Altair

HyperWorks

Altair MotionView 2019 Tutorials

MV-8050: Using the Leaf Spring Builder

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Introduction

The purpose of this tutorial is to introduce you to the **Leaf Spring Builder** utility. In this tutorial, you will learn how to:

- Access the **Leaf Spring Builder** utility in MotionView
- Populate a leaf spring model with data and save the data in an `.lpf` file
- Generate a MotionView file (`.mdl`) of the leaf spring
- Open the model in MotionView
- Create a test of the model and exercise the test using the utility

The Leaf Spring Builder is a utility designed to work with MotionView and the vehicle modeling libraries included with MotionView. Spring geometry, bushing rates and a number of other physical constants are required as input to the model. Reasonable defaults for data are included for many fields, which will make the model run. Accurate data should be substituted as it becomes available. The output of the utility is a beam and mass model of a leaf spring, in either a MotionView system definition file or a complete MotionView model.

To learn more about the Leaf Spring Builder, see the *Leaf Spring Modeling* topic.

Required Files

Copy the files listed in the table below, located in the `mbd_modeling\leafspring\leaf_profiles` folder, to the `<working directory>`.

File Name	File
Comma Separated Values files	`Leaf_1.csv`
	`Leaf_2.csv`
	`Leaf_3.csv`
	`Leaf_4.csv`

These `.csv` files contain coordinate pairs that represent the geometry of the centerline of the leaf. The leaf in this tutorial was created by measuring geometry from a light truck rear suspension. The rear suspension in this example has a GAWR of 3950 lbs.

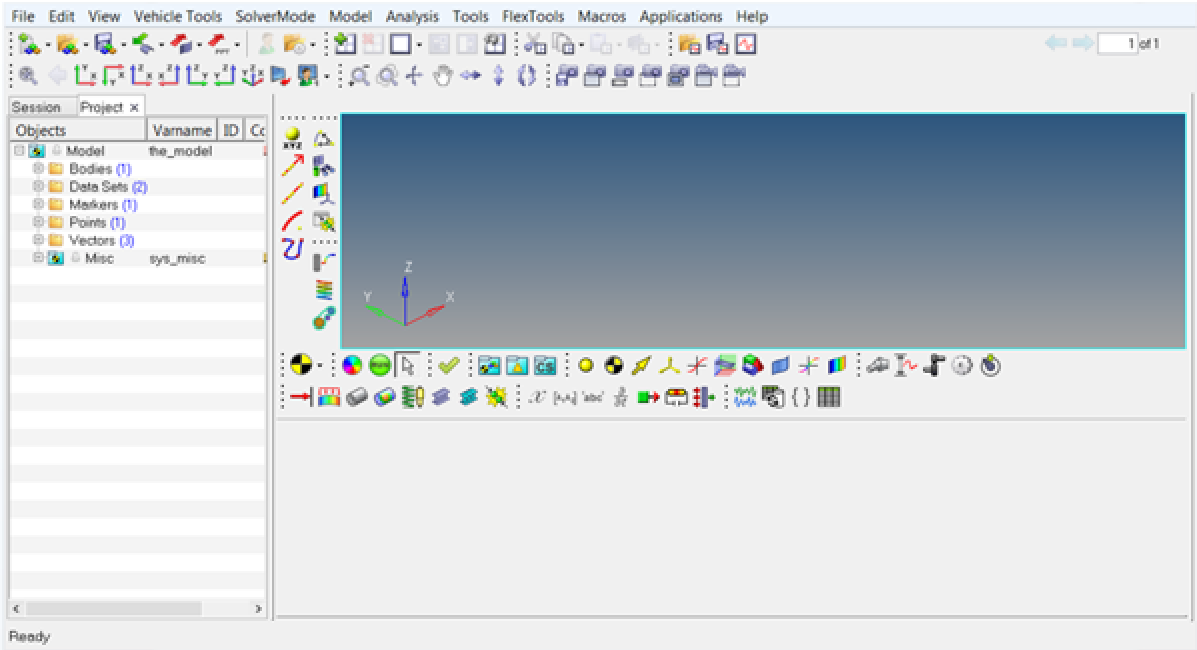
Step 1: Accessing the Leaf Spring Builder.

To build a leaf spring model, you must first load the **MBD-Vehicle Dynamics Tools** preference file in MotionView. Once loaded, HyperWorks remembers and automatically loads the **MBD-Vehicle Dynamics Tools** preference file each time you start HyperWorks. To load the **MBD-Vehicle Dynamics Tools** preference file follow the steps below.

Launching MotionView

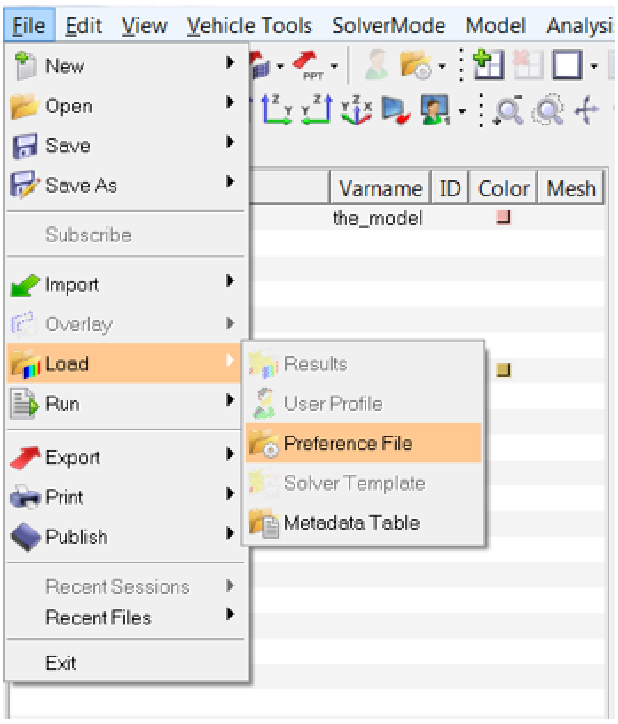
1. Start a new MotionView session.

   The MotionView window is displayed.



