

TEXAS TRANSPORTATION INSTITUTE
TEXAS A&M RESEARCH FOUNDATION

TECHNICAL MEMORANDUM 605-5

FABRICATION AND CONSTRUCTION
SAFETY PROVISIONS FOR SUPPORT STRUCTURES
ON OVERHEAD SIGN BRIDGES

By

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December 1969

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INTRODUCTION

In order to conduct the full-scale physical testing which was considered necessary to verify the "break-away" design, a prototype overhead sign bridge was constructed at the Texas A & M Research Annex, Texas A & M University. This sign bridge is shown in Figure 1.

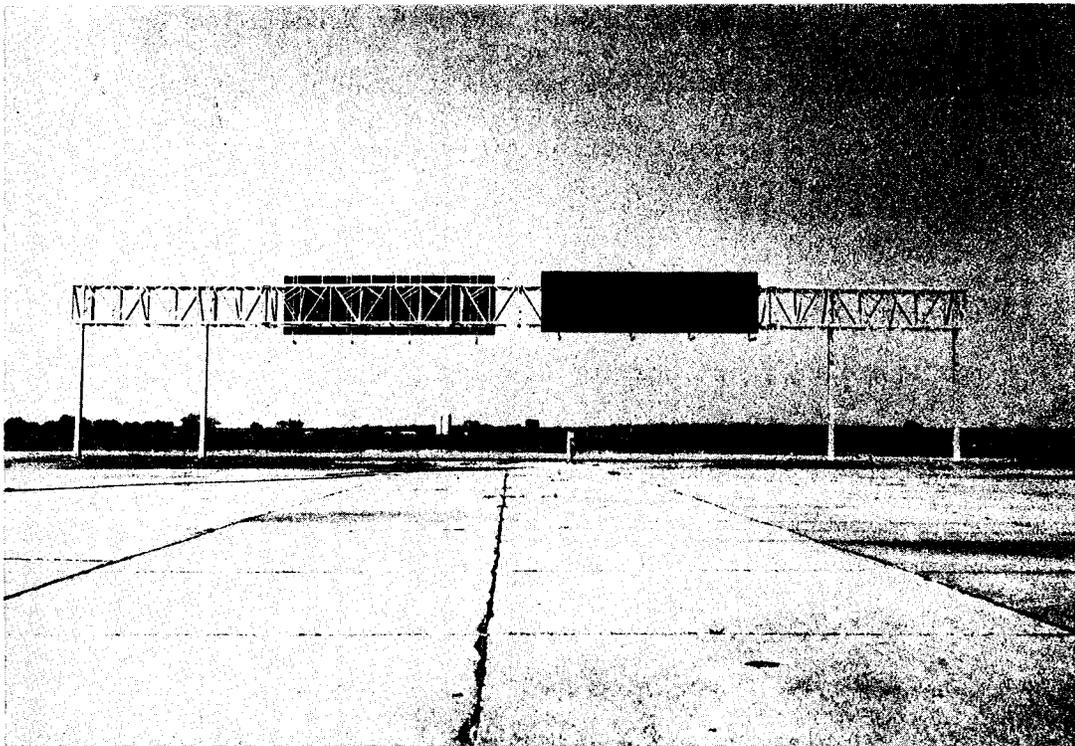


Figure 1, Overhead Sign Bridge - Break-Away Design.

The sign bridge structure has an overall length of 140 feet and is supported by four tapered column legs with the two outside legs twenty feet apart. Depth and width of the truss are six feet with approximately twenty feet clearance between the bottom of the truss and the ground. Two standard information signs were placed on opposite sides of the truss. These signs were 9'-6" high by 34'-2" long with an area of 325 square feet each.

Cost of the entire sign bridge including foundations and erection was \$18,500. An additional \$424 was spent for sign brackets and \$1,300 for fabrication and erection of the two information signs; the total cost was \$20,224.

CONTRACTS

Plans and specifications for bidding purposes on the project were sent to six firms proficient in the overhead sign bridge field who were approved for construction on state highway projects in the State of Texas. Of these six contractors, one submitted a bid, three declined to bid, and two did not respond. The three contractors who declined to bid did so mainly on the basis of their inexperience in welding the strength steel (100,000 psi) specified for the truss legs. The successful bidder does approximately 95% of the steel overhead sign bridge work in the State of Texas. The bid of \$18,500 by Riverside Industries, Incorporated of Fort Worth, Texas was considered an excellent bid since project personnel had anticipated that fabrication of the truss and legs alone would cost at least that much. As stated previously, the bid price included foundation, construction, and erection.

A contract for the foundations, complete steel structure in place, and sign brackets was awarded to Riverside Industries, Incorporated on April 29, 1969 with sixty (60) days required for completion of the project. There was a total of three bids for the fabrication and erection of the two signs. Bid prices varied from \$2,252 to a low of \$1,300. On the basis of a low bid of \$1,300, the signs were fabricated in the sign shop of District No. 17, Texas Highway Department, Bryan, Texas.

FABRICATION

Because of available facilities and previous experience in welding ASTM A-514 steel, the tapered column legs were fabricated in the Tulsa, Oklahoma plant of the fabricator. This plant has been welding high strength steel used in pressure vessels for about a year.

