

USING SPREADSHEETS FOR STEEL DESIGN

The AISC Database can easily be linked to a design spreadsheet to simplify repetitive calculations



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SPREADSHEETS HAVE BECOME NEARLY **UBIQUITOUS** among structural engineers because of the ease with which repetitive calculations can be done for a series of variables. When a design spreadsheet needs information for different steel sections, the most efficient way to get this information is to link the design spreadsheet to the AISC Database, which is available for \$60 in either U.S. or metric units (call 312-670-5444).

This database stores the dimensions and properties for each steel section listed in the *Manual of Steel Construction*. Accessing it allows for automatic lookup and input of data that would otherwise need to be physically referenced and entered into a spreadsheet. This simple automation process will allow a job to be done faster and will lower the possibility for errors to occur. Only a section's designation needs to be entered into a design spreadsheet, which can be programmed to retrieve the necessary information from the database.

Procedure

Although there are many ways of using the database, one easy way is to use Microsoft's Excel 97—a procedure which is outlined below. (A modest amount of Excel knowledge is needed to follow this procedure. To become more familiar with Excel, an excellent reference book is *Excel for Scientists and Engineers* by William J. Orvis.) Although this procedure is for Excel 97, a similar procedure can easily be developed for Lotus 1-2-3 or Quattro Pro spreadsheets.

There are three necessary steps that need to be completed before the database can be accessed from a design spreadsheet. The steps include the following:

1. Loading the database into an Excel

spreadsheet.

2. Modifications to the database spreadsheet.
3. Linking your design spreadsheet to the database spreadsheet.

Step 1: Loading the Database into an Excel Spreadsheet

AISC provides the database in an ASCII text format. However, to be able to load the database into a spreadsheet, it must first be converted into what is called a comma-delimited text file. AISC includes the program CONV123 on the database disk to complete the conversion.

The procedure to convert the ASCII text format database to a comma-delimited text file is described on page 7 of AISC's document readme.doc included on the database disk. Print and read this document. The steps below further expand on AISC's procedure. It should be noted that Windows 95 is used in the following procedure:

1. Insert AISC's disk into drive A:
2. From Windows, select **Start, Program, MS-DOS prompt**.
3. Change to the A: prompt. At the MS-DOS prompt, type **A: <Enter>**.
4. Load AISC's basic program. Type **Basic/S:256 <Enter>**.
5. Load AISC's file to complete the conversion. Type Load **"A:CONV123" <Enter>**
6. Run AISC's conversion file. Type **Run <Enter>**
7. When the conversion is complete, the basic program will automatically return to the MS-DOS prompt.
8. Exit the MS-DOS prompt. Type **Exit <Enter>**

The above procedure creates the database comma-delimited text files Aisc1.prn and Aisc2.prn on the AISC disk. These files can be imported into Excel 97. The file Aisc1.prn contains

data for W, M, S, WT, MT, ST, C, MC and HP shapes. The file Aisc2.prn contains data for angle, double angle, HSS and pipe shapes. Only the file Aisc1.prn will be further discussed below. However, the same procedure can be used for Aisc2.prn.

To load Aisc1.prn into an Excel 97 spreadsheet the following steps are needed:

1. Start Excel 97
2. Choose the commands **File, Open**.
3. The File Open dialog box will appear. At the File of type drop down list box, select **All Files (*.*)**
4. At the File name box type **a:**
<Enter>
5. The files on drive A: will appear. Double click on the file **Aisc1.prn**.
6. Next, Excel's Text Import Wizard appears to import the file. The Text Import Wizard contains three steps. These steps are the following:
 - a. In the original data type box, select the **Delimited** file type then click to the next window.
 - b. In the delimiter box, select the **Comma** delimiter then click to the next window.
 - c. In the Column data format box, select the **General** column data format. Click on finish to import the file.
7. Now that the text file is imported, it can be saved as an Excel 97 workbook. Choose the commands **File, Save As**.
8. The File Save dialog box will appear. At the Save as type drop down list box, select **Microsoft Excel Workbook (*.xls)**
9. At the File name box, type the workbook name and directory where you want to store the database spreadsheet. For example, type **c:\aisc\Aisc_database** and click on **Save**.

The Conversion of the database to a spreadsheet is now completed.

Step 2: Modifications to the Database Spreadsheet

Before the database spreadsheet can be accessed from your design spreadsheet, one slight modification needs to be made. Each section's designation must be added to the database spreadsheet.