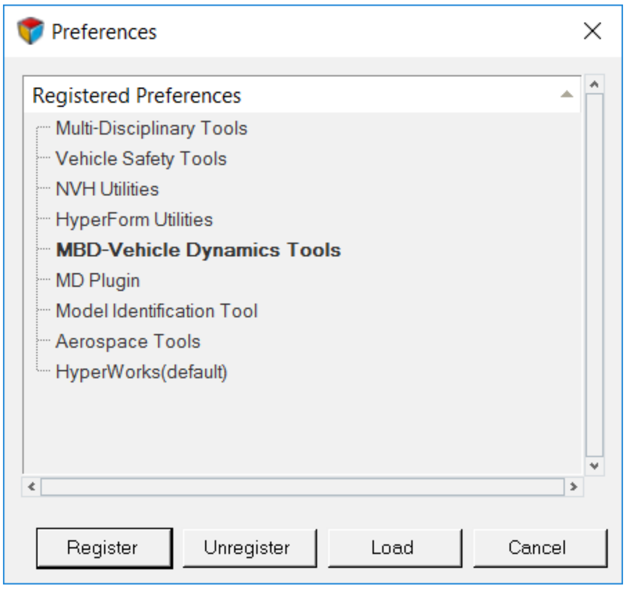
Loading the Vehicle Dynamics Tools Preference File

2. Click ***File > Load > Preference File*** from the MotionView **Menu** bar.



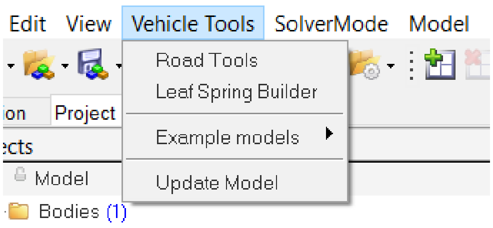
The **Preferences** dialog is displayed.

3. From the **Preferences** dialog, select ***MBD-Vehicle Dynamics Tools*** and click ***Load***.

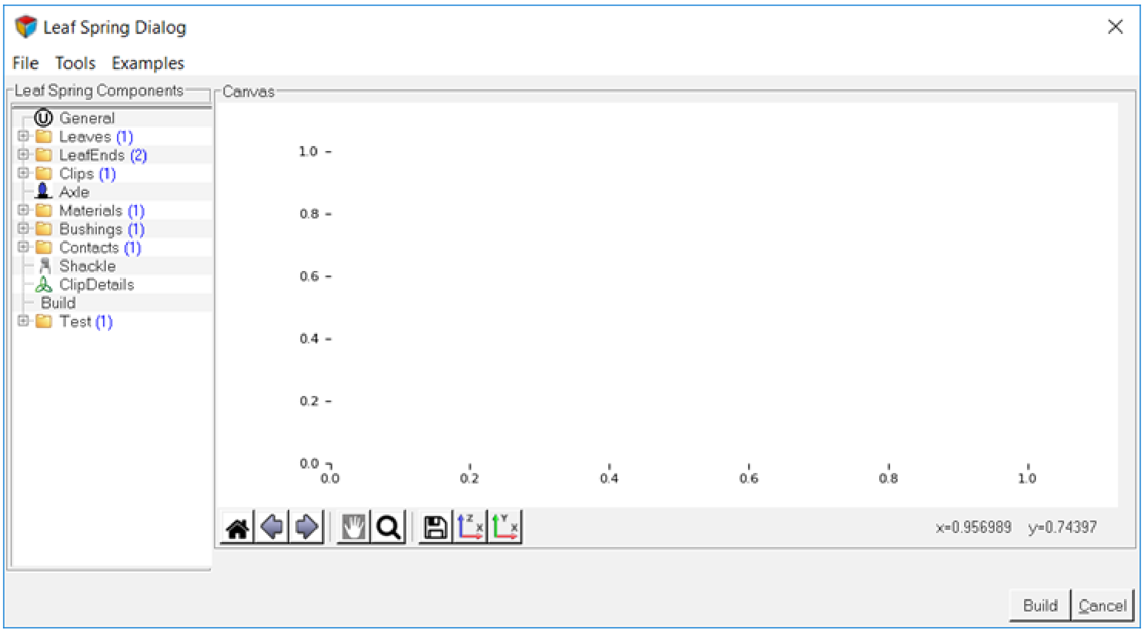


Displaying the Leaf Spring Builder

4. Click ***Vehicle Tools > Leaf Spring Builder***.

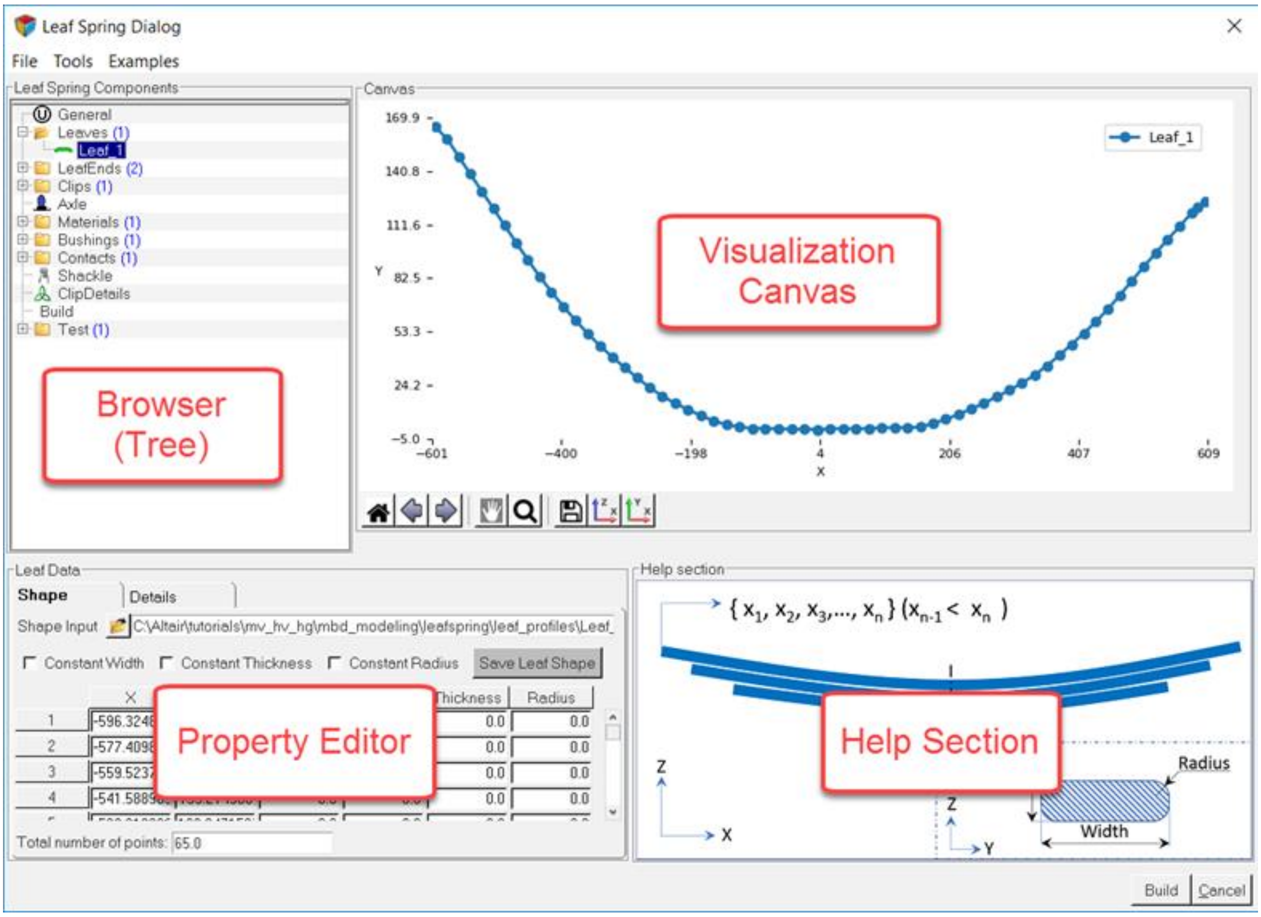


The **Leaf Spring Dialog** window opens.



