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DECISION TABLE FORMULATION OF THE 1969 AISC SPECIFICATION

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A Technical Report
of a Research Program

Sponsored by

THE AMERICAN INSTITUTE OF STEEL CONSTRUCTION

UNIVERSITY OF ILLINOIS
URBANA, ILLINOIS
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CHAPTER I

INTRODUCTION

1.1 Purpose

The purpose of this report is to present the 1969 Edition of the AISC Specification for the Design of Structural Steel Buildings(1)* in the form of decision tables. It is hoped that this form of presentation, augmenting the text of the new edition, will not only help to clarify the intent of the code and aid the development of computer programs, but also facilitate the use of the Specification in hand computations and be of value in the formulation of subsequent revisions.

1.2 Background

The AISC Specification has traditionally been used as the principal guide for the design of steel buildings. The American Institute of Steel Construction has continued to keep the Specification up-to-date by issuing new editions incorporating results of analytical and experimental research and practical experience. Also, many building code authorities have incorporated the AISC Specification directly into local and regional building codes. Thus, the Specification serves both as a compendium of knowledge about steel design and as a legal criterion against which designs are to be compared.

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* Numbers in parentheses refer to items listed in the References.

The text of the Specification has been written for use by experienced engineers as a guide or criterion in the design process. Absolute precision in wording is not necessary for this type of use; wherever precision is lacking, the engineer can be expected to supplement the information contained in the specifications from the background of his own experience and judgment. However, large portions of the detailed design or proportioning operations are now being performed by digital computer programs, and there is every indication that such computer use will continue to increase significantly. This change from manual to computer processing places the Specification in an entirely different environment.

The present method of incorporating Specification provisions into computer programs presents some serious problems. The task of programming is often assigned to a junior engineer or a small group of engineers, who may have to interpret the missing or ambiguous portions of the Specification. The program based on such interpretations may process many more designs than an experienced engineer can accomplish in a lifetime. Furthermore, the interpretations and assumptions made in the program may be so deeply buried in flowcharts and program statements as to be almost impossible to ferret out.

The three gravest consequences of the present approach are:

a) In many cases, those responsible for the actual design of a steel structure do not know, and cannot locate a person who knows, exactly what interpretations have been included in the design.

b) Because of the inefficiency associated with producing computer programs based on a given set of specifications by present methods, such programs become very expensive. This large economic investment in the specifications tends to inhibit or delay revisions.

c) Because programs based on the Specification are developed independently, there is no standard against which programs developed by different organizations can be compared, short of compiling an exhaustive list of test problems upon which each such program is to operate.

1.3 Objectives

This report is the result of a search to document the provisions of the AISC Specification in a clear-cut and rigorous manner and eliminate, as far as possible, the problems mentioned above. Using tabular decision logic, or decision tables[2,3,4,5] to represent the provisions of the Specification, the following three objectives are attained:

a) The presentation contributes to a more precise interpretation of the Specification;

b) Because of the facility of displaying all possible combinations of the logical conditions which may exist, the decision tables can be helpful in formulating future editions of the Specification by uncovering existing gaps;

c) The decision tables essentially complete the problem definition and analysis phases of computer programming.[9,10] The translation of decision tables into computer programs is almost a mechanical process, and, in fact, the translation can be performed by a digital computer. Also, computer programs developed on the basis of decision tables should be much more adaptable to future changes in specifications.

1.4 Scope of the Tables Presented

The decision tables compiled in this report cover those sections of Parts 1 and 2 of the AISC Specification which deal with design decisions and which are not purely descriptive in character. The Specification does not prescribe certain computational procedures which are essential for a specification check of a design. Examples of such cases are: (a) equilibrium calculations to obtain the member forces, given the loads on the structure; (b) procedures for calculating the force on a particular connector given the force on the connection; and (c) procedures for calculating section properties. Such procedures have not been included in the tables, and must, of course, be provided by the user either for manual calculations or for developing complete computer programs.

Decision tables are capable of displaying all the possible combinations of logical conditions. However, certain combinations may represent either invalid combinations or combinations occurring so seldom in practice that they are not mentioned in the Specification. In the development of the tables presented, only those combinations which are pertinent to a literal interpretation of the provisions of the Specification were used.

1.5 Scope of the Report

The decision tables developed for this report are presented in Appendix A. The Appendix is preceded by Figs. 1 through 11 showing the hierarchical scheme of the tables. Appendix B presents a cross-reference between the text of the Specification and the tables presented.

Chapter 2 of the report deals with a brief description of decision tables. This chapter presents sufficient background for the understanding of the remainder of the report.

Chapter 3 deals with conventions used in decision tables peculiar to this report.

Chapter 4 deals with the organization and coverage of the report and gives an example of manual use of the decision tables.

Chapter 5 deals with computer implementation of the decision tables presented.

Chapter 6 is a brief summary of the project effort and presents some suggestions for further work.

CHAPTER 2

DESCRIPTION OF DECISION LOGIC TABLES

2.1 General

In this chapter, a brief description of decision logic tables, sufficient for the understanding of the remainder of the report, is given. For a more extended treatment of the topic, the reader is referred to References 2, 3, 4 and 5.

A decision logic table (henceforth called decision table) is a concise tabular display of the logical condition(s) applicable in a given situation and of the appropriate action(s) to be taken as a result of the values of the conditions.

A decision table consists of four sections as shown:

Condition Stub	Condition Entry
Action Stub	Action Entry

The condition stub is a list of the logical conditions involved in the problem. These conditions are called logical because they have only two possible values: yes or no. The condition entry lists the pertinent combinations of the logical conditions in columns. Each column specifies a rule. The action stub lists all the possible actions that may be taken in the problem. The term "action" is taken in its most general sense, and may denote the assignment of a value to a variable, printing a message, etc. The action entry specifies the particular action or actions to be taken corresponding to the specified rule.

The elements of the condition entry can have only one of three possible values, i.e., Y, N and I, which stand for yes, no and immaterial, respectively. The elements of the action entry may be either Y, signifying that the corresponding action is to be executed, or blank, signifying that the action is not to be executed.

Decision tables of the type described are referred to in the literature as "limited-entry" tables. Other types of tables, called "extended-entry" tables, allow for a wider variety of condition and action entries.

2.2 An Introductory Example

The provisions of codes and specifications are readily adaptable to representation by means of decision tables. An example of Section 1.5.5 of the AISC Specification, dealing with allowable stress on masonry bearing, will be used to demonstrate this point. That section is represented by the following decision table:

Table T1

Sandstone or limestone	Y	N	N	N
Brick in Cement Mortar	N	Y	N	N
Concrete	N	N	Y	Y
Area of Bearing Plate, $A_2 \geq 1/3$ Area of Support A_1	I	I	Y	N
$F_p = 0.40$ ksi	Y			
$F_p = 0.25$ ksi		Y		
$F_p = 0.25\ f'_c$			Y	
$F_p = 0.375\ f'_c$				Y

As an example of use of the table, it is required to determine the allowable bearing stress, F_p, on a brick surface in cement mortar. To find the appropriate rule, set the values of the first three conditions in the condition stub to N, Y and N, respectively, and let the fourth condition be Y. The values of these conditions can then be compared with the corresponding condition entries in the different rules. It is found that rule 2 has the first three entries matching with the values in the condition stub. The fourth condition entry is immaterial, which means that it does not matter whether the value of this condition in the condition stub is Y or N. Thus, rule 2 is applicable. (It should be noted that in rules 3 and 4, the value of condition 4 is not immaterial and so a definite value will be required.)

Returning to rule 2, it is noted that there is a Y in this rule in the row corresponding to action 2, which means that action 2 of the action stub is to be performed. This action gives the allowable bearing stress of 0.25 ksi, as specified by the code.

The reader can verify that the remaining rules specify all of the conditions specifically stated in the text of Section 1.5.5, together with the appropriate actions.

2.3 Size of Decision Tables and the Else Rule

As explained in Section 2.1, each logical condition has only two possible values, namely Y and N. Hence in a decision table with only one logical condition, there can be only two rules. Similarly, in a decision table with two logical conditions, the maximum number of possible rules is four, as shown in Table T2.

Table T2

Condition # 1	Y	Y	N	N
Condition # 2	Y	N	Y	N
Action # 1	Y			
Action # 2		Y		
Action # 3			Y	
Action # 4				Y

It follows that in a table with n logical conditions, the maximum number of rules possible is 2^n. Such a table is termed a "complete table." Complete tables rarely occur in practice for the following three reasons.

First, in the decision table T2, suppose actions 3 and 4 happen to be the same, then the table can more conveniently be written in the form of Table T3.

Table T3

Condition # 1	Y	Y	N
Condition # 2	Y	N	I
Action # 1	Y		
Action # 2		Y	
Action # 3			Y

The I in rule 3 of this table stands for "immaterial" which means that it is immaterial whether condition 2 is Y or N so far as this rule is concerned. Hence, conceptually, I stands for both Y and N and it has conveniently reduced the size of the decision table by collapsing two rules into one.

Second, all the conditions are generally not mutually independent, as is assumed in Table T2. For example, in Table T1, the first three conditions are mutually exclusive, since the bearing material can be only one of the three items listed. Therefore, there are only three valid combinations of the three conditions, i.e., YNN, NYN or NNY, rather than the $2^3 = 8$ rules in a complete table.

The third, and by far most important reason, for the lack of completeness in the sense defined above is that decision tables generally contain provisions for reasonable combinations of conditions only, rather than for all possible conbinations.

This lack of completeness makes it imperative that the decision tables have a clearcut, unequivocal way of isolating combinations for which none of the stated provisions apply. This can be achieved simply by appending to all of the valid rules an additional rule, called the else rule. The action associated with the else rule is to signal to the user that the given combination of conditions does not match any of the valid rules. In this report, the else rule has been indicated by the letter E in the first row of the last column. It may be noticed that complete tables do not have an else rule.

2.4 Checking vs. Design Approach

In the example used in Section 2.2, the value of the allowable bearing stress obtained from the decision table could be used in one of the following two ways:

1. to calculate the area, A_2, of the bearing plate required, by dividing the given force, P, by the allowable bearing stress obtained from the table; or
2. to check whether a given bearing plate has sufficient area to satisfy the requirements of the allowable bearing stress.

There is an important distinction between these two uses, tied to the basic purpose of the Specification. Whereas case 1 helps in the design process, case 2 helps in checking a given design against the provisions of the Specification. The two approaches can be termed as the "design approach" and the "checking approach" respectively. In the form of decision tables, the design approach can be incorporated as shown in Table T4 and the checking approach as shown in Table T5. In the condition entry of Table T5, blank entries have been used whenever a condition is immaterial or not applicable, in order to increase readability.

Table T4, Design Approach

Sandstone or limestone	Y	N	N	N
Brick in Cement Mortar	N	Y	N	N
Concrete	N	N	Y	Y
Area of bearing plate, $A_2 \geq 1/3$ area of support, A_1	I	I	Y	N
$F_p = 0.40$ ksi	Y			
$F_p = 0.25$ ksi		Y		
$F_p = 0.25\ f'_c$			Y	
$F_p = 0.375\ f'_c$				Y
$A_2 = P/F_p$	Y	Y	Y	Y

Table T5, Checking Approach

Sandstone or Limestone	Y	Y	N	N	N	N	N	N
Brick in Cement Mortar	N	N	Y	Y	N	N	N	N
Concrete	N	N	N	N	Y	Y	Y	Y
Area of Bearing Plate, $A_2 \geq 1/3$ area of support, A_1					Y	Y	N	N
$P/A_2 \leq 0.40$ ksi	Y	N						
$P/A_2 \leq 0.25$ ksi			Y	N				
$P/A_2 \leq 0.25\ f'_c$					Y	N		
$P/A_2 \leq 0.375\ f'_c$							Y	N
Size of bearing plate Satisfactory	Y		Y		Y		Y	
Size of bearing plate Not Satisfactory		Y		Y		Y		Y

It should be noted that in the design approach, an a priori decision must be made by the designer whether he intends to set the (unknown) area of the bearing plate to be greater than or equal to 1/3 of the area of support, i.e., use rule 3, or otherwise to use rule 4. In contrast, in the checking approach, given the values of A_1 and A_2, the adequacy of the bearing plate is automatically checked for both possible cases.

In this report, decision tables are generated for the checking approach mentioned above. This approach seems to be in line with the trend in the use of specifications in the design process, as well as the legal authority generally associated with the codes.

A comparison of Tables T1 and T5 shows that the latter has twice as many rules as the former, which is almost self-defeating. The problem can be handled much better in the form of two tables, with Table T1 giving the allowable stress, F_p, and Table T6 testing the design as follows:

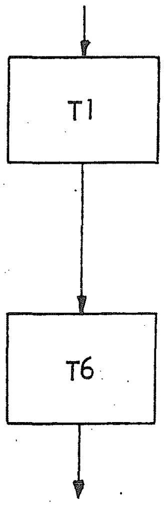
Table T6, Design Check

$P/A_2 \leq F_p$ from Table T1	Y	N
Size of bearing plate Satisfactory	Y	
Size of bearing plate Not Satisfactory		Y

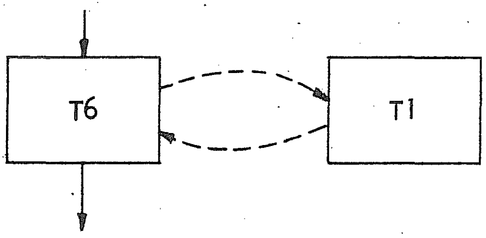
2.5 Direct Execution vs. Conditional Execution

When the checking of a given design is performed in two tables, as outlined above, two approaches are possible. In the first approach, Table T1 is executed first, which gives a value of F_p, the allowable bearing stress. This value is then used by Table T6 to check the adequacy of the design. In general, all data which could possibly be needed by a given table must be available before commencing the execution of that table. This approach has been termed <u>direct execution</u>.

In the second approach, execution of Table T6 is attempted, even though one of the elements needed to evaluate the conditions, namely F_p, may not be available at that time. Then, as soon as the value of F_p is required for the first time, it is obtained from Table T1 by temporarily suspending execution of Table T6. After returning from Table T1, the processing of Table T6 can be completed. This approach is termed as <u>conditional approach</u>. The two approaches are shown diagrammatically as follows:



Direct Execution



Conditional Execution

In this report, both schemes are used. However, the conditional execution scheme has been used to the maximum possible extent, for two reasons. First, a direct execution scheme may sometimes be inefficient because it results in the generation of large amounts of data which ultimately may not be used at all, as they might pertain to conditions which turn out to be immaterial for the particular set of data. Second, future changes in the Specification and adaptations for special conditions can be accommodated more readily by this approach. Direct executions do appear in some instances where they have been found more useful. In the diagrams given in Figs. 1 through 11, conditional execution is shown by a single broken line and direct execution by a continuous line.

To make the decision tables completely self-contained, each table is preceded by a complete list of data which are needed to execute it. Details about data requirements are discussed in section 3.3.1. However, in conditional execution not all of the data listed may be required for a particular case.

CHAPTER 3

CONVENTIONS

3.1 General

In this chapter, the notations and conventions used in the formulation of the decision tables given in Appendix A are discussed.

In general, the wording and symbols of the AISC Specification have been followed consistently throughout the tables. In all cases, signs and units of variables are the same as those used in the Specification. For example, loads are in kips, stresses in kips per square inch and dimensions in inches.

In the remainder of this chapter, the conventions for table designations, data requirements, conditions, and actions are presented.

3.2 Table Designations

The designation assigned to each table consists of two parts. The first part corresponds to the section in the text of the AISC Specification to which the decision table pertains most directly. In general, each table corresponds to specific numbered paragraphs of the text of the Specification. Occasional departures from this rule have been made in order to combine several related paragraphs into a single table, or to break up long paragraphs into more manageable smaller tables.

The second part of the designation consists of a letter, which is either in upper case or lower case, depending upon the type of the decision table as explained below.

Functionally, there are three broad types of decision tables used in this report, as follows:

a) <u>Switching Tables</u>: These tables are similar to the table of contents of a book, and specify which table to execute under a given situation. The last element of their designation is a capital letter X, Y or Z.

b) <u>Testing Tables</u>: These tables make the actual test specified by the Specification and generate the appropriate messages. The last element of the table designation is always a capital letter A, B, C, etc.

c) <u>Working Tables</u>: These are the tables which generate information to be used by other tables. Their designation has as its last element a lower case letter a, b, c, etc.

All messages needed by the designer are generated by the testing tables, except that some working tables, such as 1.8.2.a, 1.9.1.2.a and 1.9.2.2.a, generate error messages in order to provide more specific error diagnosis. If a given design could be in error because of more than one reason, distinct error messages have been provided to the maximum extent possible.

3.3 <u>Data Requirements</u>

As described in Chapter 2, each decision table requires specific items of data for its execution. The required data are of two general types.

Some are conventional numerical data, such as the value of the yield stress, F_y. The second type are logical data, which can only have values of "yes" or "no" and which specify the presence or absence of a specific property, i.e., "Is the section symmetric about the major axis?" The wording of the data item description, which follows the text of the AISC Specification, makes it clear whether numerical or logical data is involved. Occasionally it is necessary to have both a logical and a numerical value associated with a given data item. For example, in Table 1.8.4.a it is necessary to know both whether a value of K has been provided (a logical data item) and if yes, the numerical value of K.

3.3.1 Format of Data Specifications

The data required for the execution of each table are listed preceding that table, in the following format:

Data Item	Data must be supplied	Data to be obtained from

The first column identifies the data item by name. A check mark (X) in the second column indicates that the data item must be supplied externally. An entry in the third column, of the form of n(m), indicates that the data item can be obtained by conditionally executing table n, and that the desired information is the m'th result in the action stub of that table. Such result numbers precede the appropriate action in the action stub.

Using this convention, the data requirements for Tables T1 and T6 presented in Chapter 2 would appear as follows:

Data for Table T1

Sandstone or limestone	X	
Brick in cement mortar	X	
Concrete	X	
A_2, area of bearing plate	X	
A_1, area of support	X	
f'_c	X	

Data for Table T6

P, force	X	
A_2, area of bearing plate	X	
F_p		T1(1)

It may be noted that in Table T6, the value of F_p is specified obtainable as result number 1 of Table T1. All four actions in Table T1 produce the same result, i.e., the appropriate value of F_p, and thus all should be preceded by result number 1.

3.3.2 Data in Mutually Exclusive Sets

Part of the logical data required in some tables falls into mutually exclusive sets, in the sense that only one element of the set can have the value "yes" at a time, all other elements having the value "no." For example, in Table 1.5.1.X, the list of data required consists of the type of stress, which can be one and only one of the following: tension, shear, compression, bending, or bearing. These five data elements thus form a mutually exclusive set. It is conceivable to have all values in a set equal to "No." The implication of a mutually exclusive set is that the user needs to supply only the one element in the set which has a definite value, the other values in the set are automatically assumed to be "no." The use of mutually exclusive sets reduces considerably the volume of input required.

Data belonging to mutually exclusive sets have been bracketed in the list of data requirements, as in the example for Table T1 above.

3.3.3 Notation for "OR" in the Data

There are many cases in the list of data requirements where one or more data values are to be treated in exactly the same fashion. For example, in Table 1.5.1.3.a, whether the member is a "bracing member" or some other "secondary member" does not affect the resultant actions. Such cases of logically equivalent data are denoted by slashes in the list of data requirements, the slash standing for "or." The above example is shown in the list of data requirements as "Bracing/Secondary Member."

3.4 Conditions

3.4.1 Contents of Condition Stub

The condition stub of each table lists the conditions pertinent to that table. The conditions involve testing either a logical data item, e.g., "Is the section symmetric about the major axis?" or the result of a calculation on numerical data, e.g., "Is $\ell/r \geq 200$?" In the tables, the conditions are listed without question marks, i.e., for the above examples, the condition entry would be "symmetric about major axis" and "$\ell/r \geq 200$."

3.4.2 Equivalence of Blank and Immaterial in Condition Entries

In section 2.3, the meaning of I standing for "immaterial" in the condition entry, was explained. It was seen that it stands for either Y or N because both lead to the same action.

In many instances, because of interdependence between the various conditions of a table, some set of conditions may not apply in one situation whereas another set may not apply in another situation. For example, in Table 1.9.1.2.a, if the unstiffened element is a single angle or a double angle with separators, conditions 5, 6, 9 and 10 are not pertinent to the situation. The corresponding condition entries for such conditions are represented by a blank.

The boundary between a "blank" entry and an "immaterial" entry is not so well defined in all circumstances. Functionally, the two do not make any difference, because both are processed in the same fashion.

3.5 Actions

The three types of tables described in Section 3.2, differ primarily in the kind of actions specified.

In the switching tables, the action involves transfer to a specified Table Q, denoted in the action stub as:

Execute Table Q

In the testing tables, the action is to output a specific message, denoting whether the check is satisfactory or not. These actions are denoted in the action stub in the form:

Msg: Design satisfactory

In the working tables, the actions generate information which is used by the testing tables. These actions are again of two kinds; they involve either setting logical values, i.e., "Section 1.9. satisfactory" or "Section 1.9. not satisfactory," or calculating numerical results, such as the value of the effective K. Where the Specification prescribes conditions on the result, i.e., "the value given by formula X, but not larger than Y," this is shown as a single action in the form

$$\min(\text{formula } X, Y)$$

The use of min and max functions in the actions avoids the necessity of including in the decision tables additional tests to determine whether the formula or the cutoff value governs.

3.6 Use of Formulas

Most of the formulas which are numbered in the AISC Specification have not been reproduced in the decision tables; they are referred to by their numbers. Thus, the last action in the action stub of Table 1.5.1.4.a is: $F_{bc} = \min[0.60\ Q_s F_y$, max(formula 1.5-6b, formula 1.5-7, value provided)] which means that the specified value of the allowable bending stress in compression is the largest of that provided by formula 1.5-6b, formula 1.5-7 or the value otherwise provided by a rational analysis, but is not larger than $0.60\ Q_s F_y$.

3.7 Notation for Stress Ratios

The Specification requirement that the stress f in a member should be less than the corresponding allowable stress F can be stated as:

$$f \leq F$$

Alternately, the requirement can be expressed as:

$$R \leq 1$$

where $R = f/F$.

The latter approach has been used throughout this report, even in cases where it is not normally used in practice, because the value of R, once calculated in a working table, can be used repeatedly wherever needed. An example is the case of combined stress in a member where the ratio R_a (for axial compression) calculated by Table 1.5.1.3.a, may be used in Tables 1.6.1.X, 1.6.1.a and 1.6.1.B, as well as being used directly in Table 1.5.1.3.A.

Subscripts are used to indicate the type of stress. Thus, for compressive stress in the above example,

$$R_a = f_a / F_a$$

3.8 Modifications of Results

There are instances where a data value, either supplied externally or previously calculated, needs to be modified to meet the provisions of the Specification. An example is the allowable bending stress in girder flanges, which must be reduced according to formulas 1.10-4 and 1.10-5 to take into account the effect of thin webs. Modified values of this type are denoted by primes, as in Table 1.10.6.a for the above case. However, when the modified value is used as data in another table, it is referred to without the prime. Whether the original or modified value is intended is taken care of by the result number as recorded in the third column of the list of data requirements. For example, the value of allowable bending stress in compression, F_{bc}, is needed in Table 1.11.2.2.a, and is referred to as the result of result number 2 of Table 1.5.1.4.a. Reference to that table shows that the unmodified value of F_{bc} is desired. If the modified value, F'_{bc}, were desired, it would be referred to as result 1.10.6.a(3), but the name of the variable still would be F_{bc}.

