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Subj: Tensile Fasteners

1. Purpose. The purpose of the attached notes is to provide information on the applications, installation and inspection of tensile fasteners used as structural connections on inspected vessels. This information is furnished for guidance purposes. Where specifics are given it should be understood that mandatory application is not intended.. Nothing herein shall be taken as amending regulations or limiting the authority and responsibility of the Officer in Charge, Marine Inspection in the exercise of his good judgment.

2. Discussion. Over the years, considerable experience has been gained in the use of tensile fasteners for making structural connections on vessels. Some general conclusions can flow be drawn with regard to satisfactory types, sizing, spacing. installation and proper applications. Constructive comments and suggestions are solicited and will be the basis for future revisions to the attached notes.

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Incl: (l) Notes on the Use of Tensile Fasteners as Structural Connections on Inspected Vessels

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NOTES OF THE USE TENSILE FASTENERS AS STRUCTURAL CONNECTIONS ON INSPECTED VESSELS

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In simplest terms a tensile fastener is one which pulls structural components together by tension "stretch" in the fastener. The bolt and the lockpin art two examples. The mount of tension can be closely controlled with these fasteners and thus a predetermined "clamping force" in the joint can be attained. This is a distinct advantage in some situations.

The hot driven rivet, on the other hand, is not a true tensile fastener since it is unable to pull the work together. The structural components must be held closely before they are riveted, As the rivet cools, however, it shrinks, clamping the joint. In this sense, the rivet is similar to a true tensile fastener.

II. GENERAL COMMENTS

In this age of welded ships hot driven rivets are no longer the principal method of connecting ship structural components. Yet there are locations where riveted connections (or their equivalent) are necessary or desirable. For. example, riveted joints are used as "crack arrestors". There is also a significant amount of repair work on existing riveted structure.

Because of the vast experience with riveted joints in the marine field, installation and inspection techniques are well known. The riveted joint can be depended upon to give satisfactory results if it is properly designed and is made by skillful riveters. However, riveters are in short supply. This has caused designers and shipbuilders to investigate tensile fasteners which are easy to. install at a cost competitive with the rivet. These fasteners are not merely “rivet substitutes” Each has its own advantages and disadvantages. Each has special techniques and precautions which mist be observed if satisfactory results are to be obtained. The following discussion is intended to provide general background and answer some of the questions which arise when tensile fasteners are used.

III. SWAGE LOCXING PINS AND COLLARS (lockpins)

Lockpins comprise a headed, tapered, smooth shanked, cirtcumferentially grooved pin secured by a collar swaged into the grooves. During installation the pin is stretched in tension by a special pull tool. While the pin is held in tension the collar is swaged tight against the work. When tension is released (usually by means of a "break away" stud) the head of the pin and the collar are pulled tight against the work by the tension in the pin.

Experience bas shown that satisfactory results can be obtained in nontight, watertight and oiltight applications. Lockpins have been used successfully both above and below the waterline in hull applications. However, there is still insufficient service experience to justify blanket acceptance in all applications. Specifically lockpins have not yet been authorized for use in main longitudinal strength joints such as hull plating butts.

IV. STRUCTURAL BOLTING

The common smooth shanked bolt has not proven satisfactory in locations where high joint stability is required. The joints are subject to slip when highly stressed and water and oil tightness is difficult to attain and maintain. Ribbed shanked "body bound" bolts have also proven unsatisfactory. Installation tolerances are severe and the bolt ribs tend to peel and pack under the

"body bound" bolt of such a design that there is a relief behind each knurl which prevents "packing" of material displaced when the bolt is installed. The knurls usually form a spiral pattern which "threads" the hole, thus reducing installation forces. Because of the knurled shank, torquing is required only from the nut end; thus only one washer is needed. This fastener fills the hole, is not subject to slippage and has good strength. However, the knurled shank grooves the hole as the fastener is pulled tight. This is a possible source of cracking when the material fastened has a high a transition temperature in excess of normally encountered ambient temperatures.

The high strength bearing bolt has been accepted thus far for use in structural applications except for shell plating below the waterline and main longitudinal strength connections such as hull plating butts, provided that the material fastened has acceptable ductility properties.

V. DESIGN CRITERIA (New Construction or Conversion)

The designer should consider the following factors when evaluating the use of lockpins or high strength bolts for a particular application:

1) The fastening system chosen should be one with which a significant: amount of marine experience has been obtained or he should be prepared to furnish test results and/or other technical and service data to establish its suitability. Coast Guard acceptance of the type fastener for the application intended should be obtained early in the design process.