Step 2: Building a Leaf Spring Model.

Using the Leaf Spring Builder you can define the properties of a leaf spring model, by entering the data about the number of leaves, the leaf shapes, cross-sections, material properties, and contact properties, the shackle length if your spring employs a shackle, the nominal axle load and other information to create a MDL system definition. The system definition can be imported into a suspension or full vehicle model. You can also test the leaf spring by applying a load and plotting the load versus deflection in the Leaf Spring Builder. The Leaf Spring Builder user interface has four parts as shown in the following image:

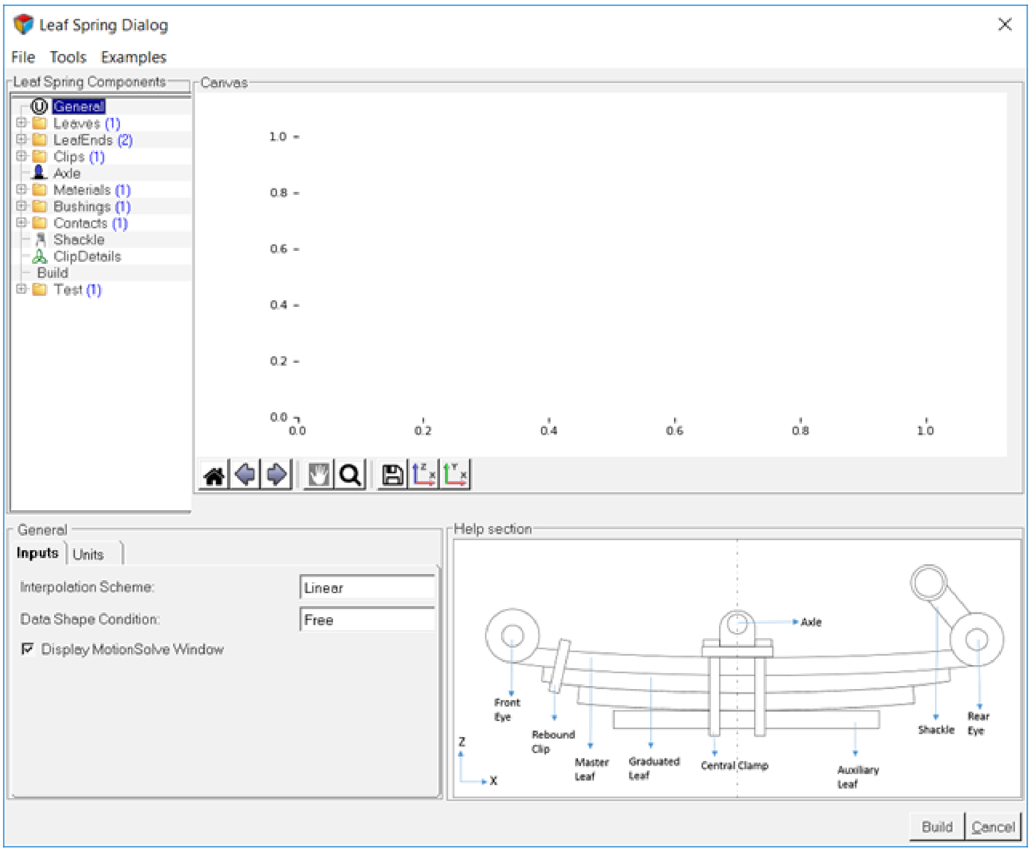


- **Browser**: Used for navigating and selecting leaf spring components.
- **Property Editor**: Used for entering and modifying data.
- **Help Section**: Used for describing the data you enter.
- **Visualization Canvas**: Used for viewing leaf shapes. When you select data in the browser the leaf spring builder displays the corresponding editor, visualization canvas and help section.

The following steps show you the process involved in creating a leaf spring model using the components of the Leaf Spring Builder.

General

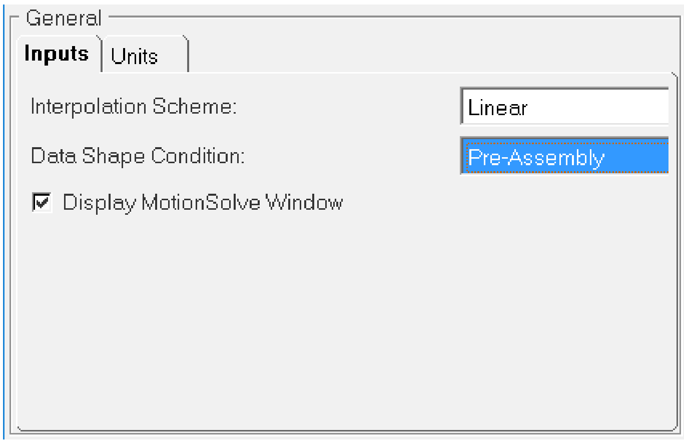
1. Click on the ***General*** option in the **Leaf Spring Components** browser section.



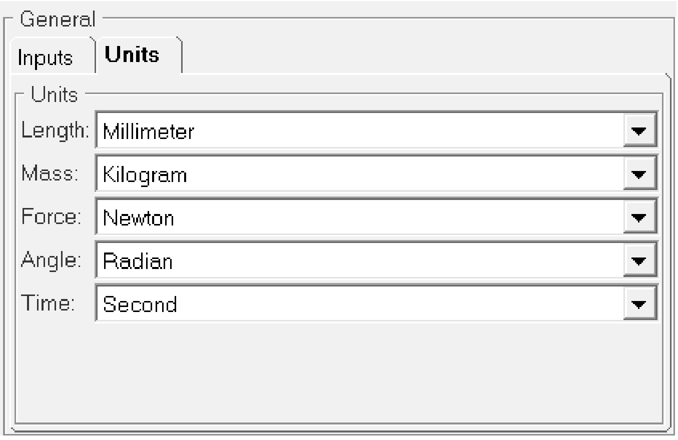
The entire leaf model is displayed in the **Help** section.