CHAPTER 4

ORGANIZATION AND COVERAGE

4.1 Functional Organization

The decision tables are included in Appendix A, ordered according to the numerical part of the table designations corresponding to the section and paragraph numbering of the Specification, as explained in Section 3.2.

The order in which the tables are to be used for any particular task may be followed with the aid of the hierarchical organization presented in Fig. 1 through 11. In following this hierarchical organization the letter constituting the last element of each table designation indicates the function and significance of each table, as was explained in Section 3.2.

Fig. 1 gives the general outline of the organization. In Table 1.X a decision is made whether checking is to be performed according to the allowable stress procedure (Part 1) or the plastic design procedure (Part 2). The former is treated in Table 1.Y and the latter in Table 2.X. The allowable stress procedure treats structural elements according to one of the following five types:

i) Structural Steel Member
ii) Cast Steel Member
iii) Composite Construction Member
iv) Connection
v) Masonry Bearing

Structural steel members are dealt with in Table 1.5.X, and the tables shown in Figs. 2 through 6, and are discussed in more detail in Section 4.1.1 below. Cast steel members are treated by the same procedure as structural steel members. Composite construction members are dealt with in Table 1.11.X and subsequent tables, as shown in Fig. 7, but their processing depends on some values of data generated by the working tables in the structural steel member portion. Connections are dealt with in Fig. 8, and are discussed more fully in Section 4.1.2 below. Finally, masonry bearing is covered in Table 1.5.5.A.

In Figs. 1 through 11, the complete chain leading to the last working table is indicated only the first time it is encountered in the hierarchical sequence. In subsequent references to the same chain, only the first table of the chain is shown, and a cross-reference given to the detailed chain.

4.1.1 Structural Steel Members

A structural steel member, in general, needs to pass the following two requirements in order to satisfy the provisions of the Specification:

i) Stress requirements; and

ii) Geometry requirements

Whereas the stress requirements are self-evident, the geometry requirements generally mean limits on ℓ/r ratios, provisions against local buckling in the form of b/t ratios, etc. It will be seen in the testing tables for members that all such possible requirements have been grouped together and must be passed for the design of a member to be satisfactory. Whenever a member fails because of more than one unmet requirement, as many error messages are indicated as possible.

It should be noted that for allowable stress on compression members in Table 1.5.1.3.a, formula C5-1 has been used rather than formula 1.5-1. This was done to avoid repeating certain tables which would have been necessary for the case where post-buckling of compression elements is a consideration in the proportioning of the member. In the large majority of cases, member elements are designed to be capable of reaching yield stress without buckling, so that post-buckling strength is not involved. In these cases the values of Q_s and Q_a in formula C5-1 are unity. This concept of universally using these factors with values equal to unity in cases where post-buckling is not involved is also applicable to compression elements of bending members.

For members under combined stress, (Fig. 6), the stress ratios are provided by the working tables corresponding to Section 1.5 of the Specification, as discussed previously in Section 3.7. Also, although provisions for plate girders are covered in Section 1.10 of the Specification, for convenience in the organization of the decision tables, their shearing stress requirements and bending stress requirements, etc., are covered in Fig. 3 and Fig. 5, respectively, as for any other member.

4.1.2 Connections

There are two important differences between the processing of connections and members.

First, a connection must be checked for the overall force on it, as provided in Section 1.15 of the Specification, while each connector, or alternatively the most heavily stressed connector, must be checked for the stress on that connector. Similarly, a welded connection must be checked for the overall force as well as for the maximum stress in the weldment. Thus, there are checks involved at two different levels. The method of transition from one level to the other is not a part of the Specification.

Second, the geometry requirements of the connectors, in the form of maximum or minimum distances, must be tested only at the second level mentioned above. Also, stress and geometry checks for connections are much more independent of each other than in the case of members. Consequently, an option has been provided to perform one check at a time or to skip any test. This has been incorporated in Table 1.15.Y and forms part of Fig. 8.

In Table 1.15.X, the term "homogeneous connection" is used to denote a connection having only one type of connector, whether rivet, bolt, or weld. Any combination of more than one type of connector makes a "heterogeneous connection," with the implications specified in Sections 1.15.9, 1.15.10 and 1.15.11 of the Specification. The heterogeneous connection is considered to be made up of the constituent homogeneous connections, the share of the force on each component homogeneous connection being given by Table 1.15.B.

4.1.3 Plastic Design

The major subdivisions of the AISC Specification in the case of plastic design are (1) members and (2) bracings, as shown in Fig. 11. Members are classified either as columns or as beams and girders. This classification is followed in the decision tables for Part 2.

4.2 Coverage and Cross-Referencing

The decision tables cover those sections of the Specification which deal with logical decisions and are not purely descriptive in character. Appendix B provides a list of the sections and subsections covered along with the cross-references from the text to the tables.

4.3 Repetition of Subtables

There are a number of subtables which must be executed more than once in order to complete the specification checking. One such example is the local buckling requirement specified in Section 1.9, which must be checked for each compression element. Since only one compression element can be checked in one cycle of Table 1.9.a, the table must be cycled as many times as the number of compression elements.

The concept of cycling of a table is also needed in calculation of section properties in Table 1.14.a, which is served by Table 1.14.b to provide the contribution to the gross and net areas of each element in the cross section. The latter table must, therefore, be executed as many times as the number of elements in the cross section, and the contribution of each element to gross and net areas accumulated, to be eventually used by Table 1.14.a. Table 1.14.b in turn is served by Table 1.14.c to give accumulated reduction in net area due to staggered rivet holes and thus must be cycled for all the gage spaces in the chain for each element.

4.4 An Example of Use of the Tables

Although the example to follow is routine so far as hand calculations are concerned, it is useful as an illustration of the manner in which the decision tables handle this and much more complex routines in specification checking.

It is desired to check a main tension member without a pin hole, by the allowable stress procedure. The check for slenderness ratio (optional in case of a tension member) is to be made. The force on the member is 50 kips and the net area of the cross section is 3 sq. in. The length is

15 ft. and the radius of gyration is 1.20 in. The yield stress for the material is 36 ksi and the ultimate stress is 49 ksi.

The standard procedure is to assign values to conditions in the condition stub, compare them with the columns of the condition entry, find the applicable rule and then execute the action entries of that rule, as was discussed in Section 2.2.

Table 1.X, the main switching table, is executed first. The values of the two conditions are (YN), which match with column 1 and thus rule number 1 is applicable. The corresponding action is "Execute Table 1.Y." In Table 1.Y, since a structural steel member is under investigation, the values of the conditions are (YNNNN). The values of the conditions match rule 1 which commands the execution of Table 1.5.X. Table 1.5.X is again a switching table. In this case, the conditions are (YN) because the problem at hand is not concerned with combined stress. The applicable rule is rule 1, and the corresponding action is to "Execute Table 1.5.1.X." The condition stub in Table 1.5.1.X is (YNNNN) which corresponds to rule 1 and commands the execution of Table 1.5.1.1.A.

Table 1.5.1.1.A is a testing table. The first condition is a logical test "ℓ/r satisfactory." The list of data requirements specifies that this value is obtained by executing Table 1.8.4.a and obtaining the first result. Thus, execution of Table 1.5.1.1.A is suspended temporarily and execution of Table 1.8.4.a is started. This is an example of conditional execution.

In Table 1.8.4.a, the member is not a rod, the check for slenderness is desired, it is a main member and since $\ell = 180$ and $r = 1.20$, $\ell/r = 150$ which is less than 240. Hence without even checking condition number 5, it is clear that rule 3 applies which specifies that "ℓ/r is satisfactory."

Resuming the execution of Table 1.5.1.1.A, it is found that the next condition requires the value of R_t which is obtainable by executing Table 1.5.1.1.a and obtaining result number 3. Again, execution of Table 1.5.1.1.A is suspended temporarily to start execution of Table 1.5.1.1.a, where rule number 1 is found to apply. The three actions in this rule are performed in the following order:

1) $f_t = P/A_n$

$= 50/3.0 \quad = 16.67$ ksi

2) $F_t = \min(0.60F_y, 0.50F_{TS})$

$= \min(21.6, 24.5)$

$= 21.6$ ksi

3) $R_t = 16.67/21.6$

$= 0.772$

Although Table 1.5.1.1.a shows that the net area may be found by executing Table 1.14.a, it was not necessary to do so because the value was available externally. If it were not, execution of Table 1.5.1.1.a would have been suspended and execution of Table 1.14.a would have been started. Thus, it is possible to suppress conditional execution whenever desired by providing adequate data. On the other hand, it is possible to suspend temporarily execution of a series of tables.

Returning to Table 1.5.1.1.A, the value of R_t just obtained is 0.772, which is less than 1.0 and thus condition number 2 of the table is satisfied. Thus, the two conditions are (YY) which match rule 1 and the corresponding action is the message "Design Satisfactory," which indicates that all the requirements specified for a tension member have been met.

CHAPTER 5

COMPUTER IMPLEMENTATION

5.1 General

One of the prime reasons for this report has been the desire to facilitate the implementation of computer programs based on the AISC Specification. This chapter deals with the requirements of such programs, as well as with concepts which can be useful in the conversion process.

It should be pointed out that a decision table is not a computer program, but merely a convenient means of documentation of logical rules. Decision tables provide a clear and systematic display of all the relevant combinations of logical conditions along with the consequent actions.

In the process of developing the decision tables for this report from the text of the Specification, a number of possibly ambiguous statements were clarified. Also, the process of compiling the list of data required for each table has brought out a large number of interrelations which are not mentioned in the Specification. It is hoped that the assembly of these two types of information will further aid the generation of computer programs.

5.2 Programming of Decision Tables

Decision tables are an alternate to flow diagrams for expressing logical relationships. Their chief advantage over flow diagrams is that the y

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logical conditions and actions are displayed without regard to sequence of execution, and therefore are easier to follow. Decision tables can be converted into flow diagrams, and hence into computer programs, by systematically testing the conditions and branching to the specified actions.

Formal techniques for converting decision tables into optimal programs are discussed in References 2, 3, 4 and 5. Programs which perform such conversions are also available (7,8). However, the tables presented in this report have been restricted in size to suit visual inspection. Therefore, the application of formal conversion techniques to these tables does not appear to be warranted. Inspection of the tables will generally suggest an appropriate testing strategy.

A computer implementation aimed at specification checking, including conditional evaluation, is presented in Ref. (6).

5.3 Implementation Requirements

The following paragraphs outline some of the requirements which must be met for an efficient computer implementation of the decision tables presented in this report.

A suitable data storage scheme must be provided so that the program segments correponding to the evaluation of conditions and actions have access to the data listed with each table. Such a storage scheme might appropriately be global in nature so that any element of data may be made available to any or all the tables. Also, by this scheme, data generated by a table can be made most readily available to the table or tables where it is required.

All external calculation procedures not specified by the Specification must be inserted into the program, as explained in Section 1.4. The actual procedure may vary from user to user and can appropriately be programmed in the form of subroutines.

5.4 Implementation Options

The hierarchical scheme presented is organized in such a fashion that any organization wishing to implement only selected, self-contained portions of the Specification may do so by simply consulting Figs. 1 through 11 to determine the tables needed for that portion.

At a few points in the Specification, options for some situations are indicated. Examples are: the use of formula 1.6-2 instead of 1.6-1a and 1.6-1b in combined stresses; and the alternative approach for encased composite beams, which requires checking only the unassisted steel beam. Organizations tend to adopt office standards in such situations. It is possible to treat all such alternate conditions as constants, and simply not program the corresponding test and actions.

The ordering of the conditions and rules in the decision tables is immaterial. The ordering chosen for presentation in this report has been dictated by maximum legibility. However, for conditional execution schemes, it is desirable to evaluate the minimum number of conditions necessary to execute a table. This can be achieved by re-arranging the rules so that as many "immaterial" condition entries are in the lower left triangle as possible. This reordering can improve execution time and causes less chance of evaluating irrelevant data. It should be noted, however, that the ordering of actions is generally not immaterial, and should not be altered.

Finally, it is entirely feasible to implement programs based on the tables presented using a direct execution scheme, as explained in Section 2.5. It should be noted, however, that, if not implemented properly, such a scheme may turn out to be inefficient in the sense that it may require large amounts of data and calculations which eventually may turn out to be irrelevant for the applicable rule because of the "immaterial" condition entries. If a direct execution scheme is chosen for implementation, the sequence of execution of tables may be obtained by tracing backwards the conditional execution portions of Figs. 1 through 11.

CHAPTER 6

CONCLUSIONS

The AISC Specification is presented in the form of decision tables, resulting in a concise and unambiguous description of its provisions.

The decision tables have been formulated with emphasis on using the Specification for checking, rather than design. When an element of a structure fails to satisfy more than one provision of the Specification, as many error messages as possible are indicated. However, if the user restricts his communication with the tables to the input required and the output messages presented, he will not know the amount of overstress or understress in any particular case. For this information, he will have to check the values of the relevant data in the testing tables and take appropriate action. Thus, putting the Specification in the form of decision tables is, by itself, not an attempt at optimal or fully stressed design.

The results of this study suggest three concepts which may be used to guide the preparation of future editions of the Specification. First, a functional organization similar to the one presented in this report may serve as a better arrangement of the text of the Specification than the present one, where functionally related elements of information are widely scattered throughout the text. Second, in the draft stage, decision tables may be used to ascertain whether all relevant conditions are in fact accounted for. Third, the large volume and variety of data requirements suggests that all data of relevance to the Specification be classified in some logical form, e.g., member properties, material properties, connection properties, etc. Such a classification scheme could materially reduce the difficulties in ascertaining whether a given provision is applicable.

As far as computer implementation is concerned, only experience in use will determine the degree to which the tables presented are effective. It is hoped that persons responsible for developing programs based on the Specification will receive a more-than-adequate tradeoff in programming efficiency by using the tables presented rather than implementing their own schemes.

