | 5¼" | 2⅛" | 9/16" | 860 lbs. | 3002T4 | 3.72 | 3. |

## Drop Forged Bronze Turnbuckles

Resists corrosion. National Fine threads provide accurate adjustment. Jaw & Jaw type. Furnished with pins and cotters.

| Bolt Dia. | Take Up | Length Min. | Length Max. | Recommended Wire Dia. | No. | NE EAC |
|---|---|---|---|---|---|---|
| 5/16" | 3¾" | 7½" | 11¼" | ⅛" or 5/32" | 3011T21 | $30 |
| ⅜" | 4 7/16" | 8 3/16" | 12⅝" | 3/16" | 3011T22 | 28 |
| ½" | 4⅞" | 10" | 14⅞" | ¼" or 9/32" | 3011T23 | 47. |

## Heavy Duty Ratchet Turnbuckles



For pipe lines, conveyors a other heavy applications. C malleable iron barrels with 3062T and "V" thread design with 3062T Acme thread for extra strength. integral gear to engage a handle ratchet is mounted at center barrel. Jaw and jaw end fittings f nished with round pins and cot keys.

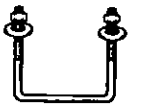
**Handle.** Open end. Malleable ir Turn over to reverse direction.

**TURNBUCKLES**

| Length Min. | Length Max. | Work Load Limit | A | B | C | D | No. | NET EAC |
|---|---|---|---|---|---|---|---|---|
| 18" | 26" | 5 tons | ⅞" | 1⅝" | ½" | 8 13/16" | 3062T72 | $53. |
| 25" | 33" | 15 tons | 1⅝" | 2⅝" | ⅞" | 12 3/16" | 3062T77 | 58. |

**HANDLES FOR TURNBUCKLES**

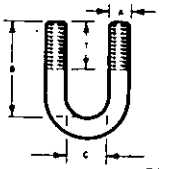
For 3062T72 ..... No. 3062T74 ..... NET EACH $22.
For 3062T77 ..... No. 3062T75 ..... NET EACH 43.



## Square Bend U-Bolts

For use with channels or other squa structural shapes. Zinc plated finish. Unifi National Coarse (UNC) threads. Furnish with flat washers and hex nuts.

| Thread Dia. | Width Between Legs | Thread Length | No. | NE EAC |
|---|---|---|---|---|
| ⅜" | 2" | 1½" | 3060T44 | $1. |
| ⅜" | 2" | 3" | 3060T45 | 1. |
| ⅜" | 2" | 3¾" | 3060T46 | 1. |
| ⅜" | 4" | 1½" | 3060T47 | 1. |
| ⅜" | 4" | 3" | 3060T48 | 1. |
| ⅜" | 4" | 3¾" | 3060T49 | 1. |
| ⅜" | 6" | 3" | 3060T51 | 1. |
| ⅜" | 6" | 3¾" | 3060T52 | 1. |
| ⅜" | 6" | 5⅛" | 3060T53 | 2. |



## Stainless Steel U-Bolts

Constructed of corrosion resistant Type 304 stainless steel. Furnished with four hex nuts.

For hanging pipe or joists, securing scaffolding and numerous other suspension jobs.

| Pipe Size | Dimensions A | B | C | T | No. | NE EAC |
|---|---|---|---|---|---|---|
| ½" | ¼"-20 | 2 15/16" | ⅞" | 2½" | 8889T41 | $5. |
| ¾" | ¼"-20 | 3 3/16" | 1⅛" | 2½" | 8889T42 | 5. |
| 1" | ¼"-20 | 3 7/16" | 1⅜" | 2½" | 8889T43 | 5. |
| 1¼" | ⅜"-16 | 3¾" | 1¾" | 2½" | 8889T44 | 6. |
| 1½" | ⅜"-16 | 4" | 2" | 2½" | 8889T45 | 6. |
| 2" | ⅜"-16 | 4½" | 2½" | 2½" | 8889T46 | 6. |
| 2½" | ½"-13 | 5¼" | 3" | 3" | 8889T47 | 14. |
| 3" | ½"-13 | 5 13/16" | 3⅝" | 3" | 8889T48 | 15. |
| 4" | ½"-13 | 6 13/16" | 4⅛" | 3" | 8889T49 | 19. |

| MATL CODE | MATERIAL NAME | PRODUCER NUMBER | PRODUCER NAME | CITY | ST | PROD DIST | P/S | CONTRACT TOTALS STD UNITS | UNASSIGNED QUANTITY STD UNITS |
|---|---|---|---|---|---|---|---|---|---|
| 65307501 | SHAPE M270 50W | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 668.0 | .0 |
| 65307501 | | | | | | | | 668.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 212-12 | BETHLEHEM STEEL CORP | BETHLEHEM | PA | 00 | PS | 12,747.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 4071-01 | BIERBAUM STEEL CO IN | GODFREY | IL | 98 | S | 30,720.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 436-01 | COMMERCIAL FABRICATR | BRIDGEVIEW | IL | 91 | S | 1,023.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 23,149.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 846-01 | HARTWIG MFG. CORP. | WAUSAU | WI | 00 | S | 43,885.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 320-01 | HENNEGAN & ASSOCIATE | LAGRANGE PARK | IL | 91 | S | 1,826.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 31,736.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 1449-01 | NORTHWESTERN STL&WIR | STERLING | IL | 92 | PS | 26,936.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 2394-01 | NUCOR CORPORATION | NORFOLK | NE | 00 | PS | 1,395.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 2186-01 | PHOENIX STEEL CORP | EAU CLAIRE | WI | 00 | S | 18,881.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 3890-01 | SMI STEEL INC | BIRMINGHAM | AL | 00 | PS | 1,994.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 14,366.0 | .0 |
| 65402 | SHAPE ANGLE M183 | 4007-01 | VASQUEZ METAL PROD. | LENZBURG # | IL | 98 | S | 392.0 | .0 |
| 65402 | | | | | | | | 209,050.0 | .0 |
| 65405 | SHAPE ANGLE M222 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 8,470.0 | .0 |
| 65405 | | | | | | | | 8,470.0 | .0 |
| 6540642 | SHAPE ANGLE M223 42 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 4,055.0 | .0 |
| 6540642 | | | | | | | | 4,055.0 | .0 |
| 65407 | TEE EXPANSION JOINT | 1611-01 | J.H. BOTTS, INC. | LEMONT | IL | 91 | PS | 8,883.0 | .0 |
| 65407 | | | | | | | | 8,883.0 | .0 |
| 65408 | ARMOR ANGLE | 3423-01 | DREW, JAMES CORP. | INDIANAPOLIS | IN | 00 | PS | 24.0 | .0 |
| 65408 | | | | | | | | 24.0 | .0 |
| 6541036 | SHAPE ANGLE M270 36 | 2186-01 | PHOENIX STEEL CORP | EAU CLAIRE | WI | 00 | S | 1,490.0 | .0 |
| 6541036 | SHAPE ANGLE M270 36 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 28,381.0 | .0 |
| 6541036 | | | | | | | | 29,871.0 | .0 |
| 65411 | ARMOR PLATE | 1875-01 | STRUCT RUBBER PROD | SPRINGFIELD | IL | 96 | PS | 74.0 | .0 |
| 65411 | | | | | | | | 74.0 | .0 |
| 65501 | BOLT ASTM A325 TY 1 | 4903-01 | DELTA SCREW | CHICAGO | IL | 91 | S | 1,035.0 | .0 |
| 65501 | BOLT ASTM A325 TY 1 | 2394-05 | NUCOR FASTENER CORP | ST. JOE | IN | 00 | PS | 4,617.0 | .0 |
| 65501 | BOLTS ASTM A325 TY 1 | 1728-01 | ST LOUIS SCREW BOLT | ST LOUIS | MO | 98 | PS | 3,117.4 | .0 |
| 65501 | BOLT ASTM A325 TY 1 | 2010-02 | UNYTITE-LOHR | PERU | IL | 93 | PS | 21,628.1 | .0 |
| 65501 | | | | | | | | 30,397.5 | .0 |
| 65503 | BOLT ASTM A325 TY 3 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 2,695.8 | .0 |
| 65503 | BOLTS ASTM A325 TY 3 | 1728-01 | ST LOUIS SCREW BOLT | ST LOUIS | MO | 98 | PS | 27,005.2 | .0 |
| 65503 | | | | | | | | 29,701.0 | .0 |

| MATL CODE | MATERIAL NAME | PRODUCER NUMBER | PRODUCER NAME | CITY | ST | PROD DIST | P/S | CONTRACT TOTALS STD UNITS | UNASSIGNED QUANTITY STD UNITS |
|---|---|---|---|---|---|---|---|---|---|
| 6521350 | PLATE M270 50 | 2186-01 | PHOENIX STEEL CORP | EAU CLAIRE | WI | 00 | S | 10,793.0 | .0 |
| 6521350 | PLATE M270 50 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 262,529.0 | .0 |
| 6521350 | | | | | | | | 1,763,032.0 | .0 |
| 65213501 | PLATE M270 50W | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 290,326.0 | .0 |
| 65213501 | PLATE M270 50W | 846-01 | HARTWIG MFG. CORP. | WAUSAU | WI | 00 | S | 773.0 | .0 |
| 65213501 | PLATE M270 50W | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 19,188.0 | .0 |
| 65213501 | PLATE M270 50W | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 74,664.0 | .0 |
| 65213501 | | | | | | | | 384,951.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 158,136.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 671-04 | FLORIDA STEEL CORP. | JACKSON | TN | 00 | PS | 151.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 846-01 | HARTWIG MFG. CORP. | WAUSAU | WI | 00 | S | 127,900.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 959-01 | INLAND STEEL COMPANY | EAST CHICAGO | IN | 00 | PS | 625.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 3991-01 | ISC | HODGKINS | IL | 91 | S | 8,271.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 1611-01 | J.H. BOTTS, INC. | LEMONT | IL | 91 | S | 255.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 9,880.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 1449-01 | NORTHWESTERN STL&WIR | STERLING | IL | 92 | PS | 7,519.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 2186-01 | PHOENIX STEEL CORP | EAU CLAIRE | WI | 00 | S | 2,802.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 3,200.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 2000-03 | UNITED STATES STEEL | SOUTH CHICAGO | IL | 91 | PS | 4,572.0 | .0 |
| 65302 | SHAPE AASHTO M183 | 4007-01 | VASQUEZ METAL PROD. | LENZBURG # | IL | 98 | S | 22,016.0 | .0 |
| 65302 | | | | | | | | 345,327.0 | .0 |
| 65305 | SHAPE AASHTO M222 | 212-04 | BETHLEHEM STEEL CORP | BURNS HARBOR | IN | 00 | PS | 246,494.0 | .0 |
| 65305 | SHAPE AASHTO M222 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 176,860.0 | .0 |
| 65305 | | | | | | | | 423,354.0 | .0 |
| 6530642 | SHAPE AASHTO M223 42 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 19,405.0 | .0 |
| 6530642 | | | | | | | | 19,405.0 | .0 |
| 6530650 | SHAPE AASHTO M223 50 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 242,284.0 | .0 |
| 6530650 | SHAPE AASHTO M223 50 | 846-01 | HARTWIG MFG. CORP. | WAUSAU | WI | 00 | S | 3,368.0 | .0 |
| 6530650 | SHAPE AASHTO M223 50 | 3991-01 | ISC | HODGKINS | IL | 91 | S | 68,046.0 | .0 |
| 6530650 | | | | | | | | 313,698.0 | .0 |
| 6530736 | SHAPE M270 36 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 61,161.0 | .0 |
| 6530736 | SHAPE M270 36 | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 24,000.0 | .0 |
| 6530736 | SHAPE M270 36 | 2186-01 | PHOENIX STEEL CORP | EAU CLAIRE | WI | 00 | S | 137,266.0 | .0 |
| 6530736 | SHAPE M270 36 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 16,500.0 | .0 |
| 6530736 | | | | | | | | 238,927.0 | .0 |
| 6530750 | SHAPE M270 50 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 1,069,533.0 | .0 |
| 6530750 | SHAPE M270 50 | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 423,579.0 | .0 |
| 6530750 | SHAPE M270 50 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 73,163.0 | .0 |
| 6530750 | | | | | | | | 1,566,275.0 | .0 |