Primary Systems Selection

2. Select the ***Linear*** and ***Pre-Assembly*** options from the **Interpolation Scheme** and **Data Shape Condition** drop-down menus.

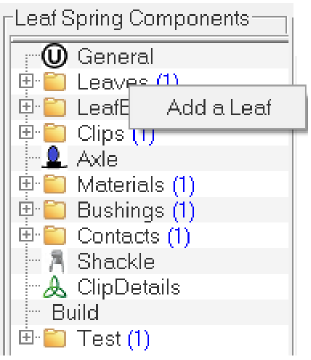


3. Default units are set in the **Units** tab.

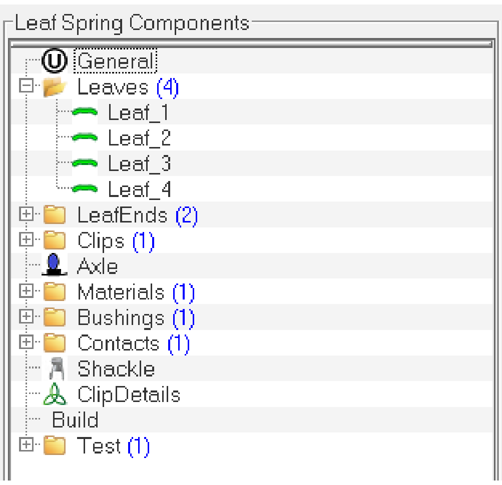


Leaves: Leaves components allow you to add leaves to the leaf spring.

4. Right-click on the ***Leaves*** component and click ***Add a Leaf***, to add leaves.

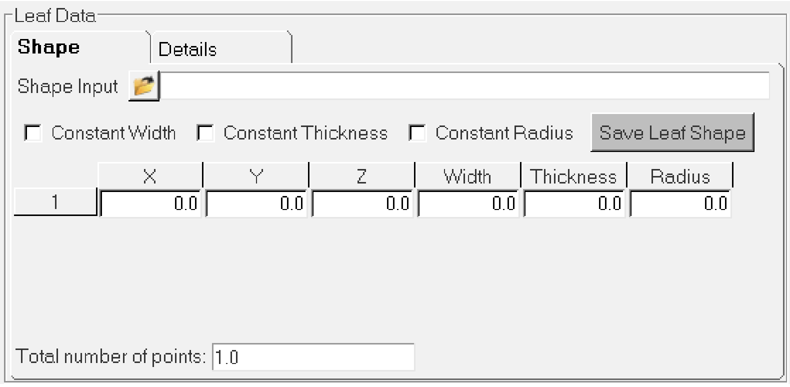


A **Leaf 2** component is added to the leaves component. In a similar manner, add two additional leaves (for a total four).



Leaf 1

5. Click on the ***Leaf 1*** component and see where the required data can be entered under **Leaf Data**.

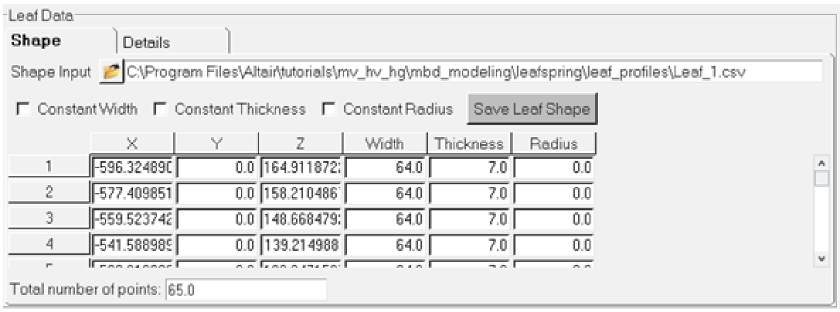


6. Browse and locate the required `.csv` file, `Leaf_1.csv` for the **Shape Input** field.

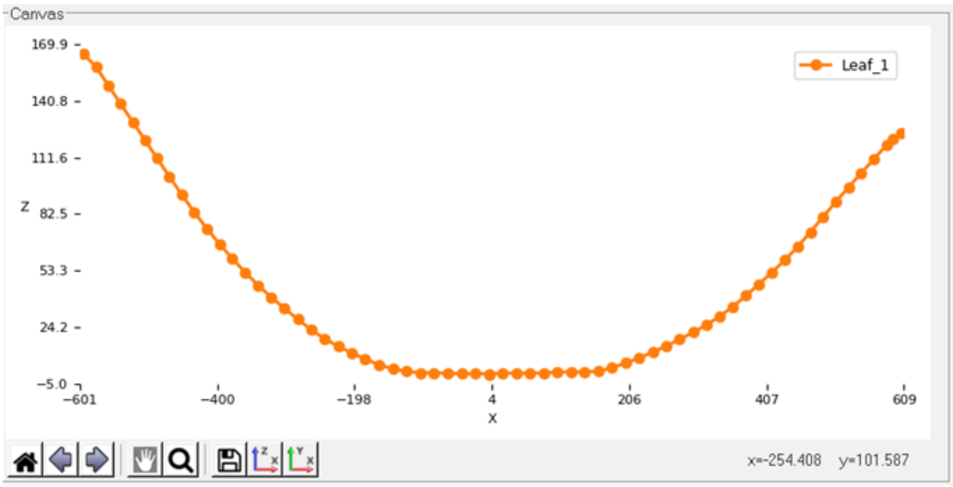
   OR

   – You can specify the required values for the X coordinate, Z coordinate and width and thickness variation manually for the leaf profile.

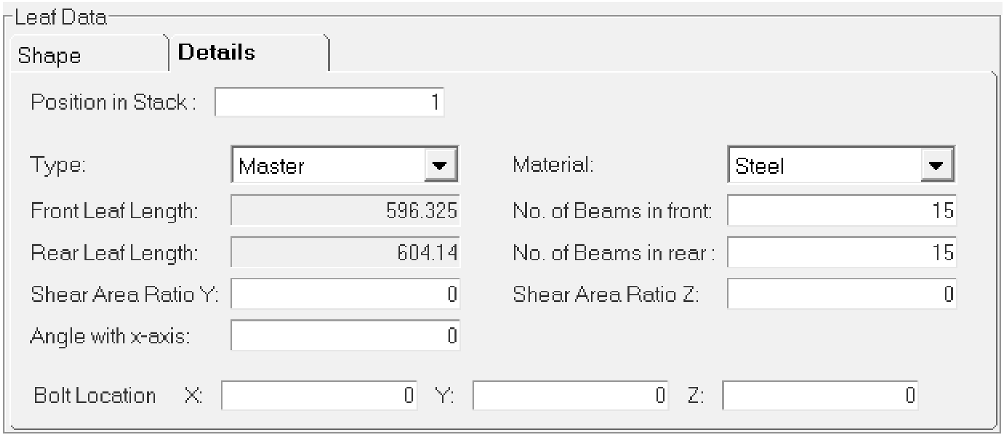
   Note If the leaf is a constant thickness (and/or width), you need to specify the values only in the first row. The same value will be used along the entire length of the leaf.



