1966

# Supplement to bibliography on bolted and riveted structural no. 48 joints, February 1966, ASCE Manual No. 48 (67-15)

J. W. Fisher

R. Kormanik

R. N. Allan

# SUPPLEMENT TO

# BIBLIOGRAPHY ON BOLTED AND RIVETED STRUCTURAL JOINTS

by

John W. Fisher

Robert Kormanik

Ronald N. Allan

This work was carried out as a part of the Bibliography on Bolted and Riveted Connections Project, sponsored by the Research Council on Riveted and Bolted Structural Joints.

Fritz Engineering Laboratory
Department of Civil Engineering
Lehigh University
Bethlehem, Pennsylvania

February 1966

Fritz Engineering Laboratory Report No. 302.2

## CONTENTS

1. ABSTRACT

2. ACKNOWLEDGEMENTS

3. INTRODUCTION

4. ABSTRACTS (Arranged Chronologically)

5. TABLES (Graphical Summaries of the Experimental Work)

6. AUTHOR INDEX

7. SUBJECT INDEX

8. CROSS REFERENCE LIST (Correlates Material in Report 302.1 with List of References)

9. LIST OF REFERENCES

# 1. <u>ABSTRACT</u>

In this supplement are presented abstracts of most of the work that has been performed during the past decade in non-English speaking countries on riveted and bolted structural joints. In addition, articles overlooked during the preparation of the initial effort (302.1) and articles written up through the end of calendar year 1965 are included.

Altogether, 249 abstracts were prepared and are included in this report. This supplements the 241 abstracts reported in the initial effort. A revised series of graphical summaries are also presented for many of the abstracts reported herein and has been combined with the summary provided in Report 302.1. These summaries are provided for all articles which report the results of experimental investigations. They provide a rapid summary of the type of connection and the major variables studied.

New lists are also provided for the user. They include the subject and author indexes and a complete listing of all the references. These lists include the material presented in the initial report (302.1). All abstracts have been renumbered by year.

## 2. ACKNOWLEDGEMENTS

The investigation reported herein was conducted at Fritz Engineering Laboratory, Lehigh University, Bethlehem, Pennsylvania. Professor W. J. Eney is Head of the Civil Engineering Department and of the Laboratory. The Research Council on Riveted and Bolted Structural Joints has continued to sponsor the project.

Throughout the work has been guided by the Council's Committee on Bibliography (Mr. R. B. Belford, Chairman and Messrs. J. E. Burke, E. L. Erickson, T. R. Higgins, E. J. Ruble, members). Dr. L. S. Beedle has served as Project Director. The authors acknowledge the advice and guidance of the Committee and Project Director.

Sincere appreciation is due Messrs. J. F. Parola and E. Chesson, Jr. for suggesting many references to include in this report. In addition, Dr. Chesson has provided many articles that were not otherwise available so that suitable abstracts could be prepared.

Thanks are also due Mr. R. Sopko and his staff for preparing the drawings; to Mrs. Carol Kostenbader for typing the manuscript; and to Mr. William Digel for reviewing the manuscript.

Sincere appreciation is due Mr. K. P. Gaedke who assisted in the preparation of many of the German language articles.

## 3. INTRODUCTION

As was noted in the initial volume of this bibliographic work, the emphasis was on Council-sponsored work. The results of this study was presented as Fritz Engineering Laboratory Report No. 302.1 entitled "Bibliography on Bolted and Riveted Structural Joints". The coverage in that report extended in time from 1944 up to June 1964. Most of the articles were reported in the English language and were also readily available.

In this report all known literature not covered in the earlier study up to December 1965 is covered. Much of the work appeared in foreign language literature. Included are articles appearing in West German, East German, Dutch, Austrian, Japanese, French, Belgium, Swiss, and Italian periodicals. In addition several early works not reported by deJonge in his bibliography on Riveted Joints which was published in 1945 were abstracted and are reported herein.

Articles published since January 1964 in the Journals of ASCE have had suitable abstracts prepared and they are not repeated herein. However, these articles are listed in the List of References which appears as in Section 9.

The abstracts in Section 4 follow the format established for the initial report. Each abstract is printed in the middle of a special card-type format so that it can be cut out and pasted on a 3 x 5 in. file card if desired. Complete bibliographic information is included with each abstract so that the article may be retrieved if desired.

All sources for each published article are listed with the principle source listed first. The other sources are enclosed in brackets after the principle source. Articles published by the ASCE in the Transactions up to 1963 are listed as principle sources even though they first appeared in the Proceedings. Articles published by AREA have the AREA Proceedings indicated as the principle source. Original reports issued by the research agency are also included in the bracketed sources.

The abstract number assigned in this supplement appears in the bottom right hand corner. These numbers are used for reference in all sections of this report. The numbering system used herein differs from that used in the initial report (302.1). Numbers have been assigned chronologically within each year.

The tables in Section 5 are designed to give a quick summary of the experimental work. The tables in this supplement include the material presented in the first report as well as the new material reported herein. The revised Reference number system has been used for all reports. Cross reference to the numbering system used in Report 302.1 is provided in Section 8.

The list of references given in Section 9 includes all the abstracts reported in this supplement and the initial report. An effort has been made to make this listing as complete as possible. All possible reference sources are included in this listing. Reference is made to the principle source as only one abstract has been prepared. Since reference numbers are assigned to sources which appear earlier than the principle source, they have been assigned numbers for the year they appeared.

The author and subject indexes follow standard format. They include information presented in Report 302.1.

## 4. A B S T R A C T S

The abstracts in this section appear in chronological order. The numbers are not necessarily consecutive since the abstracts presented in the earlier report (302.1) have been included in the revised numbering system. The reader is referred to Section 8 if he desires to correlate the material. Complete bibliographic information is included with each abstract.

Greiner, J. E.
RECENT TESTS OF BRIDGE MEMBERS, Transactions, ASCE, Vol. 38, December, 1897

The Results are given for six series of tension tests of bridge members other than eye-bars. Studied were the strength and value of built-up tension members, the net area required behind pin holes in plates having sheared and planed ends, the tensile strength of single angles having ends riveted to connection plates, and the strength of steel which has been worked partly hot and partly cold. The test specimens and the results are discussed in detail.

KEY WORDS: joint; rivet; steel; strength; tension; testing

97-1

---

Deming, G. M.
THE STRENGTH OF BOLT THREADS AS AFFECTED BY INACCURATE MACHINING, Mechanical Engineering, Vol. 45, 1923, pp. 583-585

Discussed are the results of experiments conducted at the National Bureau of Standards to determine the effect of variations in the pitch-diameter clearance, the face angle of the nut on tensile strength and the effect of materials used. It was found that as the clearance increases the proportional limit and yield point decrease. As the face angle of the nut increases the proportional limit and yield point are practically constant for angles up to 6 degrees. The strength of heat-treated nickel steel is higher than that of open-hearth cold-rolled steel. Bolts of nickel steel showed more strength after the proportional limit is reached than did bolts of open-hearth cold-rolled steels.

KEY WORDS: bolts; steel; strength; testing

23-1

---

Whittemore, H. L., Nusbaum, G. W., and Seaquist, E. O.
THE RELATION OF TORQUE TO TENSION FOR THREAD-LOCKING DEVICES, U. S. Bureau of Standards, Journal of Research, Vol. 7, 1931, pp. 945-1016.

This investigation determined the torsional resistance to unscrewing of nuts, with and without locking devices, under static loads, and the relationships these torques have to the stresses in the bolt. The torque required to produce a given bolt stress was also determined for each device. Forty-one devices were tested, including standard nuts, jam nuts, and slotted nuts with cotter pins. Only about one-quarter of these devices showed a static torque-tension relation different from that of the American National coarse-thread standard nut.

KEY WORDS: bolts; nuts; testing; torque

31-1

---

Whittemore, H. L., Seaquist, E. O., and Nusbaum, G. W.
IMPACT AND STATIC TENSILE PROPERTIES OF BOLTS, U. S. Bureau of Standards, Journal of Research, Vol. 14, 1935, pp. 139-188.

This investigation determined the properties of bolts under impact and static tensile loading. The 360 specimens tested represented all possible combinations of 5 different materials, 4 different bolt diameters, and 3 different thread forms. In all cases the impact work for bolts of American National coarse threads was less than for bolts of the same size and material with American National fine threads. Except for the brass bolts and those cold-rolled steel bolts which showed brittle failures, the impact work for bolts with American National fine threads was approximately the same as for bolts of the same size and material with Dardelet threads. Similar relations were observed for static work and maximum static load.

KEY WORDS: bolts; impact; steel; strength; testing; threads

35-1

Chapin, C. H.
THE NET SECTION OF RIVETED TENSION MEMBERS, Proceedings, AREA, Vol. 36, 1935, pp. 775-779.

Previous methods of determining the net section of a riveted tension member and general background information are given. A discussion of the Cochrane 1922 formula and its adoption into the proposed A.R.E.A. Railway Bridge Specifications is presented. The specifications are given, together with an illustration of their application.

KEY WORDS: analysis; joints; specification

35-2

---

Brueggeman, W. C.
MECHANICAL PROPERTIES OF ALUMINUM-ALLOY RIVETS, NACA Technical Note 585, Nov., 1936.

This report gives the results of tests to develop the riveting technique for test specimens and to determine the effect of several factors on the strength of riveted joints. These factors include the form of the head, the ratio of the rivet diameter to sheet thickness, and the driving stress. Also discussed is the effect of upsetting the rivet shank upon the tensile and shear strength of a joint, and whether there is a relationship between the radial deformation of the sheets and the driving stress at which buckling and separation of the sheets occur.

KEY WORDS: joints; rivet; strength; steel; testing

36-1

---

Korber, F., and Hempel, M.
THE BEHAVIOR OF WELDED AND BOLTED BEAM COLUMN CONNECTIONS IN STATIC AND FATIGUE BENDING, Welding Journal, Vol. 17, March, 1938, pp. 23-30

Reported are investigations of stress distribution and yield phenomenon under load in beams with especially stiff welded or welded and bolted column connections. The behavior of the connections under bending fatigue was also examined for several mean stress levels. Irregularities in the stress distribution in the welded specimens were detected at the edges of the upper and lower flanges, which indicated local stress concentrations at the junction between weld and beam. The measurements also show that the strains depend on the shape of the specimens and that concentrated loads materially affect the results, particularly in the continuous beams.
Fatigue tests caused the weld to fail in the column sections with welded connecting plate, but caused the bolts to fracture in the combined bolted and welded specimens.

KEY WORDS: bolt; fatigue; joints; steel; strength; testing; weld

38-1

---

Goodier, J. N.
THE DISTRIBUTION OF LOAD ON THE THREADS OF SCREWS, ASME Transactions, Vol. 62, 1940, pp. A10-A16.

The distribution of loads and the types of deformation affecting the threads of screws were investigated by means of extensometer measurements made on the outside of the nut. The types of deformation characteristic of concentrations of load on different parts of the thread were found by using a bolt carrying only a single turn of thread. Conclusions are reached concerning low and high load values on threads, and an application of an approximate method for deducing the distribution from deformation measurements. Distribution is governed by stretch and compression in the bolt and nut, respectively; bending of the thread; circumferential stretch (at the base); and contraction (near the free end) of the nut wall, all of which have comparable effects in reducing the concentration.

KEY WORDS: analysis; bolts; nuts; stress; testing; threads

40-1

Rust, T. H.
SPECIFICATION AND DESIGN OF STEEL GUSSET PLATES, ASCE Transactions, Paper No. 2058, Vol. 105, 1940, pp. 142-166.

This general article presents specifications for and design of gusset plates, supported by experimental work with photoelasticity.

KEY WORDS: design; joints; specifications; steel; testing

40-2

---

Johnston, B. and Hechtman, R. A.
DESIGN ECONOMY BY COLUMN RESTRAINT, Engineering News Record, Vol. 125, October, 1940, pp. 484-487.

A design procedure is prepared that proportions the connections for the semi-rigid end movements which will occur if the columns do not rotate, and proportions the beam for the maximum center movement which occurs when the columns do rotate. A study of 105 beam sizes shows that this design reduces beam weight by 15 to 20 percent. The semi-rigid joint and the joint constant are discussed in detail. The design procedure is explained step by step, and an illustration is provided.

KEY WORDS: analysis; design; joints; semi-rigid

40-3

---

Brueggeman, W. C. and Roop, F. C.
MECHANICAL PROPERTIES OF FLUSH RIVETED JOINTS, NACA Report No. 701, 1940

The strength of representative types of flush-riveted aluminum joints was determined by testing 865 single shearing, double shearing, and tensile specimens representing 7 types of rivet and 18 types of joint. The results, presented in graphic form, show the stress at failure, type of failure, and d/t ratio. In general, dimpled joints were appreciably stronger than countersunk or protruding-head joints, but their strength was greatly influenced by constructional details. The optimum d/t ratios have been determined for the several kinds of joints. Photomacrographs of each type show constructional details and, in several instances, cracks in the sheet.

KEY WORDS: aluminum; joints; rivets; strength; testing

40-4

---

Hartmann, E. C.
FATIGUE TESTS RESULTS, THEIR USE IN DESIGN CALCULATIONS, Product Engineering, February, 1941, pp. 74-78.

Design to include the effects of repeated loading is discussed in this paper. The following factors which must be taken into consideration to prevent a faulty fatigue analysis are discussed in detail: stress range; number of cycles; condition of surface of metal; influence of holes, notches, re-entrant corners, and other points of stress concentration; and effect of plastic action at stresses above the elastic range. An example of how such factors are employed in predicting the strength of an aluminum alloy riveted joint is given and compared to experimental results.

KEY WORDS: aluminum; design; fatigue; joints; testing

41-1

Templin, R. L. and Hartmann, E. C.
STATIC AND REPEATED LOAD TEST OF ALUMINUM ALLOY AND STEEL RIVETED HULL PLATE SPLICES, Alcoa Research Laboratories Technical Paper, No. 5, 1941.

The 6 different types of joints tested in static load and fatigue represented actual riveted hull plate splices of high tensile steel, medium steel, and aluminum alloy designed for equal loads per inch of width. Comparative deformations, static strengths, and fatigue strengths were measured. The tests indicate that aluminum alloy riveted hull construction should be as satisfactory, from the standpoint of strength in actual service, as the medium steel riveted construction which has been so successful.

KEY WORDS: aluminum; fatigue; joints; rivet; steel; strength; testing

41-2

---

Brueggeman, W. C.
MECHANICAL PROPERTIES OF FLUSH-RIVETED JOINTS SUBMITTED BY FIVE AIRPLANE MANUFACTURERS, NACA Wartime Report W-79, February, 1942.

Reported are tests on standardized specimens obtained from 5 airplane manufacturers. Strength, defects, and the effect of the angle of rivet head were determined. The specimens represent combinations of structural members frequently joined by flush rivets and were selected to afford a comparison between the different types of rivets and riveting processes. The present program completes tests on series of specimens from 15 manufacturers of which 5 series have been completed and are reported herein.

KEY WORDS: aluminum; joints; rivets; testing

42-1

---

Levy, S., McPherson, A. E., and Ramberg, W.
EFFECT OF RIVET AND SPOT-WELD SPACING ON THE STRENGTH OF AXIALLY LOADED SHEET-STRINGER PANELS OF 24S-T ALUMINUM ALLOY, NACA Technical Note 856, August, 1942.

Eighteen 24S-T aluminum alloy sheet stringer panels were tested in end compression under carefully controlled edge conditions. The stringers were fastened to the sheet by either brazier head rivets, or spot welds, or round head rivets. For the first two fastener types, measurements were made of the stringer strains and of the buckling deflections of the sheet. In the tests of the panels with round head rivets, only the buckling loads and ultimate loads were measured. Most of the observed buckling loads and deflections were in agreement with Howland's theory and Timoshenko's theory, and indicated that the two types of buckling were substantially independent of each other for the specimens tested. A nomogram was devised for calculating the load for failure by stringer instability of panels. No significant differences were found in strength of panels fabricated with the different fasteners.

KEY WORDS: aluminum; compression; rivets; stringers; testing

42-2

---

Johnston, B., and Mount, E. H.
ANALYSIS OF BUILDING FRAMES WITH SEMI-RIGID CONNECTIONS, Transactions, ASCE, Vol. 107, 1942, pp. 993-1019.

Methods using charts and diagrams for analysis of building frames with semi-rigid riveted or welded connections between the beams and columns are presented. Economy through reduced beam size requirements is made possible by considering partial restraint afforded by standard or near-standard connections, particularly riveted or welded connections of the top- and seat-angle type. This paper also presents test results of a welded building frame that corroborate the methods of analysis. Included is a study of the effect of neglecting the member width in the analysis.

KEY WORDS: analysis; joints; rivets; testing; welds

42-3

Sharp, W. H.
THE EFFECT OF THE TYPE OF SPECIMEN ON THE SHEAR STRENGTHS OF DRIVEN RIVETS, NACA Technical Note 916, November, 1943.

Tests of various types of riveted joints composed of 24S-T sheet and 1/8-inch A17S-T rivets were made to determine the effects of specimen type on shear strengths and deformation characteristics of the joints. There was only slight variation in shear strength with considerable variation in the type of specimen. Lap joints gave a shear strength about 2 percent greater than joints with a single-butt strap and about 4 percent greater than double shear double-butt-strap joints. Joints in which a single rivet resists the shearing forces gave about 0.6 percent greater shear strength than joints with two or more rivets. The double-shear joints generally resisted deformation better than other types of joints.

KEY WORDS: aluminum; joints; rivets; strength; testing

43-1

Arnold, S. M.
EFFECT OF SCREW THREADS ON FATIGUE, Mechanical Engineering, Volumn 65, pp. 497-505, 1943.

The failure of metal parts under repeated loads at stresses well below the stresses for failure under static loading is discussed. This review is primarily concerned with investigations which include endurance testing of threaded members and screwed joints and was made in an attempt to segregate information concerning screw threads from the general topic of metal fatigue. Three broad classifications of recommendations are established. These are the choice and treatment of the material to be used as screw stock, changes affecting the physical dimensions and shape of the threaded part, and the post-manufacturing treatment.

KEY WORDS: bolts; fatigue screws; testing; threads

43-2

Hetenyi, M.
A PHOTOELASTIC STUDY OF BOLT AND NUT FASTENINGS, Transactions, ASME, Vol. 65, 1943, pp. A93-A100.

This investigation was designed to find ways of improving stress distribution in bolt and nut fastenings through changes in nut design. For this purpose four bolt models, with nuts at both ends of each bolt, were machined out of photoelastic Bakelite and were tested by the three-dimensional photoelastic stress freezing method. Six different nut designs were tested, and the maximum stress values at the bottom of the threads for each design were obtained. It has been found that by the application of either a tapered-thread nut or a nut with a tapered lip the strength of the fastening can be increased by more than 30 per cent. This improvement can be expected only when the type of loading or condition of application is conducitve to brittle failure, such as dynamic loads or static loads at elevated temperatures.

KEY WORDS: analysis; bolts; nuts; photoelastic; stress; testing

43-3

Hartmann, E. C. and Wescoat, C. F.
THE SHEAR STRENGTH OF ALUMINUM ALLOY DRIVEN RIVETS AS AFFECTED BY INCREASING D/t RATIOS, NACA Technical Note 942, July, 1944

This report describes the results of an investigation of single shear joints and of previous investigations of double shear joints. The 1/2-inch protruding-head aluminum alloy rivet used for these tests was driven in aluminum alloy plates of various thicknesses. The single- and double-shear strength of these rivets decreases below the basic value if the bearing stress exceeds 2-1/2 times the shear stress, and the rate of decrease of shear strength is greater with double-shear than single-shear rivets. Equations for prediction of shear strength of protruding-head aluminum alloy rivets driven in aluminum alloy plates are given.

KEY WORDS: aluminum; joints; rivets; strength; testing

44-2

Hartmann, E. C., Hoglund, G. O., and Miller, M. A.
JOINING ALUMINUM ALLOYS, Steel, Vol. 1151, September 11, 1944, pp. 116

A method for resin-binding metal-to-metal or non-metal joints is presented. The uses of natural, synthetic, and thermoplastic adhesives are discussed. Resin-bonded joint design and the performance of joints made with adhesives are outlined.

KEY WORDS: aluminum; adhesive; design; joint; strength

44-3

---

Zamboky, A. N.
ARTIFICIAL AGING OF RIVETED JOINTS MADE IN ALCLAD 24S-T SHEET USING A17S-T, 17S-T, AND 24 S-T RIVETS, NACA Technical Note 948, September, 1944.

Investigated was the effect of artificial aging on the shear strength of joints of alclad 24S-T sheet using commercial alloy rivets A17S-T, 17S-T, and 24S-T. The change in shear strengths from aging treatment of 10 hours at 375°F applied to the driven rivets was as follows: 24S-T rivets increased 6 percent, 17S-T driven refrigerated showed no change, 17S-T driven in the full T temper decreased 8 percent, and A17S-T decreased 10 percent.

KEY WORDS: aluminum; aging; joints; rivets; strength testing; temperature

44-4

---

Hartmann, E. C., Lyst, J. O., and Andrews, H. J.
FATIGUE TESTS OF RIVETED JOINTS: PROGRESS OF TESTS OF 17S-T AND 53-T JOINTS, NACA Advance Restricted Report 4115, September, 1944 (also Wartime Report W-55)

This report presents fatigue data obtained at the Aluminum Research Laboratories from tests of various types of 17S-T and53S-T specimens. These specimens were designed to be large enough to represent actual service conditions, but the repetition of loading was more rapid than would occur in normal service, to shorten the testing time. Two plate materials, 3 rivet materials, 29 types of specimens, and 4 different stress ratios were used in the tests and 486 test specimens are covered in this progress report. In addition to tests of actual joint specimens, 72 of the 486 tests were made using single plate specimens which either were solid or contained open holes or idle rivets. A summary of results is given.

KEY WORDS: aluminum; fatigue; joints; rivets; testing

44-5

---

Moisseiff, L. S., Hartmann, E. C., and Moore, R. L.
RIVETED AND PIN-CONNECTED JOINTS OF STEEL AND ALUMINUM ALLOYS, Transactions, ASCE Paper No. 2233, Vol. 109, 1944, pp. 1359-1396

In view of the need for experimental data on the behavior of newer (sic) structural materials, tests of riveted and pin-connected joints were undertaken. Five alloys (two steel and three aluminum) having a fairly wide range of ductilities and ratios to yield to ultimate strength were included. All of the joints tested behaved in a manner consistent with the basic assumptions of design and with the properties of the materials. Furthermore, the tests showed that the plastic yielding must be relatively small, for a uniform distribution of load among the rivets and that differences in ratios of yield strength to ultimate strength, elongation values, and moduli of elasticity are not significant factors in static ultimate strength of compact joints.

KEY WORDS: aluminum; load distribution; joint; rivet; steel; strength; testing

44-8

Wilson, W. M., Bruckner, W. H., Duberg, J. E. and Beede, M. C.
FATIGUE STRENGTH OF FILLET-WELD AND PLUG-WELD CONNECTIONS IN STEEL STRUCTURAL MEMBERS, Bulletin No. 350, University of Illinois Engineering Experiment Station, 1944.

The majority of the tests reported are of fillet-weld and plug-weld joints to determine the best type of each to withstand fatigue. Reported also are fatigue tests of 12 double-strap and 18 single-strap riveted butt joints in carbon and low-alloy steels. Several composite riveted and fillet-weld joints were tested, as well as a series of connections riveted eccentrically to gusset plates. Twelve continuous plates with riveted transverse double-tee connections were also tested. Riveted joints reinforced with plates to compensate for reductions due to rivet holes did not have higher fatigue strengths than riveted joints without reinforcement. Results of all fatigue tests are given.

KEY WORDS: fatigue; joints; rivets; steel; strength; testing; welds

44-9

---

Hartmann, E. C., Hoglund, G. O., and Miller, M. A.
METHODS OF JOINING ALUMINUM-ALLOY PRODUCTS, Transactions ASME, Vol. 67, No. 1, January 1945, pp. 1-21

This detailed discussion clarifies the many procedures for making joints with aluminum alloys, including riveting, welding, brazing, soldering, and resin-bonding. Included under each method is the basic method, the joint design, and the performance of joints; but more information will be required to actually use the methods.

KEY WORDS: aluminum; bracing; joints; rivets; soldering; welds

45-1

---

Andrews, H. J., and Holt, M.
FATIGUE TESTS ON 1/8 INCH ALUMINUM ALLOY RIVETS, NACA Technical Note, February, 1945

The purpose of this report is to summarize the results of fatigue tests made to date in the Aluminum Research Laboratories of lap joints having 1/8-in. aluminum alloy rivets. The rivet materials were 175-T, A17 S-T, 24S-T, and Alclad 24S-T. Summarized in a table are the test results of 1/8-in. diameter rivets, including information on alloy and type of rivet, sheet alloy and thickness, preparation of rivet holes, and type of failure. Another table lists fatigue strengths. Comparisons are made using the data.

KEY WORDS: aluminum; fatigue; joints; rivets; testing

45-2

---

Moore, R. L., and Hill, H. N.
COMPARATIVE FATIGUE TESTS OF RIVETED JOINTS OF ALCLAD 24S-T, ALCLAD 24S-T81, ALCLAD 24S-RT, ALCLAD 24S-T86, AND ALCLAD 75S-T SHEET, NACA, Bulletin No. SF11, August, 1945 (Also Wartime Report W-76).

Reported is a series of tests to determine the fatigue strength of various types of riveted and spot-welded joints in the aluminum alloys of current interest in aircraft design. All sheets were 0.064 in. thick with 2-1/2 percent Alclad coating on each side, and the rivets were 3/16-in. 24S-T with brazier manufactured heads and flat-driven heads. Listed in tables are the tensile properties of the specimens and the average joint strengths obtained in both static and fatigue tests.

KEY WORDS: aluminum; fatigue; joints; rivets; testings; welds

45-4

Wilson, W. M., and Ozell, A. M.
INVESTIGATION OF THE STRENGTH OF RIVETED JOINTS IN COPPER SHEETS, Bulletin No. 360, University of Illinois Engineering Experiment Station, 1945.

The 220 riveted joint tests described in this report determined the strength of riveted joints against failure by each of the following: tearing out of rivets to the edge of the sheet, shearing the rivets, bearing pressure of the rivets against the edge of the holes in the sheet, and tension failure of the sheet between the rivets. Also conducted were tests to determine the effect of the rivet pattern upon the strength of the sheets. Determined also was the relation between the load and the slip of the rivets, and between the load and separation of the sheets at the edge of the joints. The results are reported, including joint efficiencies.

KEY WORDS: analysis; copper; joints; rivets; strength; testing

45-7

---

Hartmann, E. C. and Zamboky, A. N.
COMPARISON OF STATIC STRENGTHS OF MACHINE COUNTERSUNK RIVETED JOINTS IN 24S-T, X75S-T, AND ALCLAD 75S-T SHEET, NACA Technical Note 1036, May, 1946

This investigation compared the static strengths of machine-countersunk riveted joints of different alloys to evaluate the differences in cutting action of the sharp edge of the sheet when the machine-countersunk hole was the same depth as the thickness of the sheet. The ultimate shear strength of aluminum alloy rivets in machine-countersunk joints is 23 to 39 percent less in this series of tests than the shear strength of protruding-head rivets of the same alloy. The reduction in ultimate shear strength caused by the cutting action of the countersunk hole is greater in hard sheet (X75S-T) than in softer sheet (24S-T) and greater in non-clad sheet (X75S-T) than in Alclad sheet (Alclad 75S-T).

KEY WORDS: aluminum; joints; rivets; strength; testing

46-2

---

Bolt, M.
FATIGUE FAILURES OF BOLTED, WELDED, AND RIVETED CONNECTIONS, Proceedings, Society of Experimental Stress Analysis, Vol. 3, No. 2, pp. 131, 1946.

Included in this general discussion of fatigue failures in structures, machines, and other manufactured parts, are the following factors: material, design of joints, manufacture and operation, and maintenance of structural joints. The various responsibilities of designer, manufacturer, and operator share in the sucessful operation of manufactured parts subjected to fatigue action.

KEY WORDS: bolts; fatigue; failures; joints; rivets; strength; welds

46-3

---

Boiten, R. G.
HEF GEDRAG VAN OP TREK BELASK VERBINDINGEN, BESTAANDE UIT STRIPPEN, DIE DOOR EEN BOUT OP EL KARR WORDEN GEKLEMD. (CONNECTIONS SUBJECTED TO TENSION FORCES, CONSISTING OF LONG PLATES WHICH ARE CONNECTED BY BOLTS). De Ingenieur, Vol. 59, No. 2, 1947, Holland, pp. 1-7.

Tests were performed on butt joints fastened with two bolts. The bolts were prestressed by tightening. The joints were then tested under static tensile forces. The results of 55 tests are presented. The effects of surface conditions and surface treatment on the slip resistance and ultimate capacity of joints are investigated.

KEY WORDS: bolts; friction; joints; surface treatment; testing

47-3

Pefferman, R. L., and Langhaar, H. L.
INVESTIGATION OF 24S-T RIVETED TENSION JOINTS, Journal of the Aeronautical Sciences, Vol. 14, No. 3, March, 1947, pp. 133-147

Test data are given, in duplicate, for approximately 110 different tension joints formed by uniting 24S-T sheets with protruding-head rivets. With the aid of a general empirical "stress-concentration" factor, the data are well correlated with a modified form of the elementary theory of tension joints. The modification lies in the assumption that rivets of unequal diameter in a joint carry equal bearing stresses, rather than equal shearing stresses, when ultimate load is approached. Extensive data are given to demonstrate that this is a good approximation for 17S-T rivets in 24S-T sheets. An algebraic formulation of the elemtary theory is presented to render the problem of optimum proportions of a multiple-row joint accessible to mathematical analysis. Explicit rules are developed for laying out efficient joints.

KEY WORDS: aluminum; analysis; joints; rivets; strength; testing

47-4

---

Badir, M.
THE EFFECT OF RIVET PATTERN ON THE STRENGTH OF RIVETED JOINTS, M. S. Thesis, University of Illinois, 1947.

Previous static tests of riveted joints have led to the following two conclusions: first, their useful net area cannot be increased to more than about 75% of the gross area by choosing rivet patterns in which some of the rivets in the outer row are omitted; and secondly, that the rules used in determining the effective net area of riveted members do not agree with test results. This thesis attempts to check these conclusions and to find a rivet pattern which yields a joint efficiency higher than 75%. Six specimens with different rivet patterns were tested, each designed to fail in the plates. A digest is made of the literature describing similiar tests and includes a summary of the results.

KEY WORDS: design; efficiency; joints; rivets; steel; testing

47-6

---

Hendry, A. W.
THE TESTING OF STRUCTURAL CONNECTIONS, Engineering, Vol. 164, No. 4259, September 12, 1947, London, pp. 261-263

Experiments on portal-frame knees are reported in this discussion. The main object was to demonstrate the stability of the knee joint. Discussed are the design of portal frames, the parts of the stresses at the knees, and the best detail for the knees. The first series of tests ecamined the stress distribution in various types of knees in the elastic range, and further tests were conducted on 3 transparent plastic models, using the photo-elastic method. The effect of varying the length of the legs of the frame and the stresses in other shapes of knees was investigated. Tests on steel frames were carried out to determine the maximum loads the connections would carry and their behavior after plastic yielding had commenced. Simple rules were deduced from these tests for proportioning stiffeners for the portal frames. Twenty welded frames were tested to determine the variation in strength that may be encountered in welded construction.

KEY WORDS: analysis; design; frames; joints; plastic; steel; strength; testings; welds

47-7

---

Hechtman, R. A.
A STUDY OF THE EFFECTS OF HEATING AND DRIVING CONDITIONS ON HOT-DRIVEN STRUCTURAL STEEL RIVETS, Ph.D. Thesis, University of Illinois, Sept. 1948.

The investigation studies the thermal and mechanical behavior of the structural rivet during heating, driving, and subsequent cooling, and then correlated this behavior with the metallurgical characteristics and mechanical properties of the rivet steels. Secondly the effect of heating and driving conditions upon the metallurgical quality of the driven rivet was determined. These studies were made with 7/8-in. rivets of 3 carbon steels and 1 silico-manganese steel, all driven by pneumatic hammer. The suitability of full-killed carbon steel for rivets and the comparative forgeability of the 4 rivet steels were examined. The determination of initial tensions developed in a hot-driven rivet during driving and cooling is carried out.

KEY WORDS: metallurgy; properties; rivets; steel; testing

48-5

Sopwith, D. G.
THE DISTRIBUTION OF LOAD IN SCREW THREADS, Proceedings, Institution of Mechanical Engineers, Vol. 159, London, pp. 373-383, 1948

The distribution of load along the length of a nut is examined. The strains set up in the bolt and nut under load are analyzed, and the load distribution along the thread helix is deduced. It is shown that the load may be taken as concentrated at mid-depth of the threads. In the normal bolt-and-nut case the maximum intensity of loading occurs at the bearing face of the nut, and may be two to four times the average, depending on thread form, proportions of the members, and lubrication. Discussed are possible methods of improving the load distribution such as differential pitch, tapered threads, and softer material for the nut; and the effect of yielding on load distribution. Experimental results are included.

KEY WORDS: analysis; bolts; nuts; stress; testing

48-6

---

Hartmann, E. C., Miller, M. A., and Stroup, P. T.
JOINING ALUMINUM ALLOYS, National Metals Handbook, 1948, pp. 777-786

Methods of joining aluminum alloys are presented, including detailed descriptions of riveting; welding by gas, metal arc, carbon-arc, tungsten-torch; furnace and dip processes; diffusion bonding; resin bonding; and soldering.

KEY WORDS: aluminum; bonding; joints; riveting; welding

48-7

---

Ros, M. and Ceradine, G.
STATIC AND FATIGUE TESTS WITH DIFFERENT TYPES OF COVER STRAPS WELDED ON AND MACHINED FROM THE SOLID STEEL MATERIAL AND ALSO WITH LAP JOINTS, Bericht Nr. 168, EMPA, Zurich, 1949.

Reported are 3 groups of tests to determine the fatigue strength of the specimens and to support mathematical evaluation of the fatigue strength. The group of interest is the third group, Lap Joints, of which 9 were tested in static tension and fatigue in riveted, welded, and combined riveted and welded conditions. The lateral deflections are reported for the different joints, and a comparison is made between the measurements and the calculations.

KEY WORDS: fatigue; joints; rivets; strength; steel; testing; welds

49-3

---

Cayci, M. A.
FATIGUE STRENGTH OF RIVETED JOINTS, M. S. Thesis, University of Illinois, 1949

This report reviews German literature on the fatigue strength of riveted joints and compares the results of the German tests with the results of similar tests conducted at the University of Illinois. The test variables compared and thier effect on the fatigue strength are as follows: kind of steel, influence of friction between plates, unit rivet bearings, unit rivet shear, relation of minimum to maximum stress in stress cycle, and transverse distance between rivets. A summary of the results of all tests and the effect of the variables is given.

KEY WORDS: fatigue; joints; rivets; steel; strength; testing

49-5

Wilson, W. M., and Munse, W. H.
THE FATIGUE STRENGTH OF VARIOUS DETAILS USED FOR THE REPAIR OF BRIDGE MEMBERS, Bulletin No. 382, University of Illinois Engineering Experiment Station, 1949

Experiments were conducted to determine the relative fatigue strength of various devices proposed or actually used to strengthen or repair old bridge members to discover and eliminate those methods that involve details with low fatigue strength, and to determine quantitatively the fatigue strength of the members thus strengthened or repaired. The methods included the shortening of eyebars of reinforced bridge members for which an increased area has become necessary due to an increase in load and other expedients used to splice members in service.

KEY WORDS: fatigue; joints; repairs; steel; strength; testing

49-6

---

Holt, M.
RESULTS OF SHEAR FATIGUE TESTS OF JOINTS WITH 3/16 INCH DIAMETER 24S-T31 RIVETS IN 0.064 INCH THICK ALCLAD SHEET, NACA Technical Note 2012, February, 1950

This report summarizes the available test data of joints with 3/16-in. 24S-T31 rivets in 0.064-in. thick alclad sheet of the high-strength aluminum alloys. These shear-fatigue tests showed that the design of the joint gives a wider range of fatigue strengths than does the choice of material from the group studied. No one sheet alloy showed superiority over the others.

KEY WORDS: aluminum; fatigue; rivets; strength; testing

50-1

---

AREA Committee on Iron and Steel Structures
STRESS DISTRIBUTION IN BRIDGE FRAMES-FLOORBEAM HANGERS, Proceedings, AREA, Vol. 51, 1950, pp. 470-503.

Summarized are investigations into the cause of and remedies for the failures in floorbeam hangers in railway bridges. Reported are 91 failures in floorbeam hangers of riveted truss spans and the results of a detailed stress analysis. The failures are then classified according to location. The analysis of 79 failures in 28 different pin-connected truss spans is also discussed, and the detailed stress analysis, including the classification of the failures according to their location, is also given. The results listing the causes which contributed to the failures and laboratory tests which were conducted to explain the failures are summarized. Listed also are some of the unsolved problems and current laboratory studies.

KEY WORDS: bolts; bridges; joints; rivets; structural engineering

50-14

---

Dolan, T. J. and McClow, J. H.
THE INFLUENCE OF BOLT TENSION AND ECCENTRIC TENSILE LOADS ON THE BEHAVIOR OF A BOLTED JOINT, Proceedings, Society for Experimental Stress Analysis, Vol. 8, No. 1, 1950, pp. 29-43

This paper deals with the strains developed in bolted joints loaded with forces perpendicular to the surfaces of contact of the joined members. Derived is an approximate expression for the stresses developed in critical areas of this type of bolted assembly. A laboratory study of the strains in a conventional model was made and the accuracy of the analysis was checked. The stress range in the bolt decreased if the bolt was replaced by one having a lower modulus of elasticity. Also, shifting the bolt to a position nearer the action line of the load reduced optimum initial stresses and total stresses in the bolt. Equations derived served to approximate the stresses in assembly and predict entire bolt tension required to prevent separation of members under external load.

KEY WORDS: analysis; bolts; joints; testing

50-17

Naval Research Laboratory,
INVESTIGATION OF BOLT DESIGNS UNDER SHOCK LOADING, Navy Department, Washington, D. C., February, 1950

The purposes of a series of dynamic tests conducted at the Naval Research Laboratory were: to determine the physical properties of some commonly used types of bolts when subjected to shock loading; to determine the best design and materials for holding down bolts subjected to shipboard type shocks; and to investigate the effectiveness of the best bolt design as determined when applied to the securing of a deisel engine to its foundation under simulated shock loadings. The tentative results of shock tests on a limited number of SAE 1020 steel bolts are discussed. The effects of stress concentration factors, straight and reduced shank bolts, length and necking are discussed. The differences in the physical properties for a representative specimen under static and dynamic conditions are enumerated.

KEY WORDS: bolts; dynamics; joints; steel; strength; testing

50-18

---

Eaton, I. D., and Holt, M.
FLEXURAL - FATIGUE STRENGTHS OF RIVETED BOX-BEAMS ALCLAD 14S-T6, ALCLAD 75S-T6, AND VARIOUS TEMPERS OF ALCLAD 24S, NACA Technical Note 2452, November, 1951

These tests were conducted to obtain more information about the fatigue strength of built-up members. The flexural fatigue strengths of the 5 alloy-temper combinations studied in riveted box-beam sections lay in a narrow band, and no one combination was found to have higher strength values than all others for the entire range of fatigue life covered. This is in contrast with a previous investigation where the moduli of failure and impact strengths varied with the tensile strength of the material. Most of the specimens had more than one failure at completion of the tests; the most common failure involved rivet holes in the channel. The fatigue strengths of the box beams exceeded the net section fatigue strengths of riveted lap joints having single rivets of the same diameter and sheet of the same thickness.

KEY WORDS: aluminum; beams; fatigue; rivets; strength; testing

51-12

---

Stang, A. H.
THE TENSILE FORCES IN TIGHTENED BOLTS, Product Engineering, February, 1951

Various methods of measuring the tension induced in a high tensile bolt are discussed; the micrometer method, use of skilled workmen, angular turn-of-nut, and torque wrench. The micrometer method yields good accuracy. A skilled workman can sense a slight yield when the bolt reaches yield strength. The angular turn-of-nut and torque wrench methods can give results within a certain allowable range provided the variables involved are controlled.

KEY WORDS: bolts; installation; steel

51-13

---

Baron, F., and Larson, E. W., Jr.
THE EFFECT OF CERTAIN RIVET PATTERNS ON THE FATIGUE AND STATIC STRENGTHS OF JOINTS, Part I, Department of Civil Engineering, Northwestern University, February 1, 1952 (Summarized by Baron, F., Larson, E. W. Jr., and Kenworth, K. J., THE EFFECT OF CERTAIN RIVET PATTERNS ON THE FATIGUE AND STATIC STRENGTH OF JOINTS; RCRBSJ, Engineering Foundation, Feb. 1955)

This investigation was to determine the effect of rivet patterns on the fatigue and static tension strengths of structural steel joints. Fifty tests were conducted in fatigue using 9 different rivet patterns to determine the effect of varying the pitch between the rows of a joint and of advancing certain rivets beyond the first row of rivets of a joint. Nineteen joints were tested in static tension to determine the efficiencies, characteristics of failure, load-slip relationships, and the coefficients of friction. Conclusions regarding the factors are included.

KEY WORDS: fatigue; geometry; joints; rivet; steel; strength; static; testing

52-5

Bailey, J. C., and Brace, A. W.
STRENGTH TESTS ON DRIVEN LARGE DIAMETER ALUMINUM RIVETS The Aluminum Development Association, Research Report No. 13, May, 1952, London

Tests were conducted using single shop-fabricated riveted specimens to determine the shear and tensile strengths of driven aluminum alloy rivets in a range of alloys, including some not at present widely used in riveting. In addition, the strength and quality of joints made with rivets with various types of driven points, hole sizes, and driving methods were studied. Representative joints were examined visually and also with a new system of radiographic examinations, sectioning, polishing, etching, and hardness explorations. Presented are the conclusions from the results of both shear and tensile specimens.

KEY WORDS: aluminum; rivets; strength; testing

52-7

---

Davey, J. S.
STRENGTH OF BOLTED ASSEMBLIES, Tool Engineer, May, 1952.

A detailed discussion of bolts is given. Included is the new standard of the American Standards Association concerning the strength of a bolted joint. Examined are bolt preload, fatigue tests at Northwestern University and stress concentrations due to the hole in a single plate. Non-rigid joints such as gasket joints or plastic material or aluminum joints are covered, and torquing and torquing methods are investigated. Various types of bolts and threads in current use are discussed. Factors affecting stripping strength are listed.

KEY WORDS: aluminum; bolts; fatigue; friction; joints; steel; strength

52-8

---

Brown, A. A.
ANALYSIS OF ANCHOR BOLTS AND CONCRETE PIERS FOR LARGE STILLS AND KETTLES, Civil Engineering, Vol. 22, July, 1952, pp. 491-492.

This paper deals with the design problem of anchor bolts and concrete piers for large kettles, stills, or tanks subjected to unusually large horizontal forces in proportion to the vertical reactions. In the solution presented it is assumed that horizontal forces transmitted from the base plates to the pier are brought about by the coefficient of friction or by other means besides the anchor bolts. The problem can be solved by using tables or formulas developed for the analysis of concrete beams with some tension at the section. A numerical example is solved by both approaches.

KEY WORDS: analysis; bolts; anchor design

52-11

---

Higgins, T. R., and Ruble, E. J.
HIGH-STRENGTH BOLTS - A NEW CONCEPT IN STRUCTURAL CONNECTIONS, Civil Engineering, Vol. 22, No. 9, Sept. 1952, pp. 760-763

The development of the use of high-strength bolts in structural connections is described and they are compared to rivets. The various applications and the economical use of high strength bolts and the use of hardened washers are included. Installation of high strength bolts by pneumatic-impact wrenches is discussed, along with several devices that adjust the air pressure at the wrench to obtain the desired bolt tension. Described are several buildings using high-strength bolts in which some cost comparisons were made, and bolting procedures are discussed. Listed are some projects in which research by the Council is being or will be conducted.

KEY WORDS: bolts; joints; installation; steel; strength

52-13

Kreisle, L. F., and Oliphiht, J. B.
BOLT ELONGATIONS AND LOADS, Transactions, ASME Vol. 74, 1952, pp. 38.

This paper is a rationalization of the general bolt problem showing the interaction of mating threads, elongations of both unmated and mated threaded shanks, magnitude of the applied load, number of load applications, bolt size, thread size, and gasket effects. Equations are derived to predict total elongations of a bolt corresponding to a desired total load in the bolt and to predict total load in the bolt for a given set of conditions. An elongation factor B and an interaction factor M are defined and methods are presented for calculating B and M in terms of known dimensions and experimentally determined values.

KEY WORDS: analysis; bolts; design; threads

52-15

---

Howard, D. M., and Smith, F. G.
FATIGUE AND STATIC TESTS OF FLUSH-RIVETED JOINTS, NACA Technical Note 2709, 1952.

Fatigue tests at zero mean loads were made on 190 multiple-rivet joints having 1/8-inch diameter AL7S-T3 100° countersunk-head rivets. Both machine-countersunk and dimpled holes were used. Thirty-four tests in static tension of butt and lap joints were made, and 190 fatigue tests were also conducted. Joints made by dimpling showed marked superiority in both fatigue and static strength over those made by machine countersinking. Lap joints were superior under fatigue, and joints of Alclad sheets had greater fatigue strength than joints of bare sheets. The relationships between static properties of lap joints and fatigue life of the materials are given, but no single relation for all four materials tested could be found.

KEY WORDS: fatigue; joints; rivets; steel; testing

52-17

---

Scott, M. B., and Cox, J. W.
A FURTHER STUDY OF THE BEHAVIOR OF FLOOR BEAM HANGERS, Proceedings, AREA, Vol. 53, 1952, pp. 35-64.

A description and analysis of a static test made on a floor beam hanger in a 124-ft, 2-in., pin connected through-truss span, near Ponca City, Oklahoma, is reported. The objectives were to determine the effectiveness of continuous shear lacing in tying the main components of the hanger together, the general distribution of stresses in the hanger, and any bending stresses due to rotation induced by stringer deflection. Also investigated were the stress distribution in the laced hanger, the stress concentrations in bridges due to the hanger, and the stress concentrations occurring at the sharp re-entrant cut where the channel flange is coped. The test procedure, the results, and the analysis, as well as a theoretical analysis, are presented.

KEY WORDS: analysis; bridge; stress; testing

52-18

---

Carter, J. W.
STRESS CONCENTRATIONS IN BUILT-UP STRUCTURAL MEMBERS, Proceedings, AREA, Vol. 53, 1952, pp. 1-34. (First prepared as STRESS CONCENTRATION IN BUILT-UP STRUCTURAL MEMBERS AND ITS EFFECT ON THEIR ENDURANCE LIMIT, Ph.D Thesis, Purdue University, 1951).

Described and analyzed is a test to determine stress concentrations in plates near fastener holes under varying conditions of pitch, gage, edge distance, bearing, and clamping force. SR-4 strain gages and photo-elasticity techniques were used in the investigation. The items investigated and results are described.

KEY WORDS: joints; stress concentrations; models; testing

52-19

Bergendoff, R. C., and Munse, W. H.
THE EFFECT OF BEARING PRESSURE ON THE STATIC STRENGTH OF RIVETED JOINTS, SRS No. 55, University of Illinois, June, 1953. (First prepared as M.S. Thesis by R. C. Bergendoff, University of Illinois, 1953.)

Tests provided further information on the effect of high rivet bearing pressures and the strength and behavior of double-strap butt-type joints tested in static tension and compression at room temperature, and answered questions developed from previous tests. Eight different designs were used in the 48 joints tested in tension and the 18 tested in compression. The bearing ratio varied from 1.45 to 2.74 for the tension specimens and from 1.88 to 4.71 for the compression specimens. Some conclusions are: joint efficiency apparently varies with the relative gage; it seems impossible to isolate the effect of bearing pressure on joint efficiency; and ultimate stress on the net section and efficiency of the net section decreases slightly with an increase in bearing ratio.

KEY WORDS: analysis; bearing; joints; rivets; steel; strength; testing

53-5

---

Sossenheimer, H.
ZUR VERWENDUNG HOCHFESTER SCHRAUBEN (ON THE APPLICATION OF HIGH-STRENGTH BOLTS), Der Stahlbau, Vol. 22 (1953), Heft 9, pp. 214-215.

The article is based on: Higgins, T. R., BOLTED JOINTS FOUND BETTER UNDER FATIGUE, Engineering News Record, Vol. 147, August 2, 1951, pp. 35-36, Abstract No. 51-7.

KEY WORDS: bolts; fatigue; structural engineering

53-6

---

Hyler, W. S., and Grover, H. J.
THE TENSION-TENSION FATIGUE BEHAVIOR OF 1/4-INCH ALLOY-STEEL HUCK LOCKBOLTS, S-1205-4, Huck Manufacturing Company, Detroit, Mich., December 18, 1953.

The qualititative effect of tensile preload on tension-tension fatigue behavior of Huck Lockbolts was determined. Tested also were the Standard-Aircraft AN-4 bolts, and both bolts were tested in fatigue with and without tensile preload in 114 fatigue tests. The most important results show that the fatigue-limit lead of the Lockbolt assembly with tensile preload (when driven with normal practice), is about twice as high as that for the Lockbolt assembled with no tensile preload. This difference was less noticeable at higher test loads.

KEY WORDS: bolts; fatigue; joints; steel; strength; testing

53-12

---

Nelson, H. M.
ANGLES IN TENSION, SUMMARY OF A REPORT ON TESTS CARRIED OUT FOR THE BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION, BCSA Publication No. 7, London, 1953

Tests were conducted to discover a simple, safe, and more economical design method for angles in tension. It was first necessary to establish the stress distribution and the deformation of a tension angle at all stages of loading up to failure to define clearly a "failure" of an angle. As a result of 18 angle tests, 3 criteria of failure are suggested, each of which can be used as the basis for a design rule. Equations are developed to calculate the loads for each stage, and reduction factors are formulated to account for the number of bolts. The design procedure for each stage is then discussed.

KEY WORDS: angles; bolts; design; joint; steel; strength; testing

53-13

Cox, J. W.
EXPERIMENTAL AND ANALYTICAL STUDIES OF STRESS DISTRIBUTION IN LABORATORY MODELS OF FLOORBEAM HANGER FRAMES, Proceedings, AREA, Vol. 54, 1953, pp. 65-132.

Studies of the behavior of floorbeam hanger frames independent of the effect of adjoining members were conducted using model frames under laboratory conditions. The frames of floorbeams and hangers were similar in section and detail to the prototype frames. Three specimens were marked and tested to isolate one of the factors observed to contribute to the measured bending stresses. The paper describes the frames and the supplementary specimens, and includes the test procedure and results. A shear slope theory is developed and applied to the models to explain the measured stresses.

KEY WORDS: analysis; frames; joints; models; structural engineering

53-14

---

Stewart, W. C.
PROPERTIES OF PRELOADED STEEL BOLTS, Product Engineering, November, 1953

The behavior of preloaded steel bolts in assemblies that are loaded in direct tension and shear is discussed. The ratio between the torque applied to the nut and the tension induced in the bolt is investigated. Reasons causing relaxation of initial bolt tension and factors that affect fatigue and endurance life of high tensile bolts are discussed. The different grades of high tensile steel bolts and their properties are compared.

KEY WORDS: bolts; connections; fatigue; installation; steel

53-16

---

Baron, F., and Kenworthy, K. J.
THE EFFECT OF CERTAIN RIVET PATTERNS ON THE FATIGUE AND STATIC STRENGTH OF JOINTS, Part II, Department of Civil Engineering, Northwestern University, February 1, 1954 (Summarized by Baron, F., Larson, E. W. Jr., and Jenworthy, K. J., THE EFFECT OF CERTAIN RIVET PATTERNS ON THE FATIGUE AND STATIC STRENGTH OF JOINTS; RCRBSJ, Engineering Foundation, Feb. 1955).

Studied were the effects of edge distance, gage distance, and certain rivet patterns on the fatigue and static behavior of riveted structural joints. Fourteen different types of double lap joints were tested, 96 in static tension, and 32 in fatigue. The test variables listed above included 3 rivet diameters, 3 main plate thicknesses, and 5 rivet patterns. The clamping force of the driven rivets is reported, and the static efficiencies of the test specimens are compared with those predicted by design rules. The coefficient of slip for the joints is reported, and conclusions are made concerning edge distances, gage distances, and rivet patterns.

KEY WORDS: fatigue; joints; geometry; rivet; steel; strength; testing

54-1

---

Nicholson, H. H.
A MILLION AND A HALF HIGH-STRENGTH BOLTS SPEED UP STEEL ERECTION, Civil Engineering, Vol. 24, No. 8, August 1954, pp. 521-524.

Fabrication and erection of three process buildings in an Atomic Energy Commission site are discussed, and the use of bolts and rivets is compared. The procedure for using bolts in erecting and fabrication, and the make-up of the bolt crew are outlined. Air impact wrenches were used, and they were calibrated in a hydraulic pulling jack frame. They also could be checked by a manual torque wrench. Specification for inspection of bolting operations is included, and the results showed that less than 0.5% of the bolts were off more than 10% of the set torque value. The average bolting crew of two men handles from 350 to 450 bolts per shift, compared to a riveting crew of four men averaging 175 rivets per shift, with about 15% cut-outs.

KEY WORDS: bolts; joints; installation; inspection

54-6

Ernst, E.
DIE ERSTE EISENBAHNBRUCKE DER DEUTSCHEN BUNDESBAHN MIT VORGESPANNTEN, HOCHFESTEN SCHRABUEN A/S VERBINDUNGSMITTEL (THE FIRST RAILROAD BRIDGE OF THE GERMAN RAILROAD WITH PRESTRESSED, HIGH-STRENGTH BOLTS AS CONNECTIONS MEANS), Der Stahlbau, Vol. 33 (1954), Heft 10, pp. 225-228.

The experiences gained during the design and construction of the first railroad bridge assembled in Germany with high-strength bolts are described. The behavior of the structure under load is discussed.

KEY WORDS: bolts; bridge; steel; structural engineering

54-10

---

Steinhardt, O. and Mohler, K.
VERSUCHE ZUR ANWENDUNG VORGE SPANNTER SCHRAUBEN IM STAHLBAU, I. TEIL (TESTS ON THE APPLICATION OF HIGH-STRENGTH BOLTS IN STEEL CONSTRUCTION, PART I), Berichte des Deutschen Ausschusses fur Stahlbau, Stahlbau-Verlags, GmbH, Cologne, 1954 Heft. Nr. 18

Simple static tension tests of slip resistance and behavior of high-strength bolted joints are reported. Various faying surface treatments were tested to determine the influence of surface treatment on the slip coefficient. Also, bolt positions were varied to ascertain the influence of geometry. Tests of single bolts were conducted to determine the relationship between internal bolt tension and applied torque. Relaxation tests were conducted to determine the loss in preload with time. The tests indicated that a significant increase in the slip coefficient resulted when the faying surfaces were flame cleaned or sand blasted. Also demonstrated is the feasibility of using high-strength bolts as a structural fastener.

KEY WORDS: bolts; friction; joints; relaxation; steel; tests

54-11

---

Schmid, W.
NEUERE AMERIKANISCHE VERSUCHE MIT HOCHFESTEN SCHRAUBEN (NEW AMERICAN TESTS ON HIGH-STRENGTH BOLTS), Der Bauingenieur 30 (1955), Heft 8, pp. 302-307.

The article is based on: Stewart, W. C., HISTORY OF THE USE OF HIGH-STRENGTH BOLTS, Transaction, ASCE, Vol. 120, Paper No. 2778, 1955, pp. 1296-1298, Abstract No. 55-13. Munse, W. H., Wright, D. T., and Newmark, N. M., LABORATORY TESTS OF BOLTED JOINTS, Transactions, ASCE, Vol. 120, Paper No. 2778, 1955, pp. 1299-1318, Abstract No. 55-14.

KEY WORDS: bolts; fatigue; joints; plasticity; rivets; slip

55-21

---

Schmid, W.
HOCHFESTE SCHRAUBEN IN DER AMERIKANISCHEN STAHLBAUPRAXIS (HIGH-STRENGTH BOLTS IN AMERICAN STEEL CONSTRUCTION), Der Bauingenieur 30 (1955), Heft 12, pp. 436-439

Article is based on: Nicholson, H. H., A MILLION AND A HALF HIGH-STRENGTH BOLTS SPEED UP STEEL ERECTION, Civil Engineering, Vol. 24, No. 8, Aug. 1954, pp. 49-52, Abstract 54-6, Higgins, T. R., and Ruble, E. J., STRUCTURAL USES OF HIGH-STRENGTH BOLTS, Transactions, ASCE, Vol. 120, 1955, pp. 1389-1398, Abstract No. 55-20. Munse, W. H., RESEARCH ON BOLTED CONNECTIONS, Transactions, ASCE, Vol. 121, 1956, pp. 1255-1266, Abstract No. 56-11.

KEY WORDS: bolts; construction

55-22

Schmid, W.
ZUGVERSUCHE MIT GROSSEN TRAGERANSCHLUSSEN (TENSILE TESTS ON LARGE BEAM CONNECTIONS), Der Bauingemieur 30 (1955), Heft 12, pp. 439-441.

Article is based on Fuller, J. R., Leahey, T. F., and Munse, W. H., A STUDY OF THE BEHAVIOR OF LARGE I-SECTION CONNECTIONS, Proceedings, ASCE 81 (1955), No. 659, Abstract No. 55-4.

KEY WORDS: bolts; efficiency; joints; rivets; steel; testing

55-23

---

Sippell, K. W.
DAS FLAMMSTRAHLEN (FLAME TREATMENT). Metalloberflache, Teil A, Vol. 9 (1955), Heft 10, pp. 147(A) - 162(A)

The advantages of a good surface treatment are discussed. A desirably dry and clean surface can be easily and inexpensively achieved through flame treatment.

KEY WORDS: cost; surface treatment; steel

55-24

---

Wiegand, H., Schaar, K., and Nieth, F.
BEITRAG ZUM ENTZUNDERN VON WALZMATERIAL DURCH FLAMMSTRAHLEN (ON THE FLAME TREATMENT OF ROLLED MATERIALS), Metalloberflache, Teil A, Vol. 9 (1955), Heft 10, pp. 162(A) - 173(A).

Flame treatment of rolled materials is discussed. The effectiveness of the flame treatment for various plate thicknesses was investigated. The results of 50 tests are summarized.

KEY WORDS: surface treatment; steel

55-25

---

Nieth, F.
DIE BESCHAFFENHEIT DER STAHLOBERFLACHE BEI ANWENDUNG VESCHIEDENER ENTROSTUNGS-UND ENTZUNDERUNGSVERFAHREN. (THE CONDITION OF THE STEEL SURFACE AFTER THE APPLICATION OF THE VARIOUS METHODS OF SURFACE TREATMENT), Metalloberflache, Teil A., Vol. 9 (1955), Heft 10, pp. 174(A) - 178(A).

Three different types of surface treatment are investigated, manual brushing, sand blasting, and flame treatment. Manual brushing is completely insufficient because the surface cannot be cleaned well enough. The effectiveness of sand blasting was investigated for three different kinds of sand. All three types of sand are effective. The flame treatment was also very adequate.

KEY WORDS: surface treatment; steel

55-26

Berg, S., and Sippell, K. W.
EINFLUSS DES FLAMMSTRAHLENS AUF DIE FESTIGKEIT VON BAUTEILEN (THE INFLUENCE OF FLAME TREATMENT ON THE STRENGTH OF STRUCTURAL MEMBERS), Metalloberflache, Teil A., Vol. 9 (1955), Heft 10, pp. 179(A) - 185(A)

From 46 tests of steel bars under static and fatigue loading is is concluded that flame treatment has no significant effect on the strength of structural steel.

KEY WORDS: strength; surface treatment; steel; testing

55-27

Ingenerf, W.
HOCHFESTE, VORGESPANNTE SCHRAUBEN FUR DEN STAHL-UND KRANBAU (HIGH-STRENGTH, PRESTRESSED BOLTS FOR STEEL AND CRANE CONSTRUCTION), Fordern und Heben, 1955, Heft 6, pp. 372-376

Tests at the Technical University of Karlsruhe were used to develop formulas for the design of bolted connections. The most suitable types of bolts are discussed. Some applications of high-strength bolts in Germany, the United States, and Canada are given.

KEY WORDS: bolts; design formulas

55-28

Kellermann, R., and Klein, H. -CH.
UNTERSUCHUNGEN UBER DEN EINFLUSS DER REIBUNG AUF VORSPANNUNG UND ANZUGSMOMENT VON SCHRAUBENVERBINDUNGEN, Konstruktion, Vol. 7, No. 2, 1955, pp. 54-68

The load-carrying capacity of bolts in bolted connections was investigated. The bolts were subjected to prestressing. The effect of the thread of the bolts on their strength was investigated in particular. Formulas for the tightening of the bolts are derived which take into account the effect of friction in the thread and also of the diameter of the bolt. Using the geometric relations of the thread and the head of the bolt, the tightening moment is derived considering that some parts carry more load than others. These theoretical results are compared with test results from approximately 200 bolts. The effect of different kinds of threads and different types of grease on the coefficient of friction was also investigated. The best form for bolts is thus determined both experimentally and theoretically.

KEY WORDS: bolts; friction; tension

55-29

Hancke, A.
ANZUGSMOMENT, REIBUNGSWERT UND VORSPANNKRAFT BEI HOCHFESTEN SCHRAUBEN (TIGHTENING MOMENT, COEFFICIENT OF FRICTION, AND PRESTRESSING FORCE FOR HIGH-STRENGTH BOLTS), Draht, Vol. 6 (1955), No. 2, pp. 39-42 and No. 3, pp. 86-93

Various formulas for the determination of the tightening moment are given and the results obtained from these formulas are critically compared. The formulas gave quite different values for the tightening moment. The assumptions made in the different formulas are not met in many cases so that their application is questionable. A completely new formula should be derived, making as few assumptions as possible. Special consideration was given to the determination of the coefficient of friction.

KEY WORDS: bolts; coefficient of friction; tightening moment

55-30

Sossenheimer, H.
ZUR ANWENDUNG VON HOCHFESTEN SCHRAUBEN (ON THE APPLICATION OF HIGH-STRENGTH BOLTS), Der Stahlbau 24, 1955, Heft 1, pp. 11-16

Article is based on: W. C. Stewart, THE WORK OF THE RESEARCH COUNCIL ON RIVETED AND BOLTED STRUCTURAL JOINTS, Proceedings, ASCE, Vol. 80 (1954), Sept. No. 440, Abstract No.55-13.
W. H. Munse, D. T. Wright, N. M. Newmark, LABORATORY TEST OF HIGH-TENSILE BOLTED STRUCTURAL JOINTS, Proceedings, ASCE, Vol. 80 (1954), Sept. No. 441, Abstract No. 55-14.

KEY WORDS: bolts; fatigue; joints; history; rivets; slippage; tension

55-31

---

Steinhardt, O.
VORGESPANNTE SCHRAUBEN IM STAHLBAU (PRESTRESSED BOLTS IN STEEL CONSTRUCTION) VDI-Zeitschrift 97 (1955), p. 701-708

Article is based on: Steinhardt, O., and Mohler, K., VERSUCHE ZUR ANWENDUNG VORGESPANNTER SCHRAUBEN IM STAHLBAU, I. Teil, Berichte des Deutschen Ausschusses fur Stahlbau, Deutscher Stahlbau - Verband, Heft 18, Cologne 1954, Abstract No. 54-11.

KEY WORDS: bolts; friction; joints; relaxation; steel; tests

55-32

---

Hebrant, F. and Demol, L.
TENSILE TEST ON RIVETED CONNECTIONS OF ROLLED SECTIONS MADE OF STEEL A37, Acier Stahl Steel, April, 1955, pp. 178-184

Several types of end connections of standard rolled sections with gusset plates were investigated; holes were either punched or drilled. The bar strength was the main object of the tests, and the effects of the hole forming methods are discussed. An analysis of the effective section for design purposes for riveted tension members is given, as well as a discussion of the plasticity load of the net section and the slip of the test specimens.

KEY WORDS: analysis; joints; rivets; strength; testing

55-33

---

Mordfin, L.
CREEP AND CREEP RUPTURE CHARACTERISTICS OF SOME RIVETED AND SPOT-WELDED LAP JOINTS OF AIRCRAFT MATERIALS, NACA Technical Note 3412, June, 1955

Twenty-seven tests of riveted aluminum-alloy joints fabricated from 75S-T6 and 24S-T3 with 24S and 24S-T31 rivets are reported. Nine tests were made at temperatures of 300°, 400°, and 500°F. Spot-welded joints of ½ - hard, type 301 stainless steel were tested at 800°F. Each type of joint was also tested in tension at room temperature. Riveted joint creep is considerably greater than that of unriveted sheet, although not so large that the creep of the sheet is negligible compared to that of the joints. An empirical relation based on the experimental results is proposed to give estimates of the creep-rupture strength of a riveted joint. The creep at 800°F of spot-welded joints of cold-worked austenitic stainless steel is negligible.

KEY WORDS: aluminum; creep; joints; rivets; steel; testing; welds

55-34

Boomsma, M.
LOOSENING AND FATIGUE STRENGTH OF BOLTED JOINTS, The Engineer, Vol. 200, p. 284, London, August 26, 1955

The effect of bolted joints loosening under variable tension loads is discussed, together with the knowledge of this topic. The parameters which are compared are the effect of bolt length and bolt diameter on loosening, the advantage of using many small bolts instead of a few large ones, and the fatigue strength of bolted joints with comparatively rigid abutments. Equations are derived for the stress loss in a bolt for a given amount of linear loosening and for the fatigue strength of a bolted joint. Test results from other references are compared to calculated values.

KEY WORDS: analysis; bolts; joints; fatigue; structural engineering

55-35

---

Sandberg, C. H.
INVESTIGATION OF FLOORBEAM HANGERS IN RAILROAD TRUSSES, Journal of the Structural Division, ASCE, Vol. 81, Proceedings Paper No. 762, August, 1955

Reviewed are recent investigations of the causes of and possible remedies for failure in floorbeam hangers of railroad truss bridges. A survey was conducted to find the failures, and type them. Strain measurements were made on floorbeam hangers of various railroad trusses under static and dynamic loads. In addition, laboratory investigations including static and fatigue tests were made on models of floorbeams and floorbeam hangers and components to explain the failures. The fatigue life of floorbeam hangers in existing bridges can be extended by increasing the radius of re-entrant cuts at copes. Another method is to replace the two lowest rows of rivets in the upper hanger gussets with high-strength bolts.

KEY WORDS: bolts; floor beam hangers, trusses; fatigue; rivet; static; gussets

55-36

---

Wilson, W. R.
HIGH-TENSILE BOLTS ARE GAINING, Railway Track and Structures, Sept., 1955, pp. 43-45

The use of high-strength bolts on the Santa Fe is discussed and the background of the introduction and the properties of the high-strength bolt are outlined. The current practice of bolting is explained, and economic advantages of high-strength bolts and their ease in installation are enumerated. Given is an example of a 75-ft. deck plate girder span that was erected with an inexperienced crew of 4. It took the bolting crew 7 hours to bolt up the entire span while it would take 4 men 4 days to rivet the same span.

WORDS: bolts; bridge; construction; joints; steel

55-37

---

Winter, G.
TESTS ON BOLTED CONNECTIONS IN LIGHT GAGE STEEL, Journal of the Structural Division, ASCE, Vol. 82, Proceedings Paper 920, Feb. 1956.

Results are summarized of 574 tests on bolted connections in light-gage steel, covering considerable ranges of the pertinent variables such as bolt diameter, sheet thickness, mechanical properties of sheet and bolt steels, edge distance, etc. This series of tests was to provide information for the development of design methods for connections with "handtight" black bolts in light gage, cold-formed construction. Four conditions are formulated for predicting failure loads, and test results are compared to expected values. It is shown that if an adequate safety factor is applied to these four conditions, joint deformations at design loads can be held to reasonably small values.

KEY WORDS: bolts; joints; steel; testing

56-1

Committee on Design in Lightweight Structural Alloys, J. W. Clark, Chairman
SPECIFICATIONS FOR STRUCTURES OF ALUMINUM ALLOY 6061-T6, Proceedings ASCE Vol. 82, Paper 970, May, 1956

These specifications cover allowable stresses, design rules, and fabrication procedures for structures using the highly corrosion-resistant aluminum alloy known commercially as 6061-T6 (formerly 61S-T6). The basic allowable tensile working stress is 15 kips per sq. in. based on a minimum yield strength of 35 kips per sq. in. and a minimum tensile strength of 38 kips per sq. in.

KEY WORDS: aluminum; design; specification

56-2

---

Committee on Design in Lightweight Structural Alloys, J. W. Clark, Chairman
SPECIFICATIONS FOR STRUCTURES OF ALUMINUM ALLOY 2014-T6, Procéedings ASCE V82, Paper 971, May, 1956.

These specifications cover allowable stresses, design rules, and fabrication procedures for riveted heavy-duty structures built of the high-strength aluminum alloy commonly used for such structures and known commercially as 2014-T6 (formerly 14S-T6). The basic allowable tensile working stress is 22 kips per sq. in. and the minimum tensile strength is 60 kips per sq. in.

KEY WORDS: aluminum; design; specification

56-3

---

McFarland, W. J.
HIGH STRENGTH BOLTS-FEATURE OF AN ALASKA MAST, Civil Engineering, Vol. 29, Sept., 1959, pp. 630-632

Discussed is a 450-ft. "radiator" tower at Kodiak, Alaska, and the use of high-strength bolts and their subsequent economy and adaptability for construction of such structures in remote locations. The tower took only 12 working days to top out, and no more than 7 workers were on the job at any one time. The design criteria and an approximate method of design are explained. The method of torquing the bolts was thoroughly explored, and the methods discussed include the pneumatic impact wrench, turn of the nut, and the manually-operated calibrated torque wrench.

KEY WORDS: bolts; construction; design; joints; steel; tower

56-7

---

Dornen, A., and Trittler, G.
NEUE WEGE DER VERBINDUNGSTECHNIK IM STAHLBAU (NEW TYPES OF CONNECTIONS IN STEEL CONSTRUCTION), Der Stahlbau, Vol. 25 (1956), Heft 5, pp. 181-184

Riveted, bolted, and glued connections are broadly discussed. The three types are compared and their advantages and disadvantages are listed. The behaviors of the different types of connections under various loading conditions are described. No test results are given.

KEY WORDS: bolts; costs; glue; joints; rivets

56-13

Schmid, W.
UBER DAS ANSPANNEN HOCHFESTER SCHRAUBEN (ON THE TIGHTENING OF HIGH-STRENGTH BOLTS), Der Bauingenieur 31 (1956), Heft 5, pp. 183-185

Article is based on: Drew, F. P., TIGHTENING OF HIGH-STRENGTH BOLTS, Proceedings, ASCE, 81 (1955), No. 786, See Abstract No. 55-7.

KEY WORDS: bolts

56-14

---

Schmid, W.
SCHLUPFVERHALTEN VON STOSSEN MIT HOCHFESTEN SCHRAUBEN (SLIP BEHAVIOR OF CONNECTIONS WITH HIGH-STRENGTH BOLTS), Der Bauingenieur 31 (1956), Heft 9, pp. 354-55

Article is based on: R. A. Hechtman, D. R. Young, H. G. Chin and E. R. Savikko, SLIP OF JOINTS UNDER STATIC LOADS, Proceedings, ASCE, 80 (1954), No. 484, Abstract No. 55-18.

KEY WORDS: bolts; friction; joints; static; slip; testing

56-15

---

Winter, G.
LIGHT GAGE STEEL CONNECTIONS WITH HIGH-STRENGTH, HIGH TORQUED BOLTS, Publications, IABSE, Vol. 16, 1956, pp. 513-528

Results previously published by the author of cold-formed, light-gage steel connections with ordinary bolts are briefly reviewed, and 4 equations are given, referring to the 4 possible modes of failure. The equations permit the strength of such connections to be computed. Detailed results are then presented for 476 additional tests made with high-strength, high-torqued bolts of the kind increasingly used in steel construction in the U.S.A. These tests were undertaken to investigate how high-strength bolted connections would perform differently than those made with ordinary bolts, and what advantage would accompany their use. It is shown that: a) the quoted 4 equations also apply to connections with high-strength bolts; b) the required number of bolts can be reduced because of their higher shear strength; c) connection slip at design loads can be eliminated by use of such bolts; and d) a lower factor of safety is warranted for connections using high-strength bolts than for those using ordinary black bolts.