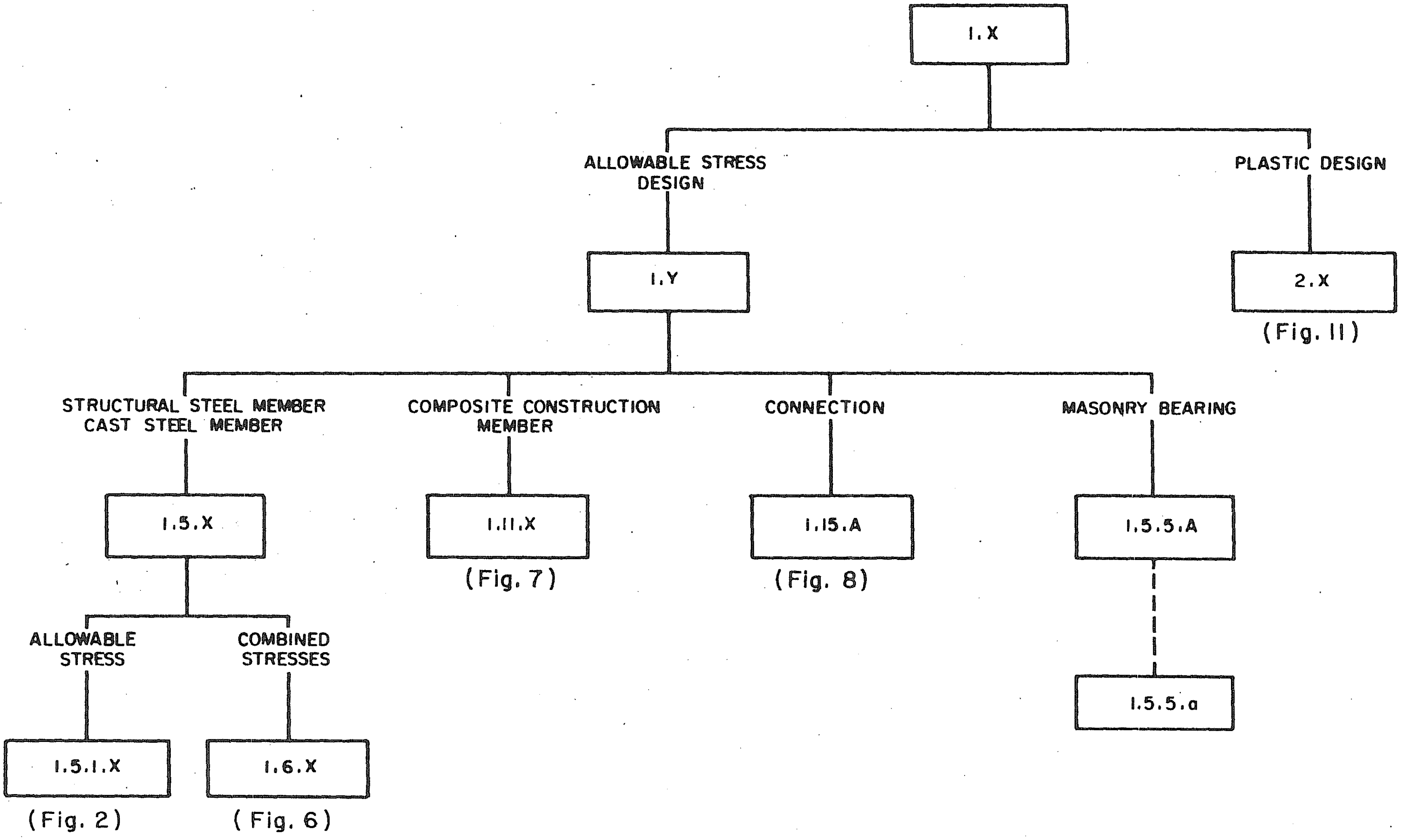

FIG. 1 INITIAL ENTRY

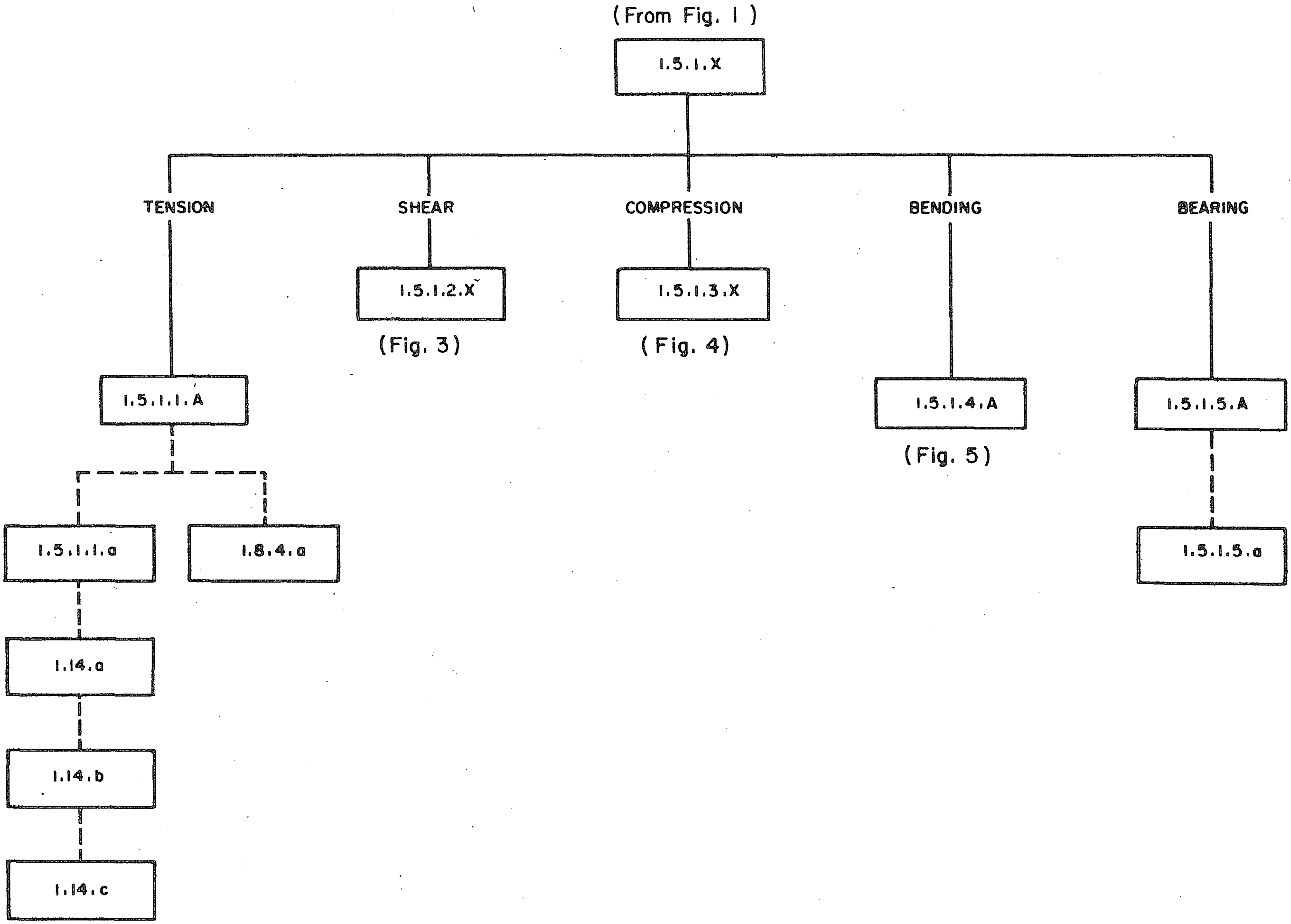

FIG. 2 ALLOWABLE STRESS DESIGN, TENSION AND BEARING STRESSES

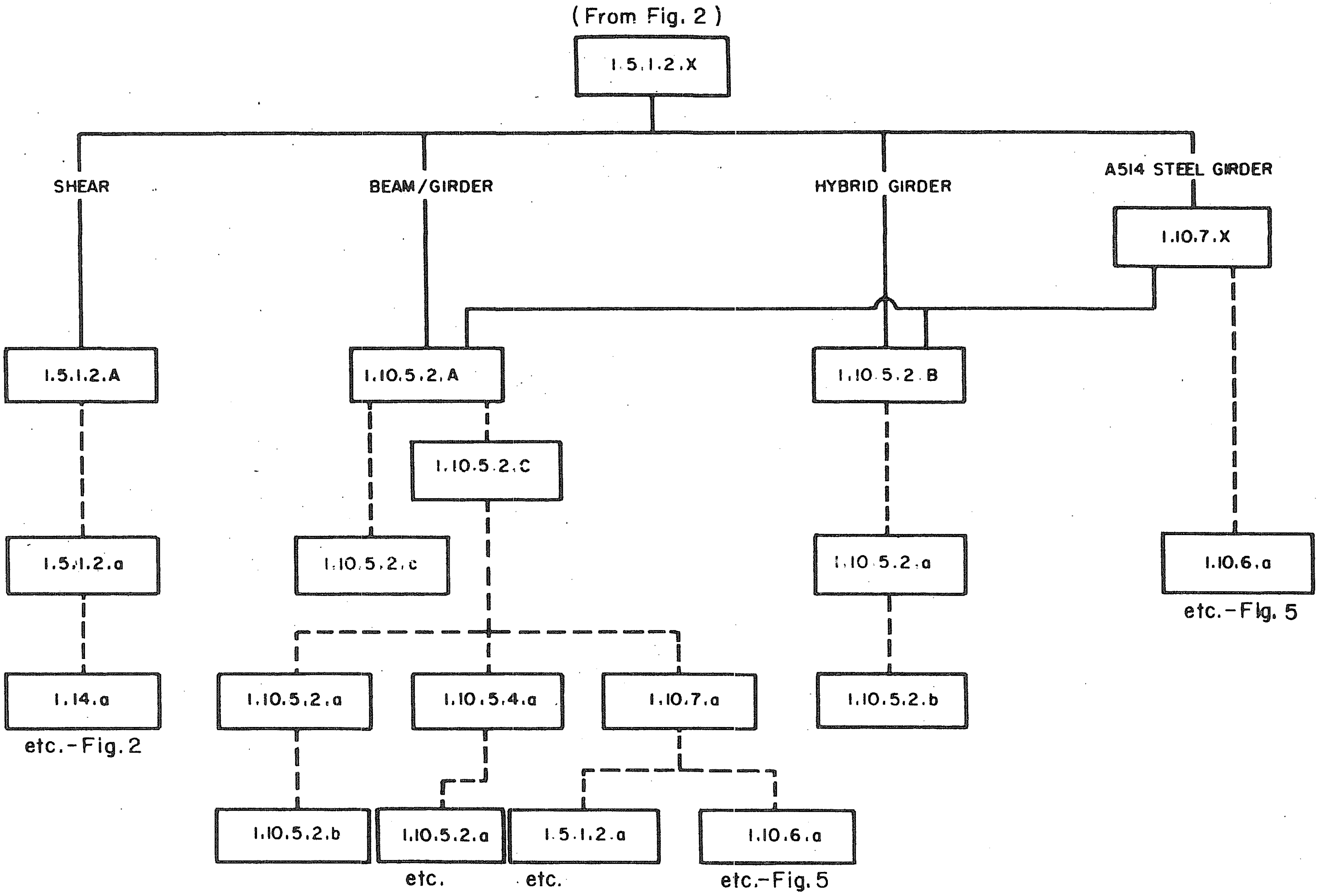

FIG. 3 ALLOWABLE STRESS DESIGN, SHEAR STRESSES

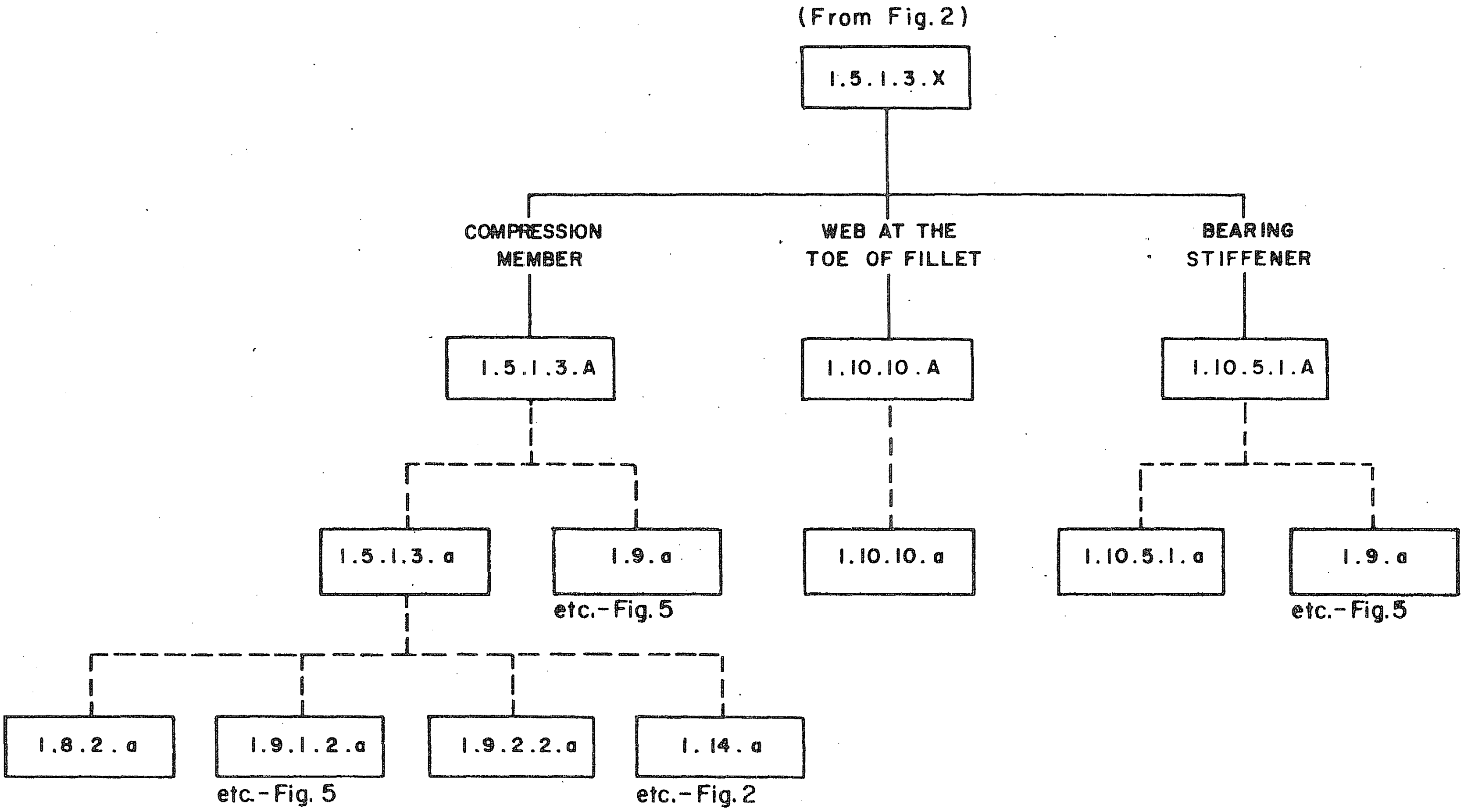

FIG. 4 ALLOWABLE STRESS DESIGN, COMPRESSIVE STRESSES

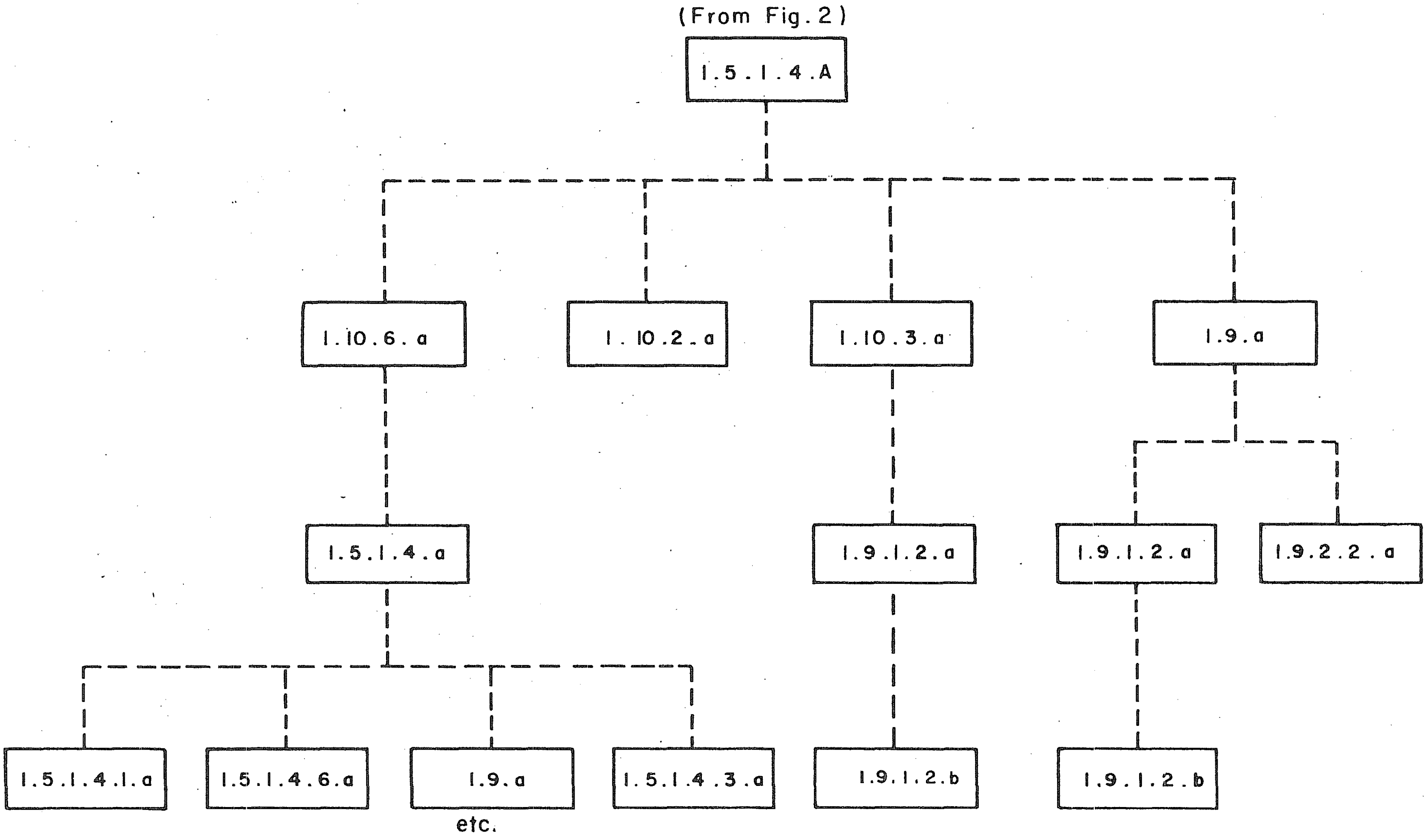

FIG. 5 ALLOWABLE STRESS DESIGN, BENDING STRESSES

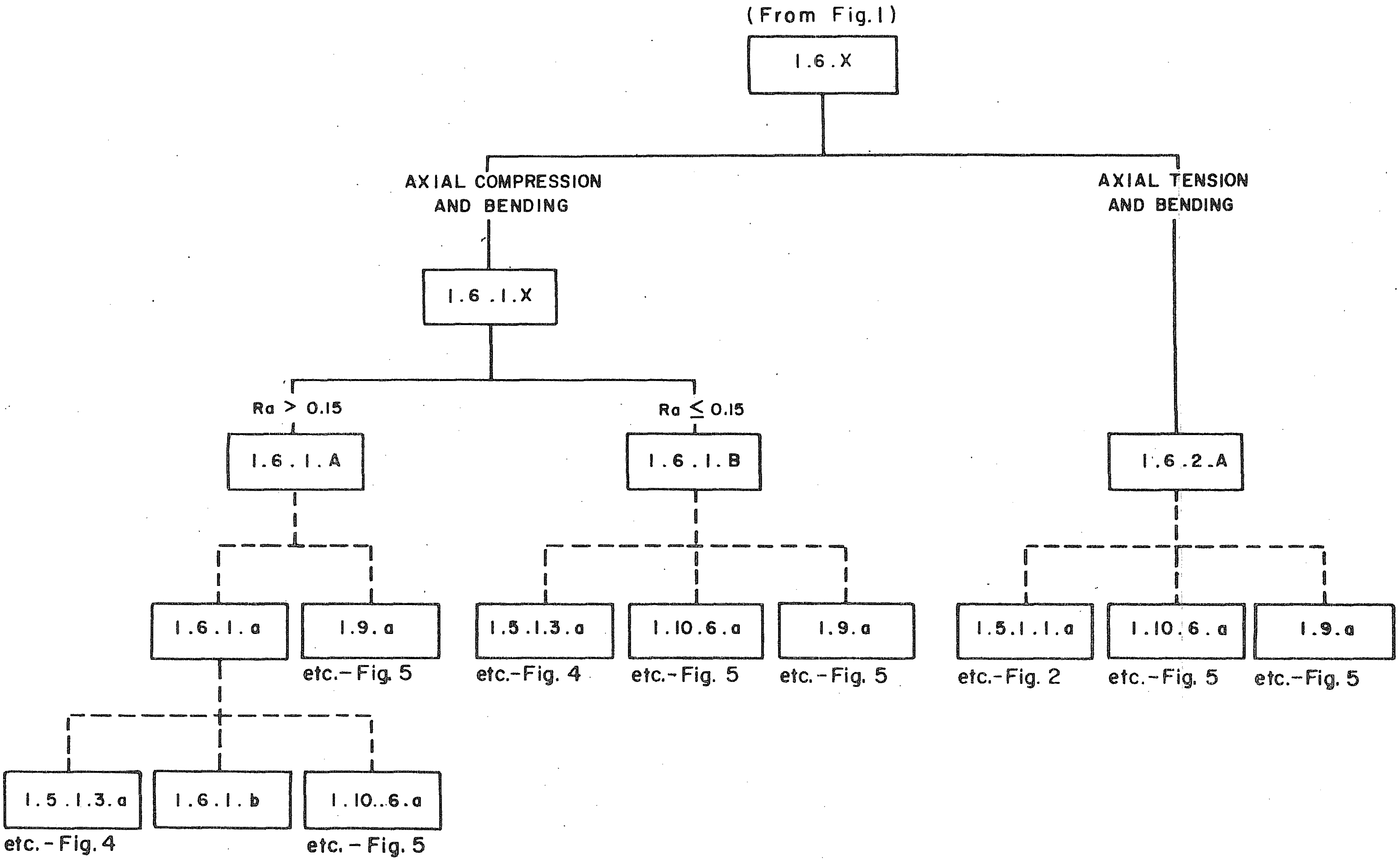

FIG. 6 MEMBERS UNDER COMBINED STRESSES

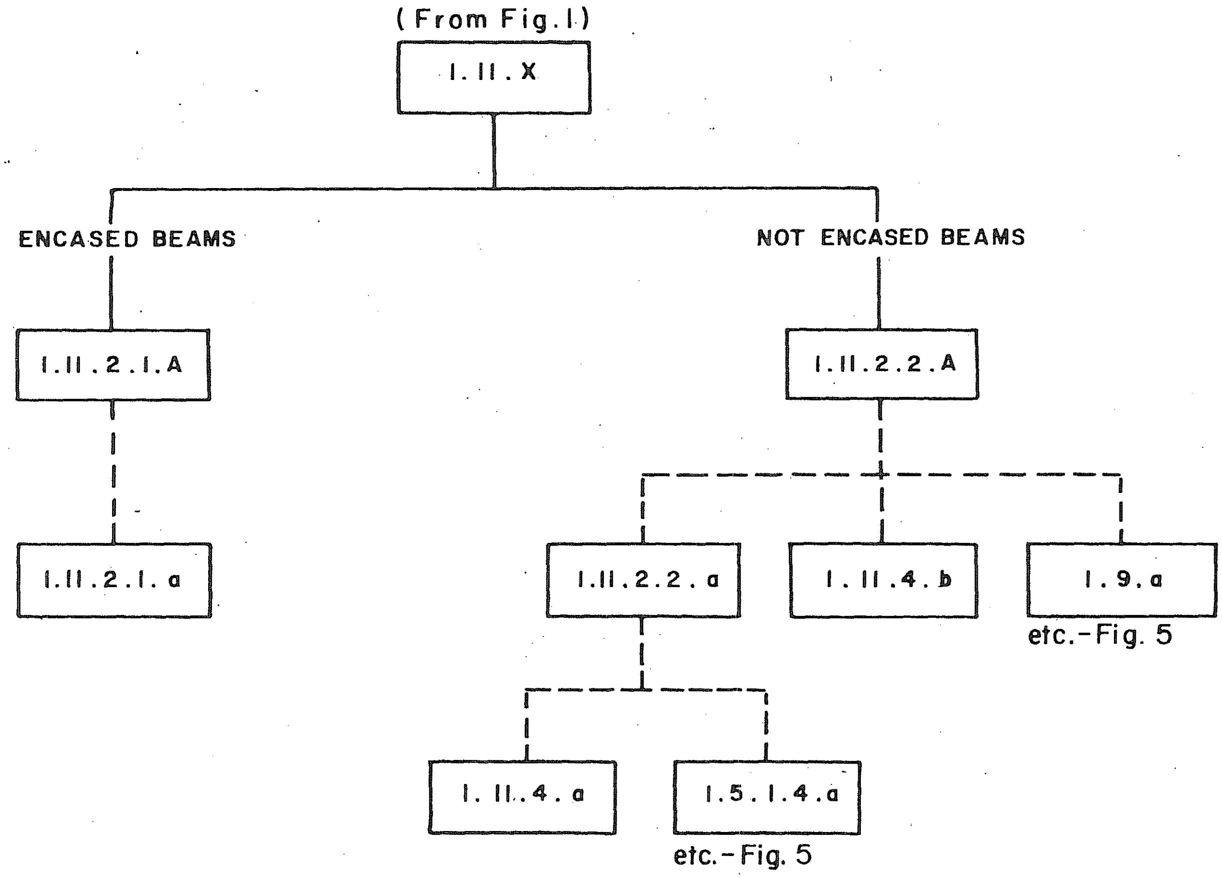

FIG. 7 COMPOSITE CONSTRUCTION MEMBERS

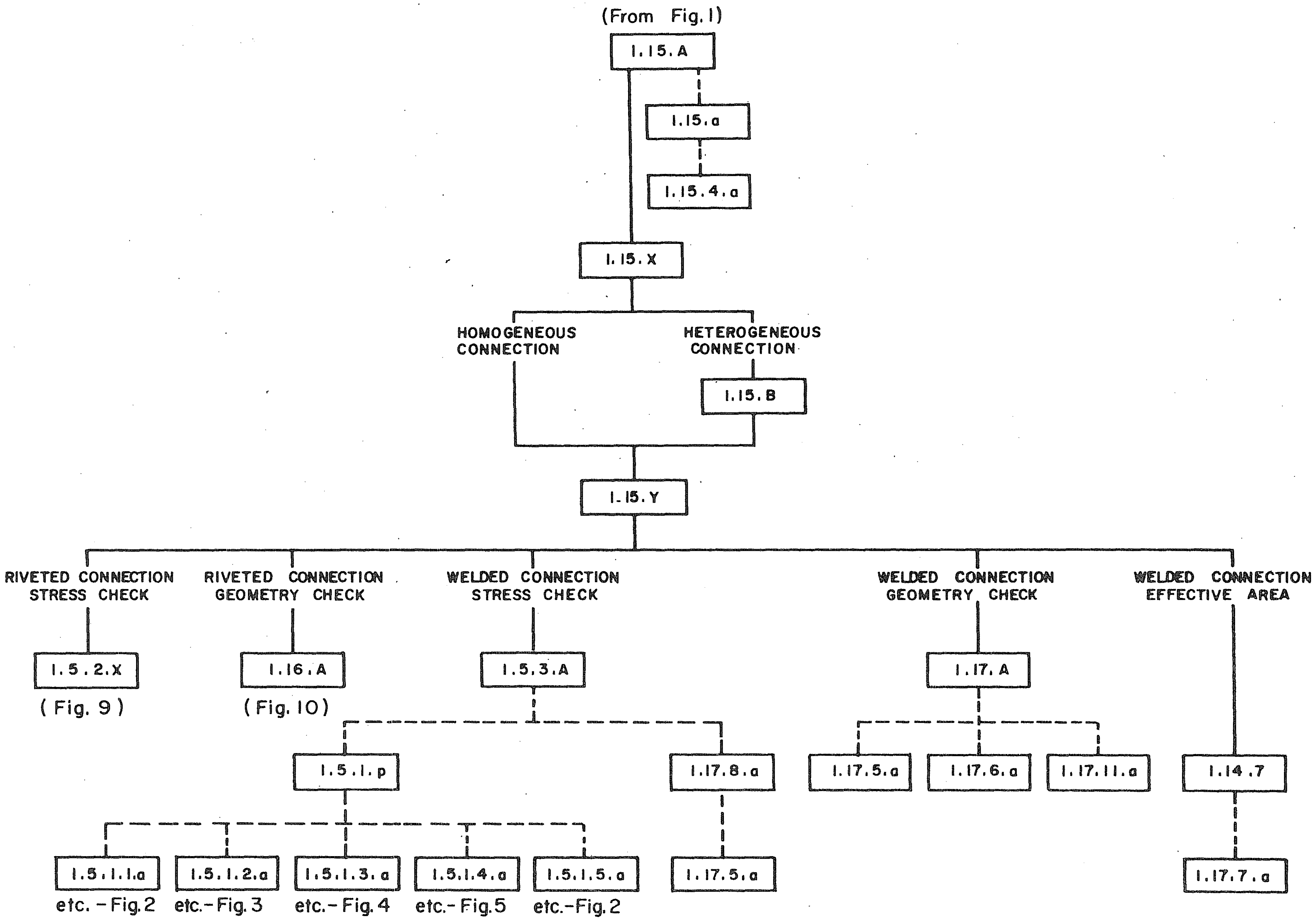

FIG. 8 CONNECTIONS

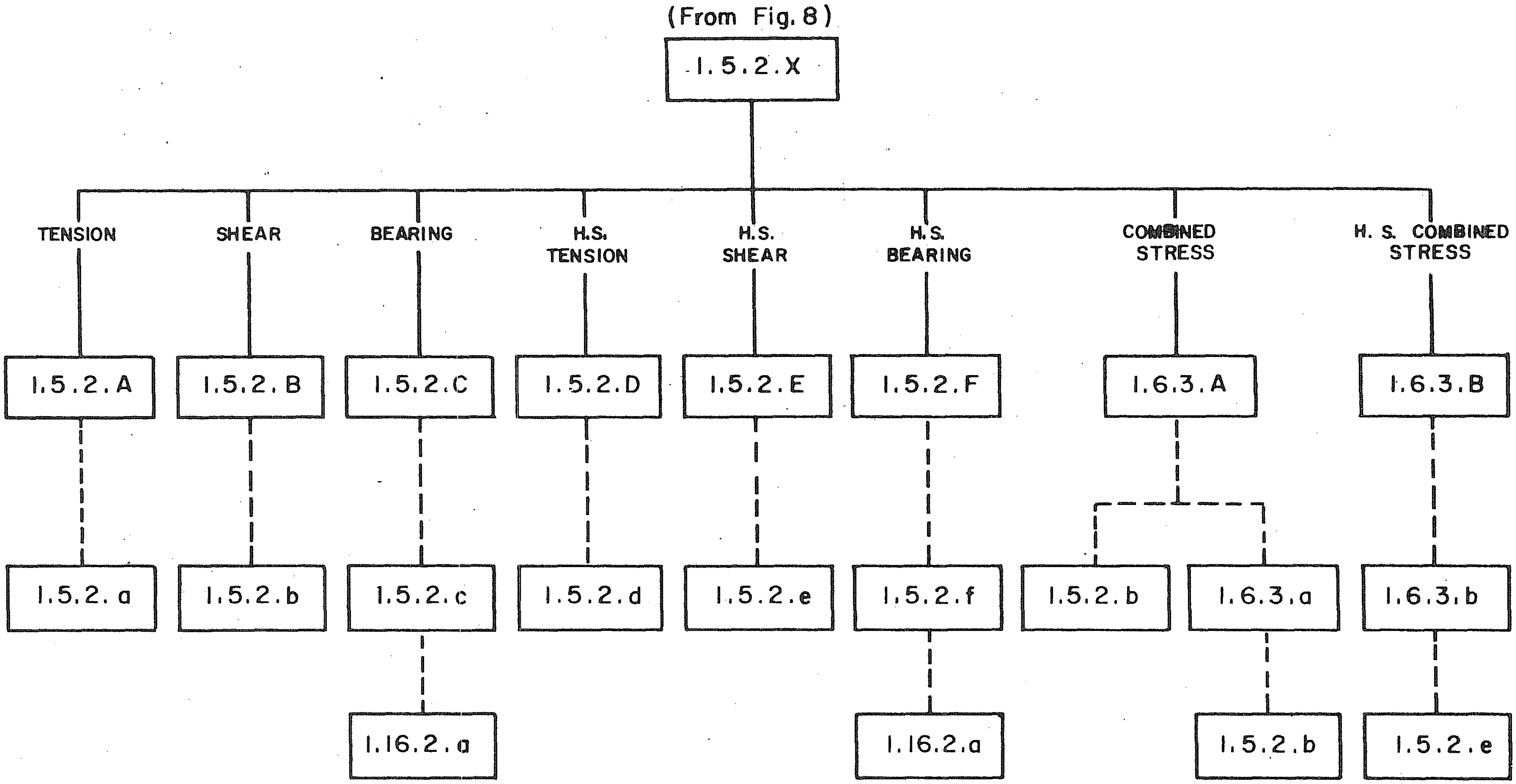

FIG. 9 STRESSES IN RIVETS AND BOLTS

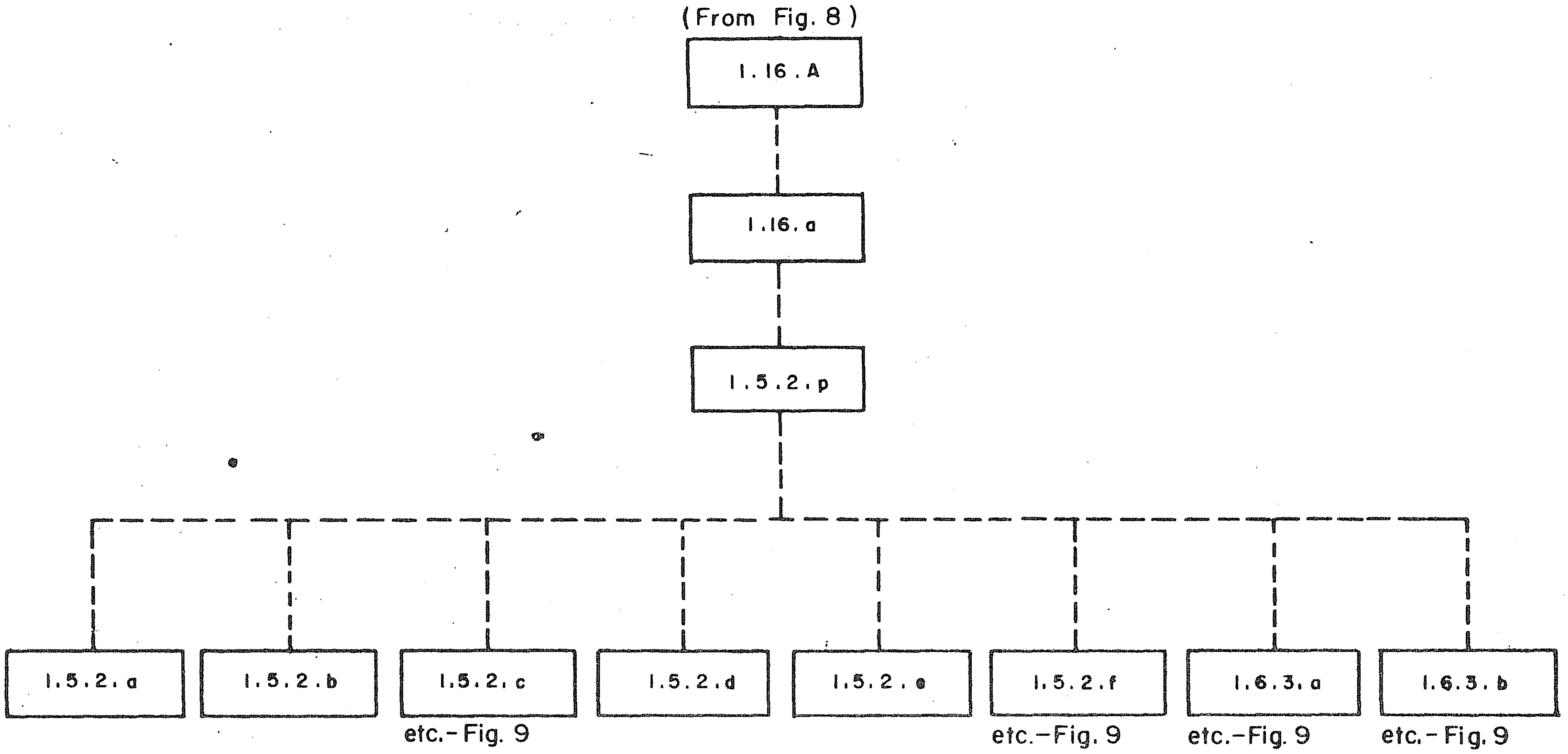

FIG. 10 GEOMETRY CHECK FOR RIVETED/BOLTED CONNECTIONS

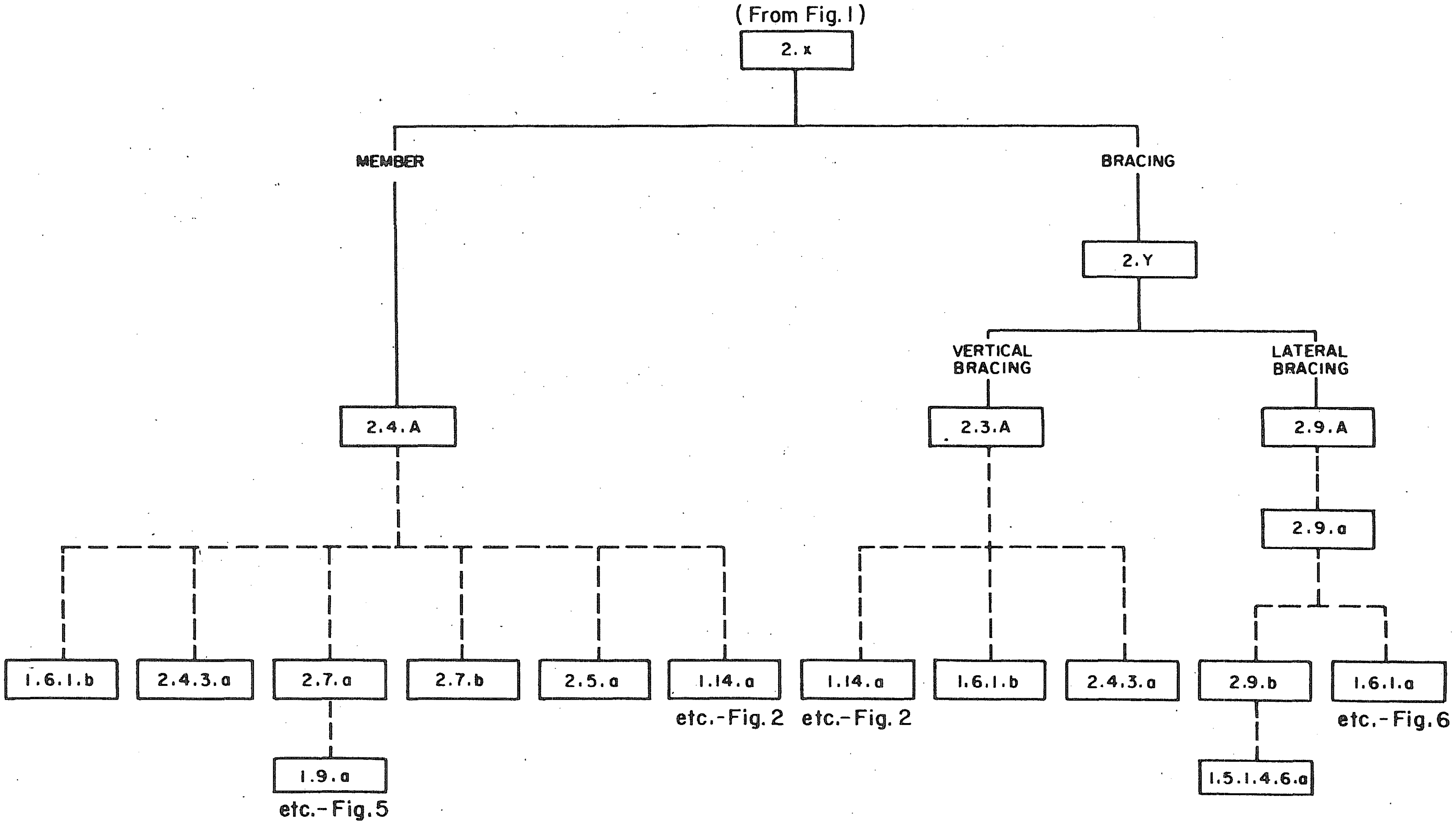

FIG. 11 PLASTIC DESIGN

APPENDIX A

DECISION TABLES

In the following, the decision tables representing the 1969 Edition of the AISC Specification are presented. The sequence of the tables is according to the Specification section numbers, in the order corresponding to that given in Appendix B. The hierarchical organization of the tables may be followed by using Figs. 1 through 11.

Table 1.X, Main Entry

Data Required

Allowable Stress Design	X	
Plastic Design	X	

Decision Table

Allowable Stress Design	Y	N	E
Plastic Design	N	Y	
Execute Table 1.Y	Y		
Execute Table 2.X		Y	
Else Rule			Y

Table 1.Y, <u>Allowable Stress Design</u>

Data Required

Structural Steel Member	X	
Cast Steel Member	X	
Composite Construction Member	X	
Connection	X	
Masonry Bearing	X	

Decision Table

Structural Steel Member	Y	N	N	N	N	E
Cast Steel Member	N	Y	N	N	N	
Composite Construction Member	N	N	Y	N	N	
Connection	N	N	N	Y	N	
Masonry Bearing	N	N	N	N	Y	
Execute Table 1.5.X	Y	Y				
Execute Table 1.11.X			Y			
Execute Table 1.15.A				Y		
Execute Table 1.5.5.A					Y	
Else Rule						Y

Table 1.5.X, Structural Steel or Cast Steel Member

Data Required

Combined Stress	X	

Decision Table

Combined Stress	Y	N
Execute Table 1.5.1.X		Y
Execute Table 1.6.X	Y	

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Table 1.5.1.X, Type of Stress in the Member

Data Required

Tension	X	
Shear	X	
Compression	X	
Bending	X	
Bearing	X	

Decision Table

Tension	Y	N	N	N	N	E
Shear	N	Y	N	N	N	
Compression	N	N	Y	N	N	
Bending	N	N	N	Y	N	
Bearing	N	N	N	N	Y	
Execute Table 1.5.1.1.A	Y					
Execute Table 1.5.1.2.X		Y				
Execute Table 1.5.1.3.X			Y			
Execute Table 1.5.1.4.A				Y		
Execute Table 1.5.1.5.A					Y	
Else Rule						Y

Table 1.5.1.p, Allowable Stress in Base Material

Data Required

Tension Stress	X	
Shear Stress	X	
Compression Stress	X	
Bending Stress (Tension Side)	X	
Bending Stress (Compression Side)	X	
Bearing Stress	X	
F_t		1.5.1.1.a(2)
F_v		1.5.1.2.a(2)
F_a		1.5.1.3.a(3)
F_{bt}		1.5.1.4.a(1)
F_{bc}		1.5.1.4.a(2)
F_p		1.5.1.5.a(2)

Decision Table

Tension Stress	Y	N	N	N	N	N	E
Shear Stress	N	Y	N	N	N	N	
Compression Stress	N	N	Y	N	N	N	
Bending Stress (Tension Side)	N	N	N	Y	N	N	
Bending Stress (Compression Side)	N	N	N	N	Y	N	
Bearing Stress	N	N	N	N	N	Y	
(1) $F_{base} = F_t$	Y						
(1) $F_{base} = F_v$		Y					
(1) $F_{base} = F_a$			Y				
(1) $F_{base} = F_{bt}$				Y			
(1) $F_{base} = F_{bc}$					Y		
(1) $F_{base} = F_p$						Y	
Else Rule							Y

Table 1.5.1.1.A, Tension

Data Required

R_t		1.5.1.1.a(3)
ℓ/r Satisfactory		1.8.4.a(1)

Decision Table

ℓ/r Satisfactory	Y	Y	N	E
$R_t \leq 1.0$	Y	N	I	
Msg: Design Satisfactory	Y			
Msg: Allowable Stress Exceeded		Y		
Msg: Slenderness Ratio Exceeded			Y	
Else Rule				Y

Table 1.5.1.1.a, Tension

Data Required

Stress Required at a Pin Hole	X	
At Pin Hole in Eye Bar/Pin Connected Plate/Pin Connected Built-up Member	X	
Axial Force, P	X	
A_n, Net Area		1.14.a(1)
F_y	X	
F_{TS}, Minimum Tensile Strength	X	

Decision Table

	Stress Required at a Pin Hole	N	Y	E
	At Pin Hole in Eye Bar/Pin Connected Plate/Pin Connected Built-up Member	I	Y	
(1)	$f_t = P/A_n$	Y	Y	
(2)	$F_t = \min(0.60\ F_y,\ 0.50\ F_{TS})$	Y		
(2)	$F_t = 0.45\ F_y$		Y	
(3)	$R_t = f_t\ /\ F_t$	Y	Y	
	Else Rule			Y

Table 1.5.1.2.X, Shear

Data Required

Beam/Girder	X	
A514 Steel Member	X	
Hybrid Construction	X	

Decision Table

Beam/Girder	N	Y	Y	Y	E
A514 Steel Member	I	N	Y	N	
Hybrid Construction	I	N	N	Y	
Execute Table 1.5.1.2.A	Y				
Execute Table 1.10.5.2.A		Y			
Execute Table 1.10.5.2.B				Y	
Execute Table 1.10.7.X			Y		
Else Rule					Y

Table 1.5.1.2.A, Shear

Data Required

R_v		1.5.1.2.a(3)

Decision Table

$R_v \leq 1.0$	Y	N
Msg: Shear Stress Satisfactory	Y	
Msg: Shear Stress Exceeded		Y

Table 1.5.1.2.a, Shear

Data Required

Shear Force, P	X	
Gross Area, A_g		1.14.a(2)
F_y	X	

Decision Table

	Condition	I
(1)	$f_v = P/A_g$	Y
(2)	$F_v = 0.40\ F_y$	Y
(3)	$R_v = f_v\ /\ F_v$	Y

Table 1.5.1.3.X, Compression Member Type

Data Required

Axially Loaded Compression Member	X	
Web of Beam/Girder	X	
Bearing Stiffener	X	

Decision Table

Axially Loaded Compression Member	Y	N	N	E
Web of Beam/Girder	N	Y	N	
Bearing stiffener	N	N	Y	
Execute Table 1.5.1.3.A	Y			
Execute Table 1.10.10.A		Y		
Execute Table 1.10.5.1.A			Y	
Else Rule				Y

Table 1.5.1.3.A, Compression Members

Data Required

R_a		1.5.1.3.a(4)
ℓ	X	
r	X	
Section 1.9 Satisfactory		1.9.a(1)

Decision Table

Section 1.9 Satisfactory	Y	Y	Y	Y	N	E
$\ell/r \leq 200$*	Y	Y	N	N	I	
$R_a \leq 1.0$	Y	N	Y	N	I	
Msg: Design Satisfactory	Y					
Msg: Allowable Stress Exceeded		Y		Y		
Msg: Slenderness Ratio Exceeded			Y	Y		
Msg: Section 1.9 Does Not Conform					Y	
Else Rule						Y

* Condition specified in Section 1.8.4

Table 1.5.1.3.a, Compression (Axially Loaded Members)

Data Required

Main Member	X	
