

Adapting the AISC Specification to Computer-Aided Design

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INITIAL APPLICATIONS of high-speed computers in structural engineering were mostly numerical or computational in nature and dealt with analysis of structures. As a result, structures are now routinely analyzed with a much higher degree of realism and accuracy than ever before. However, even though the early programs were followed by various design programs, we do not have design programs comparable in scope and generality to existing analysis programs.

There are two reasons for this lag in computer-aided design. First, the nature of the problem is decidedly more complex. While analysis consists overwhelmingly of numerical or computational operations, the design process consists predominantly of "logical" operations of checking and testing, the calculations themselves being almost trivial. General procedures for defining such logical processes are much more difficult to develop as compared to analysis procedures. Second, design processes are governed to a great extent by external constraints prescribed by the various codes and specifications. Typically, these codes and specifications are implicitly written as an aid to hand computation, and are not readily adaptable to computer applications. Verbal descriptions of the provisions of codes and specifications often require lengthy interpretation based on the user's experience and judgment. Thus, a major step towards computer-aided design can be taken by using a scheme which displays clearly and concisely the logic embodied in the specification constraints. Furthermore, the rapidly changing state of the art of structural design requires a mode of presentation capable of readily accommodating revisions.

This paper describes a general technique, called "decision logic tables," for the documentation and communication of design constraints such as those

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Table T1. Allowable Compressive Stress

	(1)	(2)	(3)	(4)	(5)	(6)
	CONDITION STUB			CONDITION ENTRY		
(1) Main Member	Y	Y	N	N	N	N
(2) $Kl/r \leq C_c$	Y	N	Y	Y	N	N
(3) $l/r > 120$	I	I	Y	N	Y	N
	ACTION STUB			ACTION ENTRY		
(1) $F_a = \text{Formula (1.5-1)}$	Y			Y		
(2) $F_a = \text{Formula (1.5-2)}$		Y				Y
(3) $F_a = \frac{F_a \text{ (by Formula (1.5-1))}}{1.6 - l/200r}$			Y			
(4) $F_a = \frac{F_a \text{ (by Formula (1.5-2))}}{1.6 - l/200r}$					Y	

provided by specifications. The adaptation of the 1969 AISC Specification¹ to this technique will be used for illustration, based on a recent study sponsored by AISC. The technique is also applicable to constraint not covered by the Specification, and computer programs using this form of the Specification can be readily incorporated into larger, overall design programs.

DECISION LOGIC TABLES

A brief description of decision tables is given in this section. References 2, 3, and 6 contain a more extended treatment. 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. Table T1, which is discussed in detail subsequently, is an example. A decision table contains four sections, as shown in this table. The *condition stub* is a list of the logical conditions involved as variables 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, as constants. Each column in the condition entry constitutes a *rule*. The elements of the condition entry ca

Table T1'. Allowable Compressive Stress (Completed)

	(1)	(2)	(3)	(4)	(5)	(6)	Result number
(1) Main Member	Y	Y	N	N	N	N	
(2) $Kl/r \leq C_c$	Y	N	Y	Y	N	N	
(3) $l/r > 120$	I	I	Y	N	Y	N	
(1) $F_a = \text{Formula (1.5-1)}$	Y			Y			1
(2) $F_a = \text{Formula (1.5-2)}$		Y				Y	1
(3) $F_a = \frac{F_a \text{ (by Formula (1.5-1))}}{1.6 - l/200r}$			Y				1
(4) $F_a = \frac{F_a \text{ (by Formula (1.5-2))}}{1.6 - l/200r}$					Y		1

have only one of three possible values, i.e., Y, N, and I, which stand for yes, no, and immaterial, respectively. 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, transferring to another table, etc. The *action entry* specifies the particular action or actions to be taken corresponding to the rule specified by the condition entry. 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.