| MATL CODE | MATERIAL NAME | PRODUCER NUMBER | PRODUCER NAME | CITY | ST | PROD DIST | P/S | CONTRACT TOTALS STD UNITS | UNASSIGNED QUANTITY STD UNITS |
|---|---|---|---|---|---|---|---|---|---|
| 65202 | PLATE AASHTO M183 | 846-01 | HARTWIG MFG. CORP. | WAUSAU | WI | 00 | S | 1,951.0 | .0 |
| 65202 | PLATE AASHTO M183 | 3517-01 | INDIANA STEEL & ENG | BEDFORD | IN | 00 | S | 19,679.0 | .0 |
| 65202 | PLATE AASHTO M183 | 1611-01 | J.H. BOTTS, INC. | LEMONT | IL | 91 | S | 23,999.0 | .0 |
| 65202 | PLATE AASHTO M183 | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 18,196.0 | .0 |
| 65202 | PLATE AASHTO M183 | 1443-02 | NORTH STAR STEEL CO | WILTON | IA | 00 | PS | 44.4 | .0 |
| 65202 | PLATE AASHTO M183 | 1443-05 | NORTH STAR STEEL KY | CALVERT CITY | KY | 00 | PS | 144.0 | .0 |
| 65202 | PLATE AASHTO M183 | 1449-01 | NORTHWESTERN STL&WIR | STERLING | IL | 92 | PS | 57,457.0 | .0 |
| 65202 | PLATE AASHTO M183 | 2394-01 | NUCOR CORPORATION | NORFOLK | NE | 00 | PS | 4,986.0 | .0 |
| 65202 | PLATE AASHTO M183 | 2186-01 | PHOENIX STEEL CORP | EAU CLAIRE | WI | 00 | S | 8,082.0 | .0 |
| 65202 | PLATE AASHTO M183 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 69,539.0 | .0 |
| 65202 | PLATE AASHTO M183 | 1400-01 | TOBI ENGINEERING INC | GLENVIEW | IL | 91 | S | 2,090.0 | .0 |
| 65202 | PLATE AASHTO M183 | 2000-05 | UNITED STATES STEEL | GARY | IN | 00 | PS | 1,114.0 | .0 |
| 65202 | PLATE AASHTO M183 | 4007-01 | VASQUEZ METAL PROD. | LENZBURG # | IL | 98 | S | 122,141.0 | .0 |
| 65202 | | | | | | | | 364,015.5 | .0 |
| 65205 | PLATE AASHTO M222 | 4682-01 | CITISTEEL USA | CLAYMONT | DE | 00 | PS | 93.0 | .0 |
| 65205 | PLATE AASHTO M222 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 4,234.0 | .0 |
| 65205 | PLATE AASHTO M222 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 2,142.0 | .0 |
| 65205 | | | | | | | | 6,469.0 | .0 |
| 6520642 | PLATE AASHTO M223 42 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 2,157.0 | .0 |
| 6520642 | PLATE AASHTO M223 42 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 4,522.0 | .0 |
| 6520642 | | | | | | | | 6,679.0 | .0 |
| 6520650 | PLATE AASHTO M223 50 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 2,505.0 | .0 |
| 6520650 | PLATE AASHTO M223 50 | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 4,896.0 | .0 |
| 6520650 | PLATE AASHTO M223 50 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 40,443.0 | .0 |
| 6520650 | PLATE AASHTO M223 50 | 4007-01 | VASQUEZ METAL PROD. | LENZBURG # | IL | 98 | S | 2,019.0 | .0 |
| 6520650 | | | | | | | | 49,863.0 | .0 |
| 65210 | PLATE ASTM A607 GR50 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 527.0 | .0 |
| 65210 | | | | | | | | 527.0 | .0 |
| 65212 | PLATE ASTM A606 TY 4 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 395.0 | .0 |
| 65212 | | | | | | | | 395.0 | .0 |
| 6521336 | PLATE M270 36 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 7,218.0 | .0 |
| 6521336 | PLATE M270 36 | 846-01 | HARTWIG MFG. CORP. | WAUSAU | WI | 00 | S | 2,854,626.0 | .0 |
| 6521336 | PLATE M270 36 | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 27,744.0 | .0 |
| 6521336 | PLATE M270 36 | 2186-01 | PHOENIX STEEL CORP | EAU CLAIRE | WI | 00 | S | 59,546.0 | .0 |
| 6521336 | PLATE M270 36 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 16,208.0 | .0 |
| 6521336 | | | | | | | | 2,965,342.0 | .0 |
| 6521350 | PLATE M270 50 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 209,036.0 | .0 |
| 6521350 | PLATE M270 50 | 846-01 | HARTWIG MFG. CORP. | WAUSAU | WI | 00 | S | 1,013,976.0 | .0 |
| 6521350 | PLATE M270 50 | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 266,698.0 | .0 |

| MATL CODE | MATERIAL NAME | PRODUCER NUMBER | PRODUCER NAME | CITY | ST | PROD DIST | P/S | CONTRACT TOTALS STD UNITS | UNASSIGNED QUANTITY STD UNITS |
|---|---|---|---|---|---|---|---|---|---|
| 63105 | STRAND 7WR GR270 LRX | 2185-01 | AMERICAN SPRING WIRE | BEDFORD HEIGHTS | OH | 00 | PS | .0 | 700,943.0 |
| 63105 | STRAND 7WR GR270 LRX | 2210-01 | DYWIDAG SYSTEMS | LEMONT | IL | 91 | S | 70,000.0 | .0 |
| 63105 | STRAND 7WR GR270 LRX | 2666-01 | FLORIDA WIRE-CABLE | JACKSONVILLE | FL | 00 | PS | .0 | 84,000.0 |
| 63105 | STRAND 7WR GR270 LRX | 2327-06 | INSTEEL WIRE PRODS | GALLATIN | TN | 00 | PS | .0 | 84,000.0 |
| 63105 | STRAND 7WR GR270 LRX | 5020-01 | PBM CONCRETE INC | ROCHELLE | IL | 92 | S | .0 | 171,976.0 |
| 63105 | STRAND 7WR GR270 LRX | 3982-01 | RAIDER PRECAST | W. BURLINGTON | IA | 00 | S | .0 | 232,580.0 |
| 63105 | | | | | | | | 70,000.0 | 1,273,499.0 |
| 63203 | BAR SPLICER COUPLER | 3989-01 | BARSPLICE PROD INC | DAYTON | OH | 00 | PS | 108.0 | .0 |
| 63203 | BAR SPLICER COUPLER | 3200-01 | J & M CONST PRODUCTS | HINSDALE | IL | 91 | S | 512.0 | .0 |
| 63203 | BAR SPLICER COUPLER | 2349-01 | MATHIS-KELLEY CONST | MORTON | IL | 94 | S | 135.0 | .0 |
| 63203 | BAR SPLICER COUPLER | 1650-01 | RICHMOND SCR AN | FT. WORTH | TX | 00 | PS | 639.0 | .0 |
| 63203 | BAR SPLICER COUPLER | 4518-01 | UNIVERSAL REBAR | BELLWOOD | IL | 91 | PS | 1,161.0 | 350.0 |
| 63203 | | | | | | | | 2,555.0 | 350.0 |
| 63204 | BAR SPLICE COUP EPXY | 3989-01 | BARSPLICE PROD INC | DAYTON | OH | 00 | PS | 2,370.0 | .0 |
| 63204 | BAR SPLICE COUP EPXY | 3131-01 | BIRMINGHAM STEEL | BOURBONNAIS | IL | 93 | PS | 16.0 | .0 |
| 63204 | BAR SPLICE COUP EPXY | 2177-01 | DOWNEY B. L. CO. | BROADVIEW | IL | 91 | S | 6,703.0 | .0 |
| 63204 | BAR SPLICE COUP EPXY | 2918-01 | MIDWEST PIPE COATING | SCHERERVILLE | IN | 91 | S | 2,888.0 | .0 |
| 63204 | BAR SPLICE COUP EPXY | 1650-01 | RICHMOND SCR AN | FT. WORTH | TX | 00 | PS | 3,345.0 | .0 |
| 63204 | BAR SPLICE COUP EPXY | 1650-02 | RICHMOND SCR AN | TREMONT | PA | 00 | PS | 5,225.0 | .0 |
| 63204 | BAR SPLICE COUP EPXY | 4518-01 | UNIVERSAL REBAR | BELLWOOD | IL | 91 | PS | 12,296.0 | 12,888.0 |
| 63204 | | | | | | | | 32,843.0 | 12,888.0 |
| 65102 | BAR AASHTO M183 | 138-01 | ATLANTIC STEEL CO. | ATLANTA | GA | 00 | PS | 112.0 | .0 |
| 65102 | BAR AASHTO M183 | 3131-01 | BIRMINGHAM STEEL | BOURBONNAIS | IL | 93 | PS | 494.0 | .0 |
| 65102 | BAR AASHTO M183 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 11,552.0 | .0 |
| 65102 | BAR AASHTO M183 | 1611-01 | J.H. BOTTS, INC. | LEMONT | IL | 91 | S | 1,982.0 | .0 |
| 65102 | BAR AASHTO M183 | 4838-01 | LINCOLN STEEL CO. | LINCOLN | NE | 00 | S | 2,618.0 | .0 |
| 65102 | BAR AASHTO M183 | 1449-01 | NORTHWESTERN STL&WIR | STERLING | IL | 92 | PS | 45,194.8 | .0 |
| 65102 | BAR AASHTO M183 | 2394-01 | NUCOR CORPORATION | NORFOLK | NE | 00 | PS | 282.5 | .0 |
| 65102 | BAR AASHTO M183 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 102.0 | .0 |
| 65102 | BAR AASHTO M183 | 4007-01 | VASQUEZ METAL PROD. | LENZBURG # | IL | 98 | S | 170.0 | .0 |
| 65102 | | | | | | | | 62,507.3 | .0 |
| 65105 | BAR AASHTO M222 | 1443-01 | NORTH STAR STEEL CO | ST. PAUL | MN | 00 | PS | 53.0 | .0 |
| 65105 | BAR AASHTO M222 | 1879-02 | STUPP BROS B & I CO | ST LOUIS | MO | 98 | S | 855.0 | .0 |
| 65105 | | | | | | | | 908.0 | .0 |
| 6510650 | BAR AASHTO M223 50 | 846-01 | HARTWIG MFG. CORP. | WAUSAU | WI | 00 | S | 1,545.0 | .0 |
| 6510650 | | | | | | | | 1,545.0 | .0 |
| 65202 | PLATE AASHTO M183 | 138-01 | ATLANTIC STEEL CO. | ATLANTA | GA | 00 | PS | 1,598.0 | .0 |
| 65202 | PLATE AASHTO M183 | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 25,334.0 | .0 |
| 65202 | PLATE AASHTO M183 | 845-01 | DREW, P.H., INC. | INDIANAPOLIS | IN | 00 | S | 960.0 | .0 |
| 65202 | PLATE AASHTO M183 | 4473-01 | GENEVA STEEL | PROVO | UT | 00 | PS | 6,701.1 | .0 |