The Leaf 1 graphics are displayed in the **Canvas** section.



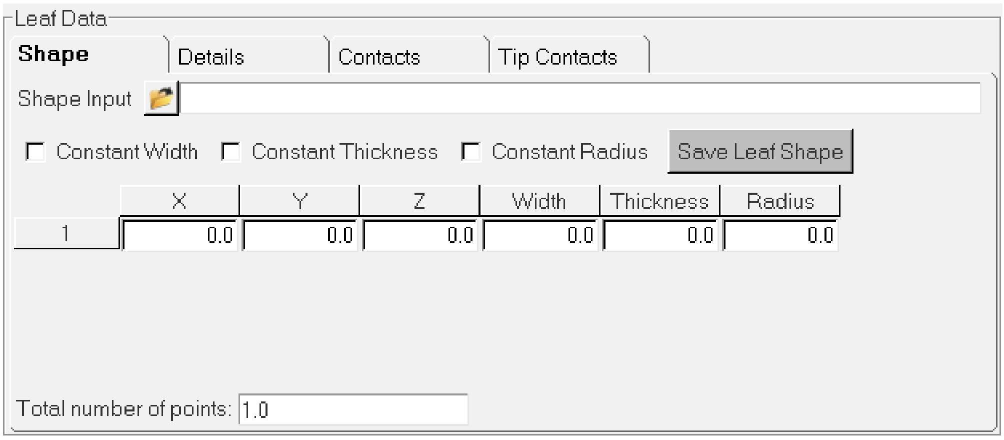
7. Click on the ***Details*** tab and select the ***Master*** option from the **Type** drop-down menu. Enter the Leaf 1 data for the **Details** tab as shown in the following image.



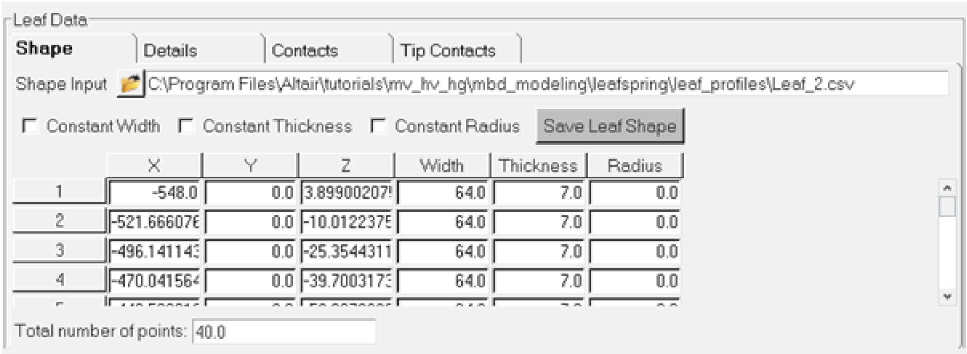
The Leaf 1 graphics in the **Canvas** section are changed accordingly.

Leaf 2

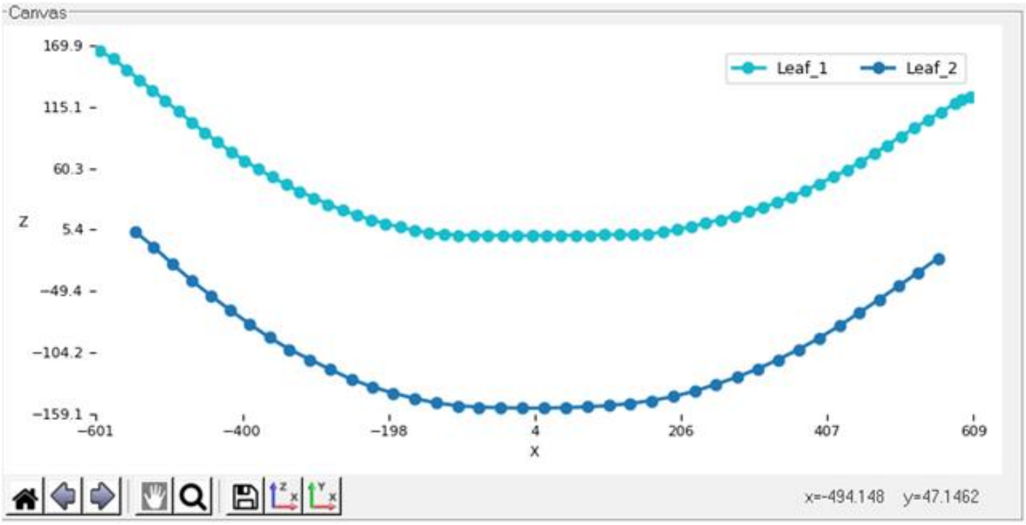
8. Click on the ***Leaf 2*** component and enter the required data under **Leaf Data** in the **Shape** tab.



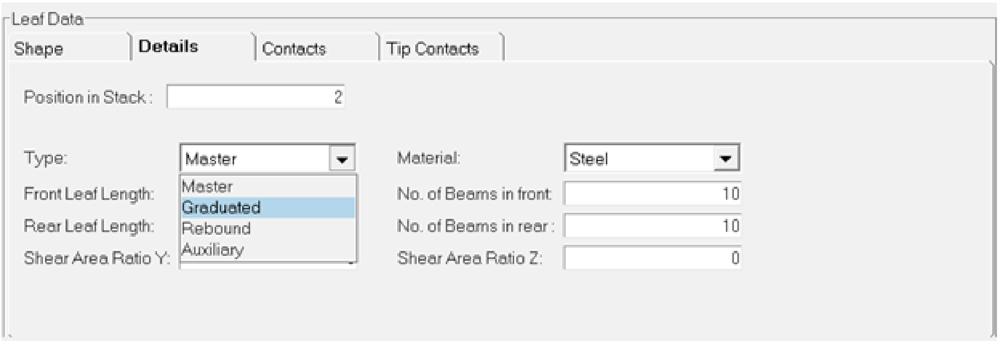
9. Browse and locate the required `.csv` file, `Leaf_2.csv`, for the **Shape Input** field. Enter the **Width** and **Thickness** as shown in the image below.