Example—The provisions of codes and specifications are readily adaptable to representation by means of decision tables. As an example, Sect. 1.5.1.3 of the AISC Specification, dealing with the allowable stress for compression members, will be used to demonstrate this point. That section is represented by the decision table shown in Table T1, consisting of 3 conditions, 4 actions, and 6 rules, where it is assumed that if the member is not a main member, it is automatically classified as a bracing or secondary member. Suppose that the allowable stress in axial compression, F_a , is to be determined for a main member with Kl/r larger than C_c . This verbal description corresponds to values of the first two conditions in the condition stub of Y and N, respectively. The values of these conditions can now be compared with the corresponding condition entries in the various rules (columns). It is found that the first two entries of rule 2 match the values in the condition stub. The third condition entry is immaterial for a main member. Thus, rule 2 is applicable. In this rule, there is a Y in the second row of the action entry, which means that action 2 of the action stub is to be performed. This

action states that the allowable stress is to be computed by Formula (1.5-2). The reader can verify that the remaining five rules specify all of the conditions specifically stated in the text of Sect. 1.5.1.3, together with appropriate actions.

Size of Decision Tables and the ELSE Rule—Each logical condition has only two possible values, namely Y and N. Hence, there can be only two rules in a decision table with only one logical condition. Similarly, in a decision table with two logical conditions the maximum number of possible rules is four. It follows that in a table with n logical conditions, the maximum number of possible rules is 2^n . Such a table is termed a “complete” table. Complete tables occur rarely in practice, however, for the following reasons:

1. In general, not every condition affects every rule. Whenever the value of a condition has no effect on the outcome of a rule, the two possible values of Y and N can be replaced by a single entry, I, thereby conveniently reducing the size of the decision table by collapsing two rules into one.

2. Conditions are often mutually dependent. For example, in Table T1 we could have introduced two conditions: “main member” and “secondary member,” which would have been mutually exclusive, resulting only in the two valid combinations YN or NY, rather than the $2^2 = 4$ combinations (YY, YN, NY, and NN). Similarly, two tests $x \leq a$ and $x \leq b$, with a and b constant such that $a < b$ produces only three valid combinations.

3. Certain logically possible combinations are simply not covered by specific provisions. For example, Sect. 1.6 of the AISC Specification covers only two combinations, namely “compression and bending” and “tension and bending,” and omits consideration of other possible combinations, e.g., “torsion and shear.” Whereas in this case, the implication of an omission is

Table T2. Design for Allowable Compressive Stress

	(1)	(2)	(3)	(4)	(5)	(6)
(1) Main Member	Y	Y	N	N	N	N
(2) $Kl/r \leq C_c$	Y	N	Y	Y	N	N
(3) $l/r > 120$			Y	N	Y	N
(1) $F_a = \text{Formula (1.5-1)}$	Y			Y		
(2) $F_a = \text{Formula (1.5-2)}$		Y				Y
(3) $F_a = \frac{F_a \text{ (by Formula (1.5-1))}}{1.6 - l/200r}$			Y			
(4) $F_a = \frac{F_a \text{ (by Formula (1.5-2))}}{1.6 - l/200r}$					Y	
(5) $A = P/F_a$	Y	Y	Y	Y	Y	Y

clear, i.e., that the interaction need not explicitly be taken into account; there are many cases where the implication of a logical combination not specifically covered by a rule is far more difficult to ascertain.

There exists a clear-cut, unequivocal procedure for treating combinations which either violate dependencies of the type discussed under 2 above or which pertain to all rules not specifically covered in the table. This procedure consists of appending to all of the valid rules an additional rule, called the "ELSE rule." The action associated with the ELSE rule simply informs the user that the given combination of conditions does not match any of the valid rules. ELSE rules, identified by the letter E in the last column of the condition entry, appear in several of the tables presented.

USE OF DECISION TABLES

The value of the allowable stress obtained from the decision table T1 presented above could be used in one of the following ways:

1. To calculate the area of the compression member required, by dividing the given force by the allowable stress obtained from the table, or
2. To check whether a given member has sufficient area to satisfy the requirements of the allowable compressive stress.

There is an important distinction between these two uses. Whereas the first application is used in the design process, the second is used to check a given design against the provisions of the Specification. The two approaches can be termed the "design approach" and the "checking approach", respectively. In the form of decision tables, the design approach can be incorporated as shown in Table T2 and the checking approach as shown in Table T3. In the condition entry of these, and all subsequent tables, blank entries have been used whenever a condition is immaterial or not applicable, to increase readability of the table. It should be noted that in the design approach (Table T2), an *a priori* assumption must be made by the designer about the radius of gyration of the member to be designed, whereas in the checking approach no such assumption is required, since values of both r and A will have been supplied.