Only minor changes and substitutions were made relative to the original plans and specifications.* The fabricator initially chose to galvanize the complete structure but because of the development of a warping problem on the first leg during welding, he requested that painting of the legs be allowed. This request was granted because maximum interpass temperature** was 300°F for welding the legs and galvanizing is done at 850°F. The possibility of additional warpage during galvanizing was the reason for the request.

* See Appendix B for "Specifications-Prototype Overhead Sign Bridge with Break-Away Columns".

** See Appendix C for "Shop Procedure for Fabrication and Welding of High Strength Low Allow, Break-Away Overhead Sign Columns".

The original intention was to use ASTM A-514 Type F steel for the legs and the welding procedure was written on this basis. When it was found that Type F plate had a 60-day delivery, the fabricator's request to use Type A was granted and the welding procedure rewritten and approved.

Other minor specification changes were made relative to bolts and the stainless steel pin sleeves for the legs.

An experiment was conducted at the Tulsa plant in an effort to remove the 7/16" camber of the first leg which was fabricated. After heating failed to get the camber down to the allowable 5/16", dry ice in slabs 1" thick and the width of the flange was placed on the flange. The dry ice was covered and the camber changed from the plus (+) 7/16" to a minus (-) 3/16". However, the leg returned to its initial (+) 7/16" camber when the dry ice was removed. It was necessary to load the column with a 200-ton jack to force the camber to that allowed by the specifications. It was found that the established procedure for alternating welding beads was not followed in the shop on the first column. Adherence to this procedure on the remaining three columns eliminated the camber problem.

A suggestion was made by Riverside personnel that the tapered columns could be fabricated by cutting the web of a wide flange section, reversing one piece, and making only one weld to rejoin the web (Appendix A - Figure 2). Actually, this possibility was considered by the design section personnel for the project, but not carried through because a wide flange section in high strength steel with the desired web and flange dimensions was not available. However, after full-scale testing and analysis, it is possible the design can be changed and a modified wide flange section

used.

Slower welding speeds were required in welding the A-514 steel. The fabricator felt that only their most qualified craftsmen should do the job. Both of these factors increased the cost. The following table shows a rough comparison between the welding of A-36 steel and A-514 material.

	A-514	A-36
Welding Speed	13"-15"/min	18"-22"/min
Amperes	200 amps	400 amps
Rod Deposited	2' to 3'/min	3' to 4'/min
Rod Size	1/8"	3/16"
Number of Passes	2	1

Table 1

The fabricator feels that plant environmental conditions such as temperature and humidity must be controlled to a greater degree when welding high strength steel. Also, about 1/16" must be ground off of a torch cut piece of an A-514 before it can be welded. This is a time-consuming process due to the toughness of the metal.

Shop inspection during fabrication and fit-up was done by the Materials and Test Division (D-9), Texas Highway Department, Austin, Texas.

FOUNDATIONS

Plans for the project have not been made a part of this report because of their size and volume. The foundation consisted of two 30" drilled shafts with 60" bells joined by a 3' by 12'-2" beam for each leg. The drilled shafts were 9' deep.

The foundation was constructed by Mica Construction Company of Wichita Falls, Texas under a subcontract to Riverside Industries. No

major problems were encountered in the field during construction and all concrete test cylinders exceeded the 28-day 3,000 psi strength requirement.

The foundation has three bolt patterns instead of the one required for the single column leg in this program. Since many existing overhead sign bridge structures have two-column legs for support, it was decided to construct the foundation so that a two-column leg could be tested at some future date, if desired. (Appendix A, Figure 4, Photograph No. 2).

Close attention to dimensional accuracy by field engineers during construction and the cooperation of the contractor in obtaining a high degree of quality workmanship resulted in a foundation that minimized erection problems.

ERECTION

The 140' truss was delivered to the job site in three sections, the two end segments were 60' and the middle segment 20' in length. The truss was assembled on the ground and the four legs installed while the truss was on its side (Appendix A, Figure 5, Photograph No. 1). Because of the close tolerances at the pin connections (Appendix A, Figure 5, Photograph No. 4), this assembly sequence was used rather than erecting the four legs and then hoisting the complete truss into place on the legs.

The total assembly was raised into position with two 35-ton motor cranes as shown in Appendix A, Figure 6, Photograph No. 3. No problems were encountered and a minimum of wedging was necessary to get the hanging legs into position for bolting to the stub base plates.

DISCUSSION

Because of the unusual design of this structure and the use of high

strength steels, a trip was made by the author to the Fort Worth, Texas and Tulsa, Oklahoma plants of the fabricator to gather information from personnel of Riverside Industries prior to writing this report. Discussion with the two Texas Highway Department inspectors who followed the progress of the job during fabrication also yielded some excellent information.

Riverside Industries stated that they bid the job figuring \$10,000 for the truss, \$5,000 for the legs, and the balance of \$3,500 for foundation, construction, and erection. After encountering the problems associated with welding the high strength steel legs, they indicated they would bid a similar overhead sign bridge of this type at \$10,000 for the truss, \$6,500 for column fabrication, and the same \$3,500 for foundations and erection.

It is the opinion of the chief engineer of Riverside's Tulsa plant that the weld thickness used on the columns may be reduced by as much as one-half and still be adequate.

