

1949

Test of a rigid frame knee, Lehigh University, (1949)

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LEHIGH UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING
FRITZ ENGINEERING LABORATORY
BETHLEHEM, PA.

September 9, 1949

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File No. 205C

To: Members, Lehigh Project Subcommittee
Structural Steel Committee
Welding Research Council

REVISED PROPOSAL FOR CONNECTION TESTS

Gentlemen:

The minutes of the June second, 1949, meeting of the Lehigh Subcommittee call for a proposal on connection tests. It is the purpose of this letter to forward to you our recommendations. This revision is intended to supplement the previous proposals and discussions that have been issued⁽¹⁾.

PURPOSE

As a part of the study to determine the basic behavior of welded joints in the elastic and plastic range, it is the primary purpose of these "model" tests to study the influence of certain variables within several connection types. An example is the influence of radius of curvature and thickness of curved flanges.

PROGRAM OF TESTS

A total of 14 tests are proposed as shown in Table I. The sketch of connection types originally included in Progress Report "A" is presented in modified form as Fig. 1 for information. Figs. 3-9, containing detail drawings of the various connection types, are referred to in Table I.

Although not strictly in accordance with the purpose stated above, tests, "C" and "N" are suggested for comparison with the other tests of "bracketed" corners. Both are taken from actual construction examples.

SELECTION OF SECTION

Use of a 6" section is recommended. Models using this section can be handled without a crane, which will

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- (1) Progress Report A, Nov. 26, 1948, Appendix B.
Progress Report E, Jun. 1, 1949.
Proposal to Office of Naval Research, May 7, 1948, p.1 of Encl.
Progress Report F, July 19, 1949, p. 9.

facilitate the experimental program.

The various 6" sections available are shown in Fig. 2, the 6WF15.5 having been selected. The flanges will be flame cut by machine to 2.9", thus simulating the 14WF30 section used in test of connection 7, as shown by the following comparison:

Section	Depth	Flange		Web w	D/b	t/w
		Width=b	Thickness=t			
14WF30	13.875	6.750	0.375	0.3125	2.055	1.2
6WF15.5	6.0	cut to 2.9"	0.250	0.250	2.07	1.0

The 14WF30 section, tested as type 7, gave results that are typical for average rolled members of similar b/d ratio. A calculation has been made which shows that in most cases, type 7 knees fabricated of these sections would fail by shear in the knee web before reaching the yield point in bending.

TEST ARRANGEMENTS

Instead of using a dynamometer and jack as on connection 7, these models can be tested in our 300,000 lb. testing machine, the length of each leg being 4'-0". Both legs will be of the same section, and all tests will be made in "compression" as was the type 7 test.

On some tests it may be desirable to use a maximum of 4 SR-4 gages to determine M- ϕ characteristics at a particular section. Otherwise level bars, dial gages and whitewash will be depended upon to give information on moment-rotation, deformation, yielding, and load-carrying capacity.

GENERAL

A further discussion of each test is contained in Appendix 1.

Arrangements will proceed in two weeks to order additional material and commence tests. Your opinion on the attached postcard will be most welcome. This proposal is

September 9, 1949

the work of Mr. Topractsoglou, Jan Ruzek, and the undersigned.

Sincerely yours,

Lynn S. Beedle
Research Engineer

Bruce G. Johnston
Director

BGJ:LSB:fs


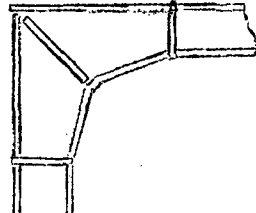
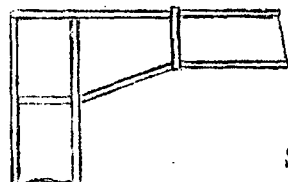
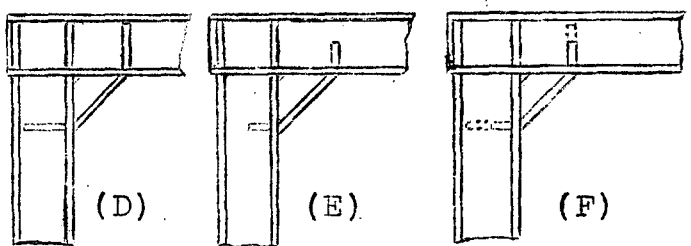
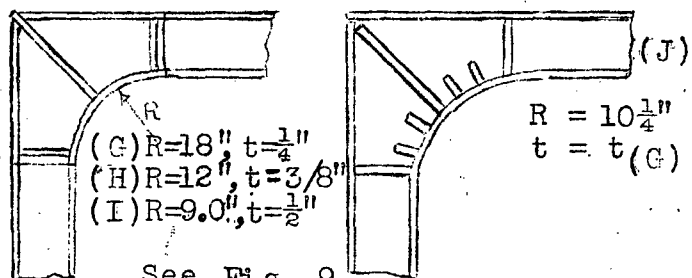
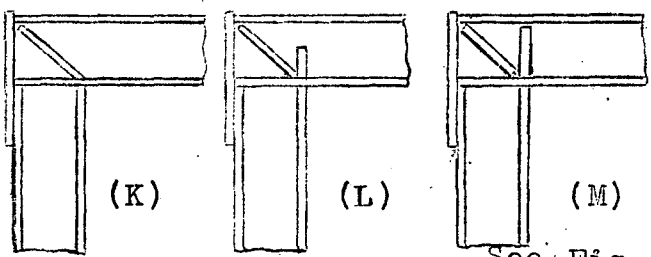
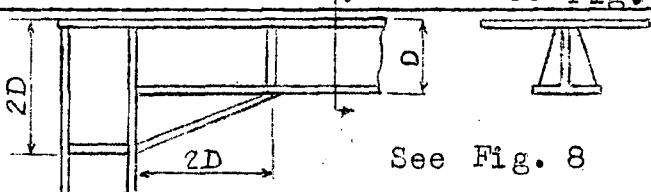
CC: William Spraragen
LaMotte Grover
John Vasta

CC: (w/o Figs. 2-9)

Paul Kratz
J. M. Robertson
Members, Subcommittee D
ONR Scientific Section, N. Y.

