AUTOMATING THE SAP2000 VERIFICATION CHECKING PROCESS

Overview

The automated procedure for running the SAP2000 verification check uses Visual Basic for Applications subroutines in specially prepared Excel files. The subroutines run the SAP2000 models, process the results, and compare the results with the published verification values. The Excel files are named *SAP2000_Verification_xxx.xls*, *SAP2000_Verification_SFD_xxx.xls*, and *SAP2000_Verification_CFD_xxx.xls* for analysis, steel frame design, and concrete frame design, respectively. The xxx is a sequence of numbers (e.g., 909) indicating the version of the SAP2000 program (e.g., version 9.0.9) from which the comparison results in the Excel files were obtained.

Successful completion of the automated check using the Excel Visual Basic for Applications subroutines requires that you have both Microsoft Excel and Microsoft Access. Microsoft Access is run automatically (in the background) by the Microsoft Excel verification subroutines.

If desired, instead of running the verification examples using Excel, they can be run directly from SAP2000 using a batch file. If this method is used then only the comparison of results is done using the Excel file. The advantage to running the models using a batch file is that the verification will run faster. Running the models using the Excel file is slower because Excel has to open and close SAP2000 for each model whereas the batch file method starts out with SAP2000 open and never has to close or reopen it.

Important Note: The SAP2000 verification models (*.sdb files) must be exactly as they were issued, with no user modifications. Otherwise the automated procedure may not work as intended. If any doubt exists as to whether the verification models have been modified, get the verification files from a fresh SAP2000 installation or the SAP2000 DVD. See step 1 in the following section.

Important Note: All of the verification examples will run in the Ultimate version of SAP 2000. Some of the examples will not run in the Basic, Plus, or Advanced versions of the program.

Steps for Automation if Analyses Are Run Using the Excel File

Use the following steps to perform the verification and check when the models are run using the Excel file:

1. Choose or create a directory where the verification problems are to be run. For the purposes of these instructions, we will call that new directory C:\MyDir.

2. Delete all files in the C:\MyDir directory, if any.

3. From the SAP2000 Verification subdirectory where SAP2000 was originally installed, copy all files into the C:\MyDir directory.

   - If the files in your SAP2000 Verification subdirectory have been modified since they were installed, copy the files from the Verification directory on your SAP2000 DVD or from a fresh installation. After copying the files into C:\MyDir, be sure to select all files using Windows Explorer and then click the **File menu > Properties** command (in Windows Explorer) and turn off the Read Only attribute.

4. Open one of the three previously mentioned Excel files located in the subfolders of the C:\MyDir directory. Be sure that macros are enabled when you open the file.

5. In the Excel file go to the worksheet named "Verification Control" and do the following:

   a. Set the path to the Sap2000.exe file in cell C3. If the full path to this file is C:\Program Files\Computers and Structures\Sap2000\ Sap2000.exe then cell C3 should contain C:\Program Files\ Computers and Structures\Sap2000\Sap2000.exe. An easy way to set this path is to click the **Browse for Sap2000.exe** button, locate the SAP2000.exe file and click **Open**. The correct path for the selected file will be filled in cell C3.

   b. Check that the path to the *.sdb files in cell C4 is C:\MyDir. If it is not, type in the path to C:\MyDir or click the **Set Path to Location of Excel File** button, which will automatically fill in cell C4 with the path to C:\MyDir as long as the Excel file is located in C:\MyDir.

    c. In cell E2 set the equation solver option as either **Default**, **Force Standard** or **Force Advanced**. The **Default** option allows the program to select the appropriate solver for the problem. The **Force Standard** option forces the program to use the Standard solver. The **Force Advanced** option forces the program to use the Advanced solver. Note that the Advanced solver requires the Advanced version of SAP2000. If you specify **Force Advanced** and do not use the advanced version of the SAP2000 then the Standard solver will be used. We recommend that you use **Default** for this option.

    d. In cell E3 set the option to delete analysis files. This item can be **Yes** or **No**. We recommend using **Yes**.

    e. In column D indicate which problems are to be automatically run. A Yes in this column means the model is automatically run and No means it is not run. The **Set All To Be Run** and **Set All To Not Be Run** buttons can be useful when filling this column.

    f. In column E indicate which problems are to be checked. A Yes in this column means the model is checked and No means it is not checked. The **Set All To Be Checked** and **Set All To Not Be Checked** buttons can be useful when filling this column.

6. Click the **Run Verification Check** button to start running the models and performing the verification checks. If the models are run the entire verification may take several hours to complete. If only the checks are performed then they may take several minutes to complete. A progress report form indicates the example that the program is currently analyzing or checking. A summary message box appears when the verification process is complete.

- If desired, before clicking the **Run Verification** button, click the **Clear Verification Check** button to clear and reset any verification check items that the Visual Basic for Applications subroutine may have previously written to the Excel file. This step is not necessary because it occurs automatically when the **Run Verification** button is clicked. However, use of the **Clear Verification Check** button clearly illustrates which items are filled by the Visual Basic for Applications subroutine.

Steps for Automation if Analyses Are Run Using Batch File in SAP2000

Use the following steps to perform the verification analyses and check when the analyses are run using the batch file analysis capability in SAP2000:

1. Choose or create a directory where the verification problems are to be run. For the purposes of these instructions, we will call that new directory C:\MyDir.

2. Delete all files in the C:\MyDir directory, if any.

3. From the SAP2000 Verification subdirectory where SAP2000 was originally installed, copy all files into the C:\MyDir directory.

    - If the files in your SAP2000 Verification subdirectory have been modified since they were installed, copy the files from the Verification directory on your SAP2000 DVD or from a fresh installation. After copying the files into C:\MyDir, be sure to select all files using Windows Explorer and then click the **File menu > Properties** command (in Windows Explorer) and turn off the Read Only attribute.