ASSIGNMENT OF MATERIALS 100 THRU 999
01/01/94 - 12/31/94
CONTRACT TYPE(S): A L L

YEAR: 94 ========== RPT: MIRC09D

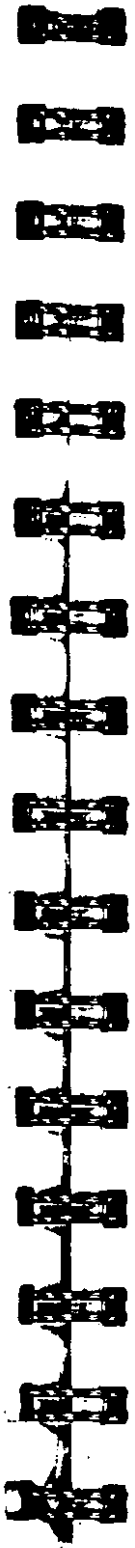
| MATL CODE | MATERIAL NAME | PRODUCER NUMBER | PRODUCER NAME | CITY | ST | PROD DIST | P/S | CONTRACT TOTALS STD UNITS | UNASSIGNED QUANTITY STD UNITS |
|---|---|---|---|---|---|---|---|---|---|
| 65506 | ROD THREADED A687 | 138-01 | ATLANTIC STEEL CO. | ATLANTA | GA | 00 | PS | 96.0 | .0 |
| 65506 | | | | | | | | 96.0 | .0 |
| 65602 | NUT ASTM A194 GR 2H | 4903-01 | DELTA SCREW | CHICAGO | IL | 91 | S | 389.8 | .0 |
| 65602 | NUT ASTM A194 GR 2H | 4744-01 | DOMESTIC NUT CORP. | PAINESVILLE | OH | 00 | PS | .0 | 1,745.0 |
| 65602 | NUT ASTM A194 GR 2H | 551-01 | DYSON CORP. | PAINESVILLE | OH | 00 | PS | .0 | 378.0 |
| 65602 | NUT ASTM A194 GR 2H | 1611-01 | J.H. BOTTS, INC. | LEMONT | IL | 91 | S | .0 | 5,073.1 |
| 65602 | NUTS ASTM A194 GR 2H | 1728-01 | ST LOUIS SCREW BOLT | ST LOUIS | MO | 98 | S | 934.1 | .0 |
| 65602 | NUT ASTM A194 GR 2H | 2010-02 | UNYTITE-LOHR | PERU | IL | 93 | PS | 8,732.0 | 3,312.5 |
| 65602 | | | | | | | | 10,055.9 | 10,508.6 |
| 65606 | NUT ASTM A563 GR DH | 4744-01 | DOMESTIC NUT CORP. | PAINESVILLE | OH | 00 | PS | .0 | 3,381.1 |
| 65606 | NUT ASTM A563 GR DH | 1611-01 | J.H. BOTTS, INC. | LEMONT | IL | 91 | S | .0 | 3,559.1 |
| 65606 | NUT ASTM A563 GR DH | 2394-05 | NUCOR FASTENER CORP | ST. JOE | IN | 00 | PS | 1,243.0 | .0 |
| 65606 | | | | | | | | 1,243.0 | 6,940.2 |
| 65701 | WASHER F436 CRBN STL | 4903-01 | DELTA SCREW | CHICAGO | IL | 91 | S | 2,020.0 | .0 |
| 65701 | WASHER F436 CRBN STL | 2394-05 | NUCOR FASTENER CORP | ST. JOE | IN | 00 | PS | 102.0 | .0 |
| 65701 | WASHERS A325 TY1OR2N | 1728-01 | ST LOUIS SCREW BOLT | ST LOUIS | MO | 98 | S | 217.5 | .0 |
| 65701 | WASHER F436 CRBN STL | 2172-01 | WROUGHT WASHER MFG | MILWAUKEE | WI | 00 | PS | 1,656.0 | .0 |
| 65701 | | | | | | | | 3,995.5 | .0 |
| 65702 | WASHER F436 WTHR STL | 3484-01 | DELONG'S INC. | JEFFERSON CITY | MO | 00 | S | 310.2 | .0 |
| 65702 | WASHER F436 WTHR STL | 1728-01 | ST LOUIS SCREW BOLT | ST LOUIS | MO | 98 | S | 2,341.3 | .0 |
| 65702 | | | | | | | | 2,651.5 | .0 |
| 65801 | CONNECTOR STUDSHEAR | 4636-01 | A & A ERECTORS | CAMPBELL HILL | IL | 99 | S | 21,861.0 | .0 |
| 65801 | CONNECTOR STUDSHEAR | 701-03 | FREESEN, INC. | BLUFFS | IL | 96 | S | 2,900.0 | .0 |
| 65801 | CONNECTOR STUDSHEAR | 5067-01 | INVENTORY SALES CO. | ST. LOUIS | MO | 00 | S | 168.0 | .0 |
| 65801 | CONNECTOR STUDSHEAR | 1611-01 | J.H. BOTTS, INC. | LEMONT | IL | 91 | S | 72.0 | .0 |
| 65801 | CONNECTOR STUDSHEAR | 1423-01 | NELSON STUD WELDING | BRIDGEVIEW | IL | 91 | S | 104,641.0 | 9,000.0 |
| 65801 | CONNECTOR STUDSHEAR | 1423-02 | NELSON STUD WELDING | LORAIN | OH | 00 | PS | 134,500.0 | 520,340.0 |
| 65801 | CONNECTOR STUDSHEAR | 4392-01 | NSS INDUSTRIES | PLYMOUTH | MI | 00 | PS | 5,610.0 | .0 |
| 65801 | CONNECTOR STUDSHEAR | 4272-01 | POWER FASTENING SUPP | GILBERTS | IL | 91 | S | 101,711.0 | 229,150.0 |
| 65801 | CONNECTOR STUDSHEAR | 4273-01 | STUD WELDING ASSOC. | ELYRIA | OH | 00 | PS | 97,640.0 | .0 |
| 65801 | CONNECTOR STUDSHEAR | 4687-01 | TOBEK, INC | ST. CHARLES | MO | 98 | S | 12,943.0 | .0 |
| 65801 | CONNECTOR STUDSHEAR | 1964-01 | TRU-FIT SCREW PDTS | MEDINA | OH | 00 | PS | 103,199.0 | 18,800.0 |
| 65801 | | | | | | | | 585,245.0 | 777,290.0 |
| 67601 | BOLT AN GALV STDSPC | 99-01 | ANCHOR BOLT COMPANY | ST LOUIS | MO | 98 | PS | 8.0 | .0 |
| 67601 | BOLT AN GALV STDSPC | 224-02 | BBC FASTENERS | ALSIP | IL | 91 | PS | 192.0 | 100.0 |
| 67601 | BOLT AN GALV STDSPC | 4146-01 | BELLEVILLE ELEC SUP | BELLEVILLE | IL | 98 | S | 68.0 | .0 |
| 67601 | BOLT AN GALV STDSPC | 4480-01 | CENTREX ELEC. SUPPLY | ST. LOUIS | + MO | 00 | S | 148.0 | .0 |
| 67601 | BOLT AN GALV STDSPC | 2540-01 | EGIZII ELECTRIC | SPRINGFIELD | IL | 96 | S | .0 | 60.0 |
| 67601 | BOLT AN GALV STDSPC | 2540-03 | EGIZII ELECTRIC | DECATUR | IL | 95 | S | 126.0 | .0 |
| 67601 | BOLT AN GALV STDSPC | 629-02 | FABSCO CORPORATION | CALUMET PARK | IL | 91 | PS | 60.0 | 16.0 |