KEY WORDS: bolts; friction; joints; steel; slip; testing

56-16

---

Holt, M., Eaton, I. D., and Matthiesen, R. B.
FATIGUE TEST OF RIVETED OR BOLTED ALUMINUM ALLOY JOINTS, Journal of the Structural Division, ASCE, Vol. 83, No. ST1, Proceedings Paper 1148, Jan. 1957.

Fatigue tests for aluminum-alloy monoblock specimens assembled in butt joints, lap joints and double-strap butt joints were conducted and the effects of joint geometry, type, stress rate, and fatigue strength reduction factors were investigated. Symmetrical joints have higher fatigue strength than unsymmetric joints, as lap joints or single-strap butt joints have lower fatigue strength than double-strap butt joints. Increasing the stiffness also increases the fatigue strength of unsymmetric joints. Joints with hot-driven aluminum alloy rivets have about the same fatigue strength as those with cold-driven aluminum alloy rivets. The authors believe that the fatigue strength of a joint with a stress concentration factor greater than 2.4 can be obtained by reducing the allowable stress in proportion to the stress concentration factor of the joint. The data presented suggest improvements in current design specifications.

KEY WORDS: bolts; fatigue; joints; rivets; testing

57-3

Musnitsky, H.
BOLTS: HOW TIGHT IS TOO TIGHT?, The Iron Age, March 28, 1957, pp. 120-121.

The problem of tightening bolts to proper torque values is examined. Several variables affecting the torque value are discussed, including bolt material, assembled material, friction in the threads, shape and area of surface contact of nut or bolt, and type of washers. A workable formula that gives an approximate value of the torque requirement that would compensate for these variables is discussed in this report. Presented is a table showing the computed theoretical torque values to produce 60% bolt stress in the different stress classifications of unlubricated steel bolts.

KEY WORDS: bolts; installation; steel

57-5

---

Viglione, J.
FATIGUE STRENGTH OF BOLTS REDUCED BY LONGITUDINAL FLAWS, Product Engineering, Vol. 28, March, 1957, pp. 203-204

Fatigue tests were conducted on 3/8- and 1/4-in. aircraft bolts of nickel-chrome-molybdenum steel. The longitudinal flaws investigated were seams, laps, and inclusions, and these flaws were made visible by circular magnetizations. There were no transverse defects. Twenty sound bolts were tested to form a mean and a standard deviation to compare with the flawed bolts. Twenty bolts with severe flaws and twenty with mild flaws were tested, half at loads of zero to 1400 lbs. and half at zero to 2300 lbs. Failure in fatigue for all cases occurred in the threads and was related to the flaws. The bolts were inspected after testing to correlate the fatigue life to the flaws. Tension tests showed no difference between sound bolts and defective bolts.

KEY WORDS: bolts; fatigue; strength; steel; testing

57-6

---

Sommer, A. A.
THE ADVANTAGES OF HIGH TENSILE BOLTS IN STRUCTURAL WORK, Construction in South Africa, March 1957.

High-Strength bolts are important in machinery design because of their strength. Bolts are more economical than rivets as structural fasteners because they require less manpower, time, and on-site equipment; and finally, they require less maintenance. Furthermore, their installation is quieter. Because they are stronger than rivets, bolts are now used where dynamic loading is encountered. Assemblies using high-strength bolts are relatively light, because a small, strong fastener can do the work of a larger, heavier but weaker fastener. Examples of steel construction with high-strength bolts are discussed.

KEY WORDS: bolts; construction; joints; machinery; steel

57-7

---

Hardrath, H. F., and Whaley, R. E.
FATIGUE-CRACK PROPAGATION AND RESIDUAL STATIC STRENGTH OF BUILT-UP STRUCTURES NACA Technical Note 4012, May, 1957

Fatigue tests were conducted on box beams and tension panels in order to study factors affecting fatigue-crack propagation. The box beams had essentially the same configuration except for the mode of connecting stringers to the tension cover. The beams with bonded stringers had the lowest rate of crack growth, and beams with riveted and integral stiffeners had higher rates of crack growth. Crack growth was slower in beams with close rivet spacing than in beams with greater rivet spacing. The tension panels were all of the same configuration except that the proportions of cross-sectional areas of skin, stringers, and flanges were varied. The comparison of results with predictions made by simple theory indicated that test results were affected by a redistribution of loads among the various remaining elements and by whether cracks terminated at rivet holes.

KEY WORDS: aluminum; beams; fatigue; joints; rivets; stiffeners; testing

57-11

Fincher, J. R.
INVESTIGATION OF BASIC REQUIREMENTS FOR A DIRECT MOMENT CONNECTION USING HIGH STRENGTH STRUCTURAL BOLTS AND WIDE FLANGE BEAMS, M.S. Thesis, Georgia Institute of Technology, May, 1957

This study was undertaken to develop a moment connection for wide-flange beams that would stress the high-strength bolts in tension, develop the full plastic moment of the beam, have adequate rotation capacity, be practical to fabricate and erect, and be capable of design by rational means. A direct moment connection was devised in which steel plates were welded to the end of 2 sections of a wide-flange beam. Five such beams of varying strength were tested by loading the connection in pure moment. Tested were two 8WF20 beams where connection plate thickness varied, two 8WF17 beams where the bolt size varied, and one 18WF50 beam in balanced design. Design of the connections was made using theoretical equations developed during this study.

KEY WORDS: analysis; bolts; frame; joints; steel; strength; testing

57-12

---

Sanks, R. L., and Rampton, C. C.
GRIT AND SHOT-REINFORCED HIGH TENSILE BOLTED JOINTS, Journal of the Structural Division, ASCE, Vol. 83, No. ST6, Proceedings Paper No. 1435, Nov. 1957 (First appeared as REINFORCED HIGH TENSILE BOLTED JOINTS, Dept. of Civil Engineering, University of Utah, Nov. 1956).

This report summarizes procedures and results of tests to determine the effectiveness of reinforcement in increasing the frictional resistance of painted structural steel joints. The reinforcement consisted of angular white cast iron grit, rounded white cast iron shot, or polished steel balls. The particles were held in place by wet red lead paint or by spot welding to washers. Comparisons were made to tests of unreinforced joints with painted and with clean mill scale surfaces. Although the paint drastically reduces frictional resistance to slip, these tests show it can be restored by reinforcement. The best reinforcement appears to be the polished balls somewhat less than 1/16-in. in diameter. Rounded shot is nearly as effective as polished balls, and far superior to angular grit.

KEY WORDS: bolts; friction; joints; steel; surface treatment; testing

57-19

---

Irvan, W. G., Jr.
EXPERIMENTAL STUDY OF PRIMARY STRESSES IN GUSSET PLATES OF A DOUBLE PLANE PRATT TRUSS, University of Kentucky Experimental Station Bulletin No. 46, December, 1957.

The article provides a thorough study of a miniature joint using electrical resistance strain gages. An aluminum model with a continuous chord was used.

KEY WORDS: aluminum; joints; rivets; testing

57-20

---

Steel
THE LIMITS OF THE TRANSMISSION OF FORCE IN RIVETED AND BOLTED CONNECTIONS IN STRUCTURAL STEELWORK, Acier-Stahl Steel, Vol. 22, No. 3, 1957, pp. 131-137

The slip resistance of a riveted connection depends on the gripping force exerted the rivet and contact surface condition. Discussed further are the kinds of materials for rivets and grip length. Explained is the behavior of riveted connections under fluctuating loads, and a comparison is made between connections using high-tensile bolts and those using rivets. The bolt used is 10K steel, and the rivet ST. 37.11. The behavior of bolted connections under plates and fluctuating loads is examined, and surface treatment and the factors in choice of bolt type are discussed.

KEY WORDS: bolts; fatigue; joints; rivets; steel

57-21

Mordfin, L., and Legate, A. C.
CREEP BEHAVIOR OF STRUCTURAL JOINTS OF AIRCRAFT MATERIALS UNDER CONSTANT LOADS AND TEMPERATURE, NACA Technical Note 3842, January, 1957.

The results of 55 creep and creep-rupture tests on structural joints are presented. Methods are described by which the time to rupture, the mode of rupture, and the deformation of joints in creep may be predicted. These methods use data on the creep of the materials used and the tension, bearing and shear to which the materials are subjected. The accuracy of these methods is within the scatter of the materials creep data.

KEY WORDS: aluminum; creep; joints

57-22

---

Pfungen, R.
HOCHFESTE SCHRAUBEN ERSETZEN NIETE IM STAHLBAU (HIGH-STRENGTH BOLTS REPLACE RIVETS IN STEEL CONSTRUCTION) Bauindustrie (Vienna), 1957, No. 3, pp. 141-144.

The advantages of structural joints using high-strength bolts instead of rivets are discussed. The Austrian specification for bolted connections is explained. No test results are reported.

KEY WORDS: bolts; joint; rivets; specification

57-28

---

Schmid, W.
DAUERBRUCHE IN GENIETETEN UND HOCHFEST VERSCHRAUBTEN LASCHENSTOSSEN (RIVETED AND BOLTED LAP JOINTS UNDER FATIGUE LOADING), Der Bauingenieur 32 (1957), Heft 12, pp. 474-476.

Article is based on: J. W. Carter, K. H. Lenzen, and L. T. Wyly, FATIGUE IN RIVETED AND BOLTED SINGLE LAP JOINTS, Proceedings, ASCE, 80 (1954), No. 469, Abstract No. 55-19.

KEY WORDS: bolts; clamping; fatigue; joint; rivet; slip; testing

57-29

---

Michalos, J., and Louw, J. M.
PROPERTIES FOR NUMERICAL ANALYSIS OF GUSSETTED FRAMEWORKS, AREA Proceedings, Vol. 58, 1957, pp. 1-51.

This paper compares various methods for including the effect of the gusset plate in the slope deflection or moment distribution methods of analyses to find secondary moments and effects. The method advocated is based on the method of equivalent lengths. The charts provided are used for easier computation. The method, as demonstrated in examples, could be used as a check for values of typical secondary moments on a particular gusset plate.

KEY WORDS: analysis; joints; steel

57-30

Hebrant, F., Hermitte, G. L., and Massonet, C.
BOULONS A HAUTE RESISTANCE (BOLTS WITH HIGH RESISTANCE): Imprimenie Sainte Catherine, Tempelhof 37, Belgigue: 1957.

The development and advantages of high-strength bolts as structural fasteners are described. The report describes tests which were conducted in the United States and Europe. These tests led to the following conclusions: the use of hard washers under the nuts and heads of the bolts yields a clamping force far superior to that obtained through the shrinkage of rivets. Preloading bolts diminishes the concentration of stresses near holes. High-strength bolts do not necessitate the replacement or modification of erection equipment for bridges or buildings and are economical compared to rivets.

KEY WORDS: bolts; joints; rivets

57-31

---

Hebrant, F. Demol, L., and Massonnet, C.
ESSAIS D'ASSEMBLAGES A BOULONS ON RIVETS TIRES (TESTS ON ASSEMBLIES WITH STRETCHED BOLTS OR RIVETS), Publications, IABSE, Vol. 17, 1957, Zurich

Two series of tests were conducted to define rules for dimensioning riveted assemblies in which the rivets are subjected to combined tension and shear under static or fatigue loading. Comparative tests were also conducted with each series on ordinary black bolts and on high-strength pretensioned A325 bolts. The first series of tests involved one or two rivets or bolts. The rivets were machine or hand driven. Tests on single rivets subjected to combined tension and shear enabled a criterion for static rupture to be defined as $R_r = (\sqrt{\sigma^2} + 1.5\tau^2)^{1/2}$. The fatigue tests indicated that the endurance limit of the rivets was about 19.1 ksi and all fractures occurred in the plates. The second series of tests was carried out on trianglar brackets fixed to a column and subjected to a force parallel to the plane of the assembly. The test variables included: (1) fastener type, (2) magnitude of clamping force, and (3) stiffener type. One static and 2 fatigue tests were conducted for each type of specimen. conventional methods for designing these assemblies gave reliable results if the root area of the threaded fasteners was used. Also, the use of pretensioned high-strength bolts instead of rivets provided a 20% increase in static strength and a 100% increase in fatigue strength.

KEY WORDS: analysis; bolts; fatigue; joints; rivets; steel; strength; structural engineering; static; testing

57-32

---

Hyler, W. S., Popp, H. G. Gideon, D. N., Gordon, S. A., and Grover, H. J.
FATIGUE BEHAVIOR OF AIRCRAFT STRUCTURAL BEAMS, NACA Technical Note 4137, January, 1958.

This investigation involves a study of the correlation between composite structural behavior of basic material and simple-element behavior. Fatigue and related static tests were made on aluminum alloy box beams and beams and also on elements simulating the failure locations in the two beams. The study indicates that the simulation approach will be useful when it is possible to assess factors contributing to stress-raisers in the structure. The more complex the secondary stress becomes, the more exacting will be the requirements of the stress analysis. Fatigue notch-failures much higher than might be expected on simply notched specimens were found in both beams. Such high fatigue notch factors may be expected in composite structures involving stress gradients and stress distributions at or near rivets.

KEY WORDS: aluninum; beams; fatigue; rivets; strength; testing

58-1

---

Jenkins, J. W., Williams, W. L., and Herring, J. L.
EFFECTS OF COLD ROLLED THREADS IN THE PROPERTIES OF HIGH TEMPERATURE CHROMIUM-MOLYBDENUM STEEL THREADS, U. S. Bureau of Ships Journal, Vol. 6, February, 1958, pp. 7-12

Room temperature tension tests and elevated temperature creep relaxation tests were performed on chromium-molybdenum steel bolt studs to compare cut threads and cold rolled threads. The thread rolling produced a significant reduction in proof stress which could be largely recovered by stress relief. The yield strength was not similarly affected, at least not much. The relaxation properties were independent of the threading procedure and of the stress relief treatment used to improve the proof stress. The yield strength had greater utility than the proof tests for specifications acceptance testing.

KEY WORDS: bolts; creep; steel; strength; threads; testing

58-6

Field, J. E.
TIGHTENING AND TENSILE TESTS ON JOINTS, The Engineer, May 2, and May 9, 1958, London, pp. 654 and 700.

The static strengths of BSW, BSF, UNC, and UNF bolt-nut combinations have been compared under various conditions of tightening, with a particular view to checking the stability of UNF threads for general use. Tests were carried out under single and repeated tightening, and some of the nuts were loaded out to simulate conditions caused by an over-size tapping drill. While the UNF combinations were at least as strong as the other types of bolts for a single tightening, many of them failed by thread bending and stripping, and they were not so resistent to repeated tightening as the other types. The UNC threads would generally be preferable in heavy applications where close control of tightening is not possible.

KEY WORDS: bolts; installation; steel; strength; testing

58-7

---

Aviation Week
BRITISH ACCIDENT INVESTIGATION REPORT: FLAP BOLT FAILURE CAUSED VISCOUNT CRASH, Aviation Week, London, June 9, 1958, pp. 72-87.

This report concerns the crash of a Vickers Viscount aircraft while approaching to land at Ringway Airport, Manchester, and the subsequent investigation into the cause of the crash. The final conclusion of the investigation was that the cause of the accident was the fracture of the 9/16-in. bolt holding the bottom of a starboard flap unit, and that this failure was due to fatigue. Discussed in detail are the reasons for the fatigue failure.

KEY WORDS: bolt; fatigue; failure

58-8

---

Zar, M.
WATCH YOUR BOLTS, Civil Engineering, Vol. 28, No. 7, July, 1958, pp. 521-522.

Installing bolts to their required minimum tension is discussed. An inspection of 5 power plants is cited: 4 had bolts which were 20% under-torqued, and on the 5th, the steel erector had to retorque 13,000 bolts. The first 4 were installed by turn-of-nut method, and the 5th was installed by a calibrated impact wrench. The problems of using a calibrated wrench for obtaining minimum tension in the bolts are enumerated. Under-torquing may prevent the joints from developing the required strength. The Research Council is preparing a new specification to reduce the number of bolts required in joints, which are now designed according to rules for rivets, which are weaker. Recommended are specifications for installing high-strength bolts, and also specifications for an independent inspection service to maintain adequate checks and a high performance standard. To obtain the greatest benefit from bolting, a visible turn-of-nut procedure is needed with tight fit-up for snug.

KEY WORDS: bolts; joints; installation; inspection

58-9

---

Hardin, B. O.
EXPERIMENTAL INVESTIGATION OF THE PRIMARY STRESS DISTRIBUTION IN THE GUSSET PLATES OF A DOUBLE PLANE PRATT TRUSS JOINT WITH CHORD SPLICE AT THE JOINT, University of Kentucky Engineering Experiment Station Bulletin No. 49, Sept., 1958.

A study of a miniature joint using electrical strain gages is reported. Secondary stresses were purposely avoided in the test setup.

KEY WORDS: bolts; joints; model; testing

58-11

Schmid, W.
DIE ZULASSIGE BEANSPRUCHUNG HOCHFESTER SCHRAUBEN (ALLOWABLE STRENGTH OF HIGH-STRENGTH BOLTS), Der Bauingenieur 33 (1958), Heft 3, pp. 101-105.

The American specifications for high-strength bolted connections are compared with the German Preliminary Specifications. American test results for connections under static and fatigue loading are presented.

KEY WORDS: bolts; fatigue; joints; static; specifications

58-20

Schmid, W.
EINFLUSS DER KLEMMLANGEN AUF DIE DAUERFESTIGKEITEN GESCHRAUBTER UND GENIETETER STOSSE, (EFFECT OF GRIP LENGTH ON THE STRENGTH OF RIVETED AND BOLTED CONNECTIONS), Der Bauingenieur 33 (1958), Heft 7, pp. 277-79.

Article is based on: Baron, F., and Larson, E. W., COMPARATIVE BEHAVIOR OF BOLTED OR RIVETED JOINTS, Proceedings ASCE 80, (1954), No. 470, Abstract No. 55-17.

KEY WORDS: bolts; fatigue; force; clamping; joint; load; static; rivet

58-21

Mohler, K.
VERSUCHE MIT HV-VERBINDUNGEN (TESTS ON BOLTED CONNECTIONS) Veroffentlichungen des Deutschen Stahlbau-Verbandes, Stahlbau-Berlags GmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 8-26.

Diagrams are given summarizing the results of tests of bolted connections, also described in Abstracts Nos. 54-11 and 59-43. The test program was designed to investigate: 1) load-carrying and deformation behavior of bolted joints under static loading, including determination of slip load for connections with differently treated contact surfaces and the effect of number and location of bolts as well as of the holes in the slip load, yield load and ultimate load of bolted connections under static tensile loading; 2) effect on fatigue behavior in bolted joints of the stress distribution in the cross-section of the hole and the location of bolts and holes; 3) the mechanism of load transfer in bolted connections in the elastic range; and 4) behavior of T-section tension connections under static loads.

KEY WORDS: bolts; deformation; fatigue; joints; load transfer; slip load; stress distribution; testing

58-22

Hamm, B.
FABRIKATION DER SCHRAUBEN (FABRICATION OF BOLTS), Veroffentlichungen des Deutschen Stahlbau-Berbandes, Stahlbau-Verlags GmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 27-36

The different types of bolts used in Germany are discussed. The essential types of fabrication procedures are presented in detail.

KEY WORDS: bolts; fabrication

58-23

**Wolf, W.**
VORLAUFIGE RICHTLINIEN FURBERECHNUNG, AUSFUHRUNG UND BAULICHE DURCHBILDUNG VON GLEITFESTEN SCHRAUBEN VERBINDUNGEN (HV-VERBINDUNGEN) (PRELIMINARY SPECIFICATIONS FOR THE ANALYSIS, DESIGN, AND FABRICATION OF SLIP-PROOF BOLTED CONNECTIONS), Veroffentlichungen des Deutschen Stahlbau-Verbandes, Stahlbau-Verlags GmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 37-47.

The preliminary specifications for the design and analysis of bolted connections adopted by the German Steel Association are explained. They are based on tests carried out at the Technical University of Karlsruhe under the supervision of the author.

KEY WORDS: analysis; bolts; design; fabrication; specifications

58-24

---

Steinhardt, O.
KONSTRUIEREN IN STAHL UNTER BESONDERER BERUCKSICHTIGUNG DER HV-SCHRAUBEN, (STEEL CONSTRUCTION WITH SPECIAL CONSIDERATION OF HIGH-STRENGTH BOLTS), Veroffenflichungen des Deutschen Stahlbau-Verbandes, Stahlbau-Verlags GmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 48-60.

The behavior of structural elements composed of differing materials, such as composite concrete-steel members, is discussed in broad terms. The problems of connecting these different materials with high-strength bolts are discussed. The effect of welding on bolted connections was determined in two tests. Comparative tests of welded and bolted connections were also made. The load-carrying capacity of the bolts and the weld can be added to obtain the ultimate strength of the connection.

KEY WORDS: bolts; composite members; construction; welding

58-25

---

Dornen, K.
AUSGEFUHRTE BRUCKEN MIT HV-SCHRAUBEN, (BRIDGES WITH HIGH-STRENGTH BOLTS), Veroffentlichungen des Deutschen Stahlbau-Verbandes, Stahlbau-Verlags GmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 61-81.

The author discusses the experience gained in design and construction of the first 7 railroad bridges in which high-strength bolts were used. The steel frame systems were mostly shop welded, and high-strength bolts were used only for the construction joints. The use of high-strength bolts was successful. Even on the basis of costs, bolts can at least compete with rivets. Reference is made to the test results reported in Abstracts Nos. 54-11 and 59-43 for supporting evidence.

KEY WORDS: bolts; construction; economy; welding

58-26

---

Munse, W. H.
TESTS OF TRUSS-TYPE CONNECTIONS ASSEMBLED WITH BEARING BOLTS, The Lamson and Sessions Company, Cleveland, Ohio, Feb. 1959.

Tests are reported of two truss-type connections assembled with bearing bolts for comparison with similar tests conducted previously. One of the principle factors studied was the reduction in the number of fasteners, and hence the allowable shear and bearing stresses exceeded the design specifications. The load-slip behavior of the truss-type connections was similar to that obtained for riveted connections. The experiment indicated that the most effective use of bolts in an I-section truss-type connection may result when a greater number of small bolts is used instead of a small number of large bolts.

KEY WORDS: bolts; bearing; joints; steel; testing

59-4

Ritchie, J., Gregory, P. and Bangay, A. J.
IMPROVEMENTS IN BOLTED JOINT EFFICIENCY BY THE ADDITION OF A COLD-SETTING RESIN MIXTURE, The Structural Engineer, June, 1959, London, pp. 175-177.

This investigation covered the use of epoxy-polyamide cold-setting resin mixture to fill the clearance space between bolt and bolt hole and minimize bolt slip. Suitably applied, it also provides adhesion at the plate interface which, for single bolted lap joints subjected to bending, would restrict rotation of the plates. The tests were repeated with galvanized surfaces. Using the results of the tests, it was decided to apply the resin mixture to a bridge structure where sagging and distortion after erection would be a problem. The results of that experiment are reported and indicated good behavior.

KEY WORDS: bolts; epoxy; installation; joints; steel

59-8

---

Brody, I. H.
A REVIEW OF HAND TOOLS WHICH FACILITATE THE USE OF HIGH STRENGTH STRUCTURAL BOLTS, Institution of Structural Engineers Jubilee Symposium, Session 2, June, 1959, London, pp. 24-29

A general review is given of hand tools for accurately torquing bolts. The torque wrench is defined, and methods of determining the torque-bolt load relationship are given. The types of torque wrenches covered are the dual, bending beam, slipping, and breakback; and advantages and disadvantages of each type are given. Also discussed is the torque wrench with a gearbox to increase the input torque. Listed are 3 methods of inspecting bolts to determine whether the proper minimum torque has been induced.

KEY WORDS: bolts; installation; wrench

59-24

---

Brown, W. C.
THE USE OF PRETENSIONED BOLTS IN STRUCTURAL CONNECTIONS, Institution of Structural Engineers Jubilee Symposium, Session 2, June, 1959, London, pp. 16-24.

A discussion is given of bolts in shear and in tension, together with their characteristics in either condition. The bolted connection is explained according to type and function of bolts used, resistance to slip, and determination of load factor. The practice of tightening bolts with the impact wrench is explained, as well as the usage of the Torshear Bolt. The available bolt tensions with waisted bolts and parallel shanked bolts are compared, and test results with waisted bolts are given in tables. Bolts used in direct tension in joints and their limitations are discussed.

KEY WORDS: bolts; joints; steel

59-25

---

Grant, M.
HIGH STRENGTH BOLTS FOR STRUCTURAL ENGINEERING, Institution of Structural Engineers Jubilee Symposium, Session 2, June 1959, London, pp. 11-15.

Progress in the use of bolts up to their current application as high-strength fasteners and the problems solved during this progress are discussed. Installation is discussed, using as an example a BS 1768 grade waisted bolt, nut, and washer assembly. Safety and consistency in bolt use are stressed.

KEY WORDS: bolts; construction; joints; installation; steel

59-26

Martin, H.
THE PROPERTIES OF HIGH STRENGTH BOLTS, Institution of Structural Engineers Jubilee Symposium, Session 2, June, 1959, London, pp. 2-11.

Early investigations of the use of high-strength bolts and conclusions concerning bolts, nuts, and washers are discussed. The development of specifications and the various tests including wedge test, proof load of nuts and bolts, and washer hardness are described. Tightening techniques and the bolt tension obtained with various torque values are examined. The latest developments in bolts which are discussed include the Prolong Bolt, Alloy Steel Bolt V, and the Torshear Bolt.

KEY WORDS: bolts; nuts; steel; specification; washers

59-27

---

Quertier, J. R.
PNEUMATIC TOOLS FOR TIGHTENING HIGH STRENGTH BOLTS, Institution of Structural Engineers Jubilee Symposium, Session 2, June, 1959, London, pp. 30-35

Compared are the manual wrench, the electric impact wrench, the hydraulic wrench, and the pneumatic impact wrench. The advantages of the pneumatic wrench over the others are listed, and the principles of operation of 5 different pneumatic impact wrenches from different manufacturers are outlined. The advantages and disadvantages of the torque control method and turn-of-the-nut method are discussed and compared. Torquing bolts with the Torshear-Pneumatic tool and using Torshear bolts are explained.

KEY WORDS: bolts; installation; wrench

59-28

---

van Douwen, A. A., deBack, J., and Bouwman, L. P.
CONNECTIONS WITH HIGH-STRENGTH BOLTS, The Friction Factor Hinder Influence of Different Tightening Methods of the Bolts and of Different Conditions of the Contact Surfaces, Technological University Delft, Civil Engineering Department, Stevin-Laboratory, Report No. 6-59-9-VB-3, August, 1959.

Two series of tests were conducted; the first series investigated the effects of different surfaces, tightening methods, and bolt qualities on the coefficient of friction. The second series evaluated the influence on slip load of a dissimilarity in thicknesses of the contacting plates. The first series of tests used flame cleaned, shot blasted, and untreated surfaces, and A325 and 10K bolts tightened by a torque wrench or pneumatic tool. There is no significant influence due to tightening methods or bolt quality; and as expected, rusted surfaces had high coefficient values. The second series of tests showed a marked influence on the coefficient and further studies are recommended.

KEY WORDS: bolts; friction; joints; steel; surface treatment; testing

59-36

---

Ault, Robert T.
RAPID LOADING OF ALUMINUM ALLOY RIVETED JOINTS, Wright Air Development Center, T. R. 59-433, October, 1959.

Slow and rapid loading tensile shear tests conducted at room temperature determined the failing strength of multiple riveted lap and butt joints. Both concentric and eccentric loading conditions were used. The time to failure for the rapid loading tests ranged from 0.02 to 0.08 seconds. All failures were by rivet shear. For both loading conditions, rapid loading had no significant effect on the strength of the joint.

KEY WORDS: joints; rapid loading; rivets; strength; testing

59-39

Estes, E. R., Jr.
HIGH STRENGTH BOLTS, Presented at the Tenth National Conference in Standards of the American Standards Association, Detroit, October 20-22, 1959.

Uses for high-strength bolts and the reasons for their rapid acceptance as substitutes for rivets are discussed. The research for the development of the ASTM A325 bolt by the RCRBSJ is described. The need for continuing research and cooperation to keep specifications up to date is emphasized.

KEY WORDS; bolts; research; specifications; steel

59-40

---

Toint, E.
JOINTS ASSEMBLED WITH HIGH STRENGTH FRICTION GRIP BOLTS, Acier-Stahl-Steel, Vol. 24, No. 11, Nov. 1959, pp. 469-473.

A brief background of the development of the high-strength bolt is given, as well as the chief advantages of using high-strength friction-grip bolts instead of rivets or turned and fitted bolts. A sample joint design problem is worked, and listed are particulars which must be considered with the use of friction-grip bolts.

KEY WORDS: bolts; friction; joints

59-42

---

Steinhardt, O., and Mohler, K.
VERSUCHE ZUR ANWENDUNG VORGESPANNTER SCHRAUBEN IM STAHLBAU. II. TEIL (TESTS ON THE APPLICATION OF HIGH-STRENGTH BOLTS IN STEEL CONSTRUCTION, PART II), Berichte des Deutschen Ausschusses fur Stahlbau, Stahlbau-Verlags GmbH, Cologne, 1959, Heft 22.

This extensive study of bolts and bolted joints includes: 1) Investigations of the form and material quality of bolts and their behavior under prestressing forces and installation conditions, and relaxation tests. 2) Tests to determine the slip resistance of high-strength bolted joints. Several joints were retested. All bolts were installed by torquing. The tests indicated that the slip coefficient of clean mill scale varied between 0.382 and 0.68. Flame cleaning increased the slip coefficient to a value varying between 0.608 and 0.852. High-strength steel (ST52) had the largest slip coefficients when flame cleaned and the lowest slip coefficients for clean mill scale. 3) The effect of the bolt location on the strain behavior and on the strength of the bolts under static loads. 4) High-strength bolted connections under fatigue loading using ST37 and ST52. Comparative fatigue tests were also conducted on plates with holes. The results did not indicate a significant difference between bolted joints of differing steels. 5) Investigations and tests of the handling and behavior of high-strength bolted connections commonly used in steel construction. Altogether, the results of 252 tests are summarized and reported.

KEY WORDS: bolts; fatigue; friction; geometry; joints; steel; testing

59-43

---

Hoyer, H.
UBER GLEITFESTE SCHRAUBENVERBINDUNGEN IM STAHLBAU (VERSUCHSERGEBNISSE UND BEMESSUNGSRICHTLINIEN) (ON SLIDE-PROOF BOLTED CONNECTIONS IN STEEL STRUCTURES ( TEST RESULTS AND DESIGN SPECIFICATIONS)), Wissenschaftliche Reihe der Hochschule fur Bauwesen, Cottbus, 1959, Heft 1.

Static tensile and compression tests were conducted on 30 and 10 specimens, respectively. Contact surfaces were either sand-blasted, flame-cleaned, or painted. Sand-blasting and flame-cleaning gave very good results as compared to non-treated contact surfaces. Connections with painted contact surfaces were unsatisfactory. Two sliding movements in important segments of the joint were visible to the unaided eye. Photoelastic investigations on a plexiglas model of a bolted joint showed the distribution of prestress over the faying surface. The distribution area is confined. Considering the compressive stress distribution, it appears to be advisable to space the bolts as closely as two diameters. Preliminary specifications for the design and analysis of bolted high-strength connections are presented.

KEY WORDS: friction; joints; bolts; surface treatment; photoelastic techniques

59-44

Hoyer, W., and Skwirblies, H.
UBER GLEIFFESTE SCHRAUBENVERBINDUNGEN (2. BERICHT) HOCHFESTE SCHRAUBEN IN VERBINDUNG MIT SCHWEISSNAHTEN (ON SLIDE-PROOF BOLTED CONNECTIONS (2nd REPORT) HIGH-STRENGTH BOLTS TOGETHER WITH WELDS), Wissenschaflliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 3 (1959-60), Heft 1, pp. 33-48.

The load-carrying capacity of 45 joints with both high-strength bolts and welds was investigated. The test program was divided into five phases according to the type of weld used. The five types of welds were: light and heavy butt welds, light and heavy longitudinal fillet welds, and transverse fillet welds. In each phase of the test program the following types of connections were tested: (1) Welding and high-strength bolts; (2) No welding, high strength bolts, and (3) Welding, no high-strength bolts. The load-carrying capacities of the connecting media, high-strength bolts and welds, can be added to obtain the strength of the joint. Only short test specimens having 2 rows of bolts were tested, and therefore the results may be applied for only this specific type of connection. At ultimate, the stresses in the lap plate will be so high that the prestressing force of the bolt decreases substantially. A part of the applied load will then be transmitted from the bolt to the faces of the holes by bearing.

KEY WORDS: bolts; joints; strength; testing; welds

59-45

---

Hoyer, W.
UBER GLEITFESTE SCHRAUBENVERBINDUNGEN (3. BERICHT) HOCHFESTE SCHRAUBEN MIT VERSCHIEDENEM LOCHSPIEL (ON SLIDE-PROOF BOLTED CONNECTIONS (3rd REPORT ) HIGH-STRENGTH BOLTS WITH DIFFERENT HOLE CLEARANCE), Wissenschaffliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 3 (1959-60), Heft 1, pp. 49-53.

Twenty-one specimens were tested with hole clearance as the only variable. For each of the 3 values of hole clearances ranging from 1 mm to 3 mm, 7 tests were conducted. The size of the hole clearance within the mentioned limits did not have any effect on the sliding load. This is important to assembling steel structures because reaming of holes can be eliminated. Extraordinary high friction coefficients (.79 to 0.82) were obtained. These results show the importance of a careful surface treatment (sand-blasting and flame-cleaning).

KEY WORDS: bolts; hole clearance; friction; joints; steel; surface treatment; testing

59-46

---

Prynne, P.
STRESS DISTRIBUTION IN HIGH TENSILE BOLTED CONNECTIONS, Ph.D. Thesis, University of Leeds, England, 1959

A brief history on the research of high-tensile bolted joint performance is presented. Eight types of high-tensile bolts with standard nuts were tested to determine a reliable method of inducing tension in the bolts. The torque method, turn-of-nut method and half-torque-half-turn method were investigated. Relationships between the torque applied to the nut and the tension induced in the bolt and also relationships between the angle turned by the nut and the induced bolt tension are studied. Four types of high tensile bolted joints were tested in tension: 29 single bolt lap joints, 17 double bolt lap joints, 10 single bolt butt joints and 9 double bolt butt joints were tested. Factors considered are: slip load, slip, creep, roughness, bending factor, rotation factor, coefficient of friction, and per cent fall in bolt tension in slip. The joints varied in plate roughness, plate thickness, and washer design. The tests are discussed with graphs of load-slip relationships presented. The general problems of distribution of pressure between the plates and the coefficient of friction between steel surfaces were discussed. The object of the work is to obtain sufficient information to lay down a rational method for the design of high tensile bolted connections based on a friction criterion of failure.

KEY WORDS: analysis; bolts; creep; friction; joints; installation; steel; strength; testing

59-50

---

Mathison, W.
MOMENT-ROTATION CHARACTERISTICS OF SEMI-RIGID HIGH-TENSILE BOLTED CONNECTIONS, M.S. Thesis, McGill University, Montreal, August, 1959

Moment-rotation characteristics are obtained for a standard web connection for a 12-inch deep beam using high tensile bolts. Four tests were performed using varying initial bolt tension, angle thickness and moment-shear ratios. The results obtained are compared with existing information. The rotation is found to be due to angle deformation and column deformation. The effect of the column flange stiffness on the connection is shown also. The determination of pre-tension in the bolts is described as well as the complete instrumentation and behavior during the testing.

KEY WORDS: bolts; joints; steel; strength; testing

59-51

Charlton, T. M.
COLLAPSE BEHAVIOR OF A BOLTED FRAME, Engineering, London, February 12, 1960

Described is a test of a frame using bolted joints of a simple pattern, and designed having regard to the use of the plastic theory for the design of steel structures. The structure consisted of two symmetric purlin-braced pitched-roof portals having concentrated loads applied simultaneously to the center of each rafter. The joints, designed to transmit without significant distortion the full plastic moment of the members, consisted of 3/4-in. steel plate flame cut from stock, drilled, and then profile welded to the ends of members. They were bolted with 3/4-in. diameter BSF high-tensile steel bolts. The loading at collapse was predicted by the elementary plastic theory to be 10.8 tons. The frame collapsed unsymmetrically when the load was 11.7-tons; the 0.9-tons excess is attributed to strain hardening at the plastic hinge. This type of bolted joint can be used with confidence if designed for ultimate load-carrying capacity and shear loading provision is made where necessary.

KEY WORDS: bolts; frame; joints; steel; testing

60-3

---

Lewitt, C. W., Chesson, E., Jr., and Munse, W. H.
STUDIES OF THE EFFECT OF WASHERS ON THE CLAMPING FORCE IN HIGH-STRENGTH BOLTS, Dept. of Civil Engineering, University of Illinois, SRS No. 191, March 1960.

In 46 relaxation tests of regular and heavy head bolts neither washers, lack of washers, oversize holes, or type bolt head or nut affected the clamping force of A325 bolts significantly. Nine fatigue tests of four-bolt double lap joints indicated that the omission of washers had no appreciable influence on the fatigue strength.

KEY WORDS: bolts; clamping; fatigue; force; oversize holes; washers

60-4

---

Lehman, F. G.
STRESS ANALYSIS OF GUSSET PLATES, D.Sc. Degree thesis, M.I.T., June 1960

Two methods of analysis for determining stress distribution in a gusset plate were investigated. The first was a methematical model using the finite difference technique and the theory of elasticity, and the other method was a small-scale physical model using brittle lacquer and wire resistance strain gages. The results were sufficiently accurate, but it is noted that higher accuracy could be obtained in the numerical solution by using finer networks. The author concludes that the physical model has certain inherent advantages over the mathematical model in this case.

KEY WORDS: analysis; joint; model; testing

60-6

---

Munse, W. H.
TESTS OF VARIOUS CONNECTIONS ASSEMBLED WITH BEARING BOLTS, The Lamson and Sessions Company, Cleveland, Ohio, August, 1960.

Tests were performed for better understanding of connections assembled with bearing bolts, and for information comparable to that available for connections assembled with A325 bolts. Tests included studies of the static and fatigue behavior of bearing bolts in shear, 2 connections with painted contact surfaces and fitted together with bearing bolts, and 2 large flat-plate connections assembled with bearing bolts. These results are compared with previous tests with A325 bolts. The painted surface had no effect, and the joints connected with bearing bolts behaved similarly to the joints with A325 bolts in the aspects investigated.

KEY WORDS: bolts; joints; steel; surface treatment; testing

60-7

de Bach, J. and Bouwan, L. P.
EFFECT OF THERMOGALVANIZING AND SHERADIZING OF PRESTRESSING BOLTS ON THEIR MECHANICAL PROPERTIES AND ON THE RELATIONSHIP BETWEEN WRENCH TORQUE AND PRESTRESSING FORCE, Stevin Laboratory, Delft Polytechnic Institute, Report No. 6060-8-VB-5, September, October, 1960, Holland

Eighteen type 10K prestressing bolts were tested in tension, and 18 of the same bolts were tested to determine the relationship between wrench torque and prestressing force. Thermogalvanized and sherardized bolts of the same type were tested in the same manner. Thermogalvanizing, at 460°C produced a coating of zinc 100-110 microns thick, while sherardizing at 400°C produced a coating about 15 microns thick. Untreated and treated bolts had identical properties. Very high torques were required to prestress the thermogalvanized bolts, while sherardized bolts required less torque. Greasing the threads would lower torque requirements, but this would probably be impractical because tightening to a given torque would not always produce the same amount of prestressing. The advantages and disadvantages of torquing with a pneumatic wrench are discussed.

KEY WORDS: bolts; galvanize; installation; steel; testing

60-19

---

Graves, F. E.
HOW TO CUT THE COST OF THREADED FASTENERS, Purchasing, September, 1960, pp. 78-81

The many fasteners available and the problems they create for the purchasing agent are discussed. Reasons are given for standardization of fasteners, and the economies from such a step are shown in an example. Seven rules are listed for the purchasing agent to simplify fastener usage and specifications, and lead to cutting threaded fastener cost. Included also is the simplified fastener nomenclature developed by Russell, Burdsall, and Ward.

KEY WORDS: bolts; cost; standards

60-20

---

Romualdi, J. P. and Sanders, P. H.
FRACTURE ARREST BY RIVETED STIFFENERS, Carnegie Institute of Technology, Contract No. AF 49(638) -237, October, 1960.

This study considers the effectiveness of riveted stiffeners as crack arresters. Investigated in detail are the static and dynamic relationships involved in fracture arrests, and experiments were conducted to support the investigation. The theoretical analysis is based on energy release concept. Conclusions are drawn regarding the necessary and sufficient conditions for fracture arrests, and are embodied in a design procedure for crack-arresting riveted stiffeners. Suggestions for further study are made.

KEY WORDS: design; fracture; rivets; steel; stiffener; testing

60-23

---

Sattler, K.
BETRACHTUNGEN UBER DIE VERWENDUNG HOCHZUGFESTER SCHRAUBEN BEI STAHLTRAGER-VERBUNDKONSTRUKTIONEN (CONSIDERATIONS ON THE USE OF HIGH-TENSILE BOLTS IN COMPOSITE CONCRETE AND STEEL GIRDER STRUCTURES), Preliminary Publication, Sixth Congress, IABSE, 1960, pp. 333-349.

If a connection between concrete and steel components is made with high-tensile bolts instead of steel studs, then the coefficient of friction is very important. Two preliminary push-out tests were conducted with specimens consisting of a concrete slab to which steel T-shapes were attached by means of high-strength bolts. Also, four tests were run on full-sized composite beams where the steel beam was connected to the concrete plate by means of high-strength bolts. This type of connection seemed suitable for use in practice. For working load conditions a lower limiting value, $\mu = .45$, can be adopted to give a sufficient safety factor. It is important that the concrete slab be cast in place and that the holes in the concrete be reinforced by a simple helical reinforcement.

KEY WORDS: bolts; composite structures; concrete; friction; steel; testing

60-25

Steinhardt, O.
HOCHFESTE VORGESPANNTE SCHRAUBEN (HV-SCHRAUBEN) ALS NEUARTIGE VERBINDUNGSMITTEL DES STAHLBAUS (HIGH-TENSILE PRESTRESSED BOLTS AS A NEW TYPE OF STRUCTURAL CONNECTION IN STEEL CONSTRUCTION), Preliminary Publication, Sixth Congress, IABSE, 1960, pp. 351-370.

The author summarizes the results of numerous tests conducted at the Technical University of Karlsruhe. The results presented are a summary of the material given in greater detail in References 54-11 and 59-43. During the 3 test series the following topics were investigated:

1. Behavior of single bolts,
2. Slip resistance of bolted connections,
3. Behavior of bolted connections under static loading,
4. Behavior of bolted connections under dynamic loading,
5. Deformations of bolted connections under increasing loads,
6. Influence of fatigue on the prestressing forces of the bolts, and
7. Forms of construction using high-strength bolts.

Structural connections fastened with high-strength bolts are an advancement in steel construction. Composite steel and concrete construction provides another field of application. In fabricating bolted joints it is essential to apply the correct tightening torque and provide suitable preparation of the faying surface.

KEY WORDS: bolts; fatigue; friction; composite construction; joints; static testing

60-26

---

Beer, H.
EINIGE GESICHTSPUNKTE ZUR ANWENDUNG HOCHFESTER, VORGESPANNTER SCHRAUBEN, (SOME ASPECTS OF THE USE OF HIGH-STRENGTH BOLTS). Final Report, Sixth Congress, IABSE, 1960, pp. 157-172.

Fifteen tests were carried out in Austria to determine the effect of repeated cycles of loading and unloading on prestressed bolted joints, when the loads approached the friction limit. There was no substantial reduction in the friction resistance in these cyclical tests when compared to tests performed with static loads. When the "turn-of-nut" method of tightening high-strength bolts is used it is important to know the rotational factor of safety against failure through torsion of the shank or stripping of the threads. Diagrams relating the load to nut rotation were prepared and show that the most suitable angle of rotation after tightening by hand is $180^{\circ}$. The arrangement of high-strength bolts in the connections of truss bridges with welded box-section members involves new forms for these types of connections. Design details for this problem are given.

KEY WORDS: bolts; fatigue; friction; design details, static loads

60-27

---

Steinhardt, O.
ZUR ANWENDUNG VON HV-SCHRAUBEN IM STAHLBAU, (ON THE APPLICATION OF HIGH-STRENGTH BOLTS IN STEEL CONSTRUCTION), Final Report, Sixth Congress, International Association for Bridge and Structural Engineering, Stockholm, 1960, pp. 173-189.

This paper summarizes the research reported in Ref. 62-15 on bolted end plate connections and the development of a new bolt profile. Tests in Germany in order to determine the best "design" for high-strength bolts demonstrated that the ratio of the pressure between the bolt-head and the washer to the stress in the cross-sectional area of the root of the thread on the bolt shaft can be improved by changes in the dimensions of the bolt head and the fillet radius. This makes it possible to increase the pre-tension force by about 30%, which allows greater forces to be applied to the bolted connection. Tests of girders with butt type bolted moment connections and rigid bolted joints of portal structures have proven that economical and technically unobjectionable standardized bolted joints can be established for normal steel sections. Suggestions are made for these standardized joints, including the arrangement and number of bolts and the size and thickness of the butt plates.

KEY WORDS: bolts; frame; geometry; joints; steel; testing

60-28

---

McMullen, A. C.
AN INVESTIGATION INTO THE STRENGTH OF BOLTED JOINTS IN DOUGLAS FIR, M.S. Thesis, University of Alberta, Edmonton, April, 1960

In the investigation into the effects of moisture content on the strength of bolted joints in Douglas Fir, a total of 60 specimens were tested in compression. All specimens were identical with regard to number of bolts, bolt size, bolt spacing, end distance, edge distance and size of the individual wood pieces. In all specimens the grain in the side plates was parallel to the grain in the main member. Results indicate that the strength of a bolted joint decreases with an increase in the moisture content. It appears that the modification factors for various seasoning conditions as given in the Canadian Standards Association Specification Number 086-1959 are conservative. It is found that bolted joints which are seasoned after fabrication and in which the joints are retightened after seasoning are as strong as joints fabricated from seasoned lumber. On the basis of the results of this investigation it is uncertain whether bolted joints which are seasoned after fabrication and in which the nuts are not retightened after seasoning are as strong as joints fabricated from seasoned lumber.

KEY WORDS: bolts; joints; specifications; strength; wood

60-29

Chronis, N. P.
55% THREAD DEPTH WILL MAKE BERYLLUIM BOLTS PRACTICAL, Product Engineering, Nov. 14, 1960, pp. 75-77.

A new thread form using threads with a large root radius and a thread depth only 55% of the theoretical has been developed by Standard Pressed Steel. The radius at the root blends with the thread flanks at a point 55% below the crest of the Unified and American basic thread depth. It requires that holes with internal threads be tapped larger. The advantages gained by using berylluim are listed, as well as several other innovations used to obtain maximum bolt strength. A strength-to-weight comparison demonstrates that in shear strength, the berylluim bolts are 1-1/2 times stronger than titanium bolts and twice as strong as steel bolts and that in fatigue, beryllium bolts are 2 times stronger than titanium and 10 times stronger than steel bolts.

KEY WORDS: beryllium; bolts; fatigue; strength; testing

60-30

---

Kuzmanovic, B. O.
RIVETED WEB CONNECTIONS IN BENDING, Publications, IABSE, Vol. 20, 1960, Zurich, pp. 151-178.

Reported are a series of tests to obtain basic information on the behavior of riveted web connections. The two main details of the investigation concerned the mechanisms of deformation and of forces in rivets in connections subjected to simple bending under static loading. It was found that the collapse load of riveted connections is higher than computed according to normal practice if instability or other discontinuities are excluded. According to the assumed mode of functioning of the connection, a tentative calculation is made of the actual forces in each rivet and the results are compared with the values from normal practice.

KEY WORDS: analysis; joints; rivets; steel; strength; testing

60-31

---

Wright, D. T., and Lewis, E. M.
FUNDAMENTAL CONCEPTS, AND THE DEVELOPMENT OF SPECIFICATIONS FOR HIGH-TENSILE BOLTED JOINTS, Preliminary Publications, 6th Congress, IABSE, 1960, Zurich, pp. 371-382

The development of the specifications for high-strength bolts and the adoption into practice of high-strength bolts in North America and the United Kingdom are related and compared. The design parameters of both specifications are discussed, the design criteria of fatigue and static loadings are examined in detail, and suggestions for the design of bolted joints are given.

KEY WORDS: bolts; design; joints; specifications

60-32

---

Berridge, P. S. A.
THE USE OF HIGH STRENGTH BOLTS IN RAILWAY GIRDER BRIDGES, Prelimary Publication, Sixth Congress, IABSE, 1960, Zurich, pp. 313-332.

The general discussion includes the use of the friction grip joint, and a comparison is made between bolted and riveted friction joints. Tests of 11 bolted joints with various faying surface conditions are reported, together with the effect of bolt thread condition on bolt torque coefficient. Bolt loading by the Torque Coefficient Method and the Turn-of-the-Nut Method are explained in detail, as is the use of the Torshear Bolt. The article concludes by discussing the use of high-strength bolts in bridgework.

KEY WORDS: bolts; bridges; joints; installation

60-33

Pringle, O. A.
LOOSENING OF BOLTED JOINTS BY SMALL PLASTIC DEFORMATIONS, ASME Paper Number 60-WA-116, 1960

Formulas are derived for several cases of loosening of bolted joints caused by stresses in excess of elastic limits and accompanying permanent deformations. It is shown that loosening occurs during the initial application of an external force, but that subsequent repetitions of the same force cause no further loosening. External impact loads, which require a definite energy absorption of the joint, result in loosening upon both the initial load application and later repetitions. The effects of initial tightening, gaskets, and spring washers are investigated. Loosening under moderate loads may be completely avoided if the initial bolt tension does not exceed a certain maximum value. Loosening is unavoidable under extremely high loads, but the amount of loosening can be decreased by use of higher initial tensions. Illustrative experimental data are reported.

KEY WORDS: analysis; bolts; joints; installation

60-41

---

Gerstung, H.
FRICTION AS A FACTOR IN BOLT TENSION, GALLING, SEIZING, Assembly and Fastener Engineering, Vol. 4, No. 1 and No. 2, January and February, 1961

Friction and its relationship to the ability of torque to tighten a bolt, along with the effects of galling and seizing, are discussed in detail. The need for thread lubrication is emphasized; and the application of molybdenum disulfide concentrate as a lubricant, and results of tests of this lubricant, are explained. Included is a listing of requirements for a friction bond between parts and the high temperature problems faced. Several examples are given of the advantage of using molybdenum disulfide in high temperature, and a list of applications of molybdenum disulfide on threaded connections in various industries is given.

KEY WORDS: bolts; friction; installation; threads

61-1

---

Budiansky, B. and Wu. T. W.
TRANSFER OF LOAD TO A SHEET FROM A RIVET - ATTACHED STIFFENER, Technical Report No. 11, Division of Engineering and Applied Physics, Harvard University, February, 1961.

This paper considers the problem of an infinite sheet stiffened by an infinite stringer subjected to single concentrated load. It is assumed to be fastened by equally spaced rivets of equal diameter. The simplifying assumptions made are as follows: loss of gross section area due to rivet holes is neglected, frictional (clamping) forces are ignored, and the rivets act as rigid inclusions in the plate. Several cases are described to show how other configurations can be approached by superposition.

KEY WORDS: analysis; plate rivets; stiffeners; steel

61-2

---

Denkhaus, H. G.
STRENGTH OF WASHERS, The National Mechanical Engineering Research Institute, CSIR Contract No. CN378, Council for Scientific and Industrial Research, Pretoria, South Africa, February 3, 1961.

Tests were conducted to investigate the influence of different washer sizes and treatments on friction-gripped joints. Four different types of hardened washers were examined in the tests. The variables were size 3/4- and 7/8-in; and maximum bolt load. The bolt used in all tests was a BS 1768, Grade V. The loss in preload tension was considered the most important factor in evaluating the relative suitability of the washers. This was done by measuring the plastic flow in the steel under the washer after the bolt was tightened. The four types of hardened washers were all suitable for use with bolts up to the strength of BS 1768 Grade V, and the best overall results were obtained from the German DIN washer. The total loss in bolt load was about 9% after 1 day, and only 2% from 1 day to 1 year.

KEY WORDS: bolts; relaxation; testing; washers

61-3

Munse, W. H.
FATIGUE OF HUCKBOLT FASTENERS AND JOINTS ASSEMBLED WITH HUCKBOLT FASTENERS, Huck Manufacturing Company, Detroit, Michigan, February, 1961.

The purpose of this report is to demonstrate that the Huckbolt can be used in high-strength bolting. Included are (a) measurements of clamping force and relaxation, (b) a fatigue evaluation of Huckbolt fasteners in direct tension, and (c) fatigue tests of connections assembled with Huckbolt fasteners. Eight 5/8- and 3/4-in. regular Huckbolts and eight high-tensile Huckbolts were tested in part (a), 27 tests of 5/8- and 3/4-in. diameter were conducted in part (b), and 3 joints assembled with 4-7/8-in. high-tensile Huckbolt fasteners were tested in fatigue, and after the fatigue test were statically pulled apart. The high-tensile Huckbolt exceeded by 30% the minimum bolt tension, but the tension of the commercial type Huckbolt was only 70% of the minimum bolt tension required by Council Specification. The Huckbolts behaved like high-strength bolts in fatigue in direct tension and in the joints tested in fatigue, meeting requirements of the RCRBSJ.

KEY WORDS: bolts; fatigue; relaxation; testing

61-4



Munse, W. H.
STATIC AND FATIGUE TESTS OF BOLTED CONNECTIONS COATED WITH DIMETCOTE, the Amercoat Corporation, South Gate, California, March, 1961

The primary purpose was to evaluate the behavior of bolted structural connections in which the faying or contact surfaces are coated with Dimetcote, an inorganic zinc coating. Static and fatigue tests were included in the study to demonstrate that the coated surfaces could develop high frictional resistance, and the fatigue tests were compared to fatigue tests of non-coated joints. One joint was tested statically and two were tested in fatigue.

From these few tests it was noted that the fatigue resistance of members coated with Dimetcote is about the same as for bolted joints with dry mill scale surfaces, and, in general, that frictional resistance is comparable to that of sand-blasted or riveted surfaces.

KEY WORDS: bolts; fatigue; joints; steel; surface treatment; testing

61-5

Hyler, W. S., Humphrey, K. D., and Cioth, N. S.
AN EVALUATION OF THE HIGH TENSILE HUCKBOLT FASTENER FOR STRUCTURAL APPLICATIONS, Huck Manufacturing Company, Detroit, Michigan, Report No. 72, March, 1961.

A complete descriptive summary of the high-tensile Huckbolt fastener in 5/8-, 3/4-, 7/8-, and 1-in. diameters is presented. Included are mechanical properties of the Huckbolt fastener, which covers the design features, clamping force, tensile strength, combined shear and tensile strengths, and fatigue strength. Properties of simple connections in static and fatigue loading, and the application of the Huckbolt to these structural members, are discussed. Reported are the results of tests conducted to compare the Huckbolt to the ASTM-A325 bolt.

KEY WORDS: bolts; joints; fatigue; structural engineering

61-6

Leybold, H. A.
RESIDUAL STATIC STRENGTH OF ALUMINUM-ALLOY BOX BEAMS CONTAINING FATIGUE CRACKS IN THE TENSION COVERS, NASA Technical Note D796, April, 1961

Static tests performed on 31 box beams determined their residual static strength. The beams were constructed of 7075 and 2024 aluminum alloy according to several designs and employed stringers that were either bonded, riveted, or an integral part of the skin. Beams with stringers bonded to the skin (both material) had the highest residual static strength, whereas 7075 beams with integrally stiffened covers had the lowest residual static strength.

KEY WORDS: aluminum; beams; rivets; strength; testing

61-8

Hoyer, W.
UBER GLEITFESTE SCHRAUBENVERBINDUNGEN (4. BERICHT) VORVERSUCHE MIT VERSUCHSKORPERN AUS LEICHTMETALL (ON SLIDE-PROOF BOLTED CONNECTIONS (4th REPORT), PRELIMINARY TESTS WITH LIGHT-WEIGHT-METAL SPECIMEN), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 4 (1961), Heft 1, pp. 41-47.

The author reports the results of 20 preliminary tests in which aluminium plates were connected with high-strength steel bolts (K10 or 8G). This type of connection seems very suitable. High coefficients of friction (0.54 to 0.67) were obtained for Al Mg Si $F_{32}$ with and without substantial treatment of the contact surfaces. Decreasing of the faying surfaces by means of trichlorethylene is recommended to prevent the washers from turning when installing the bolts and to provide a suitable frictional surface. Fifty long-time tests in which the questions of creep and contact corrosion will be investigated are summarized. The results indicate that it will not be necessary to increase the size of washers to prevent undesirable creep.

KEY WORDS: aluminium; bolts; friction coefficient; creep; contact corrosion; surface treatment

61-31

---

Fernlund, I.
A METHOD TO CALCULATE THE PRESSURE BETWEEN BOLTED OR RIVETED PLATES, Report #17, Institute of Machine Elements, Chalmers University of Technology, Gotherburg, Sweden, 1961.

Presented is a derivation of an analytical method to determine the pressure between bolted or riveted plates. The cases derived for are the stresses produced in a plate by the application of pressure to its free surfaces, and the case of loaded lateral surface in a hole of a plate. A sample calculation of the determination of the pressure between two plates is given and then a simplified procedure is offered. The mode of procedure for pressures of different thicknesses of the plates is given, as well as the application to a flange coupling. Experimental investigations are conducted in the contact zone and in the sealing of a joint.

KEY WORDS: analysis; bolt; joint; pressure; rivet

61-32

---

Dewalt, W. J.
NEW TEST DATA ON ALUMINUM SCREW STRENGTH, Product Engineering, November 13, 1961, pp. 99-104.

Presented is a discussion of aluminum threaded fasteners, including types of materials, types of threaded fasteners, head styles, sizes, and strengths. Two types of screws are described in detail, wood and sheet metal. Tensile strength tests as well as tests to determine the shear strength are explained and examined in this article.

KEY WORDS: aluminum; bolts; strength; testing

61-33

---

Nitkin, I. H.
PLASTIC STEEL DESIGN WITH SEMI-RIGID CONNECTIONS, Master of Engineering Thesis, McGill University, Montreal, 1961.

The thesis is concerned with the effect of connections of the semi-rigid type on the Plastic methods of structural steel design. The basic principles of Plastic Design are presented, illustrating the formation of plastic "hinges" and their rotational properties. The beam line method for semi-rigid connections, originated by C. Batho, is shown, and a theory presented using this beam line to find the required semi-rigid connection which will transfer the hinge rotation from the beam to the connection. Experiments are described in which this theory was verified. Two connections were tested to obtain their moment-rotation characteristics. Then two statically indeterminate structures using the same types of connections were tested to demonstrate that all plastic hinges formed at the same load. Finally, the advantages of this method are discussed.

KEY WORDS: bolts; frames; joints; semi-rigid; steel; strength; testing

61-34

Leon, E. V.
MOMENT-ROTATION CHARACTERISTICS OF SEMI-RIGID HIGH-TENSILE BOLTED CONNECTIONS - III, M.S. Thesis, McGill University, Montreal, April, 1961.

Six beam-to-column test specimens of different weight beams connected to 10WF33 by web connections. Studied are moment-rotation characteristics, slip of connections, moment-shear ratio, variation of beam depth, separation of column flanges, center of rotation and effects of fabrication. A numerical problem in semi-rigid design is discussed and solved.

KEY WORDS: bolts; frames; joints; semi-rigid; steel; strength; testing

61-35

---

Howe, J. W.
MOMENT-ROTATION CHARACTERISTICS OF SEMI-RIGID HIGH-TENSILE BOLTED CONNECTIONS - II, M.S. Thesis, McGill University, Montreal, April, 1961.

Four semi-rigid type beam-to-column web angle connections with high-strength bolts were tested. Each connection was of a different type; one had no seat angle, two had seat angles of different thicknesses and the fourth had a plate stiffener on the seat angle. Moment-rotation curves were obtained for all of the joints. A theoretical explanation is given why the failures occurred the way they did. The test results were used to calculate the coefficient of friction for steel against steel. A building is designed using no-seat-angle connections and also for using seat angle connections.

KEY WORDS: analysis, bolts; joints; semi-rigid; steel; strength; testing

61-36

---

Waltermire, W. G.
EVALUATING FASTENER AND JOINT PERFORMANCE WITH A LOAD ANALYZER, Assembly and Fastener Engineering, January and February 1962, pp. 33 and pp. 44.

In this article a "load analyzer" with 2 principle functions is described to determine the load relaxation characteristics of a joint to evaluate the proper clamping load, and to determine the proper torque to obtain this clamping level. The design concept of the load analyzer is given, and its operation is described. Reported are the results of tests on bolts and locknuts. The relationship between torque and clamping load is provided for the locknuts, and the results using the load analyzer and a hand calibrator are compared.

KEY WORDS: bolts; creep; testing

62-1

---

Tajima, J.
STATICAL AND FATIGUE STRENGTH OF RIVETED AND BOLTED JOINTS USING 60 kg/mm$^2$ HIGH-STRENGTH STEEL IN TENSION, Railway Technical Research Report No. 283, Japanese National Railways, April 1962 (in Japanese).

Reported are 17 static tests to determine the slip resistance of high-strength steel joints. Both lap and butt joints having 2 bolts or rivets in a line were tested. The bolt preload was determined from torque measurements. Also reported are 33 fatigue tests of riveted, bolted, and plain high-strength steel plate. All fatigue tests were for a zero-to-tension loading. The high-strength bolts provided a substantial increase in joint stiffness. Also, the fatigue strength of the bolted joints approached that of the plain plate.

KEY WORDS: bolts; fatigue; friction; joints; steel; structural engineering; testing

62-4

Gill, P. J.
LOAD INDICATING BOLTS, The Consulting Engineer, London, April and May, 1962.

Discussed are several methods by which high-strength friction-grip bolts are tightened to ensure that the induced tensions exceed specified minimum values. The torque coefficient method in which a given applied tightening torque develops the required minimum tension, and the turn-of-the-nut methods in which a specific nut rotation induces tensions above specified minimum are discussed in detail. The load indicating bolt is then examined as an alternative to the other two methods. The load indicating bolt gives an inspector a method of determining whether the required tension has been achieved. Load relaxation and slippage tests on joints are reported.

KEY WORDS: bolts; installation; steel; testing

62-5

---

Weber, N. E.
BOLT-TORQUE INSPECTION BY STATISTICAL ANALYSIS, Civil Engineering, Vol. 32, June, 1962, pg. 69.

The principle of statistical analysis was used in the inspection of bolted field connections for a 10-story building in California. A total of 23,960 high-strength bolts were involved and the procedure used here involved a total of 36 man-inspection hours as opposed to an estimated 2,000 man-inspection hours for a complete check of every bolt. The procedure is outlined, and the results of the analysis are discussed.

KEY WORDS: bolts; installation; inspection

62-9

---

Steinhardt, O., and Mohler, K.
VERSUCHE ZUR ANWENDUNG VORGESPANNTER SCHRAUBEN IM STAHLBAU. III. TEIL (TESTS ON THE APPLICATION OF HIGH-STRENGTH BOLTS IN STEEL CONSTRUCTION, PART III,) Berichte des Deutschen Ausschusses fur Stahlbau, Stahlbau-Verlags GmbH, Cologne, 1962, Heft 24.

This extensive study on bolts and bolted joints, including a total of 104 tests, covered the following areas; (1) Calibration studies of single bolts including direct tension and torqued tension behavior. Also included is the development of the current German bolt profile. (2) The results of analysis and tests of bolted end plate connections from which design tables are developed. Also, the semi-rigid behavior of the connections is incorporated into a beam-line analysis. (3) Static and fatigue tests of bolted butt splices with main plates and lap plates inclined to increase the net section area are discussed. Plane plate specimens with similar hole geometry were tested for comparison. Changing the net-section area did not significantly alter the fatigue strength of the bolted connection. (4) A few tests of the corrosion resistance of bolted joints are reported.

KEY WORDS: bolts; steel; testing; corrosion; fatigue; friction; joints

62-15

---

Wiedemann, J.
DIE ERSTLE ANWENDUNG DER GLEITFESTEN SCHRAUBENVERBINDUNG IM BRUCKENBAU DER DEUTSCHEN REICHSBAHN (THE FIRST APPLICATION OF SLIP-PROOF BOLTED CONNECTIONS IN BRIDGE CONSTRUCTION FOR THE GERMAN RAILROAD), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 11-18.

Discussed are the experiences obtained during the design and construction of the first railroad bridge assembled with high-strength bolts in East Germany. Several preliminary bolt calibration tests and tests for the determination of the coefficients of friction, were made. The contact surfaces were all sand-blasted which gave very satisfactory coefficients of friction. The most suitable form for bolts had to be determined. It was difficult to compare the cost for this bridge with riveted bridges, since many unforeseen difficulties occurred during the fabrication and erection of the structure.

KEY WORDS: bolts; bridge; friction; joints; sand-blasting

62-16

Sammet, J.
HOCHFEST VERSCHRAUBTE ROHRVERBINDUNGEN (PIPE CONNECTIONS USING HIGH-STRENGTH BOLTS), Wissenschafliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 12, pp. 19-30.

Two different types of pipe connections were investigated. Tests were made on 4 specimens where the pipes were connected by lap plates and bolts. Ten more specimens tested were connected through head flanges and bolts. The test results are presented in the form of P-$\delta$ diagrams. The coefficients of friction for the lap specimens (no surface treatment) ranged from 0.49 to 0.67. All specimens were subjected only to static loading, but the author believes that for fatigue loading the tested types of pipe connection will prove to be as suitable as for static loading. Comparative tests using high-strength bolts and standard bolts showed that with high-strength bolts up to 30% thinner flanges can be used. An empirical design method is presented which is based on the test data.

KEY WORDS: bolts; friction; joints; pipe; testing

62-17

Rybak, M.
DIE VERSUCHE UBER SPANNUNGSVERTEILUNGEN IN GLEITFESTEN VERBINDUNGEN (TESTS ON THE STRESS DISTRIBUTION IN SLIP-PROOF CONNECTIONS), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 31-42.

Two phases of stress distribution are investigated theoretically and experimentally: first the stresses due to prestressing of the bolt, and then the stresses due to the load. Tests were conducted on double-lap connections with a single row of bolts. The most important stresses in the neighborhood of the holes were measured using the tensometric method. Since only a limited number of actual stress measurements could be taken, and these only at the outer fibers of the steel plates, it was necessary to interpolate to obtain values for the stress in the center of the plates. In addition, photoelastic tests were conducted with plexiglass models. There was a large stress concentration due to normal stress. The photoelastic studies also indicated that high stress peaks could be observed at the boundaries of the holes.

KEY WORDS: bolts; friction; joints; photoelastic technique; stress; testing

62-18

Skwirblies, D.
EINIGE BETRACHTUNGEN ZU DEN SCHRAUBENABSTANDEN HOCHFEST VERSCHRAUBTER VERBINDUNGEN (SOME ASPECTS ON THE SPACING OF BOLTS OF HIGH-STRENGTH BOLTED CONNECTIONS), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 43-48.

According to the "Preliminary German Specifications for High-Strength Bolted Connections" the spacing for the high-strength bolts is the same as for rivets. A decrease in the spacing of bolts would be desirable in order to construct smaller connections. Photoelastic investigations on a plexiglass model of a bolted connection were made to determine how much the bolt spacing can be reduced. A smaller spacing can be expected, because for bolts, as compared to rivets, the load transfer occurs over a considerably larger area. The test results showed that any spacing would be permissible which is also acceptable from the construction point of view. Therefore, bolt-to-bolt spacings of 2½ diameters are proposed.

KEY WORDS: bolts; spacing; specifications

62-19

Ziemba, St., and Rybak, M.
FESTIGKEITSVERSUCHE UBER HOCHFESTE SCHRAUBEN (TESTS ON THE ULTIMATE STRENGTH OF HIGH-STRENGTH BOLTS), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 49-57.

Theoretical and experimental work was conducted to investigate the true stress distribution in the high-strength bolt when subjected to prestressing and the applied loads. An important problem is the creep behavior of the bolt material and the resulting loss in prestressing force. Bolts subjected to both tensile and torsional forces were tested to define certain constants necessary to describe the stresses in the bolts. Diagrams for these constants are presented. The tests which gave information about creep behavior showed that the loss in the prestressing force is mostly negligible, although a few losses up to 20% were measured.

KEY WORDS: bolts; creep; tensile forces; torsional forces; stress distribution

62-20

Pfungen, R.
VERSUCHE MIT HV-SCHRAUBEN UND ANWENDUNG DER GLEITFESTEN SCHRAUBVERBINDUNG IN OSTERREICH (TESTS ON HIGH-STRENGTH BOLTS AND APPLICATION OF THE SLIP-PROOF BOLTED CONNECTION IN AUSTRIA), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 59-64

Some explanation of the "Austrian Specifications for High-Strength Bolted Connections" are given. The results of 6 torqued-tension tests where the nut was turned to failure are given. Bolts used in the Austrian construction industry were tested.

KEY WORDS: bolts; turn-of-nut; specifications

62-21

---

Hohaus, D.
UNTERSUCHUNG UBER HOCHFESTE SCHRAUBEN IN LEICHTMETALL-VERBINDUNGEN (INVESTIGATIONS ON HIGH-STRENGTH BOLTS IN LIGHT-WEIGHT METAL CONNECTIONS), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 65-73

Fifteen aluminium specimens were tested to investigate the slip load and the coefficient of friction of light-weight metal connections. The contact surfaces were treated differently to investigate the effects of sand-blasting, flame-cleaning, painting, and grease on the slip loads of the connections. The coefficient of friction varied from 0.21 to 0.26. The effect of the variation of the prestressing force of the bolt was also investigated. Formulas are given for the analytical determination of the friction coefficient. All specimens which were tested for the effect of contact corrosion did not show any decrease in the ultimate slip load, which indicates that contact corrosion can be ignored.

KEY WORDS: aluminium connection; bolts; coefficient of friction; surface treatment; slip load; contact corrosion

62-22

---

Weigand, H., and Illgner, K. H.
BERECHNUNG UND GESTALTUNG VON SCHRAUBENVERBINDUNGEN (ANALYSIS AND DESIGN OF BOLTED CONNECTIONS), Konstrucktionsbucher 5, Springer-Verlag 1962.

Various types of mechanical fasteners are discussed. Much information is presented about bolt and nut standards, both German and American. Fit and tolerances are discussed. Several chapters deal with the strength and behavior of bolts under static and fatigue loading. Formulas and graphs are presented to explain bolt deformation and stress conditions. The behavior of prestressed bolts is discussed and the stress distribution in the threaded portion is explained. Also, various types of special threaded fasteners are described and their application discussed. Considerable discussion is given on the various factors which influence the fatigue strength of threaded fasteners. Test results from a large number of sources are summarized and design suggestions are made for various machine design appoications. The final two chapters deal with the effects of temperature and corrosion on the behavior of bolted joints. Temperature deformations are discussed and their application to design is summarized. The influence of temperature on the creep of prestressed bolts and the causes of corrosion in prestressed threaded fasteners are discussed.

KEY WORDS: analysis; behavior; bolts; corrosion; fatigue; friction; joints; steel; tests

62-23

---

Task Committee on Lightweight Alloys, John W. Clark, Chairman
SUGGESTED SPECIFICATIONS FOR STRUCTURES OF ALUMINUM ALLOYS, 6061-T6, and 6062-T6, Journal of the Structural Division, ASCE, Vol. 88, No. ST6, Proceedings Paper 3341, December, 1962

The specifications presented would supersede 2 sets of specifications covering allowable stresses, design rules, and fabrication procedures for structures built of highly-corrosion-resistant aluminum alloys 6061-T6 and 6062-T6. Alloy 6061-T6 is available in sheet, plate, shapes, tubes, rods, bars, rivets, and forgings. Alloy 6062-T6 is available in shapes and tubes. The two alloys have the same mechanical properties and may be used interchangeably. Two sets of specifications are provided, one for bridges and other structures to which allowable stresses for bridges are normally applied; the other for buildings and other structures to which allowable stresses for buildings are normally applied. The basic allowable stresses are 17 KSI for bridge structures and 19 KSI for building structures, based on a minimum yield strength of 35 KSI and a minimum tensile strength of 38 KSI.

