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

AUTHOR: Bradley Posadas

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NAVAL CIVIL ENGINEERING LABORATORY
PORT HUENEME, CALIFORNIA 93043

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

**Title and Short Abstract**
AXIAL TENSION TESTING OF FORGED HORIZONTAL CONNECTORS FOR USE WITH INTERMODAL ISO CONTAINERS

**Authors**
Bradley Posadas

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**Abstract**
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.
The results of a static test to determine whether 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 requirement and should be qualified for use in the container and shelter systems.
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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 1496/1-1978(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

Messrs. 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.

REFERENCES


Table 1. Maximum Tension Recorded During the Tests

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Maximum Tension (lb)</th>
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<tbody>
<tr>
<td>B1</td>
<td>49,700</td>
</tr>
<tr>
<td>B2</td>
<td>48,700</td>
</tr>
<tr>
<td>B3</td>
<td>50,000</td>
</tr>
<tr>
<td>B4</td>
<td>49,900</td>
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</table>

Table 2. Maximum Tension as a Percentage of the Requirements

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Maximum Tension as a Percentage of---</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Marine Corps Requirement</td>
</tr>
<tr>
<td>B1</td>
<td>103</td>
</tr>
<tr>
<td>B2</td>
<td>101</td>
</tr>
<tr>
<td>B3</td>
<td>104</td>
</tr>
<tr>
<td>B4</td>
<td>104</td>
</tr>
</tbody>
</table>
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 (Bl). Note weld crack.

Figure 7. The push block drive stud with split stopnut of specimen (Bl). Note thread damage.
Figure 8. The push block drive stud of specimen (Bl). Note thread damage.

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