P= producer
S= supplier

## SQUARE STRUCTURAL TUBING
### CARBON STEEL

| Outside Dimension In Inches | Wall Thickness Ga. | Wall Thickness Dec. | Nominal* Inside Dimension in Inches | Weight per Ft. In Lbs. | ASTM A500 GrB UNS K03000 | ASTM A513 | HR Butt Welded |
|---|---|---|---|---|---|---|---|
| 1/2x | 18 | .049 | .402 | .301 | .. | X | ..... |
| | .063 | .063 | .374 | .363 | ..... | X | ..... |
| | 16 | .065 | .370 | .385 | .. | X | .. |
| 5/8x | 18 | .049 | .527 | .384 | ..... | X | ..... |
| | 16 | .065 | .495 | .500 | ..... | X | ..... |
| 3/4x | 18 | .049 | .652 | .467 | ..... | X | ..... |
| | .063 | .063 | .624 | .577 | ..... | X | ..... |
| | 16 | .065 | .620 | .606 | .. | X | .. |
| | 11 | .120 | .510 | 1.03 | .. | X | .. |
| 7/8x | 16 | .065 | .745 | .716 | ..... | X | ..... |
| 1x | 20 | .035 | .930 | .459 | ..... | X | ..... |
| | 18 | .049 | .902 | .634 | .. | X | .. |
| | .063 | .063 | .874 | .791 | .. | X | .. |
| | 16 | .065 | .870 | .827 | .. | X | .. |
| | .072 | .072 | .856 | .909 | .. | X | .. |
| | .073 | .073 | .854 | .920 | ..... | X | ..... |
| | 14 | .083 | .834 | 1.04 | .. | X | .. |
| | 12 | .109 | .782 | 1.32 | .. | X | .. |
| | 11 | .120 | .760 | 1.44 | ..... | X | ..... |
| 1 1/4 x | 18 | .049 | 1.152 | .800 | ..... | X | ..... |
| | .063 | .063 | 1.124 | 1.01 | .. | X | .. |
| | 16 | .065 | 1.120 | 1.05 | .. | X | .. |
| | .072 | .072 | 1.106 | 1.14 | .. | X | .. |
| | 14 | .083 | 1.084 | 1.32 | .. | X | .. |
| | .090 | .090 | 1.070 | 1.48 | ..... | X | ..... |
| | 11 | .120 | 1.010 | 1.84 | .. | X | .. |
| | 10 | .134 | .982 | 1.95 | .. | .. | X |
| | 3/16 | .188 | .874 | 2.61 | ..... | ..... | X |
| 1 1/2 x | 18 | .049 | 1.402 | .967 | ..... | X | ..... |
| | .063 | .063 | 1.374 | 1.22 | .. | X | .. |
| | 16 | .065 | 1.370 | 1.27 | .. | X | .. |
| | .072 | .072 | 1.356 | 1.38 | .. | X | .. |
| | 14 | .083 | 1.334 | 1.60 | .. | X | .. |
| | 12 | .109 | 1.282 | 2.06 | .. | X | .. |
| | 11 | .120 | 1.260 | 2.25 | .. | X | .. |
| | .140 | .140 | 1.220 | 2.49 | ..... | ..... | X |
| | 7 | .180 | 1.140 | 3.23 | .. | X | .. |
| | 3/16 | .188 | 1.124 | 3.23 | .. | .. | X |
| | 1/4 | .250 | 1.000 | 4.11 | ..... | ..... | X |
| 1 3/4 x | 14 | .083 | 1.584 | 1.88 | ..... | X | ..... |
| | 11 | .120 | 1.510 | 2.66 | .. | X | .. |
| | 1/4 | .250 | 1.250 | 5.10 | ..... | ..... | X |
| 2x | .063 | .063 | 1.874 | 1.66 | X | ..... | ..... |
| | 16 | .065 | 1.870 | 1.71 | .. | X | .. |
| | .072 | .072 | 1.856 | 1.89 | X | .. | .. |
| | 14 | .083 | 1.834 | 2.16 | .. | X | .. |
| | 13 | .095 | 1.810 | 2.46 | X | X | .. |
| | 12 | 1.09 | 1.782 | 2.80 | .. | X | .. |
| | 11 | .120 | 1.760 | 3.07 | X | ..... | ..... |
| | 1/8 | .125 | 1.750 | 3.12 | X | .. | .. |
| | .145 | .145 | 1.710 | 3.51 | .. | .. | X |
| | 7 | .180 | 1.640 | 4.17 | X | .. | .. |
| | 3/16 | .188 | 1.624 | 4.32† | X | .. | X |
| (Continued) | 1/4 | .250 | 1.500 | 5.41† | .. X | ..... | ..... |

*Approximate inside dimensions listed to help develop telescoping requirements. †Weight is for Electric Resistance Welded tubes—slightly less than butt welded tubes.





## SQUARE STRUCTURAL TUBING
### CARBON STEEL

| Outside Dimension In Inches | Wall Thickness Ga. | Wall Thickness Dec. | Nominal* Inside Dimension in Inches | Weight per Ft. In Lbs. | ASTM A500 GrB UNS K03000 | ASTM A513 | HR Butt Welded |
|---|---|---|---|---|---|---|---|
| (Continued) | | | | | | | |
| 2 1/2 x | 16 | .065 | 2.370 | 2.13 | ..... | X | ..... |
| | 14 | .083 | 2.334 | 2.73 | ..... | X | ..... |
| | 11 | .120 | 2.260 | 3.76 | X | .. | .. |
| | 1/8 | .125 | 2.250 | 3.98 | X | .. | .. |
| | 141 | .141 | 2.218 | 4.52 | X | ..... | ..... |
| | 7 | .180 | 2.140 | 5.40 | X | .. | .. |
| | 3/16 | .188 | 2.124 | 5.59† | X | .. | X |
| | 1/4 | .250 | 2.000 | 7.11† | X | ..... | X |
| 3x | 14 | .083 | 2.834 | 3.29 | ..... | X | ..... |
| | 12 | .109 | 2.782 | 4.29 | X | .. | .. |
| | 11 | .120 | 2.760 | 4.58 | X | .. | .. |
| | 1/8 | .125 | 2.750 | 4.83 | X | ..... | ..... |
| | 7 | .180 | 2.640 | 6.62 | X | .. | .. |
| | 3/16 | .188 | 2.624 | 6.87 | X | .. | .. |
| | 1/4 | .250 | 2.500 | 8.81 | X | ..... | ..... |
| 3 1/2 x | 1/8 | .125 | 3.250 | 5.68 | X | ..... | ..... |
| | 3/16 | .188 | 3.124 | 8.15 | X | .. | .. |
| | 1/4 | .250 | 3.000 | 10.51 | X | .. | .. |
| 4x | 11 | .120 | 3.760 | 6.22 | X | ..... | ..... |
| | 1/8 | .125 | 3.750 | 6.53 | X | .. | .. |
| | 7 | .180 | 3.640 | 9.07 | X | .. | .. |
| | 3/16 | .188 | 3.624 | 9.42 | X | .. | .. |
| | 1/4 | .250 | 3.500 | 12.21 | X | ..... | ..... |
| | 5/16 | .313 | 3.374 | 14.83 | X | .. | .. |
| | 3/8 | .375 | 3.250 | 17.27 | X | .. | .. |
| | 1/2 | .500 | 3.000 | 21.63 | X | ..... | ..... |
| 4 1/2 x | 1/4 | .250 | 4.000 | 14.21 | X | ..... | ..... |
| 5x | 7 | .180 | 4.640 | 11.40 | X | ..... | ..... |
| | 3/16 | .188 | 4.626 | 11.97 | X | .. | .. |
| | 1/4 | .250 | 4.500 | 15.62 | X | .. | .. |
| | 5/16 | .313 | 4.374 | 19.08 | X | .. | .. |
| | 3/8 | .375 | 4.250 | 22.37 | X | .. | .. |
| | 1/2 | .500 | 4.000 | 28.43 | X | ..... | ..... |
| 6x | 7 | .180 | 5.640 | 13.90 | X | ..... | ..... |
| | 3/16 | .188 | 5.640 | 14.53 | X | .. | .. |
| | 1/4 | .250 | 5.500 | 19.02 | X | .. | .. |
| | 5/16 | .313 | 5.374 | 23.34 | X | .. | .. |
| | 3/8 | .375 | 5.250 | 27.48 | X | .. | .. |
| | 1/2 | .500 | 5.000 | 35.24 | X | ..... | ..... |
| 7x | 3/16 | .188 | 6.626 | 17.08 | X | ..... | ..... |
| | 1/4 | .250 | 6.500 | 22.42 | X | .. | .. |
| | 5/16 | .313 | 6.374 | 27.59 | X | .. | .. |
| | 3/8 | .375 | 6.250 | 32.58 | X | .. | .. |
| | 1/2 | .500 | 6.000 | 42.05 | X | ..... | ..... |
| 8x | 1/4 | .250 | 7.500 | 25.82 | X | ..... | ..... |
| | 5/16 | .313 | 7.374 | 31.84 | X | .. | .. |
| | 3/8 | .375 | 7.250 | 37.69 | X | .. | .. |
| | 1/2 | .500 | 7.000 | 48.85 | X | .. | .. |
| | 5/8 | .625 | 6.750 | 59.32 | X | ..... | ..... |
| 10x | 1/4 | .250 | 9.500 | 32.63 | X | ..... | ..... |
| | 5/16 | .313 | 9.374 | 40.35 | X | .. | .. |
| | 3/8 | .375 | 9.250 | 47.90 | X | .. | .. |
| | 1/2 | .500 | 9.000 | 62.46 | X | ..... | ..... |

*Approximate inside dimensions listed to help develop telescoping requirements. †Weight is for Electric Resistance Welded tubes—slightly less than butt welded tubes.

NOTE: Larger sizes up to 24" can be furnished by press brake forming. Call us for your requirements.