A comparison of Tables T1 and T3 shows that the latter has twice as many rules as the former. The problem can be handled much better in the form of two tables, with Table T1 supplying the allowable stress, F_a , and a new table, Table T4, testing the design.

Direct Execution vs. Conditional Execution—When the checking of a given design is performed in two tables, two approaches are possible. In the first approach, Table T1 is executed first, which gives a value of F_a . This value is then used by Table T4 to check the adequacy of the design. In general, all the data which could possibly be needed by a given table must be avail-

Table T3. Checking for Allowable Compressive Stress

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Main Member	Y	Y	Y	Y	N	N	N	N	N	N	N	N
(2) $Kl/r \leq C_c$	Y	Y	N	N	Y	Y	Y	Y	N	N	N	N
(3) $l/r > 120$					Y	Y	N	N	Y	Y	N	N
(4) $P/A \leq F_a \text{ (by Formula (1.5-1))}$	Y	N					Y	N				
(5) $P/A \leq F_a \text{ (by Formula (1.5-2))}$			Y	N							Y	N
(6) $P/A \leq \frac{F_a \text{ (by Formula (1.5-1))}}{1.6 - l/200r}$					Y	N						
(7) $P/A \leq \frac{F_a \text{ (by Formula (1.5-2))}}{1.6 - l/200r}$									Y	N		
(1) Size of compression member satisfactory	Y		Y		Y		Y		Y		Y	
(2) Size of compression member not satisfactory		Y		Y		Y		Y		Y		Y

Table T4. Design Check

	(1)	(2)
(1) $P/A \leq F_a$ (from Table T1)	Y	N
(1) Size of compression member satisfactory	Y	
(2) Size of compression member not satisfactory		Y

able before commencing the execution of that table. This approach has been termed *direct execution*. In the second approach, execution of Table T4 is begun, even though one of the elements needed to evaluate the conditions, namely F_a , may not be available. Then, as soon as the value of F_a is actually required, execution of Table T4 is temporarily suspended in order to execute Table T1, which generates the value of F_a . After returning from Table T1, the processing of Table T4 can be completed. This approach is called the *conditional execution* approach. The two approaches are shown diagrammatically in Fig. 1.

Direct execution schemes will often be inefficient because they may generate large amounts of data pertaining to conditions which turn out to be immaterial for the particular case being tested. As a trivial example, if direct execution is used in Table T1, l/r would have to be computed for a main member, even though the condition " $l/r \leq 120$ " turns out to be immaterial. Furthermore, future changes in the specifications and adaptations for special conditions may involve reordering of tables as much as changes in formulae. Such rearrangements can be more readily accommodated in the conditional execution approach.

TYPES OF DECISION TABLES

Three types of decision tables are needed to formulate specifications, as follows:

1. *Switching tables*, similar to the table of contents of a book, specifying which table to execute under a given situation.
2. *Testing tables*, which make the actual tests required by the specifications and generate appropriate messages. Table T4 is an example of a testing table.

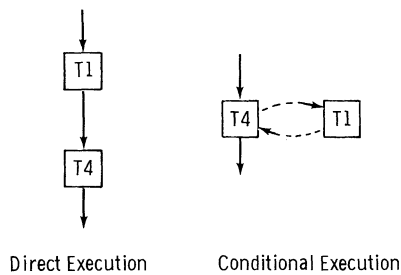


Fig. 1. Direct vs. conditional execution

Table T5. Data for Table T1

Main Member	X
K	X
l	X
r	X
E	X
F_y	X

Table T6. Data for Table T4

P , Axial Force	X	
A , Gross Area	X	
F_a , Allowable Stress		T1(1)

3. *Working tables*, which generate information to be used by other tables. For example, the allowable stress was generated by Table T1 to be used by Table T4. Thus, T1 is a working table.

