Final Report for
Project N8-97-1

REDUCTION/ELIMINATION of WELDED TEMPORARY ATTACHMENTS SURVEY AND LITERATURE SEARCH

Submitted to:

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November 3, 1998

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I. INTRODUCTION

The Marine Systems Division of the University of Michigan Transportation Research Institute (UMTRI) has been working with National Steel and Shipbuilding Company (NASSCO) to perform a literature search and survey of U.S. shipyards to support the project "Reduction/Elimination of Welded Temporary Attachments." Basically, UMTRI performed a thorough, but quick, literature search and survey of shipyards relative to welded and nonwelded temporary attachments.

II. LITERATURE AND INTERNET SURVEY

UMTRI has done extensive searches of numerous literature sources but has not found anything in the literature. It appears that rigging, welded and nonwelded temporary attachments are not a popular subject for those that publish technical papers.

The internet was a better source of practical information. Normal items like rigging sources, vacuum lifters, magnetic grabs, etc., were found. Appendix B lists some of these sources. Web sites and addresses are added (and may change) frequently, so more information is available if needed.

III. SHIPYARD VISITS

Al Horsmon conducted a tour of six (6) shipyards from 24-26 February. Appendix A is a photographic record of those visits. At the end of this appendix are more detailed descriptions of the items observed. Shipyards visited were:

- Ingalls Shipbuilding, Pascagoula, MS
- Alabama Shipyard, Mobile, AL
- Bender Shipbuilding, Mobile, AL
- Avondale Shipyard, Gulfport, MS
- Halter Marine, Gulfport, MS
- Avondale Shipyard, New Orleans, LA

Leon Woody, Steel Superintendent at Alabama Shipyard seemed the most proactive about nonwelded attachments. He showed a display of numerous grabs and jigs, and led a tour of the yard looking at others in use. Unfortunately, they did not have a lot of work in the yard at the time.

Mr. L.P. "Trip" Trepagnier at Avondale presented their *Yellow Tools Manual* which contains specifications, use instructions and drawings for nonwelded temporary attachments. A number of those tools were in use around the yard. Unfortunately, he could not secure the release of the manual for use in

the project. Perhaps having them review the draft final report could convince them there is something of value coming out of the report and they will let us reference the *Yellow Tools Manual.*

Pat Roberts of Bender showed a number of "buttonhook" attachments for staging. Additional comments on these and other attachments are in the "Analysis" section below.

However, most of the yards, even those with many innovative tools, showed many of the standard welded temporary attachments. A brief report was given to the SP-8 Panel meeting in La Jolla, CA (San Diego area) and is attached as Appendix C.

IV ANALYSIS

The philosophy behind the nonwelded temporary attachments in use in many of the yards could be applied to more uses and other attachments in shipyards. For example, (referring to Appendix A) the welded lugs used in Photo 4 could easily be replaced by an arrangement used to hold the round sections together in Photo 31. A combination of a chain extending from the top of the house section through the opening for the ladder at the lower left side of the photo could exert adequate force to hold the units together.

The alternative methods for holding the edges of two units together are shown in Photo 12. The stud welded attachments are easier to apply and cause less damage to the underlying structure when removed. The buttonhook staging (photos 16 through 20) follows this idea, but Photo 25 shows this concept taken a step further by avoiding welding all together. These are basic concepts that need to become standard work practice on the shop floor through regular training of the workers in that discipline.

The most difficult attachments to replace are the lifting and turning lugs shown as typical in Photos 1, 6, and 10. The safety and potential cost issues involved in dropping a large unit during handling have led to widespread use of these massive lugs. Alternatives discussed with some of the yards visited were:

- slings arranged in multiple layers to transfer the weight of a unit as it is turned
- adhesives to hold units or to act as anchors for wire slings
- dedicated turning stations that use clamps to hold units in a ring frame that then turns the unit over before it is set back on a transporter

A Marine Travelift (contact information is listed in Appendix B) uses multiple slings to lift and carry large yachts and commercial craft. Thus lifting and turning units with similar equipment, without welding lugs, is technically feasible, but a cost benefit analysis would have to be performed to see if it is economically feasible. Slings arranged with grabs and clamps to maintain control of a large steel unit as it is turned could be engineered.

Adhesives can generate up to 4,000 psi in lap shear. A pad arranged to place an adhesive in shear but provide a concentrated attachment for a hook is also technically feasible. A peel and stick picture hanger is a common practical example. A 20 in^2 pad could provide an attachment point to pull or hold 10 tons along the side of a unit with a safety factor of four. The pad would also have to be designed so that it could be peeled off for removal, as shown in Figure 1, because adhesives have much less strength in peel.

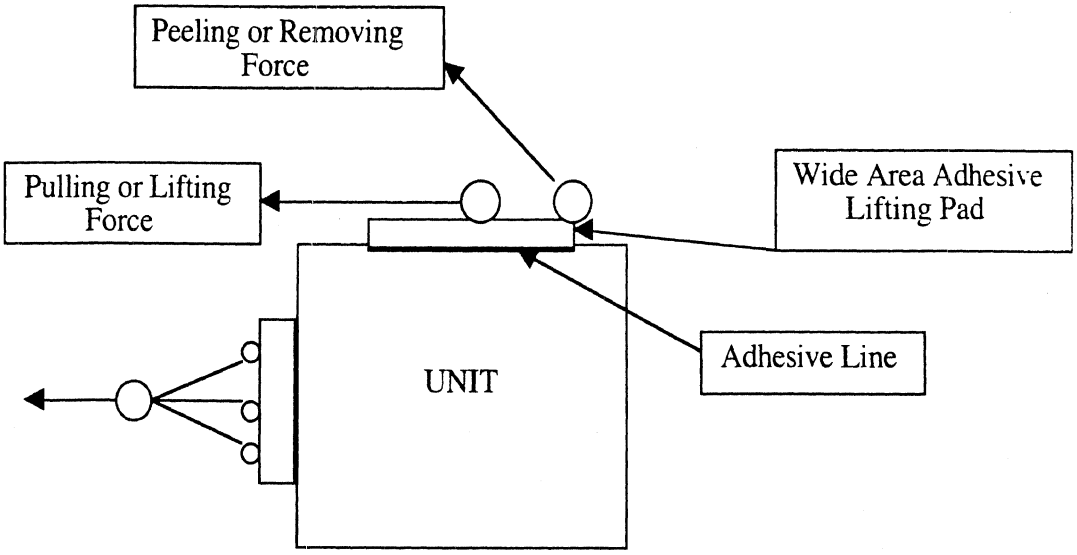

Figure 1

However, a steel surface would have to be blasted or ground clean to support very high strength adhesives. Paint systems have produced as little as 200 psi shear strength, so surface preparation would likely be necessary to support adhesive lifting pads.

Railroad bulk transfer facilities use rail car unloading stations that clamp pairs of 120 ton cars into a ring frame, then turn the cars completely over to dump the cargo out the top. A shipyard with an efficient transporter system could transport units to a dedicated turning station, designed with adjustable clamps to hold various configurations of similar sized units.

The following quote was taken from the mining web site:

"Strachan & Henshaw were responsible for the design, limited supply, installation, supervision and commissioning of this single cage triple car dumper at Qinhuangdao Port in China. The triple car dumper, one of two supplied by Strachan & Henshaw, forms part of a brand new fully integrated system to increase the port's export capacity by 30 million tons per year. The dumpers are capable of handling cars with a capacity of 73 tonnes, and an unloading rate of 90 cars per hour." (http://www.mining-technology.com/contractors/materials/strachan&henshaw/index.html#TEXT3)

Mark Miller of Strachan & Henshaw's Melbourne office stated that the base cost for such a unit is around $1.5 million, not including the rail interfaces. A shipyard could manufacture such a unit to Strachan & Henshaw's design. Figure 2 shows their bulk rail car dumper. A shipyard unit would require the capability

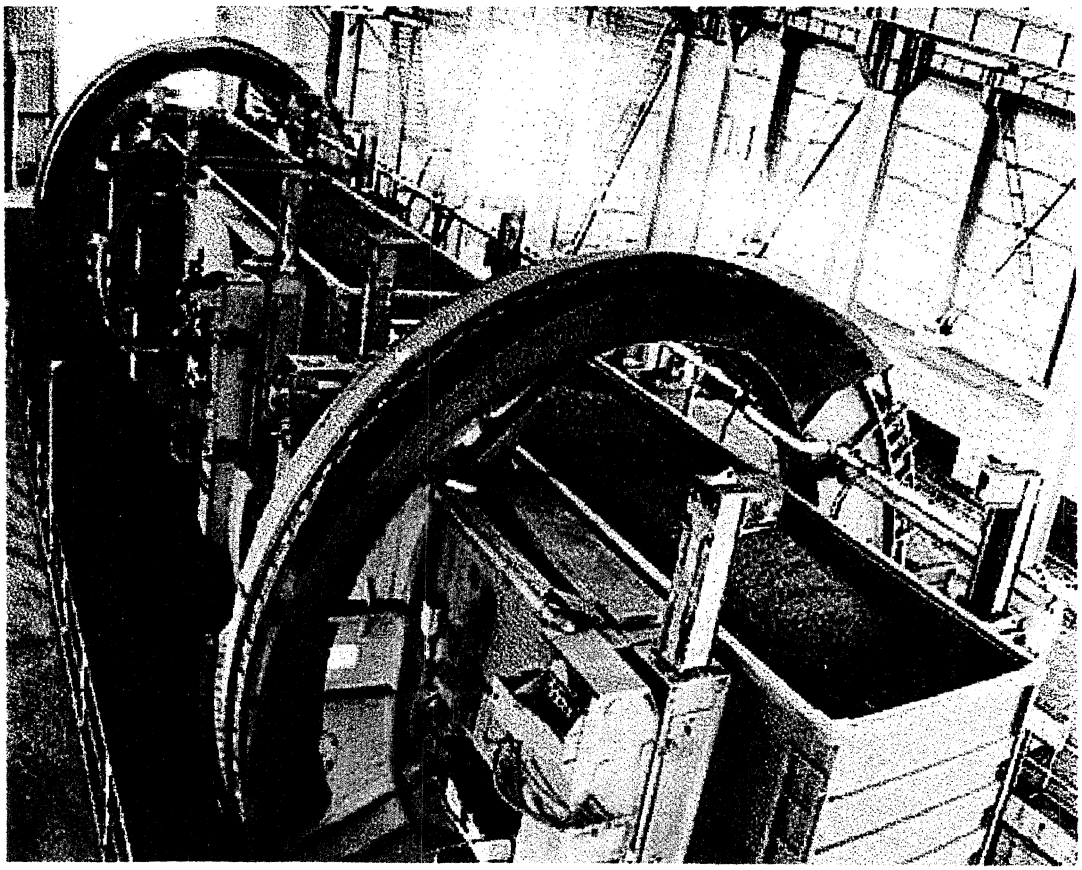

Figure 2. Single Cage Triple Car Dumper at Qinhuangdao Port."

Of handling various size and shape units, but would not need the agility to handle 90 units per hour, and so should cost much less.

The following information was found at the web site http://www.mining-technology.com/contractors/materials/elecon_materials/index.html#TEXT2. Elecon Engineering designed and built most of the rotary wagon tippler shown in Figure 3. See Appendix B for contact information.

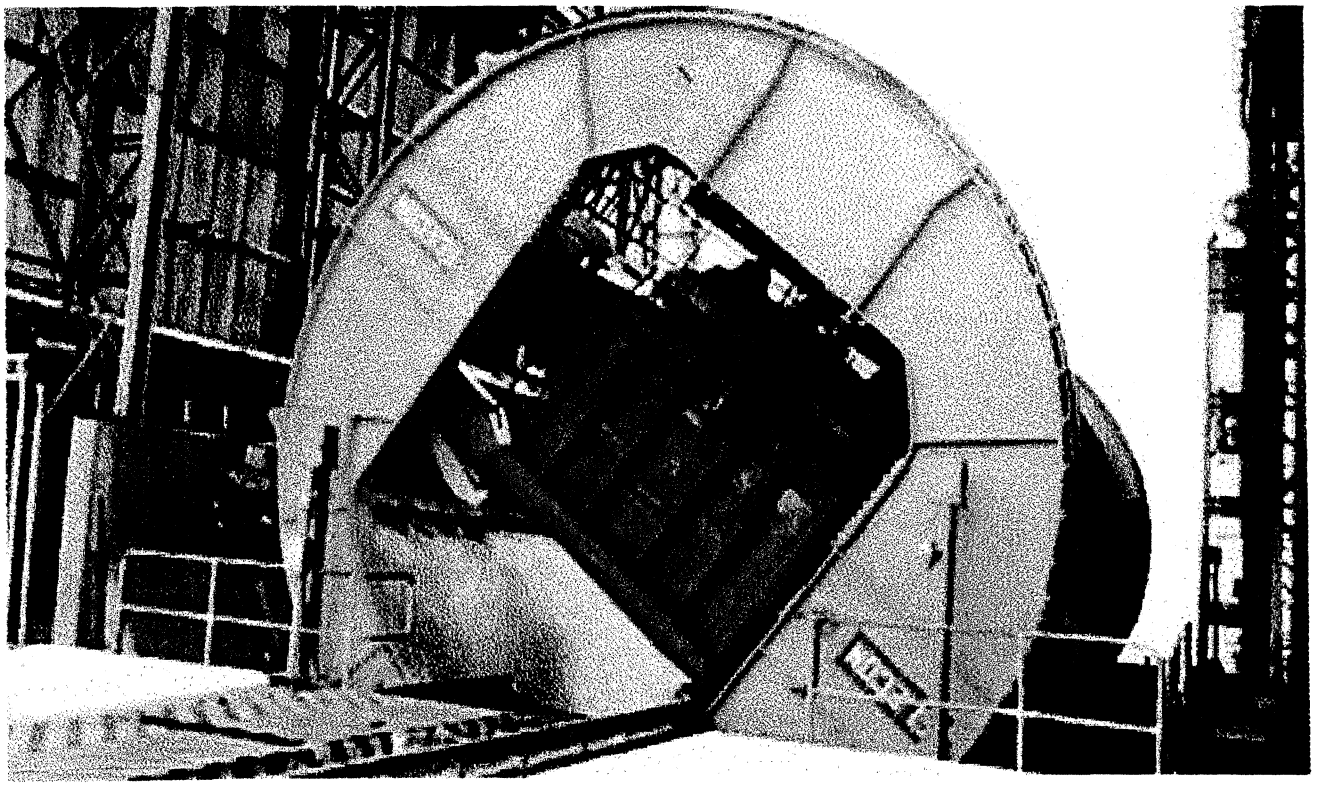

Figure 3. Rotary wagon tippler: Designed for unloading broad-gauge open rail wagons with a gross load up to 110 tons.