Bracing/Secondary Member	X	
K		1.8.2.a(1)
ℓ	X	
r	X	
Q_a		1.9.2.2.a(2)
Q_s		1.9.1.2.a(2)
E	X	
F_y	X	
Axial force P	X	
Gross Area A_g		1.14.a(2)

Decision Table

	Main Member	Y	Y	N	N	N	N	E
	Bracing/Secondary Member	N	N	Y	Y	Y	Y	
	$K\,\ell/r \leq C_c$*	Y	N	Y	Y	N	N	
	$\ell/r > 120$	I	I	Y	N	Y	N	
(1)	$f_a = P/A_g$	Y	Y	Y	Y	Y	Y	
(2)	F_a = Formula C5-1	Y		Y	Y			
(2)	F_a = Formula 1.5-2		Y			Y	Y	
(3)	F'_a = Formula 1.5-3			Y		Y		
(3)	$F'_a = F_a$	Y	Y		Y		Y	
(4)	$R_a = f_a / F'_a$	Y	Y	Y	Y	Y	Y	
	Else Rule							Y

* $C_c = \sqrt{\dfrac{2\pi^2 E}{Q_s Q_a F_y}}$

Table 1.5.1.4.A, Bending

Data Required

Section 1.9 Satisfactory		1.9.a(1)
Section 1.10.2 Satisfactory		1.10.2.a(1)
Section 1.10.3 Satisfactory		1.10.3.a(1)
R_{bt}		1.10.6.a(5)
R_{bc}		1.10.6.a(6)

Decision Table

Section 1.9 Satisfactory	N	Y	Y	Y	Y	Y	Y	Y	E
Section 1.10.2 Satisfactory		N	N	Y	Y	Y	Y	Y	
Section 1.10.3 Satisfactory		N	Y	N	Y	Y	Y	Y	
$R_{bt} \leq 1.0$					Y	Y	N	N	
$R_{bc} \leq 1.0$					Y	N	Y	N	
Msg: Design Satisfactory					Y				
Msg: Section 1.9 not Satisfactory, Stresses Not Checked	Y								
Msg: Web Dimensions Not Satisfactory, Stresses Not Checked		Y	Y						
Msg: Flange Dimensions Not Satisfactory, Stresses Not Checked		Y		Y					
Msg: Allowable Bending Stress in Compression is Exceeded; Geometry is Satisfactory						Y		Y	
Msg: Allowable Bending Stress in Tension is Exceeded; Geometry is Satisfactory							Y	Y	
Else Rule									Y

Table 1.5.1.4.a, Bending

Data Required

Hot Rolled/Built-up Member	X	
Hybrid Girder	X	
A514 Steel Member	X	
I/H Shaped Member	X	
Solid Round/Square Bar	X	
Solid Rectangular Bar	X	
Box Type Flexural Member	X	
Channel	X	
Symmetry about Minor Axis	X	
Symmetry about Major Axis	X	
Symmetry about Plane of Web[1]	X	
Bent about Major Axis	X	
Bent about Minor Axis	X	
Loading in the Plane of Web[1]	X	
Compact Section		1.5.1.4.1.a(1)
Semicompact Section[2]		1.5.1.4.1.a(2)
Checks Subparagraphs a & b of 1.5.1.4.1		1.5.1.4.3.a(1)
Section 1.9 Satisfactory		1.9.a(1)
b_f or b	X	
F_y	X	
A_f	X	
d, Depth of Web	X	
TD, Transverse Distance out-to-out of the Webs in a box	X	
ℓ, Compression Flange Unbraced Length	X	
r, of the Flange + 1/3 Web	X	
C_b	X	
Formula 1.5-7 Applicable		1.5.1.4.6.a(1)
t_f	X	
Q_s		1.9.1.2.a(2)
Value of F_{bc} Provided (by Rational Analysis)	X	
Value Provided (of F_{bc})	X	

[1] Pertains to cross-sections having a major axis in the plane of the Web.

[2] A Semi-Compact Section is one which meets the requirements of Section 1.5.1.4.2.

Table 1.5.1.4.a, Bending (continued)

Decision Table

	Hot Rolled/Built-up Member	Y	Y																										E
	Hybrid Girder	N	N									N	N			N	N				N	N			N	N			
	A514 Steel Member	N	N	N																									
	I/H Shaped Member			Y	N	N	N	N	N	N	N	N	N	N	N	N	N												
	Solid Round/Square Bar	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		
	Solid Rectangular Bar	N	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		
	Box Type Flexural Member			N	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N		
	Channel	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	I	I		
	Symmetry about Minor Axis	Y	Y	Y		Y																							
	Symmetry about Major Axis	I	I	Y		Y																							
	Symmetry about Plane of Web	I	I	I														Y	Y	Y	Y	Y	Y	Y	Y	Y			
	Bent about Major Axis	Y	Y	N		N	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	Y												
	Bent about Minor Axis	N	N	Y		Y	N	Y																			N	Y	
	Loading in the Plane of Web	I	I	I														Y	Y	Y	Y	Y	Y	Y	Y	Y			
	Compact Section	Y	N				N	I																					
	Semi-Compact Section	I	Y				N	I																					
	Checks Subparagraphs a & b of 1.5.1.4.1			Y																									
	Section 1.9 Satisfactory						Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			
	$l \leq \min(76.0\ b/\sqrt{F_y},\ 20{,}000\ A_f / dF_y)$	Y	Y																										
	$l \leq (2500/F_y)$ TD						Y	Y																					
	$l/r < \sqrt{(102{,}000\ C_b / F_y)}$								Y	N	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N			
	$l/r < \sqrt{(510{,}000\ C_b / F_y)}$								I	Y	Y	Y	Y	N	N	N	N	I	Y	Y	Y	Y	N	N	N	N			
	$l \leq 76.0\ b/\sqrt{F_y}$																											Y	
	Formula 1.5-7 Applicable								N	N	N	Y	Y	N	N	Y	Y	N	N	N	Y	Y	N	N	Y	Y			
	Falue of F_{bc} Provided (by Rational Analysis)								I	N	Y	N	Y	N	Y	N	Y	I	N	Y	N	Y	N	Y	N	Y			
(1)	$F_{bt} = 0.66\ F_y$	Y																											
(1)	$F_{bt} = F_y[0.733 - 0.0014\left(\frac{b_f}{2t_f}\right)\sqrt{F_y}]$		Y																										
(1)	$F_{bt} = 0.75\ F_y$			Y	Y	Y	Y	Y																					
(1)	$F_{bt} = 0.60\ F_y$								Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
(2)	$F_{bc} = 0.66\ F_y$	Y																											
(2)	$F_{bc} = F_y[0.733 - 0.0014\left(\frac{b_f}{2t_f}\right)\sqrt{F_y}]$		Y																										
(2)	$F_{bc} = 0.75\ F_y$			Y	Y	Y																							
(2)	$F_{bc} = 0.60\ F_y$						Y	Y	Y									Y									Y	Y	
(2)	$F_{bc} = \min(0.60\ Q_sF_y$, formula 1.5-6a)									Y									Y										
(2)	$F_{bc} = \min[0.60\ Q_sF_y$, max(formula 1.5-6a, Value Provided)}										Y									Y									
(2)	$F_{bc} = \min[0.60\ Q_sF_y$, max(formula 1.5-6a, formula 1.5-7)]											Y									Y								
(2)	$F_{bc} = \min[0.60\ Q_sF_y$, max(form. 1.5-6a, form. 1.5-7, Value Provided)]												Y									Y							
(2)	$F_{bc} = \min(0.60\ Q_sF_y$, formula 1.5-6b)													Y									Y						
(2)	$F_{bc} = \min[0.60\ Q_sF_y$, max(formula 1.5-6b, Value Provided)]														Y									Y					
(2)	$F_{bc} = \min[0.60\ Q_sF_y$, max(formula 1.5-6b, formula 1.5-7)]															Y									Y				
(2)	$F_{bc} = \min[0.60\ Q_sF_y$, max(form. 1.5-6b, form. 1.5-7, Value Provided)]																Y									Y			
	Else Rule																												Y