These three types of tables differ primarily in the kinds of actions specified. In switching tables, the action involves transfer to a specified Table, T_k , denoted in the action stub as:

Execute Table T_k

In 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

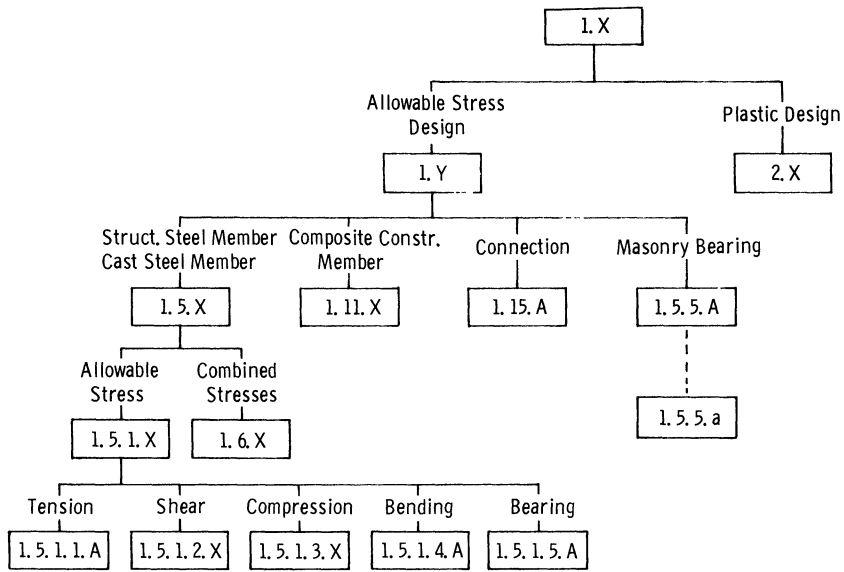
In working tables, the actions generate information which is used by testing tables. These actions are again of two kinds: they involve either setting logical values, e.g., "Sect. 1.9 satisfactory" (or not satisfactory) or calculating numerical results, such as the value of the allowable compressive stress, F_a , computed by Table T1. Where the Specification prescribes conditions on the result, e.g., "the value given by Formula X, but not larger than Y," this may be 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.

DATA REQUIREMENTS

Each decision table requires specific items of data for its execution, and a systematic procedure can be developed by listing these data along with each table. The required data are of two general types. Some items are numerical data, such as the value of the yield stress, F_y . Other items are logical data, which can only have



(Fig. 3)

Fig. 2. Initial entry

values of “yes” or “no” and which specify the presence or absence of a specific property, e.g., “Is the section symmetric about the major axis?” The data required for the execution of each table are listed preceding that table, in the following format:

Data item	Data 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 $n(m)$ indicates that the desired information is the m 'th result generated in the action stub of table n . Using this convention, the data requirements for Tables T1 and T4 are shown in Tables T5 and T6, respectively.

It will be noted that in the data for Table T4, the value of F_a is specified as result number 1 of Table T1. All four actions in Table T1 produce the same result, i.e., the appropriate value of F_a , and so, each action in this case is called result number 1. Result numbers have been shown by augmenting the action entry part of the tables by the result numbers, as shown in Table T1'.