V. Recommendations and Future Work

Some of the concepts and items displayed in the photographs and discussed above should be investigated further for feasibility and cost effectiveness. The concepts used for small items, such as buttonhooks, could be applied for heavier requirements, such as ganged, stud-welded pins in place of lifting eyes. Properly engineered, adequate safety factors could be developed. The options identified in the report should be investigated further by NASSCO for feasibility, safety, cost and benefit.

APPENDIX A

PHOTOGRAPHS

Photo 1. Welded pad eye with added angle support and chafing guard around bottom plate.

Photo 2. Welded temporary supports of scrap metal.

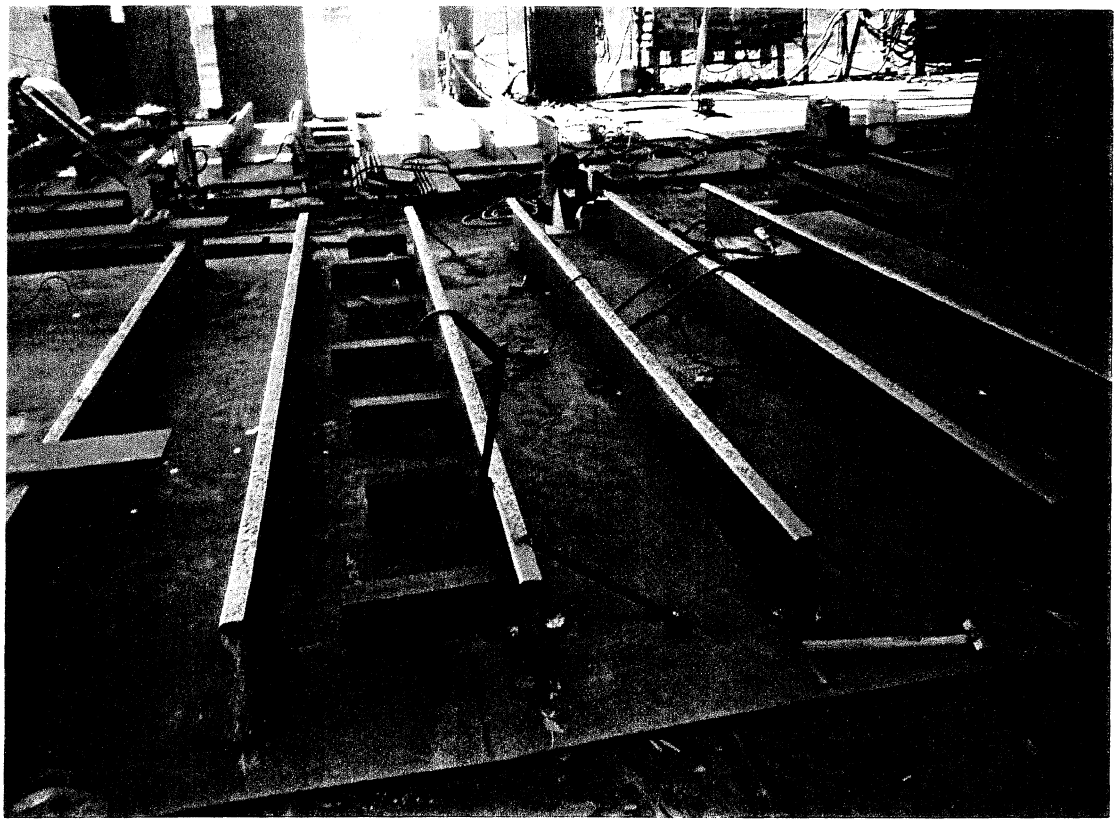

Photo 3. Welded butt joint strongbacks.

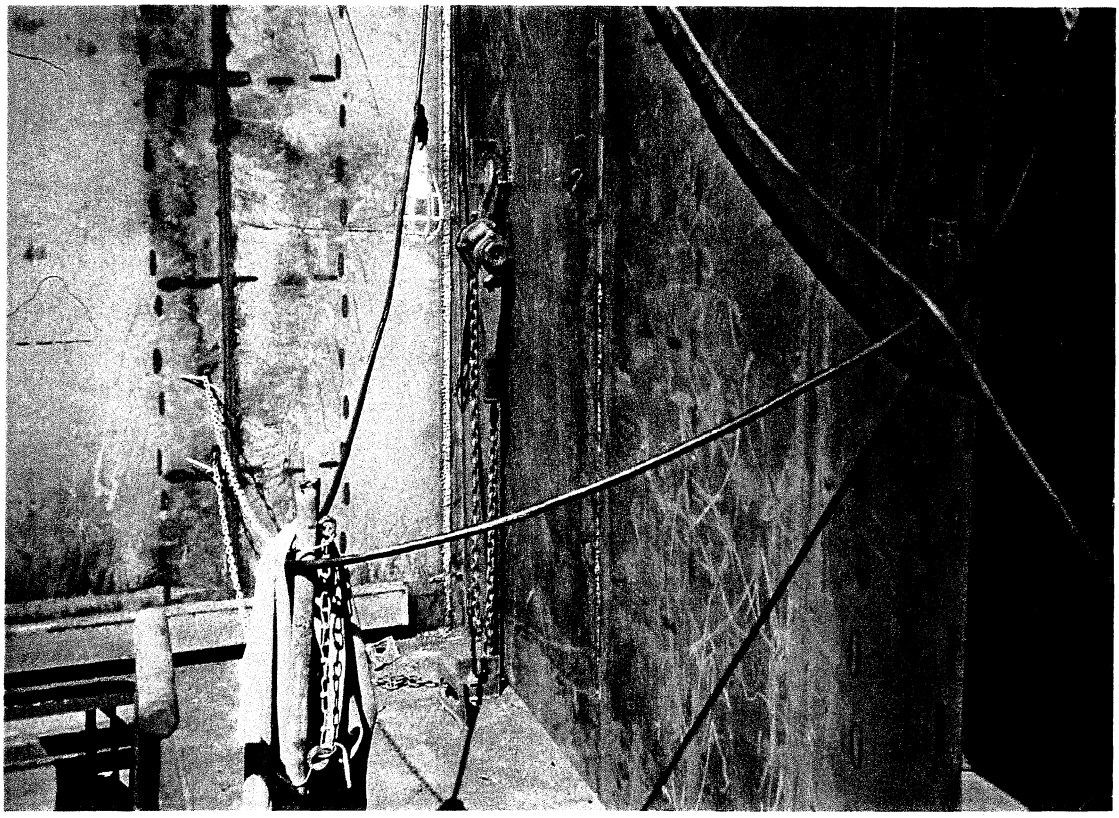

Photo 4. Welded lugs are used for the chain fall.

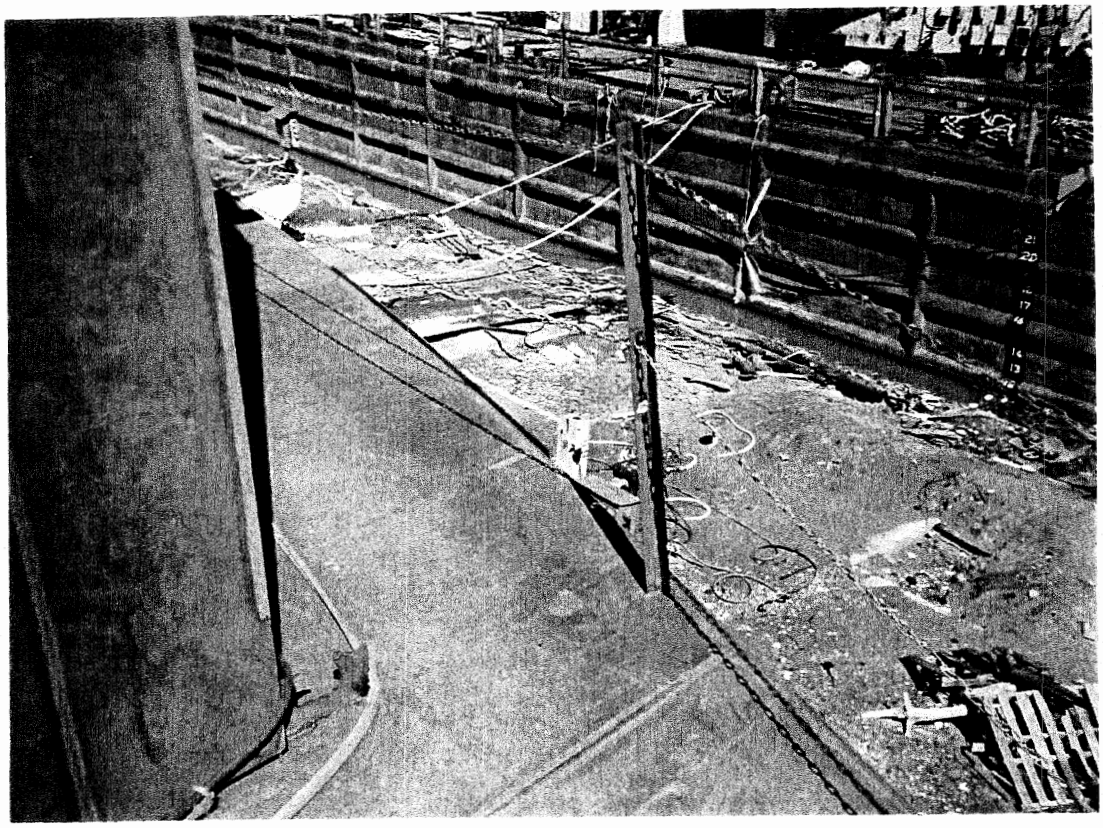

Photo 5. Welded temporary lifeline stanchion.

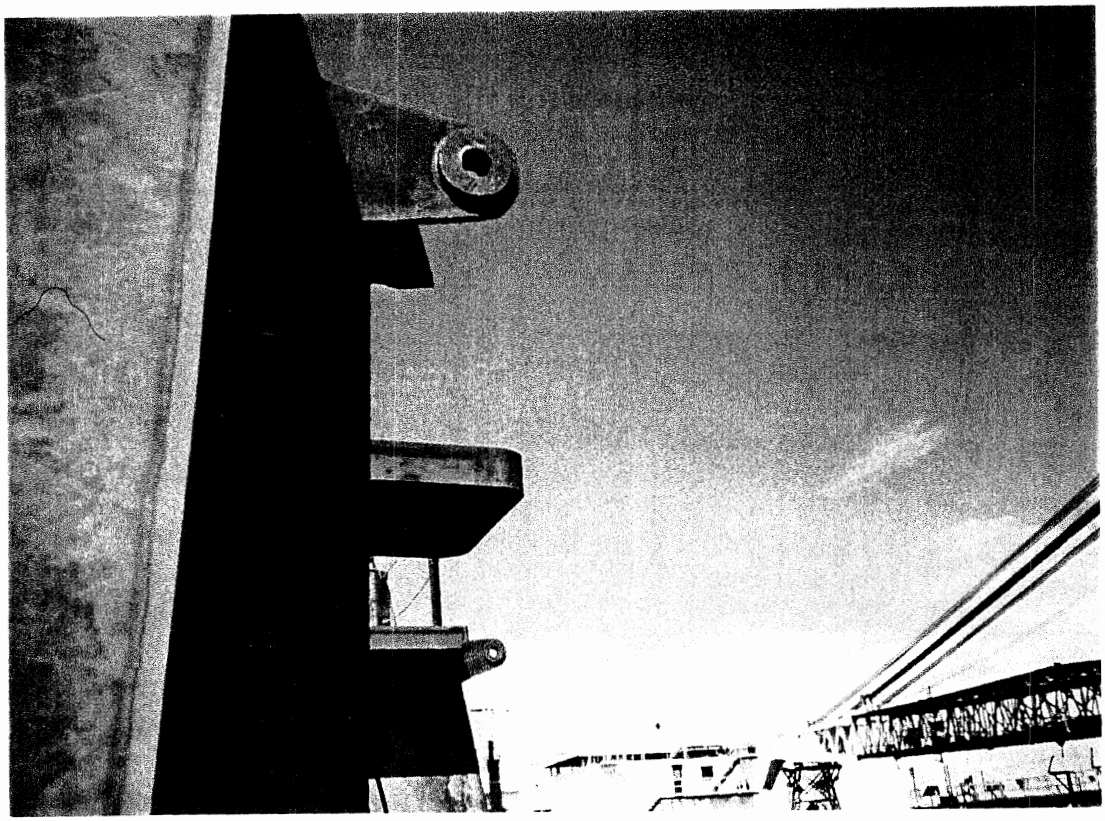

Photo 6. Welded pad eyes.

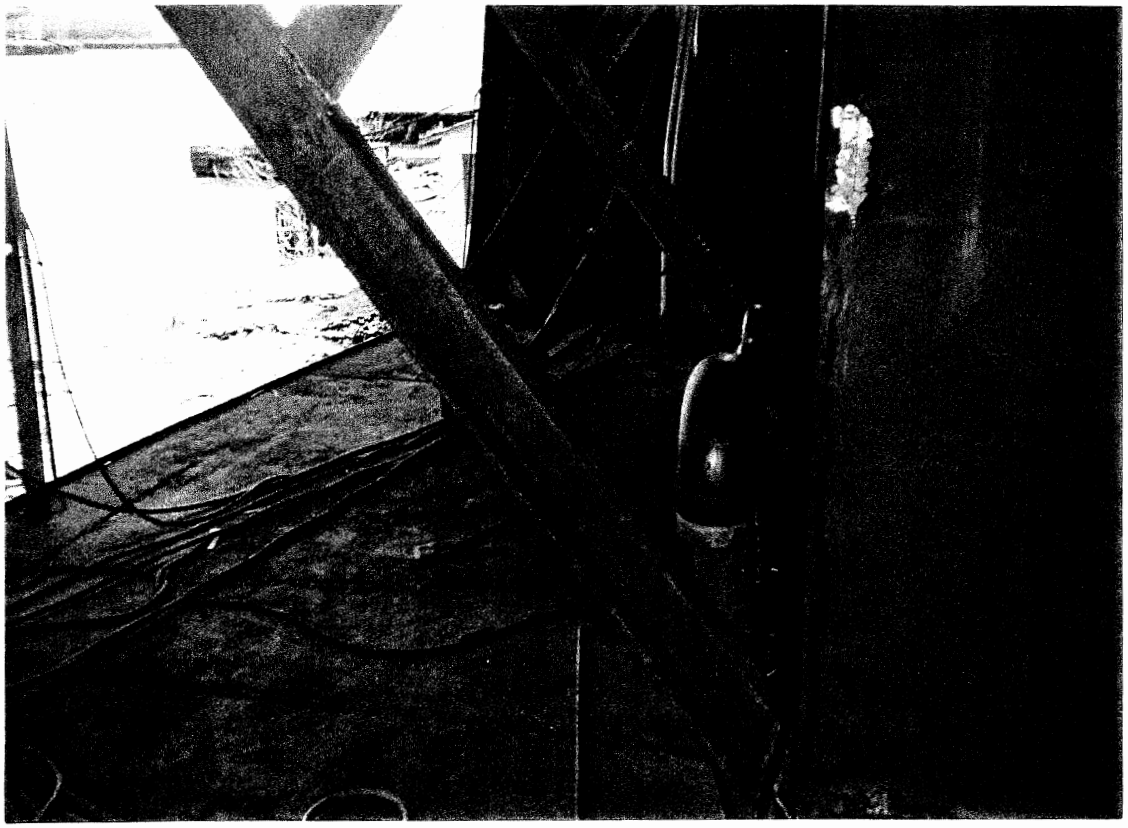

Photo 7. Welded temporary supports, partially cut and awaiting removal.