TABLE I

Proposed Corner Connection Tests

Test Model	Type of Conn.	Number of Specimens	Sketch
A	2	1	 <p>See Fig. 3.</p>
B	2B	1	 <p>See Fig. 4.</p>
C	15	1	 <p>See Fig. 7.</p>
D E F	4	3	 <p>(D) (E) (F)</p> <p>See Fig. 5</p>
G H I J	5A	4	 <p>(G) $R=18''$, $t=\frac{1}{4}''$ (H) $R=12''$, $t=\frac{3}{8}''$ (I) $R=9.0''$, $t=\frac{1}{2}''$</p> <p>(J) $R = 10\frac{1}{4}''$ $t = t(G)$</p> <p>See Fig. 9</p>
K L M	8B	3	 <p>(K) (L) (M)</p> <p>See Fig. 6</p>
N	16	1	 <p>See Fig. 8</p>

APPENDIX I

DISCUSSION OF TESTS

Test A, Type 2

This model was previously approved on the basis of tests by Dr. Grinter. It seems desirable to include it in the program and compare it with Test B, even though the haunches in the latter case prevent an exact comparison.

Test B, Type 2B

See comments above. This detail has been taken from Mr. Amirikian's recent article in the Welding Journal, July, 1949. Such a corner connection is possibly of more practical application than type 2.

Test C, Type 15

This is also taken from Mr. Amirikian's article and might be considered a modification of type 7, permitting greater loading. The haunch extending to the butt plate in the upper member is built up of plate material, the rest of the model being a rolled section.

Tests D-E-F, Type 4

Proposed initially by the Navy at the beginning of the program, examples of the use of this detail may be seen in the above-mentioned article. Tests D and E study the effect of depth of the outermost stiffener. Test F will employ the sniped stiffener detail over the inner flange of the column, the outer stiffeners being selected after the first two tests.

Tests G-H-I-J, Type 5A

These have been reduced in scale from those shown in Progress Report E and are described there. Tests G, H, and I are designed to study influence of radius of curvature and thickness of inner flange according to the recommendations of the AISC in its recent paper by Mr. Griffiths, "Single Span Rigid Frames in Steel". In Test "J", a small radius is used without increasing the flange thickness, substituting additional tilting brackets in the curved portion.

Tests K-L-M, Type 8B

The influence of the stiffener at the juncture of inner flanges of the two members is being studied here. Only unanticipated difficulties would require another test of this series using a full rectangular stiffener to replace the sniped one. If tests "K" and "M" give similar results, test "L" may not be needed.

Test N, Type 16

Where bulkheads and decks of ship-like structures are both stiffened, the detail shown is one that is often employed. It is usual to assume that 30 times the thickness of the plating acts as a flange. On the basis of a 6WF15.5 section with a flange thickness of $1/4$ " , this provides an upper flange of $7\frac{1}{2}$ " , the depth being 6.0" and the lower flange width being 2.9" .

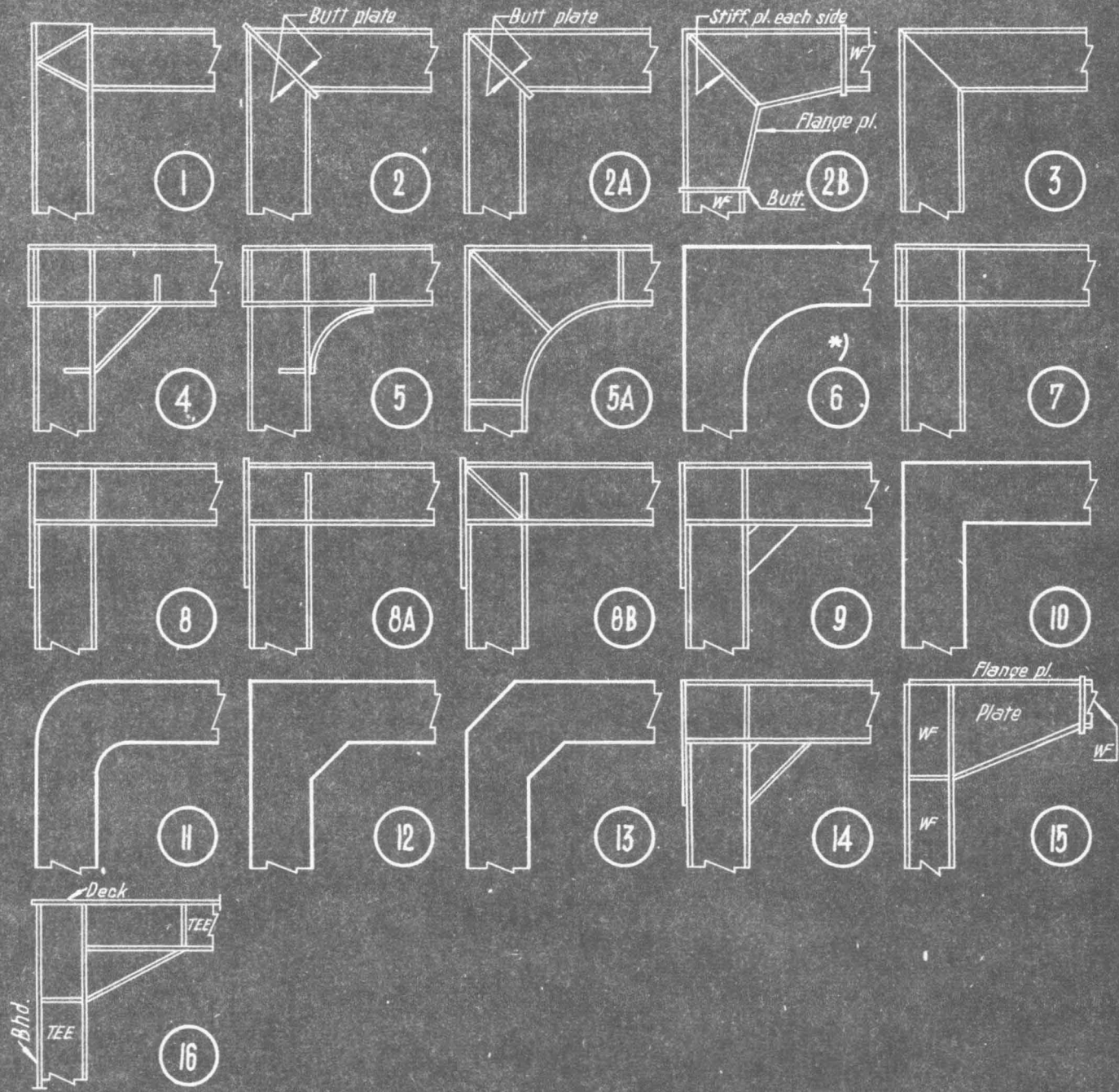
This exploratory test seems desirable on this smaller scale where simplicity and economy of experiment is being sought.