Table 1.5.1.4.1.a, Compact or Semi-Compact Sections

Data Required

Flanges Continuously Connected to Web(s)	X	
Does Compression Flange have Unstiffened Element(s)	X	
Does Compression Flange have Stiffened Element(s)	X	
b or b_f	X	
t or t_f	X	
F_y	X	
d, Depth of Web	X	
f_a	X	

Decision Table

	Flanges Continously Connected to Web(s)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	E
	Does Compression Flange have Unstiffened Element(s)	Y	Y	Y	Y	Y	N	N	N	Y	Y	Y	Y	Y	Y	Y	I	
	Does Compression Flange have Stiffened Element(s)	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	I	
	Unstiffened Element(s) $b_f / 2t_f \le 52.2/\sqrt{F_y}$	Y	Y	N	N	N	I	I	I	Y	Y	Y	N	N	N	N	I	
	Unstiffened Element(s) $b_f / 2t_f \le 95.0/\sqrt{F_y}$	I	I	Y	Y	N	I	I	I	I	I	I	Y	Y	Y	N	I	
	Stiffened Element(s) $b/t \le 190/\sqrt{F_y}$	I	I	I	I	I	Y	Y	N	Y	Y	N	Y	Y	N	I	I	
	Web $d/t \le \max\{\text{formula (1.5-4)}, 257/\sqrt{F_y}\}$	Y	N	Y	N	I	Y	N	I	Y	N	I	Y	N	I	I	I	
(1)	Section is Compact	Y					Y			Y								
(1)	Section is not Compact		Y	Y	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	
(2)	Section is Semi-Compact			Y									Y					
(2)	Section is not Semi-Compact		Y		Y	Y		Y	Y		Y	Y		Y	Y	Y	Y	
	Else Rule																	Y

Table 1.5.1.4.3.a, Check Subparagraphs a & b of section 1.5.1.4.1

Data Required

Flanges Continuously Connected to Web(s)	X	
Does Compression Flange have Unstiffened Element(s)	X	
b_f	X	
t_f	X	
F_y	X	

Decision Table

Flanges Continuously Connected to the Web(s)	Y	Y	Y	N	E
Does Compression Flange have Unstiffened Element(s)	Y	Y	N	I	
$b_f / 2t_f < 52.2/\sqrt{F_y}$	Y	N	I	I	
(1) Checks Subparagraphs a & b of section 1.5.1.4.1	Y		Y		
(1) Does not Check Subparagraphs a & b of section 1.5.1.4.1		Y		Y	
Else Rule					Y

Table 1.5.1.4.6.a, Applicability of Formula 1.5-7

Data Required

Hybrid Girder	X	
Compression Flange is Solid and Rectangular	X	
Area of Compression Flange	X	
Area of Tension Flange	X	

Decision Table

	Hybrid Girder	N	E
	Compression Flange is Solid and Rectangular	Y	
	Area of Compression Flange < Area of Tension Flange	N	
(1)	Formula 1.5-7 Applicable	Y	
(1)	Formula 1.5-7 Not Applicable		Y

Table 1.5.1.5.A, Bearing

Data Required

R_p		1.5.1.a(3)

Decision Table

$R_p \leq 1.0$	Y	N
Msg: Design Satisfactory	Y	
Msg: Allowable Stress Exceeded		Y

Table 1.5.1.5.a, Bearing

Data Required

Milled Surface (includes Bearing Stiffeners and Pins in Reamed, Pinned or Bored Holes)	X	
Expansion Roller or Rocker	X	
F_{y1}, F_{y2} of Two Parts in Contact	X	
P, Force	X	
A, Bearing Area	X	
L, Length of Roller or Rocker	X	

Decision Table

	Milled Surface, etc.	Y	N	E
	Expansion Roller or Rocker	N	Y	
(1)	$f_p = P/A$	Y		
(1)	$f_p = P/L$		Y	
(2)	$F_p = 0.90\{\min(F_{y1}, F_{y2})\}$	Y		
(2)	$F_p = \frac{\min(F_{y1}, F_{y2})-13}{20}\ 0.66d$		Y	
(3)	$R_p = f_p / F_p$	Y	Y	
	Else Rule			Y

Table 1.5.2.X, Stress Check - Riveted or Bolted Connection

Data Required

Combined Stress in Connector	X	
High Strength Connector	X	
Tension Stress	X	
Shear Stress	X	
Bearing Stress	X	

Decision Table

Combined Stress in Connector	N	N	N	N	N	N	Y	Y	E
High Strength Connector	N	N	N	Y	Y	Y	N	Y	
Tension Stress	Y	N	N	Y	N	N			
Shear Stress	N	Y	N	N	Y	N			
Bearing Stress	N	N	Y	N	N	Y			
Execute Table 1.5.2.A	Y								
Execute Table 1.5.2.B		Y							
Execute Table 1.5.2.C			Y						
Execute Table 1.5.2.D				Y					
Execute Table 1.5.2.E					Y				
Execute Table 1.5.2.F						Y			
Execute Table 1.6.3.A							Y		
Execute Table 1.6.3.B								Y	
Else Rule									Y

Table 1.5.2.A, Stress Check in Connector

(Non High Strength Connector, Tension Stress)

Data Required

RT1		1.5.2.a(4)

Decision Table

RT1 $\leq$ 1.0	Y	N
Msg: Stress Check Satisfactory	Y	
Msg: Stress Check Not Satisfactory		Y

Table 1.5.2.a, Stress in Connector

(Non High Strength Connector, Tension Stress)

Data Required

A502 Grade 1, Hot Driven Rivet	X	
A502 Grade 2, Hot Driven Rivet	X	
A307 Bolt	X	
Threaded Part of Steels Meeting Requirement of Section 1.4.1	X	
P, Force on the Connector Being Tested	X	
A_b, Area in Tension (nominal)	X	
Al, * Area in Tension	X	
g, Length of Grip	X	
d, Diameter of Connector	X	
F_y, of the Connector Material	X	

Decision Table

	A502, Grade 1, Hot Driven Rivet	Y	Y	N	N	N	N	N	E
	A502 Grade 2, Hot Driven Rivet	N	N	Y	Y	N	N	N	
	A307 Bolt	N	N	N	N	Y	Y	N	
	Threaded Part of Steel Meeting Requirement of Section 1.4.1	N	N	N	N	N	N	Y	
	Connector in Long Grip ($g > 5d$)	Y	N	Y	N	Y	N	I	
(1)	$f_{tl} = P/A_b$	Y	Y	Y	Y				
(1)	$f_{tl} = P/Al$					Y	Y	Y	
(2)	$FTl = 20.0$	Y	Y			Y	Y		
(2)	$FTl = 27.0$			Y	Y				
(2)	$FTl = 0.60\ F_y$							Y	
(3)	$FTl' = FTl$		Y		Y		Y	Y	
(3)	$FTl' = \frac{FTl}{100} \{100 - 16(g - 5d)\}$	Y		Y		Y			
(4)	$RTl = f_{tl} / FTl'$	Y	Y	Y	Y	Y	Y	Y	
	Else Rule								Y

$$* \ Al = 0.7854 \left(D - \frac{0.9743}{n}\right)^2$$

Table 1.5.2.B, <u>Stress Check in Connector</u>

(Non High Strength Connector, Shear Stress)

Data Required

RV1		1.5.2.b(4)

Decision Table

RV1 ≤ 1.0	Y	N
Msg: Stress Check Satisfactory	Y	
Msg: Stress Check Not Satisfactory		Y

Table 1.5.2.b, Stress in Connector

(Non High Strength Connector, Shear Stress)

Data Required

A502 Grade 1, Hot Driven Rivet	X	
A502 Grade 2, Hot Driven Rivet	X	
A307 Bolt	X	
Threaded Part of Steel Meeting Requirements of Section 1.4.1	X	
P, Force on the Connector Being Tested	X	
A2,* Area in Shear	X	
g, Length of Grip	X	
d, Diameter of Connector	X	
F_y, of the Connector Material	X	

Decision Table

	A502 Grade 1, Hot Driven Rivet	Y	Y	N	N	N	N	N	E
	A502 Grade 2, Hot Driven Rivet	N	N	Y	Y	N	N	N	
	A307 Bolt	N	N	N	N	Y	Y	N	
	Threaded Part of Steel Meeting Requirements of Section 1.4.1	N	N	N	N	N	N	Y	
	Connector in Long Grip (g > 5d)	Y	N	Y	N	Y	N	I	
(1)	f_{v1} = P/A2	Y	Y	Y	Y	Y	Y	Y	
(2)	FV1 = 10.0					Y	Y		
(2)	FV1 = 15.0	Y	Y						
(2)	FV1 = 20.0			Y	Y				
(2)	FV1 = 0.30 F_y							Y	
(3)	FV1' = FV1		Y		Y		Y	Y	
(3)	FV1' = $\frac{FV1}{100}\{100 - 16(g - 5d)\}$	Y		Y		Y			
(4)	RV1 = f_{v1} / FV1'	Y	Y	Y	Y	Y	Y	Y	
	Else Rule								Y

---

* A2 should account for single or double shear.

Table 1.5.2.C, Stress Check in Connector

(Non High Strength Connector, Bearing Stress)

Data Required

RB1		1.5.2.c(4)

Decision Table

RB1 ≤ 1.0	Y	N
Msg: Stress Check Satisfactory	Y	
Msg: Stress Check Not Satisfactory		Y

Table 1.5.2.c, Stress in Connector
(Non High Strength Connector, Bearing Stress)

Data Required

A502 Grade 1, Hot Driven Rivet	X	
A502 Grade 2, Hot Driven Rivet	X	
A307 Bolt	X	
Threaded Part of Steel Meeting Requirements of Section 1.4.1	X	
P, Force on the Connector	X	
A3, Area of Connector in Bearing		1.16.a(1)
g, Length of Grip	X	
d, Diameter of the Connector	X	
F_y, of the Connected Material	X	

Decision Table

	A502 Grade 1, Hot Driven Rivet	Y	Y	N	N	N	N	N	E
	A502 Grade 2, Hot Driven Rivet	N	N	Y	Y	N	N	N	
	A307 Bolt	N	N	N	N	Y	Y	N	
	Threaded Part of Steel Meeting Requirements of Section 1.4.1	N	N	N	N	N	N	Y	
	Long Grip Connector ($g > 5d$)	Y	N	Y	N	Y	N	I	
(1)	$f_{b1} = P/A3$	Y	Y	Y	Y	Y	Y	Y	
(2)	$FB1 = 1.35\ F_y$	Y	Y	Y	Y	Y	Y	Y	
(3)	$FB1' = FB1$		Y		Y		Y	Y	
(3)	$FB1' = \frac{FB1}{100}\{100 - 16(g - 5d)\}$	Y		Y		Y			
(4)	$RB1 = f_{b1} / FB1'$	Y	Y	Y	Y	Y	Y	Y	
	Else Rule								Y

Table 1.5.2.D, Stress Check in Connector
(High Strength Connector, Tension Stress)

Data Required

RT2		1.5.2.d(4)

Decision Table

RT2 $\leq$ 1.0	Y	N
Msg: Stress Check Satisfactory	Y	
Msg: Stress Check Not Satisfactory		Y

Table 1.5.2.d, Stress in Connector

(High Strength Connector, Tension Stress)

Data Required

A325/A449 Bolt	{ X	
A490 Bolt	X }	
Static Loading	X	
P1, External Load on the Connector	X	
P2, Load due to Prying Action	X	
A_b, Area in Tension (nominal)	X	

Decision Table

	A325/A449 Bolt	Y	N	N	E
	A490 Bolt	N	Y	Y	
	Static Loading	I	Y	N	
(1)	$P = P1 + P2$	Y	Y		
(2)	$f_{t2} = P/A_b$	Y	Y		
(3)	$FT2 = 40.0$	Y			
(3)	$FT2 = 54.0$		Y		
(4)	$RT2 = f_{t2}/FT2$	Y	Y		
(4)	$RT2 = \infty$ *			Y	
	Else Rule				Y

* This situation is specified as unacceptable because A490 Bolts may be used for static loading only

Table 1.5.2.E, Stress Check in Connector
(High Strength Connector, Shearing Stress)

Data Required

RV2		1.5.2.e(3)

Decision Table

RV2 $\leq$ 1.0	Y	N
Msg: Stress Check Satisfactory	Y	
Msg: Stress Check Not Satisfactory		Y

Table 1.5.2.e, Stress in Connector

(High Strength Connector, Shearing Stress)

Data Required

A325/A449 Bolt	X	
A490 Bolt	X	
Friction Connection	X	
Bearing Connection	X	
Threading Excluded from Shear Planes	X	
P, External Load on the Connector	X	
A2,* Area in Shear	X	

Decision Table

	A325/A449 Bolt	Y	Y	Y	N	N	N	E
	A490 Bolt	N	N	N	Y	Y	Y	
	Friction Connection	Y	N	N	Y	N	N	
	Bearing Connection	N	Y	Y	N	Y	Y	
	Threading Excluded from Shear Planes	I	N	Y	I	N	Y	
(1)	$f_{v2} = P/A2$	Y	Y	Y	Y	Y	Y	
(2)	FV2 = 15.0	Y	Y					
(2)	FV2 = 20.0				Y			
(2)	FV2 = 22.0			Y				
(2)	FV2 = 22.5					Y		
(2)	FV2 = 32.0						Y	
(3)	$RV2 = f_{v2}/ FV2$	Y	Y	Y	Y	Y	Y	
	Else Rule							Y

* A2 should account for single or double shear.

Table 1.5.2.F, Stress Check in Connector

(High Strength Connector, Bearing Stress)

Data Required

RB2		1.5.2.f(3)

Decision Table

$RB2 \leq 1.0$	Y	N
Msg: Stress Check Satisfactory	Y	
Msg: Stress Check Unsatisfactory		Y

Table 1.5.2.f, <u>Stress in Connector</u>
(High Strength Connector, Bearing Stress)

Data Required

A325/A449 Bolt	X	
A490 Bolt	X	
Friction Connection	X	
Bearing Connection	X	
P, External Force on the Connector	X	
A3, Bearing Area		1.16.2.a(1)
Fy, of the Connected Material	X	

Decision Table

	A325/A449 Bolt	Y	Y	N	N	E
	A490 Bolt	N	N	Y	Y	
	Friction Connection	Y	N	Y	N	
	Bearing Connection	N	Y	N	Y	
(1)	$f_{b2} = P/A3$	Y	Y	Y	Y	
(2)	$FB2 = 1.35\ F_y$	Y		Y		
(2)	$FB2 = \infty$ (Not Restricted)		Y		Y	
(3)	$RB2 = f_{b2}\ /\ FB2$	Y	Y	Y	Y	
	Else Rule					Y

Table 1.5.2.p, Stress Ratio in Fastener

Data Required

Combined Stress in Connector	X	
High Strength Connector	X	
Tension Stress	X	
Shear Stress	X	
Bearing Stress	X	
RT1		1.5.2.a(4)
RV1		1.5.2.b(4)
RB1		1.5.2.c(4)
RT2		1.5.2.d(4)
RV2		1.5.2.e(3)
RB2		1.5.2.f(3)
RT3		1.6.3.a(4)
RT4		1.6.3.b(4)
RV4		1.6.3.b(5)

Decision Tables

	Combined Stress in Connector	N	N	N	N	N	N	Y	Y	E
	High Strength Connector	N	N	N	Y	Y	Y	N	Y	
	Tension Stress	Y	N	N	Y	N	N			
	Shear Stress	N	Y	N	N	Y	N			
	Bearing Stress	N	N	Y	N	N	Y			
(1)	R = RT1	Y								
(1)	R = RV1		Y							
(1)	R = RB1			Y						
(1)	R = RT2				Y					
(1)	R = RV2					Y				
(1)	R = RB2						Y			
(1)	R = max(RV1, RT3)							Y		
(1)	R = max(RT4, RV4)								Y	
	Else Rule									Y

Table 1.5.3.A, Stress Check in Welded Connection

Data Required

f, Stress in the Weld	X	
F,* Allowable Stress in Weld	X	
f_{base}	X	
F_{base} (allowable stress)		1.5.1.p(1)
Intermittent Fillet Weld	X	
Intermittent Fillet Weld Allowed		1.17.8.a(1)

Decision Table

$f/F \leq 1.0$	Y	Y	Y	I	N	E
$f_{base}/F_{base} \leq 1.0$	Y	Y	Y	N	I	
Intermittent Fillet Weld	Y	N	Y	I	I	
Intermittent Fillet Weld Allowed	Y	I	N	I	I	
Msg: Stress Check Satisfactory	Y	Y				
Msg: Stress Check Not Satisfactory			Y	Y	Y	
Else Rule						Y

* Required as input from Table 1.5.3 of the Text of AISC Specification.

Table 1.5.5.A, <u>Masonry Bearing</u>

Data Required

R_p		1.5.5.a(3)

Decision Table

$R_p \leq 1.0$	Y	N
Msg: Design Satisfactory	Y	
Msg: Allowable Stress Exceeded		Y

Table 1.5.5.a, Masonry Bearing

Data Required

Sandstone/Limestone	X	
Brick in Cement Mortar	X	
Concrete	X	
A_1, Area of Support	X	
A_2, Area of Bearing Plate	X	
f'_c, Specified Compressive Strength of Concrete	X	
P, Bearing Force	X	

Decision Table

	Sandstone/Limestone	Y	N	N	N	E
	Brick in Cement Mortar	N	Y	N	N	
	Concrete	N	N	Y	Y	
	$A_2 \geq 1/3\ A_1$	I	I	Y	N	
(1)	$f_p = P/A_2$	Y	Y	Y	Y	
(2)	$F_p = .40$	Y				
(2)	$F_p = .25$		Y			
(2)	$F_p = 0.25\ f'_c$			Y		
(2)	$F_p = 0.375\ f'_c$				Y	
(3)	$R_p = f_p\ /\ F_p$	Y	Y	Y	Y	
	Else Rule					Y

Table 1.6.X, Combined Stress

Data Required

Compression + Bending	X	
Tension + Bending	X	

Decision Table

Compression + Bending	Y	N	E
Tension + Bending	N	Y	
Execute Table 1.6.1.X	Y		
Execute Table 1.6.2.A		Y	
Else Rule			Y

Table 1.6.1.X, Combined Stress (Compression + Bending)

Data Required

R_a		1.5.1.3.a(3)
Optional Formula 1.6-2 Acceptable	X	

Decision Table

$R_a > 0.15$	Y	N	N	E
Optional Formula 1.6-2 Acceptable	I	Y	N	
Execute Table 1.6.1.A	Y		Y	
Execute Table 1.6.1.B		Y		
Else Rule				Y

Table 1.6.1.A, Combined Stress (Compression + Bending)

Data Required

Section 1.9 Satisfactory		1.9.a(1)
SUM1		1.6.1.a(1)
SUM2		1.6.1.a(2)
ℓ_x	X	
ℓ_y	X	
r_x	X	
r_y	X	

Decision Table

Section 1.9 satisfactory	N	Y	Y	Y	Y	Y	Y	Y	E
$\ell_x / r_x \leq 200$		N	N	Y	Y	Y	Y	Y	
$\ell_y / r_y \leq 200$		N	Y	N	Y	Y	Y	Y	
SUM1 $\leq$ 1.0					Y	Y	N	N	
SUM2 $\leq$ 1.0					Y	N	Y	N	
Msg: Design Satisfactory					Y				
Msg: Section 1.9 Not Satisfactory, other checks not made	Y								
Msg: ℓ_x / r_x is exceeding the limit, stress check not made		Y	Y						
Msg: ℓ_y / r_y is exceeding the limit, stress check not made.		Y		Y					
Msg: SUM1 is exceeding the limit, geometry is satisfactory							Y	Y	
Msg: SUM2 is exceeding the limit, geometry is satisfactory						Y		Y	
Else Rule									Y

Table 1.6.1.a, Combined Stress (Compression + Bending)

Data Required

R_a		1.5.1.3.a(3)
R_{bcx}		1.10.6.a(6)
R_{bcy}		1.10.6.a(6)
C_{mx}		1.6.1.b(1)
C_{my}		1.6.1.b(1)
f_a		1.5.1.3.a(1)
F'_{ex} *	X	
F'_{ey} **	X	
F_y	X	

Decision Table

	Condition	I
(1)	$SUM1 = R_a + \frac{C_{mx}}{(1-fa/F'_{ex})} R_{bcx} + \frac{C_{my}}{(1-fa/F'_{ey})} R_{bcy}$	Y
(2)	$SUM2 = \frac{f_a}{0.60\ F_y} + R_{bcx} + R_{bcy}$	Y

$$* \ F'_{ex} = \frac{12\pi^2 E}{23(K\ \ell_x / r_x)^2}$$

$$** \ F'_{ey} = \frac{12\pi^2 E}{23(K\ \ell_y / r_y)^2}$$

Table 1.6.1.B, Combined Stress (Compression + Bending, $Ra \leq 0.15$)

Data Required

Section 1.9 Satisfactory		1.9.a(1)
R_a		1.5.1.3.a(3)
R_{bcx}		1.10.6.a(6)
R_{bcy}		1.10.6.a(6)
ℓ_x	X	
ℓ_y	X	
r_x	X	
r_y	X	

Decision Table

Section 1.9 Satisfactory	N	Y	Y	Y	Y	Y	E
$\ell_x / r_x \leq 200$		N	N	Y	Y	Y	
$\ell_y / r_y \leq 200$		N	Y	N	Y	Y	
$R_a + R_{bcx} + R_{bcy} \leq 1.0$					N	Y	
Msg: Design Satisfactory						Y	
Msg: Section 1.9 not satisfactory. Other checks not made	Y						
Msg: ℓ_x / r_x is exceeding the limit. Stress check bypassed		Y	Y				
Msg: ℓ_y / r_y is exceeding the limit. Stress check bypassed		Y		Y			
Msg: Stress is exceeded. Geometry is Satisfactory					Y		
Else Rule							Y

Table 1.6.1.b, Value of C_m

Data Required

Side Sway Permitted in the Frame	X	
Member subjected to transverse Loading between supports	X	
Value of C_m Provided *	X	
C_m (value)	X	
Ends of Member Restrained	X	
M_1	X	
M_2	X	

Decision Table

	Side Sway Permitted in the Frame	Y	N	N	N	N	E
	Member Subjected to Transverse Loading between supports		N	Y	Y	Y	
	Value of C_m Provided			Y	N	N	
	Ends of Member Restrained				Y	N	
(1)	$C'_m = 0.85$	Y			Y		
(1)	$C'_m = \max\{(0.6-0.4M_1/M_2), 0.4\}$		Y				
(1)	$C'_m = C_m$ Provided			Y			
(1)	$C'_m = 1.0$					Y	
	Else Rule						Y

* by Rational Analysis

Table 1.6.2.A, Tension + Bending

Data Required

Section 1.9 Satisfactory		1.9.a(1)
F_t		1.5.1.1.a(1)
R_{btx}		1.10.6.a(5)
R_{bty}		1.10.6.a(5)
F_y	X	
R_{bcx}		1.10.6.a(6)
R_{bcy}		1.10.6.a(6)

Decision Table

Section 1.9 Satisfactory	N	Y	Y	Y	Y	E
$\frac{f_t}{0.6F_y} + R_{btx} + R_{bty} \leq 1.0$		Y	Y	N	N	
$R_{bcx} + R_{bcy} \leq 1.0$		Y	N	Y	N	
Msg: Design Satisfactory		Y				
Msg: Section 1.9 Not Satisfactory	Y					
Msg: Combined Tensile Stress is Exceeding the Limit				Y	Y	
Msg: Combined Compressive Stress is Exceeding the Limit			Y		Y	
Else Rule						Y