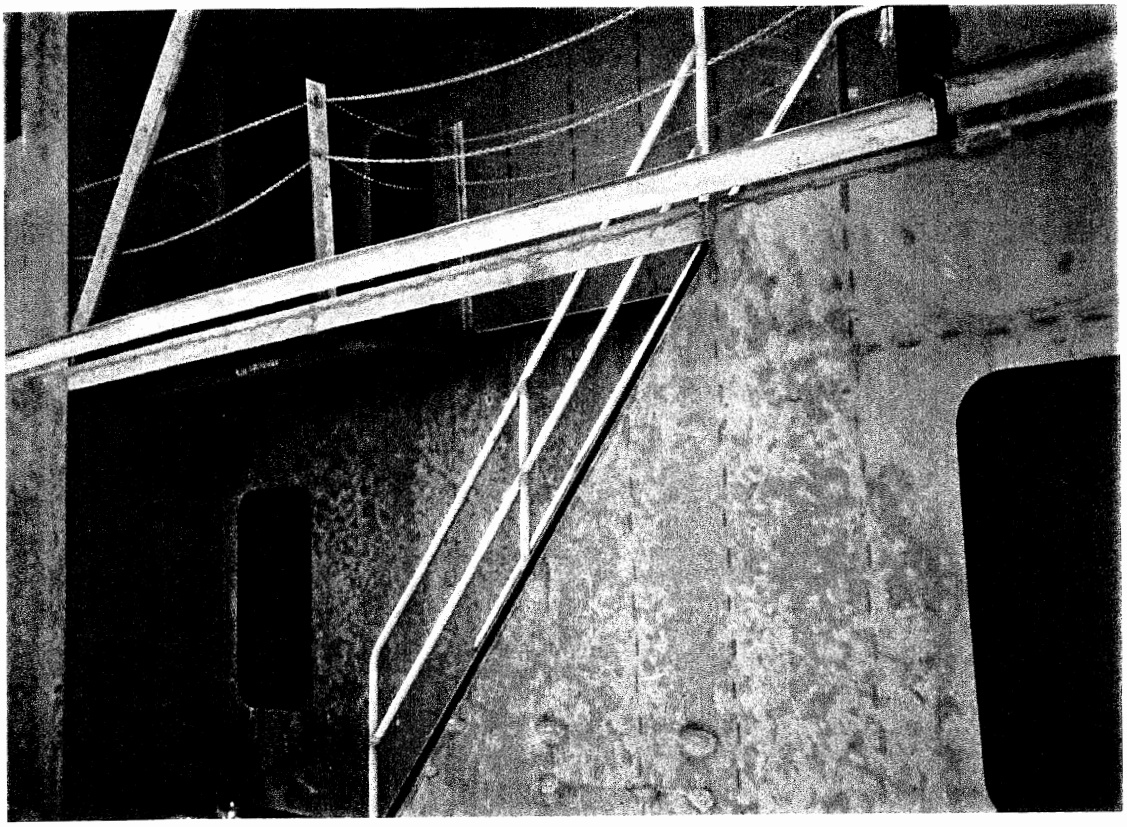

Photo 8. More welded temporary supports and temporary lifeline stanchions.

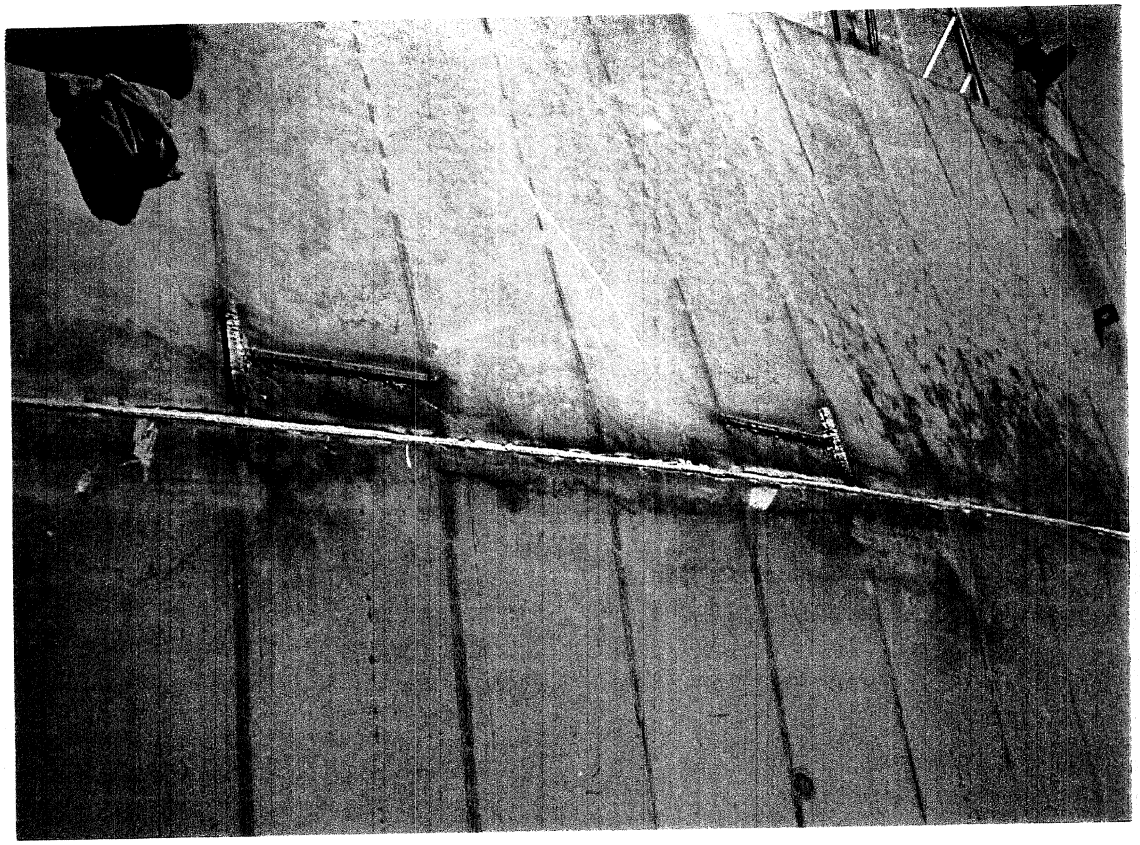

Photo 9. Remains of temporary pad eyes, more temporary pad eyes in upper right.

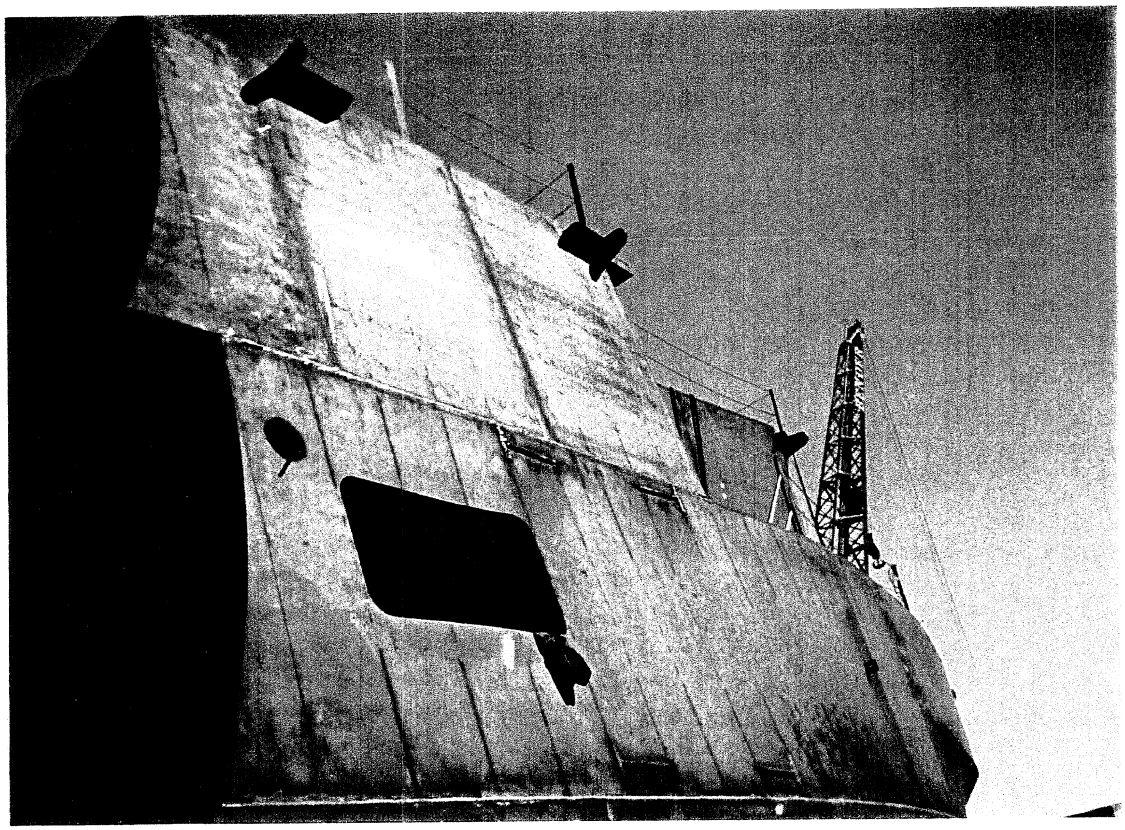

Photo 10. More welded temporary pad eyes.

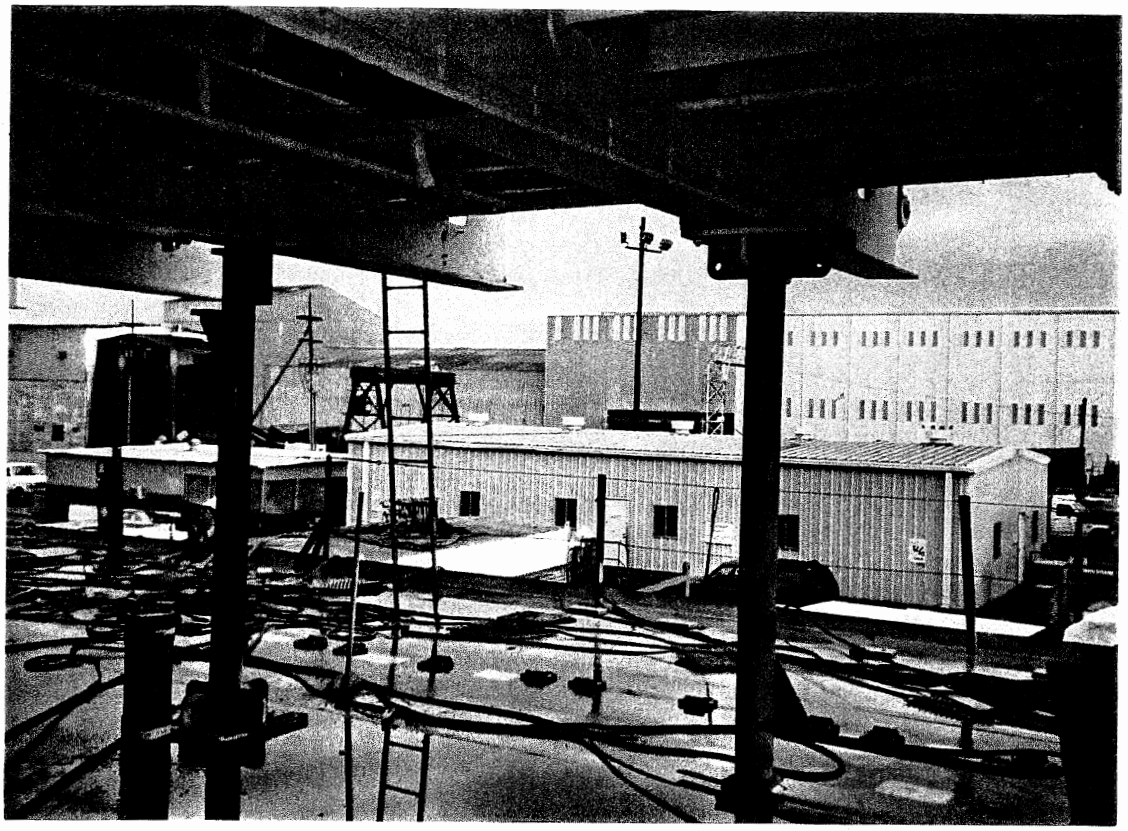

Photo 11. Temporary support stanchions. Clamped tops, welded or clamped bases. Welded lifeline stanchions in background.

Photo 12. Deckhouse erection butt joint - shows the old method (filet welded flat bar strong backs) and a new method (stud-welded threads with boxed stongbacks) of alignment.