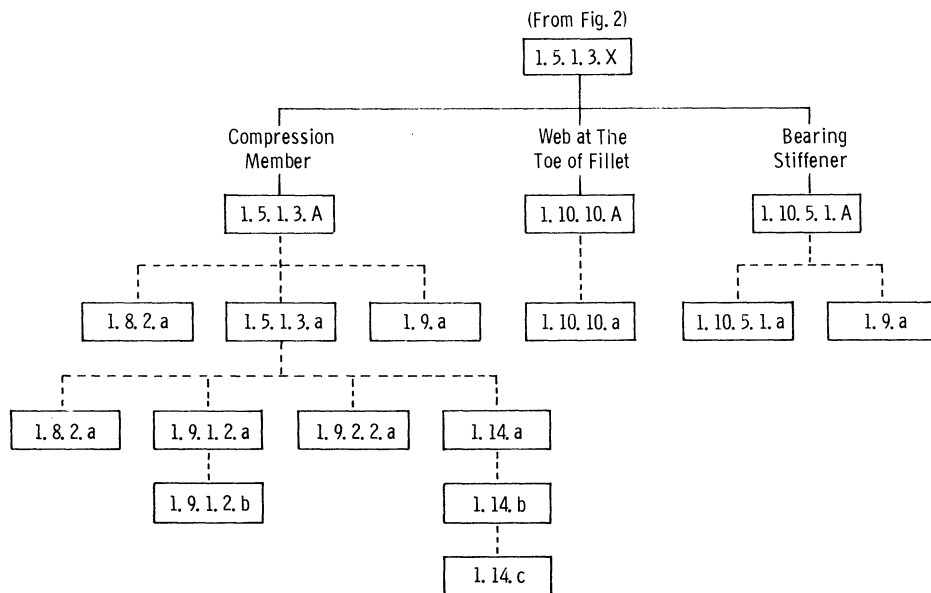


Fig. 3. Allowable stress design, compressive stresses

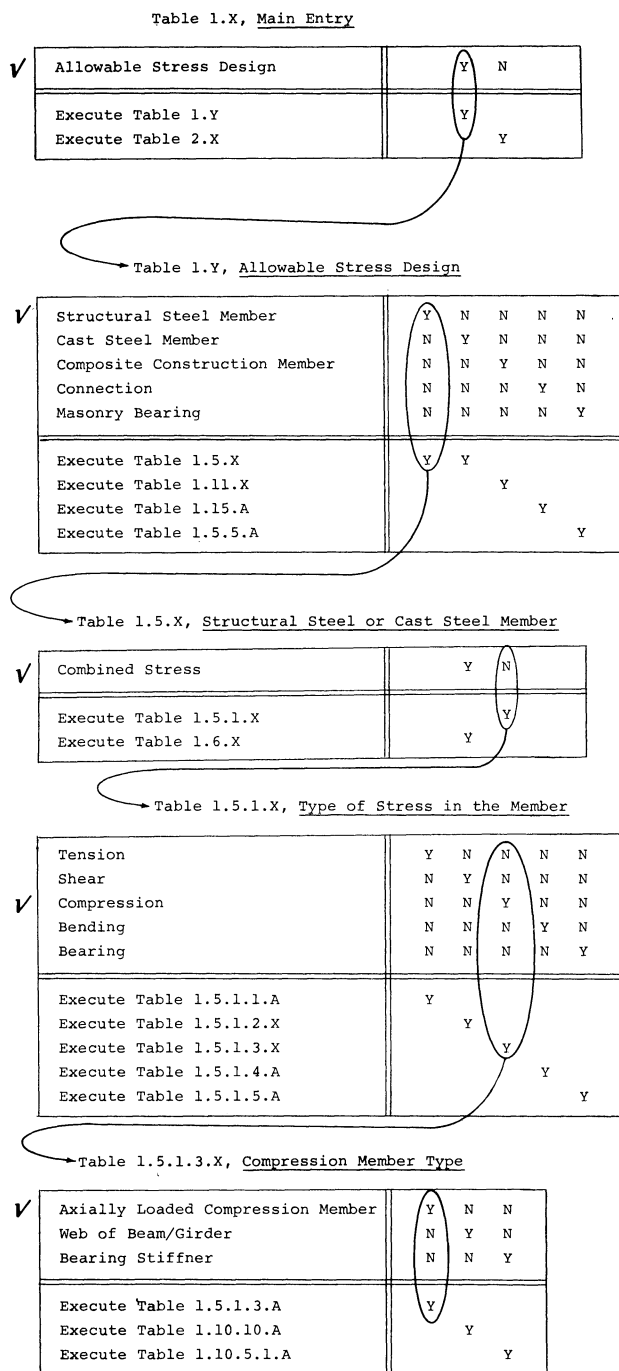


Fig. 4. Switching decision tables leading to compression members

APPLICATION TO AISC SPECIFICATION

The 1969 AISC Specification has been put in decision-table form in Reference 4. Tables for checking a member under axial compression are reproduced here, and their use illustrated by an example.

The designations assigned to each table in Reference 4 consist of two parts. The first corresponds to the section in the text of the AISC Specification to which the de-

cision 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 upper case or lower case, depending upon the type of the decision table. Thus, the last element of the table designation consists of the following:

For switching tables: a capital letter X, Y, Z, etc.

For testing tables: a capital letter A,B,C, etc.

For working tables: a lower case letter a, b, c, etc.