Comparison of Test Results

The results of each test may be compared with theoretical analysis of behavior at the section where the leg joins the knee proper. This is the section at which there is the first departure from a simple rolled section.

The experimental comparisons within each group are obvious. Comparison in behavior is also possible between types 4, and 15 since in each case the length of knee along one leg equals twice the depth of the section.

Another comparison might be based on depth of knee at the "throat" ... the minimum distance from the outside corner to the inner flange.



*) Connections No. 6, 10, 11, 12, 13 are built up connections.

FIG. 1

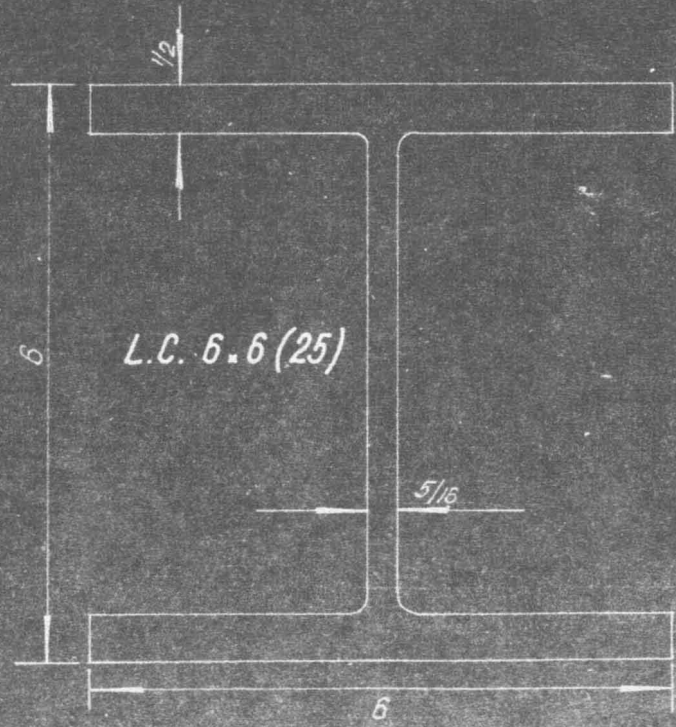
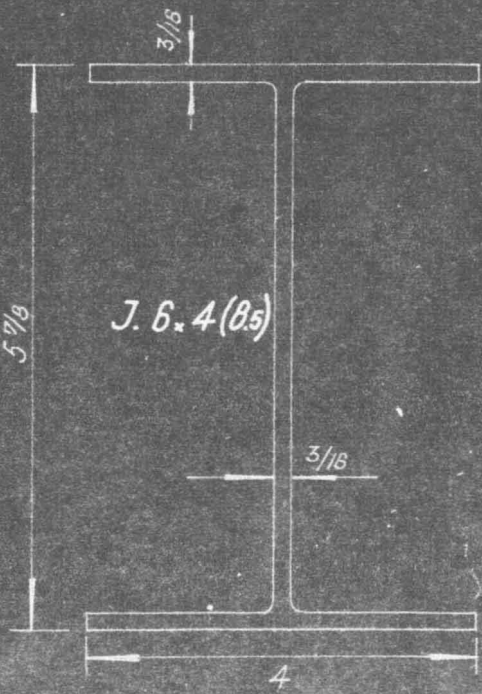
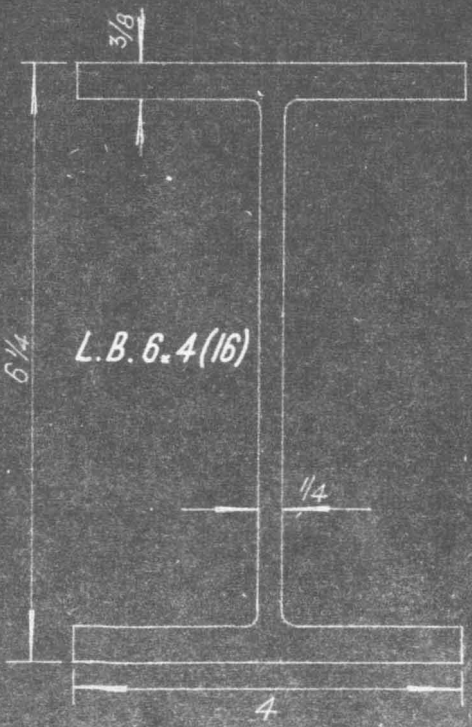
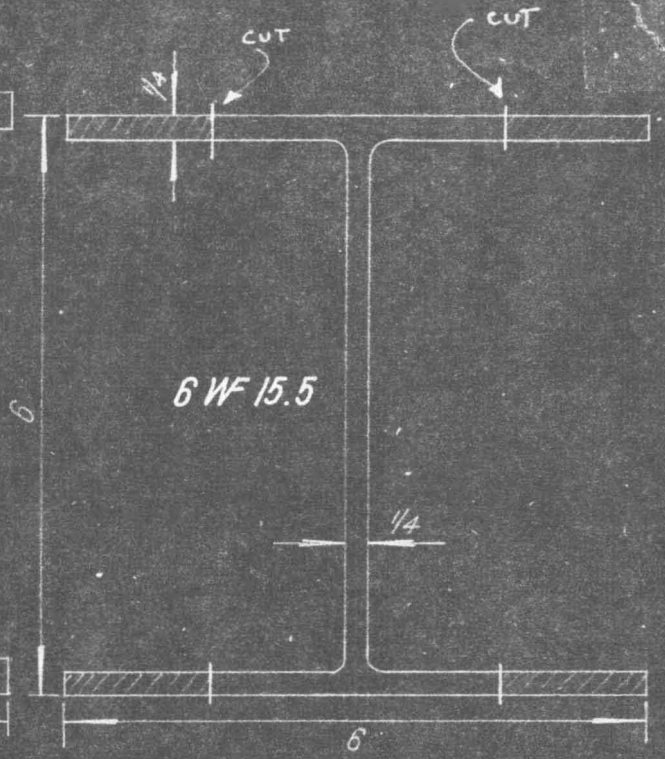
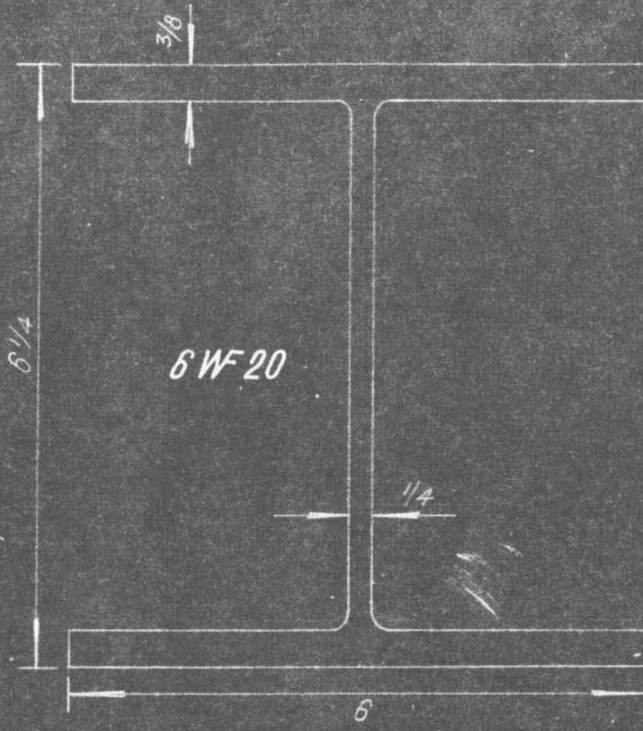
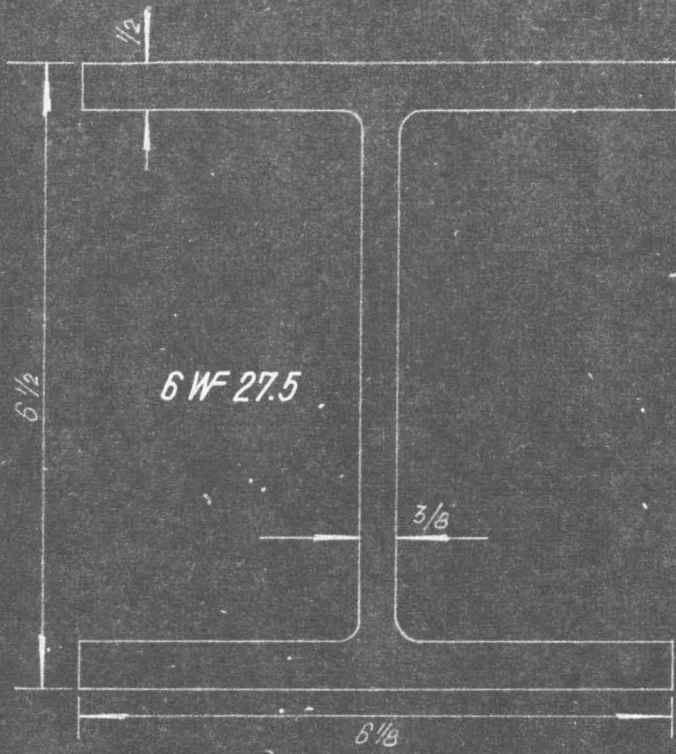