DIMENSIONS AND PROPERTIES

| | OUTSIDE DIM. (in) | WALL THICK. (in) | INSIDE DIM. (in) | AREA (in^2) | INERTIA (in^4) | r=SQRT(I/A) (in) |
|---|---|---|---|---|---|---|
| 1/2* | 0.5 | 0.049 | 0.402 | 0.088396 | 0.003032 | 0.185203 |
| | 0.5 | 0.063 | 0.374 | 0.110124 | 0.003578 | 0.180249 |
| | 0.5 | 0.065 | 0.37 | 0.1131 | 0.003647 | 0.17956 |
| 5/8* | 0.625 | 0.049 | 0.527 | 0.112896 | 0.006288 | 0.236 |
| | 0.625 | 0.065 | 0.495 | 0.1456 | 0.007713 | 0.230154 |
| 3/4* | 0.75 | 0.049 | 0.652 | 0.137396 | 0.011308 | 0.28688 |
| | 0.75 | 0.063 | 0.624 | 0.173124 | 0.013733 | 0.281643 |
| | 0.75 | 0.065 | 0.62 | 0.1781 | 0.014054 | 0.280906 |
| | 0.75 | 0.12 | 0.51 | 0.3024 | 0.02073 | 0.261821 |
| 7/8* | 0.875 | 0.065 | 0.745 | 0.2106 | 0.023177 | 0.331744 |
| 1* | 1 | 0.035 | 0.93 | 0.1351 | 0.020996 | 0.394219 |
| | 1 | 0.049 | 0.902 | 0.186396 | 0.028171 | 0.388759 |
| | 1 | 0.063 | 0.874 | 0.236124 | 0.034708 | 0.383392 |
| | 1 | 0.065 | 0.87 | 0.2431 | 0.035592 | 0.382633 |
| | 1 | 0.072 | 0.856 | 0.267264 | 0.038591 | 0.379993 |
| | 1 | 0.073 | 0.854 | 0.270684 | 0.039008 | 0.379618 |
| | 1 | 0.0836 | 0.834 | 0.304444 | 0.043017 | 0.375894 |
| | 1 | 0.109 | 0.782 | 0.388476 | 0.05217 | 0.366461 |
| | 1 | 0.12 | 0.76 | 0.4224 | 0.055532 | 0.362583 |
| 1 1/4* | 1.25 | 0.049 | 1.152 | 0.235396 | 0.056683 | 0.490714 |
| | 1.25 | 0.063 | 1.124 | 0.299124 | 0.070441 | 0.485273 |
| | 1.25 | 0.065 | 1.12 | 0.3081 | 0.072324 | 0.484501 |
| | 1.25 | 0.072 | 1.106 | 0.339264 | 0.078758 | 0.481814 |
| | 1.25 | 0.083 | 1.084 | 0.387444 | 0.088387 | 0.477629 |
| | 1.25 | 0.09 | 1.07 | 0.4176 | 0.094218 | 0.474991 |
| | 1.25 | 0.12 | 1.01 | 0.5424 | 0.116734 | 0.463915 |
| | 1.25 | 0.134 | 0.982 | 0.598176 | 0.125957 | 0.458878 |
| | 1.25 | 0.188 | 0.874 | 0.798624 | 0.154825 | 0.440301 |
| 1 1/2* | 1.5 | 0.049 | 1.402 | 0.284396 | 0.099908 | 0.592706 |
| | 1.5 | 0.063 | 1.374 | 0.362124 | 0.124869 | 0.587216 |
| | 1.5 | 0.065 | 1.37 | 0.3731 | 0.128312 | 0.586437 |
| | 1.5 | 0.072 | 1.356 | 0.411264 | 0.140129 | 0.583719 |
| | 1.5 | 0.083 | 1.334 | 0.470444 | 0.157973 | 0.579479 |
| | 1.5 | 0.109 | 1.282 | 0.606476 | 0.196777 | 0.569614 |
| | 1.5 | 0.12 | 1.26 | 0.6624 | 0.211836 | 0.565509 |
| | 1.5 | 0.14 | 1.22 | 0.7616 | 0.237264 | 0.558152 |
| | 1.5 | 0.18 | 1.14 | 0.9504 | 0.281128 | 0.543875 |
| | 1.5 | 0.188 | 1.124 | 0.986624 | 0.288865 | 0.541093 |
| | 1.5 | 0.25 | 1 | 1.25 | 0.338542 | 0.520416 |
| 1 3/4* | 1.75 | 0.083 | 1.584 | 0.553444 | 0.256962 | 0.681393 |
| | 1.75 | 0.12 | 1.51 | 0.7824 | 0.348338 | 0.667246 |
| | 1.75 | 0.25 | 1.25 | 1.5 | 0.578125 | 0.620819 |
| 2* | 2 | 0.063 | 1.874 | 0.488124 | 0.305561 | 0.791195 |
| | 2 | 0.065 | 1.87 | 0.5031 | 0.314308 | 0.790406 |
| | 2 | 0.072 | 1.856 | 0.555264 | 0.344483 | 0.787651 |
| | 2 | 0.083 | 1.834 | 0.636444 | 0.390541 | 0.783345 |
| | 2 | 0.095 | 1.81 | 0.7239 | 0.438931 | 0.778679 |
| | 2 | 11.09 | 1.782 | 0.824476 | 0.493004 | 0.773279 |
| | 2 | 0.12 | 1.76 | 0.9024 | 0.53374 | 0.769069 |
| | 2 | 0.125 | 1.75 | 0.9375 | 0.551758 | 0.767165 |
| | 2 | 0.145 | 1.71 | 1.0759 | 0.620803 | 0.759611 |
| | 2 | 0.18 | 1.64 | 1.3104 | 0.730504 | 0.746637 |
| | 2 | 0.188 | 1.624 | 1.362624 | 0.753687 | 0.743717 |
| | 2 | 0.25 | 1.5 | 1.75 | 0.911458 | 0.721688 |

# Appendix D:

# Combined Bibliography

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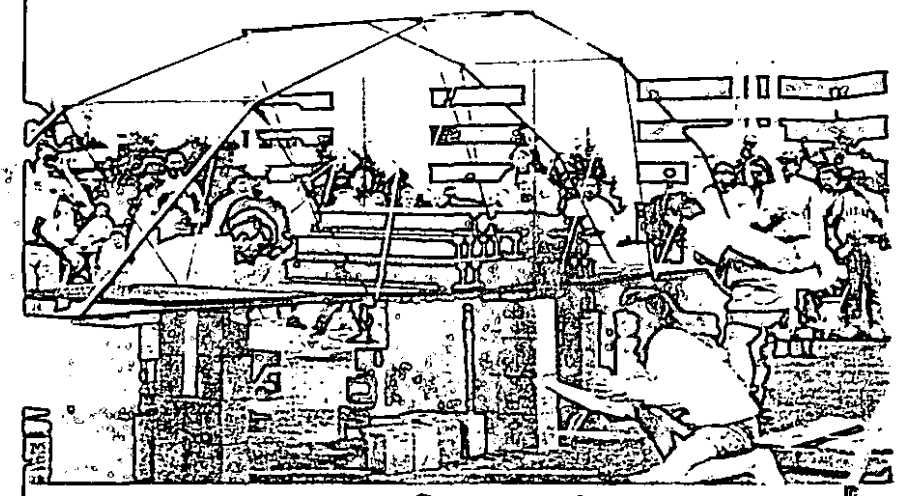
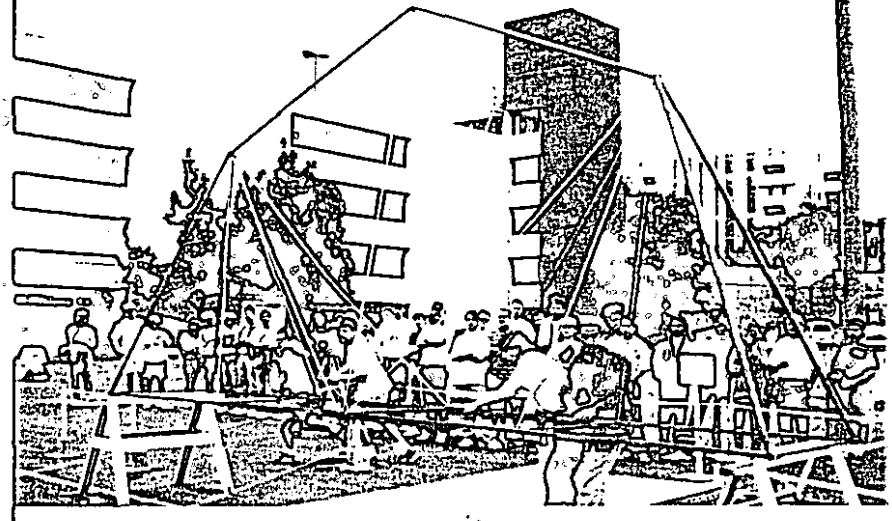
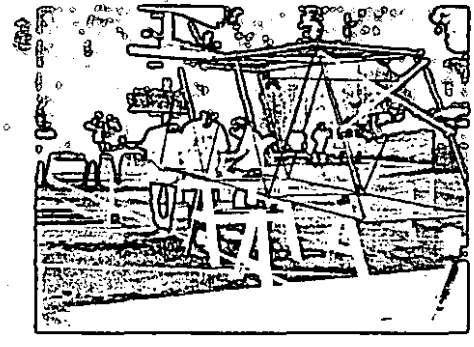
# 1995 STEEL BRIDGE BUILDING COMPETITION

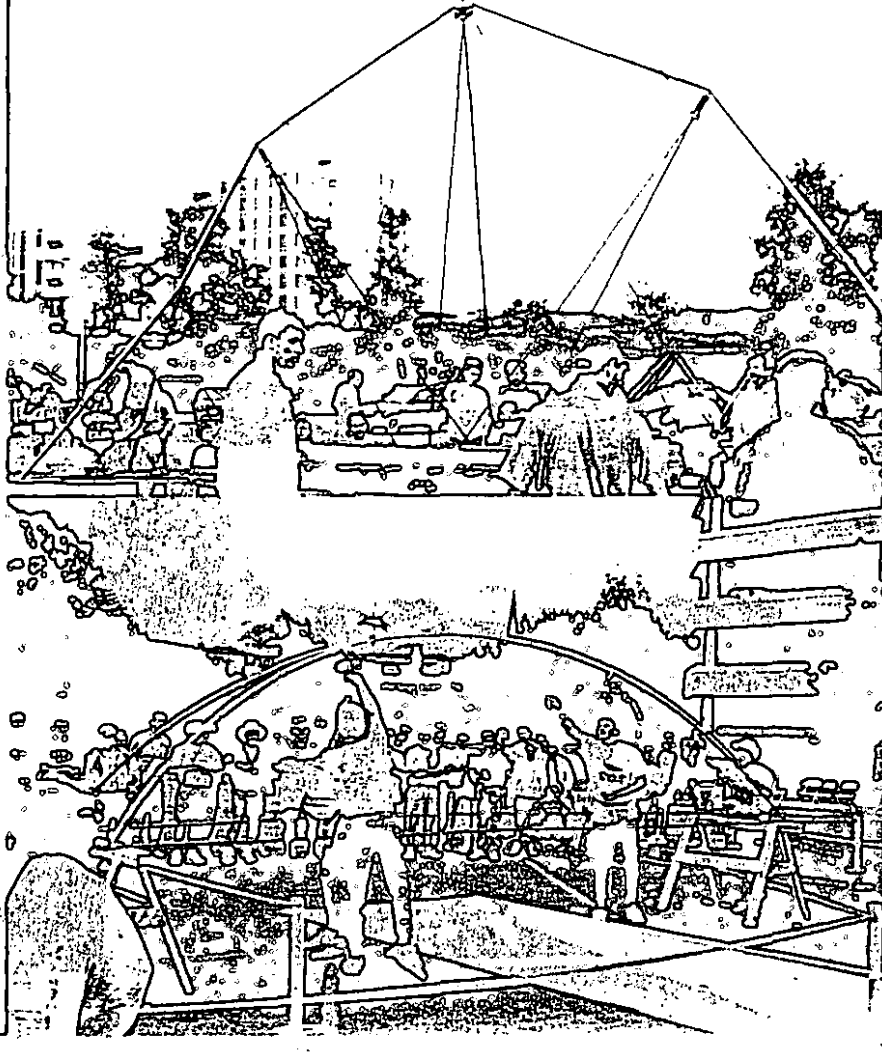






*For student chapters of the American Society of Civil Engineers*

*In Cooperation With ASCE American Society Of Civil Engineers*



# TABLE OF CONTENTS


| | page |
|---|---|
| Introduction | 3 |
| Executive Summary | 3 |
| Problem Statement | 4 |
| Qualification | 5 |
| Award Competition | 5 |
| Components | 7 |
| Construction | 7 |
| Safety Regulations | 10 |
| Accidents | 11 |
| Dimensions and Support | 11 |
| Load Tests | 13 |
| Equipment Provided by Host | 15 |
| Judging | 17 |
| Tips for Competitors | 17 |
| Score Sheet | 18 |
| Figures | |
| Site Plan | 9 |
| Side Elevation | 12 |
| Clearance and Deck Support | 12 |
| Load Tests | 14 |

# INTRODUCTION

The Steel Bridge-Building Competition is sponsored by the American Institute of Steel Construction. This inter-collegiate challenge requires Civil Engineering students to design, fabricate and construct a steel bridge.

Safety is of primary importance. The AISC requests that competitors, hosts and judges take all necessary precautions to prevent injury.

