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TECHNICAL

TITLE: AXIAL TENSION TESTING OF FORGED HORIZONTAL CONNECTORS FOR USE WITH INTERMODAL ISO CONTAINERS

AUTHOR: Bradley Posadas

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NOTE

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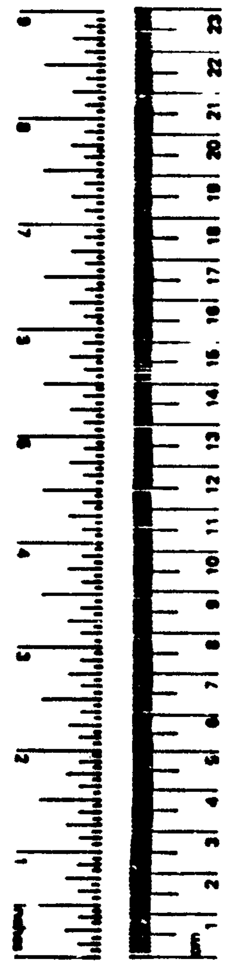
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

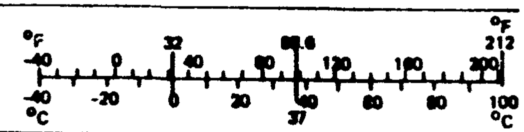
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2,000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1,000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The results of a static test to determine whether a forged Tandemloc Inc. Horizontal Connector meets the tension resistance requirements for use with International Organization for Standardization (ISO) containers in the Marine Corps Container and Expeditionary Shelter Systems are presented. Four identical connectors were tested. The maximum applied forces were measured, recorded, and then compared with the rated capacity. The connector met the tension resistance requirements and should be qualified for use in the container and shelter systems.

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TN-1733 18 pp illus September 1985 Unclassified

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INTRODUCTION

The Marine Corps Container System and the Marine Corps Expeditionary Shelter System, both of which are part of the Marine Corps Field Logistics System (FLS), use intermodal shipping containers that meet the standards of the International Organization for Standardization (ISO). Horizontal connectors are used to couple these containers for shipping by sea, highway, or rail. To determine whether a certain commercially available horizontal connector meets the tension resistance requirements for coupling intermodal shipping containers, four identical connectors were statically tested at a standard loading rate in a tension testing machine. The connectors were pulled by standard ISO corner fittings which, in turn, were pulled by the machine. Maximum applied forces were measured, recorded, and then compared with the rated capacity. This report describes the experiment and presents the results of the test.

BACKGROUND

Horizontal connectors were tested previously for tension resistance (Ref 1 and 2), with differing results. In the first test the connector failed much below the rated capacity; in the second test the connector exceeded the rated capacity. The connectors tested previously were cast steel; the connectors tested herein are forged steel. The forged connector has a manufacturer's ultimate capacity rating of 50,000 pounds. The Marine Corps requirement is 48,000 pounds (page 69 of Ref 3).

Longitudinal restraint in the rail mode is the critical condition for tension in the connector (pages 39 and 40 of Ref 3) only when: (1) 12 connectors are used to form a quad (four Marine Corps quadruple containers (QUADCONS) coupled end-to-end), (2) operational loads govern, and (3) a load factor of 2.0 is applied (page 4 of Ref 4). The Marine Corps QUADCON has a gross weight rating of 10,000 pounds, not the maximum 11,200 pounds allowed in the ISO standard, and a height of 82 inches, not the standard 96 inches.

The quad will be certified in the marine, highway, and rail modes of transportation in accordance with ISO 1496/I-1978(E) (Ref 4). It will be operated as an uncertified container with American military aircraft in accordance with Military Specification MIL-A-8421f (Ref 5), and will be uncoupled into separate QUADCONs for shipment by commercial aircraft. Furthermore, the quad will be carried on a railcar with each QUADCON lashed to the car.