The possibility that most highway departments would want a completely galvanized structure led the Texas Highway Department inspectors to recommend that some experimenting be done with trial galvanizing of tapered column legs made from the high strength steels.

CONCLUSIONS

- A. Foundations -- No significant problems were encountered in foundation construction. Stub base plates were set to proper elevation by use of a target rod in an attempt to get their elevation to within 0.001 of a foot. Some provision should be made to drain the three wells in each foundation to prevent

standing water or the accumulation of water.

- B. Fabrication -- After encountering a small camber problem in fabricating the first leg, all subsequent legs were successfully fabricated to meet the specifications.
- C. Erection -- The methods used in erection were most satisfactory and no problems were encountered.

APPENDIX A

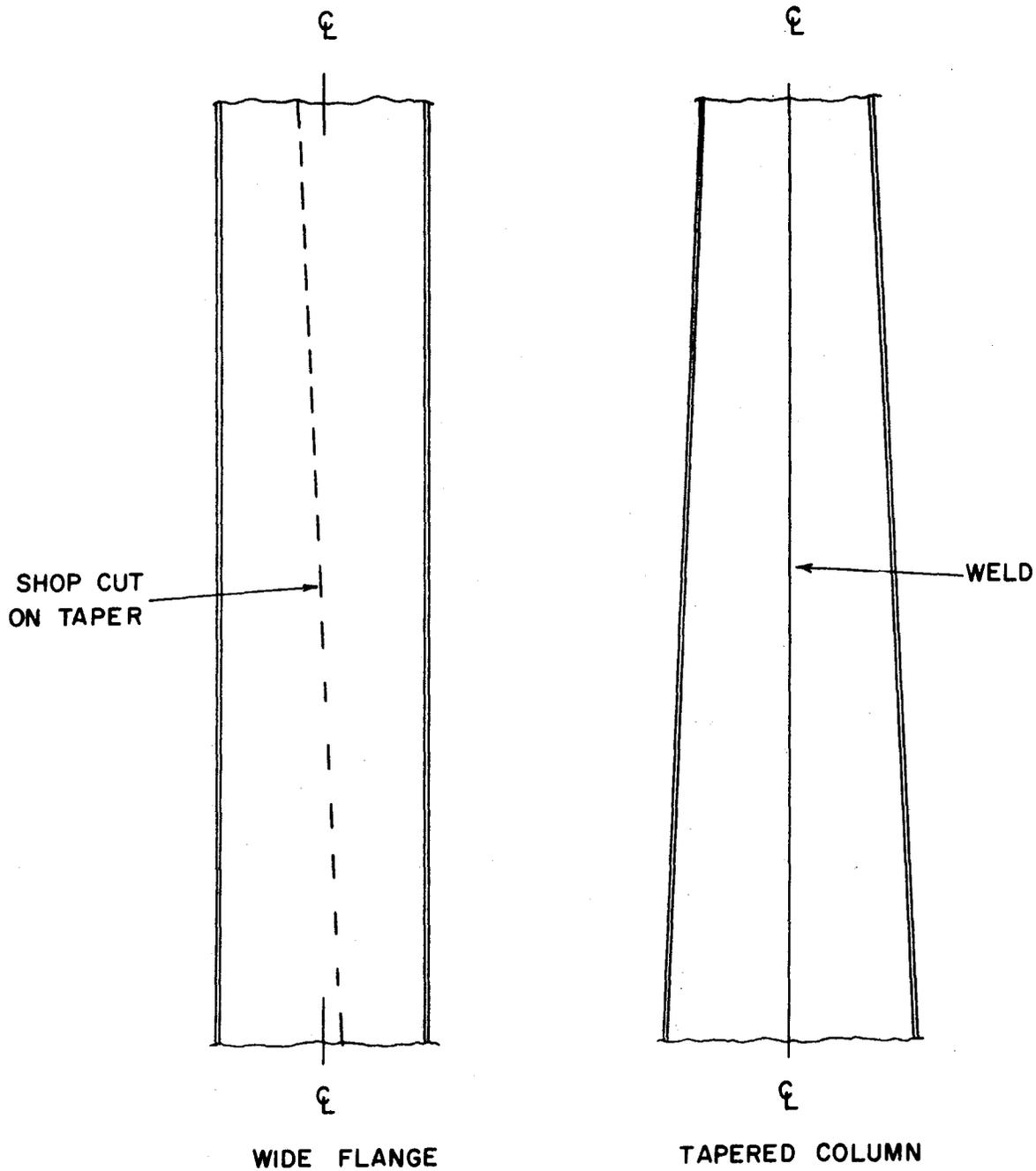
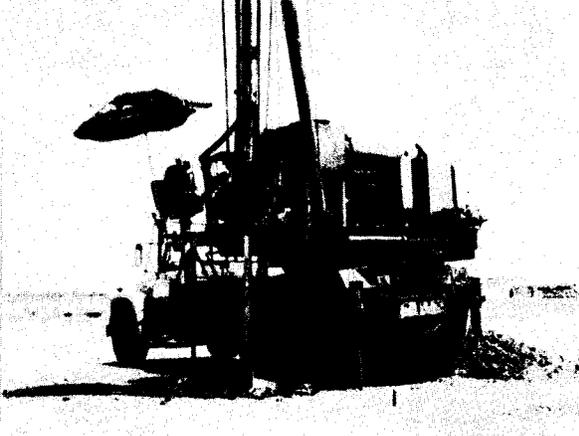
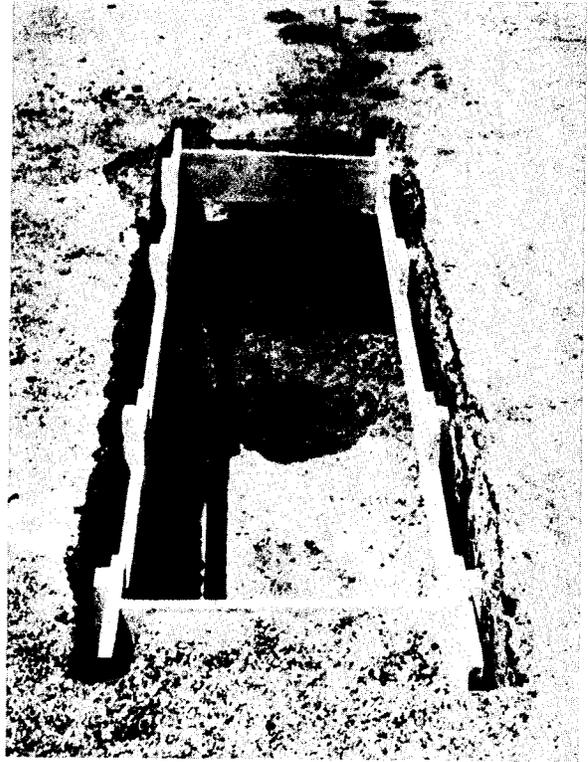