FIG. 2

SCALE 1:2

COMPARISON OF SECTIONS	FL205C-28
D-22-1949	J-M-R

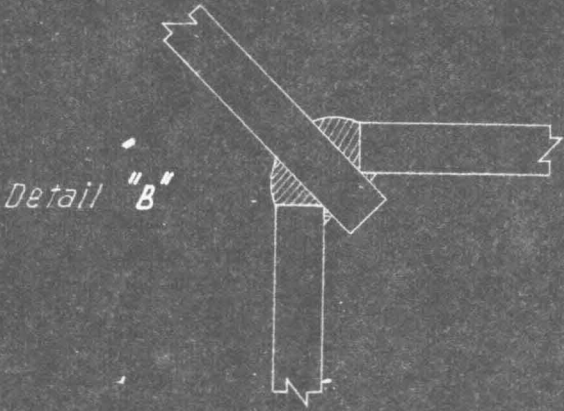
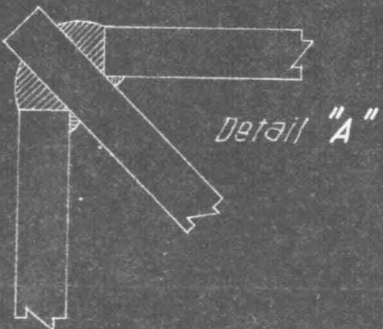
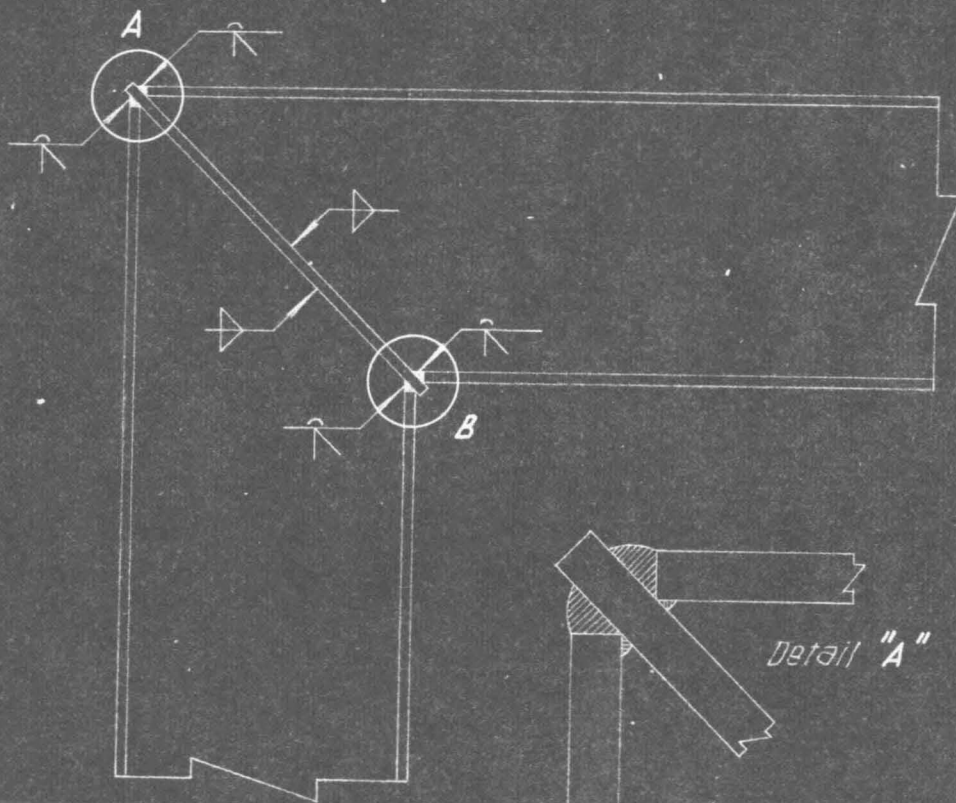


FIG. 3

CONNECTION TYPE 2	FL 205C-27
7 - 19 - 1949	J - M - R

Example of use: Arsham Amirikian · Welded Steel Structures
 The Welding Journal, July 1949.