This modification to the database spreadsheet is needed to create the link

	A	B	C	D
1	=B1&C1&"x"&D1	W	44	335
2	=B2&C2&"x"&D2	W	44	290
3	=B3&C3&"x"&D3	W	44	262
4	=B4&C4&"x"&D4	W	44	230
5	=B5&C5&"x"&D5	W	40	593
6	=B6&C6&"x"&D6	W	40	503
7	=B7&C7&"x"&D7	W	40	431
8	=B8&C8&"x"&D8	W	40	372
9	=B9&C9&"x"&D9	W	40	321
10	=B10&C10&"x"&D10	W	40	297
11	=B11&C11&"x"&D11	W	40	277
12	=B12&C12&"x"&D12	W	40	249
13	=B13&C13&"x"&D13	W	40	215

W44x335	W	44	335
W44x290	W	44	290
W44x262	W	44	262
W44x230	W	44	230
W40x593	W	40	593
W40x503	W	40	503
W40x431	W	40	431
W40x372	W	40	372
W40x321	W	40	321
W40x297	W	40	297
W40x277	W	40	277
W40x249	W	40	249
W40x215	W	40	215

The database can be easily modified as demonstrated in Figure 1 (above) and Figure 2 (left).

between your design spreadsheet and the database spreadsheet. Before the two spreadsheets can be linked (following this procedure), they must have common values that can be cross-referenced. The most practical common values to use are the section designations. Although AISC's database does not list each particular section designation, it does list each section's shape, the nominal depth, and weight per foot. These values can be joined to create the section designations.

It is noted that usually any modifications to any computer software are undesirable. However, for this particular case, the benefits of modification far outweigh the cons. Complete the following modification to the database spreadsheet:

1. In the database spreadsheet, insert a new column A (i.e. click on a cell in column A and then select the **Insert, Column** command).
2. In cell A1 type the command **=B1&C1&"x"&D1** and copy it down the column. One possible way to copy this command is the following:
 - a. Click on the cell (A1) to be copied.
 - b. Select the **Edit, Copy** command.
 - c. Drag vertically to the end of

Figure 3

NOTE: This is a RASIT text file containing the AISC Database information. The same general types of structural shapes covered in the database are included.

TYPE	DESCRIPTION	NO.
1	W, M, L, and CIP shapes	1 to 322
2	C and MC shapes (channels)	666 to 676
3	WT, WTJ, and WT shapes (tees)	140 to 141
4	L, PL, and FL shapes (plate angles), double angles, and structural submittals	67 to 122
5	I, IO, and IOJ shapes (I-beams)	122 to 126

Shape availability is listed in the AISC Manual of Steel Construction and updated in the Forming and Erection Manual of Modern Steel Construction respectively.

Dimensions and properties for each shape are listed sequentially in a single file containing 240 characters per line, with a total of 240 lines per shape. The file format is as follows:

COL 1	SECTION'S DESIGNATION	NO. OF	SEQUENCE	FORM
1	2	3	4	5
COL 1	SECTION'S DESIGNATION	NO. OF	SEQUENCE	FORM
COL 2	W44	335	1	FA
COL 3	W40	319	2	FA
COL 4	W36	307	3	FA
COL 5	W33	295	4	FA
COL 6	W30	283	5	FA
COL 7	W27	271	6	FA
COL 8	W24	259	7	FA
COL 9	W21	247	8	FA
COL 10	W18	235	9	FA
COL 11	W16	223	10	FA
COL 12	W14	211	11	FA
COL 13	W12	199	12	FA
COL 14	W10	187	13	FA
COL 15	W8	175	14	FA
COL 16	W6	163	15	FA
COL 17	W4	151	16	FA
COL 18	W2	139	17	FA
COL 19	W1	127	18	FA
COL 20	W1/2	115	19	FA
COL 21	W1/4	103	20	FA
COL 22	W1/8	91	21	FA
COL 23	W1/16	79	22	FA
COL 24	W1/32	67	23	FA
COL 25	W1/64	55	24	FA
COL 26	W1/128	43	25	FA
COL 27	W1/256	31	26	FA
COL 28	W1/512	19	27	FA
COL 29	W1/1024	7	28	FA
COL 30	W1/2048	5	29	FA
COL 31	W1/4096	3	30	FA
COL 32	W1/8192	1	31	FA
COL 33	W1/16384	1	32	FA

accessed. The database spreadsheet can be accessed from within your design spreadsheet using Excel's *VLOOKUP(lookup_value,table_array,col_index_num,range_lookup)* command and the database document *Readme.doc*. In the document *Readme.doc*, it lists the columns of the database that each shape property is stored. For instance, from this document it can be seen that a section's weight is in the fourth column of the database spreadsheet since "WGT" is the third variable listed. It should be noted that the weight, "WGT", is now in the fourth column in lieu of the third column since one was added. (See **Figure 3**.)