Figure 2 gives the general outline of the organization with direct execution represented by solid lines and conditional execution by broken lines. 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:

1. Structural steel member (Table 1.5.X)
2. Cast steel member (Table 1.5.X)
3. Composite construction member (Table 1.11.X)
4. Connection (Table 1.15.A)
5. Masonry bearing (Table 1.5.5.A)

Table 1.5.X leads to Tables 1.5.1.X and 1.6.X. The five categories of stress under Table 1.5.1.X are enumerated in Fig. 2. Thus, tension is covered in Table 1.5.1.1.A, shear in Table 1.5.1.2.X, etc. Table 1.5.1.3.X (compression) is developed further in Fig. 3. The other tables at this level are developed similarly.⁴

Structural Steel Members—A structural steel member, in general, must satisfy both stress requirements and geometrical requirements in order to satisfy the provisions of the Specification. Geometrical requirements generally mean limits on l/r ratios and provisions against local buckling in the form of b/t ratios, etc. In Reference 4, all such requirements have been grouped together in the testing tables, and must be satisfied for the design of a member to be reported satisfactory.

Example—The implementation of the decision table format for the AISC Specification will be illustrated by an example in which an axially loaded compression member is tested according to the allowable stress procedure. The column is an A36 steel W12×161 supporting a concentric load of 670 kips. It is 16 ft long and is braced against sidesway.

Normally, execution is started with Table 1.X, as shown in Fig. 4. For the allowable-stress design procedure,

TABLE 1.5.1.3.A, COMPRESSION MEMBERS

DATA REQUIRED					
(1) Section 1.9 Satisfactory				1.9.a(1)	
(2) K				1.8.2.a(1)	
(3) l		X			
(4) r		X			
(5) R_a				1.5.1.3.a(4)	
DECISION TABLE	(1)	(2)	(3)	(4)	(5)
(1) Section 1.9 Satisfactory	Y	Y	Y	Y	N
(2) $Kl/r \leq 200$	Y	Y	N	N	
(3) $R_a \leq 1.0$	Y	N	Y	N	
(1) Msg: Design Satisfactory	Y				
(2) Msg: Allowable Stress Exceeded		Y		Y	
(3) Msg: Slenderness Ratio Exceeded			Y	Y	
(4) Msg: Section 1.9 Not Satisfactory					Y

Fig. 5. Decision table for compression members

this table specifies execution of Table 1.Y. Similarly, control successively passes through switching Tables 1.5.X, 1.5.1.X, and 1.5.1.3.X to the testing Table 1.5.1.3.A. This table (Fig. 5) contains all the tests necessary to check the suitability of a compression member against the Specification requirements. The first condition to be checked is "Section 1.9 Satisfactory?" In general, this requires execution of Table 1.9. (See diagram of Fig. 3 and Tables in Figs. 8 and 9.) However, the W12X161 is known to satisfy these local-buckling requirements for A36 steel (*AISC Manual*, Seventh

Edition, Table I, pg. 3-11). Therefore, the value of this condition is taken to be Y. To evaluate the second condition in Table 1.5.1.3.A, namely " $Kl/r \leq 200$ " one of the data elements needed is the effective-length coefficient K , which is not known, but is noted under "Data Required" as being obtainable as a result number (1) of Table 1.8.2.a. Hence, execution of Table 1.5.1.3.A is temporarily suspended and that of Table 1.8.2.a (Fig. 6) is begun. This table has five conditions. Values of the first four of these conditions for the problem at hand are, respectively, Y, N, Y, N. These values match

TABLE 1.8.2.a, K FOR COMPRESSION MEMBERS

DATA REQUIRED										
Main Member										X
Bearing Stiffener										X
Sidesway Prevented										X
K Provided by Rational Analysis										X
K_p (value provided)										X
l										X
r										X
DECISION TABLE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	Result number
(1) Main Member	Y	Y	Y	Y	N	N	N	N	E	
(2) Bearing Stiffener	N	N	N	N	N	N	Y	Y		
(3) Sidesway Prevented	Y	Y	N	N						
(4) K Provided by Rational Analysis	Y	N	Y	N		Y	Y	N		
(5) $l/r > 120$					Y	N				
(1) $K = 1.0$		Y			Y					1
(2) $K = K_p$	Y					Y				1
(3) $K = \text{Max}(0.75, K_p)$							Y			1
(4) $K = \text{Max}(1.0, K_p)$			Y							1
(5) Msg: K should be provided by Rational Analysis				Y				Y		
(6) Else Rule									Y	