EXPERIMENT

Test Specimens

The connector tested is a forged Tandemloc Inc. Horizontal Connector, Part No. 7129-45M-PZN, as shown opened in Figure 1 and closed (with cover off) in Figure 2 (Ref 6). Figure 3 shows a partially disassembled connector with internal parts named. The connector weighs 18.5 pounds (Ref 6).

Apparatus

Testing Machine and Grippers. A Baldwin-Tate-Emery testing machine was used to apply and measure the tension load. The capacity of the machine is 120,000 pounds, and the dial gage can be read to the nearest 100 pounds. The gage has one pointer that indicates the applied load and another pointer that remains at the maximum load and must be reset by hand. A constant loading rate of 10,000 lb/min was used during the tests. Grippers were required to grip the bars that were used in conjunction with the corner fittings.

Corner Fittings and Tension Bars. The maximum tension force occurs in connectors that are between bottom corner fittings; therefore, the connectors were tested between two bottom corner fittings that were secured in the machine by means of tension bars that were welded to them. The corner fittings were Tandemloc Inc. ISO Container Bottom Corner Fitting Part No. 72043-VS-B. One left bottom and one right bottom corner fitting were chosen for use as test apparatus. A typical test setup is shown in Figure 4. Figure 5 shows the same assembly mounted vertically in the testing machine. The tension bars were aligned on the centers of the holes in the corner fittings; therefore, the load was applied to the specimen without any eccentricity.

Procedure

Four specimens were chosen at random from a total population of 16 connectors. The specimens were numbered B1 through B4 and tested one at a time in accordance with the following procedure:

1. Mount the connector between the two corner fittings, using a socket wrench to close the connector.

2. Mount the connector and the corner fittings into the test machine, using the tension bars and the grippers as shown in Figure 4.

3. Preset the load at 500 pounds, then slightly release the load to check alignment and security of the specimen.

4. Load the specimen at 10,000 lb/min from zero to the failure load or 50,000 pounds, whichever occurs first.

5. Record the maximum load and remove the specimen.

The corner fittings were used in more than one test; however, if holes were extremely deformed, two new corner fittings were used.

FINDINGS

The test results are listed in Table 1. In the test plan, the test load was limited at 50,000 pounds. In the first test (specimen B3), the limit was reached and, thus, the specimen did not fail. In the other three tests, the specimens failed before the load limit was reached.

The specimens that were tested to failure had internally failed, first at the welded push block retainer nut and then on the threads of the push block drive stud. A partially disassembled specimen (B2) is shown in Figure 3. A closer view of the retainer nut depicted in Figure 6 shows that the weld had failed, causing eccentricity to occur on the push block drive stud. Figures 7, 8, and 9 show that the drive stud threads had either sheared off or been compressed due to uneven distribution of bearing loads to the drive stud stopnut. The stopnut was intentionally cut in half to show thread damage in Figure 7. The chronological order of failure is proven by specimen (B3), since its retainer nut weld failed in a similar fashion as specimen (B1) but without damage to the push block drive stud threads.

The average maximum load applied to all four connectors was 49,575 pounds. This conservative value only approximates the average ultimate capacity, since specimen B3 did not fail before its maximum load limit was reached; otherwise, a higher value would have been achieved. The mean and range of the values were 49,350 ± 650 pounds. This is also a conservative approximation for the same reason. Both the average and the mean exceed the 48,100-pound Marine Corps requirement but are below the manufacturer's ultimate capacity rating of 50,000 pounds (Ref 6). For each test, the maximum applied tension is listed in Table 2 as a percentage of the requirements.

CONCLUSION AND RECOMMENDATION

The forged Tandemloc Horizontal Connector, Part No. 7129-45M-PZN, meets the Marine Corps tension resistance requirement and should be qualified for use with intermodal ISO containers in the Marine Corps Container and Expeditionary Shelter Systems.

ACKNOWLEDGMENTS

Messers. Craig Sarsfield and Laurence G. Nixon provided assistance in setting up the tests and analyzing the results. Mr. Richard H. Seabold provided technical assistance and observed the tests.