Z) The specific fasteners chosen should be suitable for the service intended. For example, there are a. wide variety of lockpins made of various materials, not all of which are suitable for use in all applications.

3) In general the fastener size, edge distance, spacing, etc., should be the same as for a riveted joint in the sane application. The requirements of Section 25 of the American Bureau of Shipping Rules for Building and Classing Steel Vessels should be used when they apply. In some instances a reduction in fastener diameter has been accepted on the basis of service data and test results of the particular fastener involved.

4) In general, hole size and countersink requirements should be to manufacturer's recommended tolerances. In the case of lockpins in watertight and oiltight applications a light drive fit is preferable. A maximum hole clearance of 1/64" on the diameter is acceptable in lost application: and 1/32" has been accepted in lightly loaded structure not requiring tightness.

5) Plans of the joint are required. These should include the details of the connection, the manufacturer and designation of the fastener, the manufacturer's markings appearing on the fastener and supplementary pieces such as nuts or collars, and the hole clearance and countersink requirements. The intent here is to provide an installation plan in enough detail to insure that the joint is properly designed and can be properly mad. using fastening components which are readily identifiable to the inspector.

6) In the case of fasteners having knurled or similar shanks which "cold work" the material fastened during installation information should be provided indicating that the material

considered as adequate.

V. CRITERIA FOR USE IN REPAIR

Tensile fasteners Ray be used as replacements for deteriorated rivets in an existing joint where the fasteners would be acceptable in new construction on the following basis:

1) Where they are used to replace. "isolated" deteriorated plans are no: required unless the cognizant Officer in Charge Marine Inspection determines that they art necessary. However, if the repair is extensive plans art required as noted above.

2) The size, edge distance, spacing, etc., should be the same as for the rivets replaced. Other proposals should be submitted for technical review.

3) Special attention should be given to the clearance and. counter-sink requirements which should adhere closely to those for new construction

4) The existing joint must be sound to insure that the high clamping force of the fasteners does not "start" the remaining rivets in the joint.

VI. INSPECTION

As is the case with reveted joints, there is no substitute for thorough inspection during and after installation. Though the skill necessary to set a tensile fastener is much less that that necessary for a hot driven rivet, the very ease of installation can lead to error. The following points are especially important:

A. Lockpins

1) The pull tool must be of proper size and type for the fastener and it must be in good condition. Tool wear is an important source of installation problems.

2) The holes should be clean, smooth and free from burrs. Special cart should be taken that the clearance and countersink requirements are met properly.

3) The proper pins and collars should be used. Cart should be taken to avoid collar substitutions.

4) The collars should be installed properly. There is in "up" side to most collars.

5) Careful visual inspection and "hammer testing" are necessary as for reveted connections. Detailed information as to the physical appearance of the properly set lockpin is usually available from the manufacturer. In addition, reference (a) contains important information on lockpin defects.

B. Structural Bolts

Inspection depending on the circumstances of the individual application.

C. Tightness

1) Caulking, seal welding or other beans of "correcting" poorly set fasteners are not acceptable. If the fastener is not properly installed it should be replaced. Care should be taken to avoid damaging the base material during this operation.

2) Caulking and seal welding are likewise not acceptable as means of obtaining oiltightness or watertightness around fasteners or their associated collars or nuts.

D. Repairs to an Existing Riveted Joint

1) As mentioned in Section VI, when tensile fasteners are used in repair of an existing join: care should be taken that the high clamping force of the fasteners does not "start" the remaining rivets in the joint.

VIII. REFERENCES

a) Military Specification, Pins and Collars, Swage Locking (Lockpins) General Specification for MIL-P-23469A (Ships) with Supplement.

This contains general data on a. wide variety of lockpins. The section on quality assurance is especially useful in evaluating possible manufacturing detects in the lockpins.

b) Specification for Structural Joints Using ASTM A325 or A490 Bolts; Approved by the Research Council on Riveted and Bolted Structural Joints of the Engineering Foundation September 1, 1966.

This is obtainable from the Industrial Fasteners Institute, 1505 East Ohio Building, Cleveland, Ohio 44114. It contains excellent information on installation techniques and field inspection.

c) Rules for Building and Classing Steel Vessels, American Bureau of Shipping, 45 Broad Street, New York, N. Y. 10004.

Many of the tensile fastener systems are patented and proprietary. When a specific type fastener and manufacturer ire considered for a particular project, the manufacturer's data should be obtained and studied closely. This data is often the primary source of detailed information on the fastener and its application.