Fig. 6. Decision table for K for compression members

TABLE 1.5.1.3.a, COMPRESSION (AXIALLY LOADED MEMBERS)

DATA REQUIRED							
Main 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								Result number
	(1)	(2)	(3)	(4)	(5)	(6)		
(1) Main Member	Y	Y	N	N	N	N		
(2) $Kl/r \leq C_c$	Y	N	Y	Y	N	N		
(3) $l/r > 120$			Y	N	Y	N		
(1) $f_a = P/A_g$	Y	Y	Y	Y	Y	Y	1	
(2) $F_a = \text{Formula (1.5-1)}$	Y		Y	Y			2	
(3) $F_a = \text{Formula (1.5-2)}$		Y			Y	Y	2	
(4) $F_{as} = \text{Formula (1.5-3)}$			Y		Y		3	
(5) $R_a = f_a/F_a$	Y	Y		Y		Y	4	
(6) $R_a = f_a/F_{as}$			Y		Y		4	

Fig. 7. Working table for axially loaded compression members

those in rule 2. Condition number 5 is immaterial for this rule. Hence rule 2 is the governing rule and the applicable action in this rule gives $K = 1$. With this information, execution of Table 1.5.1.3.A, which was under temporary suspension, is resumed.

For condition 2 in Table 1.5.1.3.A, $Kl/r = 1 \times 192/3.20 = 60$, which is less than 200. Thus, the value of this condition is Y. For evaluating condition 3, the necessary data element is R_a , the ratio of the actual to the allowable stress in the member. This is obtained by executing Table 1.5.1.3.a (Fig. 7). Thus, execution of Table 1.5.1.3.A is again temporarily suspended.

It will be noted that Table 1.5.1.3.a is written for the general case; that is, it covers compression members which meet the limiting b/t ratios of Sect. 1.9 as well as those which do not. The latter are treated in Appendix C of the Specification. The two cases are combined in order to avoid repeating certain tables, which would have been necessary had the post-buckling case been treated separately. In the large majority of cases, rolled structural shapes will satisfy Sect. 1.9, in which case Q_s and Q_a are known to be unity and the execution of Tables 1.9.2.2.a and 1.9.1.2.a called for under "Data Required" in Table 1.5.1.3.a is unnecessary.

TABLE 1.9.a, LOCAL BUCKLING

DATA REQUIRED								
Unstiffened Element(s)				X				
Stiffened Element(s)				X				
Checks Sect. 1.9.1.2						1.9.1.2.a(1)		
Checks Sect. 1.9.2.2						1.9.2.2.a(1)		

DECISION TABLE									Result number
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
(1) Unstiffened Element	Y	Y	N	N	Y	Y	Y	Y	
(2) Stiffened Element	N	N	Y	Y	Y	Y	Y	Y	
(3) Checks Sect. 1.9.1.2	Y	N			Y	Y	N	N	
(4) Checks Sect. 1.9.2.2			Y	N	Y	N	Y	N	
(1) Section 1.9 Satisfied	Y		Y		Y				1
(2) Section 1.9 Not Satisfied		Y		Y		Y	Y	Y	1

Fig. 8. Decision table for local buckling requirements

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										Result number
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	
(1) Flanges of Square/Rectangular Section	Y	Y	Y	N	N	N	N	N	N	E
(2) Perforated Cover Plate	N	N	N	Y	Y	N	N	N		
(3) $\frac{b}{t} \leq 238/\sqrt{F_y}$	Y	N	N							
(4) $\frac{b}{t} \leq 317/\sqrt{F_y}$				Y	N					
(5) $\frac{b}{t} \leq 253/\sqrt{F_y}$						Y	N	N		
(6) Use of Appendix C Desired		N	Y				N	Y		
(1) Checks Sect. 1.9.2.2	Y		Y			Y		Y		1
(2) Does not check Sect. 1.9.2.2.		Y		Y	Y		Y			1
(3) $b_e = b$	Y					Y				2
(4) $b_e = \min \left[\frac{253t}{\sqrt{f}} \left(1 - \frac{50.3}{(b/t)\sqrt{f}} \right) \leq b \right]$			Y							2
(5) $b_e = \min \left[\frac{253t}{\sqrt{f}} \left(1 - \frac{44.3}{(b/t)\sqrt{f}} \right) \leq b \right]$								Y		2
(6) Contribution to effective area = $b_e t$	Y		Y			Y		Y		3
(7) Msg: Unstiffened Compression Element Not Satisfactory		Y		Y	Y		Y			
(8) ELSE Rule									Y	