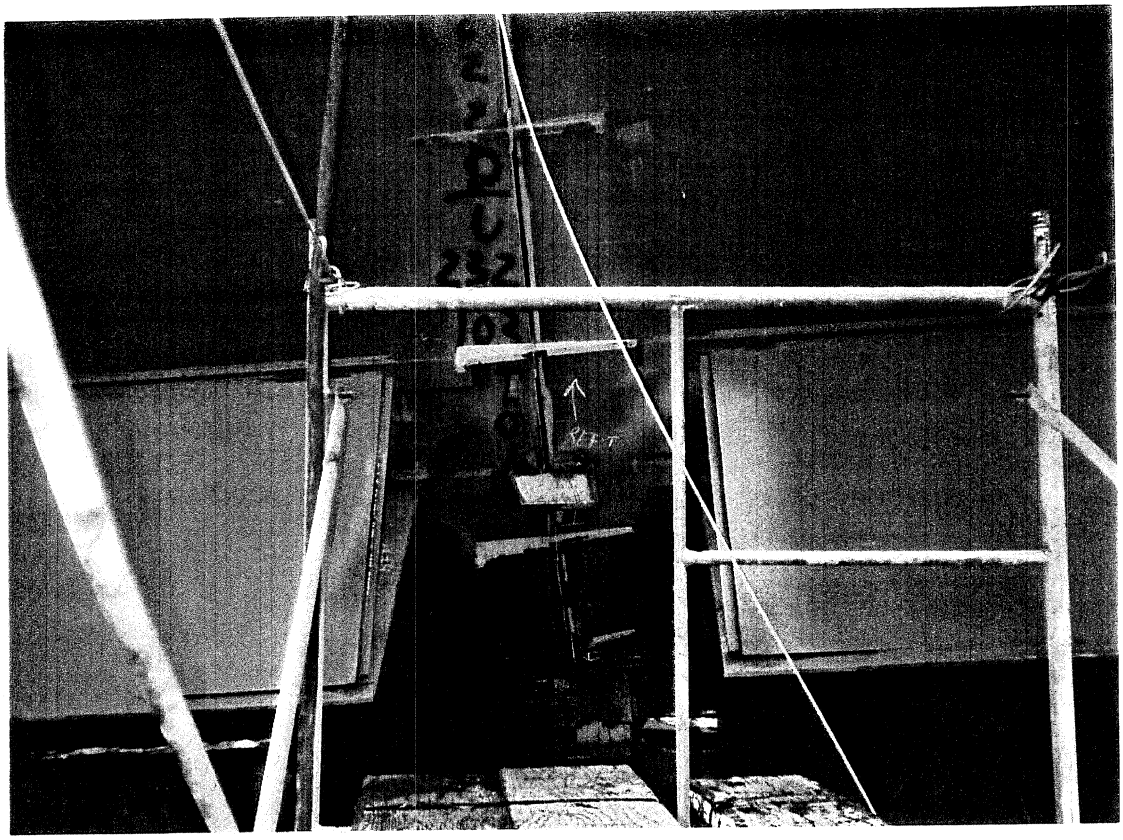

Photo 13. Slotted "T" through the butt with a long wedge. Welded strongback also.

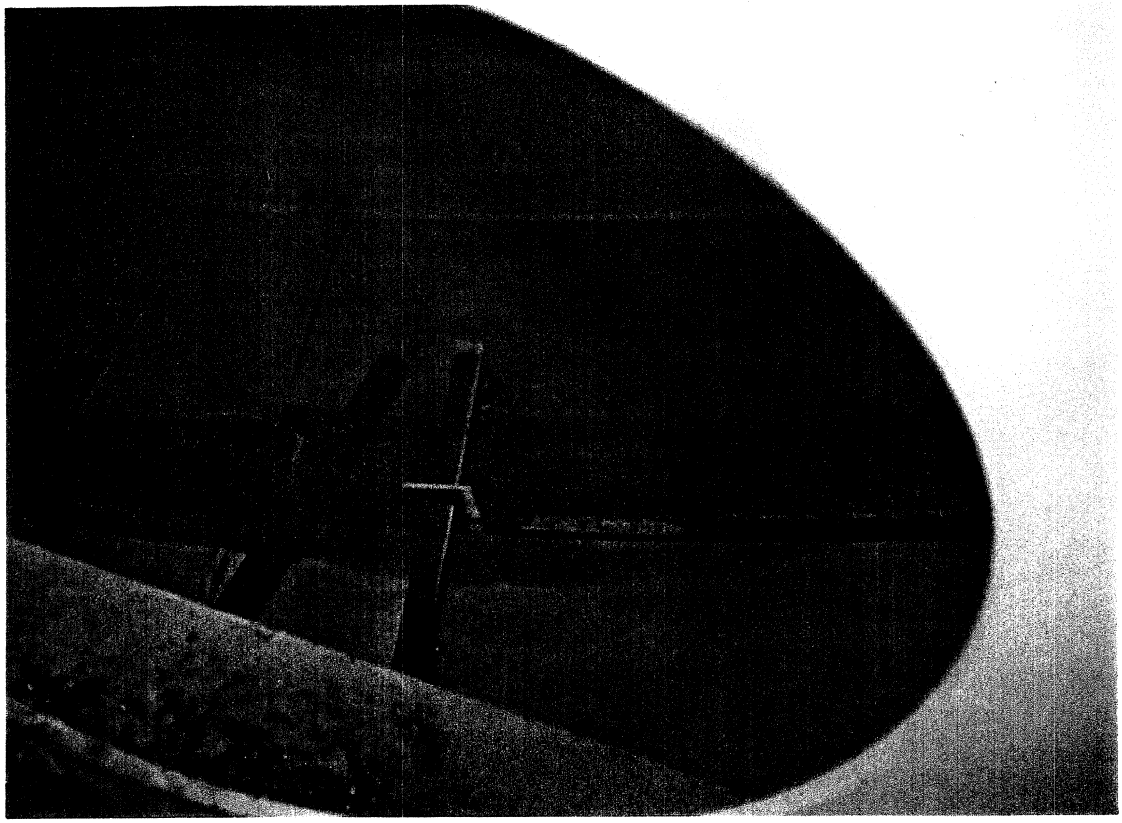

Photo 14. Slotted "T" through the butt with a long wedge - from the inside.

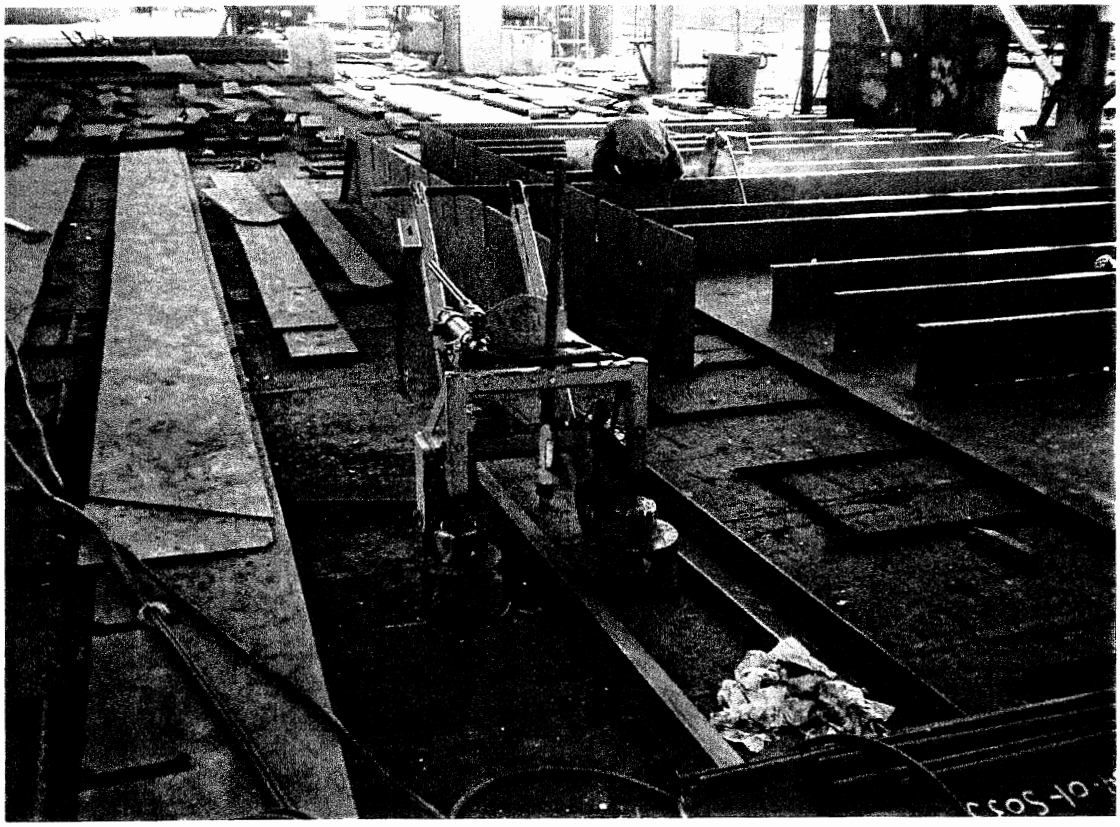

Photo 15. Magnetic hold-down device with manual hydraulic piston to push stiffeners.

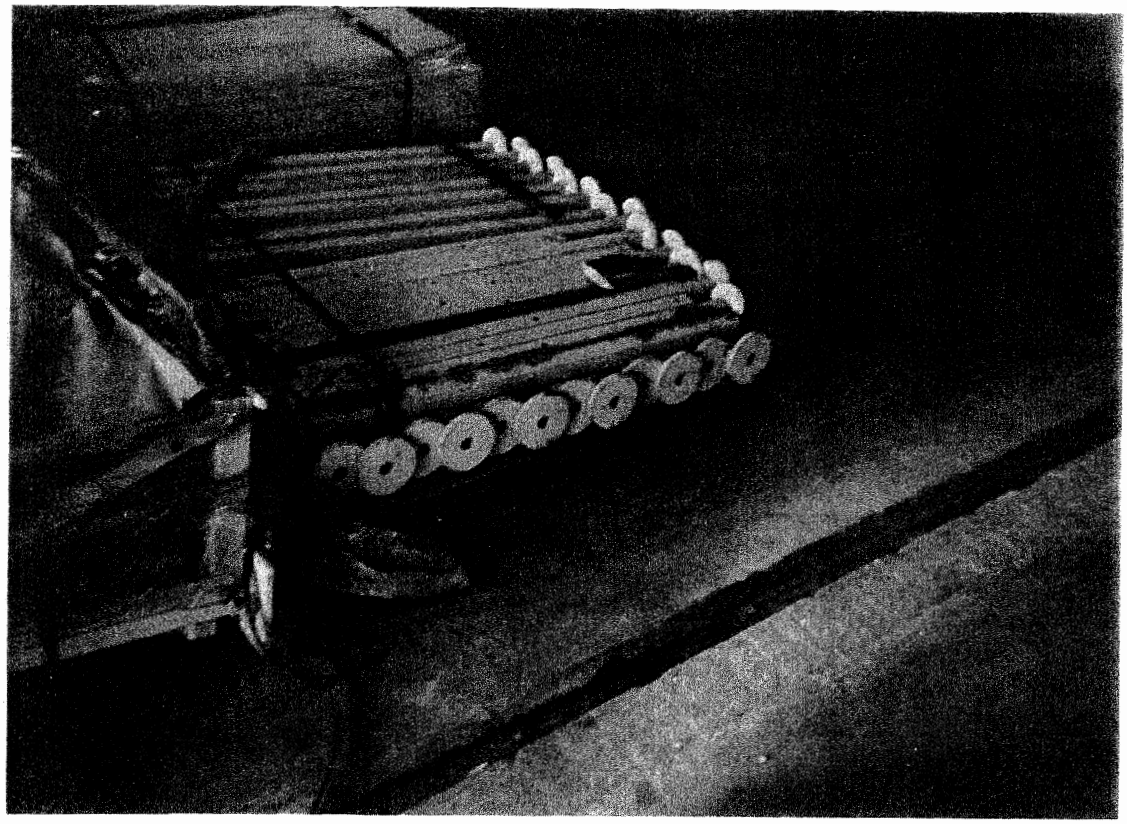

Photo 16. "Buttonhook" staging pieces.

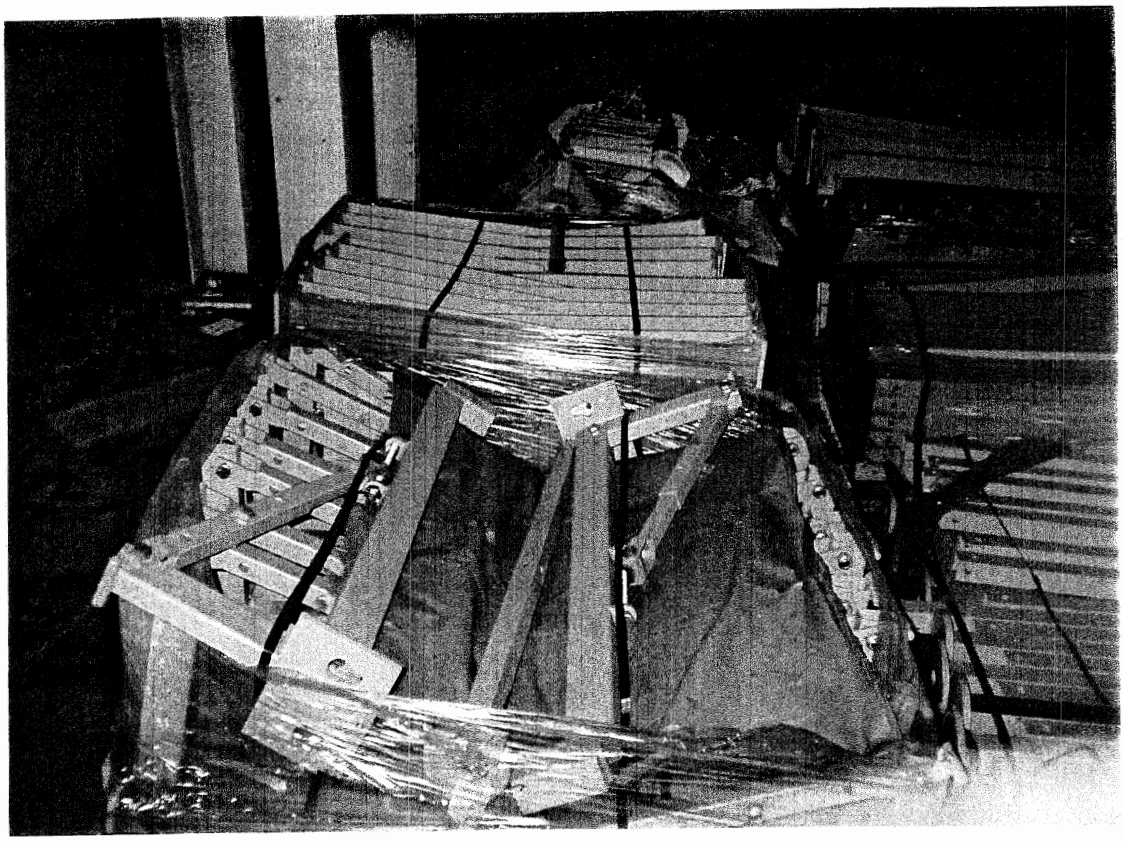

Photo 17. More "Buttonhook" staging pieces with adjustable angle supports.