KEY WORDS: aluminum; design; specifications

62-24

Komatsubara, M., Tajima, J. and Omiya, K.
SEVERAL EXPERIMENTS ON HIGH-STRENGTH-BOLTED JOINTS, Quarterly Report of the Railway Technical Research Institute, Vol. 3, No. 2, 1962, Japan.

The tests reported are a part of study on how to obtain a design method in which the characteristics of the high-strength bolted joints are fully utilized. Described are slip tests for joints given various surface treatments and stress measurement and fatigue tests for these joints. Riveted joints were tested for comparison. Reported are the results of 12 slip tests of bolted joints, their slip loads, and the riveting coefficient of friction. The yield point and tensile strength are recorded for riveted and bolted joint components. Joints with reduced cross-sectional areas of 20% and 30% are also compared to normal joints. The relation between fatigue strength and slip stress is given in figures. Altogether the results of 81 fatigue tests are summarized. Included are 14 partial-tension-to-tension tests of riveted joints with a 2 x 2 pattern, 15 tests of similar bolted joints with various faying surface conditions, 24 tests of bolted and riveted joints with 1 x 4 pattern, and 5 riveted and 5 bolted joints with 2 x 2 patterns tested in reversal. For comparative purposes 18 tests of plain and drilled plate are reported.

KEY WORDS: bolts; fatigue; friction; joints; rivets; steel; strength; testing

62-25

---

Eaton, I. D.
COMPARATIVE FATIGUE STRENGTHS OF SCREW-THREAD FORMS, Product Engineering, Vol. 34, No. 3, Feb. 4, 1963, pp. 66-69.

Tests are reported of 7 different types of threads tested in fatigue and the results are compared. Included are American National, Saw-tooth, Stub-saw tooth, Unified, 90-day Vee, Round, and the Modified Round Thread. The test results show the superiority of large-radious threads in resisting fatigue; in these tests threads with rounded flanks were used rather than V-shape threads with increased root radii. Some of the key conclusions are that the Modified Round thread form had a 60% higher fatigue strength at $10^7$ cycles and that Unified thread 22% higher than the American National. In general, with the exception of the Modified-Round thread form, the threaded members showed a greater reduction in fatigue strength than did the sharply notched round specimens when compared to smooth round specimens.

KEY WORDS: bolts; fatigue; strength; thread form; testing

63-4

---

Loubser, R. S.
A CRITICAL REVIEW OF THE LITERATURE ON FRICTION GRIP BOLTED JOINTS FOR STEEL STRUCTURES, National Mechanical Engineering Research Institute, Council for Scientific and Industrial Research, CSIR Special Report No. N273, Pretoria, South Africa, February, 1963.

A critical review is made of 19 codes of practice and standards, and 85 general articles on friction-grip bolted joints. An attempt is made to analyze the tendencies of European and American practice and to resolve some of the contradictory information on the properties of the joints and the fasteners. Also presented is the most suitable line of practice for local conditions. The reviewed articles are classified into sub-divisions, and a discussion of each is included.

KEY WORDS: bibliography; bolts; friction; joints; steel; standards

63-5

---

Cullimore, M. S. G.
BASIC FACTORS IN THE BEHAVIOR OF FRICTION GRIP BOLT JOINTS, Civil Engineering and Public Works Review, March and April, Vol. 58, No. 680 and 681, 1963, London, pp. 379-384, and pp. 498-500.

This article reviews the various design and assembly techniques in relation to their scientific backgrounds and current research. The history of high-strength friction-grip bolted joints is briefly traced and the factors affecting the strength of such joints are described. The choice of working stress in the bolt is discussed in relation to its material properties and the method of preload control, and the relevant properties of several special forms of bolts are described in light of these considerations. The nature of the contact between the plies of the joint and the causes of the resistance to slipping are examined in terms of modern ideas of solid friction. Finally it is suggested how those notions may be applied to the discussion of the behavior of the assembled joint in both static and repeated loading conditions.

KEY WORDS: bolts; behavior; joints

63-6

Daesen, J. R.
REVISE SPECIFICATIONS FOR GALVANIZING ON SLIP SURFACES, Consulting Engineer, October, 1963, pp. 127-128.

The changes and restrictions in the 1951 Specifications with respect to galvanizing of contact surfaces are discussed. Effects of galvanizing on contact surfaces of friction-type joints, including factor of safety against slip, are illustrated with test results. A 300-ft. span made with hot-dipped galvanized steel is described.

KEY WORDS: bolts; friction; galvanized; specifications

63-9

---

Wright, W.
ULTIMATE STRENGTH OF LONG LAP JOINTS, Engineering Institute of Canada, Volume 1, No. 31, Paper No. EIC-63-BR&STR 17, November, 1963

Presented is a analytical and experimental investigation into the subject of predicting the ultimate strength of bolted joints. The author makes five major assumptions for the calculation of shear deformations of the end fasteners, and a few minor assumptions. The simplified method to estimate the ultimate strength of a joint makes use of the principle that the failure of the end fastener takes place when its actual shear deformation just exceeds the tolerable value. The predicted failure load of the joint will be the intersection of the curve showing the shear deformation of a end fastener as a function of the load in the joint, and the vertical straight line representing the maximum shear deformation of the end fastener. An example using these simplying assumptions is done, and the results of three joints tests are repeated and compared to predicted values. The proposed method was in reasonably good agreement with test results.

KEY WORDS: analysis; bolts; joints; steel; testing

63-10

---

Tajima, J., and Tomonaga, K.
FATIGUE TEST ON HIGH-STRENGTH BOLTED JOINTS, Structural Design Office, Japanese National Railway, 1963.

Described are several fatigue tests of plates, plates with drilled holes, riveted plates, and bolted plates. Included are fatigue tests of bolted joints with 2, 4, and 6 bolts in line, a fatigue test of an angle with gusset plates, a fatigue test for joints of 60 $kg/mm^2$ class steel plate, and an investigation of reduction of cross-sectional area by and clamping force of bolts on fatigue strength. The conclusions are that the slip stress and the number of bolts in line affect the fatigue strength significantly. The fatigue strength for 2 x $10^6$ cycles was nearly the same for both SS41 and SM50 steels. When the slip stress becomes larger, or if the bolt tension increases, the fatigue strength of a joint will also increase.

KEY WORDS: bolts; fatigue; friction; joints; steel; testing

63-11

---

Daesen, J. R.
SLIP RESISTANCE OF BOLTED GALVANIZED STEEL JOINTS, The Galvanizing Institute, Park Ridge, Ill., 1963.

Explained are the present limitations in the Specifications barring galvanized friction surfaces in bolted joints, thus prohibiting use of a most effective protection against corrosion. These tests were to study the comparative slip under load of galvanized and bare steel joints bolted to the same proof load. These tests indicated that the prohibition against galvanized steel is not warranted where there is no substantial stress reversal, such as in bridges. It was demonstrated that at identical bolt loads, galvanized steel joints, after insignificant movement, had a slip resistance equal to or greater than that of bare steel joints.

KEY WORDS: bolts; friction; joints; surface treatment, testing

63-13

Yamada, M.
BEHAVIOR OF WIDE FLANGE BEAM-COLUMN CONNECTIONS (HIGH-STRENGTH BOLTED CONNECTIONS, Dept. of Architecture, Kobe University, Kobe, Japan, 1963, (in Japanese)

Presented are the resultsof 8 tests of bolted corner connections for rigid frames. Four of the specimens had web angles we well as a lap plate and beam seats. In addition, a comparison is made of specimens with and without diagonal stiffeners. The remaining 4 specimens had no web angles. The results are presented in load-deformation curves and strain distribution curves for various cross-sections. All connections developed the full plastic moment. Without the diagonal stiffener, the connections were substantially more flexible. In all connections the beam seat provided substantial reinforcement.

KEY WORDS: bolts; joints; frame; steel; testing

63-14

---

Onderdonk, A. B., Lathrop, R. P., and Cod, J.
END PLATE CONNECTIONS IN PLASTICALLY DESIGNED STRUCTURES, Engineering Journal, AISC, Volume 1, Number 1, January, 1964, pp. 24-27.

The use of end plate connections for moment connections and the economy of using end plates over tees as moment connections are discussed. The advantages of two-way plastic design for framing systems over other structural designs for a one-story school and a seven-story office building are presented. The savings due to plastic design and the use of end plate connections are explained.

KEY WORDS: bolts; design; joints; steel; structural engineering

64-1

---

Nordmark, G. E.
FATIGUE OF ALUMINUM WITH ALCLAD AND SPRAYED COATINGS, Journal of Spacecraft and Rockets, Vol. 1, No. 1, Jan., Feb., 1964, pp. 125-127.

Results are discussed concerning alclad materials, the surfaces of which have a greater corrosion resistance than the cores. Alclad specimens had lower fatigue strengths than bare specimens in both sheet flexure and axial-stress fatigue tests. The reduction of the fatigue strength due to the cladding was as much as 50% for 7075-T6 and 33% for 2024-T3. However, the stress raisers in riveted construction overshadow the effect of the coatings, so that there was little difference in the fatigue strengths of beams and joints fabricated of bare and clad materials.

KEY WORDS: aluminum; fatigue; strength; surface; testing

64-2

---

Upton, K. A., and Cullimore, M. S. G.
THE DISTRIBUTION OF PRESSURE BETWEEN TWO FLAT PLATES BOLTED TOGETHER, International Journal of Mechanical Sciences, V6, N. 1, February 1964, pp. 13-27.

The method described was developed to measure the distribution of pressure between two plates bolted together. From these measurements empirical formulae for the pressure distribution were established. An idealization of the geometry permitted a relaxation solution of the stress function equation. The pressure distribution for 4 different cases and the predictions of the empirical formula show that the pressure is highest at the edges of the hole but falls off quickly to zero at a point whose distance from the edges of the hole depends on the thickness of the plates.

KEY WORDS: bolts; behavior; joints; pressure; testing

64-9

Watson, I.
FLANGE-BOLT DESIGN, Engineering Materials and Design, Vol. 7, No. 10, October, 1964, pp. 687-689

The design of bolts for the end supports of beams is critical since the bolts determine the end fixity of the beams. These are two common ways to design the bolts. The author develops a third way based upon the fact that the bolts must be designed so that they may be tightened sufficiently to maintain face-to-face contact at the point of maximum tensile stress of the joint faces due to bending. The specific relationship is as follows: where $N_w = (\frac{6M}{D} - W)$, $N_w$ = number of bolts, M = bending moment, D = depth of joint face, W = tightening load per bolt. A table is included that gives formulas based on the above equation for several flange shapes. The table also has values of bolt tension based upon the three ways of design. These are compared and show that the common methods give values too low to keep the faces tight. In the case where the flanges are subjected to cyclic stresses, the bolts must be designed to operate at stresses that are ecual to the stress required to maintain face-to-face contact plus the cyclic stress. Suggestions are given concerning the control of bolt tightening for these applications.

KEY WORDS: bolts; connections; design; steel

64-10

---

Tajima, J.
LONGITUDINAL STRESS DISTRIBUTION OF THE HIGH STRENGTH-BOLTED JOINTS, Structural Design Office, Japanese National Railway, Tokyo, June, 1964.

This paper deals with the measurement and analysis of longitudinal distribution of shearing force between the contact surfaces of the plates fastened with high strength bolts. Equations are derived for the shear stress of the joint surface and the axial force in the plate when slip occurs on the faying surface. Equations are also derived for the case where applied load increases and shearing stress exceeds the frictional resistance at the end of the joint and minor slip occurs, and for the case where the applied load exceeds the total friction of the contact surfaces of the joint and major slip occurs. Experimental and theoretical values compared well.

KEY WORDS: Analysis; bolts; friction; joints; slip; steel; testing

64-11

---

Tajima, J
EFFECT OF RELAXATION AND CREEP ON THE SLIP LOAD OF THE HIGH-STRENGTH BOLTED JOINTS, Structural Design Office, Japanese National Railway, Tokyo, June, 1964

Joints were tested some time after assembly to determine their slip behavior. Relaxation of the bolts was considered of little effect on the slip load. When the induced bolt tension was 10, 90, and 100% of yield point, the extent of relaxation was only 2, 3, and 6% respectively, at 100,000 hrs. (11.4 yrs). When the combined stress of the bolt with respect to the effective cross-sectional area of the threaded part is 85% or more of the yield strength, the decrease of slip load after assembly is 5% or more; and when the combined stress is over the yield strength, the extent of decrease of the slip load is 10% or more. Decrease of slip load due to lapse of time occurs only in joints allowed to dry and joints exposed outside. The decrease in bolt tension is counteracted by an increase in the slip resistance.

KEY WORDS: bolts; creep; friction; joints; relaxation; steel; testing;

64-12

---

Johnson, L. G.
TEST ON FRICTION GRIP BOLTED SHEAR CONNECTIONS WITH VARIOUS FINISHES ON THE CONTACT FACES, Dorman Long and Co., Limited, England, July, 1964.

Sixty-one tests are reported on high-strength friction-grip bolted shear connections. Slip load values for various contact surface finishes are compared. The shear connections were tested when the various contact surface finishes were both fresh and weathered, and two types of friction-grip bolts were used, the waisted and the parallel friction grip bolt. The connections were tested in both single and double shear, with a higher slip load value for the single shear specimen. Weathering gave a reduction in slip factor for waisted friction-grip bolts, but gave an increase for parallel friction-grip bolts.

KEY WORDS: bolts; friction; joints; surface treatment; steel; testing

64-14

Daesen, J. R.
CHOOSE THE RIGHT ZINC COATING FOR LARGE STRUCTURES, Metal Progress, V86, No. 3, Sept., 1964, pp. 950-110.

Several topics are covered in this report concerning the characteristics of zinc coatings and their effect on corrosion resistance and structural integrity. An example of the use of zinc coating to prevent slippage is given in the Lizotte Bridge. Tests indicated that galvanized steel joints were more resistant than bare steel at the proof loading of the bolt but slipped more easily than the bare steel at low bolt tensions. The protective layers and the protection obtainable from galvanizing are examined. The various processes for galvanizing are mentioned and the adherence of the galvanized coats under accelerated corrosion is illustrated in figures.

KEY WORDS: bolts; galvanized; joints; strength

64-15

---

Kloppel, K., and Seeger, T.
DAUERVERSUCHE MIT EINSCHNITTIGEN HV-VERBINDUNGEN AUS ST 37 (FATIGUE TESTS ON LAP JOINTS USING ST37 STEEL AND HIGH-STRENGTH BOLTS), Der Stahlbau (Berlin) Heft 8, 33. Jahrgang, August 1964, pp. 225-245 and Heft 11, 33. Jahrgang, Nov. 1964, pp. 335-346

The results of 14 static and 143 fatigue tests of 7 different types of connections are reported and analyzed. A variety of shapes, plates, and specimen geometries were tested. Most of the joints were ST37 steel lap joints connected by high-strength bolts. The tests showed that under stress reversal and zero-to maximum loading, eccentric lap joints had considerably less fatigue strength than butt joints. A few static tests yielded similar results. Several types of eccentric lap joints had fatigue strengths of only 28% of the fatigue strength of bolted butt joints. The reason for decrease in ultimate strength is the eccentricity of the axial force in the lap joints. Formulas for the computation of stress reduction factors for the various types of connections are developed.

KEY WORDS: bolts; fatigue; geometry; joints; steel; testing

64-16

---

Chesson, E., Jr., and Munse, W. H.
STUDIES OF THE BEHAVIOR OF HIGH-STRENGTH BOLTS AND BOLTED JOINTS, Bulletin No. 469, Vol. 62, No. 26, University of Illinois Engineering Experiment Station, University of Illinois, Urbana, Illinois, Oct. 1964.

A325 and A354BD bolts were used in tests which demonstrated that washers have no significant effect on the clamping force of high-strength bolts tightened with a turn-of-nut method. Additional turning is required in a turn-of-nut method when the surfaces at the head and nut are on 5% slopes. Thirty-eight fatigue tests were made with 4-bolt double-lap shear-type joints. Some specimens had the outside plates critical, while others had the inside plates critical. The tests showed that washers generally have no effect on the fatigue lives of properly-bolted A325 joints. A few relaxation tests were conducted with oversize holes of 27/32 and 7/8-in. for studies of 3/4-in. bolts. Even with no washers under the bolt head and nut no significant differences in bolt tension were observed.

KEY WORDS: bolts; fatigue; joints; steel; structural engineering; testing

64-17

---

Shermer, C. L.
ULTIMATE-STRENGTH ANALYSIS AND DESIGN OF ECCENTRICALLY-LOADED BOLTED OR RIVETED CONNECTIONS, Preprint for ASCE Structural Engineering Conference, October, 1964

The actual behavior of small eccentrically loaded connections at ultimate load is explained, and a design method consistent with the behavior is presented. An explanation of the theoretical analysis and a sample solution using design charts is given. The results of tests conducted, with various fastener patterns,(up to 5 in a line) are listed with the average discrepancy between actual predicted ultimate loads being 2.5 percent; the maximum deviation, 5.7 percent.

KEY WORDS: Analysis; bolts; joints; steel; testing

64-18

Chesson, E., Jr.
JOINT BEHAVIOR OF A BOLTED RAILWAY BRIDGE DURING ERECTION AND SERVICE, Department of Civil Engineering, University of Illinois, SRS No. 284, October, 1964 (Published in the Journal of the Structural Division, ASCE, Vol. 91, No. ST3, June 1965).

An investigation conducted over a period of 3-1/2 years of the movements of connections of a 310-foot railway bridge is reported. The study began during shop assembly of a truss and ended after three years of service loadings. No service movements or marked changes in camber were observed. The effect of the measured movements on the camber is discussed. The problems of structural alignment and camber due to joint slippage under bibration and dynamic loads were studied, problems of special importance in joints where high strength bolts are used. The conclusion is that a properly designed structure with properly installed high-strength bolts will not slip under normal service loads.

KEY WORDS: bolts; bridge; joints; slip; steel; testing

64-19

---

White, R. N., and Fang, R. J.
SIMPLE FRAMING CONNECTIONS FOR SQUARE STRUCTURAL TUBING, Preprint of ASCE Structrual Engineering Conference, October, 1964.

This paper presents the results of an experimental and theoretical investigation of the behavior of five different types of connections for framing flanged beams into tubular columns using only AISC Type 2 framing ("conventional" or "simple" framing). The first phase of the investigation concerned only connection behavior and performance, while the second phase included the degree of column strength reduction caused by the tub-deforming action of a Type A connection, which consists of a piece of flat plate, fillet welded on both sides to the tube wall at the center of a tube face. Included is a theroetical solution for the flexibility of connection Type A, and strength reductions of 10 to 40 percent of base column capacities are observed.

KEY WORDS: bolts; column; joints; steel; testing; tubing

64-20

---

Beedle, L. S., and Christoper, R.
TEST OF STEEL MOMENT CONNECTIONS, Engineering Journal, AISC, Volume 1, No. 4, October, 1964, pp. 116-125.

The report consolidates and discusses the results of some of the more important studies of rigid moment connections in building frames, and suggests possible areas for future work. The three types of connecting media considered are welding, riveting, and bolting; and the types of connections given primary attention are the corner connection, the beam-to-column connection, and the beam splice. The moment capacity and deformation capacity of these connections are of main concern. The criterion used is the ability of the connection to undergo inelastic strain resulting in joint rotation many times that associated with initial yielding. The most important result of these tests is that for all properly designed and detailed welded and bolted moment connections, the plastic moment of the adjoining member was reached and large plastic rotation was observed.

KEY WORDS: bolts; frames; joints; steel; testing; welds

64-21

---

Fisher, J. W.
ON THE BEHAVIOR OF FASTENERS AND PLATES WITH HOLES, Fritz Engineering Laboratory Report No. 288.18, Lehigh University, Bethlehem, Pa., Dec. 1964. (Published in a shortened version in the Journal of the Structural Division, ASCE, Vol. 91, No. St6, Dec. 1965).

The behavior of the individual components of bolted or riveted joints is analyzed and discussed. The results of plate calibration tests of A7 steel and tests of A440 steel are presented. General stress-strain relationships are developed for a plate with holes in the elastic range and beyond. The relationships are shown to be valid for low alloy, low carbon steels such as A7, A36, A242, A440, and A441. Also, the relationships account for changes in specimen geometry. In addition, a load-deformation relationship is developed for mechanical fasteners in shear. The shape of the curve was observed to be governed by the ultimate shear strength and two empirical parameters. The analytical model was compared with test data for A141 and A502-grade 2 steel rivets and A325 and A490 high-strength bolts. The model was in good agreement with the test data.

KEY WORDS: analysis; bolts; connections; coupons; rivets; shear; steel; strength; structural engineering; tests

64-22

Wallaert, J. J., Sterling, G. H., and Fisher, J. W.
HISTORY OF TENSION IN BOLTS CONNECTING LARGE JOINTS, Fritz Engineering Laboratory Report No. 288.13, Lehigh University, Bethlehem, Pa., Dec. 1964. (Published in a shortened version in the Journal of the Structural Division, ASCE, Vol. 91, No. ST3, June 1965).

This report describes an experimental study of the changes in bolt tension in high-strength A325 and A490 bolts connecting A440 and constructional alloy steel joints. Various bolts in seven large joints were instrumented and changes in their internal tension measured. Until major slip occurred the bolts lost only a small amount of their initial tension. This loss was due to the lateral plate contraction caused by the Poisson effect. As inelastic deformations in the plate and bolts began to occur the bolts at the lap plate end began to show an increase in tension. This was caused by the outward prying action of the plate and the resulting force was not indicative of the normal force acting on the faying surface. These tests showed that negligible load was transferred by frictional resistance near the ultimate joint strength. Also it was found that the bolts at the lap plate ends, being under a higher combined shear and tension loading than the bolts at the main plate end, were usually the first to fail.

KEY WÓRDS: bolts; joints; friction; instrumentation; prying; shear; steel; strength; structural engineering; testing

64-23

---

Fisher, J. W., and Beedle, L. S.
BIBLIOGRAPHY ON BOLTED AND RIVETED STRUCTURAL JOINTS, Fritz Engineering Laboratory Report No. 302.1, Lehigh University, Bethlehem, Pa., Dec. 1964.

Abstracts of most of the work that has been performed during the past two decades on riveted and bolted joints are contained in this report. The bibliography covers the period from De Jonge's bibliography in 1944 up to the present time. Altogether 241 abstracts are included. The abstracts are proceeded by historical notes and discussion which cover the development of fasteners, related materials, research efforts and specifications. A series of graphical summaries are also presented for many of the articles abstracted. These provode a means of rapidly assessing the type of joints tested and the variables studied. In addition to the abstracts several lists are provided for the user. These include the subject and author indexes, a list of Research Council work and a list of references.

KEY WORDS: aluminum; bibliography; bolts; connections; rivets; steel; structural engineering; testing

64-24

---

Parola, J. F., Chesson, E., Jr., and Munse, W. H.
EFFECT OF BEARING PRESSURE ON FATIGUE STRENGTH OF RIVETED CONNECTIONS, SRS 286, Dept. of Civil Engineering, University of Illinois, December, 1964.

Reported are fatigue tests of 120 double lap joints of A7 steel connected with A141 steel rivets. They were tested using four different bearing ratios and various fatigue stress cycles. Four joints were loaded statically as control specimens. The results of these tests, along with data from other sources, were analyzed. In general, it was found that fatigue strength is reduced by increasing bearing ratios and the related geometry changes. However, the effect was not pronounced for bearing ratios of less than 2.25 for model plates.

KEY WORDS: fatigue; joints; rivets; steel; testing

64-25

---

Aurnhammer, G.
HV-VERBINDUNGEN. UBERLEGUNGEN, BETRACHTUNGEN, VERSUCHE (HIGH-STRENGTH BOLTED JOINTS, THOUGHTS, OBSERVATIONS, TESTS). Preliminary Publication, Seventh Congress, IABSE, Rio de Janeiro, 1964, pp. 415-430.

The author presents results from a test program based upon considerations and observations of the mode of action of high-strength bolted connections, in order to control unfavorable conditions. The results of 12 static tension tests and 30 fatigue tests on bolted butt joints are summarized. The subjects treated are: effect upon the friction coefficient of surface preparation and repeated application of load; divergent values of induced bolt tension; influence of form irregulatities on compression in contact surfaces; transfer of force in joints; and effect of creep and corrosion. The slip coefficient for clean mill scale was 0.38; flame cleaning increased the slip coefficient to about 0.70, and repeated loading did not significantly alter the slip coefficient. Sand blasting yielded a slip coefficient of about 0.75. The size of sand used in cleaning influenced the coefficient. The transfer of force was measured in several bridge and test joints. Also, bolts were observed to lose about 10% of their preload over a two-year period.

KEY WORDS: bolts; creep; corrosion; friction; joints; surface treatment; steel; testing

64-26

Beer, H., and Wallner, H.
BEITRAG ZUR WANDERSICHEIT VON HV-VERBINDUNGEN (THE SAFETY FACTOR OF HIGH-STRENGTH FRICTION GRIP BOLTS UNDER REPEATED LOADING), Preliminary Publications, Seventh Congress, IABSE 1964, pp. 371-378.

Friction-grip-bolted joints were tested under repeated loading. Tests were made with 50 and 1000 repetitions of loads ranging from low up to a load close to a maximum based upon the static friction coefficient. Inter-bolt slip did not occur even when a relatively high friction coefficient was used, e.g. 0.56 for ST37. The tests justify a clearance of 2mm for the bolt and show that it is impossible to justify any increase in the safety factor against sliding (1.25) used in the European Drafts.

KEY WORDS: bolts; coefficient of friction; factor of safety; slippage

64-27

Konishi, I.
STUDIES ON THE APPLICATION OF HIGH-STRENGTH BOLTED JOINTS TO BRIDGES, Preliminary Publications, 7th Congress, IABSE, 1964, pp. 363-370.

The results of an experimental investigation of the static and fatigue behavior of 4 full-scale high-strength steel welded girders with mechanically-fastened joints is reported. The connections were web- and flange-plate lap splices. Static tests were first performed with two girders having high-strength bolted joints and two with riveted joints. The girders were loaded until a significant departure from linearity was noted. The load was removed and the rivets in one girder were replaced with high strength bolts. Fatigue tests were then conducted on all the girders until failure occurred. The high-strength bolted joints were compared to the ordinary riveted joints, and the superiority of the high-strength bolted joints was clearly evident in both static and fatigue conditions.

KEY WORDS: bolts; fatigue; girders; joints; steel; strength; testing

64-28

Tomonaga, K. and Tajima, J.
THE USE OF HIGH-STRENGTH BOLTED JOINTS IN RAILWAY BRIDGES, Preliminary Publication, 7th Congress, IABSE, 1964.

In this paper, tests on high-strength bolted joints and their use in railway bridges on the Japanese National Railway are described. The effect of the slip coefficient and the number of bolts in the direction of load is significant to the fatigue strength of a joint. Discussed in detail are the factors that affect slip load, such as condition of faying surface, strength of bolted plate, type and size of joint, arrangement of bolts, the relationship between slip coefficient and slip stress, and the influence of bolt relaxation of slip load.

KEY WORDS: bolts; fatigue; friction; joints; surface treatment, steel; testing

64-29

Tada, H., and Naka, T.
EXPERIMENTS ON TENSILE JOINTS USING HIGH-STRENGTH BOLTS, Preliminary Publication, 7th Congress, IABSE, 1964.

Tests were conducted to provide a basis for the specification for field assembly of the tower members discussed by Dr. B. Kate in his paper "Stress Analysis and Test on a One-Sheet Hyperboloidal Tower." Loading tests were conducted to observe bolt tension and joint rigidity to verify the safety of joints using preloaded high-strength bolts. To determine the proper method of securing the required bolt tension, bolt tightening tests were conducted to investigate the relationship between bolt tension, torque, and turn-of-nut angle.

KEY WORDS: bolts; calibration; joints; installation; testing

64-30

Carpentier, L., and Alemany, B.
EXPERIENCE FRANCAISE DES BOULONS A HAUTE RESISTANCE (EXPERIENCE WITH HIGH STRENGTH FRICTION GRIP BOLTS IN FRANCE) Preliminary Publications, 7th Congress IABSE, 1964, Zurich, pp. 397-405.

An account is given of the principal applications of and research efforts on high-strength bolts in France since 1955. The principal applications have been in the repair and reinforcement of existing structures, construction of buildings, particularly aircraft hangars and the construction of thermal power stations. 81,000 bolts in bridges were checked for tightness and less than 3% were found to be loose. Looseness was found primarily in bolts subjected to combined tension and shear. It was noted that when high-strength bolts were used on old bridge structures a large amount of preload was necessary to bring the deformed members into contact. A few calibration tests of bolts were conducted and several different types of joint tests were undertaken. No details of tests results are reported.

KEY WORDS: bolts; behavior; joints; structures

64-31

---

Goffi, L.
L'EMPLOI DES BOULONS A HAUTE RESISTANCE DANS LA CONSTRUCTION METALLIQUE; LEUR COMPORTEMENT DANS LES CONDITIONS DE SOLLICITATIONS REPETEES (THE USE OF HIGH STRENGTH BOLTS IN STEEL STRUCTURES; THEIR BEHAVIOR UNDER REPEATED LOADING); Preliminary Publications 7th Congress, IABSE, 1964 Zurich, pp. 407-414

Preliminary results are reported of fatigue tests of web angle bolted connections. The results with high-strength bolts are compared with the results of similar tests with ordinary bolts. The high-strength bolts were preloaded to about 70% of proof load. The changes in internal bolt tension were recorded. The outstanding legs of the web angles introduced additional stresses into the bolts due to prying. The web connection was not critical because the load transfer was due to friction on the faying surfaces.

KEY WORDS: bolts; fatigue; joints; steel; testing

64-32

---

Radzimovsky, E. I.
BOLTED JOINTS, Section 21, Mechanical Design and Systems Handbook, McGraw-Hill, 1964, pp. 21-1, 21-6

Bolts as fasteners are discussed, including the material and strengths of ASTM and SAE grades of steel bolts and cap screws, as well as non-ferrous fastener materials. The design of bolts subjected to steady loads, covering several different conditions found in practice, and the design of bolts for repeated loading are examined. The diagram of many locking devices for fatigue are also given. A general discussion of improving bolt performance and reliability closes the section.

KEY WORDS: bolts; design; fatigue; joints; strength

64-33

---

Holt, M.
RIVETS AND RIVETED JOINTS, Mechanical Design and Systems Handbook, McGraw Hill, Section 22, pp. 22-1, 22-18, 1964

Different types of rivets, different head forms, and in general, factors important to the proper use of rivets are discussed. Discussed in detail are the design factors in riveted jointed designed for static and fatigue strength. Other characteristics of riveted joints such as fretting, creep, and slip are mentioned.

KEY WORDS: design; fatigues; joints; rivets

64-34

Demol, L. and Mas, E.
ASSEMBLAGES PAR BOULONS A HAUTE RESISTANCE, (JOINTS WITH HIGH-STRENGTH BOLTS), Centre de Recherches Scientifiques et Techniques de l'Industrie des Fabrications Metalliques, MT 11 December, 1964, Brussels

Reported are tests to determine the characteristics of 8G and 10K bolts. Direct tension, torqued tension, and relaxation characteristics of the bolts are discussed. Also discussed are installation conditions, including torque control and turn-of-nut. Removing residual scale from the bolt after manufacture increased strength. The turn-of-nut procedure was more practical than the use of a torque wrench. In addition to the studies on bolt calibration, 372 static tension tests of small bolted joints were conducted to determine the frictional resistance of A37 and A52 steel. Several joint configurations and surface conditions were investigated. Flame cleaning and sandblasting the faying surface increased the slip resistance and produced less scatter in the slip coefficient. The sandblasted surfaces yielded slightly higher slip coefficient that the flame-cleaned surfaces. Tests were also conducted on joints exposed to atmospheric conditions for 5, 14, and 60 days. (In all cases the slip coefficient increased from 0.36 to 0.60 after 60 days. For A52 steel the coefficient increased for 0.28 to 0.46.) Time and atmosphere did not significantly change the slip coefficient of the flame-cleaned surfaces. The results of a few tests to determine the slip resistance of aluminum and special surface treatments of A37 steel are also reported.

KEY WORDS: aluminum; bolts; friction; joints, steel; surface treatment; structural engineering; testing

64-35

---

Doyle, D. V.
PERFORMANCE OF JOINTS WITH EIGHT BOLTS IN LAMINATED DOUGLAS-FIR, U. S. Dept. of Agriculture, Forest Service, Forest Products Laboratory, Madison, Wisc., FPL-10, January, 1964

Joints similar to those of the lower chord member of a timber truss were constructed of 3-1/4 by 7-1/2-in. laminated Douglas fir and 2 steel side plates. The plates were fastened to the wooden members with 2 rows of four bolts. The bolts were either 1/2- or 3/4-in. x 6-in. long steel machine bolts with hexagonal heads and nuts. The assemblies were tested to determine joint slip, ultimate strength, bearing strength, crushing strength, and stress-strain relationships. Bolt-spacing was varied to study its effect. The results were compared with those from tests on joints with single bolts to determine the relative performance of each bolt. On the basis of the experimental studies, the author concludes that: (1) The bearing stress at the proportional limit for joints with 2 rows of 4-3/4-in. bolts in laminated Douglas-fir members is about the same as that for similar joints with one bolt, but the ultimate bearing stress is about 1/3 lower. With 1/2-in. bolts, the bearing stress at the proportional limit is about 15% higher, and the ultimate bearing stress is about 15% lower. (2) Joints with the eight bolts slip from 2 to 3 times more at the proportional limit than joints with a single bolt, but joints with a single bolt slip about twice as much as ultimate load as joints with 8 bolts. (3) The strength and behavior of joints with 8-3/4-in. bolts are not appreciably affected by such modification in construction as bolt spacing, stitch bolts, tapered end cut, or bolts in laminations of high and low density. (4) The bearing stress at the proportional limit of bolted joints is about 35% that of the maximum crushing strength of the wood when 3/4-in. bolts are used and about 30% higher when 1/2-in. bolts are used.

KEY WORDS: bolts; joints; strength; testing; wood

---

Waltermire, W. G.
RECENT RESEARCH ON BOLTED JOINTS, Building Research, Vol. 1, No. 4, July-August 1964, pp. 51, 52.

Research has been done to determine the performance of galvanized and aluminum joints. Galvanized joints were constructed as follows: (1) single lap joints using A325 bolts and nuts; (2) same joints with locknuts of the ovalized-collar type; (3) single lap joints using A325 interference body bolts and A325 nuts, and (4) same joints with locknuts. The joints were assembled to four degrees of tightness, from one-fourth right to full tight, and tested. Results showed rather large variations in torque-load relationships; the turns-load relationship was fairly constant. Use of a locknut reduced required torques and produced more uniform torque-load characteristics. Static load-slip shear tests showed that all joints, regardless of tightness, developed about the same ultimate joint load. Use of locknuts permitted higher bolt loads and therefore provided greater resistance to slipping. Joints had to be converted to butt strap joints to perform fatigue tests. The tests showed that fatigue life ranged from 600,000 to 700,000 cycles with 1/4-tight bolts; it was 3 million or more cycles with 1/2-tight bolts. Aluminum joints were similar to the galvanized joints. The fastener material was 2024-T4 aluminum and the plate was 6061-T6 aluminum. Although the work is incomplete, it appears that 3/8 turn from snug is the best criterion for tightening aluminum fasteners. Alcoa is performing similar tests. Their results show that interference body bolts in a normal 11/16 oversize hole produce load-slip characteristics similar to those of a hexagon head bolt with snug fit in a .623 reamed hole.

KEY WORDS: aluminum; bolts; fatigue; friction; galvanized; nuts; steel; strength; testing

64-37

---

Levy, S.
BOLT FORCE TO FLATTEN WARPED FLANGES, Transactions, ASME, Journal of Engineering for Industry, Vol. 86, No. 3, Series B, August 1964, pp. 269-272.

Warpage of joint flanges in pressure vessels and piping systems requires that bolts be properly tensioned, not only to prevent leakage at the joint but also to avoid overstressing of the bolts. In this discussion, the author uses two simplifying assumptions in determining the bolt stresses: (1) that the flange is sturdy and does not change cross-sectional shape and (2) that the resistance of the pipe to bending into an oval shape is completely due to hoop bending. The equations employed are based on elastic theory and do not consider yielding. The analysis is concerned with conditions where the warpage varies as the cos. 2θ. The values for bolt load, $F_B$, and pipe force, $F_p$, may be determined by equations. Values of bolt stresses computed with these equations were lower than those obtained from similar analyses by other authors.

KEY WORDS: bolts; installation; joints; pipe; pressure vessel; steel

64-38

Hood, A. C.
CORROSION IN THREADED FASTENERS, Machine Design, Vol. 36, No. 29, December 17, 1964, pp. 153-156

Corrosion of fastened joints is a serious problem in many industries, since it ultimately leads to failure of the joint. The problem of corrosion may be eliminated, or at least reduced, by selecting corrosion-resistant materials for the fasteners, by using protective coatings, or by designing the joint to minimize corrosion. Selection of corrosion-resistant fastener materials depends on strength requirements, position of the material on the galvanic scale, special design considerations such as weight and galling tendency, and susceptibility of fasteners to other types of corrosion such as fretting or stress corrosion. To help designers choose the proper corrosion-resistant material, a table is included that lists several of the common alloys, with data on their tensile and yield strengths, maximum service temperatures, coefficients of thermal expansion, densities, relative cost, and positions on the galvanic scale. Protective coatings are effective as corrosion preventers, but they sometimes introduce other problems, such as hydrogen embrittlement. The use of paints and electroplated coatings on various materials for service at different demperatures is described. The author discusses joint design from the standpoint of precautions to follow to minimize the following corrosion problems: direct attack by corrosives, galvanic corrosion, concentration-cell corrosion, fretting corrosion, oxidation corrosion, stress corrosion, and corrosion fatigue.

KEY WORDS: bolts; corrosion; design; joints; steel

64-39

---

Butz, G. A. and Nordmark, G. E.
FATIGUE RESISTANCE OF ALUMINUM AND ITS PRODUCTS, National Farm, Construction and Industrial Machinery Meeting, SAE, Milwaukee, Wisconsin, September 14-17, 1964

The analysis of tests conducted on aluminum alloy specimens to determine their behavior under fatigue conditions is duscussed. Some of the conclusions reached are as follows: the fatigue strength remains essentially constant over 500 million load cycles; there is no distinct fatigue ratio that is generally applicable to aluminum alloys; the fatigue strength of smooth separately cast or small machined coupons is usually higher than that for fabricated parts; the presence of notches, including notches associated with welds and riveted and bolted joints tends to nullify most of the differences between the various alloys and various methods of fabrication. For long fatigue life, good design and attention to details are often more important than the choice of alloy.

KEY WORDS: bluminum; bolts; fatigue; joints; rivets; strength; testing

64-45

---

Nordmark, G. E.
FATIGUE TESTS OF BOLTED ALUMINUM JOINTS, Aluminum Company of America, New Kensington, Pa., February 13, 1964

Axial stress fatigue tests have been made of double-strap bolted joints in alloy 6061-T6 and 6071-T6 plate. The following variables were investigated: method of hole preparation, bolt type and fit, clamping load, and the use of bonding agents on the faying surfaces. Alloy 2024-T4 structural bolts, 2024-T4 interfence body bolts, and A325 steel structural bolts were used. Most of the fatigue specimens were subjected to -0.5 stress ratio loadings; a few were tested at 0.0 and +0.5 stress ratios. At the allowable design stress, slip was observed in all static specimens except those having Alcoa Filler compound or an epoxy adhexive on the faying surfaces. The use of small hole clearances, interference body bolts or high strength steel bolts reduced the amount of slip. Most of the fatigue failures were a result of fretting between the mainplate and coverplates. It was found that the fatigue strength of bolted joints was improved by using interference-body bolts or small hole clearances. The use of Alcoa Filler compound or an epoxy adhesive between the mainplates and the coverplates also improved the fatigue strength.

KEY WORDS: aluminum; bolts; fatigue; joints; strength; testing

64-46

---

Higgins, T. R.
NEW FORMULA FOR FASTENERS LOADED OFF-CENTER, Engineering News-Record, Vol. 172, No. 21, May 21, 1964, pp. 65-67

Commentary is offered on two new formulae published in the 1963 AISC Manual for use in designing riveted or bolted connections. For fasteners equally spaced on:

(a) Single gage line: $l_{eff.} = l_{act.} - \frac{1 + 2n}{4}$

(b) Two or more gage lines: $l_{eff.} = l_{act.} - \frac{1 + n}{2}$

in which:

$l_{eff.}$ = effective eccentricity of bolt or rivet group in inches

$l_{act.}$ = nominal eccentricity of group

$n$ = the number of fasteners per gage line

A series of tests at Lehigh University provided the background leading to rules for calculating effective eccentricity in terms of connection geometry. Curves showing the relationship between increases in test load and rotation of the riveted connection were plotted. With these curves as a basis for study, a number of empirical formulae for reducing nominal eccentricity to a reasonable effective value were examined.
Eq. (a) and (b) were incorporated into the AISC Manual to cover cases of explicitly eccentric load on fastener groups.

KEY WORDS: bolts; design; eccentricity; joints; rivets; steel; strength; testing

64-51

Sterling, G. H., and Fisher, J. W.
TESTS OF LONG A440 STEEL BOLTED BUTT JOINTS, Fritz Engineering Laboratory Report No. 288.26, Lehigh University, Bethlehem, Pa., February 1965.

Tests of four long structural joints fabricated from A440 steel and 7/8 in. diameter A325 bolts were conducted to determine their slip resistance and ultimate strength. The major test variables were joint length and the relative proportions of the net tensile area and the bolt shear area. Two of the joints had two lines of bolts with seven bolts per line. The remaining two specimens had two lines of bolts with sixteen bolts per line. The pitch length for all four joints was three and one half inches, or four bolt diameters. One joint of each length had the net tensile area equal to eighty percent of the bolt shear area. The other two joints had the net tensile area equal to one hundred and twenty percent of the bolt shear area. These tests have shown that some differential movement should occur between the lap and main plate at the ends of a joint prior to major slip. Major slip occurred when the frictional resistance was exceeded along the entire faying surface, and a sudden large movement was noted which caused the bolts to come into bearing. The ultimate strength of the joint was predicted with a high degree of accuracy by considering the non-linear behavior of the component parts.

KEY WORDS: bolts; joints; friction; steel; structural engineering; tensile strength; testing.

65-1

---

Chesson, E. Jr., and Munse, W. H.
BEHAVIOR OF TYPE C50L HUCKBOLT FASTENERS SUBJECTED TO COMBINED TENSION AND SHEAR, Huck Manufacturing Company, Detroit, Michigan, February, 1965.

The advantages of Huckbolts in general are discussed, and reported are tests in tension, shear, and combined tension and shear, of a 7/8-inch higher-strength Huckbolt. Four tests were conducted in tension, 4 in shear, and 20 in various combinations of tension and shear. On the basis of these tests, it is concluded that the C50L Huckbolt is 65 percent stronger than A141 type rivets, 17 percent stronger than the minimum strength A325 high-strength bolts, and 3 percent stronger than A490 high-strength bolts of minimum strength.

KEY WORDS: bolts; steel; strength; testing

65-2

---

Chesson, E., Jr.
EXPLORATORY TESTS ON THE BEHAVIOR OF A490 BOLTS SUBJECTED TO FATIGUE LOADINGS IN TENSION WITH PRYING, Status Report for the Research Council on Riveted and Bolted Structural Joints, University of Illinois, February, 1965.

Exploratory fatigue tests of 7/8-inch A490 high-strength bolts were conducted. Nine tee connections fastened by four A490 bolts were tested in fatigue, and four tests were made of single A490 bolts in direct tension. Several preliminary conclusions were based on these test results, as well as on similar tests using A325 bolts. The fatigue lives for A490 bolted tee specimens are lower than current knowledge of the behavior of this type of connection would have predicted. Also, the prying force in these connections may have been as much as 100 percent of the applied bolt load. Additional research is recommended to select satisfactory design stresses for A490 bolts subjected to bending fatigue loadings.

KEY WORDS: bolts; fatigue; joints; steel; testing

65-3

---

Prynne, P.
FUNDAMENTALS OF THE USE OF HIGH TENSILE BOLTS IN STRUCTURAL CONNECTIONS, Civil Engineering and Public Works Review, March and April, 1965, London, pp. 375-383, and pp. 542-545.

This paper describes research to investigate problems of the friction grip joint and to arrive at a rational design approach. Discussed initially are tests of 10 specimens of 8 different types of H. S. bolts to determine the best method of inducing predetermined tensions. Examined were the torque, turn-of-the-nut, part-torque, and part-turn methods. Methods discussed but not tested were the Torshear Bolt, the Load Indicating Bolt, and the Load Indicating Washer. Four types of simple joints were tested and the results are reported. A detailed discussion of joint behavior during joint slip is given, with the joints having a standard surface described in the test. The mechanics of slip are explained with the information derived from micro-graph recordings. The distribution of pressure between joint plates and the effect of high pressure on the friction coefficient are outlined in the report. Conclusions are made regarding bolt tensions and the coefficient of friction. An average value of 0.47 was found in these tests for the coefficient of friction.

KEY WORDS: bolts; design; friction; joints; testing

65-4

Yoshimoto, S., Tokunaga, A., and Tadada, S.
TEST ON LARGE SPLIT TEE CONNECTIONS USING SPLICE PLATES AND HIGH-STRENGTH BOLTS WITH INITIAL TENSION, Transactions, Architectural Institute of Japan, No. 110, April, 1965 (in Japanese)

Direct tension tests of 10 different bolted tee stubs are reported. The variables included 2 bolt diameters (1/2" and 3/4"), 2 tee stub flange thicknesses (20 and 30 mm), 3 filler thicknesses (0, 10 and 20 mm) and the bolt pattern. All tees were fabricated from steel plates and were bolted to the flange of a welded built-up beam. A filler plate was inserted between the tee stub flange and the beam flange. As expected, increasing the flange thickness of the tee stub and filler produced an increase in joint strength.

KEY WORDS: bolts; joints; steel; structural engineering; testing

65-5

---

Chesson, E., Jr.
THE 1964 REVISIONS OF SPECIFICATIONS FOR HIGH-STRENGTH BOLTS, Agricultural Engineering, American Society of Agriculture Engineers, Vol. 46, No. 6, pp. 318-319, 325, June 1965.

The background of the 1964 revisions in the Specifications of the Research Council on Riveted and Bolted Structural Joints and the ASTM Specifications on the A490 bolt are given. The development of the use of the high-strength bolt are discussed together with the revision on washer dimension in the specification. Advantages and current usage of newly introduced fasteners, the interference body bolt, and the Huckbolt are also discussed.

KEY WORDS: bolts; joints; steel specifications

65-6

---

Christopher, R. J., Kulak, G. L., and Fisher, J. W.
CALIBRATION OF ALLOY STEEL BOLTS, Fritz Engineering Laboratory Report No. 288.19A, Lehigh University, Bethlehem, Pa., July, 1965

The performance of alloy steel structural bolts subjected to various conditions of installation and load was determined. The bolts investigated were ASTM A354 Grades BC and BD, and ASTM A490. Variables included bolt diameter, grip length, thread length under nut, and thread lubrication. The problems investigated in the 120 direct tension tests and 174 torqued tension tests included the behavior of a bolt loaded in tension by either direct axial force or torque, the response of bolts installed by torquing to subsequent application of direct tension, the effect of reinstallation, differences between tests performed in a hydraulic load cell and field behavior of the bolts, differences between incremental torquing and continuous torquing, and the effect of thread lubrication. Conclusions and recommendations are made concerning alloy steel bolts and their performance as structural fasteners.

KEY WORDS: bolts; steel; structural engineering; testing

65-7

---

Sterling, G. H., and Fisher, J. W.
A440 STEEL JOINTS CONNECTED BY A490 BOLTS, Fritz Engineering Laboratory Report No. 288.30, Lehigh University, Bethlehem, Pa., August, 1965.

The results of tests conducted to determine the behavior of joints fabricated of A440 steel plate and fastened with 7/8-in. diameter ASTM A490 bolts are covered in this report. The experimental results of four compact joints, conducted to determine the bolt shear strength and the effect of variation in $A_n/A_s$ ratio, and four long joints are presented. The variables covered in this investigation include pitch, joint length, and changes in the $A_n/A_s$ ratio. Theoretical studies were carried out and the conclusions reached concerning the experimental variables are included. The present specification for all A490 bearing-type bolted short joints, and the slip coefficient used for the design of friction-type joints are discussed in relation to the test results.

KEY WORDS: bolted joints; high-strength bolts; joint length; pitch; slip coefficient

65-8

Fisher, J. W., Kulak, G. L., and Beedle, L. S.
BEHAVIOR OF LARGE BOLTED JOINTS, Fritz Engineering Laboratory Report No. 288.31, Lehigh University, Bethlehem, Pa., August, 1965.

This paper summarizes the results of tension tests of long structural splices of A7 or A440 steel connected by high-strength bolts (A325 or A490) which have provided background for parts of the specification of the Research Council on Riveted and Bolted Structural Joints. The influence of the joint length, pitch, and relative proportions of the net tensile area of the plate to the bolt shear area on the ultimate strength of bearing-type connections is determined by theoretical studies and confirming tests. Data on the slip resistance is also presented for use in designing friction-type connections.

KEY WORDS: bolts; friction; joints; shear; slip; steel; structural engineering; testing

65-9

---

**Fasteners**
1,000,000 HIGH STRENGTH BOLTS SPEED FIELD ERECTION OF 526-FT. VEHICLE ASSEMBLY BUILDING, Fasteners, Vol. 20, No. 1, Spring, 1965, pp. 4, 5

Approximately 1,000,000 high-strength bolts are being used in the construction of the steel framework of the Vehicle Assembly Building at NASA's John F. Kennedy Space Center. The building, which will be the base for the man-to-moon shot, will be the largest structure in the world. It was specially designed to eliminate interfering interior stiffening trusses, yet to withstand hurricane winds. By using for fastening, designers thought it possible to alleviate distortion of the structure that might occur with welded construction. Most of the bolts will be 1-1/4-inch of A325 high-strength steel, but other sizes will also be used. The metal and plastic siding for the building will be fastened with stainless steel bolts.

KEY WORDS: bolts; construction; frame; joints; steel

65-10

---

Viglione, Joseph
"NUT DESIGN FACTORS FOR LONG BOLT LIFE", Machine Design, Vol. 37, No. 18, August, 1965

Eight samples each of 42 different high-tensile bolt-nut combinations were tested to determine the factors that affect bolt life in fatigue loading. Important factors to be considered were found to be: nut material strength, nut height, lubricants, washers, angularity of bearing surface, range of load, tightening torque, unengaged threads and re-use of nuts. Other factors, though not as important, were, strength of the nut, locking devices, and special threads.

KEY WORDS: bolts; fatigue; nuts; strength; steel

65-11

---

Roderick, J. W., and Nielsen, D. A.
THE STRUCTURAL USE OF FRICTION GRIP BOLTS, Australasian Engineer, January, 1965, Sydney, pp. 25-33, (First distributed by School of Civil Engineering, University of Sydney, 1964)

Investigations to assist in preparing a specification for the use of friction-grip bolts in Australia are reported. A review is presented of research and development leading to the use of friction-grip bolts in forming connections in structural steelwork. The underlying principles upon which bolts depend is discussed for simple tension splices. Experimental investigations of beam and beam-to-column connections are also reviewed.

KEY WORDS: bolts; friction; joints; steel; testing

65-12

Godfrey, G. B.
HIGH STRENGTH FRICTION GRIP BOLTS, British Constructional Steelwork Association, Publication No. 26, London, 1965.

Discussed in the report are: a brief historical summary of the use of high-strength bolts, a review of British Standards for bolts, the structural behavior of high-strength friction grip bolts in connections, a discussion of the various types of British high-strength bolts, nuts, and washers, and methods of storage, assembly, and tightening of high-strength bolts. Also presented are some worked examples of designs of connections using high-strength friction grip bolts.

KEY WORDS: bolts; design; joints; steel

65-22

---

Stevin Laboratory
THE PROGRAMME OF A SERIES OF TESTS IN ORDER TO COMPARE THE FRICTION FACTORS OF FE37 AND FE52, Dept. of Civil Engineering, Technological University, Delft, The Netherlands, 1965 (C.E.A.C.M. X-65-12)

A proposal to establish a definite ratio between the friction factors of Fe37 and Fe52 using butt splice test jigs with high tensile steel bolts is illustrated. A chart is presented giving results of previous tests conducted in Belgium, Germany, Sweden, and Holland which compares these factors.

KEY WORDS: bolts; friction; joints

65-23

---

Stevin Laboratory
DECREASE OF THE PRE-LOAD IN HIGH-STRENGTH BOLTS IN THE COURSE OF TIME (PROVISIONAL RESULTS), Department of Civil Engineering, Technological University, Delft, The Netherlands, 1965, (C.E.A.C.M. X-65-13)

The results of relaxation tests on 3 high-tensile steel bolts, one with 2 washers and two with 1 washer are shown on a chart using a logarithmic time scale. Extrapolation of results shows that the decrease in preload in 20 years of a bolt with 2 washers to be about 5% and about 10% for a bolt with 1 washer.

KEY WORDS: bolts; creep; steel; testing

65-24

---

Blake, J. C., and Kurtz, H. J.
THE UNCERTAINTIES OF MEASURING FASTENER PRELOAD, Machine Design, September 30, 1965, pp. 128-131

Discussed are various methods of directly and indirectly measuring bolt preloads, and the deficiencies associated with torque and bolt elongation measurements. The effect of bending and torsional strains on principle stresses are observed, and methods of reducing the effect of these strains are examined. Comparison between the results of bolt tests and current fastener technology is made.

KEY WORDS: bolts; installation; testing

65-26

Hartmann, E. C., Westcoat, C. F., and Brennecke, M. W.
PRESCRIPTIONS FOR HEAD CRACKS IN 24ST RIVETS, Aviation, Vol. 42, No. 11, November, 1943, p. 139

Various tests of 1/8-in. and 1/4-in. 24ST rivets were conducted to determine the causes of shear cracks that form in the driven heads. It is stated that although the head cracks do not adversely affect the performance of the rivets they do give the rivets an objectionally poor appearance. Two major causes of head cracks discussed are: heat-treating and reheat-treating above the specified temperature range of 910 to 930° F. and allowing the rivet to age at room temperature between heat treatment and driving. The rivets should be refrigerated immediately after quenching and transferred from the refrigerant to the work without delay. Reducing the head diameter from the commonly used size of 1-1/2 times the shank diameter decreases the tendency for head cracking but may also decrease the shear strength of the rivet and its resistance to being pulled through the hole in lap joints in thin sheet.

KEY WORDS: fatigue test; joints; rivets; shear; static test; testing

43-4

---

Bannister, A.
BEHAVIOUR OF CERTAIN CONNECTIONS INCORPORATING HIGH STRENGTH FRICTION GRIP BOLTS, Civil Engineering and Public Works Review, London, Vol. 60, No. 711, October 1965, pp. 1499-1502 and Vol. 60, No. 712, November, 1965, pp. 1619-1625

Several laboratory tests were carried out to ascertain the behavior of groups of high-strength bolts which had generally been preloaded beyond a specified proof load and also to determine the friction values of bolts in connections sustaining moment only. In the preload series of tests, the relationship between nut rotation and bolt elongation and variations in mean bolt load in different groups are studied. In the moment series of tests, by means of a four point loading system pure moments were applied to joints comprising gusset plates, coverplates, and split I connections and behaviour to slip observed. Several graphs are presented that illustrate the test results.

KEY WORDS: bolts; joints; moment connections; steel; strength; testing

65-27

---

Hagen, H. W. and Penkul, R. C.
DESIGN CHARTS FOR BOLTS WITH COMBINED SHEAR AND TENSION, Engineering Journal, AISC, Vol. 2, No. 2, April, 1965, pp. 42-45

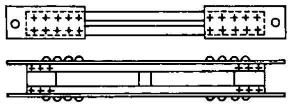
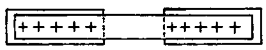
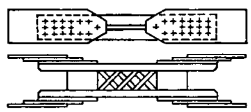
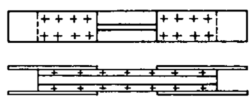
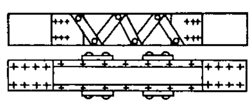
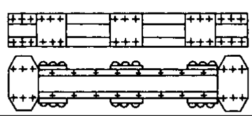
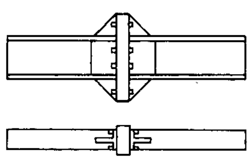
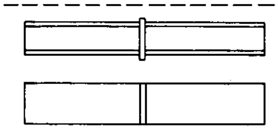
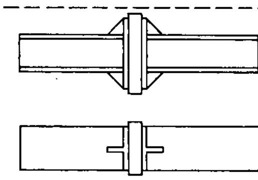
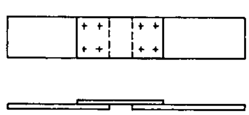
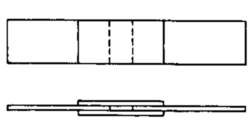
To assist designers in determining the sizes of structural joints, design charts have been developed for A325 bolts in bearing-type joints and friction-type joints. The charts were constructed by deriving equations relating shear load and fastener area, and tension load and fastener area, starting with equations relating allowable tension and shear stresses. From these derived equations, a simple nomograph was constructed from which it is possible to obtain bolt area for a given joint knowing the tension and shear load components. Also from the nomograph, the number of bolts of various diameters to make up the bolt area also could be read off easily. These design charts were illustrated for bearing-type and friction-type joints.

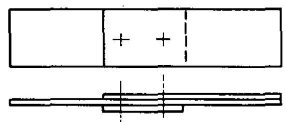
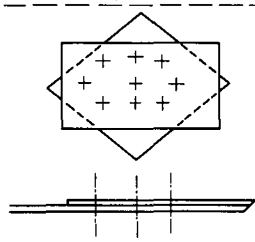
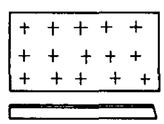
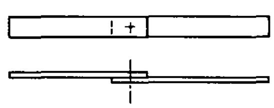
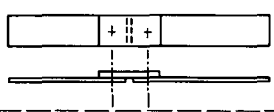
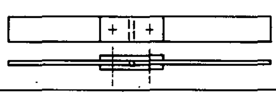
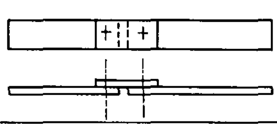
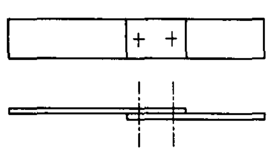
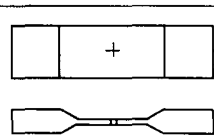
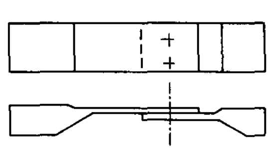
KEY WORDS: bolts; design; shear; steel; structural engineering; tension

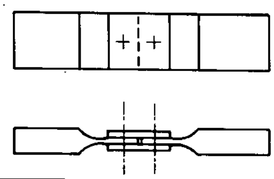
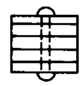
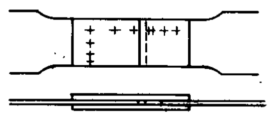
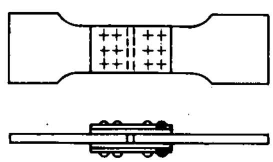
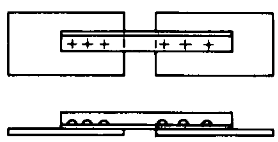
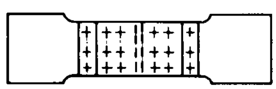
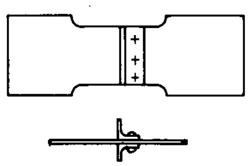
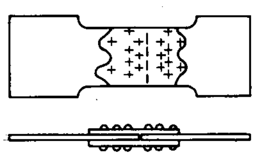
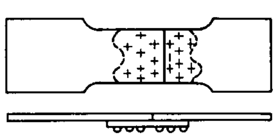
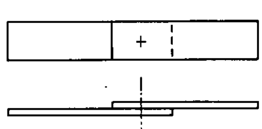
65-30

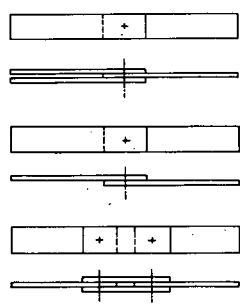
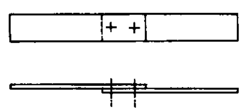
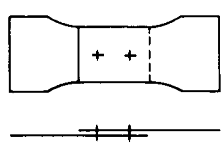
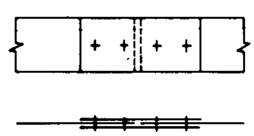
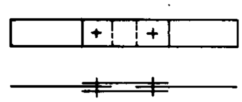
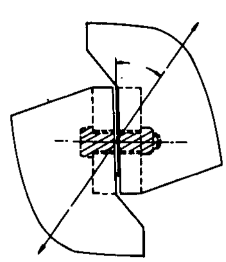
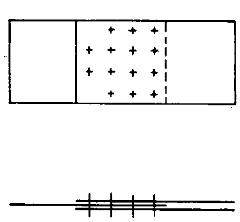
## 5. TABLES

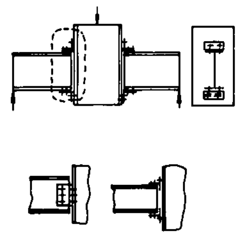
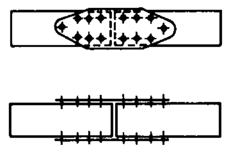
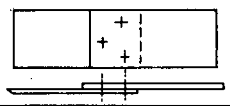
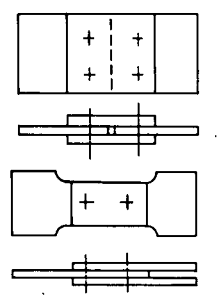
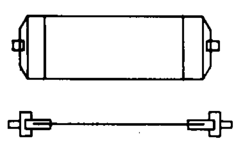
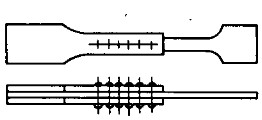
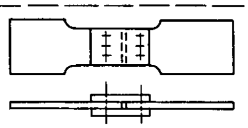
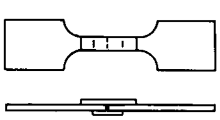
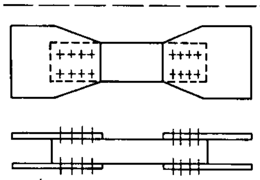
The Reference number referred to in the first column of these tables is the same as that used in the "Abstracts" and the List of References. These tables also include the material presented in Report 302.1. Section 8 correlates the abstract numbers used in these two reports.