Fig. 9. Working table for local buckling of stiffened compression elements

For the problem under investigation, the value of condition 1 in Table 1.5.1.3.a is Y. For evaluating condition 2, K is specified as obtainable by executing Table 1.8.2.a, but this has already been done at this point and K is known to be unity. Thus, $Kl/r = 60$, as previously. Computation of C_c requires values of data elements Q_s and Q_a . In this case, Q_s and $Q_a = 1$, and Tables 1.9.2.2.a and 1.9.1.2.a are by-passed, as was mentioned above. With these values of Q , $C_c = 126$ and condition 2 in Table 1.5.1.3.a is answered Y. Therefore, the first two conditions in the table are Y and Y. These match rule 1. Condition 3 is immaterial, so that rule 1 applies. The action entries in this rule indicate that action numbers 1, 2 and 5 must be executed in sequence. It should be noted that action 1 requires the gross area, A_g , which is specified as obtainable by executing Table 1.14.a. In this case, however, the tabulated value of A_g may be used, so that the conditional execution of Table 1.14.a can be by-passed.

The actions can now be evaluated:

Action 1: $f_a = 670/47.38 = 14.15$

Action 2: $F_a = \text{Formula (C5-1) with } Q_s = 1 \text{ and } Q_a = 1$

$$= \frac{36 \left\{ 1 - \frac{1}{2} \left(\frac{60}{126} \right)^2 \right\}}{\frac{5}{3} + \frac{3}{8} \times \frac{60}{126} - \frac{1}{8} \left(\frac{60}{126} \right)^3}$$

$$= 17.43$$

Action 5: $R_a = f_a/F_a$

$$= 0.812$$

This completes execution of Table 1.5.1.3.a, thus allowing restart of Table 1.5.1.3.A at the point where it was interrupted, i.e., at evaluation of condition 3. Since $R_a = 0.812$ is less than 1.0, this condition is equal to Y.

Thus, the condition vector in Table 1.5.1.3.A is (Y, Y, Y) which matches rule 1, and the corresponding action is the message "Design Satisfactory," which indicates that all the requirements specified for a compression member have been met.

In summary, the execution of this simple example required two interruptions of Table 1.5.1.3.A, in order to conditionally evaluate K and R_a . In a more complex cross-section, additional interruptions would have been necessary to evaluate A_g and to check Sects. 1.9, 1.9.1.2, and 1.9.2.2.

COMPUTER IMPLEMENTATION

It should be pointed out that decision tables are not programs by themselves, but merely convenient forms of documentation of logical conditions and their combinations. However, the clear and systematic display of all the logical conditions along with the consequent actions provided by the tabular representation makes them especially amenable to computer implementation. Formal techniques for converting decision tables into optimal programs are discussed in Refs. 2, 3, and 6. In addition, a computer implementation particularly aimed at specification checking, using the conditional execution approach as outlined in this paper, is available in Reference 5. This particular implementation uses the 1969 AISC Specification. However, the program is quite general and can accept any specification presented in the form of decision tables. The only requirement is that the evaluation of conditions and actions be programmed.

CONCLUSION

This paper has attempted to show the value of decision logic tables as a tool for representation of specifications. The decision table formulation results in a concise and unambiguous description of specification provisions. This technique is helpful not only for computer implementation of the structural design process, but also for the interpretation and communication of the intent and meaning of specifications. Decision table formulation can also be a powerful aid in the preparation of future editions of specifications, by facilitating a more logical functional organization and for ascertaining whether all relevant situations have been accounted and provided for.

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