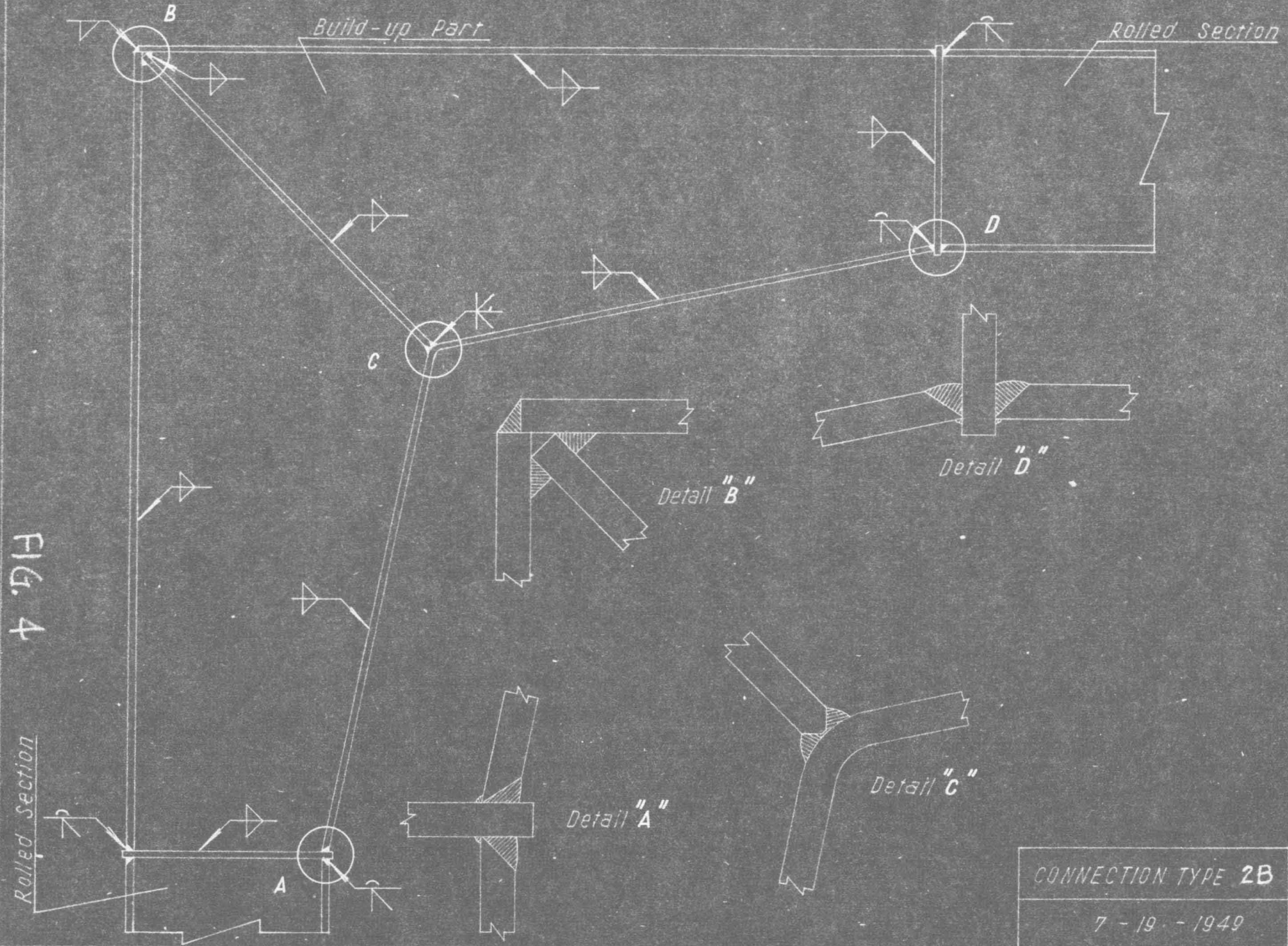


FIG. 4

CONNECTION TYPE 2B	FL 205C-26
7-19-1949	J-M-R

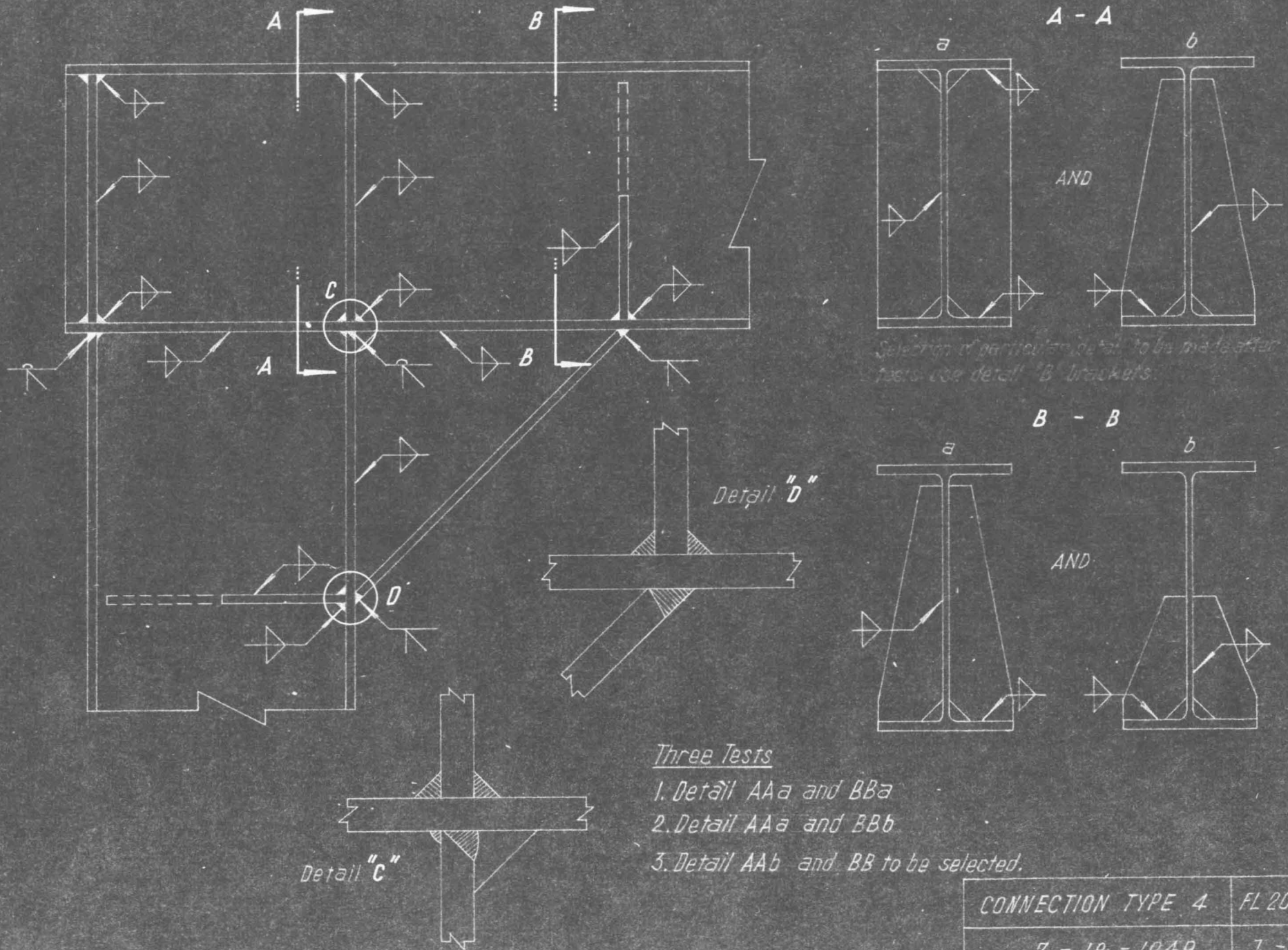
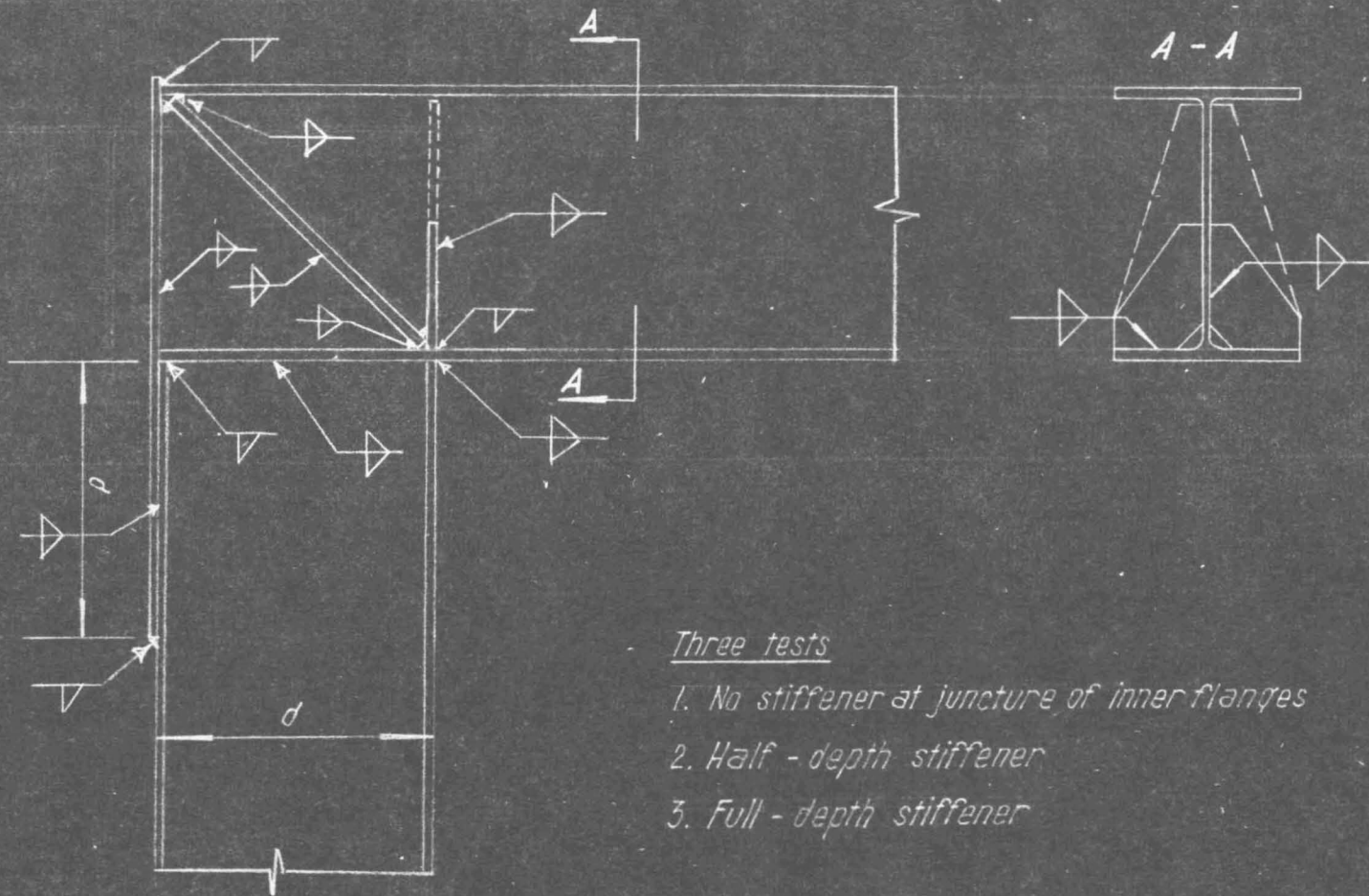


FIG. 5

CONNECTION TYPE 4	FL 205C-24
7 - 18 - 1949	J - M - R



Three tests

1. No stiffener at juncture of inner flanges
2. Half - depth stiffener
3. Full - depth stiffener

FIG. 6

CONNECTION TYPE 8B	FL 205C-29
9-4-1948	AAT

Example of use : Arsham Amirikian : Welded Steel Structures
The Welding Journal , July 1949.