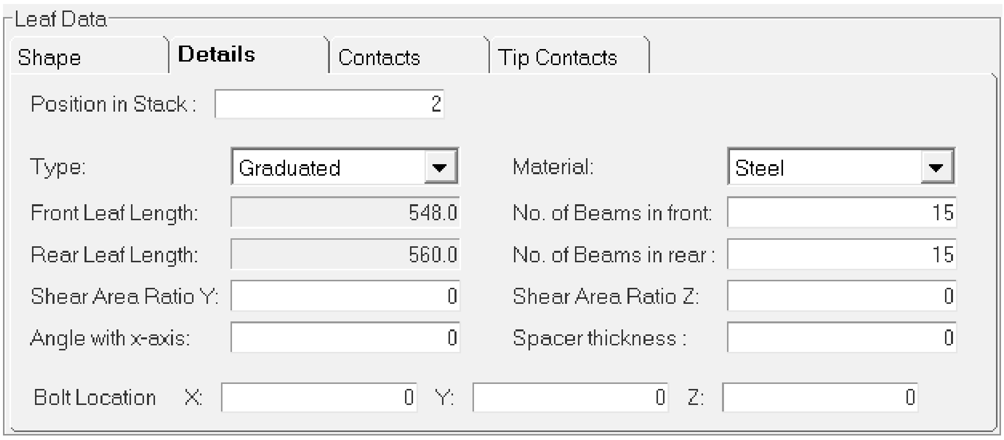


The Leaf 2 graphics are displayed in the **Canvas** section.



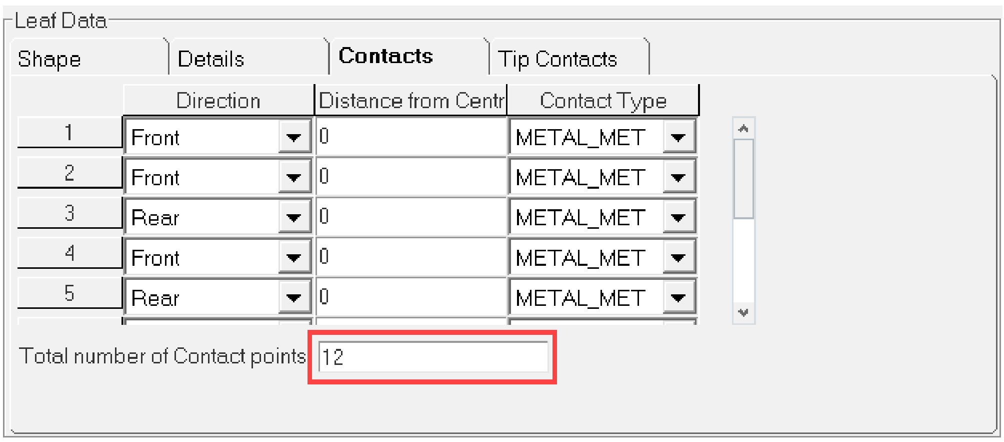
10. Click on the ***Details*** tab and select the ***Graduated*** option from the **Type** drop-down menu. Enter the Leaf 2 values for the **Details** tab as shown in the following image.





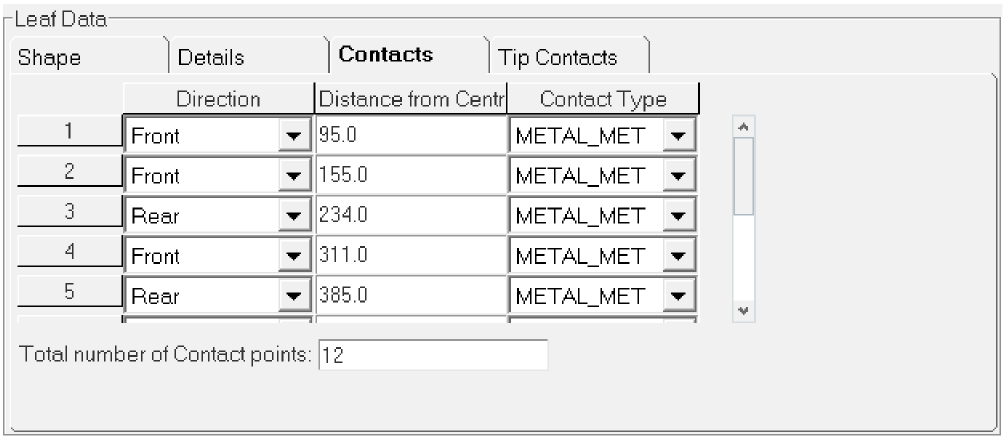
11. Click on the ***Contacts*** tab and enter the value `12` in the **Total number of Contact points** field and hit **Enter**.

 The Contacts table for Leaf 2 is generated based upon the values entered.