FIGURE 2, POSSIBLE METHOD FOR FABRICATING TAPERED COLUMN.



1.



2.



3.

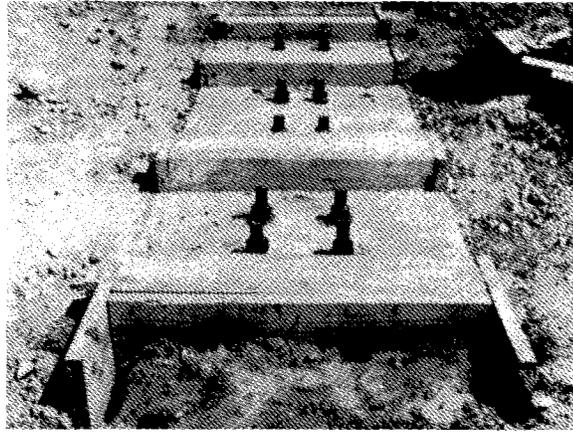


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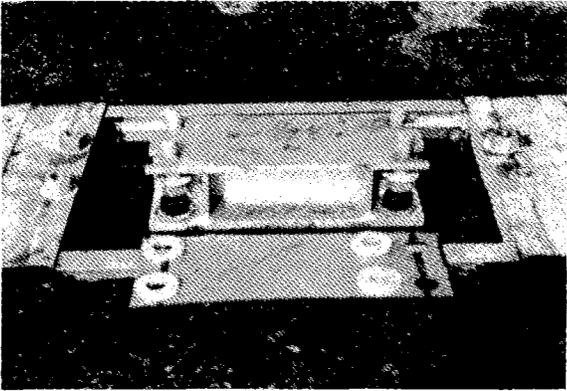
Figure 3, Excavation and Bolt Details.



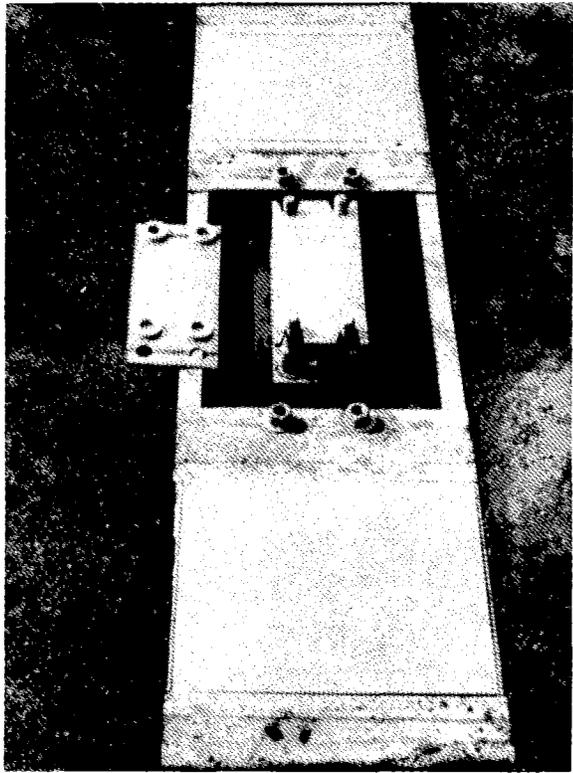
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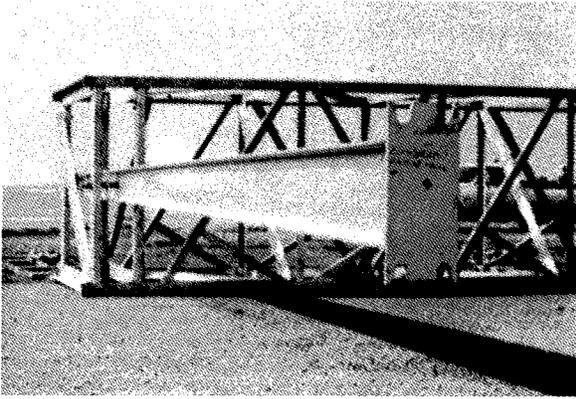