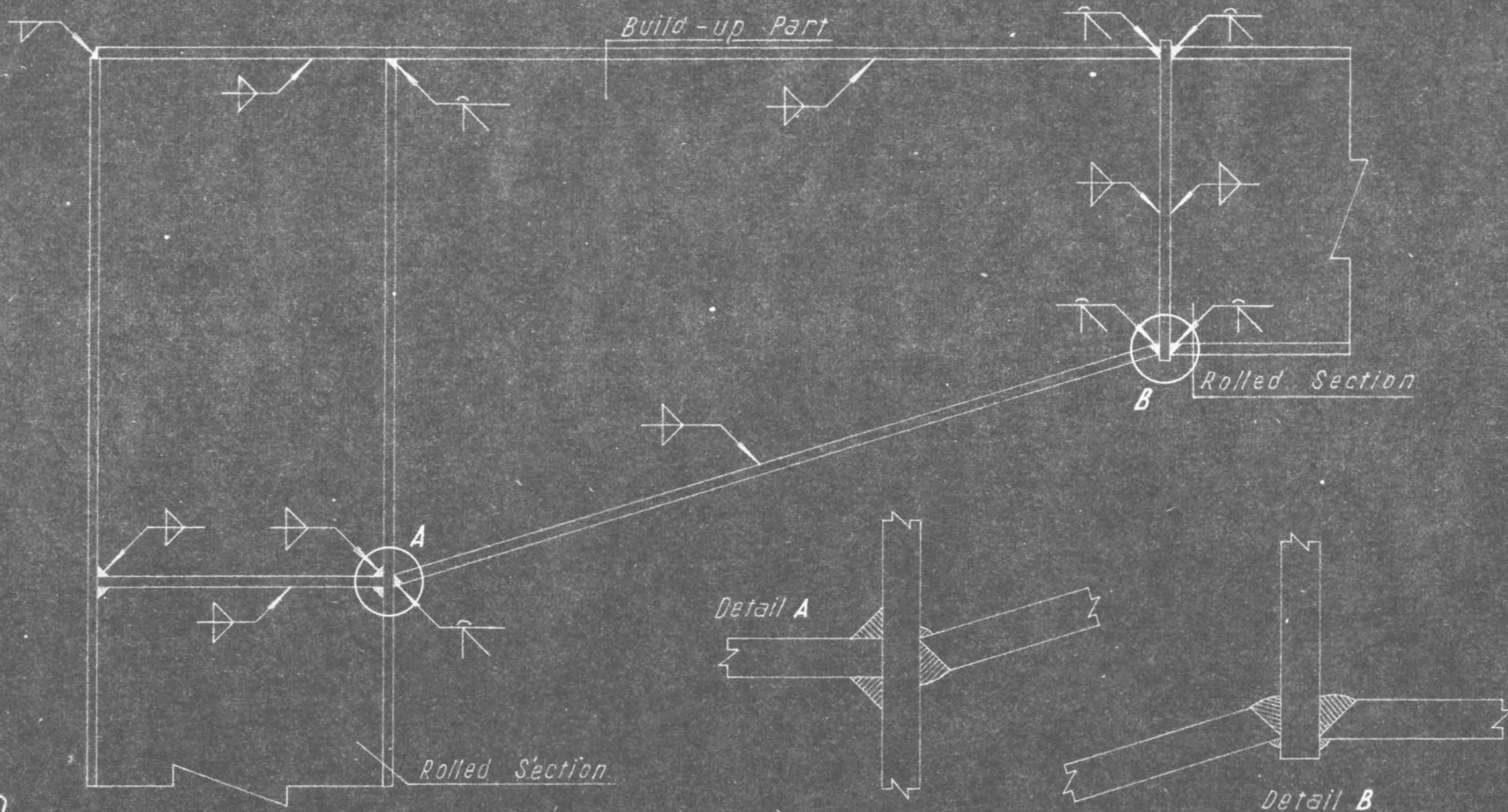


FIG. 7

CONNECTION TYPE 15	FL205C-25
7 - 18 - 1949	J - M - R

Example of use : Design Data for Stiffener Brackets
 Navy Department, Bureau of Ships
 015025

