Steel Interchange

This is the start of a new monthly column to discuss questions regarding structural steel design, fabrication and erection. *Steel Interchange* is an open forum for *Modern Steel Construction* readers to exchange useful and practical professional ideas and information on all phases of steel building and bridge construction. Opinions and suggestions are welcome on any subject covered in this magazine. If you have a question or problem that your fellow readers might help to solve, please forward it to *Modern Steel Construction*. At the same time feel free to respond to any of the questions that you have read here. Please send them to: Steel Interchange, Modern Steel Construction, One East Wacker Dr., Suite 3100, Chicago, IL 60601-2001.

Answers and/or questions should be typewritten and double spaced. Submittals that have been prepared by word-processing are appreciated on computer diskette (either as a wordperfect file or in ASCII format).

The opinions expressed in *Steel Interchange* do not necessarily represent an official position of the American Institute of Steel Construction, Inc. It is recognized that the design of structures is within the scope and expertise of a competent licensed structural engineer, architect or other licensed professional for the application of principles to a particular structure.

Information on ordering AISC publications mentioned in this article can be obtained by calling AISC at 312/670-2400 ext. 433.

How can one get the out-of-date design specifications and properties and dimensions of structural steel shapes that are not currently being produced?

When AISC prepares a new edition of the *Manual of Steel Construction* we survey the producers of structural shapes. The *Manual of Steel Construction* includes the properties and dimensions of the structural steel shapes currently rolled. The structural steel shapes are defined in the ASTM Specification A6/A6M, *Standard Specification for Rolled Steel Plates, Shapes, Sheet Piling, And Bars For Structural Use*. Surveying the producers and using the steel sections in the latest ASTM Specification A6 insures that the AISC Manual provides up-to-date information.

However, as the infrastructure ages and our buildings and bridges need renovation or retrofitting, they often have to be evaluated and, if necessary, strengthened to meet the current needs. And many of these structures were built with steel shapes and grades that are not produced today. The AISC book *Iron and Steel Beams 1873 - 1952* (AISC Publication No. M003) aims at helping engineers and architects to solve the problems that this question raises.

This book includes all of the properties and dimensions required for design of shapes that were produced in the U.S. between 1873 and 1952. In addition to providing design properties of the shapes, the book also contains a section that summarizes the history of the materials standards that were used. The data includes the tensile and yield strength requirements for the steels that were commonly used for bridges and buildings.

Iron and Steel Beams 1873 - 1952 does not contain any of the structural steel design specifications that were in effect throughout this period. Part of the reason for this is the lack of standardization prior to the organization of AISC in 1921. A great many different specifications were in use in the early 20th century: some of these had been developed by various municipalities or cities; others had been prepared by steel or construction companies. There are even instances where designers developed individual, unique design standards for major structures. However, appropriate working stress recommendations that were utilized at the time are shown in this book.

There is consequently no need to find, much less purchase a specification that is out of print. You must, though, take into account the properties of the actual steel that was used, including the very important chemical and metallurgical characteristics, as well as the production method itself. For example, if the structure in question is a bridge that was originally built in 1918, the steel is most likely ASTM A7. This material had a tensile strength between 55 and 75 ksi, and a specified minimum yield stress of 30 ksi. In addition, a laboratory evaluation of a coupon specimen from the steel is desirable, if possible. The loading and design criteria of the present-day building code can then be used along with the identified material properties to assess the adequacy of the structure.

However, it is also essential to consider the chemical composition of the steel; it is not uncommon to find that some of the older materials had relatively large amounts of agents such as sulphur and phosphorus. This composition may result in a relatively high carbon equivalent, which could make welding difficult.

(*Recent AISC* Engineering Journal's *have included several articles on reinforcing existing structures that are of great use to engineers working on renovations.*)

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The Research Council on Structural Connections' *Specification for Structural Joints Using ASTM A325 or A490 Bolts* states that reuse of non-galvanized A325 bolts is permitted if approved by the Engineer responsible. When should the Engineer approve reuse of A325 bolts?

Research has shown that non-galvanized A325 bolts can be reused in some applications. In order to make an appropriate choice the engineer should have some background knowledge of the research on bolted joints.

The AISC document *Quality Criteria and Inspection Standards* (AISC publication no. S323) has the following recommendation: "A325 Bolts (except if galvanized) shall be considered satisfactory for reuse, regardless of previous use, if the nuts can be placed on the threads and run down the full length of the thread by hand." (Chapter 2, Section III. E.) This is a good, simple rule based on prevention of plastic deformation of the bolt that an engineer can follow when reusing bolts.

The *Guide to Design Criteria for Bolted and Riveted Joints* (AISC publication no. P633) written by Kulak, Fisher, and Struik also includes a section on reuse of high-strength bolts. This book recommends that A325 bolts can be reused once or twice, provided that proper control on the number of reuses can be established. They state that A325 bolts have adequate nut rotation capacity as long as there is some lubricant on the bolt. This lubricant can be the original lubrication or oil, grease, wax or a lubricant that is added later.

There has only been limited testing on repetitive tightening of bolts but some good information can be obtained from the results. A detailed reference on this testing is a recent article in the AISC *Engineering Journal*: Bowman, Mark D. and Miguel Betancourt, "Reuse of A325 and A490 High-Strength Bolts," *Engineering Journal*, AISC, Vol. 28, No. 3, 3rd Quarter 1991, pp. 110-118. This paper reviews the work that has been completed and presents their own research program.

The conclusions that are reached in this paper are as follows:

On the basis of the limited number of tests conducted in this study using 7/8"-diameter A325, A490, and galvanized A325 bolts, the following conclusions regarding bolt behavior can be stated:

1. Bolts lubricated with either wax or grease perform much better, or at worst only equal to, that of similar bolts in the "as-received" condition. Thread lubrication resulted in improvements in the ultimate load, elongation, and rotational capacity of the structural fasteners tested, especially for the galvanized bolts.
2. The load-elongation characteristics of the bolts loaded in repetitive torque do not differ significantly from that of similar bolts in continuous torque. For most bolt types observed, there was a similar pattern of torque-tension behavior between the two loading methods.
3. The performance of 2½"-long bolts was found to be superior to that of 5½"-long bolts when the bolts were repetitively tightened until the bolts failed. The shorter bolts sustained an average of nine complete cycles prior to failure for all bolt types tested, whereas the longer bolts averaged four complete cycles prior to failure. A difference of one or two tightenings was observed between the black A325 and the galvanized A325 high-strength bolts.
4. Thread lubrication was observed to increase the number of cycles to failure of the repetitively tightened test bolts by one to three cycles. Moreover, thread lubrication was found to be more effective in improving the repetitive torque behavior of the galvanized bolts than of the black bolts.

New Questions

Listed below are some questions that we would like the readers to answer or discuss. If you have an answer or suggestion please send it to the Steel Interchange Editor. The question and responses will be printed in future editions of Steel Interchange.

Also if you have a question or problem that readers might help solve, send these to the Steel Interchange Editor.

1. What procedures should be followed when assessing steel that has been exposed to a fire?

2. How has the recent allowance of snug-tight high-strength bolting for certain types of shear/bearing connections affected your projects?

3. How do you decide when to use doubler plates and when to increase the size of the column?

4. What is a good "wind" connection for the top of a column?