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1. Naval Civil Engineering Laboratory. Technical Memorandum M-55-81-08: The ultimate tensile testing of the Line Fast light-duty and heavy-duty Tandemloc connectors, by R.M. Savage and R.H. Seabold. Port Hueneme, Calif., Sep 1981.

2. __________. Technical Note N-1670: Axial tension testing of horizontal connectors for use with intermodal ISO containers, by R.H. Seabold and B. Posadas. Port Hueneme, Calif., Jul 1983.

3. __________. Technical Note N-1614: Intermediate size containers: Advanced development testing (DT-I), by R.H. Seabold, J.Z. Oak, and L.J. Woloszynski. Port Hueneme, Calif., Sep 1981.

4. International Organization for Standardization. International Standard ISO 1496/I-1978(E): Series 1 freight containers - Specification and testing - Part 1: General cargo containers (third edition). Geneva, Switzerland, 1 Apr 1978.

5. Military Specification MIL-A-8421F: Air transportability requirements, general specification for, 25 Oct 1974.

6. Tandemloc Inc. Instruction Manual TNDLCHCI/017: Tandemloc horizontal connector part no. 7129-45M-PZN. Bayport, N.Y., Oct 1984.

Table 1. Maximum Tension Recorded During the Tests

Specimen No.	Maximum Tension (lb)
B1	49,700
B2	48,700
B3	50,000
B4	49,900

Table 2. Maximum Tension as a Percentage of the Requirements

Specimen No.	Maximum Tension as a Percentage of--	
	Marine Corps Requirement	Rated Capacity
B1	103	99
B2	101	97
B3	104	100
B4	104	100

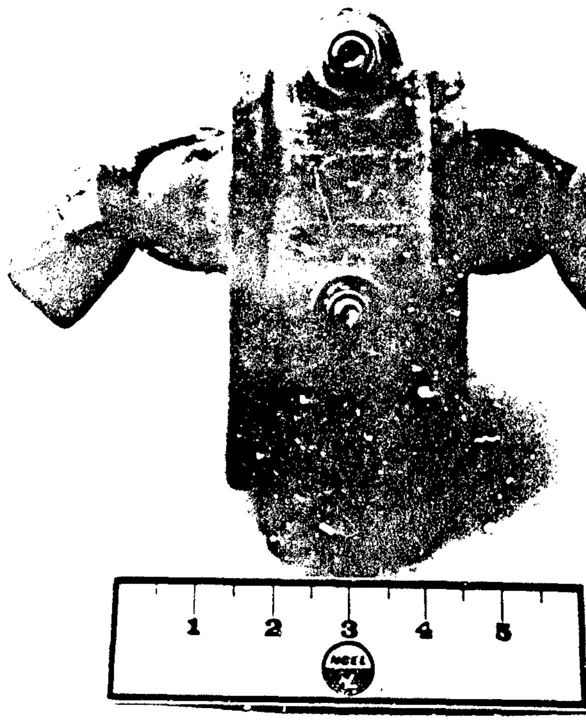

Figure 1. Tandemloc forged horizontal connector, part no. 7129-45M-PZN, in the opened position.

