12.7.8 Displaying *X–Y* plots of viscoelastic material behavior

Abaqus/CAE allows you to evaluate viscoelastic material behavior by creating either relaxation and creep curves (for Prony series coefficients, relaxation test data, or creep test data) or shear and bulk modulus curves (for frequency data) based on the material definition. When the curve fitting is complete, Abaqus/CAE opens the Visualization module and displays *X–Y* plots of the test results and a dialog box containing the material parameters. You can review the results and adjust the material as necessary. For more information, see "Evaluating hyperelastic and viscoelastic material behavior," Section 12.4.7.

To display *X–Y* plots of viscoelastic material behavior:

1. From the main menu bar, select **Material→Evaluate→*material name***. The material that you select must include time domain viscoelastic material data defined in conjunction with hyperelastic and/or elastic material data.

   Tip: You can also select the name of the material in the **Material Manager** and then click **Evaluate**.

   An **Evaluate Material** dialog box appears.

2. If you selected a viscoelastic material that also includes hyperelastic material data, click on the **Viscoelastic** tab; and toggle on **Perform viscoelastic evaluation** if it is not already selected.

   If desired, you can also evaluate the hyperelastic behavior of the material. For more information, see "Displaying *X–Y* plots of hyperelastic material behavior," Section 12.7.7.

3. In the **Available Input Data** field, do the following:

   a. Select the **Source** option of your choice:

      - Select **Test data** if you want Abaqus to calculate viscoelastic response using the experimental data specified in the material definition.

      - Select **Coefficients** if you want Abaqus to calculate viscoelastic response using the coefficients specified in the material definition. If the material was defined using a Prony series, relaxation test data, or creep test data for time, Abaqus uses the hyperelastic or elastic coefficient data. If the material was defined using frequency data for time, Abaqus uses the frequency coefficients specified in the viscoelastic material definition.

   b. If you selected **Test data** in the previous step, toggle on the test data type that you want Abaqus to use in calculating the material response. (Only data types for which you have specified data in the material definition appear in the list.)

      Note: **Combined** data cannot be selected at the same time as **Shear** or **Volumetric** data.

4. In the **Normalized Response Plots** field, toggle on **Stress Relaxation** and/or **Creep** to define the response modes that Abaqus will calculate; and enter the time period for the normalized response curves.

   If viscoelasticity is defined using frequency data in the time domain, the **Normalized Response Plots** field is not available. Instead, Abaqus produces shear and bulk modulus response curves on a logarithmic

frequency scale.

> **Note:** When you evaluate a viscoelastic material using frequency data, Abaqus obtains expressions for the shear and bulk moduli by converting the Prony series terms from the time domain to the frequency domain. It is recommended that you independently verify the material model in the domain in which the data will be used. For more information, see "Determination of viscoelastic material parameters" in "Time domain viscoelasticity," Section 22.7.1 of the Abaqus Analysis User's Guide.

5. Click **OK** to begin the response calculations.

   If the evaluation fails during the extraction of material coefficients due to problems with nonlinear curve-fitting, Abaqus/CAE displays a dialog box containing the name of the data (`.dat`) file; the path to the data file is printed in the message area. The data file provides detailed information on each problem encountered. (For more information on the data file, see "Output," Section 4.1.1 of the Abaqus Analysis User's Guide.)

   If Abaqus completes the tests successfully, Abaqus/CAE enters the Visualization module and displays *X*–*Y* plots of the test results in new viewports. (For information on *X*–*Y* plots, see Chapter 47, "X–Y plotting.") The data objects appear in the ***X–Y* Data Manager**; you can copy them to an output database or perform any of the tasks that you can perform on other *X*–*Y* data in the Visualization module.

   In addition, Abaqus/CAE displays an informational dialog box containing the viscoelastic material parameters and the stability limits and coefficients for each hyperelastic strain energy potential if a hyperelastic evaluation was performed. Abaqus/CAE also displays in the message area the path to the data (`.dat`) file that contains all the material evaluation information.

6. If desired, return to the Property module to edit the material data or to evaluate other materials.

For information on related topics, click the following item:

- "Time domain viscoelasticity," Section 22.7.1 of the Abaqus Analysis User's Guide