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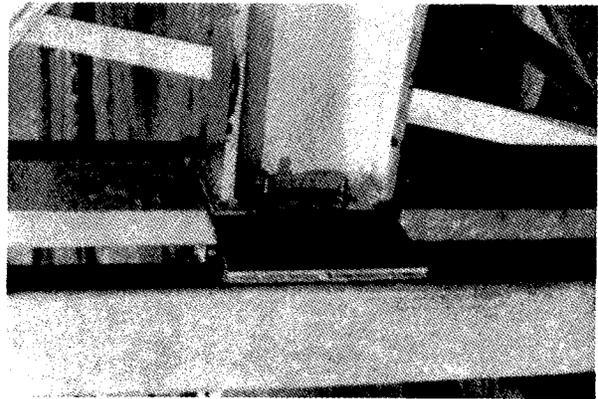


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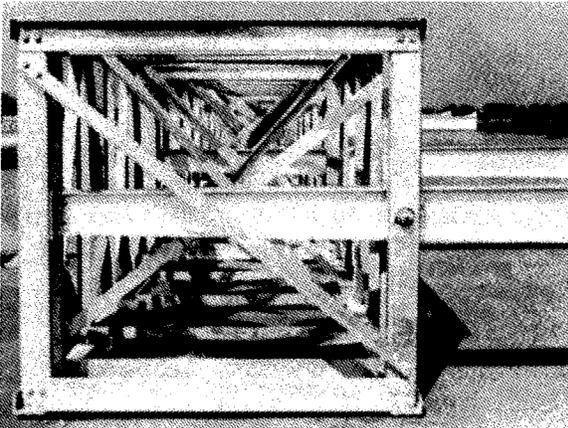
Figure 4, Foundation and Base Plate Details.



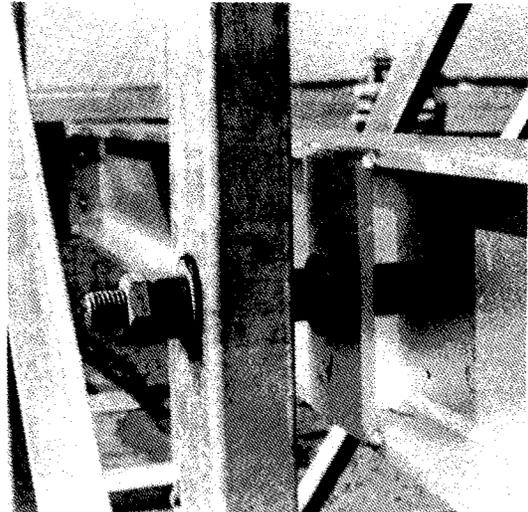
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2.

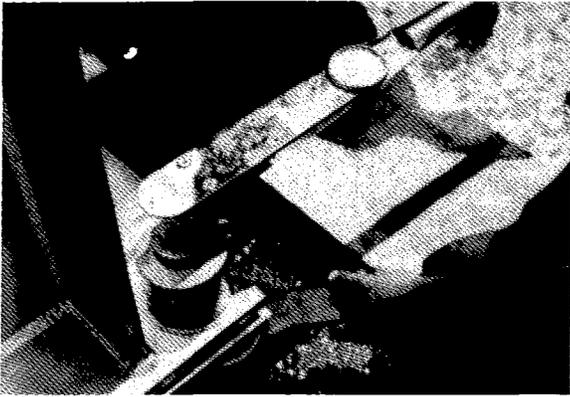


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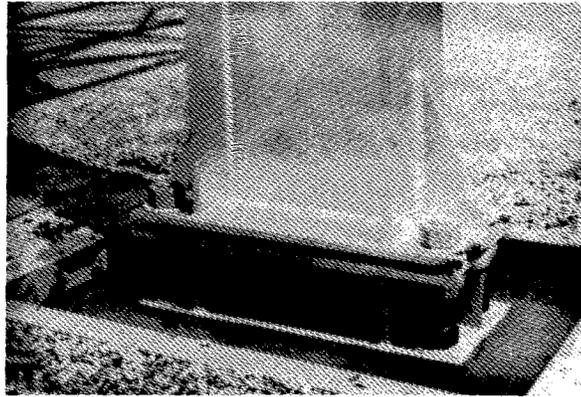


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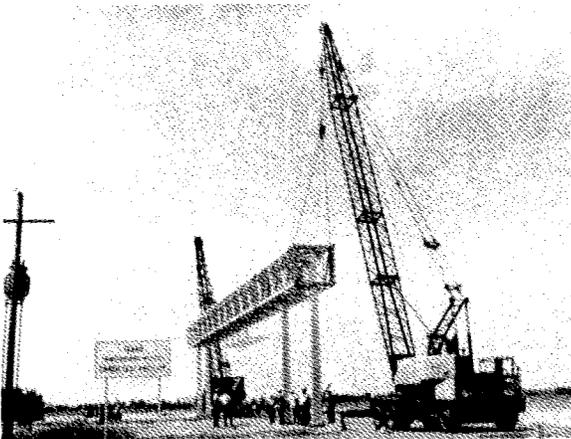
Figure 5, Truss and Column Pin & Bolt Detail.