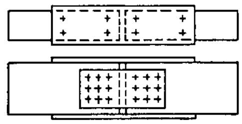
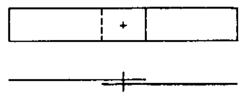
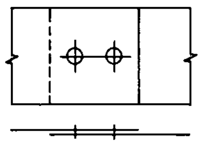
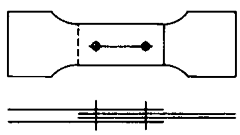
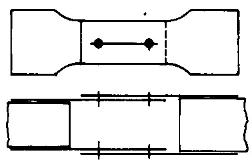
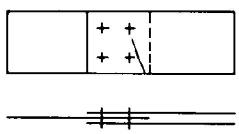
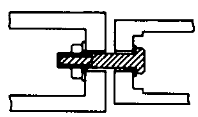
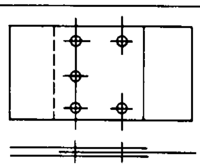
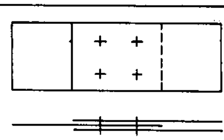
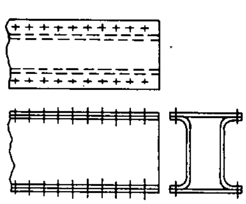
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 97-1 | 1/2" rivets | |  | | 2 tension tests | |
| | | Tension angle |  | | 2 tension tests | |
| | 1/2" rivets | Tension members |  | Geometry of connection | 2 tension tests | Ultimate Strength |
| | | |  | | 8 tension tests | |
| | | |  | | 2 tension tests | |
| | | |  | | 2 tension tests | |
| 38-1 | Welded, welded and bolted combined | Beam-to-column |  | Number of bolts, different stress levels in fatigue tests | 5 Static tension tests<br>6 Fatigue tests | |
| | | |  | | | |
| | | |  | | | |
| 41-2 | Medium steel rivets & 535-W rivets | Single butt strap |  | Number rivets in line, plate material | 9 Static tests<br>9 Fatigue tests | |
| | | double butt strap |  | | 9 Static tests<br>9 Fatigue tests | |

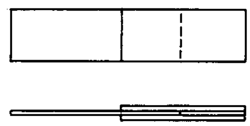
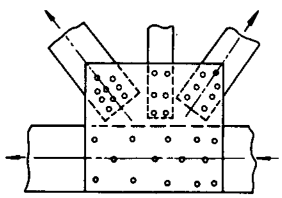
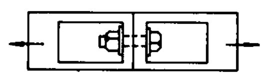
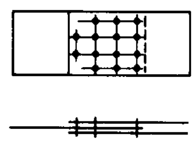
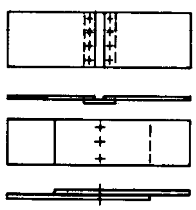
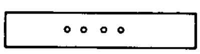
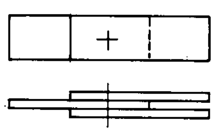
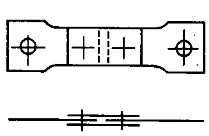
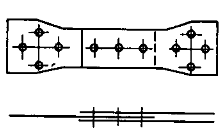
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 42-1 | Rivets | Shearing specimen |  | Rivet diameter<br>Rivet alloy<br>Plate alloy | 16 shear & 2 tension tests | |
| | | Tension specimen |  | | | |
| 42-2 | Rivets<br>Welds | Plate specimens |  | Type of fastener | 18 tests conducted | Computation of strains in stringers, deflections, buckling load. |
| 43-1 | 1/8" A17S-T rivets | Lap joint |  | Number rivets in line | 12 tension shear tests | |
| | | Single-butt strap joint |  | Number rivets in line, number rows of rivets | 20 tension shear tests | |
| | | Double-butt strap joint |  | Number rivets in line | 8 tension tests | |
| 44-2 | 1/2" aluminium alloy rivets | Single-butt strap joint |  | Plate thickness, D/t ratio, rivet alloy | 69 tension shear tests | |
| 44-4 | A17S-T, 17S-T, & 24S-T 1/8" rivets | Lap joint |  | Type of rivet alloy, driving condition, aging condition | 20 tension shear tests | |
| 44-5 | 17S-T, 53S-W & steel rivets | Single plate |  | Rivet alloy<br>Plate material<br>Driving condition<br>Diameter rivet<br>Number rows of holes | 15 Static tests<br>15 Fatigue tests | |
| | | Lap joints |  | Number rows of rivets<br>Number rivets in line<br>Rivet Alloy<br>Plate Alloy<br>Rivet diameter<br>Driving condition | 138 Static tests<br>138 Fatigue tests | |

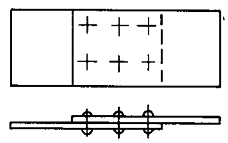
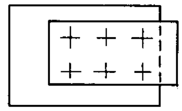
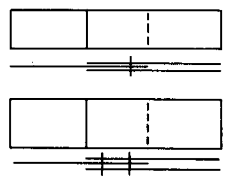
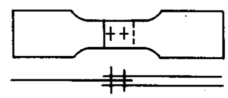
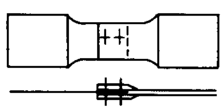
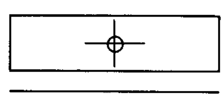
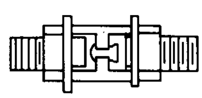
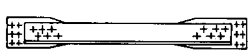
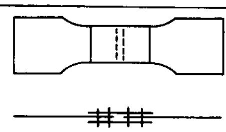
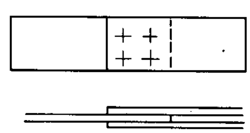
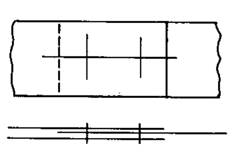
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 44-5 cont. | | Butt joints |  | Number rows of rivets<br>Number rivets in line<br>Plate alloy<br>Rivet alloy<br>Rivet diameter<br>Driving condition | 93 Static tests<br>93 Fatigue tests | |
| 44-6 | A141 steel rivets | Flange-web connection |  | Position in plate girder | 28 tests-7/8" rivet to determine clamping forc | |
| 44-8 | 7/8" rivets, pins | Double-strap butt |  | H width<br>Type fastener<br>Diameter of pin<br>Number pin in joint<br>Plate material | 55 tension shear tests | Stress distribution |
| 44-9 | 7/8" rivets, Fillet-weld combination | Butt splice |  | Location of reinforcing plate | 9 Fatigue tests | |
| | 3/4" rivets | Lateral connection |  | | 8 Fatigue tests | |
| | 7/8" rivets plugweld | Shingle joint |  | | 6 Fatigue tests | |
| | 7/8" carbon & low alloy steel rivets | Continuous plate with riveted transverse attachments |  | | 12 Fatigue tests | |
| | 3/4" rivets | Double-strap butt |  | | 12 Fatigue tests | |
| | 7/8" rivets | Single-strap butt |  | | 18 Fatigue tests | |
| 45-4 | 3/16" 24S-T rivets | Lap splice |  | Sheet alloy | 15 Static tests<br>252 Fatigue tests | |

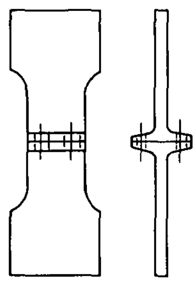
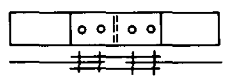
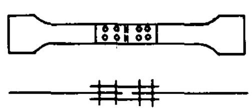
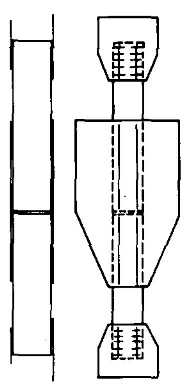
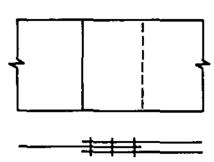
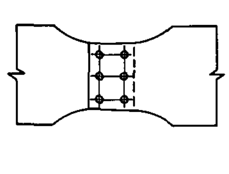
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 45-7 | Rivets | Double-Lap<br>Lap<br>Double-strap butt |  | Rivet diameter<br>Rivet pattern<br>Number rows of rivets<br>Pitch<br>Number rivets in line | 220 Tension Test | Joint Efficiency |
| 46-2 | 1/8, 3/16", 24-S-T and A17S-T Alloy Rivets | Lap joint |  | Diameter rivets<br>Rivet alloy<br>Sheet alloy | 25 Tension Shear Tests | |
| 46-4* | AN6-6, AN6-7, & AN6-11 steel bolts | Lap splice |  | Joint size<br>Plate thickness<br>Bolt pattern<br>Bolt fit<br>Stress range | Static Tension Tests<br>60 tests 3/8" A6 bolt<br>Fatigue Tests<br>788 tests 3/8" A6 bolt<br>11 tests 1/4" A6 bolt<br>7 tests 15/32" A6 bolt | |
| 46-9 | S.A.E. 2330 steel bolts | Butt splice |  | Joint length<br>~~Plate thickness~~<br>Number of bolts | Static Tension Tests<br>6 tests 1/4" bolt | 1. Development of load-deformation relationship for bolts in shear (elastic).<br>2. Analysis of load partition in bolted butt splices |
| 47-3 | | Butt splice |  | Joint size<br>Bolts<br>Plate thickness | 55 Static Tests | Computation of slip coefficient |
| 47-5 | A307 | Test jig |  | (A) Angle of applied load | Static Tention Tests<br>64 tests of 0.369" bolt | 1. Computation of<br>a. Simple sum of unit shear and unit tensile stress<br>b. Vector sum of unit shear and unit tensile stress<br>c. The principle stress<br>d. The maximum shearing stress |
| 47-6 | 7/8" rivets | Double-strap butt joints |  | Gage<br>Rivet pattern | 6 Static Tests | Efficiency of joint |

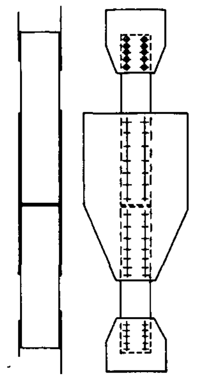
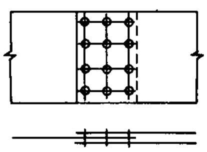
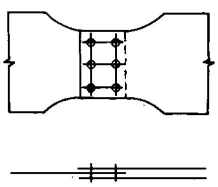
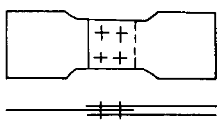
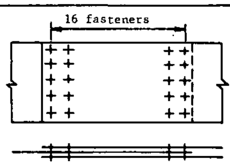
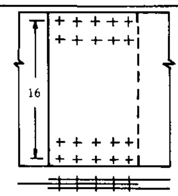
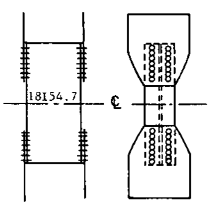
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 47-8 | A141 steel rivets | Beam-to-column | <br>Section A-A | Beam size<br>Beam length<br>Column size<br>Angle size<br>Rivet diameter<br>Connection to column flange or web | Static Tests<br>34 tests top and seat angles<br>2 tests top and seat angles to one side of column web<br>2 tests top, seat, and web angle<br>4 tests standard web angle connection<br>1 test web clip and seat angle<br>1 test tees on both beam flanges<br>1 test tees on both beam flanges and web angles | 1. Computation of percentage of rigidity |
| 48-2 | 24S-T rivets | Gusset plate (lap splice) |  | Gusset material<br>Column material<br>Gusset size<br>Gusset edge finish<br>Fastening method<br>Stress range | Fatigue Tests<br>21 tests 24S-T rivet 24S-T gusset<br>13 tests 24S-T rivet Alloy steel gusset<br>15 tests spot welds 24S-T gusset | 1. Computation of initial maximum shear stress. |
| 49-3 | Rivets welds | |  | Type of fasteners, (riveted, riveted and welded, welded) | 9 Fatigue Tests | |
| 49-5 | ST52, ST-34, ST-SI ST-MnCu | |  | Joint width<br>Plate thickness<br>Type plate steel<br>Type rivet steel<br>Pitch<br>Number of rivets in line | 175 Fatigue Tests<br>24 Static Tests | Fatigue strength |
| | | |  | | 10 Tension Tests | |
| 49-6 | Rivets and filled weld | Eyebar splice |  | Number of bolts in line<br>Shape of splice<br>Diameter of rivet<br>Size of fillet weld | 9 Fatigue Tests | |
| | 3/4" Rivets 1/4" Fillet weld | Double strap butt |  | | 6 Riveted Fatigue Tests<br>6 Riveted and Welded Fatigue Tests | |
| | Fillet weld | Double-strap butt |  | Size of fillet<br>Type steel<br>Size of strap plate | 15 Fatigue tests | |
| | 3/4" rivets | Reinforced tension members |  | | 8 Fatigue Tests | |

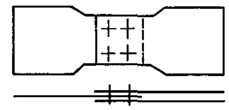
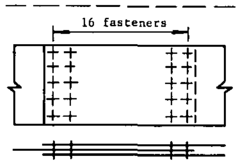
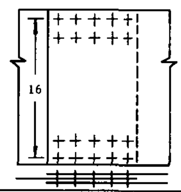
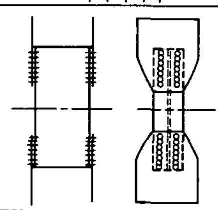
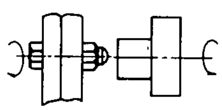
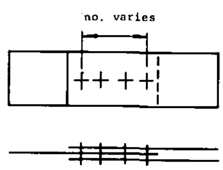
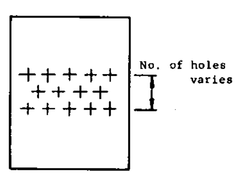
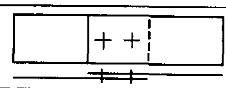
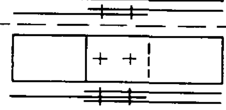
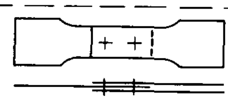
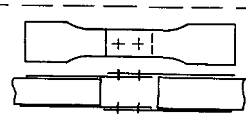
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 49-6 con't | 3/4" rivets | Beam splice |  | | 3 Fatigue Tests | Plastic moment |
| 50-1 | 3/16" 24S-T31 rivets | lap joint |  | Head style of rivet<br>Plate alloy | 11 Static Tests<br>124 Fatigue Tests | |
| 50-7 | A325 Steel bolts | Lap splice and lap with bracing |  | Stress range | <u>Fatigue Tests</u><br>4 tests 7/8" bolt | |
| | | Butt splice |  | | <u>Fatigue Test</u><br>1 test 7/8" bolt | |
| | | Double lap splice |  | Bracing length<br>Stress range | <u>Static Tension Tests</u><br>22 tests 7/8" bolt<br><u>Fatigue Tests</u><br>30 tests 7/8" bolt | |
| 51-1 | A325 steel bolts | Butt splices |  | Stress range | <u>Fatigue Tests</u><br>2 tests 1" bolt | |
| 51-2 | A325 steel bolts | Test jig |  | Bolt size<br>Grip length<br>Area of bolt shank<br>Surface treatment | <u>Combined Direct and Torqued Tension Tests</u><br>8 tests 3/4" bolts<br>8 tests 7/8" bolts<br>22 tests 1" bolts | 1. Computation of torque coefficient |
| 51-3 | A141 steel rivets | Butt splice |  | Joint size<br>Plate thickness<br>Rivet diameter | <u>Static Tension Tests</u><br>16 tests 3/4" rivet<br>16 tests 1" rivet | 1. Computation of joint efficiencies |
| 51-6 | SAE 4140 Steel bolts | Butt splice |  | Joint size<br>Bolt pattern<br>Bolt tension<br>Surface preparation | <u>Static Tension Tests</u><br>18 tests 63/64" bolt | 1. Computation of the slip coefficient |
| 51-12 | Rivets | Box-beams |  | Type of rivets<br>Plate alloy | 40 Fatigue Tests | |

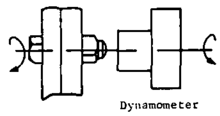
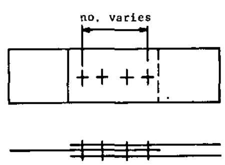
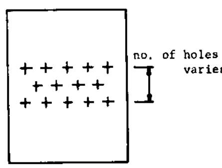
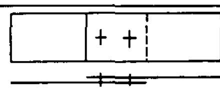
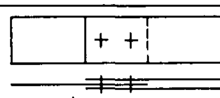
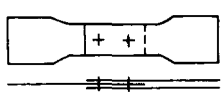
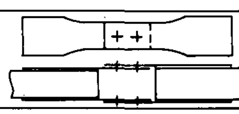
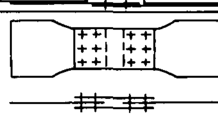
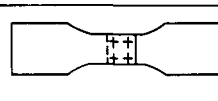
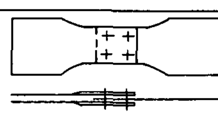
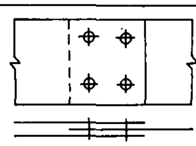
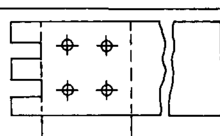
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 52-5 | A141 steel rivets 3/4" | Butt splice |  | Rivet pattern<br>Pitch<br>Rivet location | 50 Fatigue Tests<br>19 Tension Tests | 1. Joint efficiency, coefficient of slip coefficient |
| 52-6 | Aluminum Alloy bolts | Gusset Plate for Warren Truss |  | Direction of applied load | Static Tests<br>2 tests 1/4" bolt<br>61-ST plate | 1. Computation of maximum tensile, compressive and shearing stress, and their directions. |
| 52-9 | BSF 511 Steel Bolts | Test jig |  | Bolt pretension<br>Load range<br>Thickness of washer | Fatigue Tests<br>17 tests 3/4" bolt | Computation of Ratio of $\frac{\text{Change in bolt load}}{\text{Change in external load}}$ |
| 52-10 | A141 steel rivets | Butt splice |  | Joint size<br>Plate thickness<br>Rivet pattern<br>Rivet size<br>Test temperature | Static Tension Tests<br>12 tests 7/8" rivet<br>24 tests 3/4" rivet | 1. Computation of joint efficiencies |
| 52-17 | 1/8" AL7S-T3 ~~Aluminum~~ Alloy Rivets | |  | Pitch<br>Number of rivets in line | 190 Fatigue Tests<br>34 Static Tests | |
| 52-19 | Pins<br>Bolts<br>Rivets | Plates with holes |  | | Tension test | Stress concentrations |
| | | Lap joint |  | Type of fastener | Tension test | Stress concentrations |
| 53-4 | NR6 steel rivets<br>or<br>Mild steel rivets | Butt splice |  | Joint size<br>Plate thickness<br>Rivet diameter<br>Rivet material<br>Rivet pattern<br>Loading condition | Static Tension Test<br>NR6 rivets<br>8 test 3/4" rivet<br>8 test 1/2" rivet<br>1 test 1/4" rivet<br>Mild steel rivet<br>2 tests 3/4" rivet<br>6 tests 1/2" rivet | 1. Partitions of load in joint<br>2. Overall elongation of joint<br>3. Computation of loss of efficiencies<br>4. Computation of ultimate strength |
| | | Butt splice |  | | Eccentric Load Tests<br>NR6 rivets<br>8 tests 1/2" rivet<br>Mild steel rivets<br>9 tests 1/2" rivet | 1. Computation of failure loads |

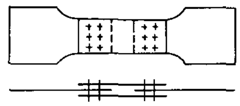
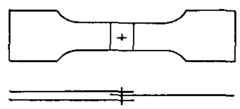
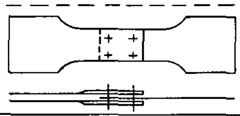
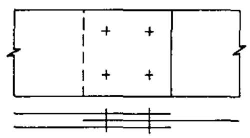
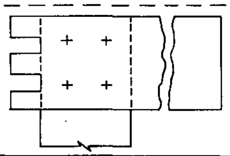
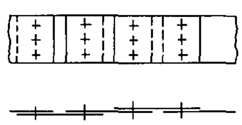
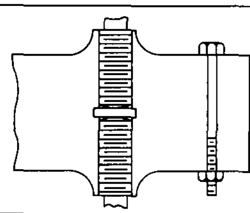
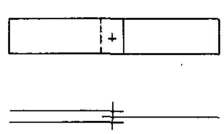
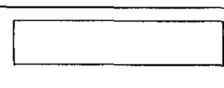
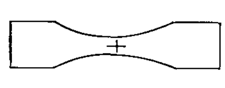
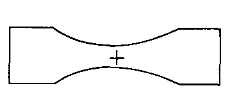
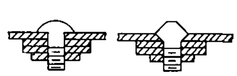
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 53-5 | 7/8" & 1" rivets | Double-strap-butt joints |  | Number of rows of rivets<br>Bearing ratio | 48 Tension tests | 1. Computation of joint efficiency. |
| | | |  | Gage<br>Bearing ratio | 18 Amplitude test | |
| 53-9 | A195 steel rivets<br>A141 steel rivets | Butt splice |  | Joint size<br>Plate thickness<br>Edge condition<br>Rivet diameter<br>Grip length | <u>Static Tension Tests</u><br>12 tests 3/4" alloy rivet<br>6 tests 7/8" alloy rivet<br>6 tests 1" alloy rivet | |
| | | Butt splice |  | Joint size<br>Plate thickness<br>Rivet materials<br>Grip length<br>Tension-shear-bearing ratio | <u>Static Tension Tests</u><br>2 tests 3/4" carbon rivets<br>4 tests 3/4" alloy rivet<br><br><u>Fatigue Tests</u><br>11 tests 3/4" carbon rivet<br>21 tests 3/4" alloy rivet | 1. Computation of joint efficiencies |
| | | Butt splice |  | Rivet materials | <u>Static Tension Tests</u><br>1 test 3/4" carbon rivet<br>1 test 3/4" alloy rivet<br><br><u>Fatigue Tests</u><br>5 tests 3/4" carbon rivet<br>5 tests 3/4" alloy rivet | |
| 53-10 | | Plate with hole |  | Kind of steel<br>Roughness of plate surfaces | <u>Static Tension Tests</u><br>7 tests A242 steel<br>1 test rimmed steel<br>3 tests A7 steel<br>4 tests A94 steel<br><u>Fatigue Tests</u><br>Total 109 tests. | |
| 53-12 | 1/4" Huck Lockbolts<br>AN-4 butts | |  | | 114 Fatigue tests | |
| 53-13 | | Angle connection |  | | 18 Angle-tension tests | |
| 53-15 | A141 steel rivets<br>A325 steel bolts | Butt splice |  | Plate thickness<br>Type of fastener<br>Length of grip<br>Tension-shear-bearing ratio<br>Diameter of holes<br>Fabricator | <u>Fatigue Tests</u><br>46 tests 3/4" A325 bolt<br>98 tests 3/4" A141 rivet<br><br><u>Static Tension Test</u><br>3 tests 3/4" A325 bolt<br>21 tests 3/4" A141 rivet | 1. Computation of joint efficiencies. |
| 54-1 | A141 rivets | Butt splice |  | Edge distribution<br>Gage distribution<br>Rivet pattern<br>Rivet diameter<br>Plate thickness | 96 Tension tests<br><br>32 Fatigue tests | 1. Efficiency of joints<br><br>2. Slip coefficient |
| 54-2 | A141 steel rivets<br>A307 bolts<br>A325 bolts | Butt splice |  | Plate width<br>Plate thickness<br>Bolt diameter<br>Bolt tension<br>T:S:B ratio | <u>Static Tension Tests</u><br>2 tests 3/4" rivet<br>2 tests 3/4" A307 bolt<br>4 tests 7/8" A307 bolt<br>14 tests 3/4" A325 bolt | 1. Computation of joint efficiencies. |

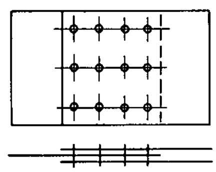
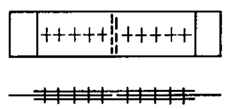
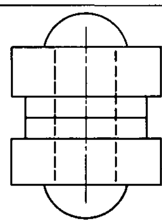
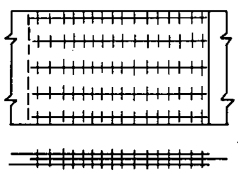
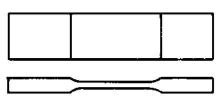
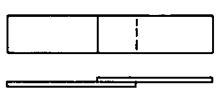
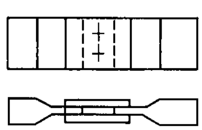
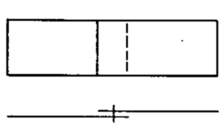
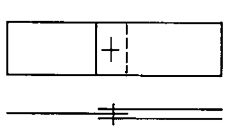
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 54-5 | A325 steel bolt<br>A141 steel rivets | T section butt |  | Initial bolt tension<br>Applied load<br>Bolt spacing<br>The use of non-parallel surfaces between the heads of bolts and the joined members. | Static Tension Tests<br>5 tests 3/4" bolt<br>1 test 3/4" rivet<br><br>Fatigue Tests<br>18 tests 3/4" bolt<br>3 tests 3/4" rivet | 1. Computation of joint efficiencies. |
| 54-11 | 8G/10K | Butt splice |  | Surface treatment | | 1. Computation of the slip coefficient.<br>2. Determination of stress distribution. |
| | 8G/10K | Butt splice |  | Location of bolts | 11 Static tests | |
| 55-1 | A141 steel rivets<br>A325 steel bolts | Two W beams with gusset plates |  | Fastener type | Static Tension Tests<br>1 test 7/8" bolt<br>1 test 7/8" bolt and 7/8" rivet | 1. Computation of principal stresses in gusset plate. |
| 55-2 | A141 steel rivets | Butt splices |  | Joint size<br>Rivet pattern | Fatigue Tests<br>45 tests 3/4" rivet<br><br>Static Tension Test<br>20 tests 3/4" rivet | 1. Computation of apparent coefficient of friction.<br>2. Computation of joint efficiencies. |
| | | |  | Joint size<br>Rivet pattern<br>Plate thickness<br>Rivet diameter | Fatigue Tests<br>42 tests 3/4" rivet<br>12 tests 7/8" rivet<br>36 tests 1" rivet<br><br>Static Tension Test<br>16 tests 3/4" rivet<br>4 tests 7/8" rivet<br>12 tests 1" rivet | |

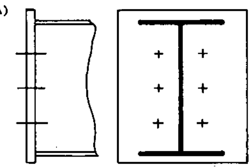
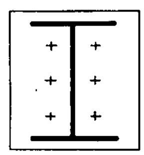
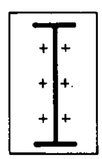
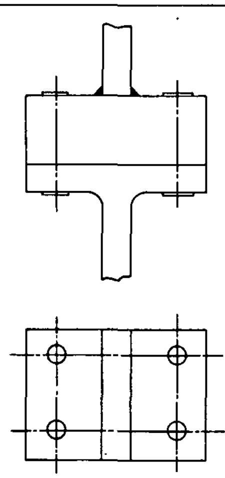
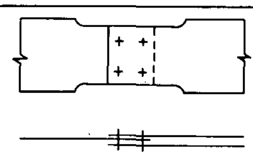
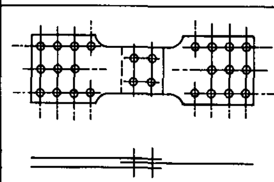
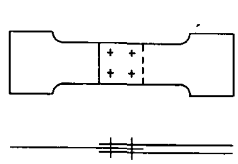
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 55-1 | A141 steel rivets<br>A325 steel bolts | Two W beams with gusset plates |  | Fastener type | Static Tension Test<br>1 test 7/8" bolt<br>1 test 7/8" bolt and 7/8" rivet | 1. Computation of principal stresses in gusset plate |
| 55-2 | A141 steel rivets | Butt splice |  | Joint size<br>Rivet pattern | Fatigue Tests<br>45 tests 3/4" rivet<br>Static Tension Test<br>20 tests 3/4" rivet | 1. Computation of apparent coefficient of friction<br>2. Computation of joint efficiencies |
| | | |  | Joint size<br>Rivet pattern<br>Plate thickness<br>Rivet diameter | Fatigue Tests<br>42 tests 3/4" rivet<br>12 tests 7/8" rivet<br>36 tests 1" rivet<br>Static Tension Test<br>16 tests 3/4" rivet<br>4 tests 7/8" rivet<br>12 tests 1" rivet | |
| 55-3 | SAE 4140 steel bolts | Butt splice |  | Joint size<br>Plate thickness | 3 static tension tests | 1. Computation of the slip coefficient<br>2. Computation of load partition in the joint based on measured strains |
| | A325 steel bolts | |  | | 2 static tension tests | |
| | | |  | | 2 static tension tests | |
| 55-4 | A325 steel bolts<br>A141 steel rivets | I-section with gusset plate |  | Washer type<br>Type fastener | Static Tension Test<br>2 tests 7/8" bolt<br>1 test 7/8" rivet | 1. Computation of load resisted by the webs<br>2. Computation of joint efficiencies. |

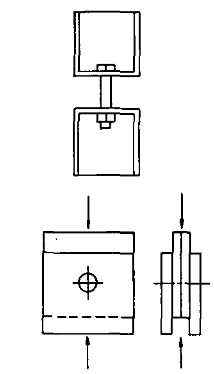
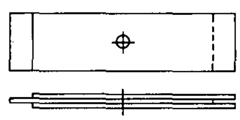
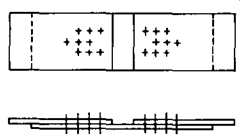
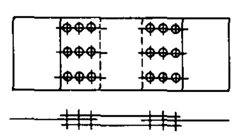
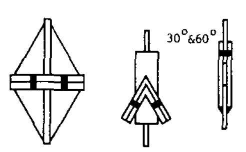
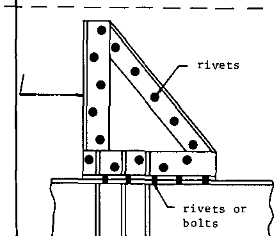
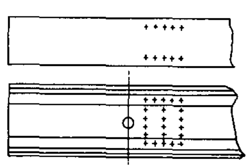
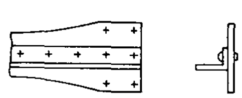
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 55-3 | SAE 4140 steel bolts | Butt splice |  | Joint size<br>Plate thickness | 3 Static Tension tests | 1. Computation of the slip coefficient.<br>2. Computation of load partition in the joint based on measured strains. |
| | A325 steel bolts | |  | | 2 Static Tension tests | |
| | | |  | | 2 Static Tension tests | |
| 55-4 | A325 steel bolts<br>A141 steel rivets | I - section with gusset plate |  | Washer type<br>Type fastener | Static Tension Tests<br>2 tests 7/8" bolt<br>1 test 7/8" rivet | 1. Computation of load resisted by the webs.<br>2. Computation of joint efficiencies. |
| 55-5 | A325 steel bolts | Test jig |  | Bolt diameter<br>Bolt length<br>Air-pressure of pneumatic wrenches<br>Time interval<br>Nut rotation | 1200 tests of single bolts | |
| 55-9 | SAE 1020 steel bolt<br>Brass 60/40 bolt<br>24ST bolt<br>Lucite bolt | Butt splice |  | Bolt materials<br>Number of bolts | Static Tension Tests<br>4 tests SAE 1020 bolt<br>4 tests brass 60/40 bolt<br>4 tests 24ST bolt<br>4 tests lucite bolt | 1. Computation of joint modulus.<br>2. Computation of load carrying capacity and load partition in the elastic region. |
| 55-12 | | Plate with holes |  | Plate materials<br>Number of holes<br>Pattern of holes | Static Tension Tests<br>29 tests hot rolled steel no holes<br>11 tests hot rolled steel with holes<br>6 tests 61S-T6 aluminum no holes | 1. Computation of stress ratio<br>2. Limit Analysis |
| 55-14 | A325 steel bolts<br>A141 steel rivets | Lap splice |  | Plate thickness<br>Bolt diameter<br>Number of holes<br>Contact surface preparation<br>Bolt Tension<br>Tension-shear ratio | Static Tension Tests<br>32 tests 3/4" bolt<br>12 tests 3/4" bolt | 1. Computation of joint efficiencies. |
| | | Butt splice |  | | Static Tension Tests<br>12 tests 3/4" bolt | |
| | | Butt splice |  | Stress range<br>Bolt diameter<br>Bolt tension<br>Type fastener | Fatigue Tests<br>35 tests 1" bolt<br>5 tests 7/8" bolt<br>3 tests 5/8" bolt<br>3 tests 3/4" bolt<br>3 tests 7/8" rivet | 1. Computation of the fatigue strength |
| | | Double-lap splice |  | Loading range<br>Bracing length | Fatigue Tests<br>3 tests 7/8" bolt | |

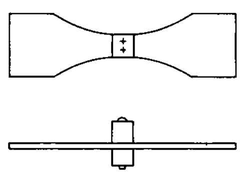
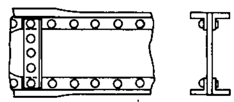
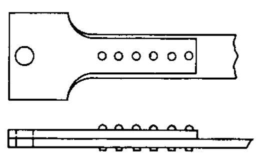
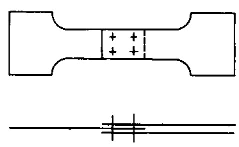
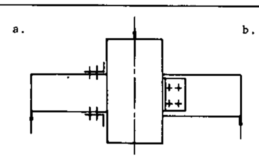
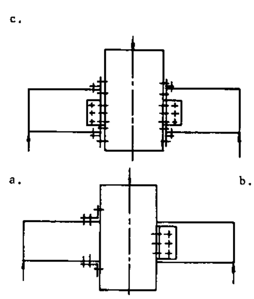
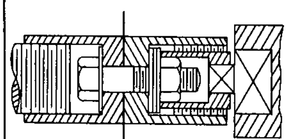
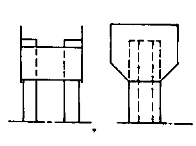
| REF. NO. | CONNECTION: CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | NOTES: TESTS | ANALYSIS |
|---|---|---|---|---|---|---|
| 55-5 | A325 steel bolts | Test jig |  | Bolt diameter<br>Bolt length<br>Air-pressure of pneumatic wrenches<br>Time interval<br>Nut rotation | 1200 tests of single bolts | |
| 55-9 | SAE 1020 steel bolt<br>Brass 60/40 bolt<br>24ST bolt<br>Lucite bolt | Butt splice |  | Bolt materials<br>Number of bolt | Static Tension Tests<br>4 tests SAE 1020 bolt<br>4 tests brass 60/40 bolt<br>4 tests 24ST bolt<br>4 tests lucite bolt | 1. Computation of joint modulus.<br>2. Computation of load carrying capacity and load partition in the elastic region. |
| 55-12 | | Plate with holes |  | Plate materials<br>Number of holes<br>Pattern of holes | Static Tension Tests<br>29 tests hot rolled steel no holes<br>11 tests hot rolled steel with holes<br>6 tests 61S-T6 aluminum no holes | 1. Computation of stress ratio<br>2. Limit Analysis |
| 55-14 | A325 steel bolts<br>A141 steel rivets | Lap splice |  | Plate thickness<br>Bolt diameter<br>Number of bolts<br>Contact surface preparation<br>Bolt Tension<br>Tension-shear ratio | Static Tension Tests<br>32 tests 3/4" bolt<br>12 tests 3/4" bolt | 1. Computation of joint efficiencies |
| | | Butt splice |  | | Static Tension Tests<br>12 tests 3/4" bolt | |
| | | Butt splice |  | Stress range<br>Bolt diameter<br>Bolt tension<br>Type fastener | Fatigue Tests<br>35 tests 1" bolt<br>5 tests 7/8" bolt<br>3 tests 5/8" bolt<br>3 tests 3/4" bolt<br>3 tests 7/8" rivet | 1. Computation of the fatigue strength |
| | | Double lap splice |  | Loading range<br>Bracing length | Fatigue Tests<br>3 tests 7/8" bolt | |
| 55-17 | A141 steel rivets<br>A195 steel rivets<br>A325 steel bolts | Butt splice |  | Type of fastener<br>Tension shear bearing ratio<br>Length of grip<br>Fastener materials<br>Loading range | Fatigue Tests<br>24 tests 3/4" A325 bolt<br>56 tests 3/4" A141 rivet | 1. Computation of joint efficiencies |
| | | Butt splice |  | Plate thickness<br>Tension shear bearing ratio<br>Length of grip<br>Surface preparation<br>Fastener Materials<br>Hole preparation | Fatigue Tests<br>5 tests 3/4" A141 rivet<br>7 tests 3/4" A195 rivet | |
| | | Butt splice |  | Fastener materials | Fatigue Tests<br>2 tests 3/4" A141 rivet<br>2 tests 3/4" A195 rivet | |
| 55-18 | 4140 steel bolts<br>A325 steel bolts | Butt splice |  | Joint size<br>Plate thickness<br>Surface condition<br>Bolt materials<br>Tension-shear ratio | Static Tension Tests<br>48 tests<br>1" 4140 steel bolt<br>13 tests<br>1" A325 steel bolt | 1. Computation of the slip coefficient. |
| | | |  | Moment-shear ratio | Static Torsion Test<br>6 tests<br>1" 4140 steel bolt | 1. Computation of shear stresses by Gullander method. |

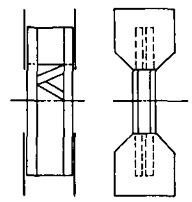
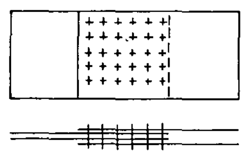
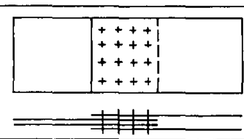
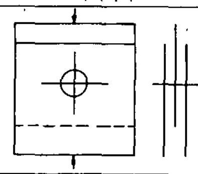
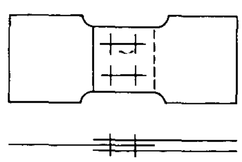
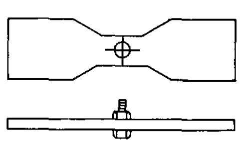
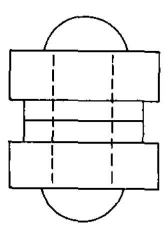
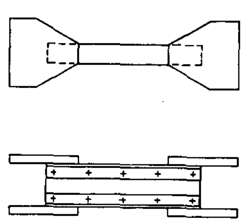
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 55-17 | A141 steel rivets<br>A195 steel rivets<br>A325 steel bolts | Butt splice |  | Type of fastener<br>Tension shear bearing ratio<br>Length of grip<br>Fastener materials<br>Loading range | Fatigue Tests<br>24 tests 3/4" A325 bolt<br>56 tests 3/4" A141 rivet | 1. Computation of joint efficiencies. |
| | | Butt splice |  | Plate thickness<br>Tension shear bearing ratio<br>Length of grip<br>Surface preparation<br>Fastener materials<br>Hole preparation | Fatigue tests<br>5 tests 3/4" A141 rivet<br>7 tests 3/4" A195 rivet | |
| | | Butt splice |  | Fastener materials | Fatigue Tests<br>2 tests 3/4" A141 rivet<br>2 tests 3/4" A195 rivet | |
| 55-18 | 4140 steel bolts<br>A325 steel bolts | Butt splice |  | Joint size<br>Plate thickness<br>Surface condition<br>Bolt materials<br>Tension-shear ratio | Static Tension Tests<br>48 tests<br>1" 4140 steel bolt<br>13 tests<br>1" A325 steel bolt | 1. Computation of the slip coefficient. |
| | | |  | Moment-shear ratio | Static Tension Test<br>6 tests<br>1" 4140 steel bolt | 1. Computation of shear stresses by Bullander method. |
| 55-34 | 24S-T31 rivets | Lap splice |  | Type of fastener<br>Sheet material<br>Temperature | 27 tests | 1. Deep-rupture efficiency . |
| 55-35 | High-strength bolts | Bolt test |  | Bolt length<br>Bolt diameter | | 1. Fatigue strength |
| 56-1 | Black bolts | Butt splice |  | Bolt diameter<br>Sheet thickness<br>Properties of bolt & sheet<br>Edge distribution<br>Number of bolts in row | 574 Tension tests | 1. Formula for failure load. |
| 56-4 | ALPPH Huck bolts<br><br>ACT509H Huck bolts | Plain plate or plate with holes | <br> | Type of hole | Fatigue Tests<br>31 tests 7075-T Alclad sheet | 1. Computation of the fatigue strength reduction factor. |
| | | Plate with bolt installed | <br> | Type of hole<br>Interference<br>Depth of countersink | Fatigue Tests<br>67 tests<br>1/4" Brazier-head Huck bolts 7075-T plate | |

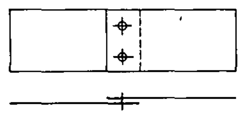
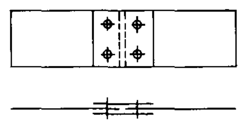
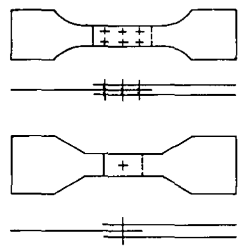
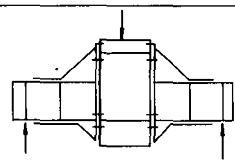
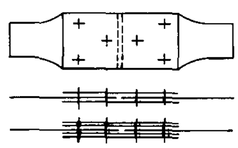
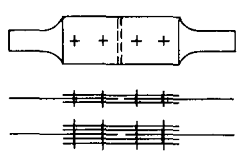
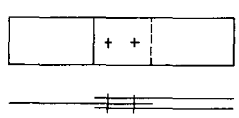
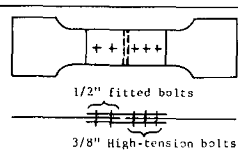
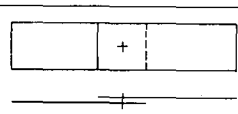
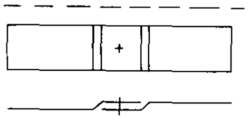
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 56-5 | A325 steel bolts | Butt splice |  | Plate thickness<br>Hole preparation<br>Plate surface condition<br>Tested temperature<br>Tension-shear ratio | <u>Static Tension Test</u><br>12 tests 3/4" bolts at room temperature<br>6 tests 3/4" bolts at -24°F. | 1. Computation of joint efficiencies<br>2. Strain-Energy absorption of the joint. |
| 56-10 | A325 steel bolts | Butt splice |  | | 1 Static Tension Test | 1. Computation of local coefficient of friction. |
| 56-12 | A141 steel rivets | Test jig |  | Grip length<br>Rivet diameter<br>Type of rivet<br>Type of rivet steel<br>Driving method<br>Shear-tension ratio | <u>Static Tests</u><br>3/4" rivets 82 tests<br>7/8" rivets 85 tests<br>1" rivets 82 tests | Development of empirical interaction curve for combined tension and shear. |
| 57-2 | A325 steel bolts | Butt splice |  | Joint size<br>Plate thickness<br>Bolt pattern | <u>Static Tests</u><br>4 tests 1" bolt | 1. Computation of load partition from strain reading.<br>2. Computation of joint efficiencies. |
| 57-3 | Riveted bolts | Plate<br><br>Lap splice<br><br>Double-strap butt | <br><br> | Number of bolts in line<br>Butt pattern<br>Loading condition | | |
| 57-8 | ALPH-T8 Huck bolts | Lap splice |  | Clamping force<br>Collar material<br>Interference | <u>Fatigue Tests</u><br>6 tests 1/4" Huck bolts 7075-T plate | |
| | | Butt splice |  | Clamping force<br>Collar material<br>Interference<br>Surface preparation | <u>Fatigue Tests</u><br>8 tests 1/4" Huck bolts 7075-T plate<br>8 tests 1/4" Huck bolts 2024-T plate<br>14 tests 1/4" Huck bolts 7075-T plate<br>3 surface conditions | |

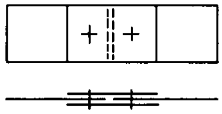
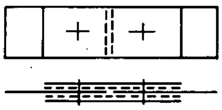
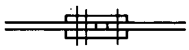
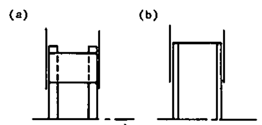
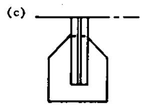
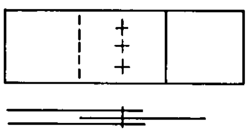
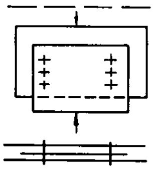
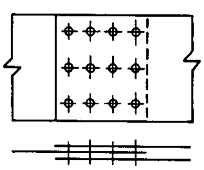
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 57-12 | 5/8" high-strength bolts | Direct-Moment- | (A)  | Varying connection plate thickness | Z-8WFZO bending test | 1. Computation of moments from theoretical equations. |
| | 5/8 & 7/8" high-strength bolts | Direct-Moment- | (B)  | Bolt size<br>Change in geometry & eccentricity of bolts | 2 8WF17 bending tests | |
| | 7/8" high-strength bolts | Direct-Moment- | (C)  | Variation in number of bolts | 1-18WFSO bending test | |
| 57-14 | A325 steel bolts | T-section |  | Bolt size<br>Number of bolts | Static Tension Test<br>5 tests 7/8" bolt<br>1 test 5/8" bolt | 1. Development of interaction curve for strength in tension and shear.<br>2. Computation of the ultimate strength of bolted tee connection. |
| 57-15 | A325 bolts | Butt splice |  | Bolt tension | Static Tension Test<br>26 tests 1" bolt | 1. Computation of the slip coefficient. |
| 57-16 | Hook-Knurl A325 bolt<br>High tensile bolt A325 | Butt splice |  | Grip length<br>Bolt type | Static Tension Test<br>3 tests high-strength bolts<br>3 tests Hook-knurl bolt<br>Fatigue Tests<br>4 tests high-strength bolt<br>8 tests Hook-knurl bolt | |
| 57-17 | A325 steel bolts | Butt splice |  | Internal tension<br>Frequency of vibration | Static Tension Test<br>29 tests without vibration<br>33 tests with vibration | 1. Computation of slip coefficient. |

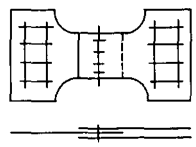
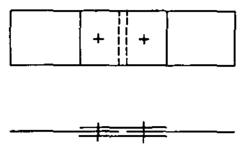
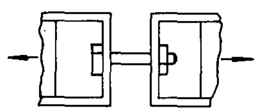
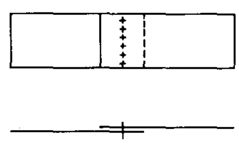
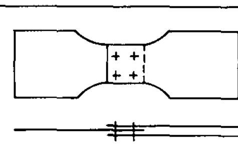
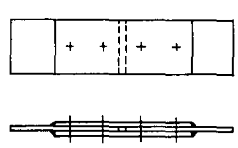
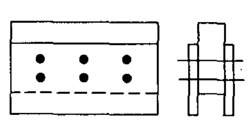
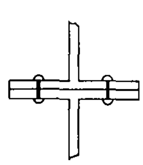
| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 57-18 | A325 steel bolts | Test jig |  | Clamping force | Direct Tension Tests<br>1 test 7/8" bolt<br>1 test 1" bolt<br>Shear Tests<br>2 tests 7/8" bolt<br>2 tests 1" bolt | |
| 57-19 | Bolts<br>Rivets | Shear test |  | Diameter of fastener<br>Surface treatment | 61 Shear Tests | |
| 57-22 | Bolts & Rivets | Lap splice |  | Pattern<br>Sheet material<br>Fastener<br>Double material | 130 creep tests | |
| 57-23 | A325 steel bolts<br>A354 steel bolts | Butt splice |  | | 1 Static Tension Test<br>7/8" A325 and A354 bolts | |
| 57-32 | Rivets<br>Black bolts<br>A325 bolts | Test jigs |  | Type of fastener<br>Type of test | Static and Fatigue Tests | 1. Computation of joint strength.<br>2. Development of interactions curve for rivets. |
| | | Bracket |  | Type of fastener<br>Type of test<br>Stiffeners | 6 Static Tests<br>12 Fatigue Tests | |
| 58-1 | Rivets 3/16" | Box-beam |  | | 7 Fatigue Tests | |
| | 3/16" rivets | Stimulated elements |  | | 7 Fatigue Tests | |

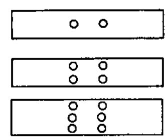
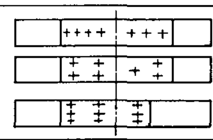
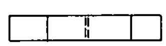
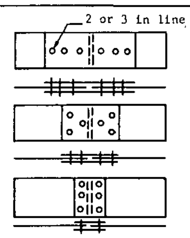
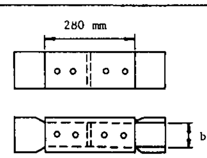
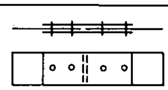
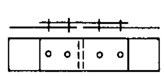
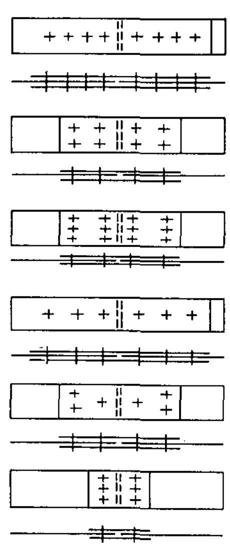
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 58-1 con't | 3/16 rivets | Simulated elements No.2 |  | Minimum stress<br>Maximum stress | 12 Fatigue Tests | |
| | | I-Beam |  | Minimum stress<br>Maximum stress | 4 Fatigue Tests | |
| | | I-Beam simulated elements |  | Number of plates<br>Pitch | 17 Fatigue Tests | |
| 58-2 | A325 steel bolts | Butt splice |  | Surface preparation | Static Tension Test<br>35 test 1" bolt | 1. Computation of slip coefficient. |
| 58-4 | A141 steel rivets<br><br>A325 steel bolts | Column Base<br>a. Flange angle<br>b. Web angle |  | Fastener type<br>Type of load<br>Type of loading steel | Static Tests<br>One test with slowly applied load and the second test with rapidly applied load<br>a. 3 tests 3/4" rivet<br>2 tests 3/4" bolt<br>b. 2 tests 3/4" rivet<br>2 tests 3/4" bolt | 1. Development of moment-relation relationships |
| | | Column-to-beam<br>a. Flange angle<br>b. Web angle<br>c. Tee |  | Fastener type<br>Type of load | Static Tests<br>a. 2 tests 3/4" rivet<br>2 tests 3/4" bolt<br>b. 2 tests 3/4" rivet<br>2 tests 3/4" bolt<br>c. 2 tests 3/4" rivet<br>2 tests 3/4" bolt | |
| 58-7 | High-tensile steel bolts BSF, BSW, UNC and UNF | Test jig |  | Bolt diameter<br>Thread type<br>Condition of Nut<br>Length<br>Type of test | Direct tensile tests are summarized<br>Torqued tension tests are summarized<br>Direct tension applied after torquing<br>Repeated torque tenion tests | |
| 58-12 | A141 steel rivets<br><br>A325 steel bolts | Box section with batten plates |  | Specimen configuration | Static Tension Tests<br>2 tests 3/4" rivet<br>1 test 3/4" bolt | 1. Distribution of load to pull plates.<br>2. Computation of joint efficiencies.<br>3. Computation of joint deformation in the elastic range. |

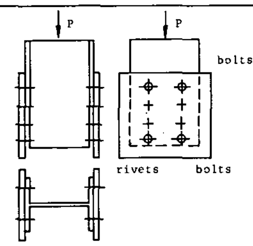
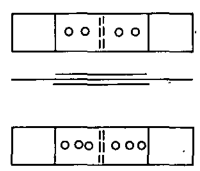
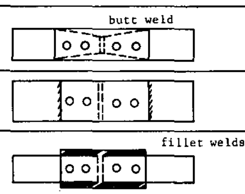
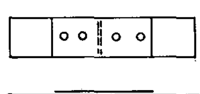
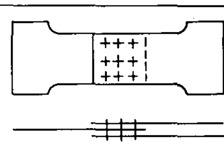
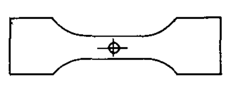
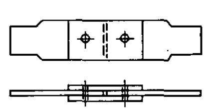
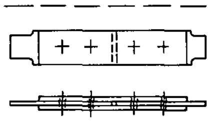
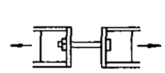
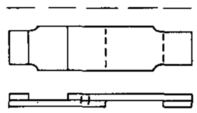
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 58-12 con't | | a. Laced angles<br>b. Built-up I section |  | Size of joint<br>Rivet pattern<br>Rivet diameter<br>Hole preparation | Static Tension Test<br>a. 8 tests 7/8" rivet<br>4 tests 3/4" rivet<br>3 tests 3/4" bolt<br>1 test weld<br>b. 2 tests 7/8" rivet | |
| 58-13 | A325 steel bolts<br>A141 steel rivets | Butt splice |  | Joint size<br>Bolt or rivet pattern<br>Tension-shear ratio<br>Fastener type | Static Tension Test<br>6 tests 7/8" bolt<br>1 test 7/8" rivet | 1. Computation of joint efficiencies.<br>2. Computation of slip coefficient .<br>3. Computation of effective area in elongation. |
| 58-18 | A325 steel bolts | Butt splice |  | Joint size<br>Tension-shear ratio<br>Bolt pattern | Static Tension Test<br>1 test 1" bolt<br>1 test 1-1/8" bolt | 1. Computation of slip coefficient.<br>2. Computation of joint efficiency. |
| 58-19 | A325 steel bolts | Test jig |  | Surface preparation<br>Bolt diameter<br>Initial tension | Static Tests<br>7/8" bolts<br>1" bolts<br>1-1/8" bolts | 1. Computation of the ratio of effective shear stress to tensile stress on stress area. |
| 59-1 | A141 steel rivets | Butt splice |  | Joint size<br>Plate thickness<br>Bearing ratio | Fatigue Tests<br>7/8" rivets and A7 steel plates<br>26 tests zero to tension<br>8 tests full reversal<br>Static Tests<br>4 tests | 1. The fatigue strength of various clamping forces.<br>2. Joint efficiency. |
| 59-2 | A325 steel bolts | Plate |  | Type of nut<br>Stress range | Fatigue Tests<br>4 tests 3/4" bolt flanged nut<br>3 tests 3/4" bolt heavy nut<br>2 tests open hole | |
| 59-3 | A325 bolts | Test jig (See Ref. 108) |  | Length of bolt<br>Tension-shear ratio<br>Loading condition | 11 tests of 4 in. bolts<br>5 tests of 2-3/4 in. bolts | 1. Development of empirical interaction curve for combined tension and shear |
| 59-4 | 7/8" bearing bolts | Tension member |  | Connection length | 2 Tension Tests | |

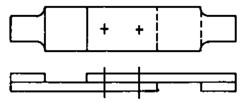
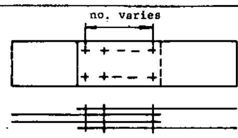
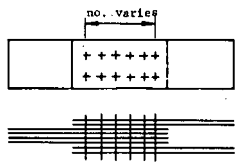
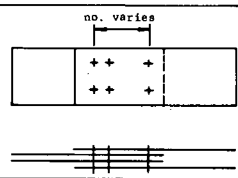
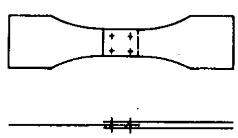
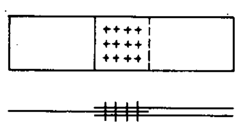
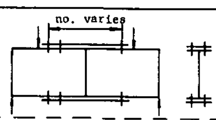
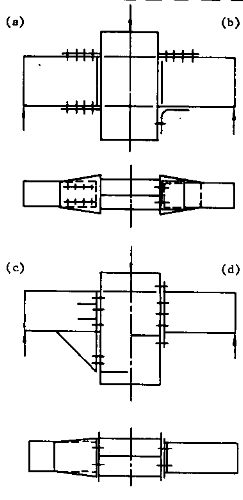
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 59-7 | A325 steel bolts | Lap splice |  | Bolt type<br>Nut type<br>Washer or no washer | Static Tension Test<br>6 tests 3/4" rib bolt<br>3 tests 3/4" hex head bolt | |
| | | Butt splice |  | | Static Tension Test<br>6 tests 3/4" rib bolt<br>3 tests 3/4" hex head bolt | |
| 59-12 | A325 steel bolts | Butt splice |  | Joint size<br>Plate thickness<br>Bolt pattern<br>Tightening torque<br>Surface preparation | **Static Tension Tests**<br>230 tests **1" bolt**<br>**Fatigue Tests**<br>15 tests **1" bolt** | |
| 59-13 | B.S. No.970 steel bolts | beam-to-column |  | | Static Test<br>2 tests 7/8" bolt | 1. Computation of **plastic moment.** |
| 59-14 | A325 steel bolts | Butt splice |  | Number of bolts<br>Tightening method<br>Grip | Static Tension Tests<br>36 tests 3/4" bolt | **1. Computation of slip coefficient.**<br>**2. Computation of safety factor.** |
| | Butt splice | |  | Plate thickness<br>Number of bolts<br>Tightening method<br>Grip | Static Tension Tests<br>12 tests 3/4" bolt<br>6 tests 7/8" bolt | |
| 59-15 | 35SG steel bolts | Butt splice |  | Tensile load on bolts<br>Surface preparation | Static Tension Tests<br>24 tests 7/8" bolts | 1. **Computation of slip coefficient.** |
| 59-16 | B.S.F. Bolts | Butt splice | <br> | Number of bolts | Static Tension Tests<br>9 tests 3/8" bolt<br>**HE30-WP plate** | 1. **Computation of slip coefficient.** |
| 59-19 | A325 steel bolts | Lap splice |  | Bolt diameter<br>Surface preparation | Number of test conducted is not reported | 1. Computation of coefficient of friction. |
| | | Joggled lap splice |  | | | |

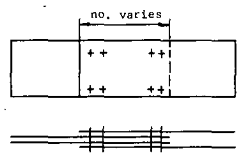
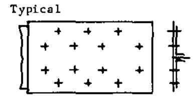
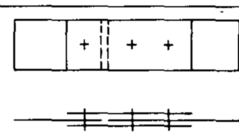
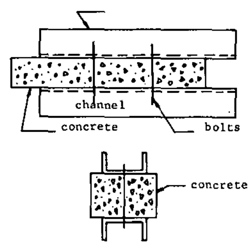
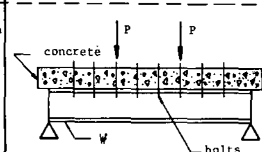
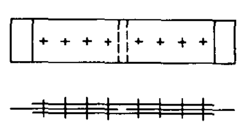
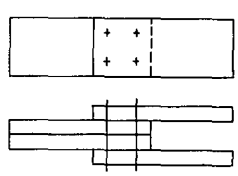
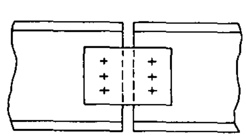
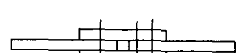
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 59-19 con't | | Butt splice |  | | | |
| | | Butt splice with liners |  | | | |
| 59-25 | Waisted high strength bolts | Single shear |  | Number of bolts in line<br>Plate thickness<br>Type nut<br>Surface conditions | 36 Shear Tests | 1. Slip load plate stress |
| | | Double shear |  | Type nut<br>Number of bolts in line | 4 tests | |
| | | Joints with packs |  | Number of bolts used | 10 tests | |
| 59-29 | A325 steel bolts | Test jig<br>Calibrator |  | Bolt diameter<br>Loading method | Direct Tension Tests<br>18 tests 7/8" bolt<br>10 tests 1" bolt<br>5 tests 1-1/8" bolt<br>Torque Tension Tests<br>6 tests 7/8" bolt<br>3 tests 1" bolt<br>2 tests 1-1/8" bolt | |
| 59-30 | A141 steel rivets<br>A325 steel bolts | (a) box section<br>(b) built-up I section |  | Specimen Configuration<br>Joint size<br>Fastener<br>Hole preparation<br>Rivet or Bolt pattern | Static Tension Tests<br>(a) 4 tests 3/4" bolt<br>(b) 4 tests 7/8" bolt | 1. Distribution of load to pull-plate<br>2. Joint efficiency<br>3. Deformation in a joint |
| | | (c) Starred angle |  | | Static Tension Tests<br>8 tests 3/4" rivet<br>6 tests 3/4" bolt<br>8 tests 7/8" rivet | |
| 59-32 | A141 steel rivets | Double lap butt splice |  | Joint size<br>Plate thickness<br>Rivet diameter<br>Rivet pattern | Static Tension Tests<br>33 tests 3/4" rivet<br>24 tests 7/8" rivet<br>64 tests 1" rivet | 1. Computation of joint efficiencies. |
| | | Double lap butt splice |  | Joint size<br>Plate thickness<br>Rivet diameter | Static Compression Tests<br>18 tests | |
| 59-33 | A325 steel bolts<br>A141 steel rivets | Butt splice |  | Joint size<br>Plate thickness<br>Bolted or riveted pattern<br>Type of holes<br>Tension-shear ratio<br>Surface condition<br>Misalignment | Static Tension Tests<br>2 tests 3/4" bolt<br>4 tests 7/8" bolt | 1. Computation of joint efficiencies<br>2. Computation of strain energy absorbed by the joints. |

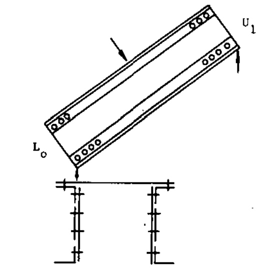
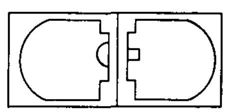
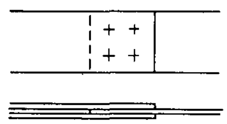
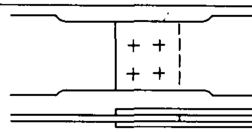
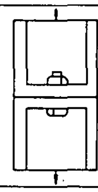
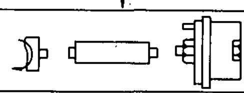
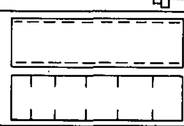
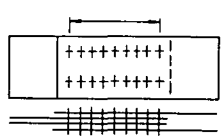
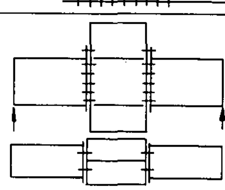
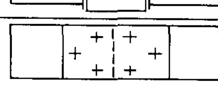
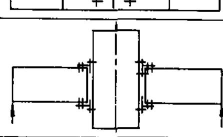
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 59-33 con't | | Butt splice |  | | <u>Static Tension Tests</u><br>8 tests 3/4" bolt<br>4 tests 3/4" rivet | |
| 59-36 | 10k & A325 | Butt splice |  | Surface condition<br>Bolt quality and diameter of bolts<br>Thickness of plate | 56 Tension Tests | |
| 59-37 | A325 steel bolts | Test jig<br><br>Bolt calibrator |  | Bolt diameter<br>Grip length<br>Thread length<br>Loading method | <u>Direct Tension Test</u><br>39 tests 7/8" bolt<br>10 tests 1" bolt<br>5 tests 1-1/8" bolt<br><br><u>Torqued Tension Test</u><br>51 tests 7/8" bolt<br>3 tests 1" bolt<br>2 tests 1-1/8" bolt | |
| 59-39 | 1/8" 2117-T4 rivets | Lap splice |  | Number rows of rivets gage<br>Type of loading<br>Location of loading | 21 rapid and slow loading tests | |
| 59-41 | A325 steel bolts | Butt splice |  | Tightening method | <u>Static Tension Tests</u><br>2 tests | 1. Computation of slip coefficient |
| 59-43 | M22/10k Fillet Welds | Butt splice |  | Type connecting media | 2 Static Tension tests of bolted joints<br>2 Static Tension tests of welded joints<br>2 Static Tension tests of bolted and welded joints | 1. Computation of slip coefficient |
| | M16/10k<br>M22/10k | Butt splice |  | Number of bolts<br>Number of faying surfaces | 8 Static Compression Tests | |
| | M16/10k | T section butt |  | Type bolt<br>Type nut | 12 Static Tension Tests<br>8 Fatigue Tests | |

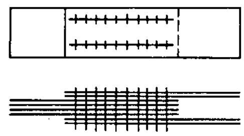
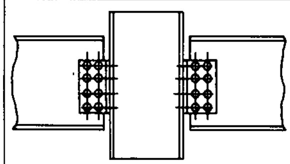
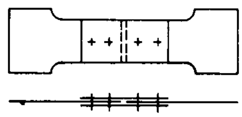
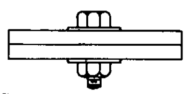
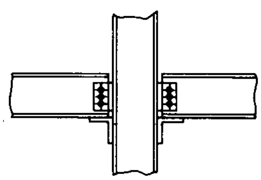
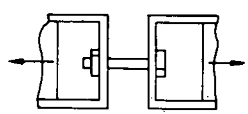
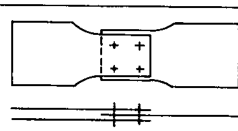
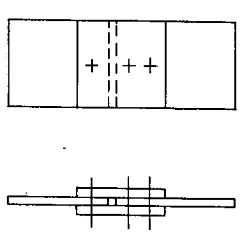
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 59-43 | | Plate with holes |  | Surface treatment<br>Net section stress<br>Pressure or absense of bolts | 13 Fatigue Tests<br>6 Fatigue Tests<br>4 Fatigue Tests | |
| | M16/10k | Butt splice |  | Surface treatment<br>Clamping force<br>Net section stress<br>Bolt pattern | 6 Fatigue Tests<br>10 Fatigue Tests<br>6 Fatigue Tests | |
| | M16/10k<br>M22/10k | Butt splice |  | Type steel<br>Minimum stress<br>Net section stress<br>Surface treatment | 25 Fatigue Tests | |
| | M16/10k<br>M20/10k | Butt splice |  | Surface treatment<br>Time after fabrication<br>Connected Material (ST37,ST48,ST52)<br>Size of bolt | 34 Static Tests | 1. Computation of the slip coefficient. |
| | M16/8G | Butt splice | <br>All surfaces flame cleaned | Contact area<br>b = variable | 1 specimen with b = 80mm<br>1 specimen with b = 70mm<br>1 specimen with b = 60mm<br>1 specimen with b = 50mm<br>1 specimen with b = 40mm<br>1 specimen with b = 30mm<br>Note: Each specimen was retested. | |
| | M16<br>M22 | Butt splice |  | Surface treatment<br>Size bolt | 24 Static Tension Tests | |
| | M22 | Lap splice |  | | 2 Static Tension Tests | |
| | M16 | Butt splice |  | Distribution of bolts<br>Surface Treatment | 18 Static Tests of bolted joints<br>8 Static Tests of plates with holes were conducted for comparative purposes | 1. Elastic load partition in bolted joints including load transfer by friction. |

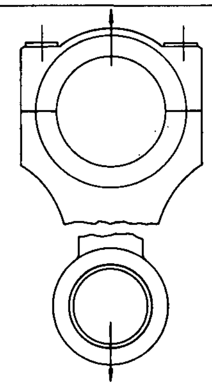
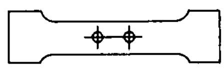
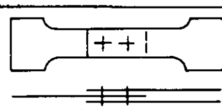
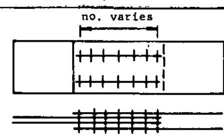
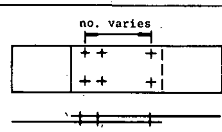
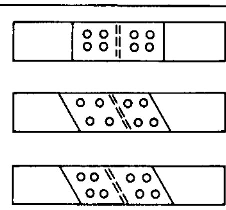
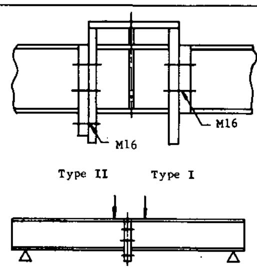
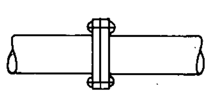
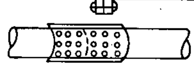
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 59-43 con't | Rivets 25 M24/10k | Beam or column splice |  | 1. Bolts only<br>2. Rivets only<br>3. Combinations | 3 Static Tests | 1. Slip coefficient<br>2. Joint strength |
| 59-44 | M16/10k | Butt splice |  | Number of bolts<br>Plate dimensions | 10 Static Tension Tests<br>Photo elastic investigations to determine distribution of clamping force | 1. Stress distribution<br>2. Computation of slip coefficient. |
| 59-45 | M16/10k Butt welds<br>M16/10k Fillet welds | Butt splice |  | Plate thickness<br>Plate width<br>Bolted connection<br>Welded connection<br>Combination bolted and welded connection | 4 Static Tests of bolted connections<br>4 Static Tests of welded connections<br>8 tests of bolted and welded connections<br>3 tests of bolted conn.<br>7 tests of welded conn.<br>12 tests of bolted and welded connections<br>3 tests of welded conn.<br>5 tests of welded & bolted connections. | 1. Joint efficiency |
| 59-46 | M16/10k | Butt splice |  | Diameter of holes<br>Surface treatment | 21 Static Tests | 1. Computation of the slip coefficient. |
| 59-49 | A325 bolts | Butt splice |  | Loading condition | Constant Cycle Fatigue Tests<br>19 tests 3/8" bolt<br>Variable Cycle Fatigue Tests<br>16 tests 3/8" bolt<br>Static Tension Tests<br>2 tests 3/8" bolt | 1. Development of S-N relationship.<br>2. Computation of the distribution coefficient. $\beta = f(\frac{N_A}{N_A + N_a})$<br>3. Computation of joint efficiencies. |
| | | Plain plate |  | Loading condition | Constant Cycle Fatigue Tests<br>38 tests<br>Variable Cycle Fatigue Tests<br>5 tests | |
| 59-50 | | Butt splice (single bolt) | 3  | | Static Tension Tests<br>10 joints | |
| | | Butt splice (double bolt) | 4  | | 9 joints | |
| | 7/8" & 3/4" High-tension bolts | Test jig |  | Diameter<br>Surface condition<br>Length | Torqued Tension Tests<br>1. "Torqued Method"<br>2. "Turn-of-the Nut" method.<br>3. "Part torque, part turn" | 1. Torque-tension relationships<br>2. Angular rotation-tension relationships. |
| | | Single lap joint | 1  | Plate thickness<br>Surface conditions<br>Shapes of washers | Static Tension Tests<br>29 single lap joints | 1. Creep bending elongation coefficient of friction.<br>2. Change in bolt tension. |

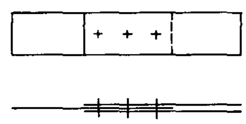
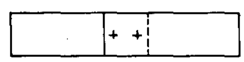
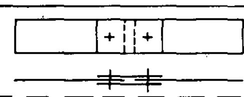
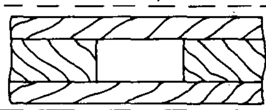
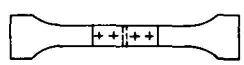
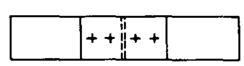
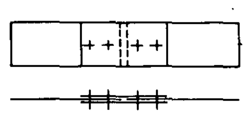
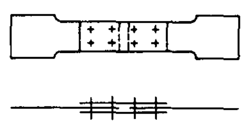
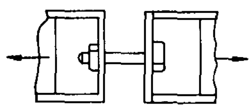
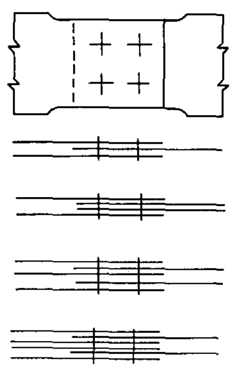
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 59-50 con't | | Double lap joint | 2  | | 17 Double lap joints | |
| 60-2 | A325 steel bolts | Butt splice |   | Joint size<br>Number of holes | Static Tension Tests<br>16 tests 7/8" bolt | 1. Computation of slip coefficients.<br>2. Computation of joint efficiencies.<br>3. Computation of unbuttoning factor.<br>$U = \frac{R_{avg}}{R} = \frac{\tau_{avg}}{\tau_{ult}}$ |
| | | |   | Joint size<br>Plate thickness<br>Grip length<br>Number of bolts | Static Tension Tests<br>16 tests 7/8" bolt | |
| 60-5 | A325 steel bolts | Butt splice |   | Joint length<br>Number of bolts in line | Static Tension Tests<br>4 tests 7/8" bolt | 1. Computation load distribution in joints. |
| 60-7 | 7/8" black bolts | Butt splice |  | Surface treatment<br>Time tested | Fatigue Test | |
| | 7/8" black bolts | |  | Number of bolts in line<br>Number of bolts in row | Static Tension Test | |
| 60-8 | A325 steel bolts | Beam splice |   | Cover plate length<br>Number of bolts | Static Tests<br>2 tests 3/4" bolt | 1. Computation of slip coefficient.<br>2. Computation of plastic moment capacity. |
| | | Beam-to-column |   | | Static Tests<br>4 tests 3/4" bolt | |

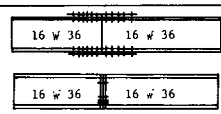
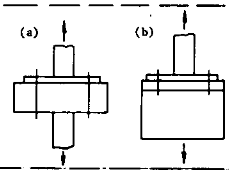
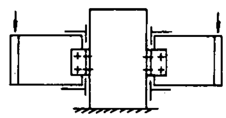
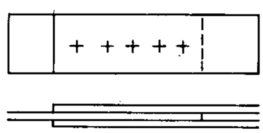
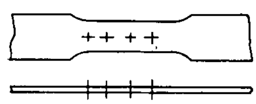
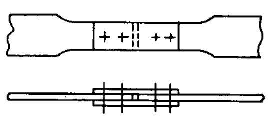
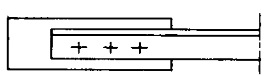
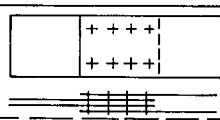
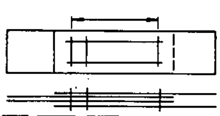
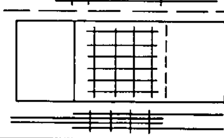
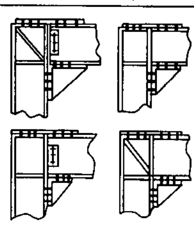
| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 60-21 | A325 steel bolts | Butt splice |  | Joint size<br>Number of bolts in line | Static Tension Tests<br>8 tests 7/8" bolt | 1. Computation of theoretical ultimate load.<br>2. Computation of slip coefficient.<br>3. Computation of joint efficiencies.<br>4. Computation of the unbuttoning factor.<br>5. Determination of the load partition. |
| 60-22 | A141 steel rivets | Portion of the plate Girder flange | Typical<br> | Location of specimen in the plate girder<br>Joint type<br>Grip length | Rivets gaps<br>16 specimens | 1. Estimation of clamping force. |
| 60-24 | A325 steel bolts | Butt splice |  | Bolt diameter<br>Bolt tension | Static Tension Tests<br>18 tests 3/4" bolt<br>18 tests 1" bolt | 1. Computation of slip coefficient. |
| 60-25 | M16 | Composite push-out specimen |  | | 4 Push-out Tests | 1. Coefficient of friction. |
| | M16 | Composite beam |  | Number of bolts used (shear connectors) | 4 Static Tests | 1. Computation of ultimate moment. |
| 60-27 | M20/101C | Butt splice |  | Maximum load | 3 Static Tests<br>12 slow cycle repeated load tests | 1. Slip load. |
| 60-29 | 3/4" Ø steel bolts | Butt splice |  | Moisture content of wood | Static Compression Tests<br>60 specimens of Douglas Fir joints | 1. Relationship of joint strength to moisture content. |
| 60-31 | Bolts & rivets | Web connections |  | Number of lines of rivets<br>Type of fastener | 78 tests | |
| 60-33 | 3/4" high-tension bolts | Test jig |  | Surface condition<br>Applied torque | 11 Double Shear Tests | 1. Coefficient of friction |

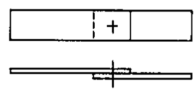
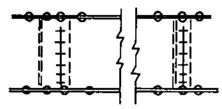
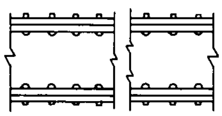
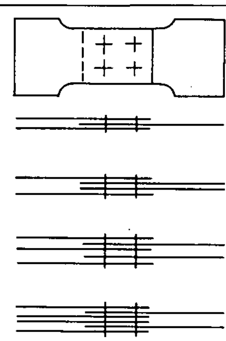
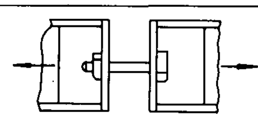
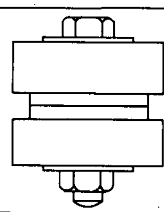
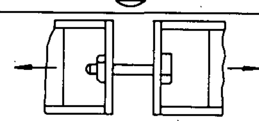
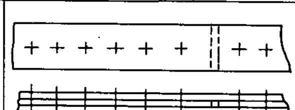
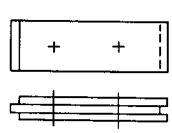
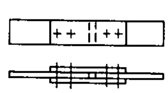
| REF. NO. | CONNECTION: CONNECTING MEDIUM | TYPE | SKETCH | VARIABLE | NOTES: TESTS | ANALYSIS |
|---|---|---|---|---|---|---|
| 60-36 | A141 steel rivets | Built-up Chord $L_oU_1$ |  | Bend parameters | Static Tension Tests<br>3 tests of end post in truss | 1. Computation of ultimate load. |
| 61-4 | 3/4" & 5/8" Huckbolt fasteners | Test jig |  | Diameter of bolt<br>Type of bolt | 27 Direct Tension-Fatigue Tests | |
| | 7/8" Huck-bolt | Butt splice |  | | 3 Fatigue Tests | |
| 61-5 | 7/8" A325 | Butt splice |  | | 1 Static Tension Tests<br>2 Fatigue Tests | 1. Slip coefficient |
| 61-7 | A325 steel bolts | Test jigs |  | Nut size<br>Nut type<br>Loading method<br>Lubrication | Tensile Tests<br>Nut Striping Tests<br>26 tests heavy nuts<br>27 tests finished thick nuts<br>Ultimate Load Tests<br>10 tests 3/4" bolts<br>6 tests 7/8" bolts<br>8 tests 1" bolts | |
| | | |  | | Torqued Tension Tests<br>216 tests 3/4" bolts<br>144 tests 7/8" bolts<br>216 tests 1" bolts | |
| 61-8 | Rivets | Box beam |  | Integrally stiffened or riveted stringers<br>Or riveted & bonded stringers | 3 Static Bending Tests | 1. Predicted statis strength. |
| 61-9 | A141 steel rivets<br>A325 steel bolts | Butt splice |  | Joint size<br>Plate thickness<br>Pitch<br>Number of fasteners in line<br>Tension-shear ratio<br>Fastener type | Static Tension Tests<br>5 tests 7/8" bolt<br>2 tests 7/8" rivet | 1. Computation of theoretical ultimate load.<br>2. Computation of unbuttoning factor<br>3. Determination of the load partition at ultimate. |
| 61-10 | A325 steel bolts | Beam-to-column |  | Bolt diameter<br>Number of bolts<br>End plate thickness<br>Column stiffener thickness | Static Tests<br>3 tests 3/4" bolt<br>2 tests 7/8" bolt | 1. Computation of load capacity of column web stiffeners.<br>2. Computation of plastic moment. |
| 61-11 | B.S. 1083 bolts | Butt splice |  | Joint size<br>Bolt diameter<br>Bolt tension<br>Number of bolts | Static Tension Tests<br>4 tests 5/8" bolt | 1. Computation of slip coefficient. |
| | | Beam-to-column |  | Number of bolts<br>Load range<br>Bolt tension | Cyclic Load Tests<br>3 tests 3/4" bolt | |

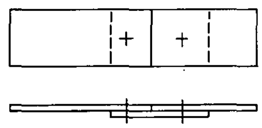
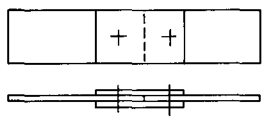
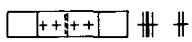
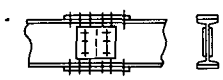
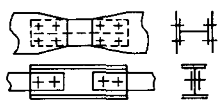
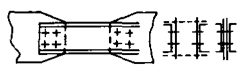
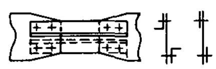
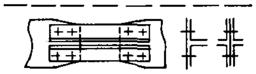
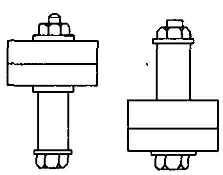
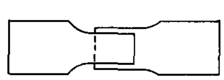
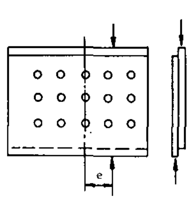
| REF | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 61-14 | A325 steel bolts | Butt splice |  | Joint size<br>Number of bolts in line | Static Tension Tests<br>4 tests 7/8" bolt | 1. Computation of slip coefficient.<br>2. Computation of unbuttoning factor. |
| 61-21 | A141 rivet<br>A325 bolt | Beam-to-column |  | Moment-shear ratio | Static Tests<br>3/4" rivets connecting beam web and<br>3/4" A325 bolts connecting column flange<br>Static Tests<br>1 test 3/4" rivets | 1. Computation of moment-resisting capacity. |
| 61-31 | M16/10k | Butt splice |  | Material<br>Surface treatment<br>Plate thickness<br>Plate width | 20 Static Tests | 1. Computation of the slip coefficient. |
| | M16/M20 | Test jig |  | Bolt diameter<br>Bolt length<br>Time | 50 Creep and Corrosion Tests | |
| 61-36 | 3/4" high tensile steel bolts | Beam-to-column (seat angle) |  | Type of seat angle | Static Moment Tests<br>7 tests no seat angle<br>7 tests 6 x 4 x 3/8L<br>7 tests 6 x 4 x 3/8L with 1/4" ℄ stiffener<br>7 tests 6 x 4 x 3/4L | 1. Moment-relation relationships.<br>2. Computation of coefficient of friction. |
| 62-2 | A325 steel bolts | Test jig |  | Grip length<br>Thread length<br>Length under head<br>Loading conditon | Direct Tension Tests<br>32 tests 7/8" bolt<br>Torqued Tension Tests<br>24 tests 7/8" bolt | |
| 62-3 | A325 bolt | Butt splice |  | Hole diameter<br>Bolt diameter<br>Tension-shear ratio<br>Load range | Fatigue Tests<br>11 tests 3/4" bolt<br>1 test 5/8" bolt | 1. Computation of slip coefficient. |
| 62-5 | 3/4"UNC x 4" | Butt splice |  | Bolt pattern<br>Number of bolts in line<br>Diameter of hole | 17 Static Tension Tests | 1. Slip load |