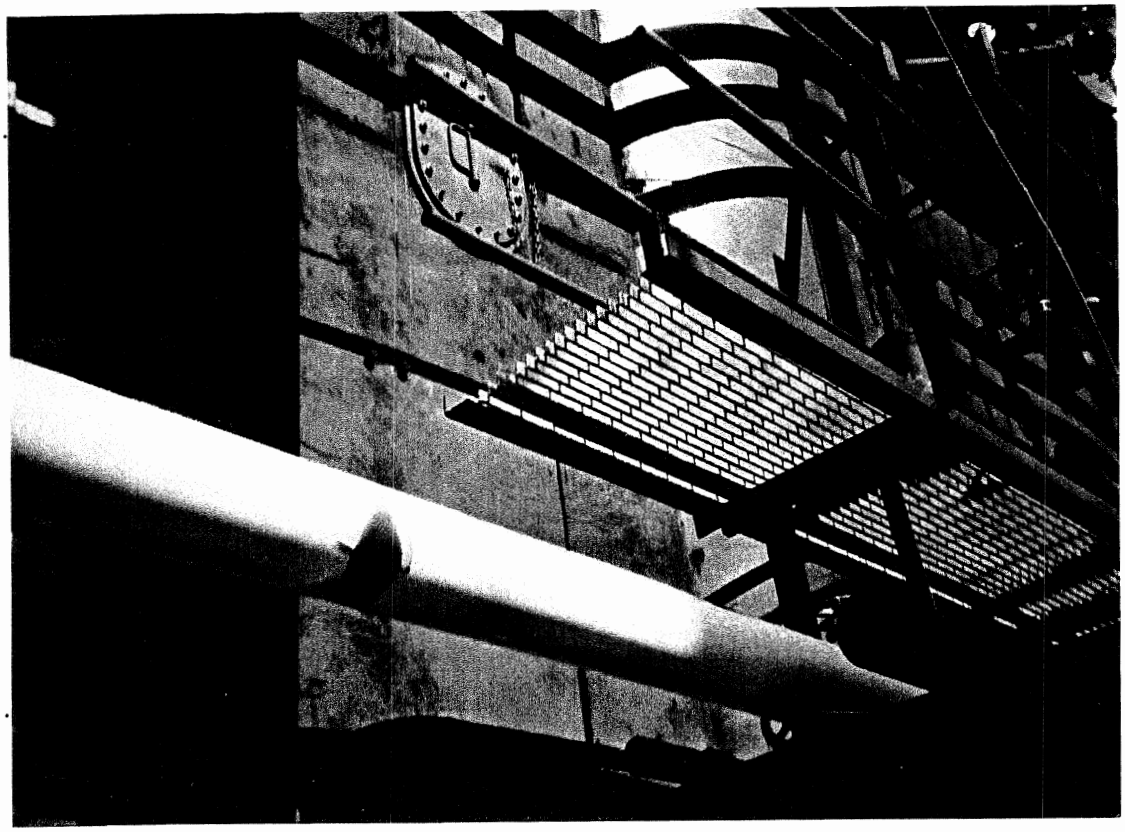

Photo 18. "Buttonhook" studs on a unit.

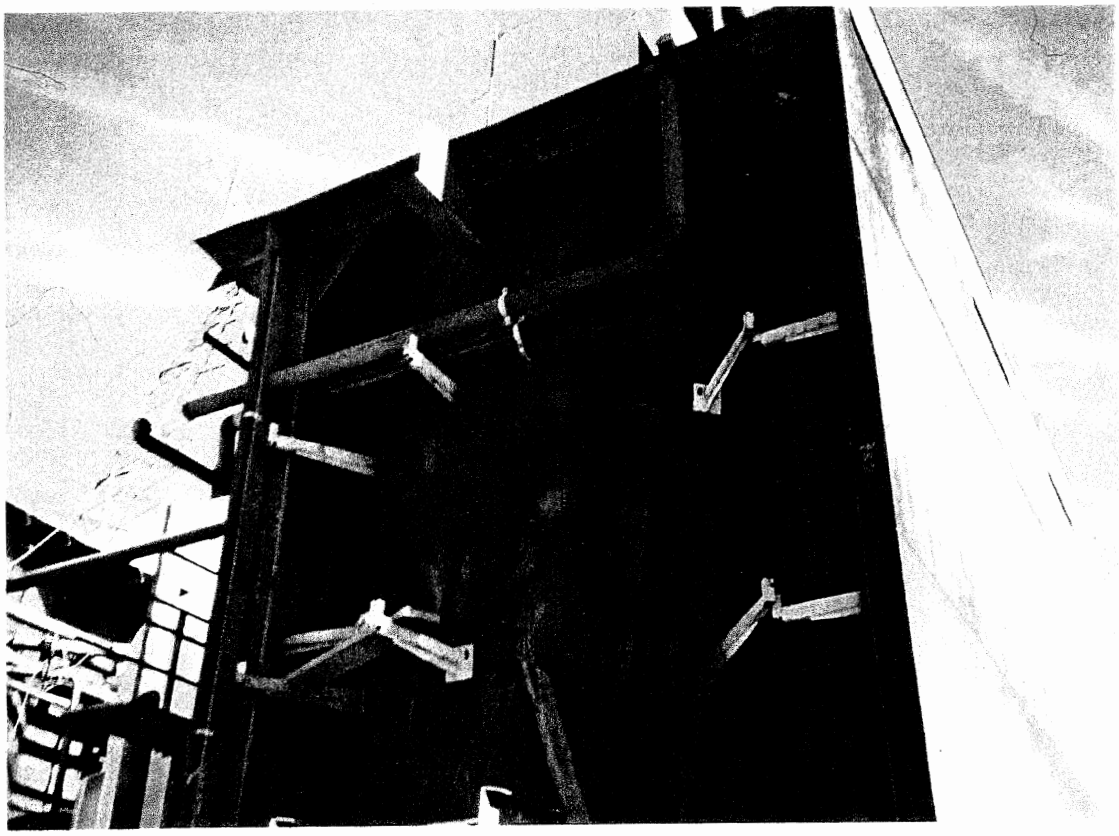

Photo 19. "Buttonhook" staging brackets in use on a mud tank for an OSV.

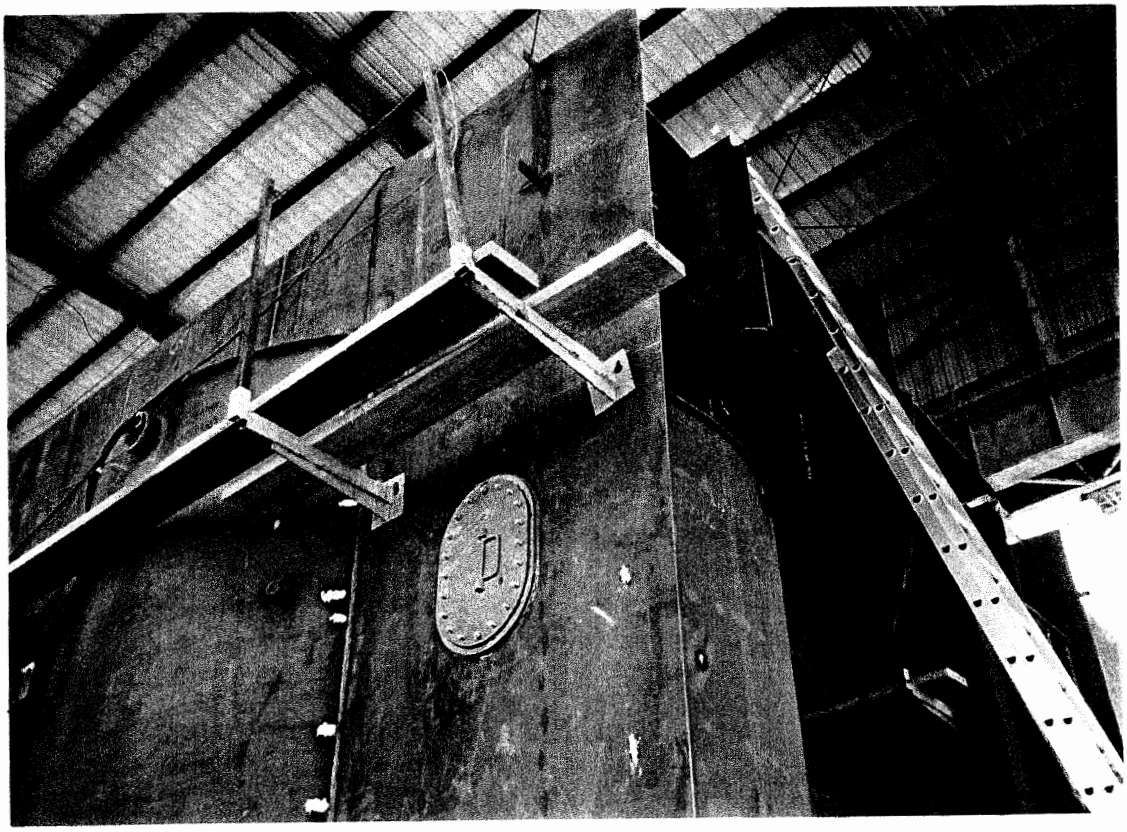

Photo 20. "Buttonhook" staging brackets in use.

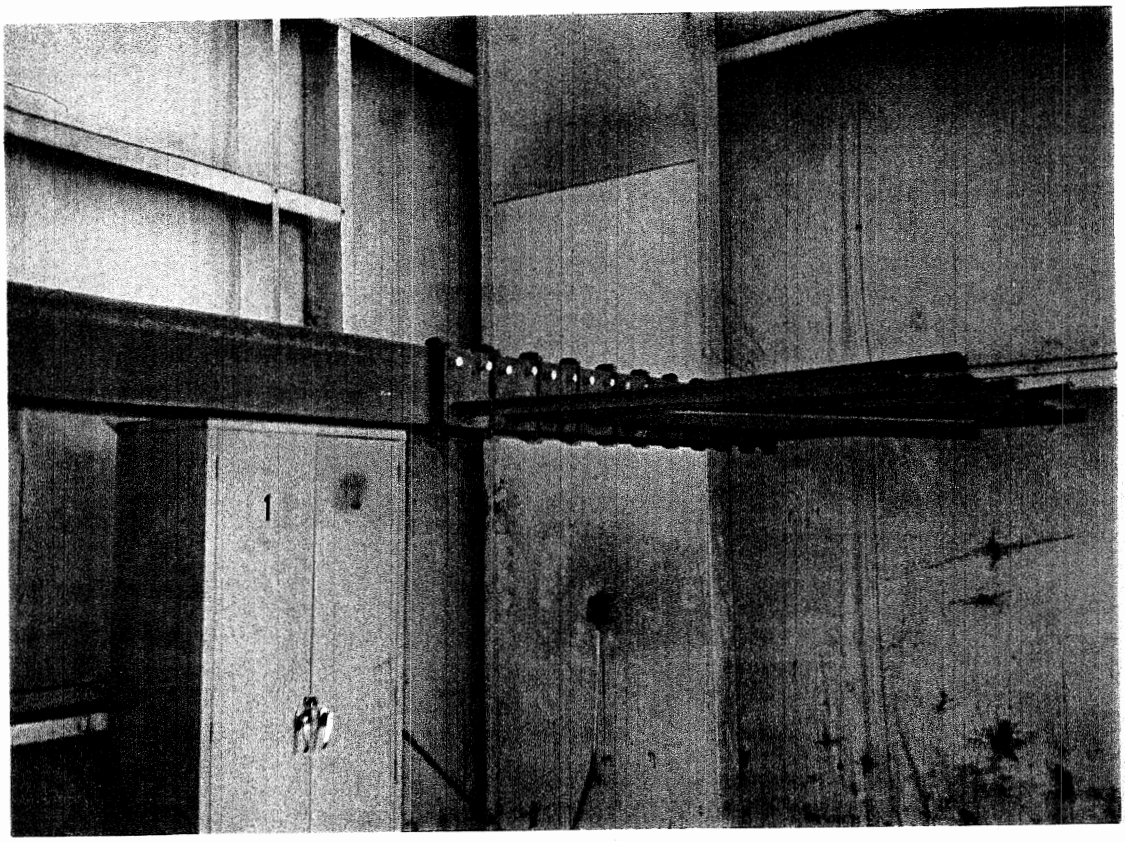

Photo 21. Adjustable alignment tool. Angles welded to the sliding base provide support for framing members. An I-beam is the fixed base. This tool is in storage.

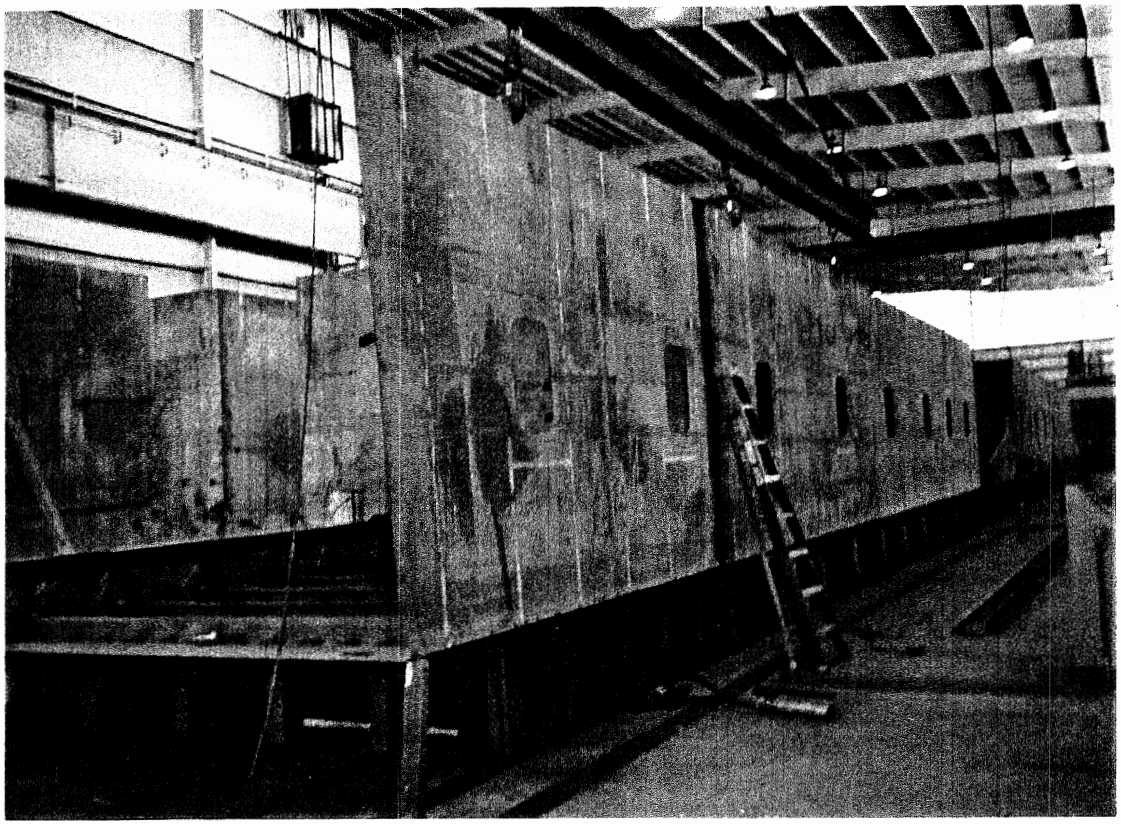

Photo 22. Plate grab support. A series of plate grabs on an I-beam strongback support a stiffened plate blanket until it can be tacked.