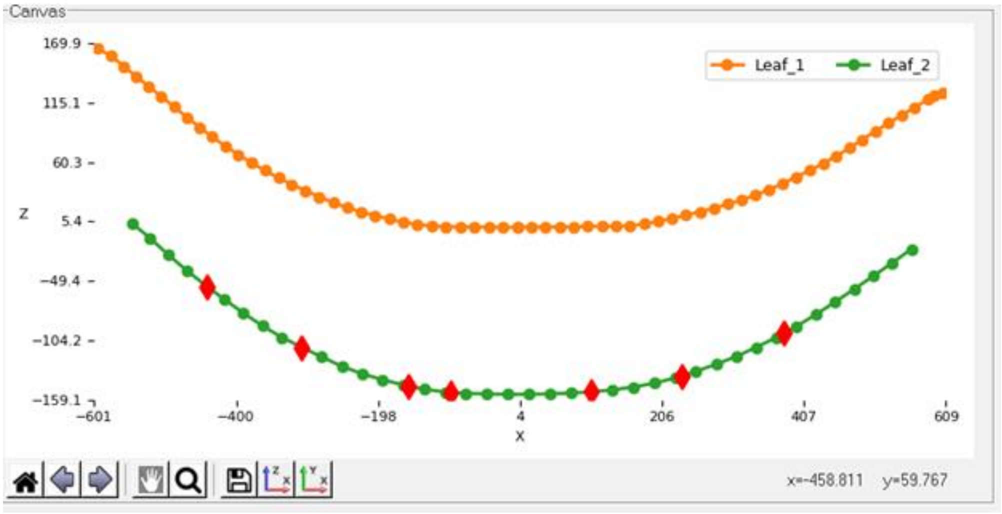


12. Enter the following data into the **Contacts** table.

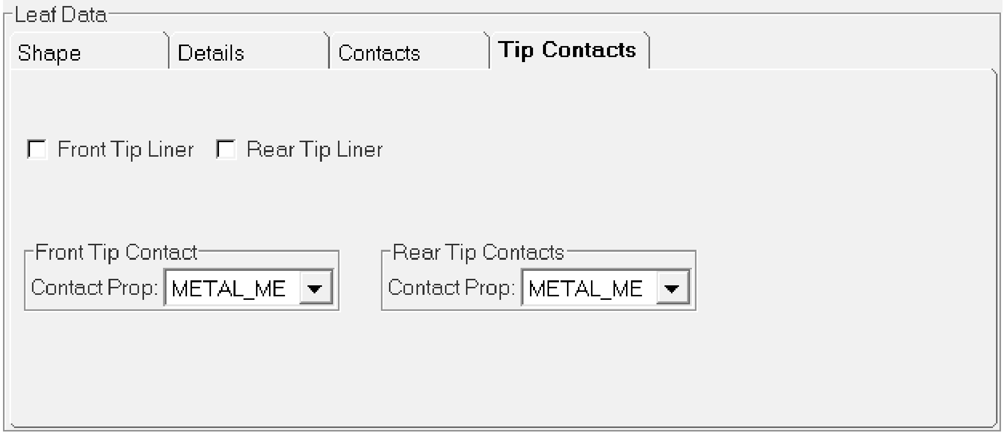
S. No	Direction	Distance	Contact Type
1	Front	95	METAL_METAL
2	Front	155	METAL_METAL
3	Front	234	METAL_METAL
4	Front	311	METAL_METAL
5	Front	385	METAL_METAL
6	Front	457	METAL_METAL
7	Rear	105	METAL_METAL
8	Rear	155	METAL_METAL
9	Rear	234	METAL_METAL
10	Rear	311	METAL_METAL
11	Rear	385	METAL_METAL
12	Rear	457	METAL_METAL



13. The entered contact points are plotted on Leaf 2 as shown in the following image in the **Canvas** section.

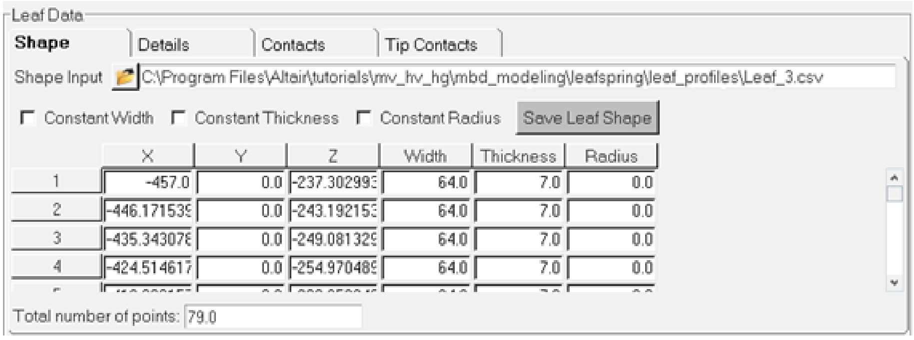


14. For this example, leave the **Tip Liners** (**Front** and **Rear**) set to ***Off*** in the **Tip Contacts** tab.



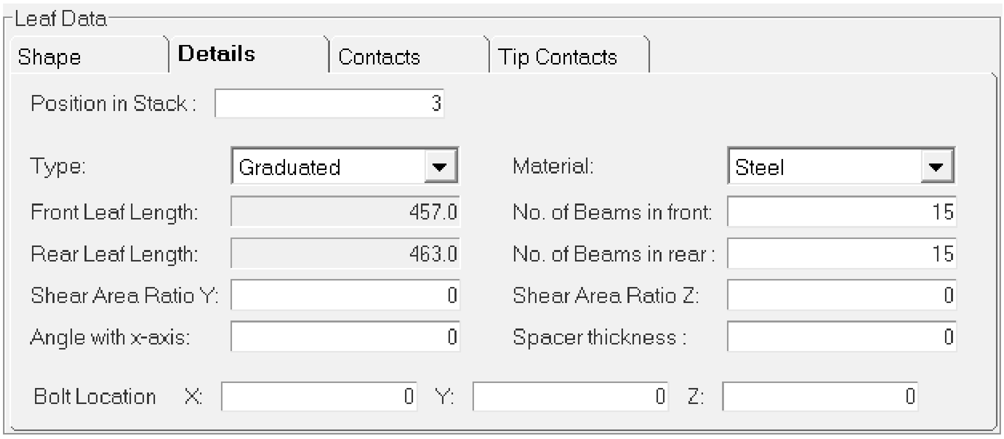
Leaf 3

15. Browse and locate the required `.csv` file, `Leaf_3.csv`, for the **Shape Input** field.



The Leaf 3 graphics are displayed in the **Canvas** section.

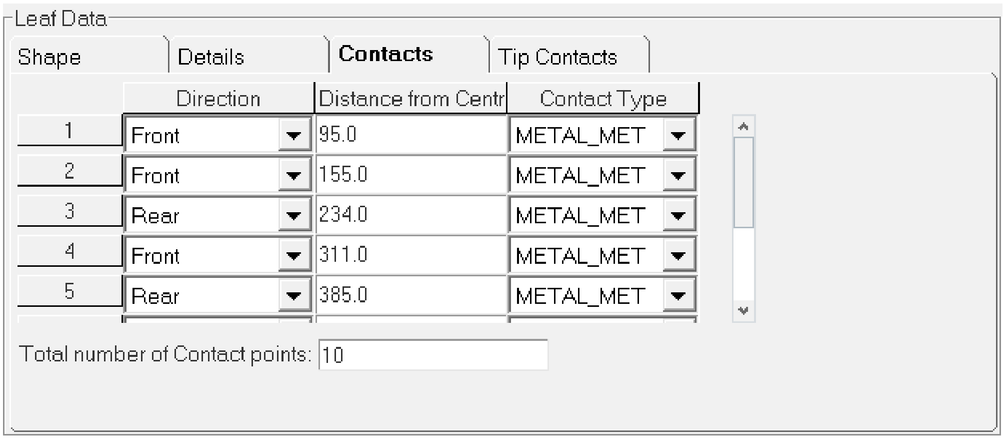
16. Click on the ***Details*** tab and select the ***Graduated*** option from the **Type** drop-down menu. Enter the Leaf 3 values for the **Details** tab as shown in the following image.