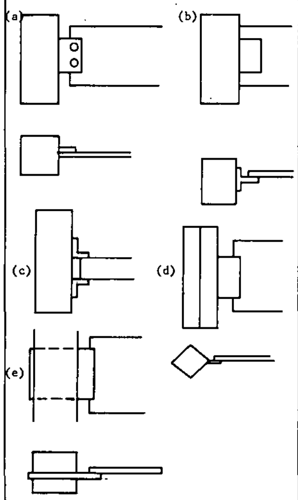
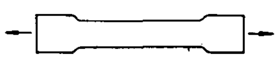
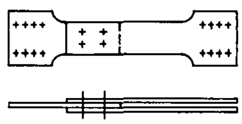
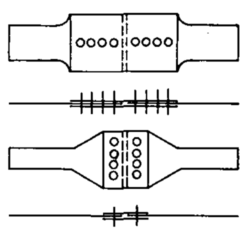
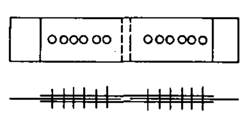
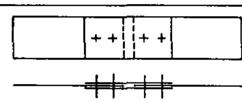
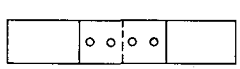
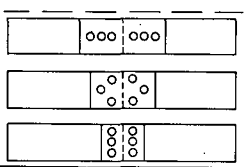
| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 62-6 | 9/16" bolts | Connecting-rod |  | Pretightening load | | 1. Computation of stress in bolt. |
| 62-7 | | Plate with hole |  | Plate thickness<br>Plate width | <u>Fatigue Tests</u><br>41 tests | 1. Development of the relationship of endurance limit to bearing ratio. |
| | High-strength steel bolts | Butt splice |  | Plate thickness<br>Plate width<br>Bearing ratio | <u>Fatigue Tests</u><br>71 tests 1/4" bolt | |
| 62-8 | A141 steel rivets | Butt splice |  | Joint size<br>Number of rivets in line | <u>Static Tension Tests</u><br>3 tests 7/8" rivet | 1. Computation of theoretical ultimate load.<br>2. Computatin of unbuttoning factor. |
| 62-12 | A325 steel bolts | Lap splice |  | Joint size<br>Number of bolts in line<br>Tension-shear ratio | <u>Static Tension Tests</u><br>4 tests 7/8" bolt | 1. Computation of slip coefficient<br>2. Computation of unbuttoning factor |
| 62-15 | M16/10k | Butt splice |  | Plate thickness<br>Inclination of cover plates<br>Type material | 5 Static Tests<br>43 Fatigue Tests | 1. Computation of slip coefficient. |
| | M16 | Beam splice<br>Beam-to-column |  | As shown Type I, II<br>Beam size<br>End plate thickness | 15 Static Tests | 1. Stiffness computation.<br>2. Application of beam-line method to be bolted moment connections.<br>3. Development of standard profiles and connections. |
| 62-17 | M16/10k | Flange plate<br><br>Lap splice | <br> | Number of bolts<br>Thickness of flange plates<br>Size of bolts | 10 Static Tension Tests<br>4 Tension Tests | 1. Computation of slip coefficient.<br>2. Yield strength of flange plate. |

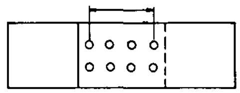
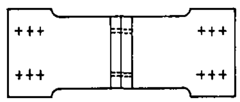
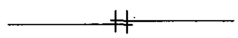
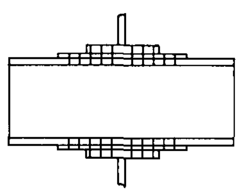
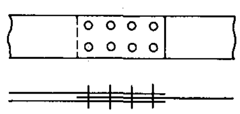
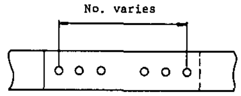
| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 62-18 | M16/10k | Butt splice |  | Prestressing forces<br>Tightening moment<br>Number of bolts in a line | 10 Static Tests | 1. Computation of the stress distribution. |
| | Al Mg Si Bolts | Butt splice |  | | 1 Photo Elastic Test on plexiglas model | 1. Stress-distribution |
| 62-19 | M16/10k | Butt splice |  | Distance between bolts | 7 Static Tests | 1. Stress-distribution<br>2. Determination of minimum end distance. |
| | | |  | | 1 Photo Elastic Test on a model | 1. Stress distribution |
| 62-22 | M10/8G | Butt splice |  | Surface treatment<br>Plate thickness | 33 Static Tests on Al Mg Si F 32 | 1. Computation of slip coefficient. |
| | M16/10k | Butt splice |  | Surface treatment<br>Plate thickness | 15 Static Tests on Al Cu Mg 2 | 1. Computation of slip coefficient. |
| 62-25 | SV34 rivets<br>B1154 medium-grade bolt | Butt splice |  | Type fastener<br>Surface treatment<br>Pitch<br>Number of bolts in line | 12 Tensile Tests | 1. Computation of slip coefficient. |
| | SV34 rivets<br>B1154 medium-grade bolt | |  | Number of bolts in line<br>Pitch<br>Surface treatment | 12 Fatigue Tests | |
| 63-2 | A354BC bolts<br>A354BD bolts | Test jig |  | Bolt grades<br>Bolt head type<br>Grip length<br>Thread in grip<br>Thread lubrication<br>Loading condition | <u>Direct Tension Tests</u><br>27 tests 7/8" bolt<br><u>Torqued Tension Tests</u><br>56 tests 7/8" bolt | |
| 63-3 | A325 bolts | Butt splice |  | Type steel<br>Number of faying surfaces | <u>Static Tension Tests</u><br>18 tests 1" bolt | 1. Computation of slip coefficient. |

| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 63-7 | A325 steel bolts | Beam splice (lap plates)<br>Beam splice |  | Bolt diameter<br>Number of bolts<br>Thickness of end plate | Static Tension Tests<br>8 tests<br>Static Tension Tests<br>6 tests | 1. Computation of bolt tension<br>2. Computation of plastic moment<br>3. Determination of prying action |
| | | Tee stubs |  | Bolt diameter<br>T-stub size<br>Flexible or rigid abutment | Static Tension Tests<br>17 tests (a) specimen<br>10 tests (b) specimen | |
| | | Beam-to-column |  | Beam size<br>Bolt diameter<br>T-stub size | Static Tension Tests<br>3 tests | |
| 63-10 | 1/4" A7 machine bolts | Butt splice |  | Number of bolts in line<br>Plate thickness<br>Pitch | 3 tests | 1. Unbuttoning efficiency<br>2. Efficiency of bolts<br>3. Ultimate strength |
| 63-11 | 7/8" bolts<br>rivets | Single plate |  | Type fastener | 18 Fatigue Tests | |
| | | Butt splice |  | Number of fasteners in line<br>Number of rows of fasteners<br>Type fastener<br>Plate width<br>Bolt diameter<br>Plate material<br>Surface treatment<br>Bolt tension | 22 Fatigue Tests | |
| | | Angle with gusset |  | Load range | 5 Fatigue Tests | |
| 63-12 | A325 steel bolts | Butt splice |  | Plate width<br>Bolt tension<br>Bolt head type<br>$A_n/A_s$ ratio<br>Number of washers | Static Tension Tests<br>6 tests 7/8" bolt<br>A440 steel plates | 1. Computation of slip coefficient.<br>2. Computation of load portion and ultimate strength |
| | | |  | Number of fasteners in line<br>Gripped material | Static Tension Tests<br>3 tests 7/8" bolts<br>A440 steel plates | |
| | | |  | Joint width | Static Tension Tests<br>3 tests 7/8" bolts<br>A440 steel plate | |
| 63-14 | High-strength bolts | Rigid frame connection |  | Size connection<br>Diameter of bolts<br>Number of bolts<br>Joint configuration | 8 Static Bending Tests | 1. Computation of ultimate strength. |

| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 64-2 | Rivets | Lap splice<br>Box beam<br>Box girder | <br><br> | | Fatigue Tests | |
| 64-4 | A325 steel bolts | Butt splice |  | Joint type<br>Plate materials<br>Plate thickness<br>Initial bolt tension | Static Tension Tests<br>29 tests 1" bolt | 1. Computation of slip coefficient. |
| 64-5 | A490 steel bolts | Test jig |  | Bolt length<br>Total grip<br>Thread length in grip<br>Loading method | Direct Tension Tests<br>21 tests 7/8" bolt<br>Torqued Tension Tests<br>26 tests 7/8" bolt | |
| 64-6 | A325 steel bolts<br>A354BD steel bolts | Test jig |  | Type of bolt<br>Bolt length<br>Bolt diameter<br>Bolt hardness<br>Grip length<br>Test block materials<br>Tension-shear ratio | Static Tests<br>86 tests 3/4" A325 bolt<br>10 tests 1" A325 bolt<br>20 tests 3/4" A354BD bolt | 1. Development of empirical interaction curve for combined tension and shear. |
| 64-7 | A490 steel bolt | Test jig |  | Bolt length<br>Nominal grip<br>Thread in grip<br>Loading method | Torqued Tension Tests<br>20 tests 7/8" bolt<br>Direct Tension Tests<br>20 tests 7/8" bolt | |
| 64-11 | 7/8" bolts | Butt splice |  | Number of bolts in line<br>Bolt tension | 10 Tension Shear Tests | 1. Normal stress<br>2. Shearing force<br>3. Stress distribution |
| 64-12 | SA90 bolts | Butt splice |  | Applied torque<br>Plate material<br>Type bolts<br>Testing time<br>Clamping time | 324 Compression Tests | |
| | 5/8" bolts | |  | Type of bolt<br>Clamping force<br>Time of testing | 322 Tension Tests | |

| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 64-14 | 7/8" bolts | Lap splice |  | Surface treatment<br>Type of bolt | 38 Single Shear Test | 1. Slip coefficient |
| | | Butt splice |  | | 23 Double Shear Test | 1. Slip coefficient |
| 64-16 | M16 | 0 Butt and lap splice |  | Type section<br>Plate thickness<br>Number of bolts<br>Length of bolts<br>Surface treatment<br>Joint geometry | 1 Static Test<br>Fatigue Tests<br>10 zero to tension | 1. Joint Efficiency<br>2. Stress distribution<br>3. Development of design<br>4. Procedure for fatigue of bolted connections<br>5. Computation of the slip coefficient |
| | | I beam splice |  | | Fatigue Tests<br>6 zero to tension | |
| | | II double lap splice |  | | 1 Static Test<br>Fatigue Tests<br>10 full reversal<br>10 zero to tension | |
| | | III butt butt splice |  | | 3 Static Tests<br>Fatigue Tests<br>10 full reversal<br>14 zero to tension | |
| | | IV angle lap splice |  | | 3 Static Tests<br>Fatigue Tests<br>12 full reversal<br>20 zero to tension | |
| | | V symmetric angle lap splice |  | | 3 Static Tests<br>Fatigue Tests<br>11 full reversal<br>15 zero to tension | |
| | | VI lap splice |  | | 1 Static Test<br>Fatigue Tests<br>19 full reversal<br>16 zero to tension | |
| 64-17 | A325 steel bolts<br>A354 steel bolts | Test jig |  | Bolt materials<br>Bolt head<br>Nut type<br>Washer<br>Bolt tension | Relaxation Tests<br>Nut Tests<br>28 tests 3/4" A325 bolt<br>11 tests 3/4" A354 bolt<br>Bolt Head Tests<br>12 tests 3/4" A325 bolt<br>Head Torque Tests<br>4 tests 3/4" A325 bolt<br>Lubrication Tests<br>2 tests 3/4" A325 bolt | |
| | | Butt splice |  | Joint size<br>Bolt diameter<br>Nut type<br>Washer<br>Stress range<br>Bolt tension | Fatigue Tests<br>0 to tension<br>19 tests 3/4" A325 bolt<br>1 test 1" A325 bolt<br>1 test 5/8" A325 bolt | 1. Computation of slip coefficient. |
| 64-18 | High-strength bolts | Eccentric lap splice |  | Connection pattern<br>Eccentricity | 13 tests | 1. Ultimate strength |

| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 64-20 | High-strength bolts & welds | Beam-to-column |  | Ratio of width to thickness of tube<br>Connection length to tube size<br>Material<br>Shape<br>Type fastener | 27 tests | |
| 64-22 | | Calibration tests |  | Plate thickness<br>Type steel<br>Plate width<br>Pitch of holes | 22 Static Tension Tests | 1. Development of mathematical model for stress-strain relationship elastic and inelastic. |
| | A325 bolts<br>A490 bolts<br>A141 steel rivets<br>A502GR2 rivets | Shear jig |  | Type steel<br>Type fastener<br>Diameter of fastener<br>Type testing device | | 1. Development of mathematical model for load-deformation. |
| 64-25 | 7/8" A141 rivets | |  | Pitch<br>Gage<br>Plate thickness<br>Edge thickness | 120 Fatigue Tests<br>4 Static Tests | |
| 64-26 | M16/10k | Butt splice |  | Specimen form<br>Material<br>Surface treatment | 12 Static Tension Tests<br>30 Fatigue Tests | 1. Computation of slip coefficient.<br>2. Influence of cycles on slip coefficient. |
| 64-27 | M16/10k | Butt splice |  | Surface treatment<br>Tightening moment<br>Prestressing force | 6 Fatigue Tests | 1. Computation of slip coefficient. |
| 64-29 | High-strength bolts | Double-strap-butt |  | Diameter of bolt<br>Number of bolts in line<br>Pitch<br>Plate material | 8 Joint Tests | 1. Stress distribution |
| 64-35 | 10k & 8G bolts | Butt splice |  | Surface preparation<br>Condition of mill scale<br>Type steel<br>Time | 156 Static Tension Tests | 1. Computation of slip coefficient |
| | | |  | Surface preparation<br>Type steel<br>Time<br>Plate width<br>Joint configuration<br>Bolt diameter | 216 Static Tension Tests | |

| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 65-1 | A325 bolts | Butt splice | No. varies  | Number of bolts in line<br>$A_n/A_s$ ratio | 4 Static Tension Tests | 1. Computation of slip coefficient<br>2. Computation of ultimate load<br>3. Determination of load partition |
| 65-3 | 7/8" A490 | |  | Bolt length | 9 Fatigue Tests | |
| 65-4 | 7/8" high-tension bolt | lap |  | Surface<br>Washer type<br>Number of bolts in line | 26 Tension Tests | 1. Slip factor |
| | | Double strap butt |  | | 13 Tension Tests | |
| 65-5 | | Tee stubs |  | Bolt diameter<br>Number of bolts<br>T-stub flange thickness<br>Filler thickness | 10 Static Tension Tests | |
| 65-8 | A490 bolts | Butt splice |  | $A_u/A_s$ ratio | 4 Static Tension Tests<br>7/8" A490 bolts | 1. Computation of slip coefficient<br>2. Computation of load partition and ultimate strength |
| | | | No. varies  | Number of bolts in line<br>$A_n/A_s$ ratio | 4 Static Tension Tests<br>7/8" A490 bolts | |
| | | | | | | |

## 6. AUTHOR INDEX


Badaliance, R., 65-13
Badir, M., 47-6
Bailey, J. C., 51-9, 52-7
Baker, A. R., 61-11
Ball, E. Y., 60-15, 61-19, 61-24, 61-29
Bangay, A. J., 59-8
Baron, F., 52-5, 52-23, 53-9, 53-10, 53-15, 54-1, 54-19, 55-2, 55-17
Baumgartner, T. C., 58-5
Beam, W. S., 54-17, 55-11
Beane, S. T., 58-2, 59-33, 59-59, 61-23
Becker, W. K., 51-3
Beede, M. C., 44-9
Beedle, L. S., 63-1, 63-12, 63-15, 64-21, 64-24, 65-9, 65-13, 68-18
Beelick, K. H., 64-50
Beer, N., 60-27, 64-27
Belford, B., 60-11
Belford, R. B., 59-35, 62-13
Bell, M. N., 55-41, 57-27
Bell, W. G., 57-37, 58-29, 59-55, 61-21
Bendigo, R. A., 59-29, 59-37, 60-2, 62-12
Berg, S., 55-27
Bergendoff, R. C., 53-5, 53-17
Berridge, P. S. A., 59-21, 60-33
Boiten, R. G., 47-3
Boomsma, M., 53-35
Bott, B. A., 65-13
Bouwan, L. P., 54-36, 60-19
Brace, A. W., 52-7
Brady, W. C., 53-18, 55-12
Brennecke, 43-4
Brody, I. H., 59-24
Brown, A. A., 52-11
Brown, W. C., 59-25
Bruckner, W. H., 44-9
Brueggeman, W. C., 36-1, 40-4, 42-1
Budiansky, B., 61-2
Butz, G. A., 64-45
Cannon, J. C., 59-17, 60-8
Carpentier, L., 64-31
Carter, J. W., 50-11, 51-14, 52-19, 54-21, 54-23, 55-1, 55-19
Cayci, M. A., 49-5, 50-20, 52-10
Ceradine, G., 49-3
Chapin, C. H., 35-2
Chauner, R. W., 57-17
Chang, F. K., 52-24, 53-11
Chang, W. N., 63-3, 63-8, 65-17
Charlton, T. M., 60-3
Chesson, E. Jr., 56-18, 56-19, 57-1, 57-33, 58-12, 58-29, 59-1, 59-3, 59-30, 59-38, 59-41, 59-52, 59-55, 59-56, 60-4, 61-7, 61-17, 61-20, 61-21, 62-3, 63-16, 63-17, 63-18, 64-5, 64-6, 64-8, 64-13, 64-17, 64-19, 64-25, 65-2, 65-3, 65-6, 65-15, 65-19, 65-20, 65-25
Chiang, K. C., 64-4
Chin, A. G., 54-20, 55-18
Christopher, R. J., 63-2, 64-21, 65-7
Chronis, N. P., 60-30
Chu, K., 50-19
Chu, T. V., 62-7
Cioth, N. S., 61-6
Clark, J. W., 64-43
Cod, J., 64-1
Committee on Design in Lightweight Structural Alloys, J. W. Clark, Chairman, 56-2, 56-3
Corrado, J. A., 65-13
Cowen, E. Y., 58-5
Cox, N. L., 50-7, 52-25, 52-26, 56-12
Cox, J. W., 52-18, 53-14
Creasy, L. R., 59-19
Crispell, C., 58-5
Crocker, S., 45-6
Cullimore, M. S. G., 59-16, 63-6, 64-9
Dassen, J. R., 63-9, 63-13, 64-15
Davey, J. S., 52-8
DeBack, J., 59-36, 60-19
Delaney, T. J., 51-10, 54-8
Demal, L., 55-33, 57-32, 64-35
Deming, G. M., 23-1
Denkhaus, N. G., 61-3
Deutscher Normenanschuss, 60-39
Deutscher Stahlbau-Verland, 57-34
Dewalt, W. J., 61-33
Diemer, C. P., 61-12, 62-14
Dineen, R. L., 61-7

Dlugosz, S. E., 62-2, 62-8
Dolan, T. J., 50-17
Dornan, A., 56-13
Dornen, K., 58-26
Douth, R. T., 61-37
Douty, R. T., 57-14, 61-18, 62-26, 63-7, 65-14
Doyle, D. V., 64-36
Drew, Y. P., 55-7
Drucker, D. C., 53-18, 55-12
Duberg, J. E., 44-9
Duffy, A. R., 56-10
Easton, Y. M., 57-9
Eaton, I. D., 51-4, 51-12, 54-4, 63-4
Ely, J. Y., 60-36
Engineering News Record, 53-1, 58-10, 60-1
Ernst, E., 54-10
Estes, E. R., Jr., 59-40, 60-16, 60-35
Fang, R. J., 64-20
Fasteners, 45-5, 51-5, 52-4, 53-3, 54-7, 60-13, 60-14, 60-18, 65-10
Faustino, N. L., 64-6, 65-19
Fesser, L. J., 57-18
Fefferman, R. L., 47-4
Feldhausen, G. J., Jr., 52-3
Fernlund, I., 61-32
Field, J. E., 58-7
Fincher, J. R., 57-12
Fisher, J. W., 62-2, 62-12, 63-1, 63-2, 63-12, 63-15, 63-19, 64-3, 64-7, 64-22, 64-23, 64-24, 65-1, 65-7, 65-8, 65-9, 65-16, 65-18, 65-20, 65-21, 65-28, 65-29
Fisher, W. A. P., 52-9
Flint, T. R., 55-3
Foreman, R. T., 58-13, 58-18, 60-40, 61-15
Frances, A. J., 55-15
Frankland, F. H., 46-1, 46-6
Fried, Bernard, 48-2
Frincke, M. H., 58-3
Fuller, T. R., 53-2, 54-13, 55-4, 55-38, 57-36, 58-28, 59-49
Gaedeke, K. P., 65-13
German Committee for Structural Steelwork, 59-11
Gerstung, H., 61-1
Gideon, D. N., 58-1
Gill, P. J., 59-18, 60-24, 62-5
Godfrey, G. B., 57-4, 59-10, 65-22
Goffi, L., 64-32
Goodier, J. N., 40-1
Gordon, S. A., 58-1
Grant, M., 59-26
Graves, Y. E., 60-17, 60-20, 64-42
Gregory, P., 59-8
Greiner, J. E., 97-1
Grinter, L. E., 48-3
Grover, H. J., 46-4, 53-12, 56-4, 57-8 58-1
Hall, J. R., 64-41
Hamm, B., 58-23
Hancke, A., 55-30
Hanna, J. C., 62-14
Hanneman, W. M., 61-13
Hansen, N. G., 59-58, 61-22
Hansen, R. M., 61-9, 61-14, 63-20
Hardin, B. O., 58-11
Hardrath, H. F., 57-11
Hartmann, E. C., 41-1, 41-2, 43-4, 44-2, 44-3, 44-5, 44-8, 45-1, 46-2, 48-7, 51-4, 54-4
Harvey, C. L., 50-8
Heap, W. J., 60-24
Hebrant, F., 55-33, 57-31, 57-32
Hechtman, R. A., 40-3, 47-8, 48-5, 49-4, 51-6, 54-20, 55-3, 55-18
Hempel, M., 38-1
Hendry, A. W., 47-7
Hermitte, G. L., 57-31
Herring, J. L., 58-6
Hetenyi, M., 43-3
Higgins, T. R., 51-7, 52-13, 52-16, 54-22 55-20, 59-22, 61-24, 61-29, 64-51
Hill, H. N., 45-4
Hill, H. O., 47-2
Hoglund, G. O., 44-3, 45-1
Hohaus, D., 62-22
Hojarczyk, S., 59-15
Holt, M., 45-2, 46-3, 50-1, 51-4, 51-12, 54-4, 57-3, 57-25, 64-34
Hood, A. C., 64-39
Hotchkiss, J. G., 62-11
Howard, D. M., 52-17
Howard, L. L., 54-18, 55-5
Howe, J. W., 61-36
Hoyer, H., 59-44, 59-45, 59-46, 61-31
Humphrey, K. D., 61-6
Hunt, E. M., 62-14
Hyler, W. S., 53-12, 56-4, 57-8, 58-1, 61-6
Illgner, K. H., 62-23, 64-47, 64-48, 64-49, 64-50
Ingenerf, W., 55-28

Institution of Structural Engineers, 57-10
Iron Age, 59-31
Irvan, W. G., 57-20
Jackson, L. R., 46-4
Jenkins, J. W., 58-6
Johnson, L. G., 59-17, 60-8, 64-14
Johnston, B., 40-3, 42-3, 52-24
Jones, J., 58-14
Jones, R., 61-11
Kaplan, S., 59-5
Kasinski, J., 59-15
Kasuha, R., 62-6
Kellermann, R., 55-29
Kelly, J. J., 48-1
Kenworthy, K. J., 54-1, 55-2
Kinney, J. W., 59-61, 61-30
Klein, H. -CH, 55-29
Kloppel, K., 64-16
Knoell, A. C., 62-3
Koepsell, P. L., 55-3
Komatsuhara, M., 61-38, 62-25
Konishi, I., 64-28
Korber, F., 38-1
Kovac, J. J., 49-2
Kreisle, L. F., 52-15
Krickenberger, C. F., Jr., 57-1
Kulak, G. L., 65-7
Kuzmanovic, B. O., 60-31
Lancaster, N., 59-14
Langdon, Howard H., 48-2
Langhaar, H. L., 47-4
Lappo, T., 50-12
LaRoy, H. E., 57-23
Larson, E. W., Jr., 52-5, 52-23, 53-9, 53-10, 53-15, 54-19, 55-2, 55-17
Laub, W. H., 54-2
Lathrop, R. P., 64-1
Leahey, T. F., 54-5, 54-13, 54-16, 55-4
Legate, A. C., 57-22
Lehman, F. G., 60-6
Lenzen, K. H., 49-7, 49-9, 50-16, 54-21, 55-19
Leon, E. V., 61-35
Levy, S., 42-2, 64-38
Lewis, E. M., 57-9, 60-32
Lewitt, C. W., 59-1, 59-3, 59-38, 59-53, 60-4, 63-16
Leybold, H. A., 61-8
Lind, H. H., 50-21, 60-10
Lindner, C. W., 49-11, 50-15
Lipson, C., 48-4
Loubser, R. S., 63-5
Louw, J. M., 57-30
Lu, Z. A., 57-2, 59-59, 61-23
Lyst, J. O., 44-5
Madison, R. B., 56-5, 59-59, 61-23
Maney, G. A., 44-1, 45-3, 46-5, 46-7, 46-8
Marcin, S. J., 60-5
Martin, H., 59-27
Mas, E., 64-35
Massard, J. M., 52-1, 58-4
Massonet, C., 57-31, 57-32
Mathison, W., 59-51
Mattheisen, R. B., 57-3
McCalley, J. C., 54-23, 55-1
McCammon, L. B., 49-11, 50-15
McClow, J. H., 50-17
McDonald, D., 58-4
McFarland, W. J., 56-7
McGuire, W., 61-37, 62-26, 63-7, 65-14
McMullen, A. C., 60-29
McPherson, A. E., 42-2
Merritt, F. S., 50-10
Michalos, J., 57-30
Milek, W. A., 64-42
Millard, E. H., 47-1
Miller, M. A., 44-3, 45-1, 48-7
Milliken, M. P., 50-2
Mitchell, W. D., 55-9
Mohler, K., 54-11, 58-22, 59-43, 62-15
Moisseiff, L. S., 44-8
Moore, H. E., 46-4,
Moore, R. L., 44-8, 45-4
Mordfin, L., 55-34, 57-22
Mount, E. H., 42-3
Munse, W. H., 49-6, 50-7, 50-20, 51-2, 51-3, 52-1, 52-2, 52-10, 52-16, 52-26, 53-2, 53-5, 54-5, 54-13, 54-15, 55-4, 55-11, 55-14, 55-16, 55-19, 55-39, 56-8, 56-11, 56-12, 56-18, 57-1, 57-16, 57-33, 57-36, 58-12, 58-28, 58-29, 59-1, 59-2, 59-4, 59-30, 59-32, 59-38, 59-41, 59-49, 59-55, 59-56, 60-4, 60-7, 61-4, 61-5, 61-7, 61-17, 61-20, 61-21, 61-27, 62-3, 63-16, 63-17, 63-18, 64-6, 64-17, 64-35, 65-2, 65-25
Musnitsky, W. D., 57-5
Naka, T., 64-30
Navy Department, 50-18
Nawrat, T., 59-15
Nelson, H. M., 53-13
Newmark, N. M., 52-12, 54-15, 55-14, 55-1

Nicholson, H. H., 54-16
Nielsen, D. A., 65-12
Nieth, F., 55-25, 55-26
Nitkin, I. H., 61-34
Nordmark, G. E., 64-2, 64-43, 64-45, 64-46
Nusbaum, G. W., 31-1, 35-1
Oliphiht, J. B., 52-15
Omiya, K., 61-38, 61-39, 62-25
Onderdonk, A. B., 64-1
Osterreichischer Stahlbauverband, 57-35
Ozell, A. M., 45-7
Pancoast, R. H., 47-5
Parola, J. F., 64-25, 65-25
Pauw, A., 55-5, 55-8
Penman, W. R., 61-19
Peterson, K. S., 56-8, 56-20, 57-36, 58-28, 59-49, 59-56, 61-17, 61-20
Pfungen, R., 57-28, 62-21
Phillips, J. R., 54-2
Pickel, W. F., 49-1, 49-8
Pinkel, R. H., 50-9
Papp, H. G., 56-4, 57-8, 58-1
Prynne, P., 59-50, 65-4
Quertier, J. R., 59-28
RCRBSJ, 49-10, 53-7
Radzimovsky, E., 62-6, 64-33
Ramberg, W., 42-2
Rampton, C. C., Jr., 56-21, 57-19
Ramseier, P. O., 63-12, 63-15
Randall, P. N., 48-9
Ranger, B. E. S., 59-13
Redshaw, S. C., 51-8
Richart, F. E., 48-8
Ringer, A. G., 54-9
Ritchie, J., 59-8
Roderick, J. W., 65-12
Romualdi, J. P., 60-23
Roop, F. C., 40-4
Ros, M., 49-3
Rosenfeld, S. G., 46-9
Rosenthal, D., 55-9
Ruble, E. J., 50-5, 50-13, 50-22, 51-11, 52-13 54-22, 55-6, 55-20, 58-17, 59-57, 61-10
Rumpf, J. L., 58-13, 58-18, 58-19, 59-37, 60-2, 60-21, 60-40, 61-14, 61-15, 62-12, 63-19, 63-20, 65-20
Rust, T. H., 40-2
Rybak, M., 62-18, 62-20
Salmon, C. G., 54-3
Sammet, J., 62-17
Sandberg, C. H., 55-36
Sanders, P. H., 60-33
Sanko, R. L., 56-9, 56-21, 57-19
Sattler, K., 60-25
Savikko, E. R., 54-20, 55-18
Schaar, K., 55-25
Schenker, L., 54-3
Schijve, J., 56-6
Schmid, W., 55-21, 55-22, 55-23, 56-14, 56-15, 57-29, 58-20, 58-21
Schultz, F. W., Jr., 50-7, 52-12, 52-20, 52-21, 59-48
Scott, M. B., 49-11, 50-15, 52-18, 55-40, 56-17
Seaquist, E. O., 31-1, 35-1
Seeger, T., 64-16
Sharp, W. H., 43-1
Sherbourne, A. N., 61-10
Sheridan, M. L., 64-40
Shermer, C. L., 64-18
Sinnamon, G. K., 51-3, 52-1
Sippell, K. W., 55-24, 55-27
Skwirblies, H., 59-45, 62-18
Smith, A. M., 60-12
Smith, C. R., 59-47
Smith, F. C., 52-17
Societe de la Tour Eiffel, 59-6
Sommer, A. A., 57-7
Sopwith, D. G., 48-6
Sossenheimer, H., 53-6, 53-31
Spooner, L. A., 59-17, 60-8
Stafford, R. W., 59-3
Stahlbau, 56-22
Stahlbau-Verlags-GmbH, 58-27
Stallmeyer, J. E., 53-19
Stang, A. H., 51-13
Steel, 57-21
Steinhardt, O., 54-11, 55-32, 58-25, 59-9 59-43, 60-26, 60-28, 62-15
Sterling, G. H., 64-7, 64-23, 65-1, 65-8, 65-21, 65-29
Stetina, H. J., 58-15
Stevin Laboratory, 65-23, 65-24
Stewart, W. C., 44-7, 50-6, 52-14, 54-14, 55-13
Stroup, P. T., 48-7
Tada, H., 64-30
Tadada, S., 65-5
Tajima, J., 61-38, 61-39, 62-4, 62-25, 63-11, 64-11, 64-12, 64-29
Task Committee on Lightweight Alloys, J. W. Clark, Chairman, 62-24

Tate, M. B., 46-9
Taylor, J. C., 60-9
Templin, R. L., 41-2, 54-12
Thrasher, J. Q., 57-13
Thurlimann, B., 57-26, 60-34
Toint, E., 59-42
Tokunaga, A., 65-5
Tomonaga, K., 63-11, 64-29
Treanor, H. E., 57-23
Trittler, G., 56-13
Troup, E. W. J., 64-5, 65-21
Upton, K. A., 64-9, 64-44
Vasarhelyi, D. D., 56-5, 57-2, 57-15, 57-17, 58-2, 59-33, 59-59, 60-9, 61-23, 63-3, 63-8, 64-4, 65-17
Vasishth, C., 57-2, 57-15, 59-59, 60-9, 60-22, 61-23
Viglione, J., 57-6, 65-11
Viner, J. A., 61-7
Vogt, F., 47-9
Wallaert, J. J., 64-23, 65-16, 65-29
Wallner, H., 64-27
Waltermire, W. G., 58-16, 62-1
Watson, I., 64-10
Weber, N. E., 62-9
Wescoat, C. F., 43-4, 44-2
Whaley, R. E., 57-11
White, M. W., 57-26
White, R. N., 64-20
Whitmore, R. E., 52-6
Whittemore, H. L., 31-1, 35-1
Wiedemann, J., 62-16
Wiegand, H., 55-25, 62-23, 64-49, 64-50
Williams, W. L., 58-6
Wilson, W. M., 44-6, 44-9, 45-7, 46-4, 49-6, 50-20, 51-1
Wilson, W. R., 55-37
Winter, G., 56-1, 56-16
Wolf, W., 58-24, 59-23
Wright, D. T., 51-2, 52-2, 52-22, 54-15, 55-14, 55-16, 57-9, 60-32
Wright, W., 63-10
Wu, T. W., 61-2
Wyly, L. T., 49-11, 50-4, 50-11, 50-15, 54-21, 54-23, 55-1, 55-19, 55-46, 56-17, 57-23, 57-24
Yamada, M., 63-14
Yeun, C. Y., 60-9
Yeakel, W. R., 62-10
Yoshimoto, S., 65-5
Young, D. R., 51-6, 54-20, 55-18
Young, W. C., 59-7
Yura, J. A., 65-13
Zamboky, A. N., 44-4, 46-2
Zar, M., 58-9, 61-26
Zardman, F., 59-47
Ziemba, St., 62-20
Zweig, B. A., 61-25

# 7. SUBJECT INDEX


A

AISC Specifications, 62-11, 64-20
Alloy Steel Bolts, 46-9, 59-27, 65-7
Aluminum Alloy
Joints, 44-3, 44-8, 45-1, 46-2, 48-7, 52-6, 53-4, 54-4, 55-34, 57-8, 57-22, 59-16, 64-24, 64-37, 64-46
Material, 50-2, 53-1, 56-2, 56-3, 62-24, 64-2, 64-45
Plates, 42-3, 46-9, 61-31, 64-45
Rivets, 44-2, 45-2, 51-9, 52-7, 54-8
Aluminum Butt Joints, 57-8, 59-16
Aluminum Highway Bridges, 51-10, 62-24
Aluminum Riveted Joints, 40-4, 44-2, 44-8, 45-1, 45-4, 51-8, 52-7, 55-34, 61-8
Analogous Grid, 48-3
Analysis
Bolted Plate Splices, 64-3, 61-32
Columns, 57-26
Assembly Clearance, 62-6
Assembly of Joints, 54-7, 59-11
ASTM, 60-16, 64-13
Axial Load, 53-4, 60-21

B

Bakelite Joints, 52-6
Balanced Design
Bolted Joints, 54-2, 55-14, 55-15, 63-1
Riveted Joints, 58-12
Beam-to-Column Joints, 40-3, 42-3, 47-8, 54-3, 58-4, 59-13, 59-14, 61-10, 61-21, 63-7, 63-14, 64-20, 64-21, 65-12
Bearing of Rivets, 55-19
Bearing Pressure, 51-3, 52-1, 53-5, 53-7, 57-24, 58-14, 59-1, 59-32, 60-35, 64-25
Bearing Ratio, 51-3, 52-1, 58-14, 59-1, 59-32, 64-25
Bearing Strength, 59-34, 62-15
Bearing Stresses, 59-4, 62-7
Bearing-Tension Ratio, 59-1
Bending Stresses of Bolts, 62-6
Beryllium Bolts, 60-30
Bolt
Assembly, 49-1, 61-27, 62-6
Calibration, 59-29, 59-37, 62-2
Characteristics, 23-1, 51-7, 52-8, 58-23, 62-23, 63-4, 63-6, 64-39, 65-2
Clearance, 54-4, 62-19
Diameter, 63-2
Fit, 46-4
Holes, 50-11, 61-32, 64-9
High Strength (see high strength bolts)
Load, 35-1, 46-9, 59-18, 59-38, 61-3
Load-Elongation Curves, 50-9, 62-17
Material, 35-1, 46-6, 63-6
Preload, 49-2, 52-8, 53-16, 59-18, 60-28, 61-11, 65-24
Proof Load, 60-13, 64-15
Properties, 50-8, 60-19, 62-23
Shear Area, 60-2, 61-14, 61-15
Shear Strength, 47-5, 60-30, 61-14
Shear Test, 57-18
Stresses, 43-3, 50-2
Tensile Stress, 59-31
Tension, 46-8, 48-3, 50-17, 51-6, 52-2, 55-8, 55-14, 56-9, 57-1, 57-27, 58-6, 58-19, 60-13, 60-19, 60-34, 61-18, 61-24, 62-2, 62-3, 63-7, 64-5, 64-23, 64-38, 65-1
Tightening, 50-2, 59-41, 61-13, 61-24, 61-25, 61-27, 61-28, 62-13
Bolted Joint Efficiency, 56-8
Bolted Joint Strength, 59-31, 60-29
Bolted Joints, 49-4, 50-3, 50-4, 50-5, 50-17, 51-7, 52-8, 52-14, 53-1, 54-5, 55-1, 55-10, 55-11, 55-14, 55-15, 55-16, 55-17, 55-21, 56-1, 56-5, 56-7, 56-8, 56-10, 56-13, 57-2, 57-9, 57-15, 57-17, 57-21, 57-24, 58-2, 58-4, 58-7, 58-13, 58-18, 58-20, 58-22, 58-24, 58-25, 59-9, 59-11, 59-12, 59-30, 59-33, 59-40, 59-41, 59-48, 59-50, 59-51, 60-3, 60-5, 60-7, 60-16, 60-21, 60-22, 60-24, 60-25, 60-26, 60-28, 60-29, 60-33,

60-34, 61-4, 61-5, 61-9, 61-14, 61-17, 61-18, 61-23, 61-30, 61-31, 61-32, 62-4, 62-7, 62-15, 62-16, 62-17, 62-19, 62-21, 62-23, 62-25, 62-26, 63-1, 63-5, 63-6, 63-8, 63-11, 63-13, 63-14, 64-1, 64-8, 64-9, 64-11, 64-12, 64-14, 64-15, 64-16, 64-17, 64-19, 64-20, 64-21, [illegible], 64-22, 64-23, 64-24, 64-26, 64-28, 64-29, 64-32, 64-33, 64-35, 64-36, 64-37, 64-38, 65-1, 65-5, 65-6, 65-7, 65-8, 65-10, 65-23
Bolted Plate Strength, 64-3
Bolting, 45-6, 54-9, 62-13
   Cost, 55-7, 58-10
   Economy, 52-4
   Specifications, 45-6, 58-20, 63-5
   vs. Riveting, 54-6, 60-17, 64-13
Bridge Construction, 57-4, 57-25, 60-33, 64-28
Bridge Hangers, 50-4, 50-14, 52-18
British Standard Specifications, 57-9
Brittle Failure, 55-3
Butt Joints, 46-9, 47-3, 53-15, 55-14, 55-17, 58-13, 59-7, 59-16, 60-2, 60-28, 61-14, 61-15, 62-4, 62-8, 63-1, 63-8, 64-4, 65-1

C

Calibrated Impact Wrench, 55-5, 59-22, 60-13, 60-18, 61-29
Calibration
   Heavy Head Bolts, 62-2
   High Strength Bolts, 51-2, 59-37, 63-2, 64-5, 64-30, 65-7
Clamping Force, 44-1, 45-3, 46-6, 50-4, 50-11, 50-16, 51-7, 53-8, 53-15, 55-5, 55-8, 55-17, 56-10, 57-2, 57-8, 57-17, 57-23, 57-24, 57-32, 59-1, 59-2, 59-31, 60-4, 60-22, 60-24, 60-28, 61-22, 61-23, 61-27, 62-3, 62-7, 62-14, 64-7, 64-17
Clamping Stresses, 53-9, 62-1
Cleavage, 63-3
Cold Driven Rivets, 46-6, 50-5, 51-9
Cold Riveting, 46-1, 46-6, 50-5, 51-9, [illegible], 51-10, 53-15, 54-8, 62-14
   Advantages, 45-5, 47-1
   Disadvantages, 47-1
Column Anchorages, 54-3
Column Base Joint, 58-4
Column Stiffeners, 61-10
Columns
   Axially Loaded, 57-26
   Eccentrically Loaded, 57-26
   Strength, 57-26
Combined Shear and Tension Strength
   Bolts, 59-3, 62-11, 64-6, 64-23, 64-31, 65-2
   Rivets, 56-12, 62-11
Combined Stress, 52-16, 53-17
Compact Bolted Joints, 61-15, 63-1
Compression Test, 55-18, 58-14, 58-19, 59-32
Construction, 51-5, 62-11
   Building, 55-20
   High Strength Bolted, 54-10, 55-22, 60-26, 62-10, 65-10
   Welded, 62-10
Contact Surface Treatment, 59-11, 59-36
Continuous Frame Joints, 54-3
Cost
   Bolts vs. Rivets, 59-19, 60-35, 61-12
   Fasteners, 58-15, 60-20
   Installing High Strength Bolts, 37-25, 52-13
Cover Plates, 57-26
Creep, 57-22, 58-6, 65-24
Critical Buckling Load for Plate Girder, 60-9
Cumulative Fatigue Damage, 59-49

D

Deflection-Rotation Characteristics, 61-21
Deformation
   of Fasteners, 61-21
   of Joints, 59-7, 60-26
   of Rivets, 56-12
   of Bolt Threads, 40-1
Design
   Aluminum Riveted Joints, 51-8, 56-2, 62-24
   Bolted Joints, 54-10, 58-24, 59-11 59-19, 59-50, 60-16, 60-27, 60-32, [illegible]

62-25, 63-1, 63-6, 64-18, 64-33, 64-39, 65-9, 65-22
Bolts, 46-6, 48-1, 48-4, 53-3, 64-10, 65-11
British High Strength Joints, 59-10
Columns, 57-26
Fasteners, 48-1, 58-15
Flexible Flange Joint, 57-14
Joints, 53-7, 54-3, 55-5
Light Alloy Structures, 47-9, 56-3
Moment Joint, 57-12, 59-48, 62-26 64-11
Non-Slip Bolted Joints, 59-11
Riveted Joints, 47-8, 50-1, 59-35, 64-18, 64-34
Rivets, 46-6, 60-23, 61-9, 62-24
Tension Members, 59-30
Web Splices, 50-12
Direct Tensile Strength, 64-7
Direct Tension Calibration, 59-29, 62-2, 63-2
Direct Tension Test of Bolts, 54-5, 59-37, 61-7, 61-22, 64-7
Distortion Energy Theory, 57-18
Distribution of Load in Gusset Plates, 59-30
Double Coverplated Butt Joint, 59-16
Double Lap Joints, 49-4, 51-6, 55-3, 55-18, 55-19, 56-5, 57-16, 57-17, 58-18, 59-12, 59-15, 59-33, 60-24, 61-22, 61-23, 63-3
Double Lap Shear Joints, 64-17
Double Lap Tension Joints, 60-5, 61-11, 63-3, 64-3
Double Scarf Joints, 54-4
Double Shear Joints, 54-4, 62-12
Double Shear Strength of Bolts, 59-5
Double Shear Test, 59-5, 59-34, 60-35
Double Strap Butt Joints, 51-3, 52-10, 52-12, 53-12, 54-2, 56-10, 59-59
Dynamic Loading, 51-7, 59-12, 60-26

E

Eccentric Static Load, 53-4, 50-17
Economic Factors
Bolts, 53-3, 60-35
Fasteners, 58-15, 60-20
Joints, 52-3, 54-6
Effect of Holes, 55-12
Effective Area, 51-2, 59-30
Efficiencies
Bolt, 49-2
Bolted Joints, 54-2
Drilled Member, 58-12
Joint, 52-10, 52-12, 53-1, 53-9, 61-11, 61-17, 61-23, 63-3, 63-8
Plate, 53-15
Punched Member, 58-12
Riveted Joints, 52-12, 55-2
Test, 51-3, 52-10, 55-4, 57-2, 58-12, 59-30, 59-32
Eiffel Tower, 59-6
Elastic Constants, 55-9
Elastic Proof Load, 48-1, 55-14
Elongation of Bolts, 63-8, 64-5
End Plate Joint, 63-7, 64-1
End Plate Stiffeners, 61-10
Endurance Limit of Bolted Joints, 62-7
Extensometer, 50-9

F

Fabrication, 51-1, 57-25, 58-24, 60-1, 60-17, 60-18
Fabrication Techniques, 61-23
Fastener
Bearing, 50-11
Behavior in Joint, 56-8, 59-2, 62-1
Cost Comparison, 58-10, 60-20
Deformation, 61-21
Diameter, 64-3
Material, 54-2
Misalignment, 59-33
Pattern, 52-12
Review, 59-35, 62-23, 63-5, 65-6
Tension, 52-12, 54-2
Use, 51-5, 59-35, 60-20
Fatigue Behavior, 56-4
Fatigue Cracks, 54-4, 57-11
Fatigue Failure, 46-3, 55-3, 57-24
Bolts, 38-1, 52-9, 58-8
Fatigue Life
Bolts, 53-16, 54-5, 60-4
Double Strap Butt Joint, 59-49

Joints, 44-5, 50-16, 51-12, 54-4, 55-2, 59-1, 62-3, 64-17
Plate, 59-49
Plate Material Around Rivets, 51-12 58-1, 59-47
Fatigue Load, 55-17, 56-11, 57-16, 59-3
Fatigue Strength
Aluminum Alloy Joints, 41-1, 41-2, 50-1, 51-2, 54-4, 57-8, 64-2
Bolted Joints, 46-4, 50-7, 50-16, 53-7, 53-15, 54-5, 55-19, 57-21, 58-16, 60-4, 60-26, 61-22, 64-25
Bolted vs. riveted joints, 53-6, 55-11, 55-14, 55-16, 55-17, 62-4, 62-25, 64-28
Bolts, 43-2, 53-3, 53-12, 57-6, 60-30, 61-4, 63-4, 65-11
Fasteners, 62-11
Gusseted Joints, 48-2
Hangers, 50-4
Lugs, 56-6
Plates, 59-2
Riveted Joints, 44-5, 51-2, 52-5, 53-7, 53-9, 53-15, 54-1, 54-5, 55-2, 55-19, 56-6, 59-1, 61-22, 64-25
Steels, 53-10
Structural Joints, 49-4, 50-5, 50-16, 55-1, 56-17, 62-7
Fatigue Test
Aluminum Bolted Joints, 41-1, 54-4, 57-3, 64-46
Bolted Joints, 50-4, 50-16, 55-14, 55-17, 56-11, 57-29, 58-20, 60-27, 61-5, 61-22, 62-3, 62-15, 63-11, 64-16, 64-17, 64-28, 64-32, 64-37, 65-3
Riveted Joints, 45-2, 50-1, 52-17, 57-3, 57-29, 58-1, 61-22, 64-25
Structural Joints, 53-7, 53-15, 54-5, 55-2, 55-11, 59-49
Fatigue Testing Machine, 46-5, 59-49
Faying Surface, 44-7, 51-6, 52-2, 53-3, 55-18, 56-5, 57-4, 57-8, 57-15, 57-17, 57-19, 58-2, 58-19, 59-5, 59-8, 59-9, 59-12, 59-15, 59-16, 59-17, 59-33, 59-36, 60-2, 60-24, 61-5, 61-14, 61-23, 61-32, 62-12, 62-23, 63-9, 63-12, 64-4, 64-11, 64-14, 64-23, 64-26, 64-29, 64-32
Field Erecting, 61-12
Fillet Welds, 58-15
Finishes, 61-13
Fitting Up Bolts, 61-26, 61-28, 61-29
Flange, 57-14, 61-18, 64-38
Joints, 45-6, 57-14, 64-10, 64-38
Rivets, 50-12
Flanges Nuts, 59-2
Flat Plates, 59-2
Flexural Deformation, 62-6
Floor Beam Hangers, 50-15, 53-14
Fretting Corrosion, 57-8
Friction, 52-11, 55-5, 56-5, 56-10, 57-2, 57-4, 57-23, 57-15, 57-17, 58-2, 58-13, 59-9, 59-15, 59-16, 59-17, 59-41, 59-50, 60-8, 60-22, 60-24, 60-25, 60-27, 61-1, 61-5, 61-14, 61-15, 61-23, 62-12, 62-16, 62-17, 62-22, 62-23, 63-3, 63-9, 63-11, 63-12, 63-13, 64-4, 64-11, 64-12, 64-23, 64-26, 64-35, 64-37, 65-1, 65-4, 65-9, 65-12, 65-23
Friction Grip Joints, 57-9, 59-12, 60-33, 61-3, 63-5, 63-6, 64-14, 65-4
Friction Type Joints, 58-18
Frictional Characteristics of Surface, 57-19, 64-4


G


Gages, 56-9
Galvanized Bolts, 47-2, 60-19, 64-39
Girders
Bolted, 53-11
Riveted, 53-11, 60-9
Web Splices, 50-12
Welded, 53-11

Grip Length, 52-15, 52-16, 53-7, 55-17, 59-1, 59-37, 62-2, 63-2
Gullander Method, 55-18
Gusset Plates, 40-2, 50-15, 52-6, 55-12, 57-20, 58-12, 59-30, 60-6
Gusseted Joints, 48-2, 48-3, 57-30, 58-11

H

Half-Torque-Half Turn Technique, 57-9, 57-10, 60-8
Half-Turn Method, 61-27, 62-2
Hand Torque Wrench, 59-41
Heat Treatment of Bolts, 50-8
Heavy Head Bolts, 62-10
Hexagonal Nuts (see Nuts)
High Strength Bearing Bolt, 58-16
High Strength Bolting, 52-4, 60-10, 62-13 63-5
High Strength Bolts, 48-4, 49-4, 50-4, 50-5, 50-16, 51-1, 51-5, 51-13, 52-13, 53-3, 53-8, 54-7, 55-3, 55-4, 55-7, 55-8, 55-11, 55-13, 55-14, 55-17, 55-18, 55-21, 56-5, 56-7, 56-9, 56-10, 56-11, 56-16, 57-1, 57-2, 57-12, 57-15, 57-16, 57-18, 57-23, 57-25, 57-27, 58-2, 58-16, 58-18, 58-26, 59-7, 59-13, 59-15, 59-17, 59-19, 59-23, 59-24, 59-25, 59-26, 59-27, 59-29, 59-33, 59-37, 59-38, 59-40, 59-50, 60-1, 60-4, 60-11, 60-13, 60-15, 60-18, 60-25, 60-26, 60-32, 60-34, 61-7, 61-9, 61-10, 61-11, 61-13, 61-14, 61-15, 61-17, 61-18, 61-21, 61-22, 61-24, 61-26, 61-28, 61-31, 62-9, 62-11, 62-12, 62-13, 62-15, 62-17, 62-19, 62-20, 62-21, 62-26, 63-1, 63-3, 64-11, 64-16, 64-23, 64-24, 64-26, 64-28, 64-29, 64-30, 65-1, 65-4, 65-5, 65-6, 65-7, 65-8, 65-10, 65-11, 65-12, 65-22, 65-23, 65-24
  A325, 58-13, 59-22, 59-40, 60-2, 60-4, 60-7, 60-16, 61-6, 63-7, 63-12, 64-3, 64-4, 64-6, 64-22, 65-3, 65-7
  A490, 64-5, 64-6, 64-7, 64-17, 64-22, 65-3, 65-7, 65-8
  Advantages, 51-1, 53-3, 56-16, 57-7, 60-1
  Advantages over Other Fasteners, 59-19, 59-23
  Advantages over Rivets, 51-7, 52-14, 57-13, 57-28, 57-31, 57-32, 58-9, 58-19, 58-21, 64-13, 64-28
  Combined Shear and Tension, 57-32, 59-3
  Concepts, 55-5
  Cost, 58-10, 58-15, 64-13
  Double Shear Test, 59-5
  Low Carbon Steel, 46-8
  Overstressed, 53-2
  Properties, 50-6, 52-12, 53-16, 64-13
  Shear Resistance, 58-19
  Specifications, (see Specification)
  Ultimate Strength, (see Ultimate Strength)
  Uses, 50-6, 53-3, 55-20, 59-22, 59-40, 60-35
High Strength Friction Grip Bolts, 59-14, 59-20, 62-5, 64-27, 64-31, 65-12, 65-22
High Strength Heavy Head Bolts, 60-11
High Strength Hexagon Head Bolts, 59-7, 62-13
High Strength Steel Joints, 57-23, 62-4
Highway Bridges in Germany, 59-23
History
  Eiffel Tower, 59-6
  High Strength Bolts, 55-13, 57-27, 59-10, 59-22, 59-23, 59-35
  High Strength Bolts in Joints, 61-24
  High Strength Friction Grip Bolts, 59-14
  RCRBSJ, (see RCRBSJ)
  Use of Rivets and Bolts, 57-13, 64-13
Hook Knurl Bolts, 57-16
Hot Riveting, 50-5, 52-15, 55-4, 59-1
Huck Bolt, 53-12, 56-4, 57-8, 61-4,

61-6, 65-2, 65-6
Hydraulic Calibrator, 64-7

I

I Section Joint, 55-4
Impact Loading, 59-3, 59-39
Impact Wrenching, 48-3, 52-13, 54-9, 57-10, 59-22, 59-27
Initial Bolt Tension, 56-11
Inspection of Bolted Joints, 50-3, 51-11, 54-6, 54-7, 55-10, 61-30, 62-5, 62-9
Installation of High Strength Bolts, 50-3, 52-13, 55-5, 55-6, 55-8, 57-25, 59-24, 59-26, 59-28, 59-37, 60-12, 60-19, 60-33, 61-24, 61-25, 61-26, 61-27, 61-28, 61-29, 61-30, 62-19, 63-5, 63-6
Installing Fasteners, 58-15, 59-35
Instructions for Tightening Bolts, 61-24, 61-28
Instrumentation, 45-3, 64-8
Interference-Body Bolts, 60-12
Interference Fit, 56-4, 57-4, 59-7

J

Joint Assembly, 60-13
Joint Efficiency, 54-1, 56-5, 56-8, 61-17, 63-3
Joint Length, 60-2, 61-14, 62-8, 62-12, 63-12, 64-3
Joint Life, 46-4
Joint Modulus, 55-9
Joint Slippage (see Slippage)
Joint Strength, 55-15, 64-10
Joints (see specific types of joints, (lap joints, butt joints))

L

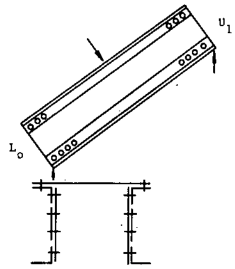
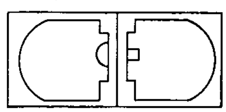
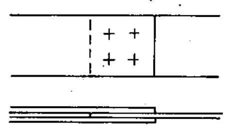
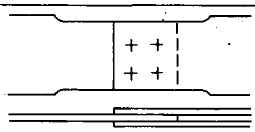
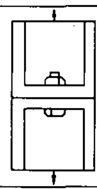
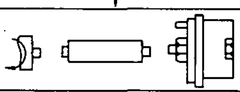
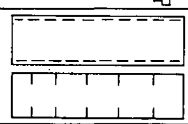
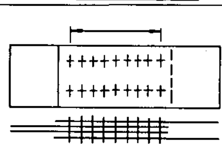
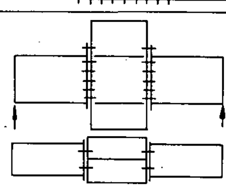
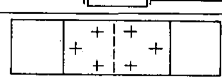
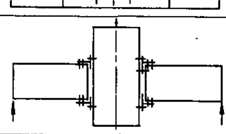
Lap Joints, 46-4, 50-7, 50-11, 51-6, 52-2, 62-4, 63-10, 64-16
    Aluminum, 55-34, 57-8
    Bolted, 53-1, 55-14, 55-19, 57-29, 59-7, 62-12
    Riveted, 49-3, 52-10, 53-1, 55-19, 57-29
Limit Design, 55-12
Load Cells, 56-9
Load Deformation, 54-3
Load Distribution, 48-6, 55-9, 56-10, 60-5, 60-21, 61-23, 64-3
    Bolts, 46-9
    Joints, 53-4
    Rivets, 47-9, 51-8
Load Elongation Characteristics, 52-15, 59-41
Load Slip Characteristics, 59-15, 59-50
Long Bolted Joints, 60-2, 63-1, 63-10, 65-1, 65-9
Lugs, 56-6

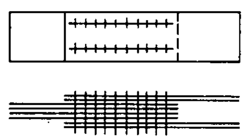
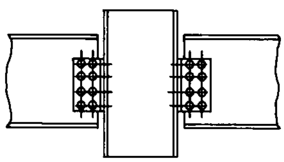
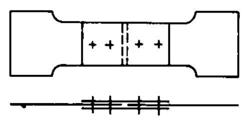
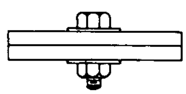
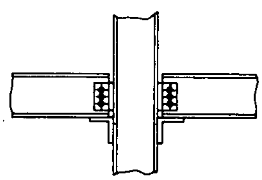
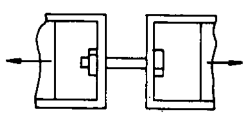
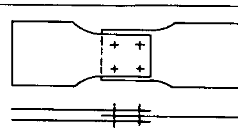
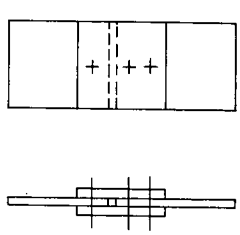
M

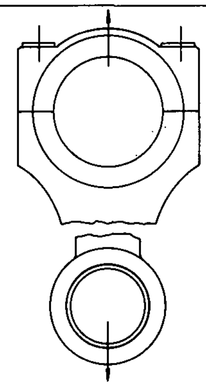
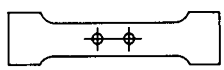
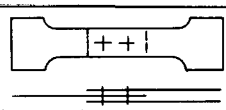
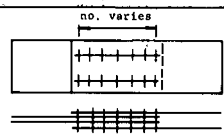
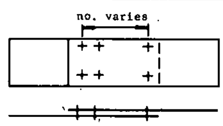
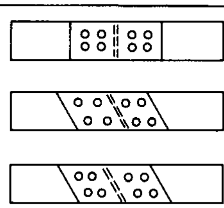
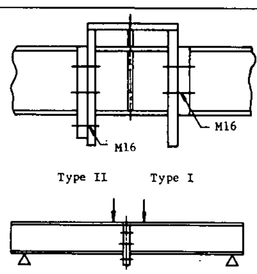
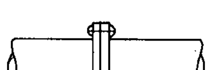
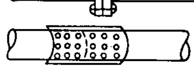
Mackinac Bridge Project, 61-30
Magnesium, 50-2
Manual Torque Wrench, 55-5, 55-6
Masonite Joint, 52-6
Metals
    Aluminum, 59-15
    Chrome Nickel Steel, 59-15
    Zinc, 59-15
Minimum Bolt Tension Method, 57-2
Misalignment
    of Fasteners, 63-3
    of Holes, 59-33, 61-23, 63-8
Moment Joint, 59-13, 59-48, 60-16, 63-7
Moment-to-Shear Ratio, 61-21
Monoblock Specimens, 56-4

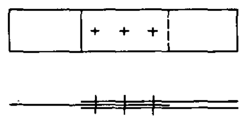
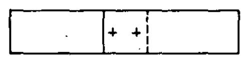
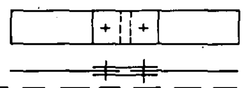
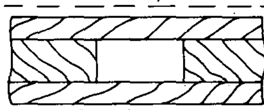
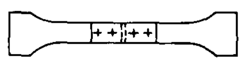
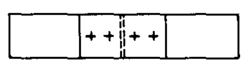
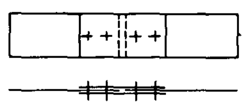
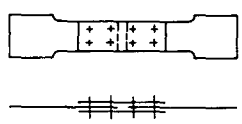
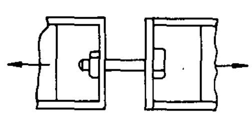
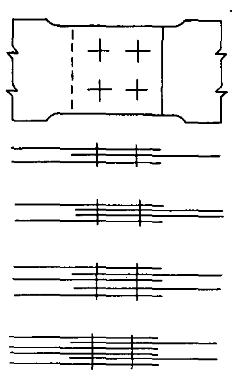
N

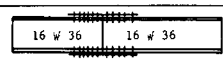
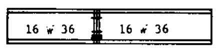
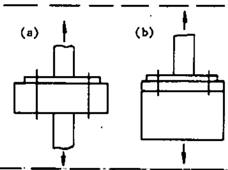
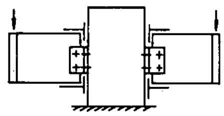
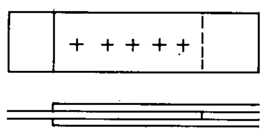
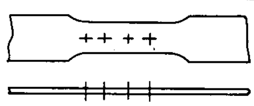
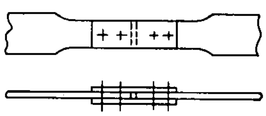
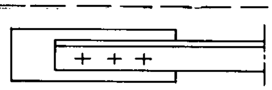
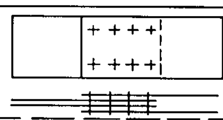
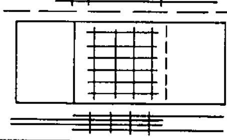
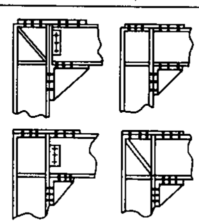
Net Area, 55-12, 60-2, 61-15, 61-20
Net Tension Stress, 58-14
Non-Slip Joints, 59-11
Nut Assemblies, 49-1

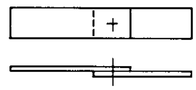
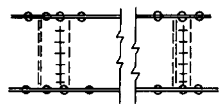
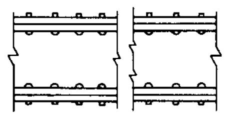
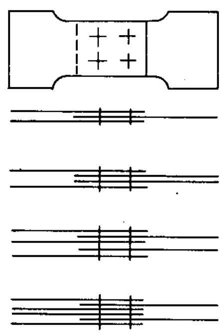
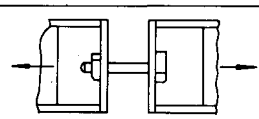
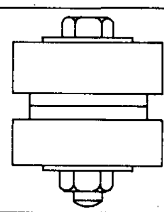
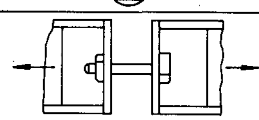
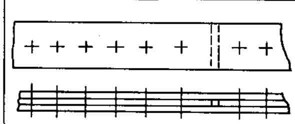
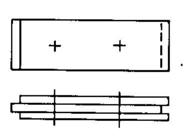
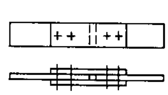
| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLE | TESTS | ANALYSIS |
| 60-36 | A141 steel rivets | Built-up Chord $L_oU_1$ |  | Bend parameters | Static Tension Tests<br>3 tests of end post in truss | 1. Computation of ultimate load. |
| 61-4 | 3/4" & 5/8" Huckbolt fasteners | Test jig |  | Diameter of bolt<br>Type of bolt | 27 Direct Tension-Fatigue Tests | |
| | 7/8" Huck-bolt | Butt splice |  | | 3 Fatigue Tests | |
| 61-5 | 7/8" A325 | Butt splice |  | | 1 Static Tension Tests<br>2 Fatigue Tests | 1. Slip coefficient |
| 61-7 | A325 steel bolts | Test jigs |  | Nut size<br>Nut type<br>Loading method<br>Lubrication | Tensile Tests<br>Nut Striping Tests<br>26 tests heavy nuts<br>27 tests finished thick nuts<br>Ultimate Load Tests<br>10 tests 3/4" bolts<br>6 tests 7/8" bolts<br>8 tests 1" bolts | |
| | | |  | | Torqued Tension Tests<br>216 tests 3/4" bolts<br>144 tests 7/8" bolts<br>216 tests 1" bolts | |
| 61-8 | Rivets | Box beam |  | Integrally stiffened or riveted stringers<br>Or riveted & bonded stringers | 3 Static Bending Tests | 1. Predicted statis strength. |
| 61-9 | A141 steel rivets<br>A325 steel bolts | Butt splice |  | Joint size<br>Plate thickness<br>Pitch<br>Number of fasteners in line<br>Tension-shear ratio<br>Fastener type | Static Tension Tests<br>5 tests 7/8" bolt<br>2 tests 7/8" rivet | 1. Computation of theoretical ultimate load.<br>2. Computation of unbuttoning factor<br>3. Determination of the load partition at ultimate. |
| 61-10 | A325 steel bolts | Beam-to-column |  | Bolt diameter<br>Number of bolts<br>End plate thickness<br>Column stiffener thickness | Static Tests<br>3 tests 3/4" bolt<br>2 tests 7/8" bolt | 1. Computation of load capacity of column web stiffeners.<br>2. Computation of plastic moment. |
| 61-11 | B.S. 1083 bolts | Butt splice |  | Joint size<br>Bolt diameter<br>Bolt tension<br>Number of bolts | Static Tension Tests<br>4 tests 5/8" bolt | 1. Computation of slip coefficient. |
| | | Beam-to-column |  | Number of bolts<br>Load range<br>Bolt tension | Cyclic Load Tests<br>3 tests 3/4" bolt | |

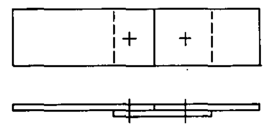
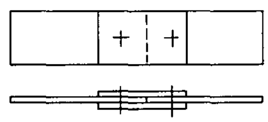
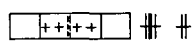
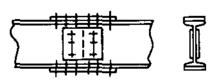
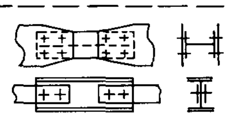
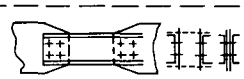
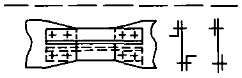
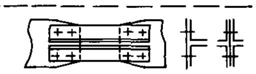
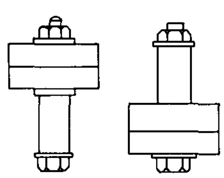
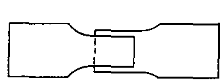
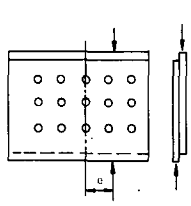
| REF | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 61-14 | A325 steel bolts | Butt splice |  | Joint size<br>Number of bolts in line | Static Tension Tests<br>4 tests 7/8" bolt | 1. Computation of slip coefficient.<br>2. Computation of unbuttoning factor. |
| 61-21 | A141 rivet<br>A325 bolt | Beam-to-column |  | Moment-shear ratio | Static Tests<br>3/4" rivets connecting beam web and<br>3/4" A325 bolts connecting column flange<br>Static Tests<br>1 test 3/4" rivets | 1. Computation of moment-resisting capacity. |
| 61-31 | M16/10k | Butt splice |  | Material<br>Surface treatment<br>Plate thickness<br>Plate width | 20 Static Tests | 1. Computation of the slip coefficient. |
| | M16/M20 | Test jig |  | Bolt diameter<br>Bolt length<br>Time | 50 Creep and Corrosion Tests | |
| 61-36 | 3/4" high tensile steel bolts | Beam-to-column (seat angle) |  | Type of seat angle | Static Moment Tests<br>7 tests no seat angle<br>7 tests 6 x 4 x 3/8L<br>7 tests 6 x 4 x 3/8L with 1/4" ℄ stiffener<br>7 tests 6 x 4 x 3/4L | 1. Moment-relation relationships.<br>2. Computation of coefficient of friction. |
| 62-2 | A325 steel bolts | Test jig |  | Grip length<br>Thread length<br>Length under head<br>Loading conditon | Direct Tension Tests<br>32 tests 7/8" bolt<br>Torqued Tension Tests<br>24 tests 7/8" bolt | |
| 62-3 | A325 bolt | Butt splice |  | Hole diameter<br>Bolt diameter<br>Tension-shear ratio<br>Load range | Fatigue Tests<br>11 tests 3/4" bolt<br>1 test 5/8" bolt | 1. Computation of slip coefficient. |
| 62-5 | 3/4"UNC x 4" | Butt splice |  | Bolt pattern<br>Number of bolts in line<br>Diameter of hole | 17 Static Tension Tests | 1. Slip load |

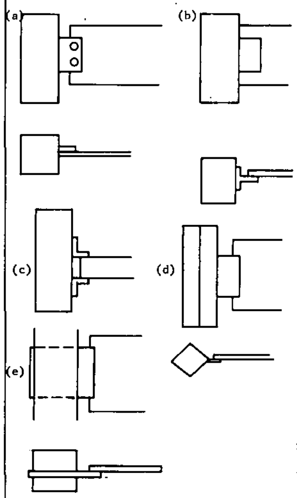
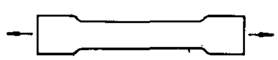
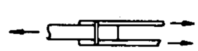
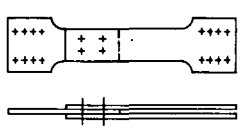
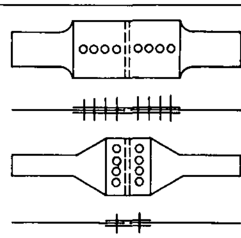
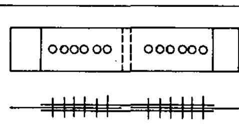
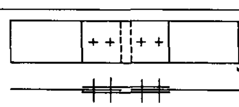
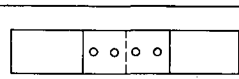
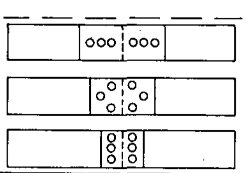
| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 62-6 | 9/16" bolts | Connecting-rod |  | Pretightening load | | 1. Computation of stress in bolt. |
| 62-7 | | Plate with hole |  | Plate thickness<br>Plate width | **Fatigue Tests**<br>41 tests | 1. Development of the relationship of endurance limit to bearing ratio. |
| | High-strength steel bolts | Butt splice |  | Plate thickness<br>Plate width<br>Bearing ratio | **Fatigue Tests**<br>71 tests 1/4" bolt | |
| 62-8 | A141 steel rivets | Butt splice |  | Joint size<br>Number of rivets in line | **Static Tension Tests**<br>3 tests 7/8" rivet | 1. Computation of theoretical ultimate load.<br>2. Computatin of unbuttoning factor. |
| 62-12 | A325 steel bolts | Lap splice |  | Joint size<br>Number of bolts in line<br>Tension-shear ratio | **Static Tension Tests**<br>4 tests 7/8" bolt | 1. Computation of slip coefficient<br>2. Computation of unbuttoning factor |
| 62-15 | M16/10k | Butt splice |  | Plate thickness<br>Inclination of cover plates<br>Type material | 5 Static Tests<br>43 Fatigue Tests | 1. Computation of slip coefficient. |
| | M16 | Beam splice<br>Beam-to-column |  | As shown Type I, II<br>Beam size<br>End plate thickness | 15 Static Tests | 1. Stiffness computation.<br>2. Application of beam-line method to be bolted moment connections.<br>3. Development of standard profiles and connections. |
| 62-17 | M16/10k | Flange plate<br><br>Lap splice | <br> | Number of bolts<br>Thickness of flange plates<br>Size of bolts | 10 Static Tension Tests<br>4 Tension Tests | 1. Computation of slip coefficient.<br>2. Yield strength of flange plate. |