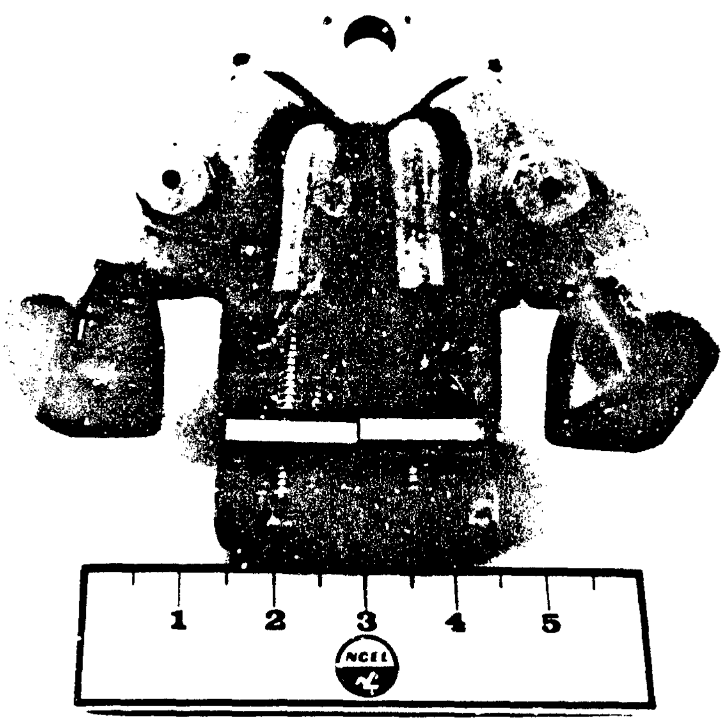

Figure 2. The Tandemloc connector in the closed position with its cover off.

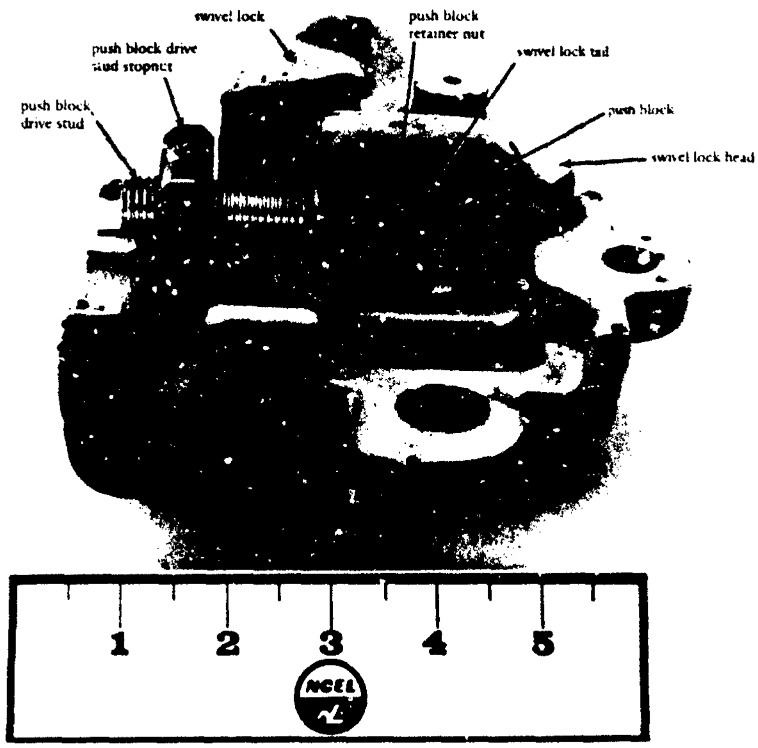

Figure 3. A partially disassembled Tandemloc connector, specimen (B2).

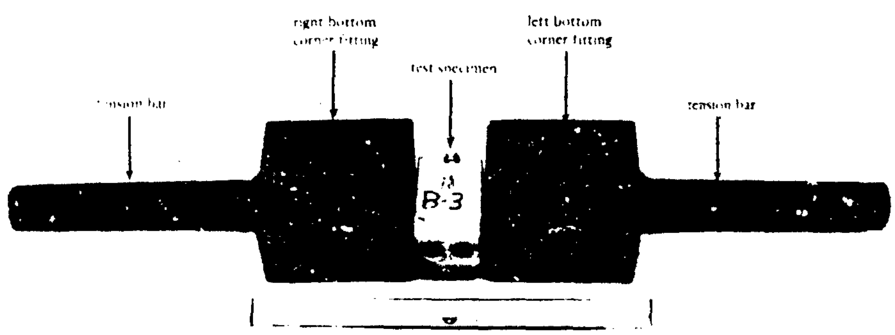

Figure 4. The corner fittings and tension bar test setup with the Tandemloc connector.