Table 1.6.3.A, Stress Check in Connector

(Non High Strength Connector, Combined Stress)

Data Required

RV1		1.5.2.b(3)
RT3		1.6.3.a(4)

Decision Table

RV1 $\leq$ 1.0	Y	Y	N	N
RT3 $\leq$ 1.0	Y	N	Y	N
Msg: Stress Check Satisfactory	Y			
Msg: Shear Stress in the Connector Exceeded			Y	Y
Msg: Tension Stress in the Connector Exceeded		Y		Y

Table 1.6.3.a, Stress in Connector

(Non High Strength Connector, Combined Stress)

Data Required

A502 Grade 1 Rivet	X	
A502 Grade 2 Rivet	X	
A307 Bolt	X	
f_{v1}		1.5.2.b(1)
g, Grip Length	X	
d, Diameter of Connector	X	
T, Tension Force on the Connector	X	
A_b, Area in Tension (Nominal)	X	
Al, Area in Tension *	X	

Decision Table

	A502 Grade 1 Rivet	Y	Y	N	N	N	N	E
	A502 Grade 2 Rivet	N	N	Y	Y	N	N	
	A307 Bolt	N	N	N	N	Y	Y	
	Connector in Long Grip (g > 5d)	Y	N	Y	N	Y	N	
(1)	$f_{t3} = T/A_b$	Y	Y	Y	Y			
(1)	$f_{t3} = T/Al$					Y	Y	
(2)	$FT3 = \min\{(28.0-1.6\ f_{v1}), 20.0\}$	Y	Y			Y	Y	
(2)	$FT3 = \min\{(38.0-1.6\ f_{v1}), 27.0\}$			Y	Y			
(3)	$FT3' = FT3$		Y		Y		Y	
(3)	$FT3' = \frac{FT3}{100}\{100-16(g-5d)\}$	Y		Y		Y		
(4)	$RT3 = f_{t3}/\ FT3'$	Y	Y	Y	Y	Y	Y	
	Else Rule							Y

$$* \ Al = 0.7854\left(D - \frac{0.9743}{n}\right)^2$$

Table 1.6.3.B, Stress Check in Connector

(High Strength Connector, Combined Stress)

Data Required

Bearing Type Connection	X	
Friction Type Connection	X	
RT4		1.6.3.b(4)
RV4		1.6.3.b(5)

Decision Table

Bearing Type Connection	N	N	Y	Y	Y	Y	E
Friction Type Connection	Y	Y	N	N	N	N	
RT4 < 1.0	I	I	Y	Y	N	N	
RV4 < 1.0	Y	N	Y	N	Y	N	
Msg: Stress Check Satisfactory	Y		Y				
Msg: Tensile Stress Exceeded				Y		Y	
Msg: Shear Stress Exceeded		Y			Y	Y	
Else Rule							Y

Table 1.6.3.b, Stress in Connector
(High Strength Connector, Combined Stress)

Data Required

A325 Bolts/A449 Bolts	X	
A490 Bolts	X	
Bearing Type Connection	X	
Friction Type Connection	X	
f_{v2}		1.5.2.e(1)
RV2		1.5.2.e(3)
T_b, Specified Pretension Load of Bolt	X	
T, Tension Force on the Connector	X	
A_b, Area in Tension (Nominal)	X	
f_t *	X	

Decision Table

	Bearing Connection	N	N	Y	Y	E
	Friction Connection	Y	Y	N	N	
	A325 Bolt/A449 Bolt	Y	N	Y	N	
	A490 Bolt	N	Y	N	Y	
(1)	$f_{t4} = T/A_b$	Y	Y	Y	Y	
(2)	$FT4 = \min\{(50.0 - 1.6\ f_{v2}), 40.0\}$			Y		
(2)	$FT4 = \min\{(70.0 - 1.6\ f_{v2}), 54.0\}$				Y	
(3)	$FV4 = \max\{15.0(1 - f_t\ A_b\ /\ T_b), 0\}$	Y				
(3)	$FV4 = \max\{20.0(1 - f_t\ A_b\ /\ T_b), 0\}$		Y			
(4)	$RT4 = f_{t4}\ /\ FT4$			Y	Y	
(5)	$RV4 = f_{v2}\ /\ FV4$	Y	Y			
(5)	RV4 = RV2			Y	Y	
	Else Rule					Y

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* Average tensile stress due to a direct load applied to all of the bolts in a connection.

Table 1.8.2.a, K for Compression Members

Data Required

Main Member	X	
Secondary Member/Bracing	X	
Bearing Stiffener	X	
Side Sway Prevented	X	
K Provided *	X	
K (value)	X	
ℓ	X	
r	X	

Decision Table

	Main Member	Y	Y	Y	Y	N	N	N	N	E
	Secondary Member/Bracing	N	N	N	N	Y	Y	N	N	
	Bearing Stiffener	N	N	N	N	N	N	Y	Y	
	Side Sway Prevented	Y	Y	N	N	I	I	I	I	
	K Provided	Y	N	Y	N	I	Y	Y	N	
	$\ell/r > 120$	I	I	I	I	Y	N	I	I	
(1)	K' = 1.0		Y			Y				
(1)	K' = K	Y					Y			
(1)	K' = Max(0.75,K)							Y		
(1)	K' = Max(1.0,K)			Y						
	Msg: K should be Provided by Rational Analysis				Y				Y	
	Else Rule									Y

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* by Rational Analysis

Table 1.8.4.a, Slenderness Ratio Requirements for Tension Members

Data Required

Member a Rod	X	
Check for Slenderness Desired	X	
Main Member	X	
ℓ	X	
r	X	

Decision Table

	Member a Rod	Y	N	N	N	N	N	E
	Check for Slenderness Desired	I	N	Y	Y	Y	Y	
	Main Member	I	I	Y	Y	N	N	
	$\ell/r \leq 240$	I	I	Y	N	I	I	
	$\ell/r \leq 300$	I	I	I	I	Y	N	
(1)	ℓ/r Satisfactory	Y	Y	Y		Y		
(1)	ℓ/r Not Satisfactory				Y		Y	
	Else Rule							Y

Table 1.9.a, Local Buckling

Data Required

Unstiffened Element(s)	X	
Stiffened Element(s)	X	
Checks Section 1.9.1.2		1.9.1.2.a(1)
Checks Section 1.9.2.2		1.9.2.2.a(1)

Decision Table

Unstiffened Element	Y	Y	N	N	Y	Y	Y	Y	E
Stiffened Element	N	N	Y	Y	Y	Y	Y	Y	
Checks Section 1.9.1.2	Y	N	I	I	Y	Y	N	N	
Checks Section 1.9.2.2	I	I	Y	N	Y	N	Y	N	
(1) Section 1.9 Satisfied	Y		Y		Y				
(1) Section 1.9 Not Satisfied		Y		Y		Y	Y	Y	
Else Rule									Y

Table 1.9.1.2.a, Unstiffened Elements

Data Required

Single angle/double angle with separators	X	
Struts comprising double angles in contact/ angles or plates projecting from girders/ columns/other compression flanges of beams/ stiffeners on plate girders	X	
Stem of T	X	
b, Actual Width of Unstiffened Elements	X	
t	X	
F_y	X	
Use of Appendix C desired	X	
Geometrical Constraints Satisfied		1.9.1.2.b(1)

Table 1.9.1.2.a, Unstiffened Element (continued)

Decision Table

	Single angle/double angle with separators	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E
	Struts Comprising Double Double Angles in Contact, etc.	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	
	Stem of T's	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	
	$\frac{b}{t} < 76.0/\sqrt{F_y}$	Y	N	N	N															
	$\frac{b}{t} \leq 95.0/\sqrt{F_y}$					Y	Y	N	N	N	N	N								
	$\frac{b}{t} \leq 127.0/\sqrt{F_y}$												Y	Y	N	N	N	N	N	
	Use of Appendix C Desired		N	Y	Y			N	Y	Y	Y	Y			N	Y	Y	Y	Y	
	$\frac{b}{t} \leq 155/\sqrt{F_y}$			Y	N															
	$\frac{b}{t} \leq 176/\sqrt{F_y}$								Y	Y	N	N				Y	Y	N	N	
	Geometrical Constraint Satisfied					Y	N		Y	N	Y	N	Y	N		Y	N	Y	N	
(1)	Checks Section 1.9.1.2	Y		Y	Y	Y			Y		Y		Y			Y		Y		
(1)	Does not Check Section 1.9.1.2		Y				Y	Y		Y		Y		Y	Y		Y		Y	
(2)	$Q_s = 1.0$	Y				Y							Y							
(2)	$Q_s = 1.340 - 0.0047(b/t)\sqrt{F_y}$			Y																
(2)	$Q_s = 15{,}500/F_y(b/t)^2$				Y															
(2)	$Q_s = 1.415 - 0.00437(b/t)\sqrt{F_y}$								Y											
(2)	$Q_s = 20{,}000/F_y(b/t)^2$										Y							Y		
(2)	$Q_s = 1.908 - 0.00715(b/t)\sqrt{F_y}$									Y						Y				
	Msg: Unstiffened Compression Element Not Satisfactory		Y				Y	Y		Y		Y		Y	Y		Y		Y	
	Else Rule																			Y

Table 1.9.1.2.b, Limiting Proportions

Data Required

Channel Section	X	
Built-up T Section	X	
Rolled T Section	X	
Flange Width	X	
Profile Depth	X	
Flange Thickness	X	
Web or Stem Thickness	X	

Decision Table

Channel Section	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	E
Built-up T Section	N	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	
Rolled T Section	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	N	
Ratio of Flange Width to Profile Depth ≤ 0.25	Y	Y	N	N	N										
Ratio of Flange Width to Profile Depth ≤ 0.50	I	I	Y	Y	N										
Ratio of Flange Width to Profile Depth ≥ 0.50	I	I	I	I	I	Y	Y	N	N	Y	Y	N	N		
Ratio of Flange Thickness to Web or Stem Thickness ≤ 3.0	Y	N	I	I											
Ratio of Flange Thickness to Web or Stem Thickness ≤ 2.0			Y	N											
Ratio of Flange Thickness to Web or Stem Thickness ≥ 1.25						Y	N	Y	N						
Ratio of Flange Thickness to Web or Stem Thickness ≥ 1.10										Y	N	Y	N		
(1) Geometrical constraints Satisfied	Y		Y			Y				Y				Y	
(1) Geometrical Constraints Not Satisfied		Y		Y	Y		Y	Y	Y		Y	Y	Y		
Else Rule															Y

Table 1.9.2.2.a, Stiffened Elements

Data Required

Flanges of Square/Rectangular Section	X	
Perforated Cover Plate	X	
Use of Appendix C Desired	X	
b, Actual Width of Stiffened Element	X	
t	X	
F_y	X	
f	X	

Decision Table

	Flanges of Square/Rectangular Section	Y	Y	Y	N	N	N	N	N	E
	Perforated Cover Plate	N	N	N	Y	Y	N	N	N	
	$\frac{b}{t} \leq 238/\sqrt{F_y}$	Y	N	N						
	$\frac{b}{t} \leq 317/\sqrt{F_y}$				Y	N				
	$\frac{b}{t} \leq 253/\sqrt{F_y}$						Y	N	N	
	Use of Appendix C Desired		N	Y				N	Y	
(1)	Checks Section 1.9.2.2	Y		Y			Y		Y	
(1)	Does not Check Section 1.9.2.2		Y		Y	Y		Y		
(2)	$b_e = b$	Y					Y			
(2)	$b_e = \min\left[\frac{253t}{\sqrt{f}}\left(1 - \frac{50.3}{(b/t)\sqrt{f}}\right), b\right]$			Y						
(2)	$b_e = \min\left[\frac{253t}{\sqrt{f}}\left(1 - \frac{44.3}{(b/t)\sqrt{f}}\right), b\right]$								Y	
(3)	Contribution to effective area = $b_e t$	Y		Y			Y		Y	
	Msg: Unstiffened Compression Element Not Satisfactory		Y		Y	Y		Y		
	Else Rule									Y

Table 1.10.2.a, Web of Girders

Data Required

Transverse Stiffeners Provided	X	
Transverse Stiffeners Spacing	X	
d	X	
t	X	
F_y	X	

Decision Table

	Transverse Stiffeners Provided	N	N	Y	Y	Y	Y	E
	Stiffener Spacing < 1.5d	I	I	Y	Y	N	N	
	$\frac{d}{t} \leq \frac{14,000}{\sqrt{F_y(F_y + 16.5)}}$	Y	N	I	I	Y	N	
	$\frac{d}{t} \leq \frac{2,060}{\sqrt{F_y}}$	I	I	Y	N	I	I	
(1)	Section 1.10.2 Satisfied	Y		Y		Y		
(1)	Section 1.10.2 Not Satisfied		Y		Y		Y	
	Else Rule							Y

Table 1.10.3.a, <u>Flanges of Girders</u>

Data Required

Checks Section 1.9.1.2		1.9.1.2.a(1)
Riveted Girder	X	
Area of Cover Plates	X	
Total Flange Area	X	

Decision Table

Checks Section 1.9.1.2	Y	Y	Y	N	E
Riveted Girder	Y	Y	N	I	
$\frac{\text{Area of Cover Plates}}{\text{Total Flange Area}} < 0.70$	Y	N	I	I	
(1) Section 1.10.3 Satisfied	Y		Y		
(1) Section 1.10.3 Not Satisfied		Y		Y	
Else Rule					Y

Table 1.10.5.1.A, Compression (Bearing Stiffeners)

Data Required

Section 1.9 Satisfactory		1.9.a(1)
R_a		1.10.5.1.a(4)

Decision Table

Section 1.9 Satisfactory	Y	Y	N	N
$R_a \leq 1.0$	Y	N	Y	N
Msg: Design Satisfactory	Y			
Msg: Allowable Stress Exceeded		Y		Y
Msg: Section 1.9 Not Satisfactory			Y	Y

Table 1.10.5.1.a, Compression (Bearing Stiffeners)

Data Required

End Stiffener	X	
P, Force on the Stiffener	X	
A_{st}, Area of Stiffener	X	
t, Thickness of Web	X	
F_y	X	

Decision Table

	End Stiffener	Y	N
(1)	$A' = A_{st} + 12\ t$	Y	
(1)	$A' = A_{st} + 25\ t$		Y
(2)	$f_a = P/A'$	Y	Y
(3)	$F_a = 0.60\ F_y$	Y	Y
(4)	$R_a = f_a\ /\ F_a$	Y	Y

Table 1.10.5.2.A, <u>Shear on Beams/Girders</u>

Data Required

h	X	
t	X	
P	X	
A_w	X	
F_y	X	
$(CK)_v$*		1.10.5.2.c(1)

Decision Table

$h/t > 260$	N	N	N	Y	E
$P/A_w > 0.4\ F_y$	N	N	Y		
$\frac{P}{A_w} > \frac{F_y}{2.89}\ (CK)_v$	N	Y			
Msg: Design Satisfactory	Y				
Msg: Insufficient Web Area			Y		
Execute Table 1.10.5.2.C		Y		Y	
Else Rule					Y

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* $(CK)_v$ is same as C_v but for no stiffeners on the web and thus corresponds to $k = 5.38$

Table 1.10.5.2.B, Shear on Hybrid/A514 Steel Girder

Data Required

F_y	X	
C_v		1.10.5.2.a(1)
P, Shear Force	X	
A_w, Web Area	X	

Decision Table

$\frac{P}{A_w} \leq \frac{F_y}{2.89} C_v$	Y	N
Msg: Shear Stress Checked Within Allowable Limits	Y	
Msg: Shear Stress Exceeded		Y

Table 1.10.5.2.C, Shear on Beams/Girders (Stiffeners are Needed and Provided)

Data Required

a	X	
h	X	
t	X	
C_v		1.10.5.2.a(1)
P, Shear Force	X	
A_w, Area of Web	X	
F_y	X	
Tension Field Action Desired	X	
Intermediate Stiffener Size Satisfactory		1.10.5.4.a(1)
Combined Stress Action Satisfactory		1.10.7.a(1)
End Panel/Panel with Large Holes	X	

Decision Table

$\frac{a}{h} \leq \min\left(\left(\frac{260}{h/t}\right)^2, 3.0\right)$	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	E
Tension Field Action Desired		Y	Y	Y	Y	Y	Y	Y	N	N	N	
End Panel/Panel with Large Holes		Y	Y	N	N	N	N	N				
$\min(a,h) \leq 348\ t/\sqrt{(P/A_w)}$		Y	N									
$C_v > 1.0$				Y	N	N	N	N				
$P/A_w > F_v$ (by formula 1.10-1)									Y	N	N	
$P/A_w > F_v$ (by formula 1.10-2)					Y	N	N	N				
Intermediate Stiffener Size Satisfactory						Y	Y	N		Y	N	
Combined Stress Action Satisfactory						Y	N	I				
Msg: Stiffener Spacing Satisfactory		Y				Y				Y		
Msg: Stiffener Spacing too Large	Y		Y		Y				Y			
Msg: Stiffener Spacing too Close for Tension Field Action				Y								
Msg: Intermediate Stiffener Size Not Satisfactory								Y			y	
Msg: Combined Stress Action Not Satisfactory							Y					
Else Rule												Y

Table 1.10.5.2.a, Value of C_v

Data Required

C_{v1}		1.10.5.2.b(2)
C_{v2}		1.10.5.2.b(3)

Decision Table

	$C_{v1} \leq 0.8$	Y	N
(1)	$C_v = C_{v1}$	Y	
(1)	$C_v = C_{v2}$		Y

Table 1.10.5 2.b, Value of k

Data Required

a	X	
h	X	
F_y	X	
t	X	

Decision Table

	$a/h \leq 1.0$	Y	N
(1)	$k = 4.0 + 5.34/(a/h)^2$	Y	
(1)	$k = 5.34 + 4.0/(a/h)^2$		Y
(2)	$C_{v1} = \dfrac{45{,}000\ k}{F_y(h/t)^2}$	Y	Y
(3)	$C_{v2} = \dfrac{6000}{h/t}\sqrt{\dfrac{k}{F_y}}$	Y	Y

Table 1.10.5.2.c, Value of $(CK)_v$

(C_v for no stiffeners present and $k = 5.34$ ($\frac{a}{h} = \infty$))

Data Required

F_y	X	
h	X	
t	X	

Decision Table

	$\frac{45,000}{F_y (h/t)^2} \times 5.34 \leq 0.8$	Y	N
(1)	$(CK)_v = \frac{45,000}{F_y (h/t)^2} \times 5.34$	Y	
(1)	$(CK)_v = \frac{6000}{(h/t)} \sqrt{\frac{5.34}{F_y}}$		Y

Table 1.10.5.4.a, Intermediate Stiffener Size

Data Required

I, Moment of Inertia With Axis in Plane of Web	X	
h	X	
A_{gst}, Gross Stiffener Area	X	
C_v		1.10.5.2.a(1)
a	X	
t	X	
Y	X	
D	X	
Tension Field Action Desired	X	

Decision Table

Tension Field Action Desired	N	N	Y	Y	Y	Y	E
$I \geq (h/50)^4$	Y	N	Y	Y	N	N	
$A_{gst} \geq A_{st}$ (formula 1.10.3)	I	I	Y	N	Y	N	
(1) Intermediate Stiffener Size Satisfactory	Y		Y				
(1) Intermediate Stiffener Size Not Satisfactory		Y		Y	Y	Y	
Else Rule							Y

Table 1.10.6.a, Reduction in Flange Stress

Data Required

Hybrid Girder	X	
t, Web Thickness	X	
F_{bt}		1.5.1.4.a(1)
F_{bc}		1.5.1.4.a(2)
A_w, Area of Web	X	
A_f, Area of Flange	X	
h, Web Depth	X	
α, Ratio of Web Yield Stress to Flange Yield Stress	X	
M, Bending Moment	X	
y_1, Distance from the Neutral Axis to the Extreme Fiber in Compression	X	
y_2, Distance from the Neutral Axis to the Extreme Fiber in Tension	X	
I, Moment of Inertia		1.14.a(3)

Decision Table

	Hybrid Girder	N	N	Y	Y
	$h/t > 760/\sqrt{F_{bc}}$	N	Y	N	Y
(1)	$f_{bt} = My_2 / I$	Y	Y	Y	Y
(2)	$f_{bc} = My_1 / I$	Y	Y	Y	Y
(3)	$F'_{bc} = F_{bc}$	Y			
(3)	$F'_{bc} = F_{bc}$ (By formula 1.10-4)		Y		
(3)	$F'_{bc} = F_{bc}$ (By formula 1.10-5)			Y	
(3)	$F'_{bc} = \min\{(\text{form. } 1.10\text{-}4), (\text{form. } 1.10\text{-}5)\}$				Y
(4)	$F'_{bt} = F'_{bt}$	Y	Y		
(4)	$F'_{bt} = F'_{bc}$			Y	Y
(5)	$R_{bt} = f_{bt} / F'_{bt}$	Y	Y	Y	Y
(6)	$R_{bc} = f_{bc} / F'_{bc}$	Y	Y	Y	Y

Table 1.10.7.X, Shear Stress (A514 Steel Girder)

Data Required

R_{bt}		1.10.6.a(5)

Decision Table

$R_{bt} \leq 0.75$	Y	N
Execute Table 1.10.5.2.A	Y	
Execute Table 1.10.5.2.B		Y

Table 1.10.7.a, Shear and Tension (in Plate Girders)

Data Required

f_{bt}		1.10.6.a(1)
F_y	X	
R_v		1.5.1.2.a(3)

Decision Table

	$f_{bt}/0.6\ F_y \leq 1.0$	Y	Y	N	E
	$\frac{f_{bt}}{F_y} + 0.375\ R_v < 0.825$	Y	N	I	
(1)	Combined Stress Action Satisfactory	Y			
(1)	Combined Stress Action Not Satisfactory		Y	Y	
	Else Rule				Y

Table 1.10.10.A, Compression (Web Toe of Fillet)

Data Required

R_a		1.10.10.a(3)
Bearing Stiffeners Provided	X	

Decision Table

$R_a \leq 1.0$	Y	N	N	E
Bearing Stiffener Provided	I	Y	N	
Msg: Compression at Web Toe of Fillet is Satisfactory	Y	Y		
Msg: Compression at Web Toe of Fillet is Not Satisfactory			Y	
Else Rule				Y

Table 1.10.10.a, Compression (Web Toe of Fillet)

Data Required

Interior Load	X	
End Reaction	X	
P, Force*	X	
F_y	X	
t	X	
N	X	
k, Distance from Outer Face of Flange to Web Toe of Fillet in Inches	X	

Decision Table

	Interior Load	Y	N
	End Reaction	N	Y
(1)	$f_a = \frac{P}{t(N + 2k)}$	Y	
(1)	$f_a = \frac{P}{t(N + k)}$		Y
(2)	$F_a = 0.75 F_y$	Y	Y
(3)	$R_a = f_a / F_a$	Y	Y

* Designated as R in formulas 1.10.7 and 1.10.6

Table 1.11.X, Composite Construction

Data Required

Encased Composite Beam *	X	

Decision Table

Encased Composite Beam	Y	N
Execute Table 1.11.2.1.A	Y	
Execute Table 1.11.2.2.A		Y