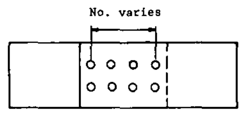
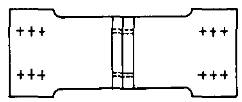
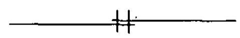
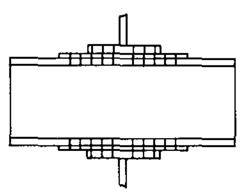
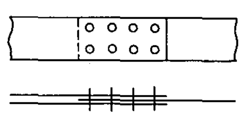
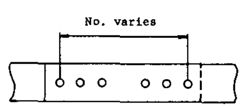
| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 62-18 | M16/10k | Butt splice |  | Prestressing forces<br>Tightening moment<br>Number of bolts in a line | 10 Static Tests | 1. Computation of the stress distribution. |
| | Al Mg Si Bolts | Butt splice |  | | 1 Photo Elastic Test on plexiglas model | 1. Stress-distribution |
| 62-19 | M16/10k | Butt splice |  | Distance between bolts | 7 Static Tests | 1. Stress-distribution<br>2. Determination of minimum end distance. |
| | | |  | | 1 Photo Elastic Test on a model | 1. Stress distribution |
| 62-22 | M10/8G | Butt splice |  | Surface treatment<br>Plate thickness | 33 Static Tests on Al Mg Si F 32 | 1. Computation of slip coefficient. |
| | M16/10k | Butt splice |  | Surface treatment<br>Plate thickness | 15 Static Tests on Al Cu Mg 2 | 1. Computation of slip coefficient. |
| 62-25 | SV34 rivets<br>B1154 medium-grade bolt | Butt splice |  | Type fastener<br>Surface treatment<br>Pitch<br>Number of bolts in line | 12 Tensile Tests | 1. Computation of slip coefficient. |
| | SV34 rivets<br>B1154 medium-grade bolt | |  | Number of bolts in line<br>Pitch<br>Surface treatment | 12 Fatigue Tests | |
| 63-2 | A354BC bolts<br>A354BD bolts | Test jig |  | Bolt grades<br>Bolt head type<br>Grip length<br>Thread in grip<br>Thread lubrication<br>Loading condition | Direct Tension Tests<br>27 tests 7/8" bolt<br>Torqued Tension Tests<br>56 tests 7/8" bolt | |
| 63-3 | A325 bolts | Butt splice |  | Type steel<br>Number of faying surfaces | Static Tension Tests<br>18 tests 1" bolt | 1. Computation of slip coefficient. |

| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 63-7 | A325 steel bolts | Beam splice (lap plates) |  | Bolt diameter<br>Number of bolts | Static Tension Tests<br>8 tests | 1. Computation of bolt tension<br>2. Computation of plastic moment<br>3. Determination of prying action |
| | | Beam splice |  | Thickness of end plate | Static Tension Tests<br>6 tests | |
| | | Tee stubs |  | Bolt diameter<br>T-stub size<br>Flexible or rigid abutment | Static Tension Tests<br>17 tests (a) specimen<br>10 tests (b) specimen | |
| | | Beam-to-column |  | Beam size<br>Bolt diameter<br>T-stub size | Static Tension Tests<br>3 tests | |
| 63-10 | 1/4" A7 machine bolts | Butt splice |  | Number of bolts in line<br>Plate thickness<br>Pitch | 3 tests | 1. Unbuttoning efficiency<br>2. Efficiency of bolts<br>3. Ultimate strength |
| 63-11 | 7/8" bolts rivets | Single plate |  | Type fastener | 18 Fatigue Tests | |
| | | Butt splice |  | Number of fasteners in line<br>Number of rows of fasteners<br>Type fastener<br>Plate width<br>Bolt diameter<br>Plate material<br>Surface treatment<br>Bolt tension | 22 Fatigue Tests | |
| | | Angle with gusset |  | Load range | 5 Fatigue Tests | |
| 63-12 | A325 steel bolts | Butt splice |  | Plate width<br>Bolt tension<br>Bolt head type<br>$A_n/A_s$ ratio<br>Number of washers | Static Tension Tests<br>6 tests 7/8" bolt<br>A440 steel plates | 1. Computation of slip coefficient.<br>2. Computation of load portion and ultimate strength |
| | | |  | Number of fasteners in line<br>Gripped material | Static Tension Tests<br>3 tests 7/8" bolts<br>A440 steel plates | |
| | | |  | Joint width | Static Tension Tests<br>3 tests 7/8" bolts<br>A440 steel plate | |
| 63-14 | High-strength bolts | Rigid frame connection |  | Size connection<br>Diameter of bolts<br>Number of bolts<br>Joint configuration | 8 Static Bending Tests | 1. Computation of ultimate strength. |

| REF. NO. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 64-2 | Rivets | Lap splice<br><br>Box beam<br><br>Box girder | <br><br> | | Fatigue Tests | |
| 64-4 | A325 steel bolts | Butt splice |  | Joint type<br>Plate materials<br>Plate thickness<br>Initial bolt tension | Static Tension Tests<br>29 tests 1" bolt | 1. Computation of slip coefficient. |
| 64-5 | A490 steel bolts | Test jig |  | Bolt length<br>Total grip<br>Thread length in grip<br>Loading method | Direct Tension Tests<br>21 tests 7/8" bolt<br><br>Torqued Tension Tests<br>26 tests 7/8" bolt | |
| 64-6 | A325 steel bolts<br><br>A354BD steel bolts | Test jig |  | Type of bolt<br>Bolt length<br>Bolt diameter<br>Bolt hardness<br>Grip length<br>Test block materials<br>Tension-shear ratio | Static Tests<br>86 tests 3/4" A325 bolt<br>10 tests 1" A325 bolt<br>20 tests 3/4" A354BD bolt | 1. Development of empircal interaction curve for combined tension and shear. |
| 64-7 | A490 steel bolt | Test jig |  | Bolt length<br>Nominal grip<br>Thread in grip<br>Loading method | Torqued Tension Tests<br>20 tests 7/8" bolt<br><br>Direct Tension Tests<br>20 tests 7/8" bolt | |
| 64-11 | 7/8" bolts | Butt splice |  | Number of bolts in line<br>Bolt tension | 10 Tension Shear Tests | 1. Normal stress<br>2. Shearing force<br>3. Stress distribution |
| 64-12 | SA90 bolts | Butt splice |  | Applied torque<br>Plate material<br>Type bolts<br>Testing time<br>Clamping time | 324 Compression Tests | |
| | 5/8" bolts | |  | Type of bolt<br>Clamping force<br>Time of testing | 322 Tension Tests | |

| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 64-14 | 7/8" bolts | Lap splice |  | Surface treatment<br>Type of bolt | 38 Single Shear Test | 1. Slip coefficient |
| | | Butt splice |  | | 23 Double Shear Test | 1. Slip coefficient |
| 64-16 | M16 | O Butt and lap splice |  | Type section<br>Plate thickness<br>Number of bolts<br>Length of bolts<br>Surface treatment<br>Joint geometry | 1 Static Test<br>Fatigue Tests<br>10 zero to tension | 1. Joint Efficiency<br>2. Stress distribution<br>3. Development of design<br>4. Procedure for fatigue of bolted connections<br>5. Computation of the slip coefficient |
| | | I beam splice |  | | Fatigue Tests<br>6 zero to tension | |
| | | II double lap splice |  | | 1 Static Test<br>Fatigue Tests<br>10 full reversal<br>10 zero to tension | |
| | | III butt butt splice |  | | 3 Static Tests<br>Fatigue Tests<br>10 full reversal<br>14 zero to tension | |
| | | IV angle lap splice |  | | 3 Static Tests<br>Fatigue Tests<br>12 full reversal<br>20 zero to tension | |
| | | V symmetric angle lap splice |  | | 3 Static Tests<br>Fatigue Tests<br>11 full reversal<br>15 zero to tension | |
| | | VI lap splice |  | | 1 Static Test<br>Fatigue Tests<br>19 full reversal<br>16 zero to tension | |
| 64-17 | A325 steel bolts<br>A354 steel bolts | Test jig |  | Bolt materials<br>Bolt head<br>Nut type<br>Washer<br>Bolt tension | Relaxation Tests<br>Nut Tests<br>28 tests 3/4" A325 bolt<br>11 tests 3/4" A354 bolt<br>Bolt Head Tests<br>12 tests 3/4" A325 bolt<br>Head Torque Tests<br>4 tests 3/4" A325 bolt<br>Lubrication Tests<br>2 tests 3/4" A325 bolt | |
| | | Butt splice |  | Joint size<br>Bolt diameter<br>Nut type<br>Washer<br>Stress range<br>Bolt tension | Fatigue Tests<br>0 to tension<br>19 tests 3/4" A325 bolt<br>1 test 1" A325 bolt<br>1 test 5/8" A325 bolt | 1. Computation of slip coefficient. |
| 64-18 | High-strength bolts | Eccentric lap splice |  | Connection pattern<br>Eccentricity | 13 tests | 1. Ultimate strength |

| REF. NO. | CONNECTION: CONNECTING MEDIUM | CONNECTION: TYPE | CONNECTION: SKETCH | CONNECTION: VARIABLES | NOTES: TESTS | NOTES: ANALYSIS |
|---|---|---|---|---|---|---|
| 64-20 | High-strength bolts & welds | Beam-to-column |   | Ratio of width to thickness of tube<br>Connection length to tube size<br>Material<br>Shape<br>Type fastener | 27 tests | |
| 64-22 | | Calibration tests |  | Plate thickness<br>Type steel<br>Plate width<br>Pitch of holes | 22 Static Tension Tests | 1. Development of mathematical model for stress-strain relationship elastic and inelastic. |
| | A325 bolts<br>A490 bolts<br>A141 steel rivets<br>A502GR2 rivets | Shear jig |  | Type steel<br>Type fastener<br>Diameter of fastener<br>Type testing device | | 1. Development of mathematical model for load-deformation. |
| 64-25 | 7/8" A141 rivets | |  | Pitch<br>Gage<br>Plate thickness<br>Edge thickness | 120 Fatigue Tests<br>4 Static Tests | |
| 64-26 | M16/10k | Butt splice |  | Specimen form<br>Material<br>Surface treatment | 12 Static Tension Tests<br>30 Fatigue Tests | 1. Computation of slip coefficient.<br>2. Influence of cycles on slip coefficient. |
| 64-27 | M16/10k | Butt splice |  | Surface treatment<br>Tightening moment<br>Prestressing force | 6 Fatigue Tests | 1. Computation of slip coefficient. |
| 64-29 | High-strength bolts | Double-strap-butt |  | Diameter of bolt<br>Number of bolts in line<br>Pitch<br>Plate material | 8 Joint Tests | 1. Stress distribution |
| 64-35 | 10k & 8G bolts | Butt splice |  | Surface preparation<br>Condition of mill scale<br>Type steel<br>Time | 156 Static Tension Tests | 1. Computation of slip coefficient |
| | | |  | Surface preparation<br>Type steel<br>Time<br>Plate width<br>Joint configuration<br>Bolt diameter | 216 Static Tension Tests | |

| REF. | CONNECTION | | | | NOTES | |
|---|---|---|---|---|---|---|
| NO. | CONNECTING MEDIUM | TYPE | SKETCH | VARIABLES | TESTS | ANALYSIS |
| 65-1 | A325 bolts | Butt splice |   | Number of bolts in line<br>$A_n/A_s$ ratio | 4 Static Tension Tests | 1. Computation of slip coefficient<br>2. Computation of ultimate load<br>3. Determination of load partition |
| 65-3 | 7/8" A490 | |  | Bolt length | 9 Fatigue Tests | |
| 65-4 | 7/8" high-tension bolt | lap |  | Surface<br>Washer type<br>Number of bolts in line | 26 Tension Tests | 1. Slip factor |
| | | Double strap butt |  | | 13 Tension Tests | |
| 65-5 | | Tee stubs |  | Bolt diameter<br>Number of bolts<br>T-stub flange thickness<br>Filler thickness | 10 Static Tension Tests | |
| 65-8 | A490 bolts | Butt splice |  | $A_u/A_s$ ratio | 4 Static Tension Tests<br>7/8" A490 bolts | 1. Computation of slip coefficient<br>2. Computation of load partition and ultimate strength |
| | | |   | Number of bolts in line<br>$A_n/A_s$ ratio | 4 Static Tension Tests<br>7/8" A490 bolts | |

## 6. AUTHOR INDEX


Badaliance, R., 65-13
Badir, M., 47-6
Bailey, J. C., 51-9, 52-7
Baker, A. R., 61-11
Ball, E. Y., 60-15, 61-19, 61-24, 61-29
Bangay, A. J., 59-8
Baron, F., 52-5, 52-23, 53-9, 53-10, 53-15, 54-1, 54-19, 55-2, 55-17
Baumgartner, T. C., 58-5
Beam, W. S., 54-17, 55-11
Beane, S. T., 58-2, 59-33, 59-59, 61-23
Becker, W. K., 51-3
Beede, M. C., 44-9
Beedle, L. S., 63-1, 63-12, 63-15, 64-21, 64-24, 65-9, 65-13, 68-18
Beelick, K. H., 64-50
Beer, N., 60-27, 64-27
Belford, B., 60-11
Belford, R. B., 59-35, 62-13
Bell, M. N., 55-41, 57-27
Bell, W. G., 57-37, 58-29, 59-55, 61-21
Bendigo, R. A., 59-29, 59-37, 60-2, 62-12
Berg, S., 55-27
Bergendoff, R. C., 53-5, 53-17
Berridge, P. S. A., 59-21, 60-33
Boiten, R. G., 47-3
Boomsma, M., 53-35
Bott, B. A., 65-13
Bouwan, L. P., 54-36, 60-19
Brace, A. W., 52-7
Brady, W. C., 53-18, 55-12
Brennecke, 43-4
Brody, I. H., 59-24
Brown, A. A., 52-11
Brown, W. C., 59-25
Bruckner, W. H., 44-9
Brueggeman, W. C., 36-1, 40-4, 42-1
Budiansky, B., 61-2
Butz, G. A., 64-45
Cannon, J. C., 59-17, 60-8
Carpentier, L., 64-31
Carter, J. W., 50-11, 51-14, 52-19, 54-21, 54-23, 55-1, 55-19
Cayci, M. A., 49-5, 50-20, 52-10
Ceradine, G., 49-3
Chapin, C. H., 35-2
Chauner, R. W., 57-17
Chang, F. K., 52-24, 53-11
Chang, W. N., 63-3, 63-8, 65-17
Charlton, T. M., 60-3
Chesson, E. Jr., 56-18, 56-19, 57-1, 57-33, 58-12, 58-29, 59-1, 59-3, 59-30, 59-38, 59-41, 59-52, 59-55, 59-56, 60-4, 61-7, 61-17, 61-20, 61-21, 62-3, 63-16, 63-17, 63-18, 64-5, 64-6, 64-8, 64-13, 64-17, 64-19, 64-25, 65-2, 65-3, 65-6, 65-15, 65-19, 65-20, 65-25
Chiang, K. C., 64-4
Chin, A. G., 54-20, 55-18
Christopher, R. J., 63-2, 64-21, 65-7
Chronis, N. P., 60-30
Chu, K., 50-19
Chu, T. V., 62-7
Cioth, N. S., 61-6
Clark, J. W., 64-43
Cod, J., 64-1
Committee on Design in Lightweight Structural Alloys, J. W. Clark, Chairman, 56-2, 56-3
Corrado, J. A., 65-13
Cowen, E. Y., 58-5
Cox, N. L., 50-7, 52-25, 52-26, 56-12
Cox, J. W., 52-18, 53-14
Creasy, L. R., 59-19
Crispell, C., 58-5
Crocker, S., 45-6
Cullimore, M. S. G., 59-16, 63-6, 64-9
Dassen, J. R., 63-9, 63-13, 64-15
Davey, J. S., 52-8
DeBack, J., 59-36, 60-19
Delaney, T. J., 51-10, 54-8
Demal, L., 55-33, 57-32, 64-35
Deming, G. M., 23-1
Denkhaus, N. G., 61-3
Deutscher Normenanschuss, 60-39
Deutscher Stahlbau-Verland, 57-34
Dewalt, W. J., 61-33
Diemer, C. P., 61-12, 62-14
Dineen, R. L., 61-7

Dlugosz, S. E., 62-2, 62-8
Dolan, T. J., 50-17
Dornan, A., 56-13
Dornen, K., 58-26
Douth, R. T., 61-37
Douty, R. T., 57-14, 61-18, 62-26, 63-7, 65-14
Doyle, D. V., 64-36
Drew, Y. P., 55-7
Drucker, D. C., 53-18, 55-12
Duberg, J. E., 44-9
Duffy, A. R., 56-10
Easton, Y. M., 57-9
Eaton, I. D., 51-4, 51-12, 54-4, 63-4
Ely, J. Y., 60-36
Engineering News Record, 53-1, 58-10, 60-1
Ernst, E., 54-10
Estes, E. R., Jr., 59-40, 60-16, 60-35
Fang, R. J., 64-20
Fasteners, 45-5, 51-5, 52-4, 53-3, 54-7, 60-13, 60-14, 60-18, 65-10
Faustino, N. L., 64-6, 65-19
Fesser, L. J., 57-18
Fefferman, R. L., 47-4
Feldhausen, G. J., Jr., 52-3
Fernlund, I., 61-32
Field, J. E., 58-7
Fincher, J. R., 57-12
Fisher, J. W., 62-2, 62-12, 63-1, 63-2, 63-12, 63-15, 63-19, 64-3, 64-7, 64-22, 64-23, 64-24, 65-1, 65-7, 65-8, 65-9, 65-16, 65-18, 65-20, 65-21, 65-28, 65-29
Fisher, W. A. P., 52-9
Flint, T. R., 55-3
Foreman, R. T., 58-13, 58-18, 60-40, 61-15
Frances, A. J., 55-15
Frankland, F. H., 46-1, 46-6
Fried, Bernard, 48-2
Frincke, M. H., 58-3
Fuller, T. R., 53-2, 54-13, 55-4, 55-38, 57-36, 58-28, 59-49
Gaedeke, K. P., 65-13
German Committee for Structural Steelwork, 59-11
Gerstung, H., 61-1
Gideon, D. N., 58-1
Gill, P. J., 59-18, 60-24, 62-5
Godfrey, G. B., 57-4, 59-10, 65-22
Goffi, L., 64-32
Goodier, J. N., 40-1
Gordon, S. A., 58-1
Grant, M., 59-26
Graves, Y. E., 60-17, 60-20, 64-42
Gregory, P., 59-8
Greiner, J. E., 97-1
Grinter, L. E., 48-3
Grover, H. J., 46-4, 53-12, 56-4, 57-8 58-1
Hall, J. R., 64-41
Hamm, B., 58-23
Hancke, A., 55-30
Hanna, J. C., 62-14
Hanneman, W. M., 61-13
Hansen, N. G., 59-58, 61-22
Hansen, R. M., 61-9, 61-14, 63-20
Hardin, B. O., 58-11
Hardrath, H. F., 57-11
Hartmann, E. C., 41-1, 41-2, 43-4, 44-2, 44-3, 44-5, 44-8, 45-1, 46-2, 48-7, 51-4, 54-4
Harvey, C. L., 50-8
Heap, W. J., 60-24
Hebrant, F., 55-33, 57-31, 57-32
Hechtman, R. A., 40-3, 47-8, 48-5, 49-4, 51-6, 54-20, 55-3, 55-18
Hempel, M., 38-1
Hendry, A. W., 47-7
Hermitte, G. L., 57-31
Herring, J. L., 58-6
Hetenyi, M., 43-3
Higgins, T. R., 51-7, 52-13, 52-16, 54-22, 55-20, 59-22, 61-24, 61-29, 64-51
Hill, H. N., 45-4
Hill, H. O., 47-2
Hoglund, G. O., 44-3, 45-1
Hohaus, D., 62-22
Hojarczyk, S., 59-15
Holt, M., 45-2, 46-3, 50-1, 51-4, 51-12, 54-4, 57-3, 57-25, 64-34
Hood, A. C., 64-39
Hotchkiss, J. G., 62-11
Howard, D. M., 52-17
Howard, L. L., 54-18, 55-5
Howe, J. W., 61-36
Hoyer, H., 59-44, 59-45, 59-46, 61-31
Humphrey, K. D., 61-6
Hunt, E. M., 62-14
Hyler, W. S., 53-12, 56-4, 57-8, 58-1, 61-6
Illgner, K. H., 62-23, 64-47, 64-48, 64-49, 64-50
Ingenerf, W., 55-28

Institution of Structural Engineers, 57-10
Iron Age, 59-31
Irvan, W. G., 57-20
Jackson, L. R., 46-4
Jenkins, J. W., 58-6
Johnson, L. G., 59-17, 60-8, 64-14
Johnston, B., 40-3, 42-3, 52-24
Jones, J., 58-14
Jones, R., 61-11
Kaplan, S., 59-5
Kasinski, J., 59-15
Kasuha, R., 62-6
Kellermann, R., 55-29
Kelly, J. J., 48-1
Kenworthy, K. J., 54-1, 55-2
Kinney, J. W., 59-61, 61-30
Klein, H. -CH, 55-29
Kloppel, K., 64-16
Knoell, A. C., 62-3
Koepsell, P. L., 55-3
Komatsuhara, M., 61-38, 62-25
Konishi, I., 64-28
Korber, F., 38-1
Kovac, J. J., 49-2
Kreisle, L. F., 52-15
Krickenberger, C. F., Jr., 57-1
Kulak, G. L., 65-7
Kuzmanovic, B. O., 60-31
Lancaster, N., 59-14
Langdon, Howard H., 48-2
Langhaar, H. L., 47-4
Lappo, T., 50-12
LaRoy, H. E., 57-23
Larson, E. W., Jr., 52-5, 52-23, 53-9, 53-10, 53-15, 54-19, 55-2, 55-17
Laub, W. H., 54-2
Lathrop, R. P., 64-1
Leahey, T. F., 54-5, 54-13, 54-16, 55-4
Legate, A. C., 57-22
Lehman, F. G., 60-6
Lenzen, K. H., 49-7, 49-9, 50-16, 54-21, 55-19
Leon, E. V., 61-35
Levy, S., 42-2, 64-38
Lewis, E. M., 57-9, 60-32
Lewitt, C. W., 59-1, 59-3, 59-38, 59-53, 60-4, 63-16
Leybold, H. A., 61-8
Lind, H. H., 50-21, 60-10
Lindner, C. W., 49-11, 50-15
Lipson, C., 48-4
Loubser, R. S., 63-5
Louw, J. M., 57-30
Lu, Z. A., 57-2, 59-59, 61-23
Lyst, J. O., 44-5
Madison, R. B., 56-5, 59-59, 61-23
Maney, G. A., 44-1, 45-3, 46-5, 46-7, 46-8
Marcin, S. J., 60-5
Martin, H., 59-27
Mas, E., 64-35
Massard, J. M., 52-1, 58-4
Massonet, C., 57-31, 57-32
Mathison, W., 59-51
Mattheisen, R. B., 57-3
McCalley, J. C., 54-23, 55-1
McCammon, L. B., 49-11, 50-15
McClow, J. H., 50-17
McDonald, D., 58-4
McFarland, W. J., 56-7
McGuire, W., 61-37, 62-26, 63-7, 65-14
McMullen, A. C., 60-29
McPherson, A. E., 42-2
Merritt, F. S., 50-10
Michalos, J., 57-30
Milek, W. A., 64-42
Millard, E. H., 47-1
Miller, M. A., 44-3, 45-1, 48-7
Milliken, M. P., 50-2
Mitchell, W. D., 55-9
Mohler, K., 54-11, 58-22, 59-43, 62-15
Moisseiff, L. S., 44-8
Moore, H. E., 46-4, 45-4
Moore, R. L., 44-8, 45-4
Mordfin, L., 55-34, 57-22
Mount, E. H., 42-3
Munse, W. H., 49-6, 50-7, 50-20, 51-2, 51-3, 52-1, 52-2, 52-10, 52-16, 52-26, 53-2, 53-5, 54-5, 54-13, 54-15, 55-4, 55-11, 55-14, 55-16, 55-19, 55-39, 56-8, 56-11, 56-12, 56-18, 57-1, 57-16, 57-33, 57-36, 58-12, 58-28, 58-29, 59-1, 59-2, 59-4, 59-30, 59-32, 59-38, 59-41, 59-49, 59-55, 59-56, 60-4, 60-7, 61-4, 61-5, 61-7, 61-17, 61-20, 61-21, 61-27, 62-3, 63-16, 63-17, 63-18, 64-6, 64-17, 64-35, 65-2, 65-25
Musnitsky, W. D., 57-5
Naka, T., 64-30
Navy Department, 50-18
Nawrat, T., 59-15
Nelson, H. M., 53-13
Newmark, N. M., 52-12, 54-15, 55-14, 55-16

Nicholson, H. H., 54-16
Nielsen, D. A., 65-12
Nieth, F., 55-25, 55-26
Nitkin, I. H., 61-34
Nordmark, G. E., 64-2, 64-43, 64-45, 64-46
Nusbaum, G. W., 31-1, 35-1
Oliphiht, J. B., 52-15
Omiya, K., 61-38, 61-39, 62-25
Onderdonk, A. B., 64-1
Osterreichischer Stahlbauverband, 57-35
Ozell, A. M., 45-7
Pancoast, R. H., 47-5
Parola, J. F., 64-25, 65-25
Pauw, A., 55-5, 55-8
Penman, W. R., 61-19
Peterson, K. S., 56-8, 56-20, 57-36, 58-28, 59-49, 59-56, 61-17, 61-20
Pfungen, R., 57-28, 62-21
Phillips, J. R., 54-2
Pickel, W. F., 49-1, 49-8
Pinkel, R. H., 50-9
Papp, H. G., 56-4, 57-8, 58-1
Prynne, P., 59-50, 65-4
Quertier, J. R., 59-28
RCRBSJ, 49-10, 53-7
Radzimovsky, E., 62-6, 64-33
Ramberg, W., 42-2
Rampton, C. C., Jr., 56-21, 57-19
Ramseier, P. O., 63-12, 63-15
Randall, P. N., 48-9
Ranger, B. E. S., 59-13
Redshaw, S. C., 51-8
Richart, F. E., 48-8
Ringer, A. G., 54-9
Ritchie, J., 59-8
Roderick, J. W., 65-12
Romualdi, J. P., 60-23
Roop, F. C., 40-4
Ros, M., 49-3
Rosenfeld, S. G., 46-9
Rosenthal, D., 55-9
Ruble, E. J., 50-5, 50-13, 50-22, 51-11, 52-13 54-22, 55-6, 55-20, 58-17, 59-57, 61-10
Rumpf, J. L., 58-13, 58-18, 58-19, 59-37, 60-2, 60-21, 60-40, 61-14, 61-15, 62-12, 63-19, 63-20, 65-20
Rust, T. H., 40-2
Rybak, M., 62-18, 62-20
Salmon, C. G., 54-3
Sammet, J., 62-17
Sandberg, C. H., 55-36
Sanders, P. H., 60-33
Sanko, R. L., 56-9, 56-21, 57-19
Sattler, K., 60-25
Savikko, E. R., 54-20, 55-18
Schaar, K., 55-25
Schenker, L., 54-3
Schijve, J., 56-6
Schmid, W., 55-21, 55-22, 55-23, 56-14, 56-15, 57-29, 58-20, 58-21
Schultz, F. W., Jr., 50-7, 52-12, 52-20, 52-21, 59-48
Scott, M. B., 49-11, 50-15, 52-18, 55-40, 56-17
Seaquist, E. O., 31-1, 35-1
Seeger, T., 64-16
Sharp, W. H., 43-1
Sherbourne, A. N., 61-10
Sheridan, M. L., 64-40
Shermer, C. L., 64-18
Sinnamon, G. K., 51-3, 52-1
Sippell, K. W., 55-24, 55-27
Skwirblies, H., 59-45, 62-18
Smith, A. M., 60-12
Smith, C. R., 59-47
Smith, F. C., 52-17
Societe de la Tour Eiffel, 59-6
Sommer, A. A., 57-7
Sopwith, D. G., 48-6
Sossenheimer, H., 53-6, 53-31
Spooner, L. A., 59-17, 60-8
Stafford, R. W., 59-3
Stahlbau, 56-22
Stahlbau-Verlags-GmbH, 58-27
Stallmeyer, J. E., 53-19
Stang, A. H., 51-13
Steel, 57-21
Steinhardt, O., 54-11, 55-32, 58-25, 59-9, 59-43, 60-26, 60-28, 62-15
Sterling, G. H., 64-7, 64-23, 65-1, 65-8, 65-21, 65-29
Stetina, H. J., 58-15
Stevin Laboratory, 65-23, 65-24
Stewart, W. C., 44-7, 50-6, 52-14, 54-14, 55-13
Stroup, P. T., 48-7
Tada, H., 64-30
Tadada, S., 65-5
Tajima, J., 61-38, 61-39, 62-4, 62-25, 63-11, 64-11, 64-12, 64-29
Task Committee on Lightweight Alloys, J. W. Clark, Chairman, 62-24

Tate, M. B., 46-9
Taylor, J. C., 60-9
Templin, R. L., 41-2, 54-12
Thrasher, J. Q., 57-13
Thurlimann, B., 57-26, 60-34
Toint, E., 59-42
Tokunaga, A., 65-5
Tomonaga, K., 63-11, 64-29
Treanor, H. E., 57-23
Trittler, G., 56-13
Troup, E. W. J., 64-5, 65-21
Upton, K. A., 64-9, 64-44
Vasarhelyi, D. D., 56-5, 57-2, 57-15, 57-17, 58-2, 59-33, 59-59, 60-9, 61-23, 63-3, 63-8, 64-4, 65-17
Vasishth, C., 57-2, 57-15, 59-59, 60-9, 60-22, 61-23
Viglione, J., 57-6, 65-11
Viner, J. A., 61-7
Vogt, F., 47-9
Wallaert, J. J., 64-23, 65-16, 65-29
Wallner, H., 64-27
Waltermire, W. G., 58-16, 62-1
Watson, I., 64-10
Weber, N. E., 62-9
Wescoat, C. F., 43-4, 44-2
Whaley, R. E., 57-11
White, M. W., 57-26
White, R. N., 64-20
Whitmore, R. E., 52-6
Whittemore, H. L., 31-1, 35-1
Wiedemann, J., 62-16
Wiegand, H., 55-25, 62-23, 64-49, 64-50
Williams, W. L., 58-6
Wilson, W. M., 44-6, 44-9, 45-7, 46-4, 49-6, 50-20, 51-1
Wilson, W. R., 55-37
Winter, G., 56-1, 56-16
Wolf, W., 58-24, 59-23
Wright, D. T., 51-2, 52-2, 52-22, 54-15, 55-14, 55-16, 57-9, 60-32
Wright, W., 63-10
Wu, T. W., 61-2
Wyly, L. T., 49-11, 50-4, 50-11, 50-15, 54-21, 54-23, 55-1, 55-19, 55-46, 56-17, 57-23, 57-24
Yamada, M., 63-14
Yeun, C. Y., 60-9
Yeakel, W. R., 62-10
Yoshimoto, S., 65-5
Young, D. R., 51-6, 54-20, 55-18
Young, W. C., 59-7
Yura, J. A., 65-13
Zamboky, A. N., 44-4, 46-2
Zar, M., 58-9, 61-26
Zardman, F., 59-47
Ziemba, St., 62-20
Zweig, B. A., 61-25

## 7. SUBJECT INDEX


A

AISC Specifications, 62-11, 64-20
Alloy Steel Bolts, 46-9, 59-27, 65-7
Aluminum Alloy
  Joints, 44-3, 44-8, 45-1, 46-2, 48-7, 52-6, 53-4, 54-4, 55-34, 57-8, 57-22, 59-16, 64-24, 64-37, 64-46
  Material, 50-2, 53-1, 56-2, 56-3, 62-24, 64-2, 64-45
  Plates, 42-3, 46-9, 61-31, 64-45
  Rivets, 44-2, 45-2, 51-9, 52-7, 54-8
Aluminum Butt Joints, 57-8, 59-16
Aluminum Highway Bridges, 51-10, 62-24
Aluminum Riveted Joints, 40-4, 44-2, 44-8, 45-1, 45-4, 51-8, 52-7, 55-34, 61-8
Analogous Grid, 48-3
Analysis
  Bolted Plate Splices, 64-3, 61-32
  Columns, 57-26
Assembly Clearance, 62-6
Assembly of Joints, 54-7, 59-11
ASTM, 60-16, 64-13
Axial Load, 53-4, 60-21

B

Bakelite Joints, 52-6
Balanced Design
  Bolted Joints, 54-2, 55-14, 55-15, 63-1
  Riveted Joints, 58-12
Beam-to-Column Joints, 40-3, 42-3, 47-8, 54-3, 58-4, 59-13, 59-14, 61-10, 61-21, 63-7, 63-14, 64-20, 64-21, 65-12
Bearing of Rivets, 55-19
Bearing Pressure, 51-3, 52-1, 53-5, 53-7, 57-24, 58-14, 59-1, 59-32, 60-35, 64-25
Bearing Ratio, 51-3, 52-1, 58-14, 59-1, 59-32, 64-25
Bearing Strength, 59-34, 62-15
Bearing Stresses, 59-4, 62-7
Bearing-Tension Ratio, 59-1
Bending Stresses of Bolts, 62-6
Beryllium Bolts, 60-30
Bolt
  Assembly, 49-1, 61-27, 62-6
  Calibration, 59-29, 59-37, 62-2
  Characteristics, 23-1, 51-7, 52-8, 58-23, 62-23, 63-4, 63-6, 64-39, 65-2
  Clearance, 54-4, 62-19
  Diameter, 63-2
  Fit, 46-4
  Holes, 50-11, 61-32, 64-9
  High Strength (see high strength bolts)
  Load, 35-1, 46-9, 59-18, 59-38, 61-3
  Load-Elongation Curves, 50-9, 62-17
  Material, 35-1, 46-6, 63-6
  Preload, 49-2, 52-8, 53-16, 59-18, 60-28, 61-11, 65-24
  Proof Load, 60-13, 64-15
  Properties, 50-8, 60-19, 62-23
  Shear Area, 60-2, 61-14, 61-15
  Shear Strength, 47-5, 60-30, 61-14
  Shear Test, 57-18
  Stresses, 43-3, 50-2
  Tensile Stress, 59-31
  Tension, 46-8, 48-3, 50-17, 51-6, 52-2, 55-8, 55-14, 56-9, 57-1, 57-27, 58-6, 58-19, 60-13, 60-19, 60-34, 61-18, 61-24, 62-2, 62-3, 63-7, 64-5, 64-23, 64-38, 65-1
  Tightening, 50-2, 59-41, 61-13, 61-24, 61-25, 61-27, 61-28, 62-13
Bolted Joint Efficiency, 56-8
Bolted Joint Strength, 59-31, 60-29
Bolted Joints, 49-4, 50-3, 50-4, 50-5, 50-17, 51-7, 52-8, 52-14, 53-1, 54-5, 55-1, 55-10, 55-11, 55-14, 55-15, 55-16, 55-17, 55-21, 56-1, 56-5, 56-7, 56-8, 56-10, 56-13, 57-2, 57-9, 57-15, 57-17, 57-21, 57-24, 58-2, 58-4, 58-7, 58-13, 58-18, 58-20, 58-22, 58-24, 58-25, 59-9, 59-11, 59-12, 59-30, 59-33, 59-40, 59-41, 59-48, 59-50, 59-51, 60-3, 60-5, 60-7, 60-16, 60-21, 60-22, 60-24, 60-25, 60-26, 60-28, 60-29, 60-33,

60-34, 61-4, 61-5, 61-9, 61-14, 61-17, 61-18, 61-23, 61-30, 61-31, 61-32, 62-4, 62-7, 62-15, 62-16, 62-17, 62-19, 62-21, 62-23, 62-25, 62-26, 63-1, 63-5, 63-6, 63-8, 63-11, 63-13, 63-14, 64-1, 64-8, 64-9, 64-11, 64-12, 64-14, 64-15, 64-16, 64-17, 64-19, 64-20, 64-21, 64-22, 64-23, 64-24, 64-26, 64-28, 64-29, 64-32, 64-33, 64-35, 64-36, 64-37, 64-38, 65-1, 65-5, 65-6, 65-7, 65-8, 65-10, 65-23

Bolted Plate Strength, 64-3

Bolting, 45-6, 54-9, 62-13
- Cost, 55-7, 58-10
- Economy, 52-4
- Specifications, 45-6, 58-20, 63-5
- vs. Riveting, 54-6, 60-17, 64-13

Bridge Construction, 57-4, 57-25, 60-33, 64-28

Bridge Hangers, 50-4, 50-14, 52-18

British Standard Specifications, 57-9

Brittle Failure, 55-3

Butt Joints, 46-9, 47-3, 53-15, 55-14, 55-17, 58-13, 59-7, 59-16, 60-2, 60-28, 61-14, 61-15, 62-4, 62-8, 63-1, 63-8, 64-4, 65-1

C

Calibrated Impact Wrench, 55-5, 59-22, 60-13, 60-18, 61-29

Calibration
- Heavy Head Bolts, 62-2
- High Strength Bolts, 51-2, 59-37, 63-2, 64-5, 64-30, 65-7

Clamping Force, 44-1, 45-3, 46-6, 50-4, 50-11, 50-16, 51-7, 53-8, 53-15, 55-5, 55-8, 55-17, 56-10, 57-2, 57-8, 57-17, 57-23, 57-24, 57-32, 59-1, 59-2, 59-31, 60-4, 60-22, 60-24, 60-28, 61-22, 61-23, 61-27, 62-3, 62-7, 62-14, 64-7, 64-17

Clamping Stresses, 53-9, 62-1

Cleavage, 63-3

Cold Driven Rivets, 46-6, 50-5, 51-9

Cold Riveting, 46-1, 46-6, 50-5, 51-9, 51-10, 53-15, 54-8, 62-14
- Advantages, 45-5, 47-1
- Disadvantages, 47-1

Column Anchorages, 54-3

Column Base Joint, 58-4

Column Stiffeners, 61-10

Columns
- Axially Loaded, 57-26
- Eccentrically Loaded, 57-26
- Strength, 57-26

Combined Shear and Tension Strength
- Bolts, 59-3, 62-11, 64-6, 64-23, 64-31, 65-2
- Rivets, 56-12, 62-11

Combined Stress, 52-16, 53-17

Compact Bolted Joints, 61-15, 63-1

Compression Test, 55-18, 58-14, 58-19, 59-32

Construction, 51-5, 62-11
- Building, 55-20
- High Strength Bolted, 54-10, 55-22, 60-26, 62-10, 65-10
- Welded, 62-10

Contact Surface Treatment, 59-11, 59-36

Continuous Frame Joints, 54-3

Cost
- Bolts vs. Rivets, 59-19, 60-35, 61-12
- Fasteners, 58-15, 60-20
- Installing High Strength Bolts, 37-25, 52-13

Cover Plates, 57-26

Creep, 57-22, 58-6, 65-24

Critical Buckling Load for Plate Girder, 60-9

Cumulative Fatigue Damage, 59-49

D

Deflection-Rotation Characteristics, 61-21

Deformation
- of Fasteners, 61-21
- of Joints, 59-7, 60-26
- of Rivets, 56-12
- of Bolt Threads, 40-1

Design
- Aluminum Riveted Joints, 51-8, 56-2, 62-24
- Bolted Joints, 54-10, 58-24, 59-11, 59-19, 59-50, 60-16, 60-27, 60-32,

62-25, 63-1, 63-6, 64-18, 64-33, 64-39, 65-9, 65-22
Bolts, 46-6, 48-1, 48-4, 53-3, 64-10, 65-11
British High Strength Joints, 59-10
Columns, 57-26
Fasteners, 48-1, 58-15
Flexible Flange Joint, 57-14
Joints, 53-7, 54-3, 55-5
Light Alloy Structures, 47-9, 56-3
Moment Joint, 57-12, 59-48, 62-26 64-11
Non-Slip Bolted Joints, 59-11
Riveted Joints, 47-8, 50-1, 59-35, 64-18, 64-34
Rivets, 46-6, 60-23, 61-9, 62-24
Tension Members, 59-30
Web Splices, 50-12
Direct Tensile Strength, 64-7
Direct Tension Calibration, 59-29, 62-2, 63-2
Direct Tension Test of Bolts, 54-5, 59-37, 61-7, 61-22, 64-7
Distortion Energy Theory, 57-18
Distribution of Load in Gusset Plates, 59-30
Double Coverplated Butt Joint, 59-16
Double Lap Joints, 49-4, 51-6, 55-3, 55-18, 55-19, 56-5, 57-16, 57-17, 58-18, 59-12, 59-15, 59-33, 60-24, 61-22, 61-23, 63-3
Double Lap Shear Joints, 64-17
Double Lap Tension Joints, 60-5, 61-11, 63-3, 64-3
Double Scarf Joints, 54-4
Double Shear Joints, 54-4, 62-12
Double Shear Strength of Bolts, 59-5
Double Shear Test, 59-5, 59-34, 60-35
Double Strap Butt Joints, 51-3, 52-10, 52-12, 53-12, 54-2, 56-10, 59-59
Dynamic Loading, 51-7, 59-12, 60-26

E

Eccentric Static Load, 53-4, 50-17
Economic Factors
Bolts, 53-3, 60-35
Fasteners, 58-15, 60-20
Joints, 52-3, 54-6
Effect of Holes, 55-12
Effective Area, 51-2, 59-30
Efficiencies
Bolt, 49-2
Bolted Joints, 54-2
Drilled Member, 58-12
Joint, 52-10, 52-12, 53-1, 53-9, 61-11, 61-17, 61-23, 63-3, 63-8
Plate, 53-15
Punched Member, 58-12
Riveted Joints, 52-12, 55-2
Test, 51-3, 52-10, 55-4, 57-2, 58-12, 59-30, 59-32
Eiffel Tower, 59-6
Elastic Constants, 55-9
Elastic Proof Load, 48-1, 55-14
Elongation of Bolts, 63-8, 64-5
End Plate Joint, 63-7, 64-1
End Plate Stiffeners, 61-10
Endurance Limit of Bolted Joints, 62-7
Extensometer, 50-9

F

Fabrication, 51-1, 57-25, 58-24, 60-1, 60-17, 60-18
Fabrication Techniques, 61-23
Fastener
Bearing, 50-11
Behavior in Joint, 56-8, 59-2, 62-1
Cost Comparison, 58-10, 60-20
Deformation, 61-21
Diameter, 64-3
Material, 54-2
Misalignment, 59-33
Pattern, 52-12
Review, 59-35, 62-23, 63-5, 65-6
Tension, 52-12, 54-2
Use, 51-5, 59-35, 60-20
Fatigue Behavior, 56-4
Fatigue Cracks, 54-4, 57-11
Fatigue Failure, 46-3, 55-3, 57-24
Bolts, 38-1, 52-9, 58-8
Fatigue Life
Bolts, 53-16, 54-5, 60-4
Double Strap Butt Joint, 59-49

Joints, 44-5, 50-16, 51-12, 54-4, 55-2, 59-1, 62-3, 64-17
Plate, 59-49
Plate Material Around Rivets, 51-12 58-1, 59-47
Fatigue Load, 55-17, 56-11, 57-16, 59-3
Fatigue Strength
Aluminum Alloy Joints, 41-1, 41-2, 50-1, 51-2, 54-4, 57-8, 64-2
Bolted Joints, 46-4, 50-7, 50-16, 53-7, 53-15, 54-5, 55-19, 57-21, 58-16, 60-4, 60-26, 61-22, 64-25
Bolted vs. riveted joints, 53-6, 55-11, 55-14, 55-16, 55-17, 62-4, 62-25, 64-28
Bolts, 43-2, 53-3, 53-12, 57-6, 60-30, 61-4, 63-4, 65-11
Fasteners, 62-11
Gusseted Joints, 48-2
Hangers, 50-4
Lugs, 56-6
Plates, 59-2
Riveted Joints, 44-5, 51-2, 52-5, 53-7, 53-9, 53-15, 54-1, 54-5, 55-2, 55-19, 56-6, 59-1, 61-22, 64-25
Steels, 53-10
Structural Joints, 49-4, 50-5, 50-16, 55-1, 56-17, 62-7
Fatigue Test
Aluminum Bolted Joints, 41-1, 54-4, 57-3, 64-46
Bolted Joints, 50-4, 50-16, 55-14, 55-17, 56-11, 57-29, 58-20, 60-27, 61-5, 61-22, 62-3, 62-15, 63-11, 64-16, 64-17, 64-28, 64-32, 64-37, 65-3
Riveted Joints, 45-2, 50-1, 52-17, 57-3, 57-29, 58-1, 61-22, 64-25
Structural Joints, 53-7, 53-15, 54-5, 55-2, 55-11, 59-49
Fatigue Testing Machine, 46-5, 59-49
Faying Surface, 44-7, 51-6, 52-2, 53-3, 55-18, 56-5, 57-4, 57-8, 57-15, 57-17, 57-19, 58-2, 58-19, 59-5, 59-8, 59-9, 59-12, 59-15, 59-16, 59-17, 59-33, 59-36, 60-2, 60-24, 61-5, 61-14, 61-23, 61-32, 62-12, 62-23, 63-9, 63-12, 64-4, 64-11, 64-14, 64-23, 64-26, 64-29, 64-32
Field Erecting, 61-12
Fillet Welds, 58-15
Finishes, 61-13
Fitting Up Bolts, 61-26, 61-28, 61-29
Flange, 57-14, 61-18, 64-38
Joints, 45-6, 57-14, 64-10, 64-38
Rivets, 50-12
Flanges Nuts, 59-2
Flat Plates, 59-2
Flexural Deformation, 62-6
Floor Beam Hangers, 50-15, 53-14
Fretting Corrosion, 57-8
Friction, 52-11, 55-5, 56-5, 56-10, 57-2, 57-4, 57-23, 57-15, 57-17, 58-2, 58-13, 59-9, 59-15, 59-16, 59-17, 59-41, 59-50, 60-8, 60-22, 60-24, 60-25, 60-27, 61-1, 61-5, 61-14, 61-15, 61-23, 62-12, 62-16, 62-17, 62-22, 62-23, 63-3, 63-9, 63-11, 63-12, 63-13, 64-4, 64-11, 64-12, 64-23, 64-26, 64-35, 64-37, 65-1, 65-4, 65-9, 65-12, 65-23
Friction Grip Joints, 57-9, 59-12, 60-33, 61-3, 63-5, 63-6, 64-14, 65-4
Friction Type Joints, 58-18
Frictional Characteristics of Surface, 57-19, 64-4

G

Gages, 56-9
Galvanized Bolts, 47-2, 60-19, 64-39
Girders
Bolted, 53-11
Riveted, 53-11, 60-9
Web Splices, 50-12
Welded, 53-11

Grip Length, 52-15, 52-16, 53-7, 55-17, 59-1, 59-37, 62-2, 63-2
Gullander Method, 55-18
Gusset Plates, 40-2, 50-15, 52-6, 55-12, 57-20, 58-12, 59-30, 60-6
Gusseted Joints, 48-2, 48-3, 57-30, 58-11

H

Half-Torque-Half Turn Technique, 57-9, 57-10, 60-8
Half-Turn Method, 61-27, 62-2
Hand Torque Wrench, 59-41
Heat Treatment of Bolts, 50-8
Heavy Head Bolts, 62-10
Hexagonal Nuts (see Nuts)
High Strength Bearing Bolt, 58-16
High Strength Bolting, 52-4, 60-10, 62-13 63-5
High Strength Bolts, 48-4, 49-4, 50-4, 50-5, 50-16, 51-1, 51-5, 51-13, 52-13, 53-3, 53-8, 54-7, 55-3, 55-4, 55-7, 55-8, 55-11, 55-13, 55-14, 55-17, 55-18, 55-21, 56-5, 56-7, 56-9, 56-10, 56-11, 56-16, 57-1, 57-2, 57-12, 57-15, 57-16, 57-18, 57-23, 57-25, 57-27, 58-2, 58-16, 58-18, 58-26, 59-7, 59-13, 59-15, 59-17, 59-19, 59-23, 59-24, 59-25, 59-26, 59-27, 59-29, 59-33, 59-37, 59-38, 59-40, 59-50, 60-1, 60-4, 60-11, 60-13, 60-15, 60-18, 60-25, 60-26, 60-32, 60-34, 61-7, 61-9, 61-10, 61-11, 61-13, 61-14, 61-15, 61-17, 61-18, 61-21, 61-22, 61-24, 61-26, 61-28, 61-31, 62-9, 62-11, 62-12, 62-13, 62-15, 62-17, 62-19, 62-20, 62-21, 62-26, 63-1, 63-3, 64-11, 64-16, 64-23, 64-24, 64-26, 64-28, 64-29, 64-30, 65-1, 65-4, 65-5, 65-6, 65-7, 65-8, 65-10, 65-11, 65-12, 65-22, 65-23, 65-24
  - A325, 58-13, 59-22, 59-40, 60-2, 60-4, 60-7, 60-16, 61-6, 63-7, 63-12, 64-3, 64-4, 64-6, 64-22, 65-3, 65-7
  - A490, 64-5, 64-6, 64-7, 64-17, 64-22, 65-3, 65-7, 65-8
  - Advantages, 51-1, 53-3, 56-16, 57-7, 60-1
  - Advantages over Other Fasteners, 59-19, 59-23
  - Advantages over Rivets, 51-7, 52-14, 57-13, 57-28, 57-31, 57-32, 58-9, 58-19, 58-21, 64-13, 64-28
  - Combined Shear and Tension, 57-32, 59-3
  - Concepts, 55-5
  - Cost, 58-10, 58-15, 64-13
  - Double Shear Test, 59-5
  - Low Carbon Steel, 46-8
  - Overstressed, 53-2
  - Properties, 50-6, 52-12, 53-16, 64-13
  - Shear Resistance, 58-19
  - Specifications, (see Specification)
  - Ultimate Strength, (see Ultimate Strength)
  - Uses, 50-6, 53-3, 55-20, 59-22, 59-40, 60-35
High Strength Friction Grip Bolts, 59-14, 59-20, 62-5, 64-27, 64-31, 65-12, 65-22
High Strength Heavy Head Bolts, 60-11
High Strength Hexagon Head Bolts, 59-7, 62-13
High Strength Steel Joints, 57-23, 62-4
Highway Bridges in Germany, 59-23
History
  - Eiffel Tower, 59-6
  - High Strength Bolts, 55-13, 57-27, 59-10, 59-22, 59-23, 59-35
  - High Strength Bolts in Joints, 61-24
  - High Strength Friction Grip Bolts, 59-14
  - RCRBSJ, (see RCRBSJ)
  - Use of Rivets and Bolts, 57-13, 64-13
Hook Knurl Bolts, 57-16
Hot Riveting, 50-5, 52-15, 55-4, 59-1
Huck Bolt, 53-12, 56-4, 57-8, 61-4,

61-6, 65-2, 65-6
Hydraulic Calibrator, 64-7

I

I Section Joint, 55-4
Impact Loading, 59-3, 59-39
Impact Wrenching, 48-3, 52-13, 54-9, 57-10, 59-22, 59-27
Initial Bolt Tension, 56-11
Inspection of Bolted Joints, 50-3, 51-11, 54-6, 54-7, 55-10, 61-30, 62-5, 62-9
Installation of High Strength Bolts, 50-3, 52-13, 55-5, 55-6, 55-8, 57-25, 59-24, 59-26, 59-28, 59-37, 60-12, 60-19, 60-33, 61-24, 61-25, 61-26, 61-27, 61-28, 61-29, 61-30, 62-19, 63-5, 63-6
Installing Fasteners, 58-15, 59-35
Instructions for Tightening Bolts, 61-24, 61-28
Instrumentation, 45-3, 64-8
Interference-Body Bolts, 60-12
Interference Fit, 56-4, 57-4, 59-7

J

Joint Assembly, 60-13
Joint Efficiency, 54-1, 56-5, 56-8, 61-17, 63-3
Joint Length, 60-2, 61-14, 62-8, 62-12, 63-12, 64-3
Joint Life, 46-4
Joint Modulus, 55-9
Joint Slippage (see Slippage)
Joint Strength, 55-15, 64-10
Joints (see specific types of joints, (lap joints, butt joints))

L

Lap Joints, 46-4, 50-7, 50-11, 51-6, 52-2, 62-4, 63-10, 64-16
    Aluminum, 55-34, 57-8
    Bolted, 53-1, 55-14, 55-19, 57-29, 59-7, 62-12
    Riveted, 49-3, 52-10, 53-1, 55-19, 57-29
Limit Design, 55-12
Load Cells, 56-9
Load Deformation, 54-3
Load Distribution, 48-6, 55-9, 56-10, 60-5, 60-21, 61-23, 64-3
    Bolts, 46-9
    Joints, 53-4
    Rivets, 47-9, 51-8
Load Elongation Characteristics, 52-15, 59-41
Load Slip Characteristics, 59-15, 59-50
Long Bolted Joints, 60-2, 63-1, 63-10, 65-1, 65-9
Lugs, 56-6

M

Mackinac Bridge Project, 61-30
Magnesium, 50-2
Manual Torque Wrench, 55-5, 55-6
Masonite Joint, 52-6
Metals
    Aluminum, 59-15
    Chrome Nickel Steel, 59-15
    Zinc, 59-15
Minimum Bolt Tension Method, 57-2
Misalignment
    of Fasteners, 63-3
    of Holes, 59-33, 61-23, 63-8
Moment Joint, 59-13, 59-48, 60-16, 63-7
Moment-to-Shear Ratio, 61-21
Monoblock Specimens, 56-4

N

Net Area, 55-12, 60-2, 61-15, 61-20
Net Tension Stress, 58-14
Non-Slip Joints, 59-11
Nut Assemblies, 49-1

Nut Rotation, 59-37
Nuts, 31-1, 40-1, 48-6, 50-6, 54-7, 57-1, 57-4, 58-5, 59-2, 59-11, 61-13, 65-11
  Heavy Finished, 61-7
  Heavy Semi-Finished, 59-29
  Hexagonal, 47-2, 60-11, 61-20
  Lubrication, 51-2
  Specifications, 51-11, 58-17, 61-20
  Turns of Nut, 64-5

O

Optimum Target Value, 55-8
Oversize Holes, 60-4, 64-17

P

Painted Joints, 54-7, 57-19, 60-7
Photoelastic Techniques, 43-3, 48-2, 50-11, 62-18
Photostress Plastic, 59-47
Pipe Flanges, 45-6, 62-17
Pitch, 50-12, 64-3
  Bolt, 53-11, 61-9, 61-14, 65-8
  Rivet, 53-11, 55-2, 61-9
Plastic Analysis, 59-48, 60-3
  Bolted Joints, 60-3, 61-18
Plastic Deformation
  Plate, 60-22, 64-22
  Rivet, 60-22
Plastic Design of Bolted Joints, 59-48, 61-10, 64-1
Plastic Moment, 59-17, 60-8, 61-18, 62-21, 63-7, 63-14
Plastic Range of Bolts, 60-13
Plastic-Self Adjustment of Bolted Joints, 63-8
Plate Efficiencies, 55-17
Plate Fracture, 60-2
Plate Girders (see Girders)
Plated Finishes, 61-13
Pneumatic Hammer Riveting, 51-9
Pneumatic Impact Wrench, 48-3, 55-6, 55-8, 55-20, 57-25, 57-27, 59-20, 59-28, 60-13, 60-19, 60-34
Pressure Vessels, 45-6, 64-38
Pretensioned Bolts, 48-3, 52-9, 54-4, 54-5, 55-5, 55-8, 57-9, 57-10, 59-16, 59-17, 59-18, 59-22, 59-25, 60-19, 60-26, 60-27, 61-10, 61-27, 62-6, 63-3, 65-5
Pretensioning Bolted Joints, 57-9, 57-10, 59-31, 60-8
Profilm, 58-2
Properties
  Bolts, 54-3
  Rivets, 54-3
Protective Metal Coatings, 59-8, 59-15
Prolong Bolt, 59-21, 59-27
Proof Load
  Bolts, 58-6, 61-7, 61-11, 64-7
  Hexagonal Nuts, 58-6, 58-17
Prying Action, 57-14, 63-7, 64-23
Punched Holes, 61-23

R

Railway Bridges, 50-3, 55-10, 64-19, 64-29
  In Germany, 53-8, 54-10, 58-26, 62-16
RCRBSJ
  Formation, 60-10
  Organization, 50-6, 55-13, 57-13
  Projects, 50-6, 50-13, 51-11, 53-7, 55-20, 59-40, 61-16
  Report, 54-7
  Specifications, 51-11, 54-7, 60-35, 61-4, 62-13, 64-13, 65-6, 65-9
Relative Gage Method, 52-10, 53-1
Relaxation Test of Bolts, 59-38, 61-3, 61-4, 62-1, 62-20, 64-12
Repeated Loading, 50-4, 51-1, 53-2, 55-11, 64-27, 64-32
Research
  Bolts, 55-22, 56-11, 64-37
  German, 59-9
Resistance Characteristics

Bolts, 58-4
Frames, 58-4
Ribbed Bolts, 58-15, 59-7
Rigid Joints, 59-17, 60-8, 63-14, 64-21
Rigid Steel Frames, 59-13, 59-48
Rivet
Diameter, 52-16
Hole Preparation, 59-30
Holes, 50-11
In Tension, 44-6
Pattern, 45-7, 47-4, 47-6, 47-8, 49-5, 52-10, 53-7, 54-3, 55-2, 62-25
Rivet-Bolt, 46-1
Riveted Joint Efficiencies, 47-6, 56-8
Riveted Column, 57-26
Riveted Joints, 35-2, 40-4, 41-2, 42-2, 43-1, 44-8, 45-4, 45-7, 46-5, 47-4, 47-6, 47-8, 48-2, 49-3, 49-5, 51-3, 52-1, 52-2, 52-12, 53-1, 53-4, 53-5, 54-5, 55-1, 55-2, 55-9, 55-11, 55-14, 55-15, 55-16, 55-17, 55-34, 56-6, 56-8, 56-13, 57-21, 57-24, 57-32, 58-4, 58-12, 58-13, 59-1, 59-6, 59-32, 59-39, 59-48, 60-22, 60-31, 60-33, 61-2, 61-9, 61-15, 61-17, 61-23, 61-32, 62-4, 62-8, 64-8, 64-24, 64-34
Rivets, 44-1, 45-5, 47-9, 50-10, 50-12, 51-5, 51-8, 53-9, 55-4, 55-17, 57-13, 58-12, 58-13, 58-14, 58-16, 59-6, 60-1, 60-16, 60-23, 61-2, 61-8, 61-9, 61-12, 61-21, 62-11, 64-13, 64-34
Advantages, 53-9, 64-13
Aluminum, 51-9, 54-8
Behavior, 48-5, 60-22, 61-17
Carbon Steel, 44-1, 48-5, 61-22
Comparison, 52-14
Cost, 58-10, 58-15, 61-12, 62-14, 64-13
Design, 62-14
Development, 61-12
Disadvantages, 57-31, 64-13
Driving Method, 62-14
Manganese, 48-5, 61-22
Manufacturing Specifications, 62-14
Material, 46-6
Properties, 48-5, 52-12, 53-9, 64-13
Requirements, 46-1
Static Strength, 56-12
Stress Distribution, 59-47
Use, 59-35

S

Safety Factor, 55-12, 60-25, 63-9, 64-27
Semi-Killed Carbon Steel, 59-15
Semi-Rigid Joints, 40-3, 42-3, 52-3, 58-4, 59-51
Shear Failure of Riveted Joints, 58-12, 59-39
Shear Jig, 60-5
Shear Load, 57-18, 62-11, 63-1
Shear Ratio, 52-2
Shear Resistance
Bolts, 58-19
Joints, 63-12, 64-14
Shear Strength
Bolted Joints, 63-12
Bolts, 57-18, 58-19, 59-5, 60-2, 61-14
Riveted Joints, 44-5, 52-7, 62-8
Rivets, 52-7, 52-16, 61-12, 62-14
Shear Test, 57-18, 58-14, 59-13, 59-34, 60-35
Shearing Stress
Bolts, 55-14, 58-18
Riveted Joints, 58-14
Shock Capacity of Bolted Joints, 58-16
Shock Loading of Bolts, 60-21
Shop Erection, 61-12
Slip Coefficients, 58-13, 60-2, 61-14, 61-15, 62-12, 64-26, 65-8
Slip Load, 58-22, 60-21, 60-24, 62-22, 64-12, 64-14
Slip Resistance, 59-9, 60-26, 62-18, 63-13, 64-12, 64-35
Slippage, 49-4, 50-7, 50-13, 50-16,

51-6, 52-15, 53-3, 55-3, 55-5, 55-14, 55-18, 56-10, 56-15, 57-2, 57-15, 57-16, 57-17, 57-23, 57-24, 58-2, 58-13, 58-16, 58-18, 59-7, 59-12, 59-15, 59-16, 59-41, 60-2, 60-22, 61-14, 61-15, 61-21, 61-23, 61-31, 62-8, 62-12, 63-3, 63-8, 63-9, 64-11, 64-15, 64-27
Space Needle, 62-10
Specifications
  ASTM, 64-13
    Bolts, 50-6, 58-20, 60-16, 65-6
    Rivet and Bolt Steel, 46-6
  Bolt Holes, 57-4
  Fasteners, 60-20, 62-11
  Field Assembly of Bolts, 57-27
  High Strength Bolting, 62-13
  High Strength Bolts, 46-1, 50-8, 51-11, 53-3, 54-7, 58-17, 59-10, 59-40, 60-32, 60-34, 60-35, 62-13, 62-19
  Joints, 58-24, 60-10, 60-29, 62-21, 63-5, 63-9, 63-13
  Nuts, 58-17
  Rivets, 62-14
  Rivets and Bolts in Tension Joints, 61-19
  Semi-Rigid Beam-to-Column Joint, 47-8
Static Load, 55-3, 55-17, 55-18, 56-11, 56-15, 57-15, 57-16, 58-22, 59-12, 59-15, 60-21, 60-26, 61-8, 61-15
Static Preload, 54-4
Static Tension Test, 47-3, 51-2, 51-4, 52-15, 53-9, 55-17, 56-8, 57-17, 58-18,
  Bolted Joints, 50-16, 58-13, 59-33, 60-2, 61-15, 62-12
  Riveted Joints, 52-17, 59-32, 61-9, 62-8
Static Strength
  Bolted Joints, 52-12, 53-2, 58-16, 63-12
  Bolted vs. Riveted Joints, 55-14, 62-4
  Bolts, 54-5, 64-6
  Large Joints, 55-15
  Riveted Joints, 35-2, 40-4, 41-2, 42-2, 43-1, 44-8, 45-4, 45-7, 46-5, 47-4, 47-6, 47-8, 48-2, 49-3, 49-5, 51-3, 52-1, 52-2, 52-12, 53-1, 53-4, 53-5, 54-5, 55-1, 55-2, 55-9, 55-11, 55-14, 55-15, 55-16, 55-17, 55-34, 56-6, 56-8, 56-13, 57-21, 57-24, 57-32, 58-4, 58-12, 58-13, 59-1, 59-6, 59-32, 59-39, 59-48, 60-22, 60-31, 60-33, 61-2, 61-9, 61-15, 61-17, 61-23, 61-32, 62-4, 62-8, 64-8, 64-24, 64-34,
  Rivets, 56-12
Static Test
  Aluminum Bolted Joints, 51-4, 54-4
  Aluminum Riveted Joints, 53-4
  Bolted Joints, 50-7, 52-2, 53-2, 55-14, 56-11, 58-20, 60-34, 61-5
  Riveted Joints, 52-2, 52-5, 53-5, 54-5, 55-11, 58-14
  Structural Joints, 59-49
Steel Railway Bridge Cost, 55-7
Steels
  Carbon, 53-10
  Low-Alloy, 53-10
  Rimmed, 53-10
  Silicon, 53-10
  Stainless, 55-34, 65-10
  Stiffeners, 61-2
Strain Gages, 45-3
Strain Hardening of Flange, 57-14
Stress Concentration Factor, 56-6
Stress Distribution, 40-1, 43-3, 47-7, 50-4, 50-14, 52-6, 52-18, 52-19, 53-13, 55-4, 58-22, 59-47, 60-6, 60-9, 61-32, 62-18, 62-20, 64-9, 64-11
Stress Ratio, 55-15
Structural Joints, 46-3, 47-7, 51-1, 52-6, 52-19, 53-8, 54-3, 55-11, 58-4, 59-7, 59-25, 62-7, 62-19,

63-5, 63-12, 64-24, 64-31, 65-12
Structural Steel, 62-11
Bolt Steel, 46-6
Material, 51-6, 53-1
Rivet Steel, 46-6

T

Temperature Effects, 52-10
Tensile Strain Concentration, 55-19
Tensile Strength, 53-10, 57-23, 61-17
Bolts, 47-2
Rivets, 52-7, 62-14
Tensile Strength to Shear Strength, 59-3
Tensile Stress Concentration, 55-19
Tension Control of High Strength Bolts, 51-13, 55-5
Tension Joint, 47-5, 57-18, 64-6
Tension Load, 47-5, 57-18, 64-6
Tension Member Analysis, 55-12, 97-1
Tension Shear Ratio, 52-16, 55-3, 55-11, 55-16, 56-5, 58-13, 59-3, 60-21, 61-15
Tension-Shear-Bearing, 52-15, 54-2, 55-17
Tension Test, 55-18, 57-23, 58-7, 58-14, 59-50, 61-4, 63-7
Bolts, 61-7
Rivets, 59-1, 59-32
Tensioning Bolts, 55-7, 59-11, 61-29
Testing Equipment, 59-50, 59-51, 64-8
Thread Length, 59-37, 60-11, 62-2, 63-2
Thread Lubrication, 61-2, 63-2
Tightening
High Strength Bolts, 48-3, 56-14, 57-5, 58-7, 59-36, 59-41, 61-24, 61-25, 61-27, 61-28, 62-13, 64-10
Fitting Up Bolts, 61-25, 61-28
Tightening Characteristics
Bolt and Nut Assemblies, 49-1
Torsional Shear Failure, 46-7
Torque, 31-1, 44-7, 47-2, 49-2, 53-2, 54-9, 55-20, 57-4, 57-25, 59-12, 59-17, 59-31, 59-37, 60-18, 60-24, 61-1, 61-7, 61-13, 61-27, 64-5
Torque Application Practices, 49-1, 56-7
Torque Calibration, 59-29
Torque Coefficient Technique, 57-9, 60-33, 62-5
Torque Failure of Bolts, 47-2
Torque Tension Relationship, 31-1, 53-16, 57-5, 59-4, 59-14, 59-50, 60-19
Torque-Tension Ratio, 44-7
Torque-Tension Test of Bolts, 51-2, 59-37, 62-2, 62-21, 63-2, 64-7
Torqued Strength of Bolts, 56-16, 58-9, 61-7, 62-1
Torshear Bolt, 59-21, 59-25, 59-27, 59-28, 60-33
Torsion, 53-11
Torsional Shear Strains, 45-3
Traverse Shear Stress, 45-3
Truss Bridge Project, 60-36
Truss Type Joint, 52-6, 55-4, 55-11, 57-20, 58-11, 59-4, 59-30
Riveted, 58-12
Turn Limiting Technique, 57-9
Turn-of-the-Nut Method, 48-3, 55-5, 55-6, 55-7, 55-8, 55-10, 56-7, 57-2, 57-15, 57-25, 58-9, 58-13, 58-28, 59-21, 59-22, 59-38, 59-50, 60-2, 60-13, 60-15, 60-27, 60-33, 61-15, 61-23, 61-26, 61-27, 61-29, 62-5, 62-13, 62-21, 63-12, 64-17
Twist-off-Bolt Failure, 46-7

U

UN Secretariat, 50-10
Unbuttoning, 61-14, 63-1
Unfinished Bolts, 58-15
Unknown Bolt Forces, 60-21
Ultimate Double Shear Strength of Bolts, 59-5
Ultimate Load of Bolted Joints, 60-21, 64-4
Ultimate Strength
Bolted Joints, 54-3, 60-21, 61-9, 61-11, 63-10, 63-12,
[illegible], [illegible], [illegible]

64-3, 64-18, 64-23
Bolts, 54-5, 56-5, 59-29, 62-20, 64-22
Bolts in Joints, 60-21
Columns, 57-26
Riveted Joints, 53-4, 61-9, 64-18
Rivets, 52-16, 56-12, 64-22

V

Vehicle Assembly Building, 65-10
Vibration, 57-17
Vibrational Loads, 50-5, 53-8
Bolted vs. Riveted Joints, 50-3

W

Washers, 50-6, 50-16, 55-4, 59-11, 59-29, 60-4, 60-14, 61-3, 61-13, 62-3, 62-13, 64-17, 65-6, 65-24
Web Clips, 63-7
Web Joint, 50-12, 60-31, 64-32
Web Plate, 60-9
Weld Construction, 58-25, 62-10
Weld Size, 53-11
Welded Joint, 38-1, 42-3, 44-9, 45-4, 48-2, 49-3, 59-9, 64-21
Welding Cost, 58-10
Wood Joint, 60-29, 64-36
Wrenches, 59-23, 59-24, 59-28
Wrought Iron, 53-1

Y

Yield Point
Bolts, 23-1, 57-18
Joint, 61-11, 62-25
Yield Strength
Bolts, 48-1
Rivets, 56-12
Steel, 53-10

## 8. CROSS REFERENCE TO REPORT 302.1

| Report 302.1 | Report 302.2 | Report 302.1 | Report 302.2 | Report 302.1 | Report 302.2 |
|---|---|---|---|---|---|
| 1 | 44-1 | 43 | 51-6 | 85 | 55-7 |
| 2 | 44-7 | 44 | 51-7 | 86 | 55-8 |
| 3 | 44-6 | 45 | 51-8 | 87 | 55-9 |
| 4 | 45-3 | 46 | 51-9 | 88 | 55-10 |
| 5 | 45-5 | 47 | 51-10 | 89 | 56-17 |
| 6 | 45-6 | 48 | 51-11 | 90 | 55-12 |
| 7 | 46-1 | 49 | 51-4 | 91 | 55-13 |
| 8 | 46-4 | 50 | 51-5 | 92 | 55-14 |
| 9 | 46-5 | 51 | 52-1 | 93 | 55-15 |
| 10 | 46-6 | 52 | 52-9 | 94 | 55-16 |
| 11 | 46-7 | 53 | 52-2 | 95 | 55-17 |
| 12 | 46-8 | 54 | 52-6 | 96 | 55-18 |
| 13 | 46-9 | 55 | 52-10 | 97 | 55-19 |
| 14 | 47-5 | 56 | 52-12 | 98 | 55-20 |
| 15 | 47-8 | 57 | 52-14 | 99 | Deleted |
| 16 | 47-1 | 58 | 53-15 | 100 | 56-4 |
| 17 | 47-2 | 59 | 52-16 | 101 | 56-5 |
| 18 | 47-9 | 60 | 52-3 | 102 | 56-6 |
| 19 | 48-2 | 61 | 52-4 | 103 | 56-8 |
| 20 | 48-3 | 62 | 53-1 | 104 | 58-14 |
| 21 | 48-1 | 63 | 53-2 | 105 | 56-9 |
| 22 | 48-4 | 64 | 53-4 | 106 | 56-10 |
| 23 | 49-1 | 65 | 53-7 | 107 | 56-11 |
| 24 | 50-16 | 66 | 53-8 | 108 | 56-12 |
| 25 | 50-15 | 67 | 53-3 | 109 | 57-1 |
| 26 | 49-4 | 68 | 53-9 | 110 | 57-2 |
| 27 | 49-2 | 69 | 53-10 | 111 | 57-4 |
| 28 | 50-4 | 70 | 53-11 | 112 | 57-8 |
| 29 | 50-5 | 71 | 54-2 | 113 | 57-23 |
| 30 | 50-6 | 72 | 54-3 | 114 | 57-26 |
| 31 | 50-7 | 73 | 54-4 | 115 | 57-9 |
| 32 | 51-1 | 74 | 54-5 | 116 | 57-10 |
| 33 | 50-3 | 75 | 55-1 | 117 | 57-27 |
| 34 | 50-13 | 76 | 54-7 | 118 | 57-13 |
| 35 | 50-2 | 77 | 54-8 | 119 | 57-14 |
| 36 | 50-8 | 78 | 54-9 | 120 | 57-15 |
| 37 | 50-9 | 79 | 55-11 | 121 | 57-16 |
| 38 | 50-10 | 80 | 55-2 | 122 | 57-17 |
| 39 | 50-11 | 81 | 55-3 | 123 | 57-18 |
| 40 | 50-12 | 82 | 55-4 | 124 | 57-24 |
| 41 | 51-2 | 83 | 55-5 | 125 | 57-25 |
| 42 | 51-3 | 84 | 55-6 | 126 | 58-2 |

## 8. CROSS REFERENCE LIST

| Report 302.1 | Report 302.2 | Report 302.1 | Report 302.2 | Report 302.1 | Report 302.2 |
|---|---|---|---|---|---|
| 127 | 58-3 | 169 | 59-37 | 211 | 61-25 |
| 128 | 58-4 | 170 | 59-38 | 212 | 61-26 |
| 129 | 58-15 | 171 | 59-41 | 213 | 61-27 |
| 130 | 59-49 | 172 | 59-47 | 214 | 61-28 |
| 131 | 58-10 | 173 | 60-1 | 215 | 61-29 |
| 132 | 58-12 | 174 | 60-4 | 216 | 61-30 |
| 133 | 58-13 | 175 | 60-2 | 217 | 62-2 |
| 134 | 58-17 | 176 | 60-35 | 218 | 62-3 |
| 135 | 58-16 | 177 | 60-36 | 219 | 62-6 |
| 136 | 58-18 | 178 | 60-5 | 220 | 62-7 |
| 137 | 58-19 | 179 | 60-34 | 221 | 62-8 |
| 138 | 59-1 | 180 | 60-8 | 222 | 62-10 |
| 139 | Deleted | 181 | 60-9 | 223 | 62-11 |
| 140 | 59-2 | 182 | 60-10 | 224 | 62-12 |
| 141 | 59-3 | 183 | 60-11 | 225 | 62-13 |
| 142 | 59-5 | 184 | 60-12 | 226 | 62-14 |
| 143 | 59-48 | 185 | 60-13 | 227 | Deleted |
| 144 | 59-32 | 186 | 60-14 | 228 | 63-1 |
| 145 | 59-6 | 187 | 60-15 | 229 | 63-2 |
| 146 | 59-7 | 188 | 60-16 | 230 | 63-3 |
| 147 | 59-9 | 189 | 60-17 | 231 | 63-7 |
| 148 | 59-10 | 190 | 60-18 | 232 | 63-8 |
| 149 | 59-11 | 191 | 60-21 | 233 | 64-17 |
| 150 | 59-12 | 192 | 60-22 | 234 | 63-12 |
| 151 | 59-13 | 193 | 60-24 | 235 | 64-3 |
| 152 | 59-14 | 194 | 61-7 | 236 | 64-4 |
| 153 | 59-15 | 195 | 61-10 | 237 | 64-5 |
| 154 | 59-16 | 196 | 61-11 | 238 | 64-6 |
| 155 | 59-17 | 197 | 61-12 | 239 | 64-7 |
| 156 | 59-18 | 198 | 61-13 | 240 | 64-8 |
| 157 | 59-19 | 199 | 61-9 | 241 | 64-13 |
| 158 | 59-20 | 200 | 61-14 | 242 | 54-11 |
| 159 | 59-21 | 201 | 61-15 | 243 | 56-22 |
| 160 | 59-22 | 202 | 61-16 | 244 | 59-54 |
| 161 | 59-23 | 203 | 61-17 | 245 | 60-37 |
| 162 | Deleted | 204 | 61-18 | 246 | 63-16 |
| 163 | 59-29 | 205 | 61-19 | 247 | 63-17 |
| 164 | 59-30 | 206 | 61-20 | 248 | 63-18 |
| 165 | 59-31 | 207 | 61-21 | 249 | 63-20 |
| 166 | 59-33 | 208 | 61-22 | 250 | 63-19 |
| 167 | 59-34 | 209 | 61-23 | 251 | 64-21 |
| 168 | 59-35 | 210 | 61-24 | | |

# 9. LIST OF REFERENCES

Following is a chronological listing of reports in which the number is identical with that used in the abstracts.