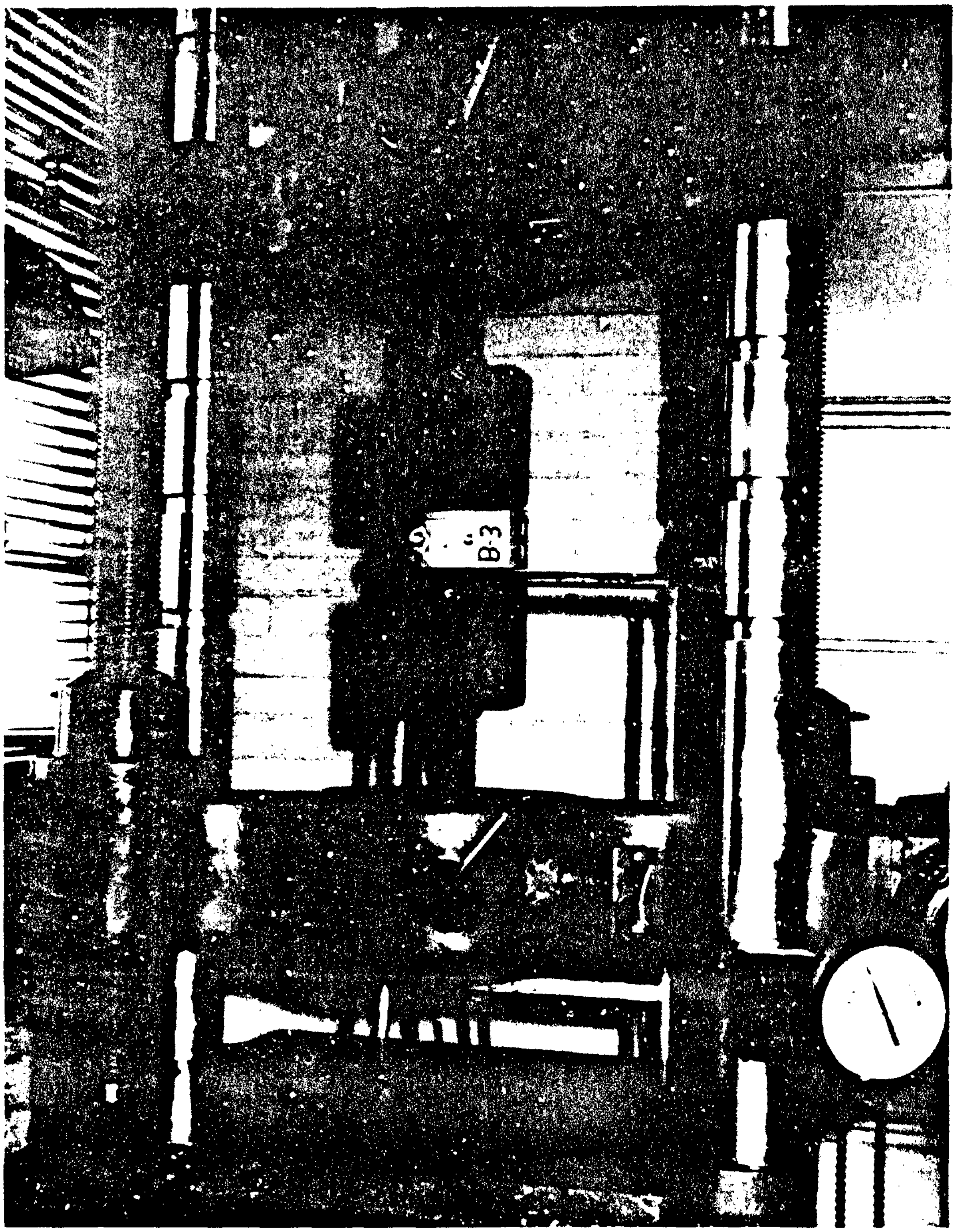

Figure 5. Specimen (B3) and corner fittings mounted vertically into the Baldwin-Tate-Emery testing machine.

Figure 6. A close-up view of the welded push block retainer nut on the drive stud of specimen (B1). Note weld crack.