The competition rules have been changed for 1995 in order to improve the contest and to assure that competitors design and build new bridges.

Ideally, students should fabricate the entire bridge themselves. However, appropriate shop facilities and supervision may not be available at every college and university. Therefore, the services of a commercial fabricator may be used provided that students observe the operations.

This booklet describes the contest and states the official rules for this year. It is distributed to universities throughout the country. A companion booklet is distributed to hosts and provides directions for conducting a competition.

# EXECUTIVE SUMMARY

Civil Engineering students are challenged to an inter-collegiate competition that includes design, fabrication and construction. Participating students gain practical experience in structural design, fabrication processes, construction planning, organization and teamwork.

The Problem Statement describes challenges encountered in a representative structural engineering project. The competition is a scaled simulation of that project.

Standards for durability, constructability, usability, strength and serviceability reflect the volumes of regulations that govern the design and construction of full-scale bridges. Criteria for excellence are represented by the award categories of stiffness, lightness, construction speed, aesthetics, efficiency and economy. As with a real construction project, safety is the primary concern.

The rules of the competition accommodate a large variety of designs and allow innovation. Designers must carefully consider the comparative advantages of various alternatives. For example, a truss bridge may be stiffer than a girder bridge but slower to construct.

The Steel Bridge-Building Competition provides design and construction planning experience, an opportunity to learn fabrication procedures, and the excitement of competing against students from other colleges and universities.

# PROBLEM STATEMENT

A century-old bridge that crosses a river valley in a mountainous region must be replaced. The bridge carries heavy truck traffic to and from mines which are the basis for the economy of this rural region, as well as providing access and emergency services to residences. A quick replacement is necessary because no other river crossing of adequate capacity is available for miles.

The State Department of Transportation has requested design/build proposals for replacing the existing bridge. Any appropriate type of bridge will be considered, but the State has specified steel as the material because of its durability and fast erection. The bridge must accommodate two lanes of traffic and be able to carry specified patterns of traffic and wind loads without exceeding deflection limits. In order to expedite environmental approvals, no piers may be erected in the river, nor may temporary scaffolding or causeways be used in the river. However, temporary shoring may be erected on the banks. Construction barges and marine cranes are not feasible due to fast currents and flash floods.

The stone abutments of the existing bridge are in good condition and will serve for the new bridge, provided that no lateral thrust nor uplift is applied to the abutments. The State DOT will not permit modification of the existing abutments. The new bridge, when complete, must be supported only by the existing abutments; for example, stays and anchorages to the river banks are prohibited.

The new bridge must accommodate modular decking, which the State DOT salvaged from another bridge. Decking units may not be modified.

Access to the construction site is limited by narrow, winding roads. This imposes restrictions on the size of components, and on the movements of construction equipment. Soil conditions restrict the weight that may be lifted by cranes.

Your company's design/build proposal is among those that the State DOT has deemed responsive. The DOT has asked each competing firm to submit a 1:10 scale model to demonstrate its concept. Models will be erected under simulated field conditions and then load tested. The DOT will evaluate the models by multiple criteria including durability, constructability, usability, stiffness, construction speed, efficiency, economy and aesthetics. The contract will be awarded to the company that submits the best model. This is an opportunity to become leaders in the bridge replacement market.

# QUALIFICATION

In order to compete for awards, a bridge must qualify by satisfying the following minimum standards for durability, constructability, usability, strength and serviceability.

## Durability

The bridge must be constructed entirely of steel.

## Constructability

The bridge may be constructed only of components conforming to the restrictions on size and weight specified in "Components." The bridge must be constructable according to regulations given in "Construction" and without violating requirements listed in "Safety Regulations."

## Usability

The bridge must conform to the specifications described in "Dimensions and Support."

## Strength and Serviceability

The bridge must pass load tests 1 and 2 described in "Load Tests."

# AWARD COMPETITION

Only qualified bridges are eligible to compete for awards. Categories of competition are stiffness, lightness, construction speed, efficiency, economy and aesthetics. In addition, overall performance is rated.

## Stiffness

The bridge with the lowest incremental vertical deflection will win in the stiffness category. Incremental vertical deflection is determined from load test 3. A bridge that fails load test 3 will be eliminated from the stiffness and efficiency categories of competition.

## Lightness

The bridge with the least total weight will win in the lightness category. Decking and temporary shoring are not included in total weight.

## Construction Speed

The bridge with the lowest construction time will win in this category. Construction time is the product of the size of the construction team and the duration of construction. The construction team includes everyone who handles the bridge or any of its components during timed construction. A bridge that accumulates $150,000 or more in penalties will be eliminated from competition in the construction speed and economy categories (see "Accidents.")

## Efficiency

The bridge with the smallest sum of normalized weight and deflection ratios (SNWD) will win in the efficiency category. The sum of normalized weight and deflection ratios is computed as

$$\text{SNWD} = \frac{\text{Incremental vertical deflection (in)}}{0.20\ \text{(in)}} + \frac{\text{Total weight (lb)}}{100\ \text{(lb)}}$$

## Economy

The bridge with the lowest cost (C) will win in the economy category. Cost is computed as

C = Total weight (lb) x 1000 ($/lb)

+ Construction time (person-min) x 5000 ($/person-minute)

+ $10,000 if temporary shoring is used

+ Penalty costs (listed in "Accidents")

## Aesthetics

Factors that may be considered include general appearance, balance and proportion of the design, elegance of connections, finish, construction organization and teamwork. Quality of fabrication should not be considered because some bridges may be fabricated professionally while other are student work.

## Overall Performance

The overall performance rating of a bridge is determined by adding the rank of the bridge in the efficiency category to its rank in the economy category. The bridge with the lowest sum will win the overall competition. A bridge that was eliminated from the efficiency and/or economy categories is not eligible for the overall performance competition. In the case of a tie, judges will use aesthetics as the tie breaker.

## COMPONENTS

A bridge may be constructed only of components made entirely of steel and conforming to the following descriptions of members, cables with fittings, assemblies, and fasteners.

A member may not weigh more than 40 pounds nor exceed overall dimensions of 5'6" x 7.5" x 7.5." A member may consist of parts connected together before timed construction begins but those parts must remain connected throughout the construction process. A member may be hinged, jointed, articulated or telescoping.

A cable together with its fittings may weigh no more than 40 pounds and must be capable of being coiled to a diameter not exceeding two feet. Fittings are eyes, hooks, plates, clamps, clevises, turnbuckles and similar parts connected to cables, and not exceeding 7.5" in any dimension. A cable with fittings may consist of parts connected together before timed construction begins but those parts must remain connected throughout the construction process. A cable with fittings may have any number of ends.

An assembly is no more than 3 members and/or cables with fittings that are connected together in the staging yards during timed construction.

Fasteners are bolts and nuts, pins, plates, shims and similar parts used for connecting members, cables and assemblies, and not exceeding 7.5" in any dimension.

## CONSTRUCTION

### Tools

Competitors provide their own tools. Only hand tools are permitted. Field welding and power tools are prohibited. Ropes are permitted but gin poles, jacks, winches, come-alongs, counterweights and other hoisting devices are prohibited. Stools, ladders and similar objects for elevating builders are prohibited.

### Construction Site

See the figure titled "Site Plan" for layout of river, banks, and other features that affect construction.

### Temporary Shoring

Shoring is temporary support on the river banks, and is provided by the competitors. There are no restrictions on the materials and design for temporary shoring other than it must provide sufficient strength and stability to

support the bridge and builders. There is a cost assigned to temporary shoring; its advantage is that builders may be supported by the bridge only if temporary shoring is in place. If temporary shoring is used, it must be used on both banks.

## Safety Support

During construction the top of the safety support must be in place at the midspan of the bridge with its top surface no more than 8 inches from the bottom of the bridge.

## Start

Before construction begins, all members, cables with fittings, fasteners, tools and builders are in the staging yards. Temporary shoring, if used, has been constructed and is in place on both river banks. The safety support is in place. Timing and construction begin when the builders signify that they are ready and the judge declares the start.

## Time

Time is kept from the start to finish of construction. The clock will be stopped:

1. if a builder or judge sees a condition that could cause personal injury;

2. when a safety regulation has been violated, and

3. if the safety support must be adjusted.

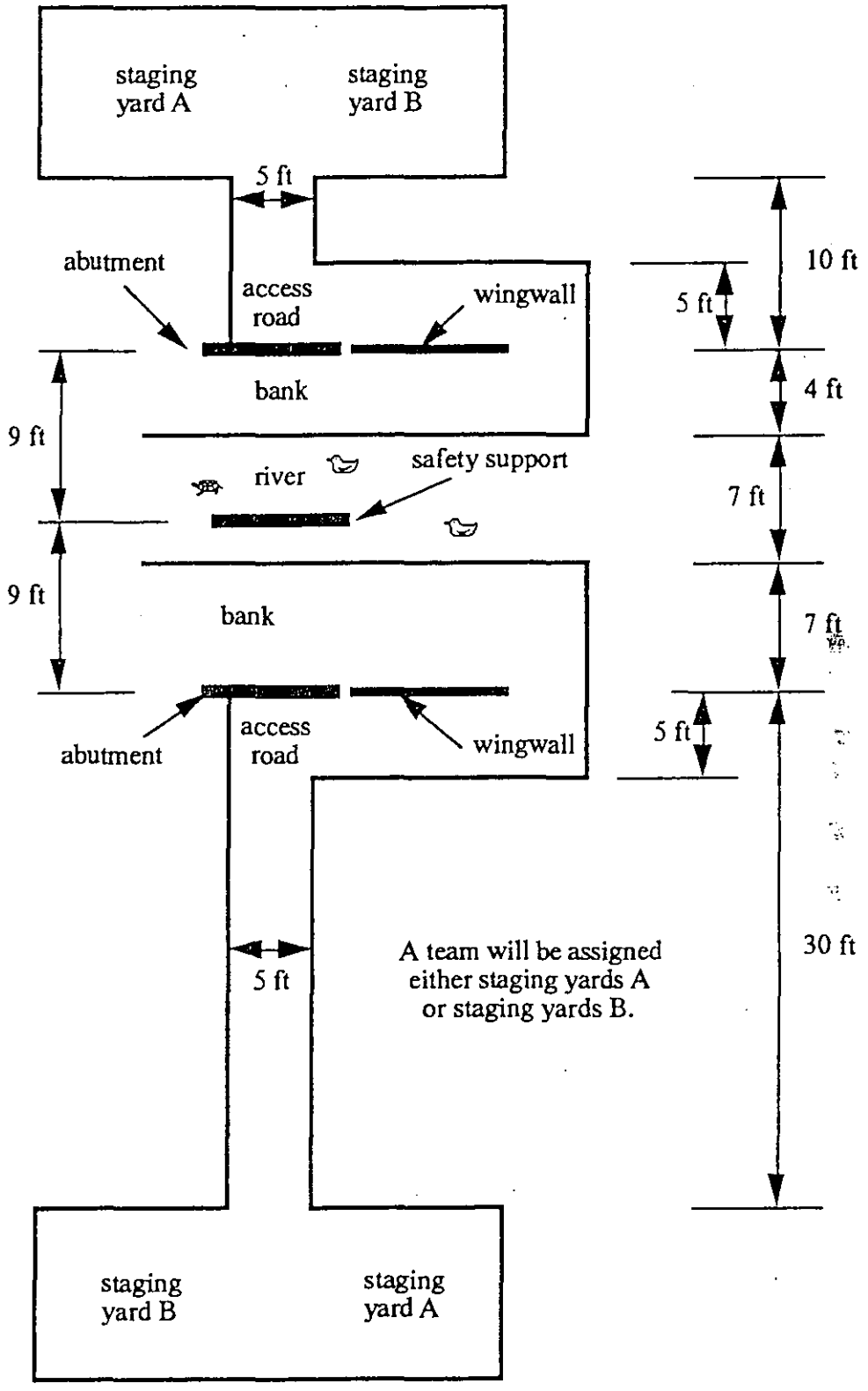
Construction ceases while the clock is stopped. The clock is restarted after the situation has been corrected.