97-1 Greiner, J. E.
RECENT TESTS OF BRIDGE MEMBERS, Transactions, ASCE, Vol. 38, December, 1897

23-1 Deming, G. M.
THE STRENGTH OF BOLT THREADS AS AFFECTED BY INACCURATE MACHINING, Mechanical Engineering, Vol. 45, 1923

31-1 Whittemore, H. L., Nusbaum, G. W., and Seaquist, E. O.
THE RELATION OF TORQUE TO TENSION FOR THREAD-LOCKING DEVICES, U. S. Bureau of Standards, Journal of Research, Vol. 7, 1931, pp. 945-1016

35-1 Whittemore, H. L., Seaquist, E. O., and Nusbaum, G. W.
IMPACT AND STATIC TENSILE PROPERTIES OF BOLTS, U. S. Bureau of Standards, Journal of Research, Vol. 14, 1935, pp. 139-188

35-2 Chapin, C. H.
THE NET SECTION OF RIVETED TENSION MEMBERS, Proceedings, AREA, Vol. 36, 1935, pp. 775-779

36-1 Brueggeman, W. C.
MECHANICAL PROPERTIES OF ALUMINUM-ALLOY RIVETS, NACA Technical Note 585, November, 1936

38-1 Korber, F., and Hempel, M.
THE BEHAVIOR OF WELDED AND BOLTED BEAM COLUMN CONNECTIONS IN STATIC AND FATIGUE BENDING, Welding Journal, Vol. 17, March, 1938, pp. 23-30

40-1 Goodier, J. N.
THE DISTRIBUTION OF LOAD ON THE THREADS OF SCREWS, ASME Transactions, Vol. 62, 1940, pp. A10-A16

40-2 Rust, T. H.
SPECIFICATION AND DESIGN OF STEEL GUSSET-PLATES, Transactions, ASCE, Vol. 105, Proc, Paper No. 2058, 1940, pp. 142

40-3 Johnston, B. and Hechtman, R. A.
DESIGN ECONOMY BY COLUMN RESTRAINT, Engineering News Record, Vol. 125, October, 1940, pp. 484-487

40-4 Brueggeman, W. C. and Roop, F. C.
MECHANICAL PROPERTIES OF FLUSH RIVETED JOINTS, NACA Report No. 701, 1940

41-1 Hartmann, E. C.
FATIGUE TESTS RESULTS, THEIR USE IN DESIGN CALCULATIONS, Product Engineering, February, 1941, pp. 74-78

41-2 Templin, R. L. and Hartmann, E. C.
STATIC AND REPEATED LOAD TEST OF ALUMINUM ALLOY AND STEEL RIVETED HULL PLATE SPLICES, Alcoa Research Laboratories Technical Paper, No. 5, 1941

42-1 Brueggeman, W. C.
MECHANICAL PROPERTIES OF FLUSH-RIVETED JOINTS SUBMITTED BY FIVE AIRPLANE MANUFACTURERS, NACA Wartime Report W-79, February, 1942

42-2 Levy, S., McPherson, A. E., and Ramberg, W.
EFFECT OF RIVET AND SPOT WELD SPACING ON THE STRENGTH OF AXIALLY LOADED SHEET STRINGER PANELS OF 24ST ALUMINUM ALLOY, NACA Technical Note 856, August, 1942

42-3 Johnston, B., and Mount, E. H.
ANALYSIS OF BUILDING FRAMES WITH SEMI-RIGID CONNECTIONS, Transactions, ASCE, Vol. 107, 1942, pp. 993-1019

43-1 Sharp, W. H.
THE EFFECT OF THE TYPE OF SPECIMEN ON THE SHEAR STRENGTHS OF DRIVEN RIVETS, NACA Technical Note 916, November, 1943

43-2 Arnold, S. M.
EFFECT OF SCREW THREADS ON FATIGUE, Mechanical Engineering, Vol. 65, pp. 497-505, 1943

43-3 Hetenyi, M.
A PHOTOELASTIC STUDY OF BOLT AND NUT FASTENINGS, Transactions, ASME, Vol. 65, 1943, pp. A93-A100

43-4 Hartmann, E. C., Wescoat, C. F., and Brennecke,
PRESCRIPTIONS FOR HEAD CRACKS IN 24S-T RIVETS, Aviation, November, 1943

44-1 Maney, G. A.
CLAMPING FORCE . . . . THE SILENT PARTNER IN RIVETED JOINT DEPENDABILITY, Fasteners, Vol. 1, No. 2, 1944, pp. 12-14

44-2 Hartmann, E. C. and Wescoat, C. F.
THE SHEAR STRENGTH OF ALUMINUM ALLOY DRIVEN RIVETS AS AFFECTED BY INCREASING D/t RATIOS, NACA Technical Note 942, July, 1944

44-3 Hartmann, E. C., Hoglund,G. O., and Miller, M. A.
JOINING ALUMINUM ALLOYS, Steel, Vol. 1151, September 11, 1944, pp. 116

44-4 Zamboky, A. N.
ARTIFICIAL AGING OF RIVETED JOINTS MADE IN ALCLAD 24S-T SHEET USING A17S-T, 17S-T, and 24S-T RIVETS, NACA Technical Note 948, September, 1944

44-5 Hartmann, E. C., Lyst, J. O., and Andrews, H. J.
FATIGUE TESTS OF RIVETED JOINTS: PROGRESS OF TESTS OF 17S-T AND 53-T JOINTS, NACA Advance Restricted Report 4115, September, 1944

44-6 Wilson, W. M.
DO RIVETS RETAIN THEIR INITIAL TENSION?, Civil Engineering, Vol.14, No. 10, October, 1944, pp. 437-438

44-7 Stewart, W. C.
WHAT TORQUE?, Fasteners, Vol. 1, No. 4, 1944, pp. 8-10

44-8 Moisseiff, L. S., Hartmann, E. C., and Moore, R. L.
RIVETED AND PIN-CONNECTED JOINTS OF STEEL AND ALUMINUM ALLOYS, Transactions, ASCE, Paper No. 2233, Vol. 109, pp. 1359-1396

44-9 Wilson, W. M., Bruckner, W. H., Duberg, J. E., and Beede, M. C.
FATIGUE STRENGTH OF FILLET-WELD AND PLUG-WELD CONNECTIONS IN STEEL STRUCTURAL MEMBERS, Bulletin No. 350, University of Illinois Engineering Experiment Station, 1944

45-1 Hartmann, E. C., Hoglund, G. O., and Miller, M. A.
METHODS OF JOINING ALUMINUM-ALLOY PRODUCTS, Transactions, ASME, Vol. 67, No. 1, January, 1945, pp. 1-21

45-2 Andrews, H. J., and Holt, M.
FATIGUE TESTS ON 1/8 INCH ALUMINUM ALLOY RIVETS, NACA Technical Note, February, 1945

45-3 Maney, G. A.
BOLT STRESS MEASUREMENTS BY ELECTRICAL STRAIN GAGES, Fasteners, Vol. 2, No. 1, 1945, pp. 10-13

45-4 Moore, R. L., and Hill, H. N.
COMPARATIVE FATIGUE TESTS OF RIVETED JOINTS OF ALCLAD 24S-T, ALCLAD 24S-T81, ALCLAD 24S-RT, ALCLAD 24S-T86, AND ALCLAD 75S-T SHEET, NACA, Bulletin No. SF11, August, 1945

45-5 Fasteners
COLD RIVETING GAINS ACCEPTANCE, Fasteners, Vol. 2, No. 3, 1945, pp. 16-17

45-6 Crocker, S.
BOLTING FOR PIPE FLANGES AND PRESSURE VESSELS, Fasteners, Part 1, in Vol. 2, No. 4, 1945, pp. 4-7, and Part 2, in Vol. 3, No. 1, 1946, pp. 16-18

45-7 Wilson, W. M., and Ozell, A. M.
INVESTIGATION OF THE STRENGTH OF RIVETED JOINTS IN COPPER SHEETS, Bulletin No. 360, University of Illinois Engineering Experiment Station, 1945

46-1 Frankland, F. H.
MORE EFFECTIVE USE OF RIVETS AND BOLTS, Engineering News Record, March 7, 1946, pp. 85-87

46-2 Hartmann, E. C. and Zamboky, A. N.
COMPARISON OF STATIC STRENGTHS OF MACHINE COUNTERSUNK RIVETED JOINTS IN 24S-T, X7S5-T, AND ALCLAD 75S-T SHEET, NACA Technical Note 1036, May, 1946

46-3 Holt, M.
FATIGUE FAILURES OF BOLTED, WELDED, AND RIVETED CONNECTIONS, Proceedings, Society of Experimental Stress Analysis, Vol. 3, No. 2, pp. 131, 1946

46-4 Jackson, L. R., Wilson, W. M., Moore, H. F., and Grover, H. J.
THE FATIGUE CHARACTERISTICS OF BOLTED LAP JOINTS OF 24S-T ALCLAD SHEET MATERIALS, NACA, TN 1030, October, 1946

46-5 Maney, G. A.
REPEATED LOADS ON RIVET JOINTS, Fasteners, Vol. 3, No. 2, 1946, pp. 14-15

46-6 Frankland, F. H.
RIVETS AND BOLTS IN STRUCTURAL DESIGN, Fasteners, Vol. 3, No. 3, 1946, pp. 4-6, 18

46-7 Maney, G. A.
WHAT HAPPENS WHEN A BOLT IS TWISTED OFF?, Fasteners, Vol. 3, No. 4, 1946, pp. 12-16

46-8 Maney, G. A.
PREDICTING BOLT TENSION, Fasteners, Vol. 3, No. 5, 1946, pp. 16-18

46-9 Tate, M. B., and Rosenfeld, S. G.
PRELIMINARY INVESTIGATION OF THE LOADS CARRIED BY INDIVIDUAL BOLTS IN BOLTED JOINTS, NACA, TN 1051, 1946

47-1 Millard, E. H.
HALF A CENTURY OF COLD RIVETING, Fasteners, Vol. 4, No. 1, 1947, pp. 7-9

47-2 Hill, H. O.
DOES TORQUE WEAKEN BOLTS?, Fasteners, Vol. 4, No. 1, 1947, pp. 10-12

47-3 Boiten, R. G.
HEF GEDRAG VAN OP TREK BELASK VERBINDINGEN, BESTAANDE UIT STRIPPEN, DIE DOOR EEN BOUT OP EL KARR WORDEN GEKLEMD. (CONNECTIONS SUBJECTED TO TENSION FORCES, CONSISTING OF LONG PLATES WHICH ARE CONNECTED BY BOLTS). De Ingenieur, Vol. 59, No. 2, 1947, Holland, pp. 1-7

47-4 Fefferman, R. L., and Langhaar, H. L.
INVESTIGATION OF 24S-T RIVETED TENSION JOINTS, Journal of the Aeronautical Sciences, Vol. 14, No. 3, March, 1947, pp. 133-147

47-5 Pancoast, R. H.
THE EFFECT ON BOLT SHEARING STRENGTH OF VARIOUS AMOUNTS OF TENSILE STRESS SIMULTANEOUSLY APPLIED, B. S. Thesis, Fenn College, May, 1947

47-6 Badir, M.
THE EFFECT OF RIVET PATTERN ON THE STRENGTH OF RIVETED JOINTS, M. S. Thesis, University of Illinois, 1947

47-7 Hendry, A. W.
THE TESTING OF STRUCTURAL CONNECTIONS, Engineering, Vol. 164, No. 4259, September 12, 1947, London, pp. 261-263

47-8 Hechtman, R. A., and Johnston, B. G.
RIVETED SEMI-RIGID BEAM-TO-COLUMN BUILDING CONNECTIONS, Committee on Steel Structures Research, No. 206, AISC, November, 1947

47-9 Vogt, F.
THE DISTRIBUTION OF LOADS ON RIVETS CONNECTING A PLATE TO A BEAM UNDER TRANSVERSE LOADS, NACA, TN No. 1134, 1947

48-1 Kelly, J. J.
DESIGN FACTORS FOR THREADED FASTENERS, Fasteners, Vol. 5, No. 1, 1948, pp. 16-18

48-2 Langdon, Howard, H., and Fried, Bernard
FATIGUE OF GUSSETED JOINTS, NACA, TN 1514, September, 1948

48-3 Grinter, L. E.
STRESSES IN GUSSET PLATES BY USE OF AN ANALOGOUS GRID (WITH APPENDIX ON PROBLEM ANALYSIS by Marvin Mass), Proceedings, IABSE, Vol. 8, September, 1948

48-4 Lipson, C.
DESIGNING BOLTS TO RESIST SHOCK LOADING, Fasteners, Vol. 5, No. 3, 1948, pp. 4-6

48-5 Hechtman, R. A.
A STUDY OF THE EFFECTS OF HEATING AND DRIVING CONDITIONS ON HOT-DRIVEN STRUCTURAL STEEL RIVETS, Ph.D. Thesis, University of Illinois, September, 1948

48-6 Sopwith, D. G.
THE DISTRIBUTION OF LOAD IN SCREW THREADS, Proceedings, Institution of Mechanical Engineers, Vol. 159, London, pp. 373-383, 1948

48-7 Hartmann, E. C., Miller, M. A., and Stroup, P. T.
JOINING ALUMINUM ALLOYS, National Metals Handbook, 1948, pp. 777-786

48-8 Richart, F. E.
A PROCEDURE FOR EVALUATING CUMULATIVE DAMAGE IN FATIGUE, Ph.D. Dissertation, University of Illinois, 1948

48-9 Randall, P. N.
FACTORS INFLUENCING THE STRENGTH AND DUCTILITY OF SLOTTED TENSILE SPECIMENS OF STRUCTURAL STEEL PLATE, Ph.D. Dissertation, University of Illinois, 1948

49-1 Pickel, W. F.
TIGHTENING CHARACTERISTICS OF NUT AND STUD ASSEMBLIES, Product Engineering, January, 1949

49-2 Kovac, J. J.
PRELOADING INTERNAL WRENCHING BOLTS, Fasteners, Vol. 6, No. 2, 1949, pp. 10-12

49-3 Ros, M. and Ceradine, G.
STATIC AND FATIGUE TESTS WITH DIFFERENT TYPES OF COVER STRAPS WELDED ON AND MACHINED FROM THE SOLID STEEL MATERIAL AND ALSO WITH LAP JOINTS, Bericht Nr. 168, EMPA, Zurich, 1949

49-4 Hechtman, R. A.
CONDITIONS AFFECTING THE SLIP OF STRUCTURAL STEEL BOLTED JOINTS, The Trend in Engineering, University of Washington, Vol. 1, No. 4, October 1949, pp. 12-18

49-5 Cayci, M. A.
FATIGUE STRENGTH OF RIVETED JOINTS, M. S. Thesis, University of Illinois, 1949

49-6 Wilson, W. M., and Munse, W. H.
THE FATIGUE STRENGTH OF VARIOUS DETAILS USED FOR THE REPAIR OF BRIDGE MEMBERS, Bulletin No. 382, University of Illinois Engineering Experiment Station, 1949

49-7 Lenzen, K. H.
BOLTED JOINTS UNDER FATIGUE LOADING, Fasteners, Vol. 6, No. 1, 1949, pp. 6-9 (See Abstract 50-16)

49-8 Pickel, W. F.
TIGHTENING CHARACTERISTICS OF NUT AND STUD ASSEMBLIES, Fasteners, Vol. 6, No. 1, 1949, pp. 10-13 (See Abstract 49-1)

49-9 Lenzen, K. H.
THE EFFECT OF VARIOUS FASTENER ON THE FATIGUE STRENGTH OF A STRUCTURAL JOINT, Bulletin 480, AREA, June-July, 1949 (See Abstract 50-16)

49-10 RCRBSJ
PROGRESS REPORT OF RESEARCH COUNCIL ON RIVETED AND BOLTED STRUCTURAL JOINTS, Bulletin 482, AREA, September-October, 1949 (See Abstract 50-13)

49-11 Wyly, L. T., Scott, M. B., McCammon, L. B., and Lindner, C. W.
A STUDY OF THE BEHAVIOR OF FLOOR BEAM HANGARS, Bulletin 482, AREA, September-October, 1949 (See Abstract 50-15)

50-1 Holt, M.
RESULTS OF SHEAR FATIGUE TESTS OF JOINTS WITH 3/16 INCH DIAMETER 24S-T31 RIVETS IN 0.064 INCH THICK ALCLAD SHEET, NACA Technical Note 2012, February, 1950

50-2 Milliken, M. P.
HOW TIGHT IS TOO TIGHT?, Fasteners, Vol. 6, No. 1, 1950, pp. 14-17

50-3 AREA Committee on Iron and Steel Structures
USE OF HIGH STRENGTH STRUCTURAL BOLTS IN STEEL RAILWAY BRIDGES, Proceedings, AREA, Vol. 51, March, 1950, pp. 506-540

50-4 Wyly, L. T.
SYMPOSIUM ON HIGH-STRENGTH BOLTS, Part I, Proceedings, AISC, April 12, 1950, pp. 22-27

50-5 Ruble, E. J.
SYMPOSIUM ON HIGH-STRENGTH BOLTS, Part II, Proceedings, AISC, April 12, 1950, pp. 27-31

50-6 Stewart, W. C.
SYMPOSIUM ON HIGH-STRENGTH BOLTS, Part III, Proceedings, AISC, April 12, 1950, pp. 31-36

50-7 Munse, W. H., Schutz, F. W., Jr., and Cox, H. L.
STATIC AND FATIGUE TESTS OF BOLTED STRUCTURAL LAP JOINTS, SRS No. 3, Department of Civil Engineering, University of Illinois, Urbana, July, 1950

50-8 Harvey, C. L.
HIGH STRENGTH STEEL BOLTS, Fasteners, Vol. 6, No. 3, 1950, pp. 10-12

50-9 Pinkel, R. H.
DETERMINING BOLT LOAD ELONGATION CURVES, Fasteners, Vol. 6, No. 4, 1950, pp. 8-9

50-10 Merritt, F. S.
UN SECRETARIAT USED UNUSUALLY LARGE RIVETS, Fasteners, Vol. 6, No. 4, 1950, pp. 12-14

50-11 Wyly, L. T., and Carter, J. W.
STRESSES NEAR BOLT AND RIVET HOLES, Fasteners, Vol. 6, No. 4, 1950, pp. 15-17

50-12 Lappo, T.
EXTRA FLANGE RIVETS FOR WEB SPLICE EASILY COMPUTED, Civil Engineering, Vol. 20, 1950, p. 786

50-13 RCRBSJ
PROGRESS REPORT OF RESEARCH COUNCIL ON RIVETED AND BOLTED STRUCTURAL JOINTS, Proceedings, AREA, Vol. 51, 1950, pp. 74-86

50-14 AREA Committee on Iron and Steel Structures
STRESS DISTRIBUTION IN BRIDGE FRAMES-FLOORBEAM HANGERS, Proceedings, AREA, Vol. 51, 1950, pp. 470-503

50-15 Wyly, L. T., Scott, M. B., McCammon, L. B., and Lindner, C. W.
A STUDY OF THE BEHAVIOR OF FLOORBEAM HANGERS, Proceedings, AREA, Vol. 51, 1950, pp. 51-73

50-16 Lenzen, K. H.
THE EFFECT OF VARIOUS FASTENERS ON THE FATIGUE STRENGTH OF A STRUCTURAL JOINT, Proceedings, AREA, Vol. 51, 1950, pp. 1-28

50-17 Dolan, T. J. and McClow, J. H.
THE INFLUENCE OF BOLT TENSION AND ECCENTRIC TENSILE LOADS ON THE BEHAVIOR OF A BOLTED JOINT, Proceedings, Society for Experimental Stress Analysis, Vol. 8, No. 1, 1950, pp. 29-43

50-18 Navy Department
BOLT DESIGNS UNDER SHOCK LOADING, NRL Problem No. 38F03-20T, Naval Research Laboratory, Washington, D. C., February, 1950

50-19 Chu, K.
A STUDY OF DESIGN SPECIFICATIONS FOR STEEL BRIDGES, Ph.D. Dissertation, University of Illinois, 1950

50-20 Wilson, W. M., Munse, W. H., and Cayci, M. A.
THE EFFECT OF THE RIVET PATTERN ON STATIC STRENGTH OF RIVETED JOINT CONNECTING PLATES, Department of Civil Engineering, University of Illinois, Progress Report Project II, January, 1950. (See Abstract 52-10)

50-21 Lind, H. H.
COOPERATIVE RESEARCH, Fasteners, Vol. 6, No. 3, 1950, pp. 8-9, (See Abstract 50-13)

50-22 Ruble, E. J.
USE OF HIGH STRENGTH STRUCTURAL BOLTS IN STEEL RAILWAY BRIDGES, Fasteners, Vol. 6, No. 4, 1950, pp. 3-5 (See Abstract 50-3)

51-1 Wilson, W. M.
HIGH-STRENGTH BOLTS AS A MEANS OF FABRICATING STEEL STRUCTURES, Proceedings, Highway Research Board, 1951, pp. 136-143

51-2 Wright, D. T., and Munse, W. H.
CALIBRATION TESTS OF HIGH STRENGTH BOLTS, Department of Civil Engineering, University of Illinois, SRS No. 9, January, 1951

51-3 Becker, W. K., Sinnamon, G. K., and Munse, W. H.
THE EFFECT OF BEARING PRESSURE ON THE STATIC STRENGTH OF RIVETED JOINTS, Department of Civil Engineering, University of Illinois, SRS No. 8, January, 1951.

51-4 Hartmann, E. C., Holt, M., and Eaton, I. D.
STATIC AND FATIGUE STRENGTHS OF HIGH-STRENGTH ALUMINUM ALLOY BOLTED JOINTS, NACA TN 2276, Washington, February, 1951

51-5 Fasteners
MORE THAN A MILLION POUNDS OF FASTENERS, Fasteners, Vol. 7, No. 1, 1951, pp. 5-6

51-6 Young, D. R., and Hechtman, R. A.
SLIP OF STRUCTURAL STEEL DOUBLE-LAP JOINTS ASSEMBLED WITH HIGH STRENGTH BOLTS, The Trend in Engineering, Part I in April 1951, pp. 24-27, and Part II in July 1951, pp. 23-26

51-7 Higgins, T. R.
BOLTED JOINTS FOUND BETTER UNDER FATIGUE, Engineering News Record, Vol. 147, August 2, 1951, pp. 35-36

51-8 Redshaw, S. C.
THE DESIGN CHARACTERISTICS OF ALUMINUM RIVETED JOINTS, Symposium on Welding and Riveting Larger Aluminum Structures, London, November, 1951, pp. 155-175.

51-9 Bailey, J. C.
THE PROPERTIES AND DRIVING OF LARGE ALUMINUM ALLOY RIVETS, Symposium on Welding and Riveting Larger Aluminum Structures, London, November, 1951, pp. 133-154.

51-10 Delaney, T. J.
COLD RIVETING USED IN FIRST ALL-ALUMINUM HIGHWAY BRIDGE, Fasteners, Vol. 7, No. 2, 1951, pp. 5-6

51-11 Ruble, E. J.
STRUCTURAL DESIGNERS ACCEPT HIGH STRENGTH BOLTS, Fasteners, Vol. 7, No. 2, 1951, pp. 7-10

51-12 Eaton, I. D., and Holt, M.
FLEXURAL - FATIGUE STRENGTHS OF RIVETED BOX-BEAMS ALCLAD 14S-T6, ALCLAD 75S-T6, AND VARIOUS TEMPERS OF ALCLAD 24S, NACA Technical Note 2452, November, 1951

51-13 Stang, A. H.
THE TENSILE FORCES IN TIGHTENED BOLTS, Product Engineering, February, 1951

51-14 Carter, J. W.
STRESS CONCENTRATION IN BUILT-UP STRUCTURAL MEMBERS AND ITS EFFECT ON THEIR ENDURANCE LIMIT, Ph.D. Dissertation, Purdue University, 1951 (See Abstract 52-19)

51-15 Becker, W. K.
THE EFFECT OF BEARING PRESSURE ON THE STATIC STRENGTH OF RIVETED JOINTS, M. S. Thesis, University of Illinois, 1951 (See Abstract 51-3)

52-1 Massard, J. M., Sinnamon, G. K., and Munse, W. H.
THE EFFECT OF BEARING PRESSURE ON THE STATIC STRENGTH OF RIVETED JOINTS, Department of Civil Engineering, University of Illinois, SRS No. 21, January, 1952

52-2 Wright, D. T., and Munse, W. H.
STATIC TESTS OF BOLTED AND RIVETED JOINTS, Department of Civil Engineering, University of Illinois, SRS No. 20, January, 1952

52-3 Feldhausen, G. J., Jr.
DO SEMI-RIGID CONNECTIONS PROVE ECONOMICAL?, Fasteners, Vol. 8, No. 1, 1952, pp. 7-10

52-4 Fasteners
BOLTS SPEED ERECTION, Fasteners, Vol. 8, No. 1, 1952, pp. 12-13

52-5 Baron, F., and Larson, E. W., Jr.
THE EFFECT OF CERTAIN RIVET PATTERNS ON THE FATIGUE AND STATIC STRENGTHS OF JOINTS, Part I, Department of Civil Engineering, Northwestern University, February 1, 1952

52-6 Whitmore, R. E.
EXPERIMENTAL INVESTIGATION OF STRESSES IN GUSSET PLATES, Bulletin No. 16, Engineering Experiment Station, University of Tennessee, Knoxville, May, 1962

52-7 Bailey, J. C., and Brace, A. W.
STRENGTH TESTS ON DRIVEN LARGE DIAMETER ALUMINUM RIVETS, The Aluminum Development Association, Research Report No. 13, May, 1952, London

52-8 Davey, J. S.
STRENGTH OF BOLTED ASSEMBLIES, Tool Engineer, May, 1952

52-9 Fisher, W. A. P., Cross, R. H., and Norris, G. M.
PRE-TENSIONING FOR PREVENTING FATIGUE FAILURE IN BOLTS, Aircraft Engineering, England, Vol. XXIV, No. 280, June, 1952, pp. 160-163

52-10 Wilson, W. M., Munse, W. H., and Cayci, M. A.
A STUDY OF THE PRACTICAL EFFICIENCY UNDER STATIC LOADING OF RIVETED JOINTS CONNECTING PLATES, Bulletin No. 402, Engineering Experiment Station, University of Illinois, July, 1952

52-11 Brown, A. A.
ANALYSIS OF ANCHOR BOLTS AND CONCRETE PIERS FOR LARGE STILLS AND KETTLES, Civil Engineering, Vol. 22, July, 1952, pp. 491-492

52-12 Schutz, F. W., and Newmark, N. M.
THE EFFICIENCY OF RIVETED STRUCTURAL JOINTS, Department of Civil Engineering, University of Illinois, SRS No. 30, September, 1952

52-13 Higgins, T. R., and Ruble, E. J.
HIGH-STRENGTH BOLTS - A NEW CONCEPT IN STRUCTURAL CONNECTIONS, Civil Engineering, Vol. 22, No. 9, September, 1952, pp. 760-763

52-14 Stewart, W. C.
STRUCTURAL JOINTS WITH HIGH-STRENGTH BOLTS, Proceedings, The Second Illinois Structural Engineering Conference, University of Illinois, Urbana, November, 1952

52-15 Kreisle, L. F., and Oliphiht, J. B.
BOLT ELONGATIONS AND LOADS, Transactions, ASME, Vol. 74, 1952, pp. 38

52-16 Higgins, T. R., and Munse, W. H.
HOW MUCH COMBINED STRESS CAN A RIVET TAKE?, Engineering News Record, December 4, 1952, Vol. 149, No. 23, pp. 40-42

52-17 Howard, D. M., and Smith, F. C.
FATIGUE AND STATIC TESTS OF FLUSH RIVETED JOINTS, NACA Technical Note 2709, 1952

52-18 Scott, M. B., and Cox, J. W.
A FURTHER STUDY OF THE BEHAVIOR OF FLOOR BEAM HANGERS, Proceedings, AREA, Vol. 53, 1952, pp. 35-64

52-19 Carter, J. W.
STRESS CONCENTRATIONS IN BUILT-UP STRUCTURAL MEMBERS, Proceedings, AREA, Vol. 53, 1952, pp. 1-34

52-20 Schutz, F. W.
EFFECTIVE NET SECTION OF RIVETED JOINTS, Proceedings, 2nd Illinois Structural Engineering Conference, November, 1952, pp. 54-62 (See Abstract 52-12)

52-21 Schutz, F. W.
THE EFFICIENCY OF RIVETED STRUCTURAL JOINTS, Ph.D. Dissertation, University of Illinois, 1952 (See Abstract 52-12)

52-22 Wright, D. T.
TESTS OF HIGH TENSILE BOLTED STRUCTURAL JOINTS, M. S. Thesis, University of Illinois, 1952 (See Abstract 52-2)

52-23 Baron, F., and Larson, E. W.
THE EFFECT OF GRIP ON THE FATIGUE STRENGTH OF RIVETED AND BOLTED JOINTS, Bulletin 503, AREA, 1952 (See Abstract 53-15)

52-24 Chang, F. K., and Johnston, B. G.
TORSION OF PLATE GIRDERS, Proceedings, ASCE, Sep. No. 125, April, 1952 (See Abstract 53-11)

52-25 Cox, H. L.
STATIC STRENGTH OF RIVETS SUBJECTED TO COMBINED TENSION AND SHEAR, M. S. Thesis, University of Illinois, 1952 (See Abstract 56-12)

52-26 Munse, W. H., and Cox, H. L.
THE STATIC STRENGTH OF RIVETS SUBJECTED TO COMBINED TENSION AND SHEAR, SRS No. 22, Department of Civil Engineering, University of Illinois, January, 1952 (See Abstract 56-12)

53-1 Engineering News Record
HERE'S A BETTER WAY TO DESIGN SPLICES, Engineering News Record, Vol. 150, Part I, January 8, 1953, pp. 41-42

53-2 Fuller, James R., and Munse, W. H.
LABORATORY TESTS OF STRUCTURAL JOINTS WITH OVER-STRESSED HIGH TENSILE STEEL BOLTS, Department of Civil Engineering, University of Illinois, SRS No. 44, January, 1953

53-3 Fasteners
HIGH STRENGTH BOLTING, Fasteners, Vol. 9, No. 1, Ohio, 1953, pp. 9-13

53-4 Francis, A. J.
THE BEHAVIOR OF ALUMINUM ALLOY RIVETED JOINTS, Research Report No. 15, The Aluminum Development Association, London, March, 1953

53-5 Bergendoff, R. C., and Munse, W. H.
THE EFFECT OF BEARING PRESSURE ON THE STATIC STRENGTH OF RIVETED JOINTS, SRS No. 55, University of Illinois, June, 1953

53-6 Sossenheimer, H.
ZUR VERWENDUNG HOCHFESTER SCHRAUBEN (ON THE APPLICATION OF HIGH-STRENGTH BOLTS), Der Stahlbau, Vol. 22 (1953), Heft 9, pp. 214-215

53-7 Research Council on Riveted and Bolted Structural Joints
NEW CONCEPTS IN STRUCTURAL JOINT DESIGN, Second Progress Report on Research Council on Riveted and Bolted Structural Joints, Distributed by the Engineering Foundation, December, 1953

53-8 AREA Committee on Iron and Steel Structures
USE OF HIGH-STRENGTH STRUCTURAL BOLTS IN STEEL RAILWAY BRIDGES, Proceedings, AREA, Vol. 54, 1953, pp. 929-940

53-9 Baron, F., and Larson, E. W., Jr.
PROPERTIES AND BEHAVIOR OF A HIGH-STRENGTH RIVET STEEL, Proceedings, ASTM, Vol. 53, 1953, pp. 597-609

53-10 Baron, F., and Larson, E. W., Jr.
STATIC AND FATIGUE PROPERTIES OF CARBON, SILICON, AND HIGH-STRENGTH LOW-ALLOY STEEL PLATES HAVING A HOLE, Proceedings, ASTM, Vol. 53, 1953, pp. 805-822

53-11 Chang, F. K., and Johnston, B. G.
TORSION OF PLATE GIRDERS, Transactions, ASCE, Paper No. 2549, Vol. 118, 1953, pp. 337-382

53-12 Hyler, W. S., and Grover, H. J.
THE TENSION-TENSION FATIGUE BEHAVIOR OF 1/4-INCH ALLOY-STEEL HUCK LOCKBOLTS, S-1205-4, Huck Manufacturing Company, Detroit, Michigan, December 18, 1953

53-13 Nelson, H. M.
ANGLES IN TENSION, SUMMARY OF A REPORT ON TESTS CARRIED OUT FOR THE BRITISH CONSTRUCTIONAL STEELWORK ASSOCIATION, BCSA Publication No. 7, London, 1953

53-14 Cox, J. W.
EXPERIMENTAL AND ANALYTICAL STUDIES OF STRESS DISTRIBUTION IN LABORATORY MODELS OF FLOORBEAM HANGER FRAMES, Proceedings, AREA, Vol. 54, 1953, pp. 65-132

53-15 Baron, F., and Larson, E. W., Jr.
THE EFFECT OF GRIP ON THE FATIGUE STRENGTH OF RIVETED AND BOLTED JOINTS, Proceedings, AREA, Vol. 54, 1953

53-16 Stewart, W. C.
PROPERTIES OF PRELOADED STEEL BOLTS, Product Engineering, November, 1953

53-17 Bergendoff, R. C.
THE EFFECT OF BEARING PRESSURE ON THE STATIC STRENGTH OF RIVETED JOINTS, M. S. Thesis, University of Illinois, 1953 (See Abstract 53-5)

53-18 Brady, W. G., and Drucker, D. C.
AN EXPERIMENTAL INVESTIGATION AND LIMIT ANALYSIS OF NET AREA IN TENSION, Proceedings, ASCE, Vol. 79, Sep. No. 296, October, 1953 (See Abstract 55-12)

53-19 Stallmeyer, J. E.
THE EFFECT OF STRESS HISTORY ON CUMULATIVE DAMAGE IN FATIGUE, Ph.D. Dissertation, University of Illinois, 1953

54-1 Baron, F., and Kenworthy, K. J.
THE EFFECT OF CERTAIN RIVET PATTERNS ON THE FATIGUE AND STATIC STRENGTH OF JOINTS, Part II, Department of Civil Engineering, Northwestern University, February 1, 1954

54-2 Laub, W. H., and Phillips, J. R.
THE EFFECT OF FASTENER MATERIAL AND FASTENER TENSION ON THE ALLOWABLE BEARING STRESSES OF STRUCTURAL JOINTS, Frita Laboratory Report 243.2, Lehigh University, Bethlehem, Pennsylvania, June, 1954

54-3 Schenker, L., Salmon, C. G., and Johnston, B. G.
STRUCTURAL STEEL CONNECTIONS, University of Michigan, AFSWP Report No. 352, Project 2065-1-F, June, 1954

54-4 Hartmann, E. C., Holt, M., and Eaton, I. D.
ADDITIONAL STATIC AND FATIGUE TESTS OF HIGH-STRENGTH ALUMINUM ALLOY BOLTED JOINTS, NACA TN 3269, Washington, D. C., July, 1954

54-5 Leahey, T. F., and Munse, W. H.
STATIC AND FATIGUE TESTS OF RIVETS AND HIGH-STRENGTH BOLTS IN DIRECT TENSION, Department of Civil Engineering, University of Illinois, SRS No. 80, July, 1954

54-6 Nicholson, H. H.
A MILLION AND A HALF HIGH-STRENGTH BOLTS SPEED UP STEEL ERECTION, Civil Engineering, Vol. 24, No. 8, August, 1954, pp. 521-524

54-7 Fasteners
RESEARCH COUNCIL ANNOUNCES NEW SPECIFICATIONS FOR HIGH STRENGTH BOLTS, Fasteners, Vol. 9, No. 3, Ohio, 1954, pp. 10-12

54-8 Delaney, T. J.
RIVETING CANADA'S ALUMINUM MINESWEEPERS, Fasteners, Vol. 9, No. 4, Industrial Fasteners Institute, Cleveland, Ohio, 1954, pp. 6-7

54-9 Ringer, A. G.
PRINCIPLES AND USES OF IMPACT WRENCHING, Fasteners, Vol. 10, No. 3, 1954, pp. 3-5

54-10 Ernst, E.
DIE ERSTE EISENBAHNBRUCKE DER DEUTSCHEN BUNDESBAHN MIT VORGESPANNTEN, HOCHFESTEN SCHRABUEN A/S VERBINDUNGSMITTEL (THE FIRST RAILROAD BRIDGE WITH PRESTRESSED, HIGH-STRENGTH BOLTS AS CONNECTIONS MEANS), Der Stahlbau, Vol. 33, (1954), Heft 10, pp. 225-228

54-11 Steinhardt, O., and Mohler, K.
VERSUCHE ZUR ANWENDUNG VORGE SPANNTER SCHRAUBEN IM STAHLBAU, I. TEIL (TESTS ON THE APPLICATION OF HIGH-STRENGTH BOLTS IN STEEL CONSTRUCTION, PART I), Berichte des Deutschen Aussachusses fur Stahlbau, Stahlbau-Verlags, GmbH, Cologne, 1954 Heft. Nr. 18

54-12 Templin, R. L.
FATIGUE OF ALUMINUM, Proceedings, ASTM, Vol. 54, pp. 641, 1954

54-13 Fuller, J. R., Leahey, T. F., and Munse, W. H.
STATIC TENSILE TESTS OF I-SECTION CONNECTIONS, SRS No. 68, Department of Civil Engineering, University of Illinois, January, 1954 (See Abstract 55-4)

54-14 Stewart, W. C.
THE WORK OF THE RESEARCH COUNCIL ON RIVETED AND BOLTED JOINTS, Proceedings, ASCE, Vol. 80, Sep. No. 440, May, 1954 (See Abstract 55-13)

54-15 Munse, W. H., Wright, D. T., and Newmark, N. M.
LABORATORY TESTS OF HIGH TENSILE BOLTED STRUCTURAL JOINTS, Proceedings, ASCE, Vol. 80, Sep. No. 441, May, 1954 (See Abstract 55-14)

54-16 Leahey, T. F.
STATIC AND FATIGUE TESTS OF RIVETS AND HIGH-STRENGTH BOLTS IN DIRECT TENSION, M. S. Thesis, University of Illinois, 1954 (See Abstract 54-5)

54-17 Beam, W. S.
EFFECTS OF REPEATED LOADINGS ON STRUCTURAL CONNECTIONS WITH HIGH STRENGTH BOLTS, M. S. Thesis, University of Illinois, 1954 (See Abstract 55-11)

54-18 Howard, L. L.
A STATISTICAL STUDY OF THE TENSION DEVELOPED IN HIGH STRENGTH STRUCTURAL BOLTS TIGHTENED WITH PNEUMATIC IMPACT WRENCHES, Department of Civil Engineering, University of Missouri, 1954 (See Abstract 55-5)

54-19 Baron, F., and Larson, E. W., Jr.
COMPARATIVE BEHAVIOR OF BOLTED AND RIVETED JOINTS, Proceedings, ASCE, Vol. 80, Sep. No. 470, August, 1954 (See Abstract 55-17)

54-20 Hechtman, R. A., Young, D. R., Chin, A. G., and Savikko, E. R.
SLIP OF JOINTS UNDER STATIC LOADS, Proceedings, ASCE, Vol. 80, Sep. No. 484, August, 1954 (See Abstract 55-18)

54-21 Carter, J. W., Lenzen, K. H., and Wyly, L. T.
FATIGUE IN RIVETED AND BOLTED SINGLE LAP JOINTS, Proceedings, ASCE, Sep. No. 469, August, 1954 (See Abstract 55-19)

54-22 Higgins, T. R., and Ruble, E. J.
STRUCTURAL APPLICATION OF HIGH STRENGTH BOLTS, Proceedings, ASCE, Vol. 80, Sep. No. 485, September, 1954 (See Abstract 55-20)

54-23 Carter, J. W., McCalley, J. C., and Wyly, L. T.
COMPARATIVE TEST OF A STRUCTURAL JOINT CONNECTED WITH HIGH-STRENGTH BOLTS AND A STRUCTURAL JOINT CONNECTED WITH RIVETS AND HIGH-STRENGTH BOLTS, Bulletin 517, AREA, September-October, 1954 (See Abstract 55-1)

55-1 Carter, J. W., McCalley, J. C., and Wyly, L. T.
COMPARATIVE TEST OF A STRUCTURAL JOINT CONNECTED WITH HIGH-STRENGTH BOLTS AND A STRUCTURAL JOINT CONNECTED WITH RIVETS AND HIGH-STRENGTH BOLTS, Proceedings, AREA, Vol. 56, 1955, pp. 217-268

55-2 Baron, F., Larson, E. W., Jr., and Kenworthy, K. J.
THE EFFECT OF CERTAIN RIVET PATTERNS ON THE FATIGUE AND STATIC STRENGTH OF JOINTS, Published by the Research Council on Riveted and Bolted Structural Joints, Distributed by the Engineering Foundation, February, 1955

55-3 Hechtman, R. A., Flint, T. R., and Koepsell, P. L.
FIFTH PROGRESS REPORT ON SLIP OF STRUCTURAL STEEL DOUBLE-LAP JOINTS ASSEMBLED WITH HIGH-TENSILE STEEL BOLTS, Department of Civil Engineering, University of Washington, Seattly, February, 1955

55-4 Fuller, J. R., Leahey, T. F., and Munse, W. H.
A STUDY OF THE BEHAVIOR OF LARGE I-SECTION CONNECTIONS, Proceedings, ASCE, Vol. 81, Sep. No. 659, April, 1955

55-5 Pauw, A., and Howard, L. L.
TENSION CONTROL FOR HIGH-STRENGTH STRUCTURAL BOLTS, Proceedings, AISC, April, 1955, pp. 13-21

55-6 Ruble, E. J.
TURN-OF-THE-NUT METHOD, Proceedings, AISC, April, 1955, pp. 21-26

55-7 Drew, F. P.
TIGHTENING HIGH STRENGTH BOLTS, Proceedings, ASCE, Vol. 81, Paper No. 786, August, 1955

55-8 Pauw, A.
DISCUSSION OF ("TIGHTENING HIGH-STRENGTH BOLTS" by F. P. Drew), Proceedings, ASCE, Vol. 81, Paper No. 381, November, 1955

55-9 Mitchell, W. D., and Rosenthal, D.
INFLUENCE OF THE ELASTIC CONSTANTS ON THE PARTITION OF LOAD BETWEEN RIVETS, Proceedings of the Society for Experimental Stress Analysis, Vol. 7, No. 2, 1955, pp. 17-26

55-10 AREA Committee on Iron and Steel Structures
USE OF HIGH STRENGTH STRUCTURAL BOLTS IN STEEL RAILWAY BRIDGES, Proceedings, AREA, Vol. 56, 1955, pp. 592-634

55-11 Beam, W. S., and Munse, W. H.
EFFECTS OF REPEATED LOADINGS ON STRUCTURAL CONNECTIONS WITH HIGH-STRENGTH BOLTS, Department of Civil Engineering, University of Illinois, SRS No. 91, January, 1955

55-12 Brady, W. G., and Drucker, D. C.
INVESTIGATION AND LIMIT ANALYSIS OF NET AREA IN TENSION, Transactions, ASCE, Vol. 120, 1955, pp. 1133-1164

55-13 Stewart, W. C.
HISTORY OF THE USE OF HIGH-STRENGTH BOLTS, Transactions, ASCE, Vol. 120, Paper No. 2778, 1955, pp. 1296-1298

55-14 Munse, W. H., Wright, D. T., and Newmark, N. M.
LABORATORY TESTS OF BOLTED JOINTS, Transactions, ASCE, Vol. 120, Paper No. 2778, 1955, pp. 1299-1318

55-15 Francis, A. J.
DISCUSSION ON ("LABORATORY TESTS OF BOLTED JOINTS" by Munse, Wright, and Newmark), Transactions, ASCE, Vol. 120, 1955, pp. 1319-1320

55-16 Munse, W. H., Wright, D. T., and Newmark, N. M.
COMMENTS ON THE DISCUSSIONS ON ("LABORATORY TESTS OF BOLTED JOINTS"), Transactions, ASCE, Vol. 120, 1955, pp. 1320-1321

55-17 Baron, F., and Larson, E. W., Jr.
COMPARISON OF BOLTED AND RIVETED JOINTS, Transactions, ASCE, Vol. 120, Paper No. 2778, 1955, pp. 1322-1334

55-18 Hechtman, R. A., Young, D. R., Chin, A. G., and Savikko, E. R.
SLIP OF JOINTS UNDER STATIC LOADS, Transactions, ASCE, Vol. 120, Paper No. 2778, 1955, pp. 1335-1352

55-19 Carter, J. W., Lenzen, K. H., and Wyly, L. T.
FATIGUE IN RIVETED AND BOLTED SINGLE LAP JOINTS, Transactions, ASCE, Vol. 120, 1955, pp. 1353-1383

55-20 Higgins, T. R., Ruble, E. J.
STRUCTURAL USES OF HIGH STRENGTH BOLTS, Transactions, ASCE, Vol. 120, 1955, pp. 1389-1398

55-21 Schmid, W.
NEUERE AMERIKANISCHE VERSUCHE MIT HOCHFESTEN SCHRAUBEN (NEW AMERICAN TESTS ON HIGH-STRENGTH BOLTS), Der Bauingerieur 30 (1955), Heft 8, pp. 302-307

55-22 Schmid, W.
HOCHFESTE SCHRAUBEN IN DER AMERIKANISCHEN STAHLBAUPRAXIS (HIGH-STRENGTH BOLTS IN AMERICAN STEEL CONSTRUCTION), Der Bauingerieur 30 (1955), Heft 12, pp. 436-439

55-23 Schmid, W.
ZURVERSUCHE MIT GROSSEN TRAGERANSCHLUSSEN (TENSILE TESTS ON LARGE BEAM CONNECTIONS), Der Bauingenieur 30 (1955), Heft 12, pp. 439-441

55-24 Sippell, K. W.
DAS FLAMMSTRAHLEN (FLAME TREATMENT), Metalloberflache, Teil A, Vol. 9 (1955), Heft 10, pp. 147(a) - 162(A)

55-25 Wiegand, H., Schaar, K., and Nieth, F.
BEITRAG ZUM ENTZUNDERN VON WALZMATERIAL DURCH FLAMMSTRAHLEN (ON THE FLAME TREATMENT OF ROLLED MATERIALS), Metalloberflache, Teil A, Vol. 9 (1955), Heft 10, pp. 162(A) - 173(A)

55-26 Nieth, F.
DIE BESCHAFFENHEIT DER STAHLOBERFLACHE BEI ANWENDUNG VESCHIEDENER ENTROSTUNGS-UND ENTZUNDERUNGSVERFAHREN (THE CONDITION OF THE STEEL SURFACE AFTER THE APPLICATION OF THE VARIOUS METHODS OF SURFACE TREATMENT), Metalloberflache, Teil A, Vol. 9 (1955), Heft 10, pp. 174(A) - 178(A)

55-27 Berg, S., and Sippell, K. W.
EINFLUSS DES FLAMMSTRAHLENS AUF DIE FESTIGKEIT VON BAUTEILEN (THE INFLUENCE OF FLAME TREATMENT ON THE STRENGTH OF STRUCTURAL MEMBERS), Metalloberflache, Teil A., Vol. 9 (1955), Heft 10, pp. 179(A) - 185(A)

55-28 Ingenerf, W.
HOCHFESTE, VORGESPANNTE SCHRAUBEN FUR DEN STAHL-UND KRANBAU (HIGH-STRENGTH, PRESTRESSED BOLTS FOR STEEL AND CRANE CONSTRUCTION), Fordern und Heben, 1955, Heft 6, pp. 372-376

55-29 Kellermann, R., and Klein, H. -CH
UNTERSUCHUNGEN UBER DEN EINFLUSS DER REIBUNG AUF VORSPANNUNG UND ANZUGSMOMENT VON SCHRAUBENVERBINDUNGEN, Konstruktion, Vol. 7, No. 2, 1955, pp. 54-68

55-30 Hancke, A.
ANZUGSMOMENT, REIBUNGSWERT UND VORSPANNKRAFT BEI HOCHFESTEN SCHRAUBEN (TIGHTENING MOMENT, COEFFICIENT OF FRICTION, AND PRESTRESSING FORCE FOR HIGH-STRENGTH BOLTS), Draht, Vol. 6 (1955), No. 2, pp. 39-42, and No. 3, pp. 86-93

55-31 Sossenheimer, H.
ZUR ANWENDUNG VON HOCHFESTEN SCHRAUBEN (ON THE APPLICATION OF HIGH-STRENGTH BOLTS), Der Stahlbau 24, 1955, Heft 1, pp. 11-16

55-32 Steinhardt, O.
VORGESPANNTE SCHRAUBEN IM STAHLBAU (PRESTRESSED BOLTS IN STEEL CONSTRUCTION), VDI-Zeitschrift 97 (1955), p. 701-708

55-33 Hebrant, F., and Demol, L.
TENSILE TEST ON RIVETED CONNECTIONS OF ROLLED SECTIONS MADE OF STEEL A37, Acier Stahl Steel, April, 1955, pp. 178-184

55-34 Mordfin, L.
CREEP AND CREEP RUPTURE CHARACTERISTICS OF SOME RIVETED AND SPOT-WELDED LAP JOINTS OF AIRCRAFT MATERIAL, NACA Technical Note 3412, June, 1955

55-35 Boomsma, M.
LOOSENING AND FATIGUE STRENGTH OF BOLTED JOINTS, The Engineer, Vol. 200, p.284, London, August 26, 1955

55-36 Sandberg, C. H.
INVESTIGATION OF FLOORBEAM HANGERS IN RAILROAD TRUSSES, Journal of the Structural Division, ASCE, Vol. 81, Proceedings Paper No. 762, August, 1955

55-37 Wilson, W. R.
HIGH-TENSILE BOLTS ARE GAINING, Railway Track and Structures, September, 1955, pp. 43-45

55-38 Fuller, J. R.
CUMULATIVE DAMAGE IN THE FATIGUE OF STRUCTURAL JOINTS, Ph.D. Dissertation, University of Illinois, 1955 (See Abstract 59-49)

55-39 Munse, W. H.
BOLTED CONNECTIONS RESEARCH, Proceedings, ASCE, Vol. 81, Sep. No. 650, March, 1955 (See Abstract 56-11)

55-40 Wyly, L. T., and Scott, M. B.
AN INVESTIGATION OF FATIGUE FAILURES IN STRUCTURAL MEMBERS OF ORE BRIDGES UNDER SERVICE LOADING, Bulletin 524, AREA, 1955 (See Abstract 56-17)

55-41 Bell, M. H.
HIGH-STRENGTH STEEL BOLTS IN STRUCTURAL PRACTICE, Proceedings, ASCE, Vol. 81, Sep. No. 651, March, 1951 (See Abstract 57-27)

56-1 Winter, G.
TESTS ON BOLTED CONNECTIONS IN LIGHT GAGE STEEL, Journal of the Structural Division, ASCE, Vol. 82, Proceedings Paper 920, February, 1956

56-2 Committee on Design in Lightweight Structural Alloys, J. W. Clark, Chairman
SPECIFICATIONS FOR STRUCTURES OF ALUMINUM ALLOY 6061-T6, Proceedings ASCE, Vol. 82, Paper 970, May, 1956

56-3 Committee on Design in Lightweight Structural Alloys, J. W. Clark, Chairman
SPECIFICATIONS FOR STRUCTURES OF ALUMINUM ALLOY 2014-T6, Proceedings ASCE, Vol. 82, Paper 971, May, 1956

56-4 Popp, H. G., Hyler, W. S., and Grover, H. J.
THE EFFECT OF INTERFERENCE FIT ON THE FATIGUE BEHAVIOR OF MONOBLOCK SPECIMENS OF 7075-T ALCLAD SHEET, Battelle Memorial Institute, Columbus 1, Ohio, June 6, 1956

56-5 Madison, R. B., and Vasarhelyi, D. D.
THE BEHAVIOR OF BOLTED JOINTS WITH MISALIGNED PUNCHED HOLES AND PAINTED FAYING SURFACES AT ROOM AND SUB-ZERO TEMPERATURE, Department of Civil Engineering, University of Washington, Sixth Progress Report, June, 1956

56-6 Schijve, J.
THE FATIGUE STRENGTH OF RIVETED JOINTS AND LUGS, NACA TN 1395, Washington, August, 1956

56-7 McFarland, W. J.
HIGH STRENGTH BOLTS-FEATURE OF AN ALASKA MAST, Civil Engineering, Vol. 29, September, 1959, pp. 630-632

56-8 Petersen, K. S., and Munse, W. H.
STATIC TENSION TESTS OF RIVETS AND HIGH STRENGTH BOLTS IN STRUCTURAL CONNECTIONS, Department of Civil Engineering, University of Illinois, SRS No. 124, November, 1956

56-9 Sanks, R. L.
TWO USEFUL GAGES MEASURE BOLT TENSION AND SLIP IN A JOINT, Civil Engineering, Vol. 26, No. 11, November, 1956

56-10 Duffy, A. R.
STATIC MECHANICS OF A DOUBLE-STRAP BUTT JOINT CONNECTED WITH HIGH-STRENGTH BOLTS, M. S. Thesis, Purdue University, Lafayette, Indiana, 1956

56-11 Munse, W. H.
RESEARCH ON BOLTED CONNECTIONS, Transactions, ASCE, Vol. 121, Paper No. 2839, 1956, pp. 1255-1266

56-12 Munse, W. H., and Cox, H. L.
THE STATIC STRENGTH OF RIVETS SUBJECTED TO COMBINED TENSION AND SHEAR, Bulletin, University of Illinois Engineering Experiment Station, Vol. 54, No. 437, No. 29, December, 1956

56-13 Dornen, A., and Trittler, G.
NEUE WEGE DER VERBINDUNGSTECHNIK IM STAHLBAU (NEW TYPES OF CONNECTIONS IN STEEL CONSTRUCTION), Der Stahlbau, Vol. 25, (1956), Heft 5, pp. 181-184

56-14 Schmid, W.
UBER DAS ANSPANNEN HOCHFESTER SCHRAUBEN (ON THE TIGHTENING OF HIGH-STRENGTH BOLTS), Der Bauingenieur 31 (1956), Heft 5, pp. 183-185

56-15 Schmid, W.
SCHLUPFVERHALTEN VON STOSSEN MIT HOCHFESTEN SCHRAUBEN (SLIP BEHAVIOR OF CONNECTIONS WITH HIGH-STRENGTH BOLTS), Der Bauingenieur 31 (1956), Heft 9, pp. 354-55

56-16 Winter, G.
LIGHT GAGE STEEL CONNECTIONS WITH HIGH-STRENGTH, HIGH TORQUED BOLTS, Publications, IABSE, Vol. 16, 1956, pp. 513-528

56-17 Wyly. L. T., and Scott, M. B.
AN INVESTIGATION OF FATIGUE FAILURES IN STRUCTURAL MEMBERS OF ORE BRIDGES UNDER SERVICE LOADINGS, Proceedings, AREA, Vol. 57, 1956, pp. 175-298

56-18 Chesson, E., Jr., and Munse, W. H.
A STUDY OF THE BEHAVIOR OF RIVETED CONNECTIONS IN TRUSS-TYPE MEMBERS, SRS 115, Department of Civil Engineering, University of Illinois, January, 1956 (See Abstract 58-12)

56-19 Chesson, E., Jr.
A STUDY OF THE BEHAVIOR OF RIVETED CONNECTIONS IN TRUSS-TYPE MEMBERS, M. S. Thesis, University of Illinois, 1956, (See Abstract 58-12)

56-20 Peterson, K. S.
STATIC TENSION TESTS OF RIVETS AND HIGH STRENGTH BOLTS IN STRUCTURAL CONNECTIONS, M. S. Thesis, University of Illinois, 1956 (See Abstract 56-8)

56-21 Sanks, R. L., and Rampton, C. C., Jr.
REINFORCED HIGH TENSILE BOLTED JOINTS, Department of Civil Engineering, University of Utah, November, 1956 (See Abstract 57-19)

56-22 Stahlbau
VORLAUFIGEN RICHTLINIEN FUR BERECHNUNG, AUSFAUHRUNG UND BAULICHE DURCH BILDUNG VON FLEITFESTEN SCHRAUBEN VERBINDUNGEN (HV-VERBINDUNGEN) FUR STAHLERNE INGENIEUR-UND HOCHBAUTEN, BRUCKEN, UND KRANE (PRELIMINARY DIRECTIVES FOR THE CALCULATION, DESIGN AND ASSEMBLY OF NON-SLIP BOLTED CONNECTIONS (H. S. CONNECTIONS) FOR STEEL STRUCTURES, BRIDGES, AND CRANES; Stahlbau-Verlags, G.m.b.H., Cologne, 1956 (See Abstract 59-11)

57-1 Krickenberger, C. F., Jr., Chesson, E., Jr., and Munse, W. H.
EVALUATION OF NUTS FOR USE WITH HIGH STRENGTH BOLTS, Department of Civil Engineering, University of Illinois, SRS No. 128, January, 1957

57-2 Lu, Z. A., Vasishth, C., and Vasarhelyi, D. D.
TESTS OF LARGE BOLTED JOINTS TIGHTENED BY THE ONE-TURN-OF-THE-NUT METHOD, Department of Civil Engineering, University of Washington, Seattle, Seventh Progress Report to RCRBSJ, January, 1957

57-3 Holt, M., Eaton, I. D., and Matthiesen, R. B.
FATIGUE TEST OF RIVETED OR BOLTED ALUMINUM ALLOY JOINTS, Journal of the Structural Division, ASCE, Vol. 83, No. ST1, Proceedings Paper 1148, January, 1957

57-4 Godfrey, G. B.
POST-WAR DEVELOPMENTS IN GERMAN STEEL BRIDGES AND STRUCTURES, The Structural Engineer, Vol. XXXV, No. 2, London, February, 1957

57-5 Musnitsky, H.
BOLTS: HOW TIGHT IS TOO TIGHT?, The Iron Age, March 28, 1957, pp. 120-121

57-6 Viglione, J.
FATIGUE STRENGTH OF BOLTS REDUCED BY LONGITUDINAL FLAWS, Product Engineering, Vol. 28, March, 1957, pp. 203-204

57-7 Sommer, A. A.
THE ADVANTAGES OF HIGH TENSILE BOLTS IN STRUCTURAL WORK, Construction in South Africa, March, 1957

57-8 Popp, H. G., Hyler, W. S., and Grover, H. J.
THE EFFECT OF INTERFERENCE FIT ON THE FATIGUE BEHAVIOR OF ALUMINUM-ALLOY JOINTS, Battelle Memorial Institute, Columbus 1, Ohio, April 19, 1957

57-9 Easton, F. M., Lewis, E. M., and Wright, D. T.
SOME NOTES ON THE USE OF HIGH PRELOAD BOLTS IN THE UNITED KINGDOM, The Structural Engineer, Vol. XXXV, No. 5, London, May, 1957, pp. 167-175

57-10 Institution of Structural Engineers
DISCUSSION OF ("SOME NOTES ON THE USE OF HIGH PRELOAD BOLTS IN THE UNITED KINGDOM" by Easton, Lewis, and Wright), The Structural Engineer, Vol. XXXV, No. 5, London, May, 1957, pp. 228-242

57-11 Hardrath, H. F., and Whaley, R. E.
FATIGUE-CRACK PROPAGATION AND RESIDUAL STATIC STRENGTH OF BUILT-UP STRUCTURES, NACA Technical Note 4012, May, 1957

57-12 Fincher, J. R.
INVESTIGATION OF BASIC REQUIREMENTS FOR A DIRECT MOMENT CONNECTION USING HIGH STRENGTH STRUCTURAL BOLTS AND WIDE FLANGE BEAMS, M. S. Thesis, Georgia Institute of Technology, May, 1957

57-13 Thrasher, J. Q.
"SILENCE, IT'S GOLDEN!", Steelways, June, 1957, pp. 22-23

57-14 Douty, R. T.
CHARACTERISTICS OF FLEXIBLE FLANGE CONNECTIONS AND FASTENERS, M. S. Thesis, Georgia Institute of Technology, June, 1957

57-15 Vasishth, U. C., Lu, Z. A., and Vasarhelyi, D. D.
A STUDY OF THE NOMINAL COEFFICIENT OF FRICTION IN STRUCTURAL STEEL JOINTS FASTENED BY HIGH TENSILE BOLTS, Department of Civil Engineering, University of Washington, Eighth Progress Report to RCRBSJ, June, 1957

57-16 Munse, W. H.
AN EVALUATION OF THE BEHAVIOR OF STRUCTURAL CONNECTIONS ASSEMBLED WITH HOOK-KNURL BOLTS, The Lamson and Sessions Co., Cleveland, Ohio

57-17 Chauner, R. W., and Vasarhelyi, D. D.
DOES VIBRATION AFFECT FRICTION IN A BOLTED JOINT, The Trend in Engineering, University of Washington, Seattle, Vol. 9, No. 4, October, 1957, pp. 23-29

57-18 Feeser, L. J.
BOLT SHEAR TESTS, Final Report for C. E. 103, Lehigh University, Bethlehem, Pa., 1957

57-19 Sanks, R. L., and Rampton, C. C.
GRIT AND SHOT-REINFORCED HIGH TENSILE BOLTED JOINTS, Journal of the Structural Division, ASCE, Vol. 83, No. ST6, Proceedings Paper No. 1435, November, 1957

57-20 Irvan, W. G.
EXPERIMENTAL STUDY OF PRIMARY STRESSES IN GUSSET PLATES OF A DOUBLE PLANE PRATT TRUSS, University of Kentucky Engineering Experiment Station, Bulletin 46, December, 1957

57-21 Steel
THE LIMITS OF THE TRANSMISSION OF FORCE IN RIVETED AND BOLTED CONNECTIONS IN STRUCTURAL STEELWORK, Acier-Stahl-Steel, Vol. 22, No. 3, 1957, pp. 131-137

57-22 Mordfin, L., and Legate, A. C.
CREEP BEHAVIOR OF STRUCTURAL JOINTS OF AIRCRAFT MATERIALS UNDER CONSTANT LOADS AND TEMPERATURE, NACA Technical Note 3842, January, 1957

57-23 Wyly, T., Treanor, H. E., and LaRoy, H. E.
DEMONSTRATION TEST OF AN A242 HIGH-STRENGTH STEEL SPECIMEN CONNECTED BY A325 AND BY A354 BOLTS, Proceedings, AISC, 1957

57-24 Wyly, L. T.
FATIGUE STUDIES ON STRUCTURAL JOINTS OF ASTM A-7 AND A242 HIGH STRENGTH STEEL, Proceedings, AISC, pp. 56-65, 1957

57-25 Holt, J. A.
300,000 HIGH STRENGTH BOLTS-WORLD'S RECORD IN BRIDGE CONSTRUCTION, Fasteners, Vol. 12, Nos. 2 and 3, Fall, 1957, pp. 2-3

57-26 White, M. W., and Thurlimann, B.
STUDY OF COLUMNS WITH PERFORATED COVER PLATES, Proceedings, AREA, Vol. 58, 1957, pp. 173-292

57-27 Bell, M. H.
HIGH-STRENGTH STEEL BOLTS IN STRUCTURAL PRACTICE, Transactions, ASCE, Vol. 122, Paper No. 2845, 1957, pp. 1-21

57-28 Pfungen, R.
HOCHFESTE SCHRAUBEN ERSETZEN NIETE IM STAHLBAU (HIGH STRENGTH BOLTS REPLACE RIVETS IN STEEL CONSTRUCTION), Bauindustrie (Vienna), 1957, No. 3, pp. 141-144

57-29 Schmid, W.
DAUERBRUCHE IN GENIETETEN UND HOCHFEST VERSCHRAUBTEN LASCHENSTOSSEN (RIVETED AND BOLTED LAP JOINTS UNDER FATIGUE LOADING), Der Bauingenieur 32 (1957), Heft 12, pp. 474-476

57-30 Michalos, J., and Louw, J. M.
PROPERTIES FOR NUMERICAL ANALYSIS OF GUSSETED FRAMEWORKS, Proceedings, AREA, Vol. 58, 1957, pp. 1-51

57-31 Hebrant, F., Hermitte, G. L., and Massonet, C.
BOULONS A HAUTE RESISTANCE (BOLTS WITH HIGH RESISTANCE), Imprimenie Sainte Catherine, Tempelhof 37, Belgigue, 1957

57-32 Hebrant, F., Demol, L., and Massonnet, C.
ESSAIS D'ASSEMBLAGES A BOULONS ON RIVETS (TESTS ON ASSEMBLIES WITH STRETCHED BOLTS OR RIVETS), Publications, IABSE, Vol. 17, 1957, Zurich

57-33 Chesson, E., Jr., and Munse, W. H.
A STUDY OF THE BEHAVIOR OF RIVETED CONNECTIONS IN TRUSS-TYPE MEMBERS, Journal of the Structural Division, ASCE, Vol. 83, ST1, Proceedings Paper 1150, January, 1957 (See Abstract 58-12)

57-34 Deutscher Stahlbau-Verband
GEITFESTE SCHRAUBEN VERBINDUNGEN IM STAHLBAU, VORTRAGSVERANSTALTUNG, 7Mai, 1951 Essen, Veroffenttichingen old Deutschen Stahlbauverbanas, No. 12

57-35 Osterreichischer Stahlbauverband
VORLAUFIGE RICHTLINIEN FUR DIE VERWENDUNG HOCHFESTER, VORGESPAONTES SCHRAUBEN IM STAHLBAU MIT ERLAUTERUNGEN, Wien, 1957

57-36 Fuller, J. R., Petersen, K. S., and Munse, W. H.
CUMULATIVE DAMAGE IN STRUCTURAL JOINTS, SRS 127, Department of Civil Engineering, University of Illinois, January, 1957
(See Abstract 59-49)

57-37 Bell, W. G.
STATIC TESTS OF STANDARD RIVETED AND BOLTED BEAM-TO-COLUMN CONNECTIONS, M. S. Thesis, University of Illinois, 1957
(See Abstract 61-21)

58-1 Hyler, W. S., Popp, H. G., Gideon, D. N., Gordon, S. A., and Grover, H. J.
FATIGUE BEHAVIOR OF AIRCRAFT STRUCTURAL BEAMS, NACA Technical Note 4137, January, 1958

58-2 Beano, S. Y., and Vasarhelyi, D. D.
THE EFFECT OF VARIOUS TREATMENTS OF THE FAYING SURFACES ON THE COEFFICIENT OF FRICTION IN BOLTED JOINTS, Department of Civil Engineering, University of Washington, Ninth Progress Report to RCRBSJ, January, 1958

58-3 Frincke, M. H.
TURN-OF-NUT METHOD FOR TENSIONING BOLTS, Civil Engineering, Vol. 28, No. 1, January, 1958

58-4 McDonald, D., Ang, A., and Massard, J. M.
AN INVESTIGATION OF RIVETED AND BOLTED COLUMN-BASE AND BEAM-TO-COLUMN CONNECTIONS UNDER SLOW AND RAPID LOADING, Department of Civil Engineering, University of Illinois, February, 1958

58-5 Baumgartner, T. C., Gowen, E. F., and Crispell, C.
TENSION-TENSION FATIGUE INVESTIGATION OF HIGH-STRENGTH AIRCRAFT BOLTS - EFFECT OF NUT ENGAGEMENT AND THREAD ROOT RADIUS, Wright Air Development Center, TR 58-326, February, 1958