To illustrate how to use the *VLOOKUP* command, the following is an example of what would be input into your design spreadsheet in order to get a section's depth:

=VLOOKUP(A1,'C:\aisc\[Aisc_database.xls]AISC1'!\$A\$1:\$AN\$676,7,FA LSE)

Where:

1. A1 - is the cell address in your design spreadsheet that has the *vlookup_value* (i.e. section designation) which will be referenced in the database spreadsheet. This could be any cell address.
2. 'C:\aisc\ - is the path to the file where the database spreadsheet is stored. This path may vary depending on where you store the database spreadsheet on your computer.
3. [Aisc_database.xls] - is the database spreadsheet (i.e. source workbook) name. Note that this name must be in square brackets.
4. AISC1 - is the worksheet name that is to be referenced. It should be noted that AISC has renamed the default worksheet name, Sheet1, to AISC1. The worksheet name must be followed by an exclamation point.
5. \$A\$1:\$AN\$676 - is the range in which all information in the database spreadsheet is stored. For more efficiency, this range could be changed for each different shape. For instance, if only information for W-Sections were needed, the range could be changed to \$A\$1:\$AN\$268. This reduced range is the range where only information for the W-Sections is stored. (Note, the "\$" is used so that the range listed will not change as the command is copied to

the range where this cell is to be copied (i.e. to cell A676).

3. Save the revised database spreadsheet (i.e. **File, Save**).

The command in item 2 above joins the contents of columns B, C and D (the section's shape, nominal depth and weight per foot) of the database spreadsheet into one text string and inserts an "x" between the values in column C and D. In the first row of the database spreadsheet, this command should give W44x335 (the section's designation). **Figures 1 and 2** show an illustration of this command and a revised portion of the database spreadsheet.

Step 3: Linking your design spreadsheet to the database spreadsheet

Now that the database conversion process has been completed, the database spreadsheet is ready to be

Table 1.				
Deflection of Simply Supported Beams, in.				
Beam	w lbs/ft	L ft	I_x in. ⁴	Deflection, Δ in.
W12x19	1.15	20	=VLOOKUP(A16,C:\mscd\Aisc_database.xls)AISC11\$A\$1:\$AN\$288,25,FALSE	=5*B16^4*C16^4*12^3/(384*E*D16)
W16x31	1.4	30	=VLOOKUP(A17,C:\mscd\Aisc_database.xls)AISC11\$A\$1:\$AN\$288,25,FALSE	=5*B17^4*C17^4*12^3/(384*E*D17)
W21x44	1.1	40	=VLOOKUP(A18,C:\mscd\Aisc_database.xls)AISC11\$A\$1:\$AN\$288,25,FALSE	=5*B18^4*C18^4*12^3/(384*E*D18)
W24x55	1	50	=VLOOKUP(A19,C:\mscd\Aisc_database.xls)AISC11\$A\$1:\$AN\$288,25,FALSE	=5*B19^4*C19^4*12^3/(384*E*D19)
Notes:				
E= 29000 ksi				

- other cell locations.)
- 7 - is the number of cells horizontally from the lookup_value cell (in the database spreadsheet) that stores the value that will be returned to your design spreadsheet. If this number were 1, then the lookup_value itself would be returned. Since the number for this case is 7, the section's depth will be returned since it is 7 cells horizontally from the cell where the section's designation is stored.
 - False - is used so that the VLOOKUP command will only work if an exact match is found. The exact section designation input into your design spreadsheet must match a section designation in the database spreadsheet or an error message (#N/A) will occur. It should be noted that Excel does not differentiate between capital and lower case letters. Hence, a W24X55 is the same as w24x55.

The VLOOKUP command links your design spreadsheet to the database spreadsheet. Now, when you open your design spreadsheet, a message will appear asking if you want to update the link. (This message only appears when the database file is not opened.) Click on "Yes" or "No" and continue. It should be noted that the database spreadsheet does not need to be opened for the VLOOKUP command to retrieve data.

Example

To illustrate the above steps, **Figures 4 and 5** show a simple design spreadsheet that determines the deflection of simply supported beams. The design spreadsheet is programmed to go into the database spreadsheet and get the moment of inertia, I_x , for W shaped beams. It will then calculate $5*w*L^4/(384EI_x)$ to determine the deflection of the beam. **Figure 4** shows the actual design spreadsheet com-

Table 1.				
Deflection of Simply Supported Beams, in.				
Beam	w lbs/ft	L ft	I_x in. ⁴	Deflection, Δ in.
W12x19	1.15	20	130	1.10
W16x31	1.40	30	510	1.73
W21x44	1.10	40	843	2.59
W24x55	1.00	50	1350	3.59
Notes:				
E= 29000 ksi				

mands while **Figure 5** shows the final design spreadsheet printout.

Conclusion

The design spreadsheet in **Figures 4 and 5** is a simple example to illustrate how useful the database can be for very simple or complex spreadsheets. Once a design spreadsheet is programmed, a user only needs to input a section designation and the spreadsheet will determine the other desired information. This can be done quickly and accurately for a series of steel sections making spreadsheets a very powerful design tool.

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Figure 4 (above) shows the actual design spreadsheet commands while **Figure 5** (left) shows the final design spreadsheet printout.