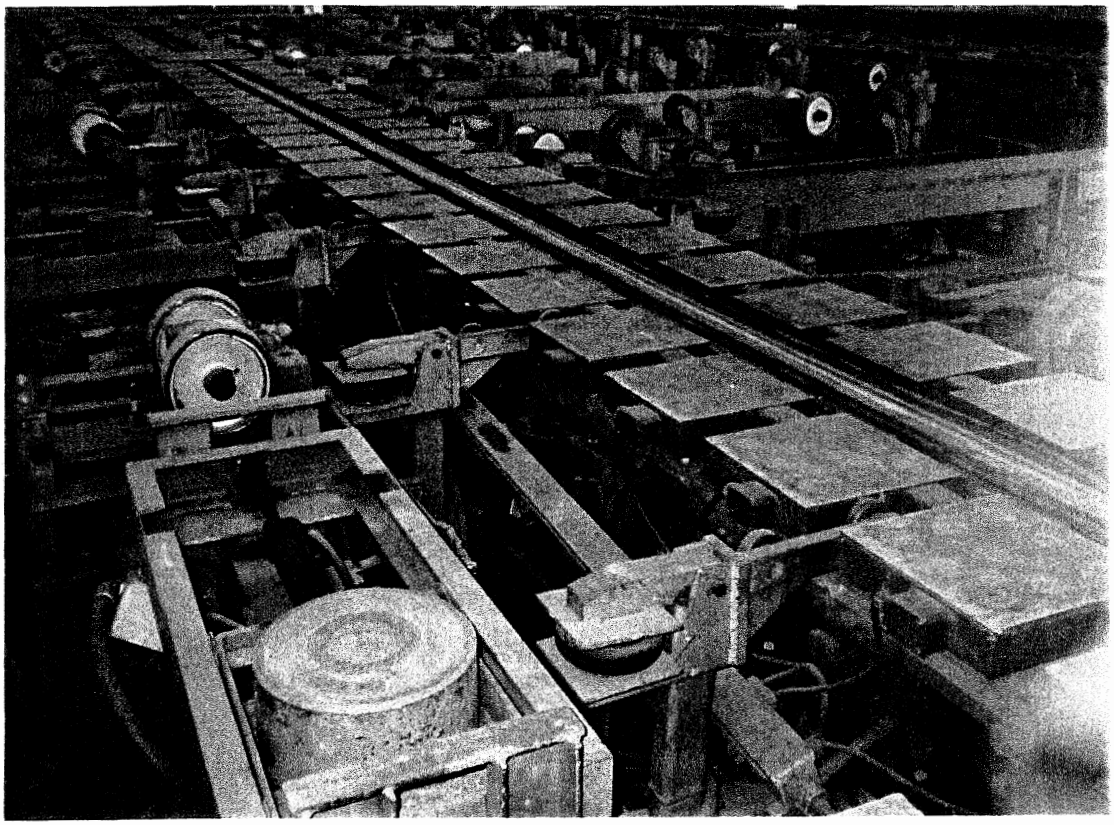

Photo 23. Magnetic pads on a panel line. The series of pads holds two plates in position while the joint is welded.

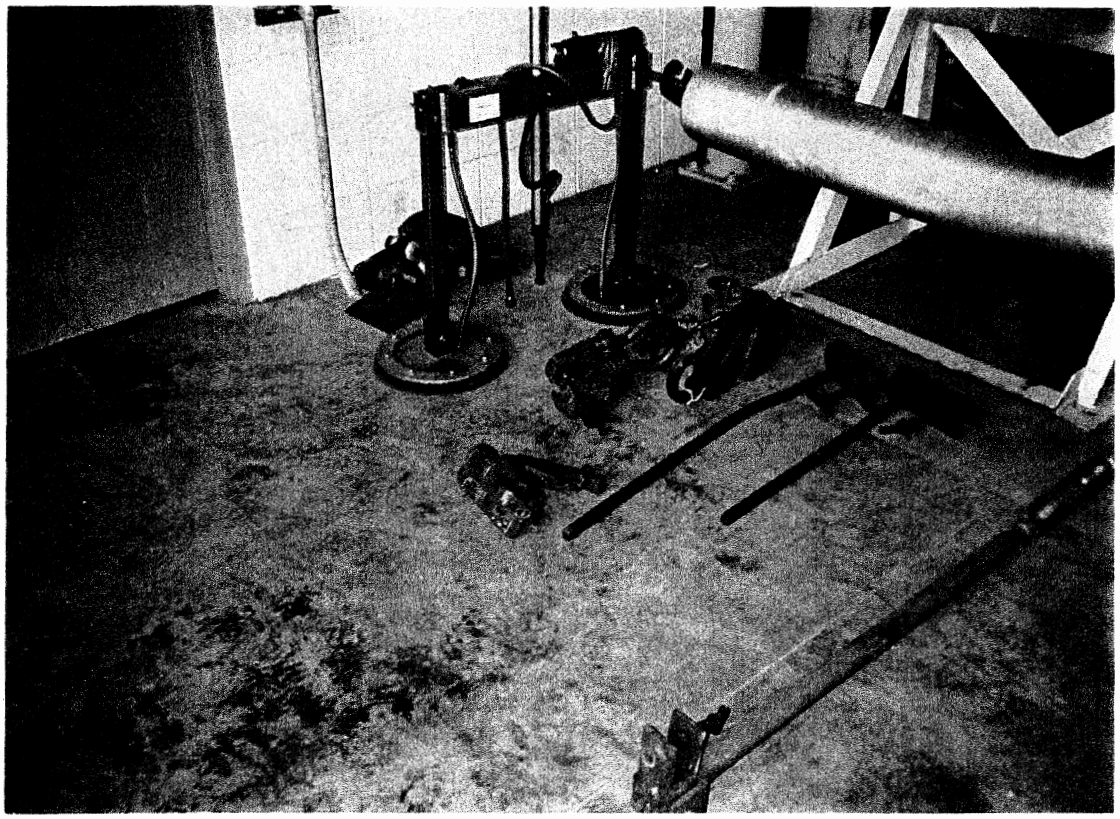

Photo 24. Non-welded attachment tools arrangement. Includes grabs, scissor grabs, bolted safety stanchions, vacuum/hydraulic hold-down, and C-clamp grabs.

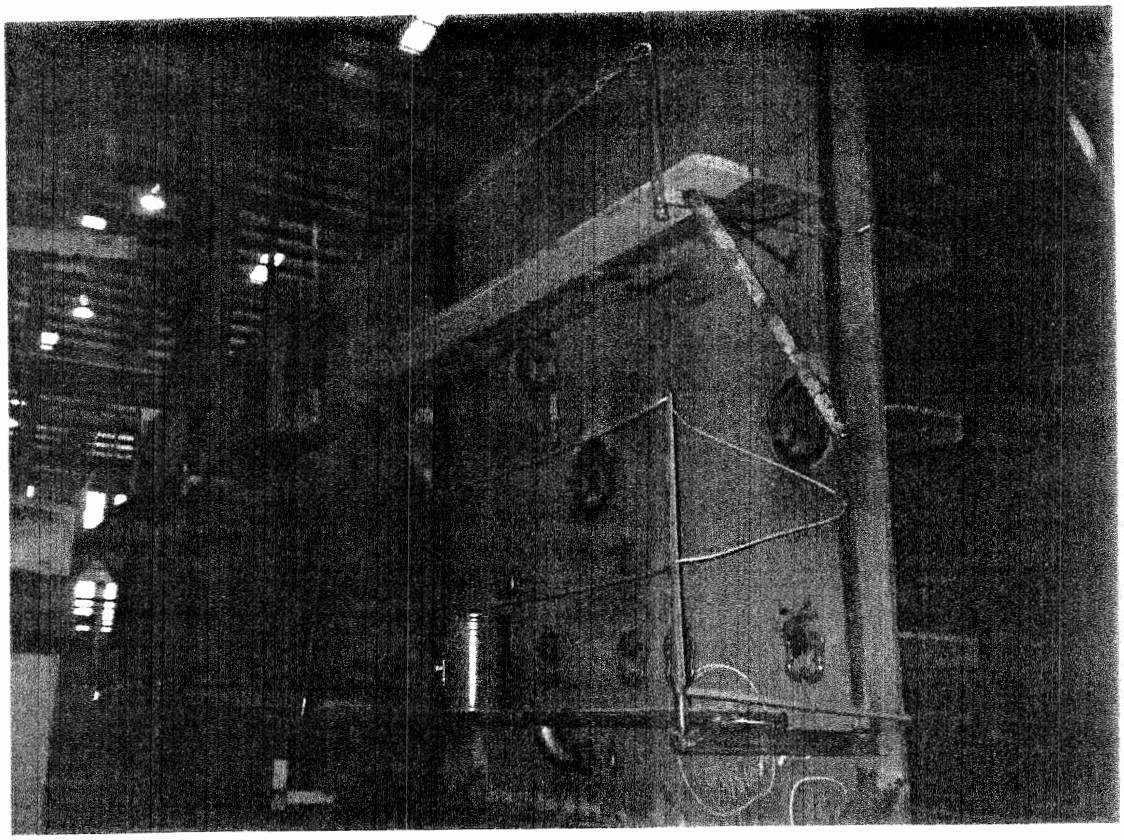

Photo 25. Staging brackets bolted to a series of angles hanging from the side of the unit.

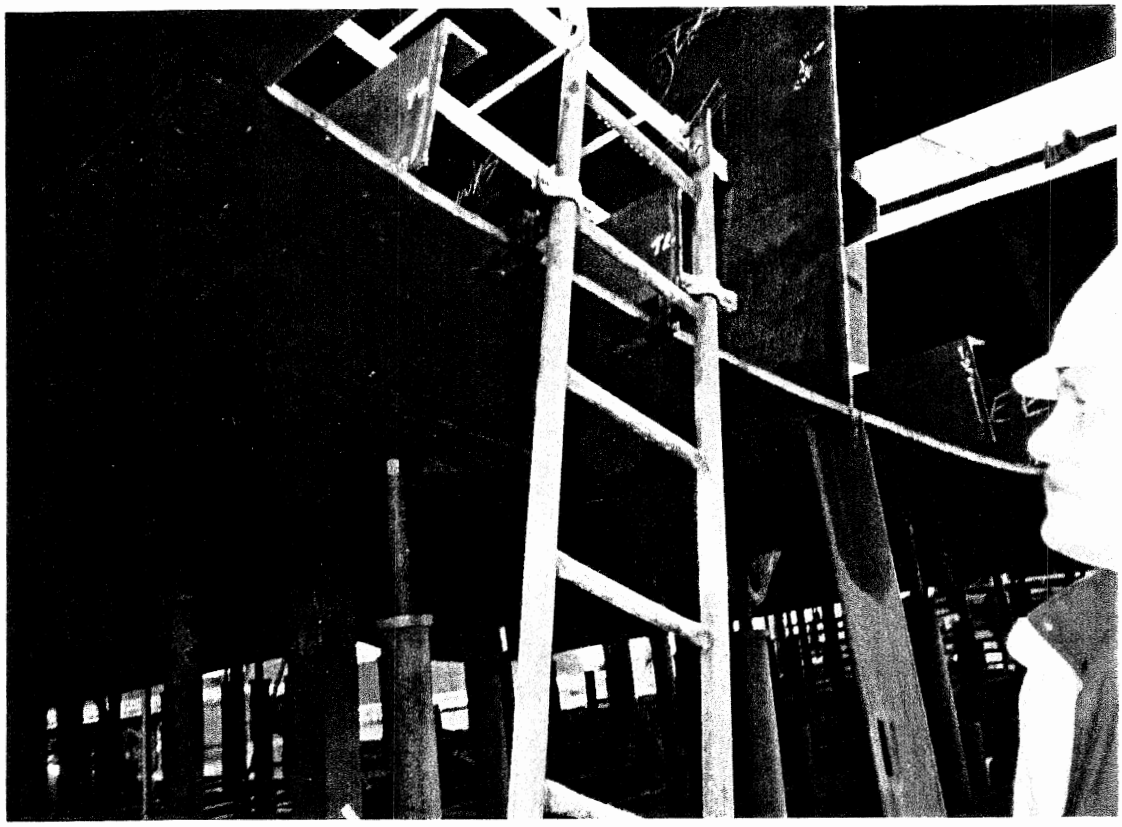

Photo 26. Bolted ladder clamp.