58-6 Jenkins, J. W., Williams, W. L., and Herring, J. L.
EFFECTS OF COLD ROLLED THREADS IN THE PROPERTIES OF HIGH TEMPERATURE CHROMIUM-MOLYBDENUM STEEL THREADS, U. S. Bureau of Ships Journal, Vol. 6, February, 1958, pp. 7-12

58-7 Field, J. E.
TIGHTENING AND TENSILE TESTS ON JOINTS, The Engineer, May 2 and May 9, 1958, London, pp. 654 and 700

58-8 Aviation Week
BRITISH ACCIDENT INVESTIGATION REPORT: FLAP BOLT FAILURE CAUSED VISCOUNT CRASH, Aviation Week, London, June 9, 1958, pp. 72-87

58-9 Zar, M.
WATCH YOUR BOLTS, Civil Engineering, Vol. 28, No. 7, July, 1958, pp. 521-522

58-10 Engineering News Record
STEEL FASTENER COSTS COMPARED, Engineering News Record, September 18, 1958

58-11 Hardin, B. O.
EXPERIMENTAL INVESTIGATIONS OF THE PRIMARY STRESS DISTRIBUTION IN THE GUSSET OF A DOUBLE PLANE PRATT TRUSS JOINT WITH CHORD SPLICE AT THE JOINT, University of Kentucky Engineering Experiment Station, Bulletin 49, September, 1958

58-12 Chesson, E., Jr., and Munse, W. H.
BEHAVIOR OF RIVETED TRUSS-TYPE CONNECTIONS, Transactions, ASCE, Vol. 123, 1958, pp. 1087-1128

58-13 Foreman, R. T., and Rumpf, J. L.
STATIC TENSION TESTS OF BOLTED JOINTS, Fritz Engineering Laboratory Report No. 271.1, Lehigh University, Bethlehem, Pa., December, 1958

58-14 Jones, J.
BEARING-RATIO EFFECT ON STRENGTH OF RIVETED JOINTS, Transactions, ASCE, Paper No. 2949, Vol. 123, 1958, pp. 964-972

58-15 Stetina, H. J.
CHOOSING THE RIGHT FASTENER, Proceedings, AISC, 1958, pp. 49-55

58-16 Waltermire, W. G.
NEW HIGH TENSILE BEARING BOLT, Proceedings, AISC, 1958

58-17 Ruble, E. J.
BEHIND THE SCENES IN THE DEVELOPMENT OF THE ASTM HIGH-STRENGTH BOLT SPECIFICATIONS, Fasteners, Vol. 13, No. 3, 1958, pp. 3-5

58-18 Foreman, R. T., and Rumpf, J. L.
FURTHER STATIC TENSION TESTS OF BOLTED JOINTS, Fritz Engineering Laboratory Report No. 271.2, Lehigh University, Bethlehem, Pa., December, 1958

58-19 Rumpf, J. L.
SHEAR RESISTANCE OF HIGH STRENGTH BOLTS, Fritz Engineering Laboratory Report No. 271.3, Lehigh University, Bethlehem, Pa., 1958

58-20 Schmid, W.
DIE ZULASSIGE BEANSPRUCHUNG HOCHFESTER SCHRAUBEN (ALLOWABLE STRENGTH OF HIGH-STRENGTH BOLTS), Der Bauingenieur 33 (1958), Heft 3, pp. 101-105

58-21 Schmid, W.
EINFLUSS DER KLEMMLANGEN AUF DIE DAUERFESTIGKEITEN GESCHRAUBTER UND GENIETETER STOSSE, (EFFECT OF GRIP LENGTH ON THE STRENGTH OF RIVETED AND BOLTED CONNECTIONS), Der Bauingenieur 33 (1958), Heft 7, pp. 277-29

58-22 Mohler, K.
VERSUCHE MIT HV-VERBINDUNGEN (TESTS ON BOLTED CONNECTIONS) Veroffentlichungen des Deutschen Stahlbau-Verbandes, Stahlbau-Berlags BmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 8-26

58-23 Hamm, B.
FABRIDATION DER SCHRAUBEN (FABRICATION OF BOLTS), Veroffentlichungen des Deutschen Stahlbau-Berbandes, Stahlbau-Verlags GmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 27-36

58-24 Wolf, W.
VORLAUFIGE RICHTLINIEN FURBERECHNUNG, AUSFUHRUNG UND BAULICHE DURCHBILDUNG VON GLEIRFESTEN SCHRAUBEN VERBINDUNGEN (HV-VERBINDUNGEN) (PRELIMINARY SPECIFICATIONS FOR THE ANALYSIS, DESIGN, AND FABRICATION OF SLIP-PROOF BOLTED CONNECTIONS), Veroffentlichungen des Deutschen Stahlbau-Verbandes, Stahlbau-Verlags GmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 37-47

58-25 Steinhardt, O.
KONSTRUIEREN IN STAHL UNTER BESONDERER BERUCKSICHTIGUNG DER HV-SCHRAUBEN, (STEEL CONSTRUCTION WITH SPECIAL CONSIDERATION OF HIGH-STRENGTH BOLTS), Veroffenflichungen des Deutschen Stahlbau-Verbandes, Stahlbau-Verlags GmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 48-60

58-26 Dornen, K.
AUSGEFUHRTE BRUCKEN MIT HV-SCHRAUBEN, (BRIDGES WITH HIGH-STRENGTH BOLTS), Veroffentlichungen des Deutschen Stahlbau-Verbandes, Stahlbau-Verlags GmbH, Cologne, Heft 12, 1958, Gleitfeste Schraubenverbindungen im Stahlbau, pp. 61-81

58-27 Stahlbau-Verlags-GmbH
GEITFESTE SCHRAUBENVERBINDUNGEN IM STAHLBAU, Veroffenflichungen des Deutschen Stahlbau-Verbandes, Stahlbau-Verlags-GmbH, Cologne, Vol. 12, 1958 (See Abstracts 58-14 and 59-11)

58-28 Munse, W. H., Fuller, J. R., and Petersen, K. S.
CUMULATIVE DAMAGE IN STRUCTURAL JOINTS, Bulletin 544, AREA, June-July, 1958, p. 67 (See Abstract 59-49)

58-29 Bell, W. G., Chesson, E., Jr., and Munse, W. H.
STATIC TESTS OF STANDARD RIVETED AND BOLTED BEAM-TO-COLUMN CONNECTIONS, SRS 146, Department of Civil Engineering, University of Illinois, January, 1958 (See Abstract 61-21)

59-1 Lewitt, C. W., Chesson, E., Jr., and Munse, W. H.
THE EFFECT OF RIVET BEARING ON THE FATIGUE STRENGTH OF RIVETED JOINTS, University of Illinois, SRS No. 170, January, 1959

59-2 Munse, W. H.
STUDY OF THE EFFECT OF FLANGED NUTS ON THE FATIGUE BEHAVIOR OF FLAT PLATES, University of Illinois, Urbana, January, 1959

59-3 Stafford, R. W., Lewitt, C. W., and Chesson, E., Jr.
PRELIMINARY TESTS OF HIGH STRENGTH BOLTS UNDER COMBINED SHEAR AND TENSION, University of Illinois, Urbana, February, 1959

59-4 Munse, W. H.
TESTS OF TRUSS-TYPE CONNECTIONS ASSEMBLED WITH BEARING BOLTS, The Lamson and Sessions Company, Cleveland, Ohio, February, 1959

59-5 Kaplan, S.
DOUBLE SHEAR TESTS OF HIGH STRENGTH BOLTS, Fritz Engineering Laboratory Report No. 271.4, Lehigh University, Bethlehem, Pa., April, 1959

59-6 Societe de la Tour Eiffel
THE EIFFEL TOWER AFTER 70 YEARS, Fasteners, Vol. 14, No. 1, Spring, 1959, pp. 7-8

59-7 Young, W. C.
RESULTS OF TESTS OF STRUCTURAL CONNECTIONS ASSEMBLED WITH HIGH TENSILE STRUCTURAL RIB BOLTS-INTERRUPTED RIBS, University of Wisconsin, May, 1959

59-8 Ritchie, J., Gregory, P., and Bangay, A. J.
IMPROVEMENTS IN BOLTED JOINT EFFICIENCY BY THE ADDITION OF A COLD-SETTING RESIN MIXTURE, The Structural Engineer, June, 1959, London, pp. 175-177

59-9 Steinhardt, O.
THE GERMAN CONTRIBUTION TO RESEARCH, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 2-9

59-10 Godfrey, G. B.
SPECIFICATIONS FOR HIGH STRENGTH BOLTS, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 10-13

59-11 German Committee for Structural Steelwork
APPENDIX-A TRANSLATION OF THE PRELIMINARY DIRECTIVES FOR THE CALCULATION, DESIGN AND ASSEMBLY OF NON-SLIP, BOLTED CONNECTIONS (H. S. CONNECTIONS) FOR STEEL STRUCTURES, BRIDGES AND CRANES, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 14-19

59-12 Alder, J. F.
EXPLORATORY TESTS ON FRICTION GRIP BOLTED JOINTS, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 19-27

59-13 Ranger, B. E. S.
DEVELOPMENT OF A MOMENT CONNECTION FOR RIGID FRAMES, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 28-36

59-14 Lancaster, N.
THE USE OF HIGH STRENGTH FRICTION GRIP BOLTS IN STRUCTURES, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 36-43

59-15 Hojarczyk, S., Kasinski, J., and Nawrat, T.
LOAD-SLIP CHARACTERISTICS OF HIGH STRENGTH BOLTED STRUCTURAL JOINTS PROTECTED FROM CORROSION BY VARIOUS SPRAYED COATINGS, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 43-48

59-16 Cullimore, M. S. G.
TESTS ON AN ALUMINUM-ALLOY JOINT WITH PRE-TENSIONED BOLTS, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 48-51

59-17 Johnson, L. G., Cannon, J. C., and Spooner, L. A.
JOINTS IN HIGH TENSILE, PRELOADED BOLTS-TESTS ON JOINTS DESIGNED TO DEVELOP FULL PLASTIC MOMENTS OF CONNECTED MEMBERS, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 52-62

59-18 Gill, P. J.
NOTES ON THE LOAD CARRYING CHARACTERISTICS OF PRE-TENSIONED BOLTS-TENSIONED JOINTS, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 62-64

59-19 Creasey, L. R.
THE USE OF HIGH STRENGTH BOLTS IN INDUSTRIAL AND COMMERCIAL BUILDINGS, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 2-10

59-20 Arch, W. H.
THE FIELD USE OF HIGH STRENGTH FRICTION GRIP BOLTS, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 10-13

59-21 Berridge, P. S. A.
HIGH STRENGTH BOLTS IN RAILWAY BRIDGES AND STRUCTURES IN BRITAIN, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 14-24

59-22 Higgins, T. R.
THE USE OF HIGH STRENGTH BOLTS IN THE UNITED STATES OF AMERICA, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 24-29

59-23 Wolf. W.
THE USE OF HIGH STRENGTH BOLTS IN GERMANY, Jubilee Symposium on High Strength Bolts, The Institution of Structural Engineers, London, June, 1959, pp. 30-35

59-24 Brody, I. H.
A REVIEW OF HAND TOOLS WHICH FACILITATE THE USE OF HIGH STRENGTH STRUCTURAL BOLTS, Institution of Structural Engineers, Jubilee Symposium, Session 2, June, 1959, London, pp. 24-29

59-25 Brown, W. C.
THE USE OF PRETENSIONED BOLTS IN STRUCTURAL CONNECTIONS, Institution of Structural Engineers Jubilee Symposium, Session 2, June, 1959, London, pp. 16-24

59-26 Grant, M.
HIGH STRENGTH BOLTS FOR STRUCTURAL ENGINEERING, Institution of Structural Engineers Jubilee Symposium, Session 2, June, 1959, London, pp. 11-15

59-27 Martin, H.
THE PROPERTIES OF HIGH STRENGTH BOLTS, Institution of Structural Engineers Jubilee Symposium, Session 2, June, 1959, London, pp. 2-11

59-28 Quertier, J. R.
PNEUMATIC TOOLS FOR TIGHTENING HIGH STRENGTH BOLTS, Institution of Structural Engineers Jubilee Symposium, Session 2, June, 1959, London, pp. 30-35

59-29 Bendigo, R. A.
BOLT CALIBRATION STUDY, Fritz Engineering Laboratory Report No. 271.5, Lehigh University, Bethlehem, Pa., June, 1959

59-30 Chesson, E., Jr., and Munse, W. H.
BEHAVIOR OF LARGE RIVETED AND BOLTED STRUCTURAL CONNECTIONS, Department of Civil Engineering, University of Illinois, Urbana, SRS No. 174, 1959

59-31 Iron Age
STRONGER JOINTS CAN COST LESS, The Iron Age, July 2, 1959, pp. 72-76

59-32 Munse, W. H.
THE EFFECT OF BEARING PRESSURE ON THE STATIC STRENGTH OF RIVETED CONNECTIONS, Bulletin No. 454, University of Illinois Engineering Experiment Station, July, 1959

59-33 Beano, S. Y., and Vasarhelyi, D. D.
THE EFFECT OF MISALIGNMENT OF HOLES ON THE BEHAVIOR OF BOLTED JOINTS, Department of Civil Engineering, University of Washington, Tenth Progress Report to RCRBSJ, August, 1959

59-34 Adler, R. C.
MORE ON BOLTS, Reader Comments, Engineering News-Record, August 6, 1959, p. 6

59-35 Belford, R. B.
A REVIEW OF THE USE OF STRUCTURAL FASTENERS, Fasteners, Vol. 14, Nos. 2 and 3, Summer, 1959, pp. 5-8

59-36 van Douwen, A. A., deBack, J., and Bouwman, L. P.
CONNECTIONS WITH HIGH-STRENGTH BOLTS, The Friction Factor Hinder Influence of Different Tightening Methods of the Bolts and of Different Conditions of the Contact Surfaces, Technological University Delft, Civil Engineering Department, Stevin-Laboratory, Report No. 6-59-9-VB-3, August, 1959

59-37 Bendigo, R. A., and Rumpf, J. L.
CALIBRATION AND INSTALLATION OF HIGH-STRENGTH BOLTS, Fritz Engineering Laboratory Report No. 271.7, Lehigh University, Bethlehem, Pa., September, 1959

59-38 Lewitt, C. W., Chesson, E., Jr., and Munse, W. H.
PRELIMINARY REPORT ON RELAXATION STUDIES OF HIGH-STRENGTH BOLTS, Department of Civil Engineering, University of Illinois, October, 1959

59-39 Ault, Robert T.
RAPID LOADING OF ALUMINUM ALLOY RIVETED JOINTS, Wright Air Development Center, T. R. 59-433, October, 1959

59-40 Estes, E. R., Jr.
HIGH STRENGTH BOLTS, Presented at the Tenth National Conference in Standards of the American Standards Association, Detroit, October 20-22, 1959

59-41 Munse, W. H., and Chesson, E., Jr.
THE EFFECT OF METHOD OF TIGHTENING ON THE SLIP BEHAVIOR OF BOLTED JOINTS, Department of Civil Engineering, University of Illinois, Urbana, Illinois, November, 1959

59-42 Toint, E.
JOINTS ASSEMBLED WITH HIGH STRENGTH FRICTION GRIP BOLTS, Acier-Stahl-Steel, Vol. 24, No. 11, November, 1959, pp. 469-473

59-43 Steinhardt, O., and Mohler, K.
VERSUCHE ZUR ANWENDUNG VORGESPANNTER SCHRAUBEN IM STAHLBAU. II. TEIL (TESTS ON THE APPLICATION OF HIGH-STRENGTH BOLTS IN STEEL CONSTRUCTION, PART II), Berichte des Deutschen Ausschusses fur Stahlbau, Stahlbau-Verlags GmbH, Cologne, 1959, Heft 22

59-44 Hoyer, H.
UBER GLEITFESTE SCHRAUBENVERBINDUNGEN IM STAHLBAU (VERSUCHSERGEBNISSE UND BEMESSUNGSRICHTLINIEN) (ON SLIDE-PROOF BOLTED CONNECTIONS IN STEEL STRUCTURES) (TEST RESULTS AND DESIGN SPECIFICATIONS), Wissenschaftliche Reihe der Hochschule fur Bauwesen, Cottbus, 1959, Heft 1

59-45 Hoyer, W., and Skwirblies, H.
UBER GLEIFFESTE SCHRAUBENVERBINDUNGEN (2. BERICHT) HOCHFESTE SCHRAUBEN IN VERBINDUNG MIT SCHWEISSNAHTAN (ON SLIDE-PROOF BOLTED CONNECTIONS (2nd REPORT) HIGH-STRENGTH BOLTS TOGETHER WITH WELDS), Wissenschaflliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 3 (1959-60), Heft 1, pp. 33-48

59-46 Hoyer, W.
UBER GLEITFESTE SCHRAUBENVERBINDUNGEN (3. BERICHT) HOCHFESTE SCHRAUBEN MIT VERSCHIEDENEM LOCHSPIEL (ON SLIDE-PROOF BOLTED CONNECTIONS (3rd Report) HIGH-STRENGTH BOLTS WITH DIFFERENT HOLE CLEARANCE), Wissenschaffliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 3 (1959-60), Heft 1, pp. 49-53

59-47 Smith, C. R., and Zandman, F.
PHOTOSTRESS PLASTIC FOR MEASURING STRESS DISTRIBUTION AROUND RIVETS, Proceedings of Society for Experimental Stress Analysis, Vol. XVII, No. 1, 1959, pp. 23-24

59-48 Schutz, F. W., Jr.
STRENGTH OF MOMENT CONNECTIONS USING HIGH TENSILE STRENGTH BOLTS, Proceedings, AISC, 1959, pp. 98-110

59-49 Munse, W. H., Fuller, J. R., and Petersen, K. S.
CUMULATIVE DAMAGE IN STRUCTURAL JOINTS, Proceedings, AREA, Vol. 60, 1959, pp. 67-128

59-50 Prynne, P.
STRESS DISTRIBUTION IN HIGH TENSILE BOLTED CONNECTIONS, Ph.D. Thesis, University of Leeds, England, 1959

59-51 Mathison, W.
MOMENT-ROTATION CHARACTERISTICS OF SEMI-RIGID HIGH-TENSILE BOLTED CONNECTIONS, M. S. Thesis, McGill University, Montreal, August, 1959

59-52 Chesson, E., Jr.
BEHAVIOR OF LARGE RIVETED AND BOLTED STRUCTURAL CONNECTIONS, Ph.D. Thesis, University of Illinois, 1959 (See Abstract 59-30)

59-53 Lewitt, C. W.
THE EFFECT OF RIVET BEARING ON THE FATIGUE STRENGTH OF RIVETED JOINTS, M. S. Thesis, University of Illinois (See Abstract 59-1)

59-54 BS 3139: 1959
HIGH STRENGTH FRICTION GRIP BOLTS FOR STRUCTURAL ENGINEERING, Part I, General Grade Bolts

59-55 Munse, W. H., Bell, W. G., and Chesson, E. Jr.
BEHAVIOR OF RIVETED AND BOLTED BEAM-TO-COLUMN CONNECTIONS, Journal of the Structural Division, ASCE, Vol. 85, ST3, Proceedings Paper 1971, March, 1959, pp. 29-50 (See Abstract 61-21)

59-56 Munse, W. H., Petersen, K. S., and Chesson, E., Jr.
STRENGTH OF RIVETS AND BOLTS IN TENSION, Journal of the Structural Division, ASCE, Vol. 85, ST3, March, 1959 (See Abstract 61-17)

59-57 Ruble, E. J.
RIVET AND BOLT COUNCIL RESEARCH, Journal of the Structural Division, ASCE, Vol. 85, No. ST3, Proceedings Paper 1969, March, 1959, pp. 1-6 (See Abstract 61-16)

59-58 Hansen, N. G.
FATIGUE TESTS OF JOINTS OF HIGH STRENGTH STEEL, Journal of the Structural Division, ASCE, Vol. 85, ST3, Proceedings Paper 1972, March, 1959, pp. 51-68 (See Abstract 61-22)

59-59 Vasorhelyi, D. D., Beano, S. Y., Madison, R. B., Lu, Z. A., and Vasishth, U. C.
EFFECTS OF FABRICATION TECHNIQUES, Journal of the Structural Division, ASCE, Vol. 85, ST3, Proceedings Paper 1973, March, 1959 (See Abstract 61-23)

59-61 Kinney, J. W.
EXPERIENCE WITH HIGH STRENGTH BOLTS IN THE MACKINAC BRIDGE, Journal of the Structural Division, ASCE, Vol. 85, ST3, Proceedings Paper 1975, March, 1959, pp. 133-144 (See Abstract 61-30)

60-1 Engineering News-Record
WHICH WAY IS BETTER IN THE SHOP?, Engineering News-Record, January 14, 1960, pp. 53-54

60-2 Bendigo, R. A., and Rumpf, J. L.
STATIC TENSION TESTS OF LONG BOLTED JOINTS, Fritz Engineering Laboratory Report No. 271.8, Lehigh University, Bethlehem, Pa., February, 1960

60-3 Charlton, T. M.
COLLAPSE BEHAVIOR OF A BOLTED FRAME, Engineering, London, February 12, 1960

60-4 Lewitt, C. W., Chesson, E., Jr., and Munse, W. H.
STUDIES OF THE EFFECT OF WASHERS ON THE CLAMPING FORCE IN HIGH-STRENGTH BOLTS, Department of Civil Engineering, University of Illinois, SRS No. 191, March, 1960

60-5 Marcin, S. J.
LOAD DISTRIBUTION IN BOLTED JOINTS, Fritz Engineering Laboratory Report No. 271.13, Lehigh University, Bethlehem, Pa., June, 1960

60-6 Lehman, F. G.
STRESS ANALYSIS OF GUSSET PLATES Sc.D. Dissertation, Massachusetts Institute of Technology, June, 1960

60-7 Munse, W. H.
TESTS OF VARIOUS CONNECTIONS ASSEMBLED WITH BEARING BOLTS, The Lamson and Sessions Company, Cleveland, Ohio, August, 1960

60-8 Johnson, L. G., Cannon, J. C., and Spooner, L. A.
HIGH-TENSILE PRELOADED BOLTED JOINTS FOR DEVELOPMENT OF FULL PLASTIC MOMENTS, British Welding Journal, September, 1960, pp. 560-569

60-9 Vasarhelyi, D. D., Taylor, J. C., Vasishth, U. C., and Yaun, C. Y.
TEST OF A RIVETED PLATE GIRDER WITH A THIN WEB, Journal of the Structural Division, ASCE, Paper No. 2621, Vol. 86, No. ST10, October, 1960, pp. 23-51

60-10 Lind, H. H.
STORY OF THE RESEARCH COUNCIL AND DEVELOPMENT OF HIGH-STRENGTH BOLTING, Fasteners, Vol. 15, Nos. 2 and 3, Fall-Winter, 1960, pp. 4-7

60-11 Belford, B.
THE FRIST REPORT ON THE NEW HEAVY STRUCTURAL BOLT, Fasteners, Vol. 15, Nos. 2 and 3, Fall-Winter, 1960, pp. 18-20

60-12 Smith, A. M.
INTERFERENCE-BODY BOLTS, Fasteners, Vol. 15, Nos. 2 and 3, Fall-Winter, 1960, pp. 22

60-13 Fasteners
HIGH-STRENGTH BOLTS ARE STRONGER THAN EVER, Fasteners, Vol. 15, Nos. 2 and 3, Fall-Winter, 1960, pp. 24-26

60-14 Fasteners
WHY CHANGES WERE MADE IN HARDENED WASHERS, Fasteners, Vol. 15, Nos. 2 and 3, Fall-Winter, 1960, pp. 27-28

60-15 Ball, E. F.
TIGHTENING HIGH-STRENGTH BY TURN-OF-NUT METHOD....SEVEN SIMPLE STEPS, Fasteners, Vol. 15, Nos. 2 and 3, Fall-Winter, 1960, p. 29

60-16 Estes, E. R., Jr.
THE ADVANTAGES OF DESIGNING STRUCTURAL STEEL CONNECTIONS USING A325 BOLTS, Fasteners, Vol. 15, Nos. 2 and 3, Fall-Winter, 1960, pp. 30-32

60-17 Graves, F. E.
HIGH-STRENGTH BOLTING MOVES INTO FABRICATION SHOPS, Fasteners, Vol. 15, Nos. 2 and 3, Fall-Winter, 1960, pp. 33-37

60-18 Fasteners
FOUR HUNDRED THOUSAND HIGH-STRENGTH BOLTS, Fasteners, Vol. 15, Nos. 2 and 3, Fall-Winter, 1960, pp. 38-99

60-19 de Bach, J., and Bouwan, L. P.
EFFECT OF THERMOGALVANIZING AND SHERADIZING OF PRESTRESSING BOLTS ON THEIR MECHANICAL PROPERTIES AND ON THE RELATIONSHIP BETWEEN WRENCH TORQUE AND PRESTRESSING FORCE, Stevin Laboratory, Delft Polytechnic Institute, Report No. 6060-8-VB-5, September, October, 1960, Holland

60-20 Graves, F. E.
HOW TO CUT THE COST OF THREADED FASTENERS, Purchasing, September, 1960, pp. 78-81

60-21 Rumpf, J. L.
THE ULTIMATE STRENGTH OF BOLTED CONNECTIONS, Ph.D. Dissertation, Lehigh University, Bethlehem, Pa., September, 1960.

60-22 Vasishth, U. C.
A STUDY OF THE BEHAVIOR OF RIVETS, The Trend of Engineering, The Engineering Experiment Station, University of Washington, October, 1960

60-23 Romualdi, J. P., and Sanders, P. H.
FRACTURE ARREST BY RIVETED STIFFENERS, Carnegie Institute of Technology, Contract No. AF 49(638) -237, October, 1960

60-24 Heap, W. J., and Gill, P. J.
SLIPPING TESTS ON BOLTED JOINTS WITH VARYING CLAMPING FORCES, Unpublished Report No. 457, G. K. N. Group Research Laboratory, London, 1960

60-25 Sattler, K.
BETRACHTUNGEN UBER DIE VERWENDUNG HOCHZUGFESTER SCHRAUBEN BEI STAHLTRAGER-VERBUNDKONSTRUKTIONEN (CONSIDERATIONS ON THE USE OF HIGH-TENSILE BOLTS IN COMPOSITE CONCRETE AND STEEL GIRDER STRUCTURES), Preliminary Publication, Sixth Congress, IABSE, 1960, pp. 333-349

60-26 Steinhardt, O.
HOCHFESTE VORGESPANNTE SCHRAUBEN (HV-SCHRAUBEN) ALS NEUARTIGE VERBINDUNGSMITTEL DES STAHLBAUS (HIGH-TENSILE PRESTRESSED BOLTS AS A NEW TYPE OF STRUCTURAL CONNECTION IN STEEL CONSTRUCTION), Preliminary Publication, Sixth Congress, IABSE, 1960, pp. 351-370

60-27 Beer, H.
EINIGE GESICHTSPUNKTE ZUR ANWENDUNG HOCHFESTER, VORGESPANNTER SCHRAUBEN, (SOME ASPECTS OF THE USE OF HIGH-STRENGTH BOLTS), Final Report, Sixth Congress, IABSE, 1960, pp. 157-172

60-28 Steinhardt, O.
ZUR ANWENDUNG VON HV-SCHRAUBEN IM STAHLBAU, (ON THE APPLICATION OF HIGH-STRENGTH BOLTS IN STEEL CONSTRUCTION), Final Report, Sixth Congress, International Association for Bridge and Structural Engineering, Stockholm, 1960, pp. 173-189

60-29 McMullen, A. C.
AN INVESTIGATION INTO THE STRENGTH OF BOLTED JOINTS IN DOUGLAS FIR, M.S. Thesis, University of Alberta, Edmonton, April, 1960

60-30 Chronis, N. P.
55% THREAD DEPTH WILL MAKE BERYLLUIM BOLTS PRACTICAL, Product Engineering, November 14, 1960, pp. 75-77

60-31 Kuzmanovic, B. O.
RIVETED WEB CONNECTIONS IN BENDING, Publications, IABSE, Vol. 20, 1960, Zurich, pp. 151-178

60-32 Wright, D. T., and Lewis, E. M.
FUNDAMENTAL CONCEPTS, AND THE DEVELOPMENT OF SPECIFICATIONS FOR HIGH-TENSILE BOLTED JOINTS, Preliminary Publications, 6th Congress, IABSE, 1960, Zurich, pp. 371-382

60-33 Berridge, P. S. A.
THE USE OF HIGH STRENGTH BOLTS IN RAILWAY GIRDER BRIDGES, Preliminary Publication, Sixth Congress, IABSE, 1960, Zurich, pp. 313-332

60-34 Thurlimann, B.
RESEARCH ON LARGE COMPACT JOINTS WITH HIGH STRENGTH STEEL BOLTS, Final Report Sixth Congress, IABSE, June 27-July 1960

60-35 Estes, E. R., Jr.
RECENT DEVELOPMENTS IN THE USE OF HIGH-STRENGTH BOLTS, Proceedings, AISC, 1960, pp. 5-9

60-36 Ely, J. F.
TRUSS BRIDGE PROJECT AT NORTHWESTERN UNIVERSITY, Proceedings, AISC, May 5-6, 1960, pp. 10-16

60-37 BS 3294: 1960
GENERAL REQUIREMENTS FOR THE USE OF HIGH STRENGTH FRICTION GRIP BOLTS IN STRUCTURAL ENGINEERING, Part I, General Grade Bolts, British Standards Institution

60-38 BS 1083: 1960
PRECISION HEXAGON BOLTS, SCREWS, NUTS (B.S.W. & B.S.F. THREADS) AND PLAIN WASHERS, British Standards Institution

60-39 Deutscher Normenansschuss
SCHRAUBEN, MUTTERN UND ANNLICHE GEWINDEUND FORMTEILE - DIN 267, December, 1960

60-40 Foreman, R. T., and Rumpf, J. L.
STATIC TENSION TESTS OF COMPACT BOLTED JOINTS, Journal of the Structural Division, ASCE, Vol. 86, ST6, Proc. Paper 2523, June, 1960, pp. 73-99 (See Abstract 61-15)

60-41 Pringle, O. A.
LOOSENING OF BOLTED JOINTS BY SMALL PLASTIC DEFORMATIONS, ASME Paper No. 60-WA-116, 1960

61-1 Gerstung, H.
FRICTION AS A FACTOR IN BOLT TENSION, GALLING, SEIZING, Assembly and Fastener Engineering, Vol. 4, No. 1 and No. 2, January and February, 1961

61-2 Budiansky, B., and Wu, T. W.
TRANSFER OF LOAD TO A SHEET FROM A RIVET-ATTACHED STIFFENER, Technical Report No. 11, Division of Engineering and Applied Physics, Harvard University, February, 1961

61-3 Denkhaus, H. G.
STRENGTH OF WASHERS, The National Mechanical Engineering Research Institute, CSIR Contract No. CN378, Council for Scientific and Industrial Research, Pretoria, South Africa, February 3, 1961

61-4 Munse, W. H.
FATIGUE OF HUCKBOLT FASTENERS AND JOINTS ASSEMBLED WITH HUCKBOLT FASTENERS, Huck Manufacturing Company, Detroit, Michigan, February, 1961

61-5 Munse, W. H.
STATIC AND FATIGUE TESTS OF BOLTED CONNECTIONS COATED WITH DIMETCOTE, the Amercoat Corporation, South Gate, California, March, 1961

61-6 Hyler, W. S., Humphrey, K. D., and Cioth, N. S.
AN EVALUATION OF THE HIGH TENSILE HUCKBOLT FASTENER FOR STRUCTURAL APPLICATIONS, Huck Manufacturing Company, Detroit, Michigan, Report No. 72, March, 1961

61-7 Viner, J. G., Dineen, R. L., Chesson, E., Jr., and Munse, W. H.
A STUDY OF THE BEHAVIOR OF NUTS FOR USE WITH HIGH-STRENGTH BOLTS, Department of Civil Engineering, University of Illinois, Urbana, SRS No. 212, April, 1961

61-8 Leybold, H. A.
RESIDUAL STATIC STRENGTH OF ALUMINUM-ALLOY BOX BEAMS CONTAINING FATIGUE CRACKS IN THE TENSION COVERS, NASA Technical Note D796, April, 1961

61-9 Hansen, R. M.
THE EFFECT OF FASTENER PITCH IN LONG STRUCTURAL JOINTS, Fritz Engineering Laboratory Report No. 271.17, Lehigh University, Bethlehem, Pa., May, 1961

61-10 Sherbourne, A. N.
BOLTED BEAM TO COLUMN CONNECTIONS, The Structural Engineer, Vol. 39, No. 6, London, June, 1961, pp. 203-210

61-11 Jones, R., and Baker, A. R.
HIGH-STRENGTH BOLTS-THE BEHAVIOR OF STRUCTURAL CONNECTIONS USING HIGH STRENGTH BOLTS STRESSED BEYOND THEIR PROOF STRESS, The Structural Engineer, Vol. 19, No. 7, London, July, 1961, pp. 228-234

61-12 Diemer, C. P.
THE RIVET....USE IT RIGHT AND YOU CAN'T BEAT IT, Fasteners, Vol. 16, Nos. 1 and 2, Spring-Summer, 1961, pp. 3-5

61-13 Hanneman, W. M.
HOW PLATED FINISHES AFFECT BOLT TIGHTENING, Fasteners, Vol. 16, Nos. 1 and 2, Spring-Summer, 1961, pp. 7-11

61-14 Hansen, R. M., and Rumpf, J. L.
FURTHER STATIC TENSION TESTS OF LONG BOLTED JOINTS, Fritz Engineering Laboratory Report No. 271.15, Lehigh University, Bethlehem, Pa., October, 1961

61-15 Foreman, R. T., and Rumpf, J. L.
STATIC TENSION TESTS OF COMPACT BOLTED JOINTS, Transactions, ASCE, Vol. 126, Part II, Paper No. 3125, 1961, pp. 228-254

61-16 Ruble, E. J.
COUNCIL RESEARCH, Transactions, ASCE, Vol. 126, Part II, Paper No. 324., 1961, pp. 694-699

61-17 Munse, W. H., Petersen, K. S., and Chesson, E., Jr.
STRENGTH IN TENSION, Transactions, ASCE, Vol. 126, Part II, Paper No. 3241, 1961, pp. 700-728

61-18 Douty, R. T.
DISCUSSION ON ("STRENGTH IN TENSION" by Munse, Petersen, and Chesson), Transactions, ASCE, Vol. 126, Part II, 1961, pp. 719-726

61-19 Penman, W. R., and Ball, E. F.
DISCUSSION ON ("STRENGTH IN TENSION" by Munse, Petersen, and Chesson), Transactions, ASCE, Vol. 126, Part II, 1961, pp. 726-727

61-20 Munse, W. H., Petersen, K. S., and Chesson, E., Jr.
COMMENTS ON (THE DISCUSSION OF THEIR PAPER "STRENGTH IN TENSION"), Transactions, ASCE, Vol. 126, Part II, 1961, p. 727

61-21 Munse, W. H., Bell, W. G., and Chesson, E., Jr.
BEHAVIOR OF RIVETED AND BOLTED BEAM-TO-COLUMN CONNECTIONS, Transactions, ASCE, Vol. 126, Part II, Paper No. 3241, pp. 729-749

61-22 Hansen, N. G.
FATIGUE TESTS OF JOINTS OF HIGH-STRENGTH STEEL, Transactions, ASCE, Vol. 126, Part II, Paper No. 3241, 1961, pp. 750-763

61-23 Vasarhelyi, D. D., Beano, S. Y., Madison, R. B., Lu, Z. A., and Vasishth, U. C.
EFFECTS OF FABRICATION TECHNIQUES, Transactions, ASCE, Vol. 126, Part VI, Paper No. 1973, 1961, pp. 764-796

61-24 Ball, E. F., and Higgins, J. J.
INSTALLATION AND TIGHTENING OF BOLTS, Transactions, ASCE, Vol. 126, Part II, Paper No. 3241, 1961, pp. 797-807

61-25 Zweig, B. A.
DISCUSSION ON "INSTALLATION AND TIGHTENING OF BOLTS", by E. F. Ball, and J. J. Giggins, Transactions, ASCE, Vol. 126, Part II, 1961, p. 807

61-26 Zar, M.
DISCUSSION ON "INSTALLATION AND TIGHTENING BOLTS, by E. F. Ball, and J. J. Higgins, Transactions, ASCE, Vol. 126, Part II, 1961, p. 808

61-27 Munse, W. H.
DISCUSSION ON "INSTALLATION AND TIGHTENING OF BOLTS", by Ball and Higgins, Transactions, ASCE, Vol. 126, Part II, 1961, pp. 808-809

61-28 Archibald, R.
DISCUSSION ON "INSTALLATION AND TIGHTENING OF BOLTS", by Ball, and Higgins, Transactions, ASCE, Vol. 126, Part II, 1961, p. 809

61-29 Ball. E. F., and Higgins, J. J.
"CLOSURE OF INSTALLATION AND TIGHTENING OF BOLTS", Transactions, ASCE, Vol. 126, Part II, 1961, pp. 809-810

61-30 Kinney, J. W.
HIGH-STRENGTH BOLTS ON MACKINAC BRIDGE, Transactions, ASCE, Vol. 126, Part II, Paper No. 3241, 1961, pp. 881-820

61-31 Hoyer, W.
UBER GLEITFESTE SCHRAUBENVERBINDUNGEN (4. BERICHT) VORVERSUCHE MIT VERSUCHSKORPERN AUS LEICHTMETALL (ON SLIDE-PROOF BOLTED CONNECTIONS (4th REPORT), PRELIMINARY TESTS WITH LIGHT-WEIGHT-METAL SPECIMEN), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 4 (1961), Heft 1, pp. 41-47

61-32 Fernlund, I.
A METHOD TO CALCULATE THE PRESSURE BETWEEN BOLTED OR RIVETED PLATES, Report No. 17, Institute of Machine Elements, Chalmers University of Technology, Gotherburg, Sweden, 1961

61-33 Dewalt, W. J.
NEW TEST DATA ON ALUMINUM SCREW STRENGTH, Product Engineering, November 13, 1961, pp. 99-104

61-34 Nitkin, I. H.
PLASTIC STEEL DESIGN WITH SEMI-RIGID CONNECTIONS, Master of Engineering Thesis, McGill University, Montreal, 1961

61-35 Leon, E. V.
MOMENT-ROTATION CHARACTERISTICS OF SEMI-RIGID HIGH-TENSILE BOLTED CONNECTIONS - III, M.S. Thesis, McGill University, Montreal, April, 1961

61-36 Howe, J. W.
MOMENT-ROTATION CHARACTERISTICS OF SEMI-RIGID HIGH-TENSILE BOLTED CONNECTIONS - II, M.S. Thesis, McGill University, Montreal, April, 1961

61-37 Douth, R. T., and McGuire, W.
HIGH STRENGTH BOLTED CONNECTIONS WITH APPLICATIONS TO PLASTIC DESIGN, 1st Progress Report for AISC and IFI, January, 1961 (See Abstract 63-7)

61-38 Komatsubara, M., Tajima, J., and Omiya, K.
FATIGUE TESTS ON HIGH STRENGTH BOLTED JOINTS, Railway Technical Research Report No. 232, Japanese National Railways, July, 1961, In Japanese (See Abstracts 62-25 and 63-11)

61-39 Omiya, K., and Tajima, J.
SLIP AND STRESS DISTRIBUTION OF HIGH-STRENGTH BOLTED JOINTS, Railway Technical Research Report No. 236, Japanese National Railways, July, 1961, In Japanese (See Abstract 62-25)

62-1 Waltermire, W. G.
EVALUATING FASTENER AND JOINT PERFORMANCE WITH A LOAD ANALYZER, Assembly and Fastener Engineering, January and February, 1962, pp. 33 and 34

62-2 Dlugosz, S. E., and Fisher, J. W.
CALIBRATION STUDY OF HEAVY HEAD A325 BOLTS, Fritz Engineering Laboratory Report No. 271.21, Lehigh University, Bethlehem, Pa., February, 1962

62-3 Knoell, A. C., Chesson, E., Jr., and Munse, W. H.
FATIGUE BEHAVIOR OF BOLTED JOINTS ASSEMBLED WITHOUT WASHERS, Department of Civil Engineering, University of Illinois, SRS No. 242, February, 1962

62-4 Tajima, J.
STATICAL AND FATIGUE STRENGTH OF RIVETED AND BOLTED JOINTS USING 60 kg/mm$^2$ HIGH-STRENGTH STEEL IN TENSION, Railway Technical Research Report No. 283, Japanese National Railways, April, 1962 (in Japanese)

62-5 Gill, P. J.
LOAD INDICATING BOLTS, Consulting Engineer, April-May, 1962, London

62-6 Radzimovsky, E., and Kasuba, R.
BENDING STRESSES IN THE BOLTS OF A BOLTED ASSEMBLY, Paper No. 731, Society for Experimental Stress Analysis, May, 1962

62-7 Chu, T. Y.
THE EFFECT OF BEARING STRESSES ON THE FATIGUE STRENGTH OF A STRUCTURAL JOINT, M.S. Thesis, University of Kansas, Lawrence, Kansas, May, 1962

62-8 Dlugosz, S. E.
STATIC TENSION TESTS OF LONG RIVETED JOINTS, Fritz Engineering Laboratory No. 271.20, Lehigh University, Bethlehem, Pa., June, 1962

62-9 Weber, N. E.
BOLT-TORQUE INSPECTION BY STATISTICAL ANALYSIS, Civil Engineering, Vol. 32, June, 1962, p. 69

62-10 Yeakel, W. R.
65,000 NEW HEAVY HEAD HIGH-STRENGTH BOLTS WERE USED IN THE ASSEMBLY OF THE SPACE NEEDLE FOR THE 1962 SEATTLE WORLD'S FAIR, Fasteners, Vol. 17, No. 2, Summer, 1962, pp. 3-5

62-11 Hotchkiss, J. G.
SINEWS OF CONSTRUCTION, Fasteners, Vol. 17, No. 2, Summer, 1962, pp. 12-15

62-12 Bendigo, R. A., Fisher, J. W., and Rumpf, J. L.
STATIC TENSION TESTS OF BOLTED LAP JOINTS, Fritz Engineering Laboratory Report No. 271.9, Lehigh University, Bethlehem, Pa., August, 1962

62-13 Belford, R. B.
NEW SPECIFICATIONS FOR HIGH-STRENGTH BOLTING, Fasteners, Vol. 17, No. 3, Fall, 1962, pp. 6-10

62-14 Diemer, J. A., Hunt, E. M., and Hanna, J. C.
THE REAL STRENGTH OF RIVETS, Fasteners, Vol. 17, No. 4, Winter, 1962-1963, pp. 6-10

62-15 Steinhardt, O., and Mohler, K.
VERSUCHE ZUR ANWENDUNG VORGESPANNTER SCHRAUBEN IM STAHLBAU. III. TEIL (TESTS ON THE APPLICATION OF HIGH-STRENGTH BOLTS IN STEEL CONSTRUCTION, PART III), Berichte des Deutschen Ausschusses fur Stahlbau, Stahlbau-Verlags GmbH, Cologne, 1962, Heft 24

62-16 Wiedemann, J.
DIE ERSTEL ANWENDUNG DER GLEITFESTEN SCHRAUBENVERBINDUNG IM BRUCKENBAU DER DEUTSCHEN REICHSBAHN (THE FIRST APPLICATION OF SLIP-PROOF BOLTED CONNECTIONS IN BRIDGE CONSTRUCTION FOR THE GERMAN RAILROAD), Wissenschraftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 11-18

62-17 Sammet, J.
HOCHFEST VERSCHRAUBTE ROHRVERBINDUNGEN (PIPE CONNECTIONS USING HIGH-STRENGTH BOLTS), Wissenschafliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 12, pp. 19-30

62-18 Rybak, M.
DIE VERSUCHE UBER SPANNUNGSVERTEILUNGEN IN GLEITFESTEN VERBINDUNGEN (TESTS ON THE STRESS DISTRIBUTION IN SLIP-PROOF CONNECTIONS), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 31-42

62-19 Skwirblies, D.
EINIGE BETRACHTUNGEN ZU DEN SCHRAUBENABSTANDEN HOCHFEST VERSCHRAUBTER VERBINDUNGEN (SOME ASPECTS ON THE SPACING OF BOLTS OF HIGH-STRENGTH BOLTED CONNECTIONS), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 43-48

62-20 Ziemba, St., and Rybak, M.
FESTIGKEITSVERSUCHE UBER HOCHFESTE SCHRAUBEN (TESTS ON THE ULTIMATE STRENGTH OF HIGH-STRENGTH BOLTS), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5, (1962), Heft 1/2, pp. 49-57

62-21 Pfungen, R.
VERSUCHE MIT HV-SCHRAUBEN UND ANWENDUNG DER GLEITFESTEN SCHRAUBVERBINDUNG IN OSTERREICH (TESTS ON HIGH-STRENGTH BOLTS AND APPLICATION OF THE SLIP-PROOF BOLTED CONNECTION IN AUSTRIA), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 59-64

62-22 Hohaus, D.
UNTERSUCHUNG UBER HOCHFESTE SCHRAUBEN IN LEICHTMETALL-VERBINDUNGEN (INVESTIGATIONS ON HIGH-STRENGTH BOLTS IN LIGHT-WEIGHT METAL CONNECTIONS), Wissenschaftliche Zeitschrift der Hochschule fur Bauwesen Cottbus, 5 (1962), Heft 1/2, pp. 65-73

62-23 Weigand, H., and Illgner, K. H.
BERECHNUNG UND GESTALTUNG VON SCHRAUBENVERBINDUNGEN (ANALYSIS AND DESIGN OF BOLTED CONNECTIONS), Konstrucktionsbucher 5, Springer-Verlag 1962

62-24 Task Committee on Lightweight Alloys, John W. Clark, Chairman
SUGGESTED SPECIFICATIONS FOR STRUCTURES OF ALUMINUM ALLOYS, 6061-T6 and 6062-T6, Journal of the Structural Division, ASCE, Vol. 88, No. ST6, Proceedings Paper 3341, December, 1962

62-25 Komatsubara, M., Tajima, J., and Omiya, K.
SEVERAL EXPERIMENTS ON HIGH-STRENGTH-BOLTED JOINTS, Quarterly Report of the Railway Technical Research Institute, Vol. 3, No. 2, 1962, Japan

62-26 Douty, R. T., and McGuire, W.
HIGH STRENGTH BOLTED CONNECTIONS WITH APPLICATIONS TO PLASTIC DESIGN, 2nd Progress Report to AISC and IFI, March, 1962 (See Abstract 63-7)

63-1 Fisher, J. W., and Beedle, L. S.
CRITERIA FOR DESIGNING BOLTED JOINTS (BEARING TYPE), Fritz Engineering Laboratory, Report No. 288.7, Lehigh University, Bethlehem, Pa., February, 1963

63-2 Christopher, R. J., and Fisher, J. W.
CALIBRATION OF A354 BOLTS, Fritz Engineering Laboratory Report No. 288.9, Lehigh University, Bethlehem, Pa., February, 1963

63-3 Chang, W. N., and Vasarhelyi, D. D.
THE COEFFICIENT OF FRICTION IN BOLTED JOINTS AND MISALIGNMENT IN BOLTED JOINTS, Department of Civil Engineering, University of Washington, Eleventh Progress Report to RCRBSJ, February, 1963

63-4 Eaton, I. D.
COMPARATIVE FATIGUE STRENGTHS OF SCREW-THREAD FORMS, Product Engineering, Vol. 34, No. 3, February 4, 1963, pp. 66-69

63-5 Loubser, R. S.
A CRITICAL REVIEW OF THE LITERATURE ON FRICTION GRIP BOLTED JOINTS FOR STEEL STRUCTURES, National Mechanical Engineering Research Institute, Council for Scientific and Industrial Research, CSIR Special Report No. N273, Pretoria, South Africa, February, 1963

63-6 Cullimore, M. S. G.
BASIC FACTORS IN THE BEHAVIOR OF FRICTION GRIP BOLT JOINTS, Civil Engineering and Public Works Review, March and April, Vol. 58, No. 680 and 681, 1963, London, pp. 379-384, and pp. 498-500

63-7 Douty, R. T., and McGuire, W.
RESEARCH ON BOLTED MOMENT CONNECTIONS-A PROGRESS REPORT, Proceedings, AISC, April, 1963, pp. 48-55

63-8 Chang, W. N., and Vasarhelyi, D. D.
MISALIGNMENT IN BOLTED JOINTS, Twelfth Progress Report to RCRBSJ, Department of Civil Engineering, University of Washington, Seattle, Washington, July, 1963

63-9 Daesen, J. R.
REVISE SPECIFICATIONS FOR GALVANIZING ON SLIP SURFACES, Consulting Engineer, October, 1963, pp. 127-128

63-10 Wright, W.
ULTIMATE STRENGTH OF LONG LAP JOINTS, Engineering Institute of Canada, Vol. 1, No. 31, Paper No. EIC-63-BR&STR 17, November, 1963

63-11 Tajima, J., and Tomonaga, K.
FATIGUE TEST ON HIGH-STRENGTH BOLTED JOINTS, Structural Design Office, Japanese National Railway, 1963

63-12 Fisher, J. W., Ramseier, P. O., and Beedle, L. S.
STATIC STRENGTH OF A440 STEEL JOINTS FASTENED WITH A325 BOLTS, Publications, IABSE, Vol. 23, 1963, pp. 320-345

63-13 Daesen, J. R.
SLIP RESISTANCE OF BOLTED GALVANIZED STEEL JOINTS, The Galvanizing Institute, Park Ridge, Illinois, 1963

63-14 Yamada, M.
BEHAVIOR OF WIDE FLANGE BEAM-COLUMN CONNECTIONS (HIGH-STRENGTH BOLTED CONNECTIONS), Department of Architecture, Kobe University, Kobe, Japan, 1963, (in Japanese)

63-15 Fisher, J. W., Ramseier, P. O., and Beedle, L. S.
STATIC STRENGTH OF A440 STEEL JOINTS FASTENED WITH A325 BOLTS, Fritz Engineering Laboratory, Report 288.4, Lehigh University, Bethlehem, Pa., 1963 (See Abstract 63-12)

63-16 Lewitt, C. W., Chesson, E., Jr., and Munse, W. H.
FATIGUE OF BOLTED CONNECTIONS, Journal of the Structural Division, ASCE, Vol. 89, No. ST1, Proc. Paper 3411, February, 1963

63-17 Chesson, E., Jr., and Munse, W. H.
TRUSS-TYPE TENSILE CONNECTIONS, Journal of the Structural Division, ASCE, Vol. 89, No. ST1, Proc. Paper 3412, February, 1963

63-18 Munse, W. H., and Chesson, E., Jr.
NET SECTION DESIGN, Journal of the Structural Division, ASCE, Vol. 89, No. ST1, Proc. Paper 3413, February, 1963

63-19 Rumpf, J. L., and Fisher, J. W.
CALIBRATION OF A325 BOLTS, Journal of the Structural Division, ASCE, Vol. 89, No. ST6, Proc. Paper 3731, December, 1963, pp. 215-234

63-20 Bendigo, R. A., Hansen, R. M., and Rumpf, J. L.
LONG BOLTED JOINTS, Journal of the Structural Division, ASCE, Vol. 89, No. ST6, Proc. Paper 3727, December, 1963, pp. 187-213

64-1 Onderdonk, A. B., Lathrop, R. P., and Cod, J.
END PLATE CONNECTIONS IN PLASTICALLY DESIGNED STRUCTURES, Engineering Journal, AISC, Vol. 1, No. 1, January, 1964, pp. 24-27

64-2 Nordmark, G. E.
FATIGUE OF ALUMINUM WITH ALCLAD AND SPRAYED COATINGS, Journal of Spacecraft and Rockets, Vol. 1, No. 1, January and February, 1964, pp. 125-127

64-3 Fisher, J. W.
THE ANALYSIS OF BOLTED PLATE SPLICES, Ph.D. Dissertation, Lehigh University, Bethlehem, Pa., February, 1964

64-4 Chiang, K. C., and Vasarhelyi, D. D.
THE COEFFICIENT OF FRICTION IN BOLTED JOINTS MADE WITH VARIOUS STEELS AND WITH MULTIPLE CONTACT SURFACES, Department of Civil Engineering, University of Washington, Seattle, February, 1964

64-5 Troup, E. W. J., and Chesson, E., Jr.
CALIBRATION TESTS OF A490 HIGH-STRENGTH BOLTS, Department of Civil Engineering, University of Illinois, SRS No. 280, March, 1964

64-6 Chesson, E., Jr., Faustino, N. L., and Munse, W. H.
STATIC STRENGTH OF HIGH-STRENGTH BOLTS UNDER COMBINED TENSION AND SHEAR, SRS 288, Department of Civil Engineering, University of Illinois, Urbana, March, 1964

64-7 Sterling, G., and Fisher, J. W.
TESTS OF A490 BOLTS (PRELIMINARY REPORT), Fritz Engineering Laboratory Report No. 288.15, Lehigh University, Bethlehem, Pa., March, 1964

64-8 Chesson, E., Jr.
EQUIPMENT FOR RESEARCH ON RIVETED JOINTS, Bulletin No. 22, RILEM, Paris, France, March, 1964, pp. 66-67

64-9 Upton, K. A., and Cullimore, M. S. G.
THE DISTRIBUTION OF PRESSURE BETWEEN TWO FLAT PLATES BOLTED TOGETHER, International Journal of Mechanical Sciences, Vol. 6, No. 1, February, 1964, pp. 13-27

64-10 Watson, I.
FLANGE-BOLT DESIGN, Engineering Materials and Design, Vol. 7, No. 10, October, 1964, pp. 687-689

64-11 Tajima, J.
LONGITUDINAL STRESS DISTRIBUTION OF THE HIGH-STRENGTH BOLTED JOINTS, Structural Design Office, Japanes National Railway, Tokyo, June, 1964

64-12 Tajima, J.
EFFECT OF RELAXATION AND CREEP ON THE SLIP LOAD OF THE HIGH-STRENGTH BOLTED JOINTS, Structural Design Office, June, 1964

64-13 Chesson, E., Jr.
HIGH-STRENGTH STRUCTURAL BOLTS VERSUS RIVETS, Building Research, July - August, 1964, pp. 49-50

64-14 Johnson, L. G.
TEST ON FRICTION GRIP BOLTED SHEAR CONNECTIONS WITH VARIOUS FINISHES ON THE CONTACT FACES, Dorman Long and Co., Limited, England, July, 1964

64-15 Daesen, J. R.
CHOOSE THE RIGHT ZINC COATING FOR LARGE STRUCTURES, Metal Progress, Vol. 86, No. 3, September, 1964, pp. 950-110

64-16 Kloppel, K., and Seeger, T.
DAUERVERSUCHE MIT EINSCHNITTIGEN HV-VERBINDUNGEN AUS ST 37 (FATIGUE TESTS ON LAP JOINTS USING ST 37 STEEL AND HIGH-STRENGTH BOLTS), Der Stahlbau (Berlin) Heft 8, 33, Jahrgang, August, 1964, pp. 225-245 and Heft 11, 33, Jahrgang, November, 1964, pp. 335-346

64-17 Chesson, E., Jr., and Munse, W. H.
STUDIES OF THE BEHAVIOR OF HIGH-STRENGTH BOLTS AND BOLTED JOINTS, Bulletin No. 469, Vol. 62, No. 26, University of Illinois Engineering Experiment Station, University of Illinois, Urbana, Illinois, October, 1964

64-18 Shermer, C. L.
ULTIMATE-STRENGTH ANALYSIS AND DESIGN OF ECCENTRICALLY-LOADED BOLTED OR RIVETED CONNECTIONS, Preprint for ASCE Structural Engineering Conference, October, 1964

64-19 Chesson, E., Jr.
JOINT BEHAVIOR OF A BOLTED RAILWAY BRIDGE DURING ERECTION AND SERVICE, Department of Civil Engineering, University of Illinois, SRS No. 284, October, 1964

64-20 White, R. N., and Fang, R. J.
SIMPLE FRAMING CONNECTIONS FOR SQUARE STRUCTURAL TUBING, Preprint of ASCE Structural Engineering Conference, October, 1964

64-21 Beedle, L. S., and Christopher, R.
TEST OF STEEL MOMENT CONNECTIONS, Engineering Journal, AISC, Vol. 1, No. 4, October, 1964, pp. 116-125

64-22 Fisher, J. W.
ON THE BEHAVIOR OF FASTENERS AND PLATES WITH HOLES, Fritz Engineering Laboratory Report No. 288.18, Lehigh University, Bethlehem, Pa., December, 1964

64-23 Wallaert, J. J., Sterling, G. H., and Fisher, J. W.
HISTORY OF TENSION IN BOLTS CONNECTING LARGE JOINTS, Fritz Engineering Laboratory Report No. 288.13, Lehigh University, Bethlehem, Pa., December, 1964

64-24 Fisher, J. W., and Beedle, L. S.
BIBLIOGRAPHY ON BOLTED AND RIVETED STRUCTURAL JOINTS, Fritz Engineering Laboratory Report No. 302.1, Lehigh University, Bethlehem, Pa., December, 1964

64-25 Parola, J. F., Chesson, E., Jr. and Munse, W. H.
EFFECT OF BEARING PRESSURE OF FATIGUE STRENGTH OF RIVETED CONNECTIONS, SRS No. 286, Department of Civil Engineering, University of Illinois, December, 1964

64-26 Aurnhammer, G.
HV-VERBINDUNGEN. UBERLEGUNGEN, PETRACHTUNGEN, VERSUCHE, (HIGH STRENGTH BOLTED JOINTS, THOUGHTS, OBSERVATIONS, TESTS), Preliminary Publication, Seventh Congress, IABSE, Rio de Janeiro, 1964, pp. 415-430

64-27 Beer, H., and Wallner, H.
BEITRAG ZUR WANDERSICHEIT VON HV-VERBINDUNGEN (THE SAFETY FACTOR OF HIGH-STRENGTH FRICTION GRIP BOLTS UNDER REPEATED LOADING), Preliminary Publications, Seventh Congress, IABSE, 1964, pp. 371-378

64-28 Konishi, I.
STUDIES ON THE APPLICATION OF HIGH-STRENGTH BOLTED JOINTS TO BRIDGES, Preliminary Publications, 7th Congress, IABSE, 1964, pp. 363-370

64-29 Tomonaga, K., and Tajima, J.
THE USE OF HIGH-STRENGTH BOLTED JOINTS IN RAILWAY BRIDGES, Preliminary Publication, 7th Congress, IABSE, 1964

64-30 Tada, H., and Naka, T.
EXPERIMENTS ON TENSILE JOINTS USING HIGH-STRENGTH BOLTS, Preliminary Publication, 7th Congress, IABSE, 1964

64-31 Carpentier, L., and Alemany, B.
EXPERIENCE FRANCAISE DES BOULONS A HAUTE RESISTANCE (EXPERIENCE WITH HIGH STRENGTH FRICTION GRIP BOLTS IN FRANCE), Preliminary Publications, 7th Congress, IABSE, 1964, Zurich, pp. 397-405

64-32 Goffi, L.
L'EMPLOI DES BOULONS A HAUTE RESISTANCE DANS LA CONSTRUCTION METALLIQUE; LEUR COMPORTEMENT DANS LES CONDITIONS DE SOLLICITATIONS REPETEES (THE USE OF HIGH STRENGTH BOLTS IN STEEL STRUCTURES; THEIR BEHAVIOR UNDER REPEATED LOADING); Preliminary Publications, 7th Congress, IABSE, 1964, Zurich, pp. 407-414

64-33 Radzimovsky, E. I.
BOLTED JOINTS, Section 21, Mechanical Design and Systems Handbook, McGraw-Hill, 1964, pp. 21-1, 21-6

64-34 Holt, M.
RIVETS AND RIVETED JOINTS, Mechanical Design and Systems Handbook, McGraw-Hill, Section 22, pp. 22-1, 22-18, 1964

64-35 Demol, L., and Mas, E.
ASSEMBLAGES PAR BOULONS A HAUTE RESISTANCE, (JOINTS WITH HIGH-STRENGTH BOLTS), Centre de Recherches Scientifiques et Techniques de l'Industrie des Fabrications Metalliques, MT 11 December, 1964, Brussels

64-36 Doyle, D. V.
PERFORMANCE OF JOINTS WITH EIGHT BOLTS IN LAMINATED DOUGLAS-FIR, U. S. Department of Agriculture, Forest Service, Forest Products Laboratory, Madison, Wisconsin, FPL-10, January, 1964

64-37 Waltermire, W. G.
RECENT RESEARCH ON BOLTED JOINTS, Building Research, Vol. 1, No. 4, July-August, 1964, pp. 51-52

64-38 Levy, S.
BOLT FORCE TO FLATTEN WARPED FLANGES, Transactions, ASME, Journal of Engineering for Industry, Vol. 86, No. 3, Series B, August, 1964, pp. 269-272

64-39 Hood, A. C.
CORROSION IN THREADED FASTENERS, Machine Design, Vol. 36, No. 29, December 17, 1964, pp. 153-156

64-40 Sheridan, M. L.
AN EXPERIMENTAL STUDY OF THE STRESS AND STRAIN DISTRIBUTION IN GUSSET PLATES, Ph.D. Dissertation, University of Michigan, 1964

64-41 Hall, J. R.
THE CASE FOR THE GALVANIZED BRIDGE, Civil Engineering, (ASCE), Vol. 34, No. 11, November, 1964, pp. 31-34

64-42 Graves, F. E., and Milek, W. A.
STRONGER STRUCTURAL BOLTS WILL CUT COSTS, SPEED CONSTRUCTION, Civil Engineering, (ASCE), Vol. 34, No. 11, November, 1964, pp. 48-52

64-43 Nordmark, G. E., and Clark, J. W.
FATIGUE OF JOINTS IN ALUMINUM ALLOY 6061-T6, Journal of the Structural Division, ASCE, Vol. 90, No. ST6, Proc. Paper 4156, December, 1964, pp. 35-50

64-44 Upton, K. A.
DAMPING IN STRUCTURAL CONNECTIONS, Engineering Institute of Canada, EIC-64-BR and STR, Vol. 7, 1964

64-45 Butz, G. A., and Nordmark, G. E.
FATIGUE RESISTANCE OF ALUMINUM AND ITS PRODUCTS, Paper 893E, Soc. of Automotive Engineers, September, 1964

64-46 Nordmark, G. E.
FATIGUE TESTS OF BOLTED ALUMINUM JOINTS, Alcoa Research Laboratories, Report 12-64-6, New Kensington, Pa., February, 1964

64-47 Illgner, K. H.
AUSLEGUNG VON SCHRAUBENVERBINDUNGEN FUR STATISCHE ZUG BEANSPRUCHUNGEN (DESIGN OF BOLTED CONNECTIONS FOR STATIC TENSILE LOADS), Maschinenmarkt, Vol. 70, No. 41, May, 1964

64-48 Illgner, K. H.
AUSLEGUNG VON SCHRAUBENVERBINDUNGEN FUR SCHWINGENDE BEANSPRUCHUNG (DESIGN OF BOLTED CONNECTIONS FOR CYCLIC LOADING), Maschinenmarkt, Vol. 70, No. 78, September, 1964

64-49 Wiegand, H. and Illgner, K. H.
HALTBARKEIT VON SCHRAUBENVERBINDUNGEN BEIM EINSCHRAUBEN IN SACKLOCHGEWINDE, (PERFORMANCE OF BOLTED CONNECTIONS UNDER TORQUED TENSION), Construktion, Vol. 16, No. 8, 1964, pp. 330-340

64-50 Wiegand, H., Illgner, K. H., and Beelich, K. H.
DIE DAUERHALTBARKEIT VON GEWINDEVERBINDUNGEN MIT ISO-PROFIL IN ABHANGIGKEIT VON DER EINSCHRAUBTIEFE (THE FATIGUE BEHAVIOR OF THREADED CONNECTIONS WITH ISO THREAD SHAPE AS A FUNCTION OF THREAD DEPTH), Construktion, Vol. 16, No. 12, 1964, pp. 485-490

64-51 Higgins, T. R.
NEW FORMULA FOR FASTENERS LOADED OFF CENTER, Engineering News-Record, Vol. 172, No. 21, May 21, 1964, pp. 65-67

65-1 Sterling, G. H., and Fisher, J. W.
TESTS OF LONG A440 STEEL BOLTED BUTT JOINTS, Fritz Engineering Laboratory Report No. 288.26, Lehigh University, Bethlehem, Pa., February, 1965

65-2 Chesson, E., Jr., and Munse, W. H.
BEHAVIOR OF TYPE C50L HUCKBOLT FASTENERS SUBJECTED TO COMBINED TENSION AND SHEAR, Huck Manufacturing Company, Detroit, Michigan, February, 1965

65-3 Chesson, E., Jr.
EXPLORATORY TESTS ON THE BEHAVIOR OF A490 BOLTS SUBJECTED TO FATIGUE LOADINGS IN TENSION WITH PRYING, Status Report for the Research Council on Riveted and Bolted Structural Joints, University of Illinois, February, 1965

65-4 Prynne, P.
FUNDAMENTALS OF THE USE OF HIGH TENSILE BOLTS IN STRUCTURAL CONNECTIONS, Civil Engineering and Public Works Review, March and April, 1965, London, pp. 375-383, and pp. 542-545

65-5 Yoshimoto, S., Tokunaga, A., and Tadada, S.
TEST ON LARGE SPLIT TEE CONNECTIONS USING SPLICE PLATES AND HIGH-STRENGTH BOLTS WITH INITIAL TENSION, Transactions, Architectural Institute of Japan, No. 110, April, 1965 (in Japanese)

65-6 Chesson, E., Jr.
THE 1964 REVISIONS OF SPECIFICATIONS FOR HIGH-STRENGTH BOLTS, Agricultural Engineering, American Society of Agriculture Engineers, Vol. 46, No. 6, pp. 318-319, 325, June, 1965

65-7 Christopher, R. J., Kulak, G. L., and Fisher, J. W.
CALIBRATION OF ALLOY STEEL BOLTS, Fritz Engineering Laboratory Report No. 288.19A, Lehigh University, Bethlehem, Pa., July, 1965

65-8 Sterling, G. H., and Fisher, J. W.
A440 STEEL JOINTS CONNECTED BY A490 BOLTS, Fritz Engineering Laboratory Report No. 288.30, Lehigh University, Bethlehem, Pa., August, 1965

65-9 Fisher, J. W., Kulak, G. L., and Beedle, L. S.
BEHAVIOR OF LARGE BOLTED JOINTS, Fritz Engineering Laboratory Report No. 288.31, Lehigh University, Bethlehem, Pa., August, 1965

65-10 Fasteners
1,000,000 HIGH STRENGTH BOLTS SPEED FIELD ERECTION OF 526-FT. VEHICLE ASSEMBLY BUILDING, Fasteners, Vol. 20, No. 1, Spring, 1965, pp. 4 and 5

65-11 Viglione, Joseph
"NUT DESIGN FACTORS FOR LONG BOLT LIFE", Machine Design, Vol. 37, No. 18, August, 1965

65-12 Roderick, J. W., and Nielsen, D. A.
THE STRUCTURAL USE OF FRICTION GRIP BOLTS, Australasian Engineer, January, 1965, Sydney, pp. 25-33

65-13 Beedle, L. S., Yura, J. A., Badaliance, R., Corrada, J. A., Gaedeke, K. P., and Bott, B. A.
SURVEY OF CURRENT STRUCTURAL RESEARCH, Journal of the Structural Division, ASCE, Vol. 91, No. ST1, Proc. Paper 4233, February, 1965, pp. 13-102

65-14 Douty, R. T., and McGuire, W.
HIGH STRENGTH BOLTED MOMENT CONNECTIONS, Journal of the Structural Division, ASCE, Vol. 91, No. ST2, Proc. Paper 4298, April, 1965, pp. 101-128

65-15 Chesson, E., Jr.
BOLTED BRIDGE BEHAVIOR DURING ERECTION AND SERVICE, Journal of the Structural Division, ASEE, Vol. 91, No. ST3, Proc. Paper 4365, June, 1965, pp. 57-70

65-16 Wallaert, J. J., and Fisher, J. W.
SHEAR STRENGTH OF HIGH-STRENGTH BOLTS, Journal of the Structural Division, ASCE, Vol. 91, No. ST3, Proc. Paper 4368, June, 1965, pp. 99-125

65-17 Vasarhelyi, D. D., and Chang, W. N.
MISALINEMENT IN BOLTED JOINTS, Journal of the Structural Division, ASCE, Vol. 91, No. ST4, Proc. Paper 4422, August, 1965, pp. 1-15

65-18 Fisher, J. W., and Beedle, L. S.
CRITERIA FOR DESIGNING BEARING-TYPE BOLTED JOINTS, Journal of the Structural Division, ASCE, Vol. 91, No. ST5, Proc. Paper 4511, October, 1965, pp. 129-154

65-19 Chesson, E., Jr., Faustino, N. L., and Munse, W. H.
HIGH-STRENGTH BOLTS SUBJECTED TO TENSION AND SHEAR, Journal of the Structural Division, ASCE, Vol. 91, No. ST5, Proc. Paper 4512, October, 1965, pp. 155-180

65-20 Fisher, J. W., and Rumpf, J. L.
ANALYSIS OF BOLTED BUTT JOINTS, Journal of the Structural Division, ASCE, Vol. 91, No. ST5, Proc. Paper 4513, October, 1965, pp. 181-203

65-21 Sterling, G. H., Troup, Emile W. J., Chesson, E., Jr. and Fisher, J. W.
CALIBRATION TESTS OF A490 HIGH-STRENGTH BOLTS, Journal of the Structural Division, ASCE, Vol. 91, No. ST5, Proc. Paper 4515, October, 1965, pp. 279-298

65-22 Godfrey, G. B.
HIGH STRENGTH FRICTION GRIP BOLTS, British Constructional Steelwork Association, Publication No. 26, London, 1965

65-23 Stevin Laboratory
THE PROGRAMME OF A SERIES OF TESTS IN ORDER TO COMPARE THE FRICTION FACTORS OF FE37 AND FE52, Department of Civil Engineering, Technological University, Delft, The Netherlands, 1965 (C.E.A.C.M. X-65-12)

65-24 Stevin Laboratory
DECREASE OF THE PRE-LOAD IN HIGH-STRENGTH BOLTS IN THE COURSE OF TIME (PROVISIONAL RESULTS), Department of Civil Engineering, Technological University, Delft, The Netherlands, 1965, (C.E.A.C.M. X-65-12)

65-25 Parola, J. F., Chesson, E. Jr., Munse, W. H.
EFFECT OF BEARING PRESSURE ON FATIGUE STRENGTH OF RIVETED CONNECTIONS, Engineering Experiment Station, Bulletin 481, University of Illinois, Urbana, Illinois, Vol. 63, No. 27, October 6, 1965 (See Abstract No. 64-25)

65-26 Blake, J. C., and Kurtz, H. J.
THE UNCERTAINTIES OF MEASURING FASTENER PRELOAD, Machine Design, September 30, 1965, pp. 128-131

65-27 Bannister, A.
BEHAVIOUR OF CERTAIN CONNECTIONS INCORPORATING HIGH STRENGTH FRICTION GRIP BOLTS, Civil Engineering and Public Works Review, London, Vol. 60, No. 711, October 1965, pp. 1499-1502 and Vol. 60, No. 712, November 1965, pp. 1619-1625

65-28 Fisher, J. W.
BEHAVIOR OF FASTENERS AND PLATES WITH HOLES, Journal of the Structural Division, ASCE, Vol. 91, No. ST6, Proc. Paper 4587, December, 1965, pp. 265-286

65-29 Wallaert, J. J., Sterling, G. H., and Fisher, J. W.
WHAT HAPPENS TO BOLT TENSION IN LARGE JOINTS?, Fasteners, Vol. 20, No. 3, Winter, 1965, pp. 8-12 (See Abstract 64-23)

65-30 Hagen, H. W., and Penkul, R. C.
DESIGN CHARTS FOR BOLTS WITH COMBINED SHEAR AND TENSION, Engineering Journal, AISC, Vol. 2, No. 2, April, 1965, pp. 42-45

65-31 White, R. N.
FRAMING CONNECTIONS FOR SQUARE AND RECTANGULAR STRUCTURAL TUBING, Engineering Journal, AISC, Vol. 2, No. 3, July, 1965 (See Abstract 64-20)