## Time Limit

In order to expedite the competition the host may limit the clock time for constructing a bridge to 30 minutes. A higher limit may be imposed. A bridge that exceeds the limit will be eliminated from all categories of competition. If the host opts to impose a time limit, all competitors must be notified at least a month before the competition.

## Finish

Construction ends when the bridge is complete, and all tools and builders are in the staging yards, and the builders signify that they are finished. Temporary shoring may remain on the banks. Installation of decking is not included in timed construction.


staging
yard A
staging
yard B
5 ft
abutment
access
road
wingwall
bank
9 ft
river
safety support
9 ft
bank
abutment
access
road
wingwall
5 ft
A team will be assigned
either staging yards A
or staging yards B.
staging
yard B
staging
yard A
10 ft
5 ft
4 ft
7 ft
7 ft
5 ft
30 ft

Site Plan

# SAFETY REGULATIONS

If any of the following safety regulations are violated the judge will stop the clock and explain the violation. Before restarting the clock, builders, tools and bridge components will be returned to the positions they occupied before the violation. Construction that necessitates violation of safety regulations is not permitted.

1. If temporary shoring is not used, a builder may not stand on the bridge nor occupy it in any other way such that the bridge supports the builder's body weight. However, a builder may lean on the bridge if both feet remain on the river bank.

2. Temporary shoring may not be placed in the river.

3. A builder may lift or carry only one member or one cable with fittings at a time.

4. An assembly may not be lifted nor carried by one builder alone.

5. Two or more builders may lift or carry only one assembly at a time.

6. Nothing may be thrown.

7. A builder may not stand, sit or kneel in the river, nor use the river for support in any way.

8. A builder must stay within the limits of the access roads and river banks.

9. A builder may not cross the wingwalls.

10. The safety support as well as temporary shoring on both banks must be in place and properly adjusted before a builder climbs onto the bridge.

11. A builder may not cross the abutments except to climb onto the bridge with temporary shoring and safety support in place.

12. No member, cable with fittings nor assembly may be carried while climbing onto the bridge.

13. A builder may not cross the river by jumping, by temporary scaffolding, by crossing the bridge, nor by any other means.

14. A member, cable with fittings, assembly, fastener or tool may not be laid down except in the staging yards, on the abutments, on the temporary shoring and on the bridge. A member, cable with fittings, assembly, fastener or tool may not be leaned against an abutment, temporary shoring or safety support.

15. A constructed portion of the bridge may be slid horizontally, provided that it is supported by both abutments, or by temporary shoring on both banks, or by one abutment and one unit of temporary shoring.

16. One side or end of a constructed portion of the bridge may be moved a few inches in any direction in order to align a connection.

## ACCIDENTS

In general, the clock is not stopped when an "accident" occurs. Builders involved in accidents may continue to build, and components involved in accidents may be recovered and used. Types of accidents and the corresponding cost penalties are:

1. A builder touches the river or the safety support. $50,000 for each occurrence.

2. A member, cable with fittings, assembly, or the bridge touches the river, a bank, an access road or the safety support. $20,000 for each occurrence.

3. A tool or fastener touches the river, a bank or an access road. $1000 for each occurrence.

## DIMENSIONS AND SUPPORT

The figures titled "Side Elevation" and "Clearance and Deck Support" illustrate some of the following specifications.

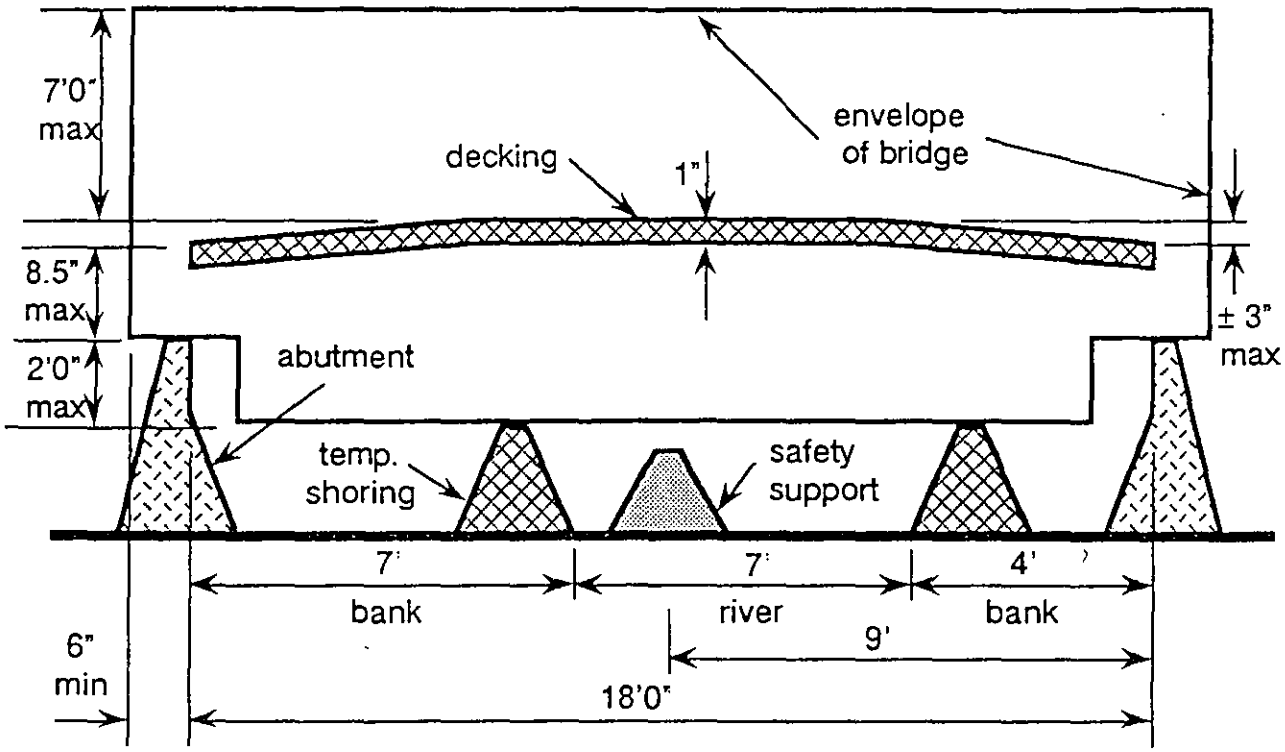
1. The bridge must span the abutments, which are fixed in place so that the distance between faces is 18 feet.

2. The bridge must provide bearing area extending at least 6 inches behind the face of each abutment so that the bridge will remain supported by the abutments in the event that it is displaced 6 inches in the direction of span.

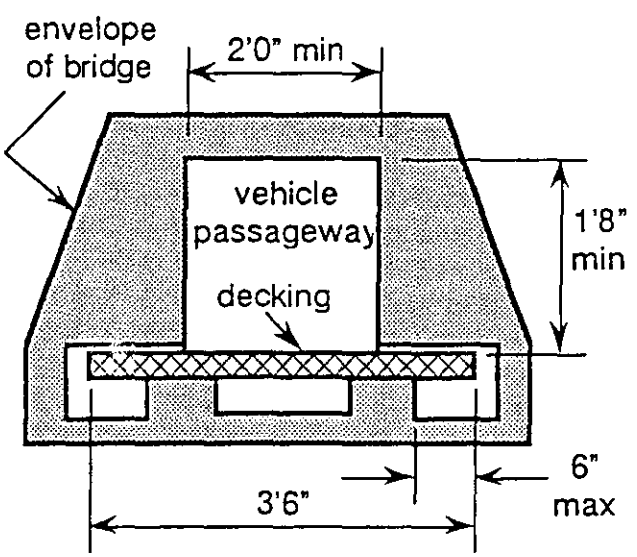
3. A 2'0" wide by 1'8" high rectangular vehicle passageway must be provided along the full length of the bridge.

4. No part of the bridge may extend more than 2 feet below the top of the abutments at any point on the span.

5. No part of the bridge may extend more than 7 feet above the top of the deck at any point on the span.




Side Elevation




Clearance and
Deck Support

6. The surface of the deck must be no more than 8.5" above the top of the abutments, measured at the abutments.

7. The absolute value of camber must not exceed 3 inches.

8. The bridge must provide support for the decking on both of the edges that run in the longitudinal direction of the bridge. The support must be continuous for the full span of the bridge.

9. The edges of the decking that run in the longitudinal direction of the bridge may be cantilevered over their supports no more than 6 inches.

10. The continuous supports for the deck must be capable of accommodating decking anywhere on the span, without gaps, overlaps or abrupt elevation differences between decking units. However, small elevation differences, such as those caused by decking resting on bolt heads, are acceptable.

11. The decking may not be attached nor anchored to the bridge.

12. The bridge may not be attached nor anchored to the abutments, and it may bear only on the top surface of the abutments.

13. The bridge may not be anchored, tied nor braced to the ground.

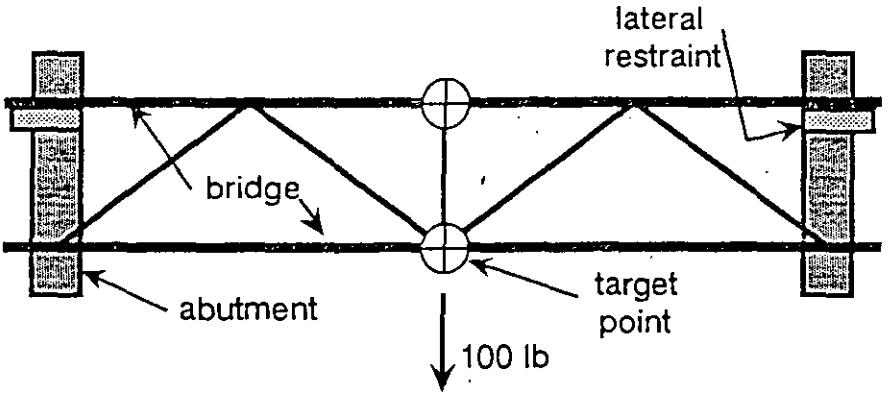
## LOAD TESTS

CAUTION: A bridge could collapse or sway suddenly during load tests. Therefore, minimize the number of people near the bridge while it is being tested. During testing the bridge must be supported so that its lowest point is no more than 8 inches above ground or above the top of the safety support.