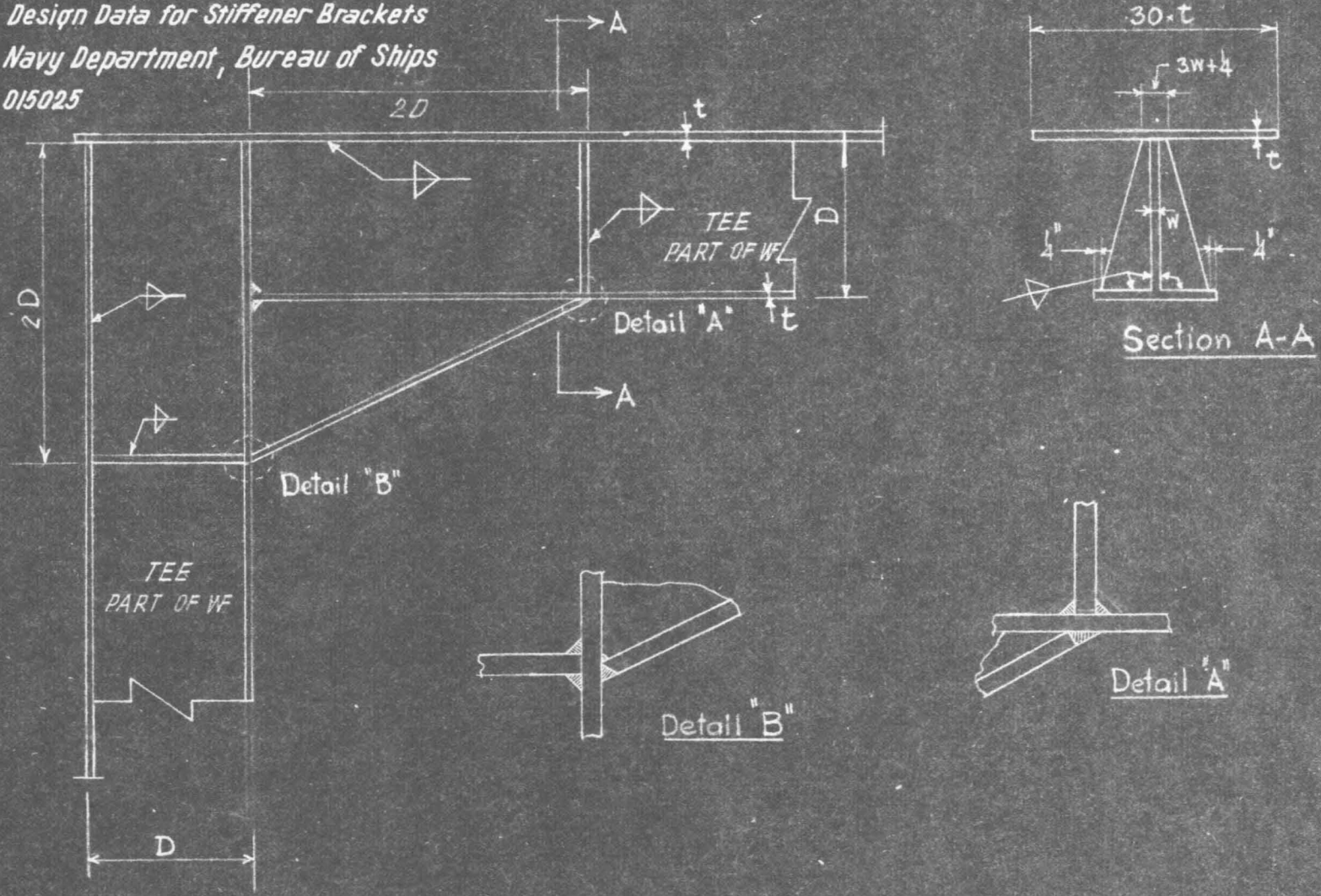


FIG. 8

CONNECTION TYPE 16	FL 205C-30
9-4-1949	AAT

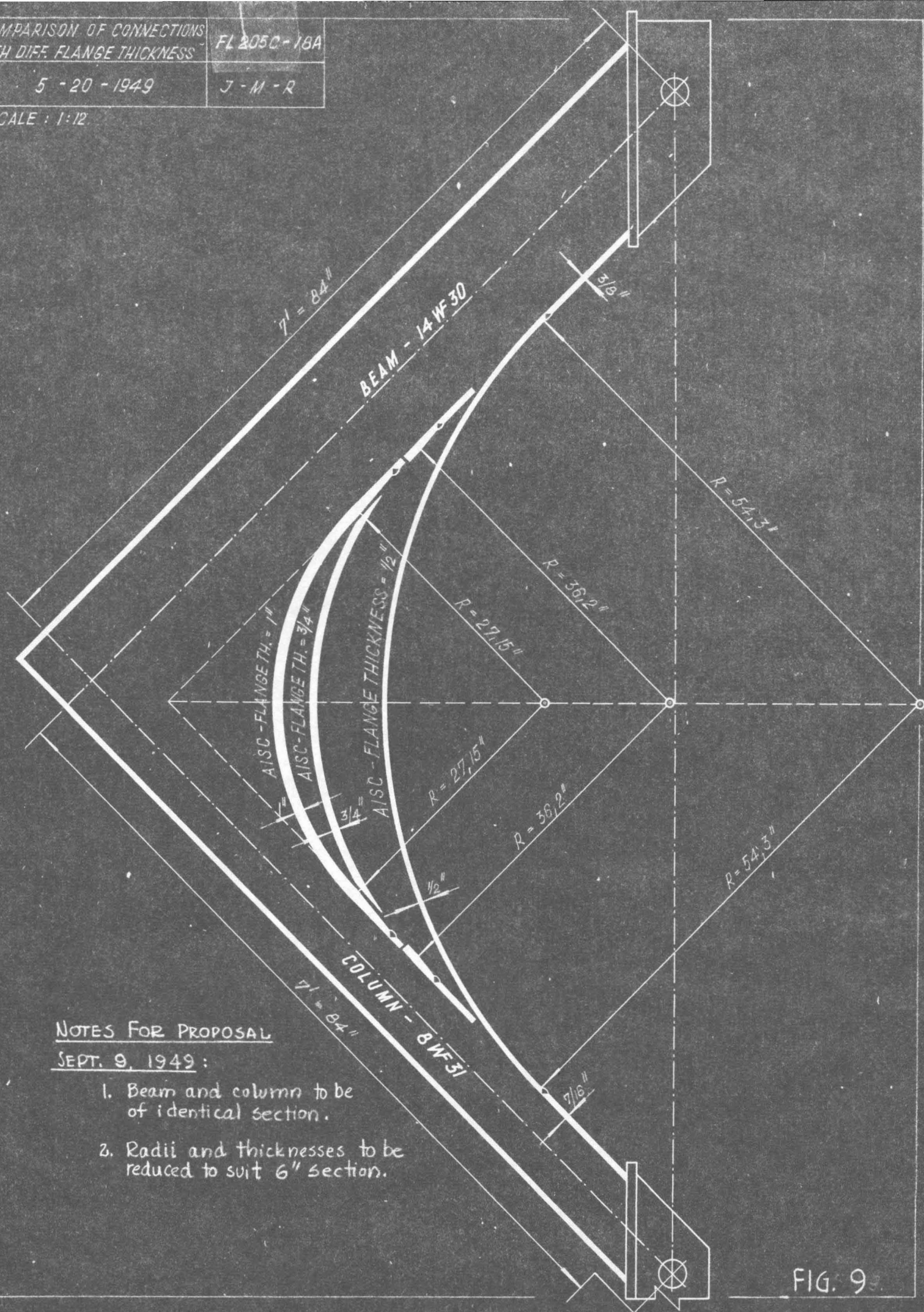
COMPARISON OF CONNECTIONS
WITH DIFF. FLANGE THICKNESS

FL 2050-18A

5-20-1949

J-M-R

SCALE: 1:12



NOTES FOR PROPOSAL

SEPT. 9, 1949:

1. Beam and column to be of identical section.
2. Radii and thicknesses to be reduced to suit 6" section.

FIG. 9