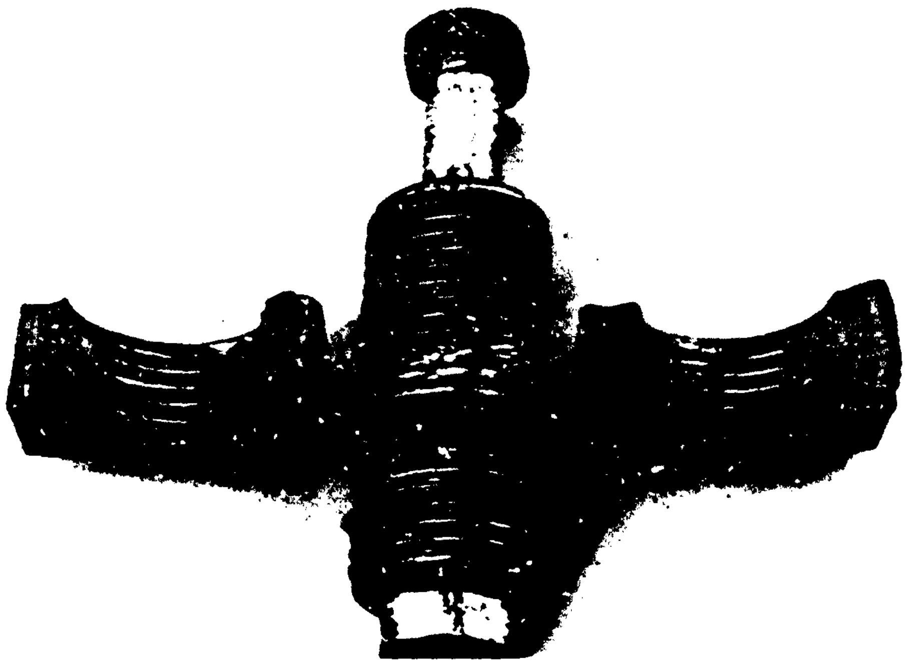

Figure 7. The push block drive stud with split stopnut of specimen (B1). Note thread damage.

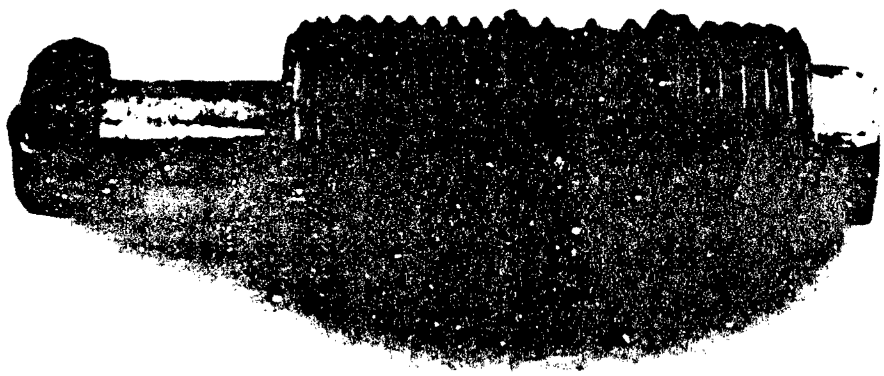

Figure 8. The push block drive stud of specimen (B1). Note thread damage.