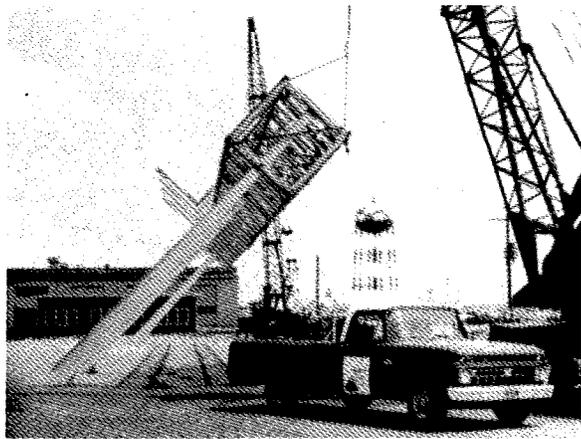
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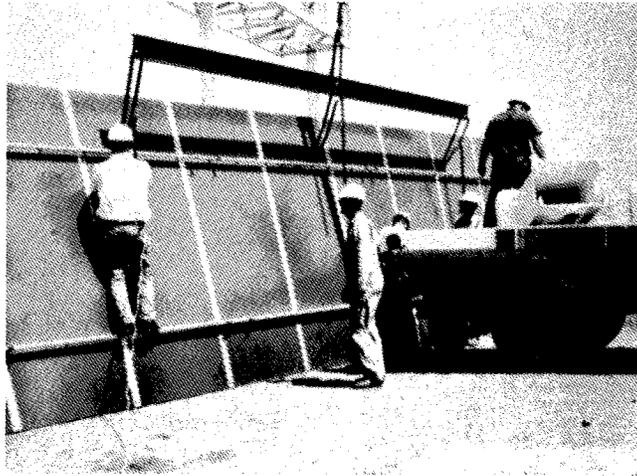


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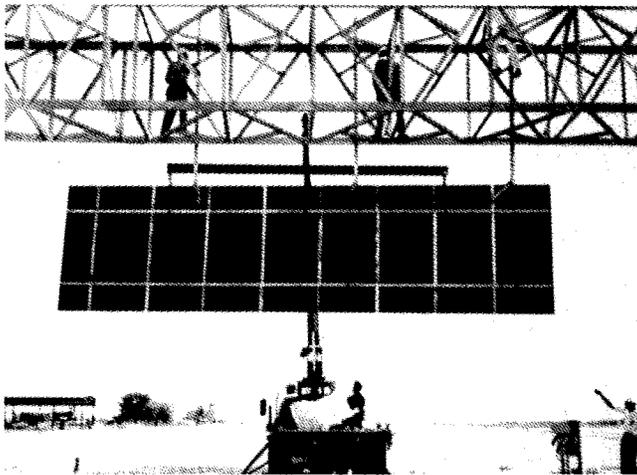


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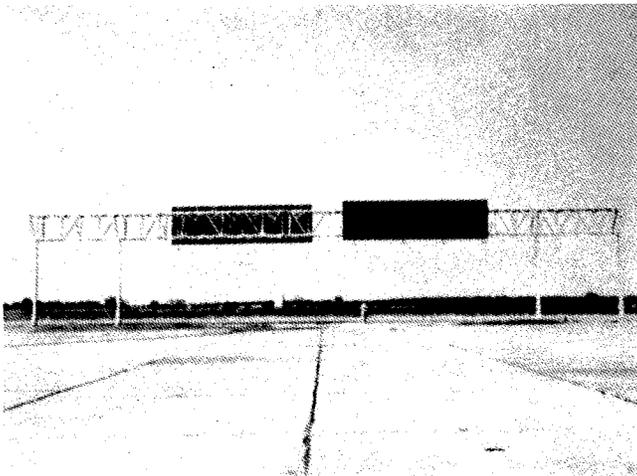
Figure 6, Erection of Truss.



1.



2.



3.

Figure 7, Sign Erection and Completed Structure.