---

* For the definition of Encased Beams, see Section 1.11.1 of AISC Specification

Table 1.11.2.1.A, Encased Composite Beams

Data Required

R_b		1.11.2.1.a(3)

Decision Table

$R_b \leq 1.0$	Y	N
Msg: Design of Encased Composite Beam Satisfactory	Y	
Msg: Design of Encased Composite Beam Not Satisfactory		Y

Table 1.11.2.1.a, Encased Composite Beams

Data Required

Intend Steel Beam to Resist Moment Alone (Alternate Approach)	X	
Shoring Provided	X	
M_{D1}, Moment Due to Dead Load Before Hardening of Concrete	X	
M_{D2}, Moment Due to Dead Load After Hardening of Concrete	X	
M_L, Live Load	X	
S_s, Section Modulus of Steel Beam Alone Referred Bottom Flange	X	
$S_{comp.}$, Section Modulus of Composite Section Referred to Bottom Flange	X	
F_y	X	

Decision Table

	Intend Steel Beam to Resist Moment Alone	N	N	Y	E
	Shoring Provided	Y	N	I	
	$(M_{D1} + M_{D2} + M_L) \geq 0$	I	I	Y	
(1)	$f_b = (M_{D1} + M_{D2} + M_L)/S_{comp.}$	Y			
(1)	$f_b = (M_{D1} / S_s) + (M_{D2} + M_L)/S_{comp.}$		Y		
(1)	$f_b = (M_{D1} + M_{D2} + M_L)/S_s$			Y	
(2)	$F_b = 0.66\ F_y$	Y	Y		
(2)	$F_b = 0.76\ F_y$			Y	
(3)	$R_b = f_b / F_b$	Y	Y	Y	
	Else Rule				Y

Table 1.11.2.2.A, <u>Non-Encased Composite Beams</u>

Data Required

Shoring provided	X	
R_1		1.11.2.2.a(5)
R_2		1.11.2.2.a(6)
Section 1.9 Satisfactory		1.9.a(1)
Distribution of Connectors Satisfactory		1.11.4.b(1)

Decision Table

Shoring Provided	Y	Y	Y	N	N	N	N	N	N	N	N	N	E
$R_1 \leq 1.0$	Y	Y	N	Y	Y	Y	Y	Y	N	N	N	N	
$R_2 \leq 1.0$	I	I	I	Y	Y	Y	N	N	Y	Y	N	N	
Section 1.9 Satisfactory	I	I	I	Y	Y	N	Y	N	Y	N	Y	N	
Distribution of Connectors Satisfactory	Y	N	I	Y	N	I	I	I	I	I	I	I	
Msg: Design of Non-Encased Composite Beam Satisfactory	Y			Y									
Msg: Tensile Stress in Composite Beam is Exceeded			Y						Y	Y	Y	Y	
Msg: Compressive Stress in Composite Beam is Exceeded							Y	Y			Y	Y	
Msg: Section 1.9 is Not Satisfactory						Y		Y		Y		Y	
Msg: Distribution of Shear Connectors is Not Satisfactory		Y			Y								
Else Rule													Y

Table 1.11.2.2.a, Non-Encased Composite Beam

Data Required

Shear Connectors Satisfactory for Full Capacity		1.11.4.a(1)
Shoring Provided	X	
$S_{comp.}$, Section Modulus of Composite Section Referred to Bottom Flange	X	
S_s, Section Modulus of Steel Beam Alone Referred to Bottom Flange	X	
M_L	X	
M_D	X	
V_h		1.11.4.a(2)
V'_h		1.11.4.a(3)
F_{bt}		1.5.1.4.a(1)
F_{bc}		1.5.1.4.a(2)

Decision Table

	Shear Connectors Satisfactory for Full Capacity	Y	Y	N	N
	Shoring Provided	Y	N	Y	N
(1)	$S_{tr} = S_{comp.}$	Y		Y	Y
(1)	$S_{tr} = \text{Min}\{S_{comp.},\ (1.35 + 0.35 \frac{M_L}{M_D})S_s\}$		Y		
(2)	$S_{eff} = S_s + \frac{V'_h}{V_h} (S_{tr} - S_s)$			Y	Y
(3)	$f_1 = (M_L + M_D)/S_{tr}$	Y	Y		
(3)	$f_1 = (M_L + M_D)/S_{eff}$			Y	Y
(4)	$f_2 = M_D/S_s$		Y		Y
(5)	$R_1 = f_1/F_{bt}$	Y	Y	Y	Y
(6)	$R_2 = f_2/F_{bc}$		Y		Y

Table 1.11.4.a, Shear Connectors

Data Required

No. of connectors Provided	X	
q	X	
f'_c	X	
A_c	X	
A_s	X	
F_y	X	

Decision Table

	No. of connectors $\geq \min\left(\frac{0.85 f'_c A_c}{2q}, \frac{A_s F_y}{2q}\right)$	Y	N
(1)	Shear connectors satisfactory for full capacity	Y	
(1)	Shear connectors not satisfactory for full capacity		Y
(2)	$V_h = \min\left(\frac{0.85 f'_c A_c}{2}, \frac{A_s F_y}{2}\right)$		Y
(3)	V'_h = No. of connectors x q		Y

Table 1.11.4.b, Distribution of Connectors

Data Required

Region of Positive Moment	X	
N_1	X	
M	X	
M_{max}	X	
β	X	
N_2	X	

Decision Table

	Region of Positive Moment	N	Y	Y	E
	$N_2 > \dfrac{N_1\left[\dfrac{M\beta}{M_{max}} - 1\right]}{\beta-1}$	I	Y	N	
(1)	Distribution of Connectors Satisfactory	Y	Y		
(1)	Distribution of Connectors Not Satisfactory			Y	
	Else Rule				Y

Table 1.14.a, Section Properties

Data Required

Net Area Desired	X	
Gross Area Desired	X	
Moment of Inertia Desired	X	
A_g, Gross Area		1.14.b(1)
A_n, Net Area		1.14.b(2)
I_g	X	
I_{red}	X	

Decision Table

	Net Area Desired	Y	Y	N	N	N	E
	Gross Area Desired	N	N	Y	N	N	
	Moment of Inertia Desired	N	N	N	Y	Y	
	$(A_g - A_n)/A_g \geq 0.15$	Y	N	I	Y	N	
(1)	$A'_n = A_n$	Y					
(1)	$A'_n = 0.85\ A_g$		Y				
(2)	$A'_g = A_g$			Y			
(3)	$I = I_{red}$				Y		
(3)	$I = I_g$					Y	
	Else Rule						Y

Note 1: In case of Built-up members, A_g and A_n are obtained by cycling each element through table 1.14.b.

Note 2: In case of bending members, A_g and A_n refer to flanges only.

Note 3: I_{red} is the moment of inertia of the modified section deducting the reduction for net flange area exceeding 15 per cent.

Table 1.14.b, Gross and Net Areas of Elements

Data Required

Element an Angle	X	
REDUCTION		1.14.c(2)
d, diameter of rivet or bolt	X	
W	X	
W_1	X	
W_2	X	
t	X	
n, number of holes	X	

Decision Table

		N	Y
	Element an Angle	N	Y
(1)	Contribution to $A_g = Wt$	Y	
(1)	Contribution to $A_g = (W_1 + W_2 - t) \times t$		Y
(2)	Contribution to $A_n = A_g - t \left\{ n(d + \frac{1}{8}) - \text{REDUCTION} \right\}$	Y	Y

Note: REDUCTION = $\sum_k (s^2/4g)_k$

Note: k refers to a gage space.

Value of $s^2/4g$ for each gage space is obtained from table 1.14.c.

Table 1.14.c, Reduction due to Staggered Holes

Data Required

Element an Angle		
Considering Opposite Legs	X	
g	X	
g_1	X	
g_2	X	
s_k	X	
t	X	

Decision Table

	Element an Angle	N	Y	Y	E
	Considering Opposite Legs of the Angle	I	Y	N	
(1)	$g_k = g$	Y		Y	
(1)	$g_k = (g_1 + g_2 - t)$		Y		
(2)	Contribution to REDUCTION = $s_k^2 / 4g_k$	Y	Y	Y	
	Else Rule				Y

Table 1.14.7.a, <u>Effective Areas of Weld Metals</u>

Data Required

Fillet Weld	X	
Groove Weld	X	
Plug/Slot Weld	X	
Weld in Holes/Weld in Slots	X	
Weld Overlapping	X	
Complete Penetration Weld	X	
Partial Penetration Weld	X	
Single V/Single J/Single U Weld	X	
Single Bevel Weld	X	
Double V/Double J/Double U Weld	X	
Double Bevel Weld	X	
Material Thickness of the Thinner Part, t_t	X	
Size of Weld	X	
Weld Made by Submerged Arc Process	X	
Weld Made by Manual Shielded Metal Arc	X	
Shortest Distance from the Root to the Face of the Diagrammatic Weld	X	
Leg Size of Weld	X	
Depth of the Groove	X	
Overall Length of the Full Size Fillet Weld Including Returns	X	
Width of the Parts Joined	X	
Nominal Cross-Sectional Area of the Slot or Hole in the Plane of Faying Surface	X	
Theoretical Throat Thickness	X	

Table 1.14.7.a, Effective Area of Weld Metals (continued)

Decision Table

	Fillet Weld	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	E
	Groove Weld	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	
	Plug Weld	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	
	Slot Weld	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	
	Weld in Holes/Slots	N	N	N	Y	Y	Y	Y	Y	Y														
	Weld Overlapping				N	N	N	Y	Y	Y														
	Weld Made by Submerged Arc Process	N	Y	Y	N	Y	Y	N	Y	Y														
	Size of Weld $\le$ 3/8''	I	Y	N	I	Y	N	I	Y	N														
	Complete Penetration Weld										Y	N	N	N	N	N	N	N	N	N	N			
	Partial Penetration Weld										N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			
	Single V/Single J/Single U Weld											Y	Y	N	N	N	N	N	N	N	N			
	Single Bevel Weld											N	N	Y	Y	Y	N	N	N	N	N			
	Double V/Double J/Double U Weld											N	N	N	N	N	Y	Y	N	N	N			
	Double Bevel Weld											N	N	N	N	N	N	N	Y	Y	Y			
	Material Thickness > 1/2''											Y	N	Y	Y	N								
	Material Thickness > 1 1/2''																Y	N	Y	Y	N			
	Weld Made by Manual Shielded Metal Arc Process													Y	N				Y	N				
(1)	Eff. Throat Thickness = Shortest Dist. from the Root to Face of Diagrammatic Weld	Y			Y			Y																
(1)	Eff. Throat Thickness = Leg Size		Y			Y			Y															
(1)	Eff. Throat Thickness = Theoretical Throat + 0.11''			Y			Y			Y														
(1)	Eff. Throat Thickness = t_t, Thickness of The Thinner Part.										Y													
(1)	Eff. Throat Thickness = max{Depth of the Groove, $\sqrt{(t_t/6)}$}											Y			Y		Y			Y				
(1)	Eff. Throat Thickness = max{(Depth of the Groove - $\frac{1}{8}$''), $\sqrt{(t_t/6)}$}													Y					Y					
(1)	Eff. Throat Thickness = $\sqrt{(t_t/6)}$												Y		Y			Y			Y			
(2)	Eff. Length = Overall length of Full Size Fillet Including Returns	Y	Y	Y	Y	Y	Y	Y	Y	Y														
(2)	Eff. Length = Width of the Parts Joined										Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			
(3)	Eff. Area = Eff. Throat Thickness x Eff. Length	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y			
(4)	Eff. Area' = min(Eff. Area, Nominal Cross-Sectional Area of the Slot or Hole in the Plane of Faying Surface)							Y	Y	Y														
(5)	Eff. Shearing Area = Nominal Cross-Sectional Area of the Slot or Hole in the Plane of the Faying Surface																					Y	Y	
	Execute Table 1.17.7.a	Y	Y	Y	Y	Y	Y	Y	Y	Y														
	Else Rule																							Y

Table 1.15.X, Connection Composition

Data Required

Homogeneous Connection	X	

Decision Table

Homogeneous Connection	Y	N
Execute Table 1.15.B		Y
Execute Table 1.15.Y for Each Connector	Y	Y

Table 1.15.Y, Check of a Single Connector

Data Required

Connector is Rivet/Bolt	X	
Connector is Weld	X	
Stress Check Desired	X	
Geometry Check Desired	X	
Effective Area of Weld Desired	X	

Decision Table

Connector is Rivet/Bolt	Y	Y	N	N	N	E
Connector is Weld	N	N	Y	Y	Y	
Stress Check Desired	Y	N	Y	N	N	
Geometry Check Desired	N	Y	N	Y	N	
Effective Area of Weld Desired	I	I	N	N	Y	
Execute Table 1.5.2.X	Y					
Execute Table 1.16.A		Y				
Execute Table 1.5.3.A			Y			
Execute Table 1.17.A				Y		
Execute Table 1.14.7.a					Y	
Else Rule						Y

Table 1.15.A, <u>Connection</u>

Data Required

Force on the Connection (actual)	X	
P, Minimum Design Force for the Connection		1.15.a(1)
Stiffener Provision Necessary		1.15.a(2)
Account for Eccentricity Necessary		1.15.a(3)
Flexibility Requirements Satisfactory		1.15.a(4)

Decision Table

Force on the connection $\leq$ P	Y	Y	Y	Y	Y	Y	Y	Y	N	E
Stiffener Provision Necessary	N	N	Y	Y	N	N	Y	Y	I	
Account for Eccentricity Necessary	N	N	N	N	Y	Y	Y	Y	I	
Flexibility Requirements Satisfactory	Y	N	Y	N	Y	N	Y	N	I	
Msg: Connection Design Force Satisfactory	Y	Y	Y	Y	Y	Y	Y	Y		
Msg: Connection Design Force Not Satisfactory									Y	
Msg: Stiffeners Must be Provided			Y	Y			Y	Y		
Msg: Eccentricity Must be Accounted					Y	Y	Y	Y		
Msg: Flexibility Requirements Not Met		Y		Y		Y		Y		
Execute Table 1.15.X	Y	Y	Y	Y	Y	Y	Y	Y		
Else Rule										Y

Table 1.15.a, Connection

Data Required

Lacing/Sag Bar/Girt Connection	X	
Beam/Girder Connection	X	
Truss Connection	X	
End Connection	X	
Intended as Flexible Connection	X	
Connection Checks Flexibility Requirement		1.15.4.a(1)
Axially Stressed Member Connection	X	
Member Axes Concurrent at Joint	X	
C.G. of Connectors on the Gravity Axis of Member	X	
Connection for Single Angle/Double Angle/ Similar Member	X	
Fillet Weld Connection Under Repeated Stress	X	
Fully Restrained Beam Framed to I or H Shaped Column	X	
Bearing Joint in Column	X	
Bearing Joint in Compression Member (Other than Column)	X	
Force in the Connected Member	X	
Reaction Shear	X	
Strength of the Connected Member	X	
Calculated Force	X	

Table 1.15.a, Connection (continued)

Decision Table

	Lacing/Sag Bar/Girt Connection	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E
	Beam/Girder Connection	N	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	
	Truss Connection	N	N	N	N	N	N	N	N	I	I	I	I	I	I	Y	N	N	
	End Connection		Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	Y			
	Intended as Flexible Connection		Y	Y	N	Y	Y	N		I	I	I	I	I	I	Y			
	Connection Checks Flexibility Requirement		Y	N		Y	N			I	I	I	I	I	I	I			
	Axially Stressed Member Connection									Y	Y	Y	Y	Y	N				
	Member Axes Concurrent at the Joint									Y	Y	Y	Y	N					
	C. G. of Connectors on the Gravity Axis of Member									Y	N	N	N						
	Connection for Single Angle/Double Angle/Similar Member										I	Y	N						
	Fillet Weld Connection Under Repeated Stress										Y	N	N						
	Fully Restrained Beam Framed to Flange of I or H Column		N	N	N	Y	Y	Y											
	Bearing Joint in Column																Y	N	
	Bearing Joint in Compression Member (Other than Column)																N	Y	
(1)	P = Force in the Member	Y																	
(1)	P = max(6 kips, Reaction Shear)		Y			Y										Y			
(1)	P = max(6 kips, Calculated Forces)			Y	Y		Y	Y	Y										
(1)	P = max(6 kips, Force in the Member, 1/2 Effective Strength of the Member)									Y	Y	Y	Y	Y	Y				
(1)	P = 0																Y		
(1)	P = 1/2 x Force in the Member																	Y	
(2)	Stiffener on Column Webs are Necessary					Y	Y	Y											
(2)	Stiffener Provision Not Necessary	Y	Y	Y	Y				Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
(3)	Eccentricity Must be Accounted										Y		Y	Y	Y				
(3)	Eccentricity Need not be Accounted	Y	Y	Y	Y	Y	Y	Y	Y	Y		Y				Y	Y	Y	
(4)	Flexibility Requirements Satisfactory	Y	Y		Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
(4)	Flexibility Requirements Not Satisfactory			Y			Y												
	Else Rule																		Y

Table 1.15.B, Heterogeneous Connection

Data Required

Welding Included in Connection	X	
Two or More Types of Welds	X	
New Work	X	
Rivets Included in Connection	X	
A307 Bolt Included in Connection	X	
High Strength Bolt Included in Connection	X	
Bearing Type Connection	X	
Friction Type Connection	X	
Bolts Put Prior to Welding	X	

Decision Table

Weld Included in Connection	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	E
Two or More Types of Welds in Connection	Y	Y	N	Y	N	Y	N	Y	N	Y	N	N	
New Work	I	Y	Y	Y	Y	Y	Y	Y	Y	N	N	I	
Rivets Included in Connection	N	Y	Y	N	N	N	N	N	N	Y	Y	Y	
A307 Bolt Included in Connection	N	N	N	Y	Y	N	N	N	N	N	N	N	
High Strength Bolt Included in Connection	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	
Bearing Type Connection	I	I	I	I	I	Y	Y	N	N	I	I	N	
Friction Type Connection	I	I	I	I	I	N	N	Y	Y	I	I	Y	
Bolts Put Prior to Welding	I	I	I	I	I	N	N	Y	Y	I	I	I	
Msg: Capacity of the Joint = Σ Capacity of Each Group of Weld	Y	Y	Y	Y	Y	Y	Y						
Msg: Entire Stress in Connection is Carried by Welds Only		Y	Y	Y	Y	Y	Y						
Msg: High Strength Bolts Share the Stresses with Welds								Y	Y				
Msg: Existing Rivets and Bolts to Carry Stresses from Existing Deal Loads, Additional Stresses by Welds										Y	Y		
Msg: Rivets and Bolts Share the Stresses												Y	
Else Rule													Y

Table 1.15.4.a, Flexibility Requirements for Beam Connections

Data Required

Beam Size Determined by Deflection	X	1.10.6.a(1)
d	X	
L	X	
f_b		
e, Horizontal Displacement of Top Flange	X	

Decision Table

	Beam Size Determined by Deflection	Y	Y	N	N	E
	$e > 0.007\ d$	Y	N	I	I	
	$e > \frac{f_b L}{3,600}$	I	I	Y	N	
(1)	Connection Checks Flexibility Requirement	Y		Y		
(1)	Connection Does Not Check Flexibility Requirement		Y		Y	
	Else Rule					Y

Table 1.16.A, Geometrical Requirements

Data Required

Given Pitch	X	
Minimum Pitch (allowable)		1.16.a(1)
Given Edge Distance	X	
Given Edge Distance in Line of Stress	X	
X1, Minimum Edge Distance		1.16.a(3)
X2, Minimum Edge Distance in Line of Stress		1.16.a(4)
Maximum Edge Distance (allowable)		1.16.a(5)

Decision Table

Given Pitch > Minimum Pitch (allowable)	Y	E
Given Edge Distance in Line of Stress > X2	Y	
Given Edge Distance > X1	Y	
Given Edge Distance ≤ Maximum Edge Distance (allowable)	Y	
Msg: Geometry Requirements Satisfactory	Y	
Msg: Geometry Requirements Not Satisfactory		Y

Table 1.16.a, Geometry Requirements

Data Required

Number of Fasteners in Line of Stress	X	
Single Shear	X	
Double Shear	X	
Tension Member	X	
Bearing Type Connection	X	
d, Diameter of the Connector	X	
t, Thickness of the Connected Part	X	
$C = (F_t)_{bolt} / (F_t)_{member}$	X	
X1,* Minimum Edge Distance	X	
R, Stress Ratio in Fastener		1.5.2.p(1)
A_b, Nominal Cross-Sectional Area	X	
Transverse Spacing	X	

Decision Table

	Number of Fasteners in Line of Stress ≤ 2	Y	Y	I	I	N	E
	Connector in Single Shear	Y	N	I	I	I	
	Connector in Double Shear	N	Y	I	I	I	
	Tension Member	Y	Y	N	I	I	
	Bearing Type Connection	Y	Y	I	N	I	
(1)	Minimum Pitch = 2.67 d	Y	Y	Y	Y	Y	
(2)	$X = A_b C/t$	Y					
(2)	$X = 2\ A_b C/t$		Y				
(3)	Minimum Edge Distance = X1	Y	Y	Y	Y	Y	
(4)	Minimum Edge Distance in Line of Stress = X2**	Y	Y				
(4)	Minimum Edge Distance in Line of Stress = X1			Y	Y	Y	
(5)	Maximum Edge Distance = min(12d, 6 in.)	Y	Y	Y	Y	Y	
	Else Rule						Y

* Required as input from Table 1.16.5 of the text of AISC Specification.