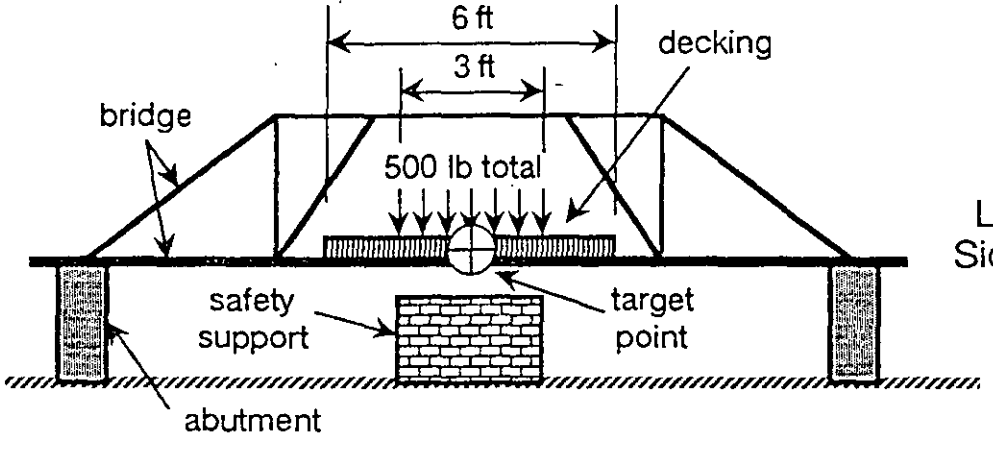
The figure titled "Load Tests" illustrates some of the following procedures.

Load tests are conducted without temporary shoring. Load test 1 is conducted without decking; load tests 2 and 3 are conducted with two decking units installed to accommodate the load.

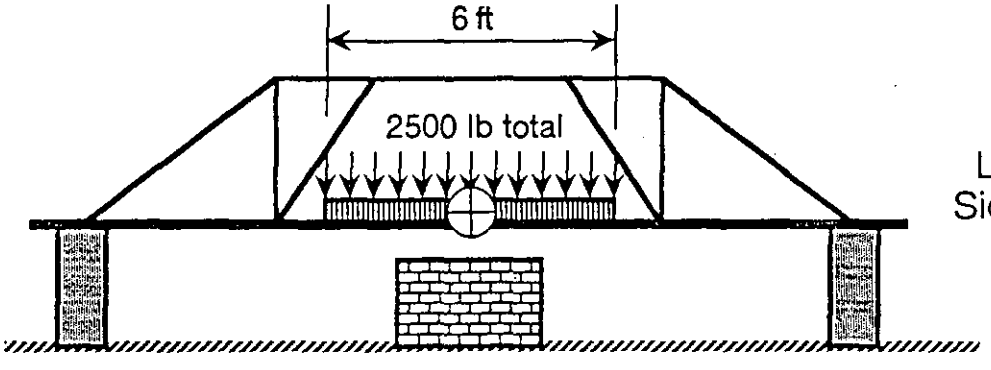
The judge designates two target points on the bridge, both located at midspan, one on each side. The target points should be close to the level of the deck, and may be on the decking itself. Lateral deflection measurements are made to the target point on one side of the bridge, designated by the judge. Vertical deflection measurements are made to both target points; vertical deflection is the maximum absolute value of the two measurements.




Load Test 1
Plan




Load Test 2
Side Elevation




Load Test 3
Side Elevation

Load Tests

Total lateral deflection is the absolute value of the horizontal distance of the target point from its position at the beginning of load test 2. Incremental vertical deflection is the maximum absolute value of the vertical distances of the target points from their positions at the beginning of load test 3.

Load tests are conducted in numerical order.

### Load Test 1 - Qualifying, Lateral

Load test 1 is conducted with lateral restraint installed on the abutments to prevent the ends of the bridge from sliding. As close as practical to midspan apply a 100 pound force in the lateral direction. To pass load test 1, the lateral deflection of the bridge must not exceed 1.0". If the bridge does not pass load test 1, do not conduct any other load test. Remove the lateral load; it is not part of the remaining load tests.

### Load Test 2 - Qualifying, Vertical

Uniformly distribute load over an area symmetric about the middle of the deck and extending 3 feet in the span direction. Terminate load test 2 when lateral deflection reaches 1.0" or vertical deflection reaches 2.0" or 500 pounds of load has been placed. A bridge passes load test 2 if 500 pounds of load was placed without a deflection limit being exceeded. If the bridge does not pass load test 2, do not conduct any other load test.

### Load Test 3 - Competition, Vertical

With the load from test 2 remaining in place, uniformly distribute additional load over an area symmetric about the middle of the deck and extending 6 feet in the span direction. Terminate load test 3 when total lateral deflection reaches 2.0" or incremental vertical deflection reaches 2.0" or 2000 pounds of additional load has been placed. A bridge passes load test 3 if 2000 pounds of additional load was placed without a deflection limit being exceeded. If the bridge passes load test 3, record the incremental vertical deflection.

## EQUIPMENT PROVIDED BY HOST CHAPTER

The following equipment will be provided at the contest site by the host. Competitors may wish to acquire similar equipment for use in practice and testing before the competition.

### Lateral Load Device

Capable of applying 100 lb force in the horizontal direction.

### Measuring Scales and/or Instruments

## Load

2500 pounds total. The load should be supplied in uniform increments of size and weight that may be handled safely. When in place, the load should not provide significant stiffness in the longitudinal direction of the bridge. Sections of steel angle of uniform size and length are recommended for load. Sacks of material, containers of liquid, concrete blocks or jacking systems could be used.

## Decking

The decking is steel bar grating identified as W-19-4 (1 x 1/8). The dimensions of a piece of grating are 3'6" x 2'11-3/4" x 1". Grating has bending strength only in the direction of the main bars, which are 3'6" long. The grating will be installed with the main bars perpendicular to the length of the bridge, creating a roadway that is 3'6" wide. Therefore, support for the grating must be provided along the edges that are parallel to the length of the bridge. No support is needed for the edges of the grating that are perpendicular to the length of the bridge.

When loading, do not exceed 400 psf uniform load nor 500 pounds concentrated load. Do not load on a cantilevered portion of the grating.

## Abutments

The top surface of each abutment should be at least 5 feet long, 3 inches wide, level, smooth, and approximately 3 feet above the ground. Temporary lateral restraints are needed during load test 1.

## Safety Support

The safety support is intended to limit the consequences of a bridge collapsing during construction or load tests, but should not come in contact with the bridge unless there is a collapse or excessive deflection. The safety support is placed at the middle of the span and adjusted so that the top of the support is no more than 8 inches from the bottom of the bridge.

The safety support should be placed and adjusted to the proper height before the start of timed construction. At all times during construction the top of the safety support should be within 8 inches of the bottom of the bridge. If the safety support must be adjusted when the bridge is partially constructed, the clock will be stopped while the safety support is positioned. Builders are prohibited from being on the bridge unless the safety support is in place, as well as temporary shoring on both banks.

The safety support must be at least 6 feet wide in the lateral direction of the bridge.

## JUDGING

The host will recruit judges. Judges have full authority over conduct of the competition and interpretation of ambiguities in the rules. Judges are empowered to halt any activity that they deem to be hazardous. Decisions, scoring and rating are the sole responsibility of the judges and will be final.

## TIPS FOR COMPETITORS

1. Strive for challenging but realistic goals for design and construction. The following statistics from the 1994 National Steel Bridge-Building Competition suggest the levels of performance that are possible. However, when reviewing these statistics keep in mind that the rules and scoring for 1995 differ from those for 1994.

| | Winning bridge in category | Winning bridge, overall |
|---|---|---|
| Weight (lb) | 84.5 | 117 |
| Construction time (person-minutes) | 10.28 | 28.60 |
| Incremental vertical deflection (inches) | 0.195 | 0.227 |

2. Start work on the design early, leaving adequate time to procure materials, fabricate the bridge, load test it and practice construction.

3. Design a bridge that may be fabricated, erected and load tested safely.

4. Design a bridge that may be fabricated with available materials, tools and facilities.

5. Allow tolerances for the decking to be slightly larger or smaller than specified. Provide adequate clearances so that the decking may be installed anywhere on the span.

6. When fabricating your bridge, use safe tools, operate them carefully and with adequate supervision.

7. When load testing your bridge before the competition keep it as low to the ground as possible and place safety supports a few inches below the bridge at intervals along the span. This will prevent injury and limit damage to the bridge if it collapses. Keep hands and feet out from under the bridge.

8. Make sure that abutments, safety supports and temporary shoring are strong enough (with a generous factor of safety) and will not tip during construction practice or if the bridge collapses during load testing.

9. Follow all safety regulations and guidelines during construction practice.

10. Don't stand, sit or lie on your bridge unless a safety support and temporary shoring are in place.

11. To expedite the competition have a preset plan for unloading and staging components of your bridge. Before the competition adjust your temporary shoring to conform to the height of the host's abutments. Know in advance the required elevation of the safety support.

## SCORE SHEET

### Penalties for Accidents

Builder touches river or safety support ($50,000 each) $_____

Part touches river, bank, road or safety support ($20,000 each) $_____

Tool or fastener dropped in river, on bank or road ($1000 each) $_____

TOTAL PENALTIES $_____

### Construction Time

_____ builders x _____ min = _____ person-min

### Total Weight

_____ pounds

### Aesthetics

Items that may be considered:

| | |
|---|---|
| General appearance | Balance and proportion |
| Finish | Elegance of connections |
| Construction organization | Teamwork |

AESTHETICS SCORE _____

**Deflection** (incremental vertical, test 3) _____ inches

## Efficiency

Total weight (lb) _____ / 100 = _____

Incremental vert. deflect. (in) _____ / 0.02 = +_____

SNWD (add) _____

## Cost

Temporary Shoring: $10,000 if used $_____

Const. Time _____ x $5000 = +$_____

Weight _____ x $1000 = +$_____

Total Penalties +$_____

TOTAL COST (add) $_____

## Rank

Construction Speed _____ Efficiency _____

Lightness _____ Economy _____

Stiffness _____ Aesthetics _____

**Overall Performance** (Efficiency + Economy) = _____

Use aesthetics as tie breaker