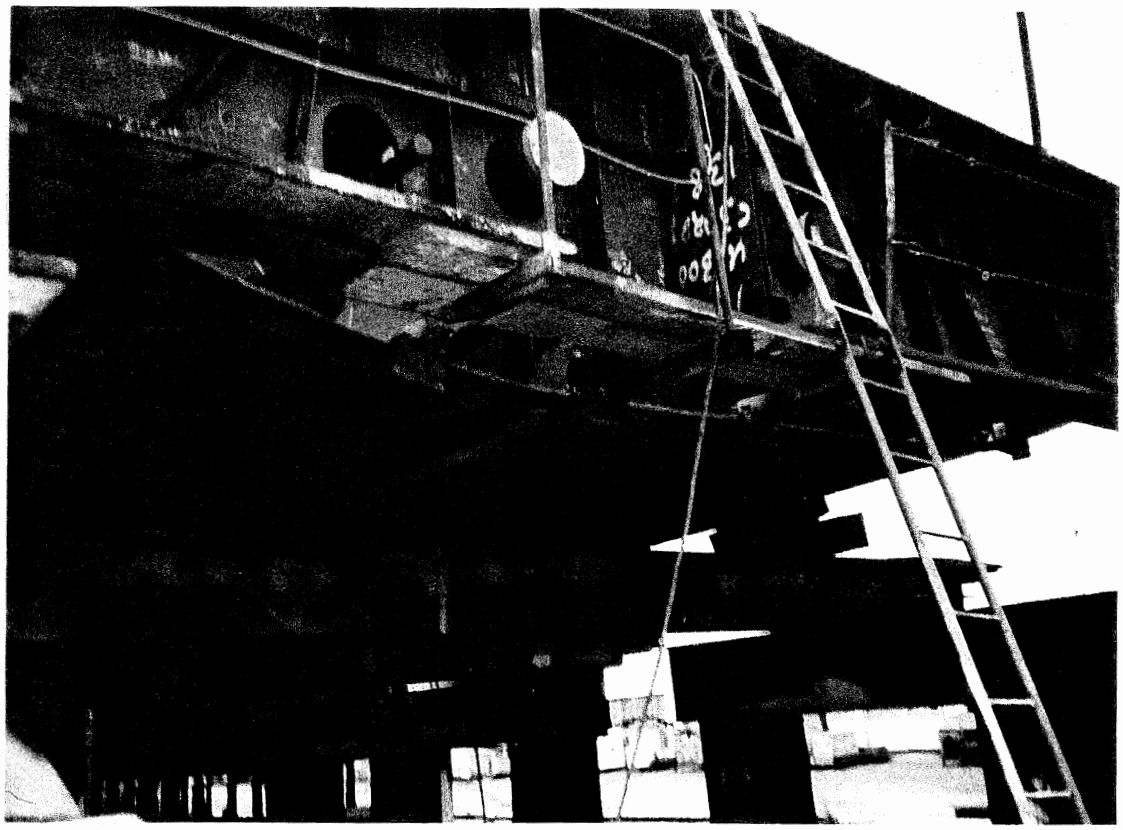

Photo 27. Bolted staging supports and ladder clamp.

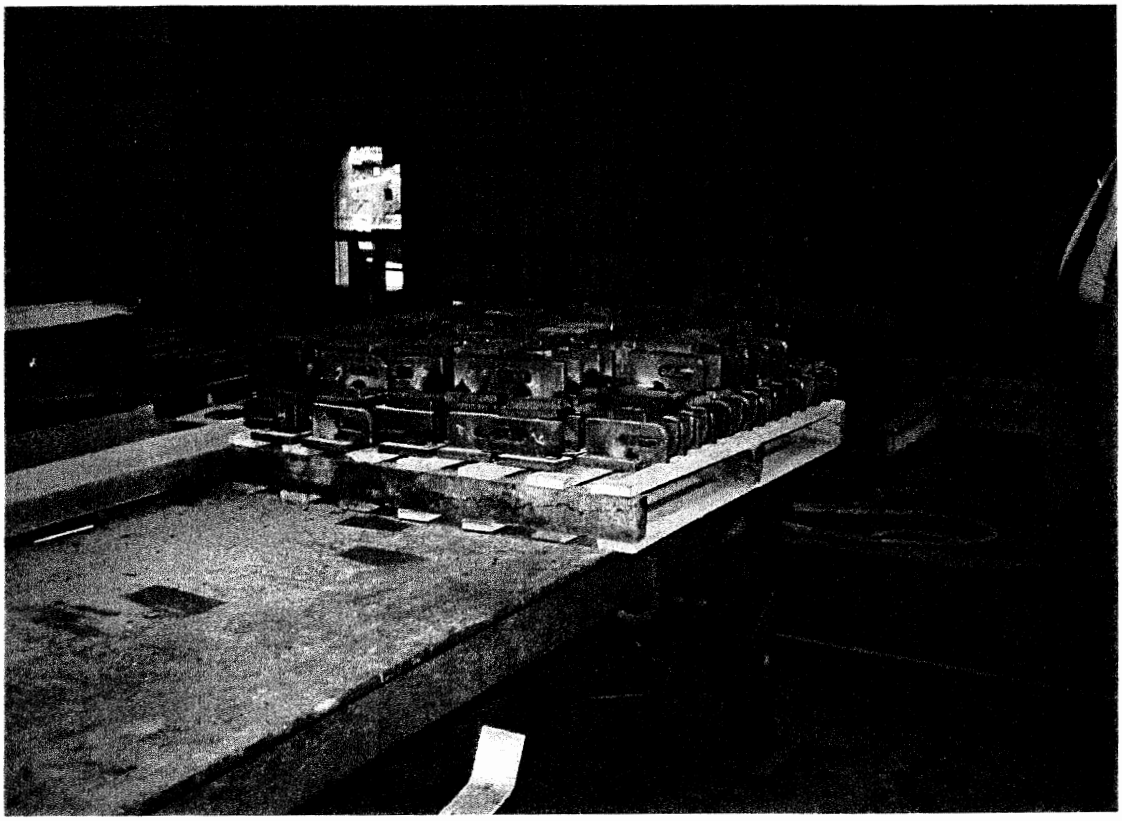

Photo 28. Temporary T joint clamps in production.

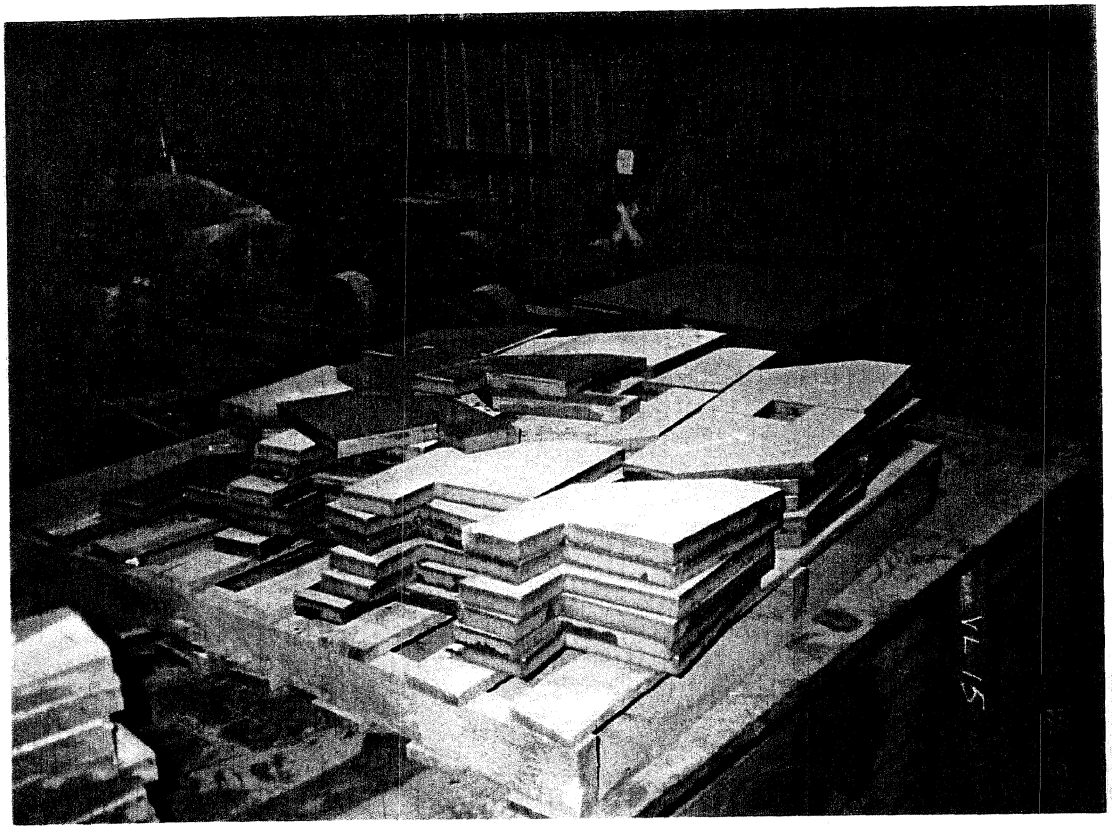

Photo 29. Brackets for dogging plates in production.

Photo 30. Finish welded dogging plates.

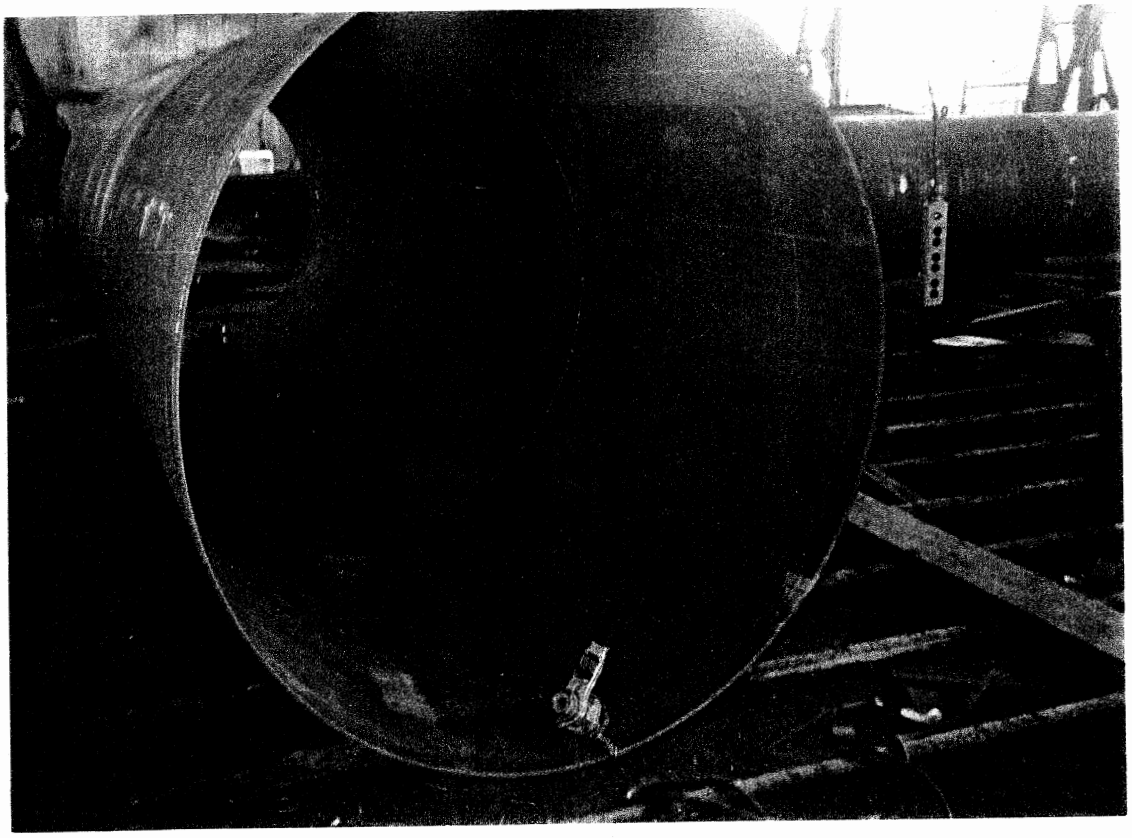

Photo 31. Chain Fall pulling pipe sections together.

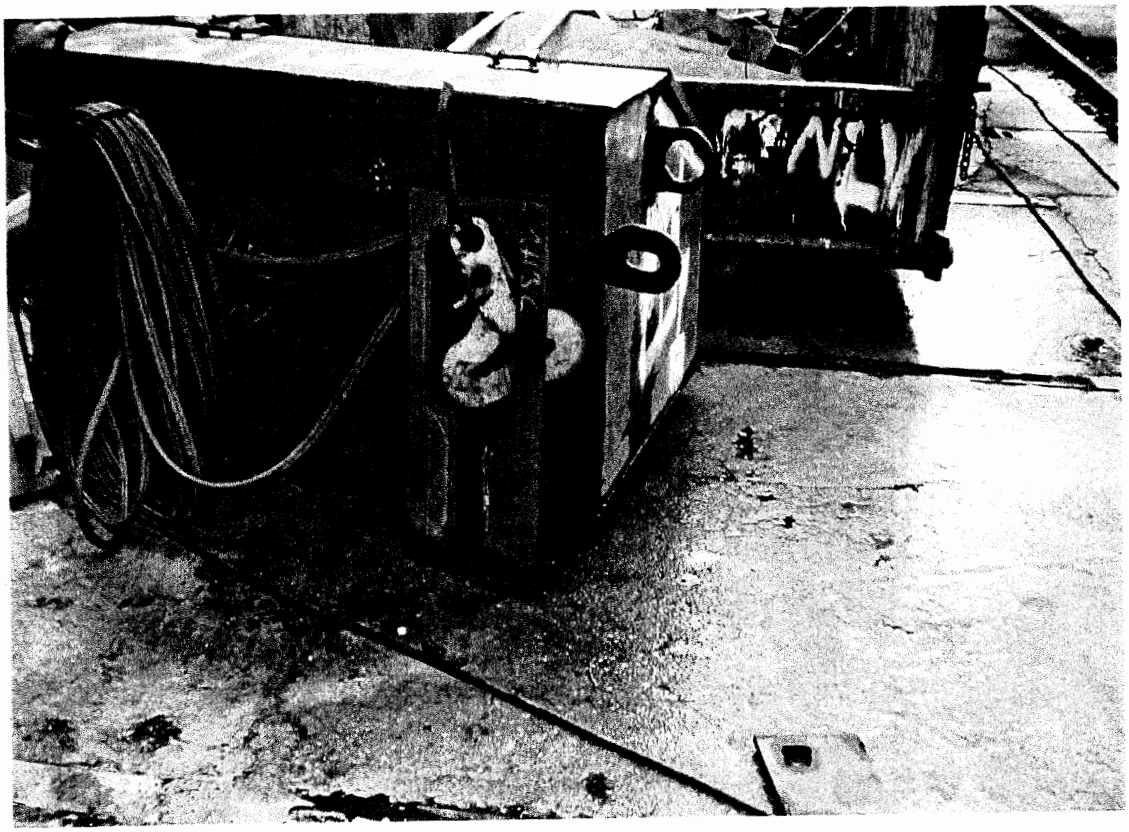

Photo 32. Scissors plate clamp.