** X2 = min(max(X1, RX), $\frac{3}{2}$ Transverse Spacing).

Table 1.16.2.a, Effective Bearing Area

Data Required

Countersunk Connector	X	
d, Diameter of Connector	X	
BL, Length in Bearing	X	
DCS, Depth of Countersunk	X	

Decision Table

	Countersunk Connector	Y	N
(1)	$A3 = d \cdot (BL - \frac{1}{2} DCS)$	Y	
(1)	$A3 = d \cdot BL$		Y

Table 1.17.A, Geometry Check on Welded Connections

Data Required

Fillet Weld	X	
Plug Weld	X	
Slot Weld	X	
Size of Fillet Weld	X	
Minimum Size of Fillet Weld Allowed		1.17.5.a(2)
Maximum Size of Fillet Weld Allowed		1.17.6.a(1)
Use of Plug Weld Permissible		1.17.11.a(1)
Diameter of Plug Weld	X	
Spacing of Plug Weld	X	
Thickness of Plug Weld	X	
Minimum Diameter of Plug Weld Allowed		1.17.11.a(2)
Maximum Diameter of Plug Weld Allowed		1.17.11.a(3)
Minimum Spacing of Plug Weld Allowed		1.17.11.a(4)
Minimum Thickness of Plug Weld Allowed		1.17.11.a(5)
Use of Slot Weld Permissible		1.17.11.a(6)
Length of Slot Weld	X	
Width of Slot Weld	X	
Transverse Spacing of Slot Weld	X	
Longitudinal Spacing of Slot Weld	X	
Thickness of Slot Weld	X	
Maximum Length of Slot Weld Allowed		1.17.11.a(7)
Minimum Width of Slot Weld Allowed		1.17.11.a(8)
Maximum Width of Slot Weld Allowed		1.17.11.a(9)
Minimum Transverse Spacing for Slot Weld Allowed		1.17.11.a(10)
Minimum Thickness of Slot Weld Allowed		1.17.11.a(11)

Table 1.17.A, Geometry Check on Welded Connections (continued)

Decision Table

Fillet Weld	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	E
Plug Weld	N	N	N	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	
Slot Weld	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	
Size of Fillet Weld ≥ Minimum size of Fillet Weld Allowed	Y	Y	N															
Size of Fillet Weld ≤ Maximum size of Fillet Weld Allowed	Y	N	I															
Use of Plug Weld Permissible				Y	N													
Diameter of Plug Weld ≥ Minimum Diameter Allowed				Y		N												
Diameter of Plug Weld ≤ Maximum Diameter Allowed				Y			N											
Spacing of Plug Weld ≥ Minimum Spacing Allowed				Y				N										
Thickness of Plug Weld ≥ Minimum Thickness Allowed				Y					N									
Use of Slot Weld Permissible										Y	N							
Length of Slot Weld ≤ Maximum Length Allowed										Y		N						
Width of Slot Weld ≥ Minimum Width Allowed										Y			N					
Width of Slot Weld ≤ Maximum Width Allowed										Y				N				
Transverse Spacing of Slot Weld ≥ Min. Transverse Spacing Allowed										Y					N			
Longitudinal Spacing of Slot Weld ≥ 2 x Length of Slot Weld										Y						N		
Thickness of Slot Weld ≥ Min. Thickness of Slot Allowed										Y							N	
Msg: Welded Connection Geometry Satisfactory	Y			Y						Y								Y
Msg: Welded Connection Geometry Not Satisfactory		Y	Y		Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	Y	

Table 1.17.5.a, Minimum Size of Fillet Weld

Data Required

Material Thickness of the Thicker Part Joined (=A)	X	
Material Thickness of the Thinner Part Joined (=B)	X	
Designed Size of Weld Given	X	
Designed Size	X	
Joint has Fillet Weld Only	X	

Decision Table

	Joint has Fillet Weld Only	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	E
	A ≤ 1/4 "	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	I	
	A ≤ 1/2 "	Y	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	I	
	A ≤ 3/4 "	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	N	I	
	A ≤ 1 1/2 "	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	I	
	A ≤ 2 1/4 "	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	I	
	A ≤ 6 "	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	I	
	A > 6 "	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	I	
	Designed Size of Weld Given	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	I	
(1)	X = 1/8 "	Y	Y														
(1)	X = 3/16 "			Y	Y												
(1)	X = 1/4 "					Y	Y										
(1)	X = 5/16 "							Y	Y								
(1)	X = 3/8 "									Y	Y						
(1)	X = 1/2 "											Y	Y				
(1)	X = 5/8 "													Y	Y		
(2)	Min. Size of Weld Allowed = max{min(X,B), Designed Size of weld}	Y		Y		Y		Y		Y		Y		Y			
(2)	Min. Size of Weld Allowed = min(X,B)		Y		Y		Y		Y		Y		Y		Y		
(2)	Min. Size of Weld Allowed = 0*															Y	
	Else Rule																Y

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* Minimum Size not Specified

Table 1.17.6.a, Maximum Effective Size of Fillet Weld

Data Required

Thickness of Connected Part	X	
Weld Specially Designed to Obtain Full Throat Thickness	X	

Decision Table

	Thickness of the Connected Part $\geq$ 1/4 "	Y	Y	N	E
	Weld Specially Designed to Obtain Full Throat Thickness	Y	N	I	
(1)	Max. Allowable Size of Fillet Weld = Thickness of the Connected Part	Y		Y	
(1)	Max. Allowable Size of Fillet Weld = Thickness of the Connected Part - 1/16 "		Y		
	Else Rule				Y

Table 1.17.7.a, Modification of Fillet Weld Effective Area

Data Required

Effective Length of Fillet Weld		1.14.7.a(2)
Size of Fillet Weld	X	
EFAREA, Effective Area		1.14.7.a(4)

Decision Table

Effective Length of Fillet Weld < 4 x Size of Weld	Y	N
$E' = 1/4 \times (\text{Effective Length})^2 \times \frac{1}{\sqrt{2}}$	Y	
$E' = \text{EFAREA}$		Y

Table 1.17.8.a, Intermittent Fillet Weld

Data Required

Force on the Weldment	X	
Smallest Size of Weld		1.17.5.a(2)
F,[*] Allowable Stress in the Weld	X	
L, Spacing of Intermittent Weld c/c	X	
Effective Size of Weld	X	

Decision Table

	Force on the Weldment $\leq$ L.F. (Smallest Size of Weld)	Y	N
(1)	Intermittent Fillet Weld Allowed	Y	
(1)	Intermittent Fillet Weld Not Allowed		Y
	Msg: Effective Length of Each Segment = max(Effective Size of Weld, 1.5 in)	Y	

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[*] Required as External Input from Table 1.5.3 of the text of AISC Specification.

Table 1.17.11.a, Geometry Requirements in Plug and Slot Welds

Data Required

Weld Transmits Shear	X	
Weld Prevents Buckling Of Lapped Parts	X	
Weld Joins Components of Built-up Members	X	
Thickness of the Part Containing Plug/Slot Weld	X	
Thickness of the Weld Metal	X	
Diameter of the Hole	X	
Thickness of Slot Weld	X	
Width of Slot	X	

Decision Table

	Weld Transmits Shear	Y	Y	I	I	I	I	N	E
	Weld Prevents Buckling of Lapped Parts	I	I	Y	Y	I	I	N	
	Weld Joins Components of Built-up Members	I	I	I	I	Y	Y	N	
	Material Thickness $\leq 5/8$ in.	Y	N	Y	N	Y	N	I	
(1)	Use of Plug Weld Permissible	Y	Y	Y	Y	Y	Y		
(1)	Use of Plug Weld Not Permissible							Y	
(2)	Min. Dia. of Plug Weld = (thickness of the part containing it + 5/16 ")	Y	Y	Y	Y	Y	Y		
(3)	Max. Dia. of Plug Weld = 2 1/4 x thickness of Weld Metal	Y	Y	Y	Y	Y	Y		
(4)	Center to Center Spacing = 4 x Dia. of the Hole of Plug Weld	Y	Y	Y	Y	Y	Y		
(5)	Min. Thickness of Plug Weld = Thickness of Material	Y		Y		Y			
(5)	Min. Thickness of Plug Weld = Max(1/2 Thickness of the Material, 5/8 ")		Y		Y		Y		
(6)	Use of Slot Weld Permissible	Y	Y	Y	Y	Y	Y		
(6)	Use of Slot Weld Not Permissible							Y	
(7)	Max. Length Allowed for Slot Welds = 10 x Thickness of Weld	Y	Y	Y	Y	Y	Y		
(8)	Min. Width Allowed for Slot Welds = Thickness of the Part Containing it + 5/16 "	Y	Y	Y	Y	Y	Y		
(9)	Max. Width Allowed for Slot Welds = 2 1/4 x Thickness of Weld Metal	Y	Y	Y	Y	Y	Y		
(10)	Min. Transverse Spacing Slot Welds = 4 x Width of Slots	Y	Y	Y	Y	Y	Y		
(11)	Min. Thickness of Slot Weld = Thickness of the Material	Y							
(11)	Min. Thickness of Slot Weld = max(1/2 x Thickness of the Material, 5/8 ")		Y						
	Else Rule								Y

Table 2.X, Plastic Design

Data Required

Member	X	
Bracing	X	

Decision Table

Member	Y	N	E
Bracing	N	Y	
Execute Table 2.4.A	Y		
Execute Table 2.Y		Y	
Else Rule			Y

Table 2.Y, **Bracing**

Data Required

Vertical Bracing	X	
Lateral Bracing	X	

Decision Table

Vertical Bracing	Y	N	E
Lateral Bracing	N	Y	
Execute Table 2.3.A	Y		
Execute Table 2.9.A		Y	
Else Rule			Y

Table 2.3.A, <u>Vertical Bracing</u>

Data Required

Bracing Component of Beam/Girder	X	
P, Axial Force in Member	X	
F_y	X	
A_g, Gross Area of the Member		1.14.a(2)
P_{cr}, by Formula 2.4-1	X	
C_m		1.6.1.b(1)
M_m		2.4.3.a(1)
P_e	X	
M, Bending Moment	X	

Decision Table

Bracing Component of Beam/Girder	N	N	Y	Y	Y	Y	E
$P \le 0.85 A_g F_y$	Y	N	Y	Y	N	N	
$\frac{P}{P_{cr}} + \frac{C_m M}{(1 - P/P_e) M_m} \le 1.0$	I	I	Y	N	Y	N	
Msg: Design Satisfactory	Y		Y				
Msg: Axial Force Exceeded		Y			Y	Y	
Msg: Formula 2.4-2 Exceeded				Y		Y	
Else Rule							Y

Table 2.4.A, Members

Data Required

Column	X	
Beam/Girder	X	
Axial Compression Only	X	
ℓ, Unbraced Length	X	
r, Radius of Gyration	X	
C_c	X	
P, Applied Axial Load	X	
A_g, Gross Area		1.14.a(1)
F_a, Allowable Stress by Formula 1.5-1	X	
P_{cr}, Formula 2.4-1	X	
C_m		1.6.1.b(1)
M	X	
P_e	X	
M_m		2.4.3.a(1)
P_y	X	
M_p	X	
Flange Dimension Satisfactory		2.7.a(1)
Web Dimension Satisfactory		2.7.b(1)
Shear on Web Area Satisfactory		2.5.a(1)

Decision Table

Column	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	E
Beam/Girder	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	
Axial Compression Only	Y	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	
$\ell/r \le C_c$	Y	Y	N	Y	N														
$P \le 1.7\ A_g\ F_a$	Y	N																	
$P/P_{r} + C_m M/(1 - P/P_e)\ M_m \le 1.0$				Y		N						Y	N						
$P/P_y + M/1.18\ M_p \le 1.0$				Y			N					Y		N					
$M \le M_p$				Y				N				Y			N				
Flange Dimension Satisfactory				Y					N			Y				N			
Web Dimension Satisfactory				Y						N		Y					N		
Shear on Web Satisfactory				Y							N	Y						N	
Msg: Design Satisfactory	Y			Y								Y							
Msg: ℓ/r Exceeded			Y		Y														
Msg: Design Not Satisfactory		Y				Y	Y	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	
Else Rule																			Y

Table 2.4.3.a, Value of M_m

Data Required

Column Braced in Weak Direction	X	
M_p	X	
ℓ	X	
r_y	X	
F_y	X	

Decision Table

	Column Braced in Weak Direction	Y	N
(1)	$M_m = M_p$	Y	
(1)	$M_m = \min\{(1.07 - \frac{(\ell/r_y)\sqrt{F_y}}{3,160})\, M_p,\ M_p\}$		Y

Table 2.5.a, Shear on Web

Data Required

Web Reinforced by Diagonal Stiffener/Double Plate	X	
F_y	X	
t	X	
d	X	
V_u	X	

Decision Table

	Web Reinforced by Diagonal Stiffener/Double Plate	Y	N	N	E
	$V_u \leq 0.55\ F_y\ t\ d$	I	Y	N	
(1)	Shear on Web Satisfactory	Y	Y		
(1)	Shear on Web Not Satisfactory			Y	
	Else Rule				Y

Table 2.7.a, Minimum Thickness of Flanges

Data Required

Flange Subjected to Compression Involving Hinge Rotation	X	
Flange of Rolled I/WF Shape/Similar Built-Up Single Web Shape	X	
Flange of Box Section/Cover Plate	X	
Section 1.9 Satisfactory		1.9.a(1)
F_y	X	
b_f	X	
t_f	X	

Decision Table

Flange Subjected to Compression Involving Hinge Rotation	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	E
Flange of Rolled I/WF Shape/ Similar Built-Up Single Web Shape	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N			
Flange of Box Section/Cover Plate	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y			
Section 1.9 Satisfactory																	Y	N	
$F_y = 36$	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N					
$F_y = 42$	N	N	Y	Y	N	N	N	N	N	N	N	N	N	N					
$F_y = 45$	N	N	N	N	Y	Y	N	N	N	N	N	N	N	N					
$F_y = 50$	N	N	N	N	N	N	Y	Y	N	N	N	N	N	N					
$F_y = 55$	N	N	N	N	N	N	N	N	Y	Y	N	N	N	N					
$F_y = 60$	N	N	N	N	N	N	N	N	N	N	Y	Y	N	N					
$F_y = 65$	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y					
$b_f/2t_f \leq 8.5$	Y	N																	
$b_f/2t_f \leq 8.0$			Y	N															
$b_f/2t_f \leq 7.4$					Y	N													
$b_f/2t_f \leq 7.0$							Y	N											
$b_f/2t_f \leq 6.6$									Y	N									
$b_f/2t_f \leq 6.3$											Y	N							
$b_f/2t_f \leq 6.0$													Y	N					
$b/t \leq 190/\sqrt{F_y}$															Y	N			
(1) Flange Dimension Satisfactory	Y		Y		Y		Y		Y		Y		Y		Y		Y		
(1) Flange Dimension Not Satisfactory		Y		Y		Y		Y		Y		Y		Y		Y		Y	
Else Rule																			Y

Table 2.7.b, Web Buckling

Data Required

d	X	
t	X	
P	X	
P_y	X	
F_y	X	

Decision Table

	$\frac{P}{P_y} \leq 0.27$	Y	Y	N	N	E
	$\frac{d}{t} \leq \frac{412}{\sqrt{F_y}} (1 - 1.4 \frac{P}{P_y})$	Y	N			
	$\frac{d}{t} \leq \frac{257}{\sqrt{F_y}}$			Y	N	
(1)	Web Dimensions Satisfactory	Y		Y		
(1)	Web Dimensions Not Satisfactory		Y		Y	
	Else Rule					Y

Table 2.9.A, Lateral Bracing

Data Required

Weak Axis Normal to Plane of Bending	X	
Segment in the Region of Last Hinge	X	
Segment Not Adjacent to a Plastic Hinge	X	
M	X	
M_p	X	
ℓ_{cr}	X	
r_y	X	
F_y	X	
ℓ_{cr}/r_y Otherwise Justified	X	
Stress Requirement Satisfactory		2.9.a(1)

Decision Table

Weak Axis Normal to Plane of Bending	Y	N	N	N	N	N	N	N	N	N	N	E
Segment in the Region of Last Hinge	I	Y	Y	N	N	N	N	N	N	N	N	
Segment Not Adjacent to a Plastic Hinge	I	N	N	Y	Y	N	N	N	N	N	N	
$M/M_p \geq -0.5$						Y	Y	Y	N	N	N	
$\ell_{cr}/r_y \leq 1{,}375/F_y + 25$						Y	N	N				
$\ell_{cr}/r_y \leq 1{,}375/F_y$									Y	N	N	
ℓ_{cr}/r_y Otherwise Justified							Y	N		Y	N	
Stress Requirement Satisfactory		Y	N	Y	N							
Msg: Lateral Bracing Satisfactory	Y	Y		Y		Y	Y		Y	Y		
Msg: Lateral Bracing's Unbraced Length Exceeds Limit								Y			Y	
Msg: Lateral Bracing's Stress Requirement Not Satisfactory			Y		Y							
Else Rule												Y

Table 2.9.a, <u>Stress Requirement in Lateral Bracing</u>

Data Required

Combined Stress	X	
R_b		2.9.b(3)
SUM1		1.6.1.a(1)
SUM2		1.6.1.a(2)

Decision Table

	Combined Stress	N	N	Y	Y	Y	E
	$R_b \leq 1.0$	Y	N				
	SUM1 $\leq$ 1.0			Y	Y	N	
	SUM2 $\leq$ 1.0			Y	N	I	
(1)	Stress Requirement Satisfactory	Y		Y			
(1)	Stress Requirement Not Satisfactory		Y		Y	Y	
	Else Rule						Y

Table 2.9.b, Stress in Lateral Bracing

Data Required

ℓ	X	
r	X	
C_b	X	
F_y	X	
Formula 1.5-7 Applicable		1.5.1.4.6.a(1)
S, Plastic Section Modulus	X	
LF, Load Factor	X	
M, Bending Moment	X	
d, Depth of the Bracing	X	
A_f, Area of Compression Flange	X	

Decision Table

	$\ell/r < \sqrt{102{,}000\ C_b / F_y}$	Y	N	N	N	N	E
	$\ell/r < \sqrt{510{,}000\ C_b / F_y}$	Y	Y	Y	N	N	
	Formula 1.5-7 Applicable	I	N	Y	N	Y	
(1)	$f_b = \frac{M}{S} \times \frac{1}{LF}$	Y	Y	Y	Y	Y	
(2)	$F_b = 0.60\ F_y$	Y					
(2)	$F_b = \min(0.60\ F_y$, formula 1.5-6a)		Y				
(2)	$F_b = \min\{0.60\ F_y$, max(form. 1.5-6a, 1.5-7)$\}$			Y			
(2)	$F_b = \min(0.60\ F_y$, formula 1.5-6b)				Y		
(2)	$F_b = \min\{0.60\ F_y$, max(form. 1.5-6b, 1.5-7)$\}$					Y	
(3)	$R_b = f_b / F_b$	Y	Y	Y	Y	Y	
	Else Rule						Y

APPENDIX B

CROSS-REFERENCE BETWEEN TEXT OF SPECIFICATION AND DECISION TABLES

The table that follows presents a cross-reference guide between the text of the 1969 Edition of the AISC Specification and the decision tables given in Appendix A.

The first column of the table lists the section and paragraph numbers in the text of the Specification. The next three columns list, in order:

a) the switching table(s) leading to the section or paragraph;

b) the testing table(s) pertinent to the section or paragraph; and

c) the working table(s) covering the provisions of the section or paragraph.

SPECIFICATION SECTION	SWITCHING TABLE(S) LEADING TO SECTION	TESTING TABLES	WORKING TABLES
1.5.1	1.X 1.Y 1.5.X 1.5.1.X		
1.5.1.1	1.5.1.X	1.5.1.1.A	1.5.1.1.a
1.5.1.2	1.5.1.X 1.5.1.2.X	1.5.1.2.A	1.5.1.2.a
1.5.1.3	1.5.1.X 1.5.1.3.X	1.5.1.3.A	1.5.1.3.a 1.8.2.a
1.5.1.4	1.5.1.X	1.5.1.4.A	1.5.1.4.a 1.5.1.4.1.a 1.5.1.4.3.a 1.5.1.6.a
1.5.1.5	1.5.1.X	1.5.1.5.A	1.5.1.5.a
1.5.2	1.X 1.Y 1.15.X 1.15.Y 1.5.2.X	1.5.2.A 1.5.2.B 1.5.2.C 1.5.2.D 1.5.2.E 1.5.2.F	1.5.2.a 1.5.2.b 1.5.2.c 1.5.2.d 1.5.2.e 1.5.2.f 1.5.2.p
1.5.3	1.X 1.Y 1.15.X 1.15.Y	1.5.3.A	Assumed available as input data
1.5.4	1.X 1.Y 1.5.X 1.5.1.X	1.5.1.1.A 1.5.1.2.A 1.5.1.3.A 1.5.1.4.A 1.5.1.5.A	1.5.1.1.a 1.5.1.2.a 1.5.1.3.a 1.5.1.4.a 1.5.1.5.a
1.5.5	1.X 1.Y	1.5.5.A	1.5.5.a
1.6	1.X 1.Y 1.5.X 1.6.X		
1.6.1	1.6.X 1.6.1.X	1.6.1.A 1.6.1.B	1.6.1.a 1.6.1.b
1.6.2	1.6.X	1.6.2.A	

SPECIFICATION SECTION	SWITCHING TABLE(S) LEADING TO SECTION	TESTING TABLES	WORKING TABLES
1.6.3	1.X 1.Y 1.15.X 1.15.Y 1.5.2.X	1.6.3.A 1.6.3.B	1.6.3.a 1.6.3.b
1.8.2			1.8.2.a
1.8.3			1.8.2.a
1.8.4		1.5.1.1.A 1.5.1.3.A 1.6.1.A 1.6.1.B	1.8.4.a
1.9		1.5.1.3.A 1.5.1.4.A 1.6.1.A 1.6.1.B 1.6.2.A 1.10.5.1.A 1.11.2.2.A 2.9.a	1.9.a 1.9.1.2.a 1.9.1.2.b 1.9.2.2.a 1.10.3.a
1.10.1			1.14.a
1.10.2	1.X 1.Y 1.5.X 1.5.1.X	1.5.1.4.A	1.10.2.a
1.10.3	1.X 1.Y 1.5.X 1.5.1.X	1.5.1.4.A	1.10.3.a
1.10.5.1	1.X 1.Y 1.5.X 1.5.1.X 1.5.1.3.X	1.10.5.1.A	1.10.5.1.a
1.10.5.2 1.10.5.3 1.10.5.4	1.X 1.Y 1.5.X 1.5.1.X 1.5.1.2.X	1.10.5.2.A 1.10.5.2.B 1.10.5.2.C	1.10.5.2.a 1.10.5.2.b 1.10.5.2.c 1.10.5.4.a
1.10.6	1.X 1.Y 1.5.X 1.5.1.X	1.5.1.4.A	1.10.6.a

SPECIFICATION SECTION	SWITCHING TABLE(S) LEADING TO SECTION	TESTING TABLES	WORKING TABLES
1.10.7	1.X 1.Y 1.5.X 1.5.1.X 1.5.1.2.X 1.10.7.X	1.10.5.2.A 1.10.5.2.B 1.10.5.2.C	1.10.7.a
1.10.10	1.X 1.Y 1.5.X 1.5.1.X 1.5.1.3.X	1.10.10.A	1.10.10.a
1.11	1.X 1.Y 1.11.X		
1.11.2.1	1.11.X	1.11.2.1.A	1.11.2.1.a
1.11.2.2	1.11.X	1.11.2.2.A	1.11.2.2.a
1.11.4			1.11.4.a 1.11.4.b
1.14.1 1.14.3 1.14.4 1.14.5			1.14.a 1.14.b 1.14.c
1.14.7	1.X 1.Y 1.15.Y		1.14.7.a 1.17.7.a
1.15	1.X 1.Y		
1.15.1 1.15.2 1.15.3 1.15.4 1.15.5 1.15.7 1.15.8	1.Y	1.15.A	1.15.a
1.15.9 1.15.10 1.15.11	1.Y 1.15.X	1.15.B	
1.16.2			1.15.2.a
1.16.3	1.X 1.Y 1.15.X 1.5.2.X		1.5.2.a 1.5.2.b 1.5.2.c 1.6.3.a

SPECIFICATION SECTION	SWITCHING TABLE(S) LEADING TO SECTION	TESTING TABLES	WORKING TABLES
1.16.4	1.X	1.16.A	1.16.a
1.16.5	1.Y		1.5.2.p
1.16.6	1.15.X		
1.16.7	1.5.Y		
1.17.5	1.X	1.17.A	1.17.5.a
1.17.6	1.Y		1.17.6.a
1.17.11	1.15.X		1.17.11.a
1.17.12	1.15.Y		
1.17.7	1.14.7.a		1.17.7.a
1.17.8	1.X	1.5.3.A	1.17.8
	1.Y		
	1.15.X		
	1.15.Y		

SPECIFICATION SECTION	SWITCHING TABLE(S) LEADING TO SECTION	TESTING TABLES	WORKING TABLES
2.3	1.X 2.X 2.Y	2.3.A	
2.4	1.X 2.X	2.4.A	2.4.3.a
2.5	1.X 2.X	2.4.A	2.5.a
2.7	1.X 2.X	2.4.A	2.7.a 2.7.b
2.9	1.X 2.X 2.Y	2.9.A	2.9.a 2.9.b

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