4. Start SAP2000. When the program comes up, click the **File menu > Batch File Control** command.

5. In the Batch File Control form, click the **Browse for Existing Batch Files** button in the upper left corner of the form. Locate and open the desired batch file from a subfolder of the C:\MyDir directory.

    - If the path name is not correct for the files (it should be pointing to C:\MyDir), click the **Change Filename Path** button in the lower left corner of the form to open the Batch File Path form.

        In the Batch File Path form, make sure the Change the Path of All Files option is selected. Then click the **Select Path** button, select the path to C:\MyDir, and click **OK** to return to the Batch File Control form. The path names in the Batch File Control form should now be pointing to C:\MyDir.

6. Click the **Run Models In Current Batch File List** button in the upper right corner of the form to automatically run all of the verification problems.

7. After the verification problems have been successfully run (this may take several hours), open the Excel file located in the same folder as the batch file. Go to the worksheet named "Verification Control" and do the following:

    a. Check that the path to the *.sdb files in cell C4 is C:\MyDir. If it is not, type in the path to C:\MyDir or click the **Set Path to Location of Excel File** button, which will automatically fill in cell C4 with the path to C:\MyDir as long as the Excel file is located in C:\MyDir.

    b. In column D set the Run This Problem item to No for each problem. Clicking the **Set All To Not Be Run** button will automatically accomplish this item.

    c. In column E indicate which problems are to be checked. A Yes in this column means the model is checked and No means it is not checked. The **Set All To Be Checked** and **Set All To Not Be Checked** buttons can be useful when filling this column.

7. Click the **Run Verification Check** button to perform the verification checks. This will take several minutes to complete. A progress report form indicates the example that the program is currently checking. A summary message box appears when the verification process is complete.

- If desired, before clicking the **Run Verification** button, click the **Clear Verification Check** button to clear and reset any verification check items that the Visual Basic for Applications subroutine may have previously written to the Excel file. This step is not necessary because it occurs automatically when the **Run Verification** button is clicked. However, use of the **Clear Verification Check** button clearly illustrates which items are filled by the Visual Basic for Applications subroutine.

Automated Verification Results

The automated verification results are all compiled in the respective Excel file. The summary of the results is provided on the worksheet named "Verification Control."

Cell C2 reports the version of SAP2000 from which the published SAP2000 results were obtained.

Cell C5 reports the date and time that the last check was performed.

Column F on the Verification Control worksheet reports the problem status. This is either Not Checked, meaning that the considered problem has not been checked, or it is the maximum percent difference between any published result obtained from the Sap2000 version specified in cell C2 and the result obtained for the verification. The percent difference for each item considered is calculated as:

$$Percent\ Difference = 100 * \frac{Verification\ Re\,sult - Published\ Re\,sult}{Published\ Re\,sult}$$

Columns G and H on the Verification Control worksheet report the program version (e.g., 8.1.2) and level (e.g., Advanced) that was found in the Program Control table in the *.mdb files for a particular problem. Note that if all of the *.mdb files for an example problem do not report the same program version then the Column F item is reported as Varies. If all of the *.mdb files do not report the same program level then the Column G item is reported as either Varies - Plus or Varies – Basic, where the Plus or Basic indicates the lowest reported program level found in the *.mdb files for that example problem.

In addition to the summary of the check results shown on the Verification Control worksheet, detailed results for each example are shown on separate worksheets with the example name.

The example worksheets typically consist of five or more columns filled with data, then a blank column, and then another four columns filled with data. The following figure shows a typical example.

Results Published in the Current Verification Examples						Results From Current Analyses			
Load Case	Output Parameter	SAP2000	Independent	Percent Difference		SAP2000 Result	Number of Decimal Places	Result for Comparison	% Diff From Version 9.09
1	Uz (jt. 3) (in)	-0.02639	-0.02639	0.00%		-0.02639	5	-0.02639	0.00000%
2	Uz (jt. 3) (in)	0.06296	0.06296	0.00%		0.06296	5	0.06296	0.00000%
3	Uz (jt. 3) (in)	0.06296	0.06296	0.00%		0.06296	5	0.06296	0.00000%
4	Uz (jt. 3) (in)	-0.29630	-0.29630	0.00%		-0.29630	5	-0.2963	0.00000%
5	Ux (jt. 2) (in)	0.31250	0.31250	0.00%		0.31250	5	0.3125	0.00000%
6	Ux (jt. 2) (in)	0.11556	0.11556	0.00%		0.11556	5	0.11556	0.00000%
7	Ux (jt. 2) (in)	0.00651	0.00651	0.00%		0.00651	5	0.00651	0.00000%

The first five or more columns show the verification results as they are published in the current verification examples. The formatting may in some cases be different from the published tables, but the data is the same.

The last four columns are related to the results obtained from the current results. The column labeled *SAP2000 Result* is automatically filled by the Excel macro that is run, as described in the previous section.

The *Number of Decimal Places* column reports the number of decimal places that are used for the comparison. It is equal to the number of decimal places used in the published results.

The values in the *Result for Comparison* column are the values in the *SAP2000 Result* column rounded to the number of decimal places indicated in the *Number of Decimal Places* column.

The *% Diff From Version xxx* column shows the percent difference between the published Sap2000 result and the result obtained for the verification. The percent difference is calculated as:

$$Percent\ Difference = 100 * \frac{Verification\ Result - Published\ Result}{Published\ Result}$$

Important: You should not edit anything in the Excel files except for cells C3 and C4 and Columns D and E on the Verification Control worksheet.