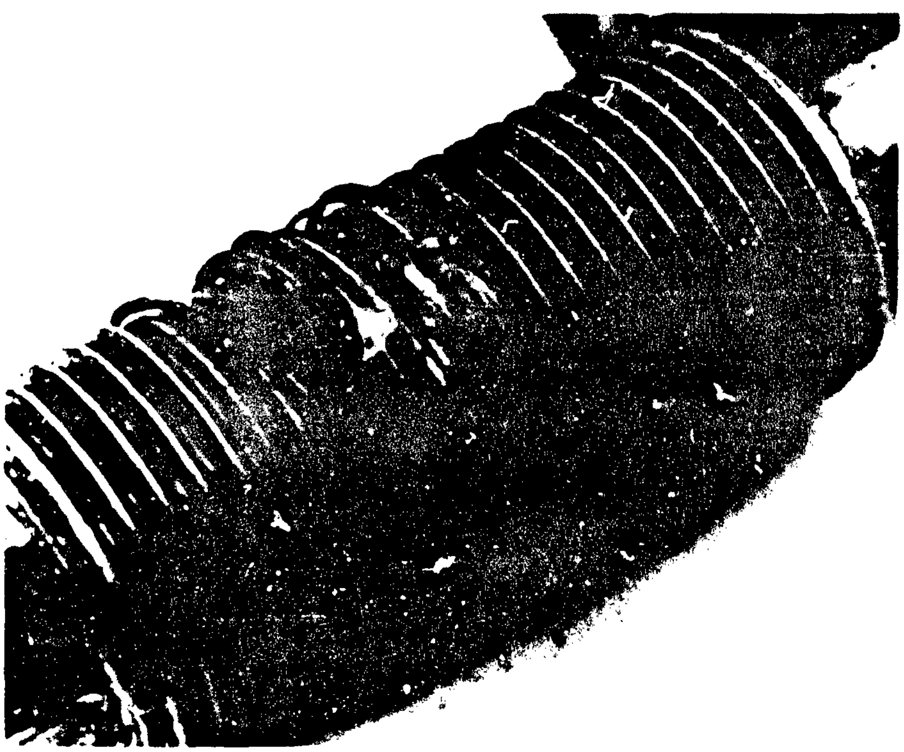

Figure 9. A close-up view of the drive stud of specimen (B1).

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DISTRIBUTION QUESTIONNAIRE

The Naval Civil Engineering Laboratory is revising its primary distribution lists.

SUBJECT CATEGORIES

1 **SHORE FACILITIES**
2 Construction methods and materials (including corrosion control, coatings)
3 Waterfront structures (maintenance/deterioration control)
4 Utilities (including power conditioning)
5 Explosives safety
6 Construction equipment and machinery
7 Fire prevention and control
8 Antenna technology
9 Structural analysis and design (including numerical and computer techniques)
10 Protective construction (including hardened shelters, shock and vibration studies)
11 Soil/rock mechanics
13 BEQ
14 Airfields and pavements
15 **ADVANCED BASE AND AMPHIBIOUS FACILITIES**
16 Base facilities (including shelters, power generation, water supplies)
17 Expedient roads/airfields/bridges
18 Amphibious operations (including breakwaters, wave forces)
19 Over-the-Beach operations (including containerization, materiel transfer, lighterage and cranes)
20 POL storage, transfer and distribution
24 **POLAR ENGINEERING**
24 Same as Advanced Base and Amphibious Facilities, except limited to cold-region environments
28 **ENERGY/POWER GENERATION**
29 Thermal conservation (thermal engineering of buildings, HVAC systems, energy loss measurement, power generation)
30 Controls and electrical conservation (electrical systems, energy monitoring and control systems)
31 Fuel flexibility (liquid fuels, coal utilization, energy from solid waste)
32 Alternate energy source (geothermal power, photovoltaic power systems, solar systems, wind systems, energy storage systems)
33 Site data and systems integration (energy resource data, energy consumption data, integrating energy systems)
34 **ENVIRONMENTAL PROTECTION**
35 Solid waste management
36 Hazardous/toxic materials management
37 Wastewater management and sanitary engineering
38 Oil pollution removal and recovery
39 Air pollution
40 Noise abatement
44 **OCEAN ENGINEERING**
45 Seafloor soils and foundations
46 Seafloor construction systems and operations (including diver and manipulator tools)
47 Undersea structures and materials
48 Anchors and moorings
49 Undersea power systems, electromechanical cables, and connectors
50 Pressure vessel facilities
51 Physical environment (including site surveying)
52 Ocean-based concrete structures
53 Hyperbaric chambers
54 Undersea cable dynamics

TYPES OF DOCUMENTS

85 Techdata Sheets
86 Technical Reports and Technical Notes
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91 Physical Security