APPENDIX B

TEXAS A&M UNIVERSITY RESEARCH FOUNDATION

TEXAS TRANSPORTATION INSTITUTE

SPECIFICATIONS

PROTOTYPE OVERHEAD SIGN BRIDGE WITH BREAK-AWAY COLUMNS

1. Description of Work. This specification covers the fabrication, delivery, construction of foundations, and erection of a steel Prototype Overhead Sign Bridge with Break-Away Columns. The sign structure is to be erected at the Texas A&M University Research Annex located on Texas State Highway 21 approximately 12 miles west of College Station and Bryan, Texas. All work shall conform to the current edition of the Texas Highway Department (THD) Standard Specifications for Road and Bridge Construction, except as noted herein.
2. Engineer. Mr. Charles J. Keese, Director of the Texas Transportation Institute, or his authorized representatives.
3. Shop Detail Drawings. The Contractor shall submit six (6) complete sets of the shop drawings to the Engineer for review not later than ten (10) working days after the award of the contract. The Contractor shall be responsible for the accuracy of the drawings. The drawings shall include welding procedures for the break-away columns and its components which are to be fabricated from a high strength low-alloy structural steel. A welding procedure for the truss will not be required.
4. Inspection. Inspection during shop fabrication will be performed by personnel from the Texas Highway Department, Materials and Tests Division (D-9), Austin, Texas. Inspection during field construction of the foundations and erection will be performed by personnel of Texas A&M University Research Foundation as designated by the Engineer.
5. Materials. The various materials to be used in fabrication of the truss, break-away columns and foundation shall conform to the specifications of ASTM as listed in the table on page 17 of these specifications.

ITEM	MATERIAL	ASTM DESIGNATION
Truss	Structural steel	A36
Column and break-away components	High strength low-alloy structural steel	A514
Column pivot pin	Stainless steel	A276
Pivot pin sleeves	Seamless stainless steel	A312
*Truss and foundation bolts, nuts and washers	High strength steel	A325
*Column slip base and foundation bolts, nuts and washers	High strength steel	A490
Column upper failure connection bolts, nuts and washers	Steel	A307
Foundation bar reinforcement	Steel	A15
Foundation bolt sleeves	High strength steel	A193

* Bolts and nuts, if not readily available, may be made from a high strength steel acceptable to the Engineer. For example, an acceptable strength steel would be AISI 4140 (lead), which conforms to the specifications of ASTM A193.

6. Shop Fabrication and Assembly of Truss. The truss shall be fabricated in four 30-foot sections and one 20 foot section, as shown on the plans.

The bolted diagonal angle members in the two side panels shall be oriented in the same direction. Also, the welded diagonal angle

members in the top and bottom panels shall be oriented in the same direction. The five truss sections shall be assembled in full length and supported by blocks of the same elevation at the four column supports in the shop before reaming or drilling of the field splice bolt holes is commenced. The camber shall be sufficient to maintain the truss between the column supports at a level height. Match-marks shall be stamped in the metal.

7. Shop Fabrication of Columns. Prior to commencing fabrication of the break-away columns and its components, procedure fillet-weld qualification tests shall be conducted, in the presence of the Inspector, in accordance with the latest edition of AWS Standard Specifications for Welded Highway Bridges and the THD Bulletin C-5. This requirement may be waived by the Engineer in consideration of previously conducted tests.

Shielded Metal-Arc (Manual-Arc) welding shall be done by certified welders that have been qualified in a horizontal fillet weld position using low hydrogen electrodes on a high strength low-alloy structural steel conforming to A514.

Evidence of welder and procedure qualification tests shall be submitted to the Engineer for review.

Welding shall be subject to nondestructive testing by the Inspector. Such testing will be performed without charge to the Contractor.

8. Protective Coating of Truss and Column Surfaces. At the option of the Contractor, the surfaces of the truss and column members shall be painted or galvanized. Painting shall consist of applying a No. 700 shop coat and a 701 field coat.
9. Field Construction of Foundations. The position and grade of the four foundations will be established by the Engineer.
10. Erection. The columns shall be erected to a true vertical position. The elevation of the column break-away slip bases shall be established by the Engineer. The slip base bolts shall then be tightened to the specified torque shown on the plans.

Springing or raking of the erected columns will not be permitted in the connection of the truss to the columns. The truss-column connection bolts shall be *SNUG-TIGHT*, as shown on the plans.

11. Workmanship. Workmanship and finish shall be acceptable to the Engineer and equal to the best general practice in modern fabrication steel shops and field construction.

12. Measurement. The Prototype Overhead Sign Bridge with Break-Away Columns will be measured by the unit complete in place.

13. Payment. Payment for the Prototype Overhead Sign Bridge with Break-Away Columns shall be made at the lump-sum price in the bid. Payment shall include full compensation for furnishing all labor, materials, tools, equipment, and incidentals, and for doing all the work involved in fabrication, delivering, constructing footings and erecting the sign structure complete in place, as shown on the plans, and as specified in these specifications, and as directed by the Engineer.

APPENDIX C

APPENDIX C

PROPOSED

SHOP PROCEDURE FOR FABRICATION AND WELDING OF
HIGH STRENGTH LOW ALLOY, BREAK-AWAY OVERHEAD
SIGN COLUMNS

RIVERSIDE INDUSTRIES, INC.
Fort Worth, Texas Tulsa, Oklahoma

PROJECT 605 COUNTY _____

S.O. Ft. Worth F-1806
Tulsa 6835

GENERAL NOTES:

MATERIAL: ASTM A-514 Type A

All plates shall be cut to shape and dimensions shown on drawings plus sufficient length for fitting and trimming to require dimensions.

Fabrication shall conform to "THD Construction Bulletin C-5 Revised" and "AWS Standard Specifications for Welded Highway and Railway Bridges".

Welding procedure (Amps., Volts, IPM) shall be posted on welding machines during use on this project.