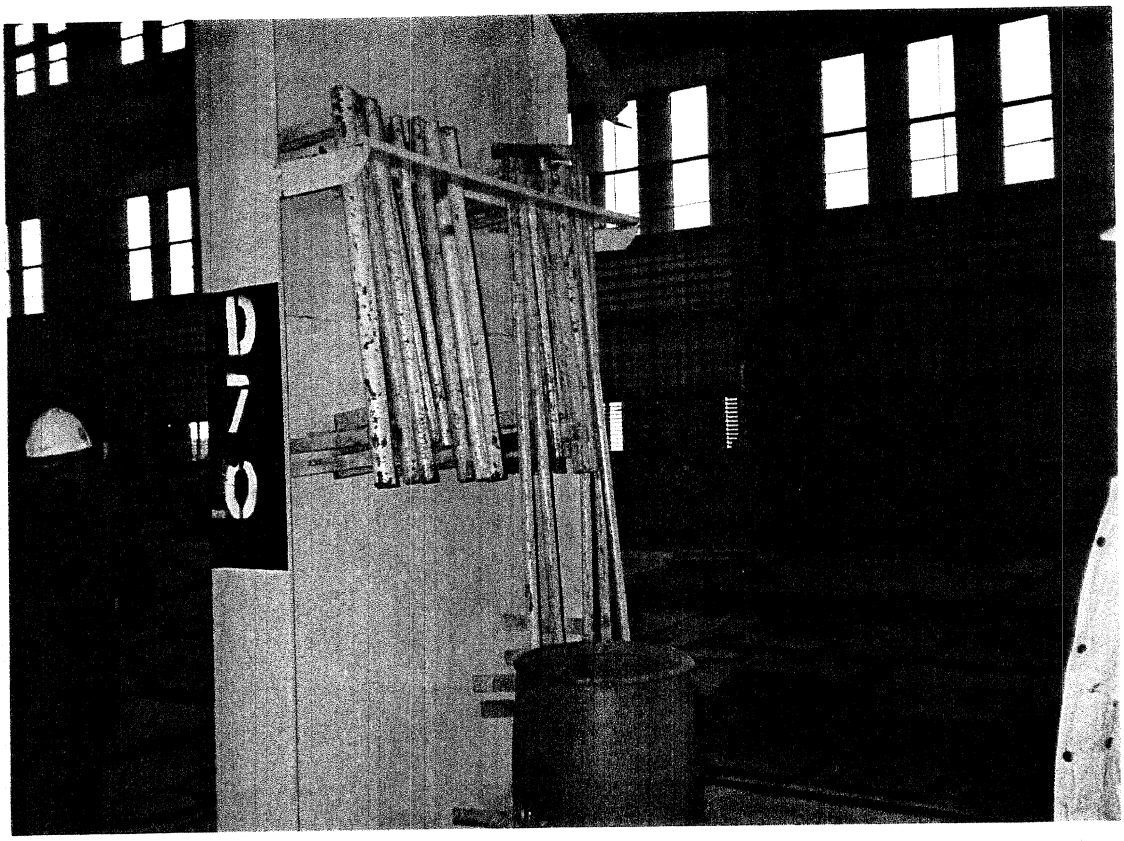

Photo 33. "Yellow Tools," in a dedicated rack - these for a specific stiffener spacing.

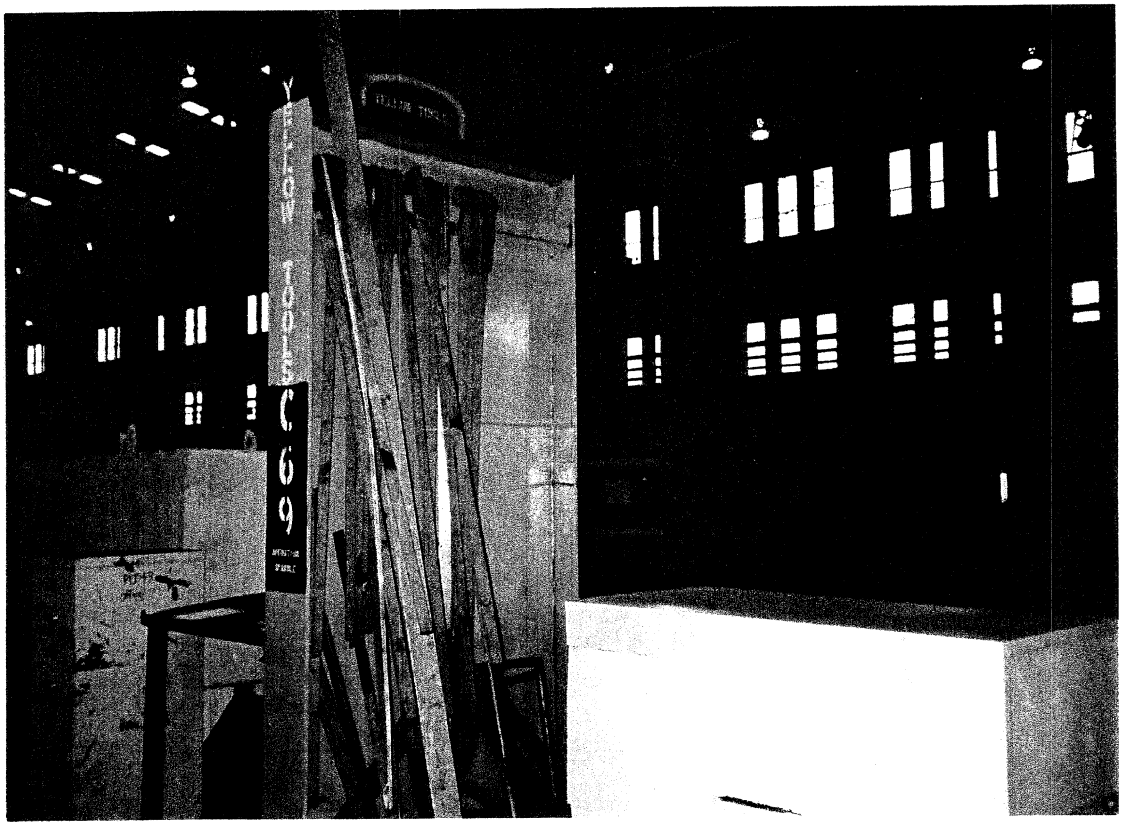

Photo 34. More "Yellow Tools."

Appendix A Commentary

Following are additional comments to expand on the photographic record.

Photo 1. Welded pad eye with added angle support and chafing guard around bottom plate.

This is indicative of the many welded pad eyes used in many yards. These are heavy plates with reinforced attachment points and, in many cases, reinforced eyes to take the large concentrated rigging loads. These are specially designed and fabricated for certain categories of loads. However, because of the damage involved in cutting them off, they are usually scrapped after use. Photos 6, 9, and 10 show more of these.

Photo 2. Welded temporary supports of scrap metal.

Application of these types of attachments are of an ad-hoc nature. The material is inexpensive because they are scrap. However, installation and removal still involves a lot of welding, then cutting and grinding, and possibly weld repair, that makes welded attachments expensive. Another potential problem with use of scraps is that the usage can extend to more critical items such as temporary life rails and heavier lifting lugs without proper design and safety. Photos 3, 4, and 25 show some more scrap metal usage.

Photo 3. Welded butt joint strongbacks.

These attachments provide in-plane strength, to hold the plates together, but have little effect on out-of-plane forces.

Photo 5. Welded temporary lifeline stanchion.

This is a good candidate for replacement by a bolted stanchion.

Photo 7. Welded temporary supports, partially cut and awaiting removal.

This continues to show the added labor involved in removing welded attachments after use.

Photo 9. Remains of temporary pad eyes, more temporary pad eyes in upper right.

The pad eyes have been removed, but a fair amount of grinding must be done to repair the surface. Photo 10 is long range shot of the same area.

Photo 11. Temporary support stanchions. Clamped tops, welded or clamped bases. Welded lifeline stanchions in background.

This arrangement preserves the coating on the overhead and uses minimal welding where the stanchions land on the flat deck.

Photo 12. Deckhouse erection butt joint - shows the old method (filet welded flat bar strong backs) and a new method (stud-welded threads with boxed stongbacks) of alignment.

The boxed strongbacks provide both in-plane and out-of-plane support and are easier to remove. Both allow placement of a backing strip for one-sided welding from inside.

Photo 13. Slotted "T" through the butt with a long wedge. Welded strongback also.

The slotted "T" is thin enough to keep the gap between plates from being too big but strong enough to align the plates in this stiff area at the turn of the bilge and bilge keel.

Photo 14. Slotted "T" through the butt with a long wedge - from the inside.

This is similar to Photo 13 but from the inside.

Photo 18, 19. and 20. "Buttonhook" staging brackets in use.

The owner of this vessel is having the studs for the staging left on the completed vessel so that they can be used later for maintenance.

Photo 25. Staging brackets (yellow colored angled piece in the foreground) bolted to a series of angles hanging (dark nearly black vertical members against the gray vertical surface) from the side of the unit.

Photos 26 - 29. Most of these are examples of simple but effective non-welded attachments.

Photo 30. Finish welded dogging plates.

The holes are for welded studs and bolted application.

Photo 31. Chain Fall pulling pipe sections together.

Where chain long enough is available, units can be pulled together form the ends as opposed to using welded eyes and a short chain across a butt.

APPENDIX B

CONTACTS

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CONTACTS

Frazier Industrial
Fairview Avenue, Long Valley, NJ 07853
908-876-3001; FAX: 908-876-3615
E-Mail: frazier@ frazier.com
http://www.frazier.com/index.html

Frazier makes KLAMP/FAST, an infinitely adjustable arm that offers unequaled flexibility for storing flat, long, or hard-to-handle items. KLAMP/FAST has many desirable features:

- Infinite adjustability due to storage arms that can be positioned anywhere you want them.
- Fast assembly and reassembly.
- Capacities to 1/4 million pounds and more
- Single or two-sided storage.
- Storage for extra-long, extra-heavy items.
- All structural steel components

Marine Travelift, Inc.
49-T E. Yew St.
Sturgeon Bay, WI 54235-1976 USA
Tel: 920-743-6202
Fax: 920-743-1622
http://www.marine-travelift.com/index.shtml

Marine Travelift produces large, mobile ,boat hoists that are used in marinas, shipyards, fishing ports and naval installations around the world. They are the original and largest manufacturer of this type of boat-handling equipment. The slings they use could be modified for handling interim shipbuilding products.

General specifications of 5 of 11 standard models.

Model	15BFM	50BFM	70BFM	100 BFM	500 BFM
Maximum lifting capacity (tons)	16.5	55	77	110	550
Recommended maximum boat length	45'	65'	70'	95'	170'
Recommended maximum width	14'	19'	20'	25'	36'

Acco Systems
12755-T E. Nine Mile Rd.
Warren, MI 48089 USA
Tel: 810-755-7500
Fax: 810-758-1901 Web site: http://www.accosystems.com

Acco manufactures material handling equipment, overhead and inverted, power and free, automated storage and retrieval systems, chain-on-edge and chain on floor systems, low-selec-tow systems and flattop conveyers. They also have full material handling system implementation and integration capability including engineering, design, manufacturing and installation.

Caldwell Group, Inc.
5049 26th Ave.
Rockford, IL 61109 USA
Tel: 800-624-5216
Fax: 815-229-5686

Manufacturer of all forms of crane and rigging attachments including a full line of shop air and electric vacuum lifters.

Casper, Phillips & Associates
3340 E 11th St
Tacoma, WA 98421-4206
Tel: 253-627-7400 E-mail: casperph@cranedesign.com
Fax: 253-627-4715 Web site: http://www.cranedesign.com/

Casper, Phillips & Associates (CP&A) is a multidiscipline engineering firm bringing together structural, mechanical, civil, and electrical engineers. Their background includes engineering of cranes, specialty rigging, port facilities, cargo handling systems, commercial/industrial facilities, and specialty structures/machinery. They also offer services of project/construction management, accident repair, automated design and equipment automation.

Rigging International (RI)
965 Atlantic Avenue
Alameda, CA 94501
Tel: 510-865-2400 E-mail: rigging@worldnet.att.net
Fax: 510-865-9450

Since its beginning in 1969, Rigging International (RI) been working with specialized heavy lift rigging and transport needs of clients in the maritime, fossil and nuclear power, refinery and petrochemical, mining and other industries. With the changing designs of larger and heavier industrial machinery and equipment, the state of the art in heavy lift rigging and transport is increasing in its complexity. Services provided by RI include:

- Heavy Lift Rigging
- Heavy Lift Transport by Land or Sea
- Container Crane Services
- RIMCO (Rigging International Maintenance Company)
- Nuclear Heavy Lift Services

Anver Corporation
36 Parmenter Road
Hudson, MA, USA 01749-3214

Tel: 978-568-0221 Toll-Free 800-654-3500
Fax: 978-568-1570 Web site: http://www.anvervacuum.com/

Anver manufactures a wide range of standard and custom vacuum lifters, offering material handling solutions for many applications. Electric, mechanical, air-powered and battery powered lifters are available. Applications engineers can help select the right lifter, system or components.

Thomas Register
Thomas Publishing Company
Thomas Register Circulation Dept.
5 Penn Plaza,
New York, NY 10001

Web site: http://www4.thomasregister.com/ss/.512292089/loggedin.cgi

From this web site one can get access to information on any number of industrial suppliers and manufacturers.

Strachan & Henshaw Inc.
100 Rialto Place Suite 212 Fax.
Melbourne, FL 32901 USA
Tel: 1 407 952 0116
Fax: 1 407 951 4648
E-mail. shmarketing@compuserve.com

They designed the rail car dumper shown in Figure 2 of the report.

Elecon Engineering Company Limited
Material Handling Division:
Anand - Sojitra Road
Vallabh Vidyanagar - 388 120.
Gujarat, INDIA
Tel: +91 2692 47016, 30017 E-mail: mhe.mkt@gnahd-mhe.globalnet.ems.vsnl.net.in
Fax: +91 2692 46457 Web site: http://www.elecon.co.in.

They designed and built the rotary car dumper in Figure 3 of the report. Elecon also has their own web site at indicating their other capabilities

APPENDIX C

SP-8 PANEL REPORT

Reduction or Elimination of Welded Temporary Attachments - SP-8 Report

Objective: (from the 1993 abstract) Analyze and identify the potential benefits and savings associated with improving/eliminating temporary structural attachments through design enhancements and technological improvements. Benchmark foreign shipbuilders and other nonrelated steel construction industries. Design and test new attachments and study the feasibility of adapting existing technology to U.S. shipbuilding.

Participants:

- NASSCO (prime) - Mauro Brattich
- UMTRI - Al Horsmon

Looking at:

- Fitting and Fairing Aids
  - Stiffener, beam clamps
  - Bulkhead alignment tools
  - Plate alignment
  - Unit alignment
- Staging, Safety Chain Stanchions
- Turning Lugs

To Eliminate or Reduce:

- Welding of temporary attachments
- Manufacturing non-reusable attachments
- Labor involved in removing temporary attachments
- Labor and materials in:
  - Grinding the excess weld
  - Weld repairs of gouges
  - Coatings

Alternatives Considered

- Vacuum handlers
- Bolted attachments
- Straps
- Adhesives
- Magnetic attachments