Fused flux shall not be removed, except for inspection areas, until deposited weld metal and base metal has returned to room temperature or a maximum of 100°F, whichever is higher. No welding shall be performed when the ambient temperature is 20°F or below.

WELDING EQUIPMENT:

Manual

Lincoln - SAE 400 AMP - 40 Volts

Automatic

Lincoln - SAE 600 AMP - 40 Volts

Lincoln - LAF2

WIRE: (Manual)

Make: Lincoln
Number: LH110
Size: 1/8"

WIRE: (Automatic)

Make: Lincoln
Number: L61
Size: 1/8"

FLUX: A-0905X10

All electrodes should be charged at 500°F maximum and heated to 800°F, with electrodes placed no more than three layers deep on a tray. The electrodes should be immediately transferred to a storage or holding oven at 250° ± 25°F. All electrodes should be used within 30 minutes after removal from the storage oven.

Electrodes removed from the storage oven and exposed to a clean, dry location for times longer than that specified should be rebaked. Electrodes should not be baked more than twice.

Flux for submerged arc welding should be kept dry and if exposed to water, grease, or dirt should be discarded. Also, reclaimed flux that has been fused during welding should be discarded.

FIT-UP ASSEMBLY:

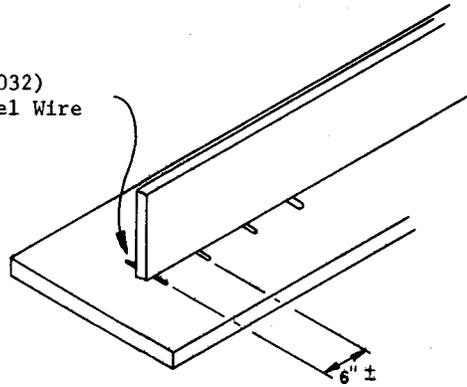
Areas of components to be welded shall be cleaned to bright metal to a minimum of 1 1/2 inches each side of each weld position prior to assembly. After cleaning, the components shall be properly fitted, allowing for run-off tabs (Extension bars), and tack welded, using LH 110 Rods.

WELDING PROCEDURE:

MANUAL SHIELDING METAL-ARC PROCESS

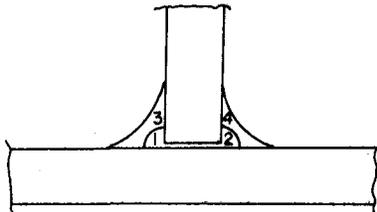
Preheat and interpass temperatures shall be restricted to an area as narrow as possible consistent with accomplishing sound welds and shall be maintained during the welding process. When the welding is interrupted for a period of time, it shall not be restarted

20 Ga (.032)
Soft Steel Wire



JOINT ASSEMBLY DETAIL

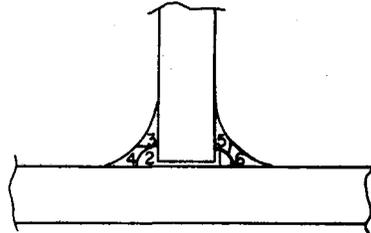
Automatic Submerged-Arc Process



Stick-Out = 1-1/2"

Pass Number	Wire Dia. In.	Volts	Amperes	Arc-Travel Speed, 1 PM
1	1/8	22-26	375-450	15-20
2	1/8	22-26	375-450	15-20
3-4	1/8	24-26	400-450	15-20
Joint Preparation-Gas Cut & Grind to Remove				
Joint Restraint		Moderately High Scale		
Wire-Flux Comb.		Lincoln L61 Wire Lincoln A-0905x10 Flux		
Position		Flat		
Welding Current		DC		
Preheat Temp.		200° / 25° F.		
Interpass Temp.		200° / 25° F.		
Root Preparation		Grind to Sound Metal		
Welder Technique		Stringer Bead		

Manual Shielded Metal-Arc Process



Pass Number	Electrode Dia. In.	Volts	Amperes	Arc-Travel Speed-1PM
1	1/8	22-26	115-165	15-20
2	1/8	22-26	115-165	15-20
3-6	1/8	24-26	130-180	15-20
Joint Preparation-Gas Cut & Grind to Remove				
Joint Restraint		Moderately High Scale		
Electrode		Lincoln LH 110		
Position		Flat		
Welding Current		DC		
Preheat Temp.		300° / 25°		
Interpass Temp.		300° / 25°		
Root Preparation		Grind to Sound Metal		
Welder Technique		Stringer Bead		

until proper preheat temperature has been established.

The welder technique shall be the straight forward stringer. The weave method shall not be used. Back Step Technique shall be used at Arc Starts. Before making subsequent passes, all flux and loose scale must be removed from the earlier bead.

The final passes shall be faired-in to surfaces of the base metal to eliminate sharp corners or under cuts. Contour of finish weld shall be relatively smooth and resemble the shape of the fillet in a rolled section.

Weld passes, as shown on page 3 shall be applied as follows:
#1, #2, #3, #4, #5 and #6

AUTOMATIC SUBMERGED-ARC PROCESS

Preheat and interpass temperatures, welder technique and final passes shall be same as above.

Weld passes, as shown on page 3 shall be applied as follows:
#1, #2, #4 and #3