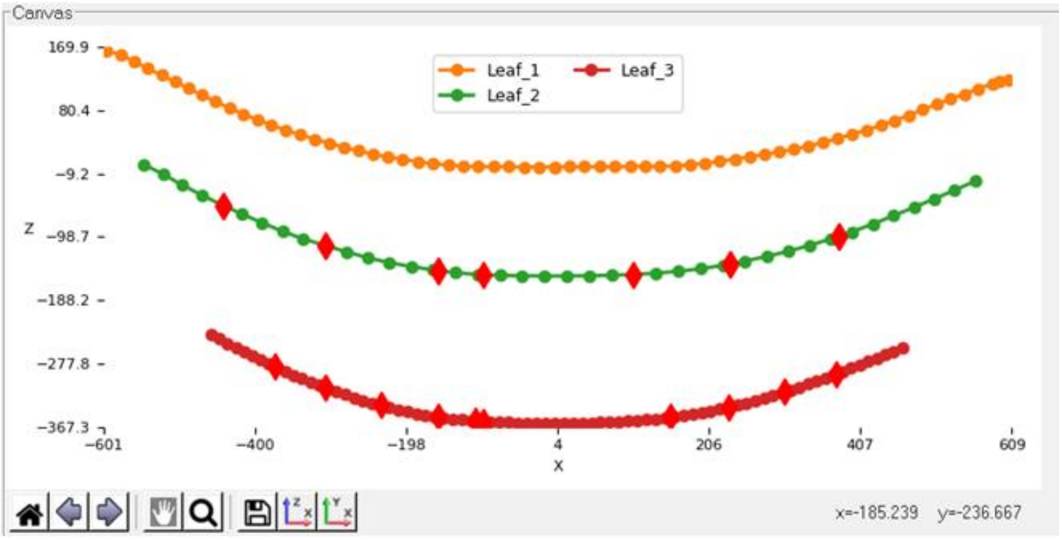
17. Click on the ***Contacts*** tab and enter the value `10` in the **Total number of Contact points** field and hit **Enter**.

18. Enter the following data into the **Contacts** table.

S. No	Direction	Distance	Contact Type
1	Front	95	METAL_METAL
2	Front	155	METAL_METAL
3	Front	234	METAL_METAL
4	Front	311	METAL_METAL
5	Front	385	METAL_METAL
6	Rear	105	METAL_METAL
7	Rear	155	METAL_METAL
8	Rear	234	METAL_METAL
9	Rear	311	METAL_METAL
10	Rear	385	METAL_METAL

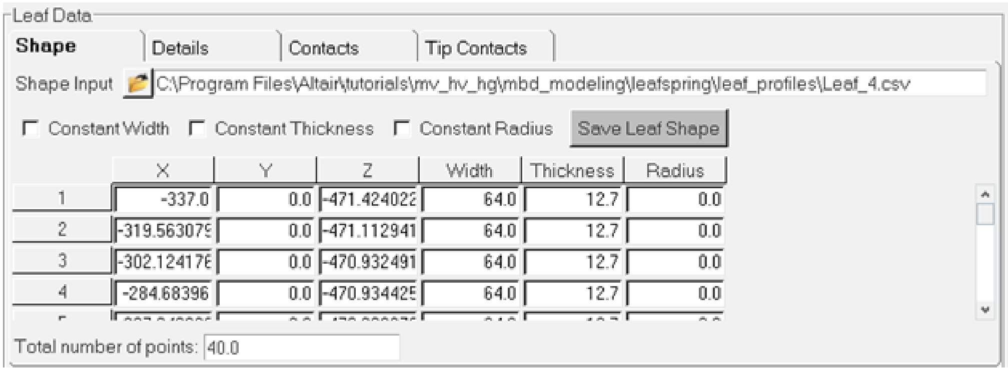


19. The entered contact points are plotted on Leaf 3 as shown in the following image in the **Canvas** section.



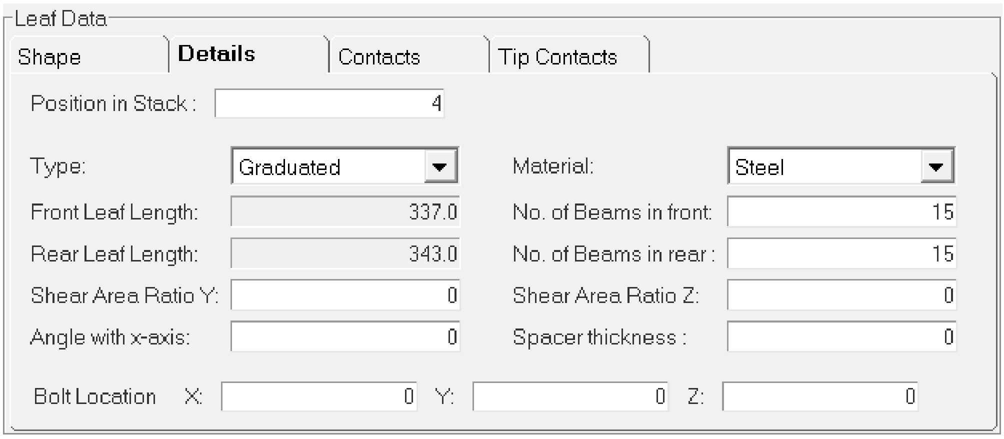
Leaf 4

20. Browse and locate the required `.csv` file, `Leaf_4.csv`, for the **Shape Input** field.



The Leaf 4 graphics are displayed in the **Canvas** section.

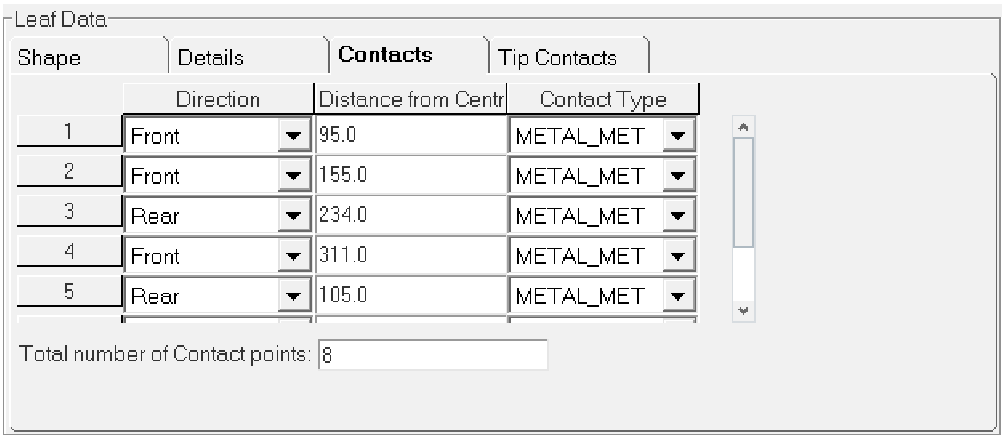
21. Click on the ***Details*** tab and select the ***Graduated*** option from the **Type** drop-down menu. Enter the Leaf 4 values for the **Details** tab as shown in the following image.



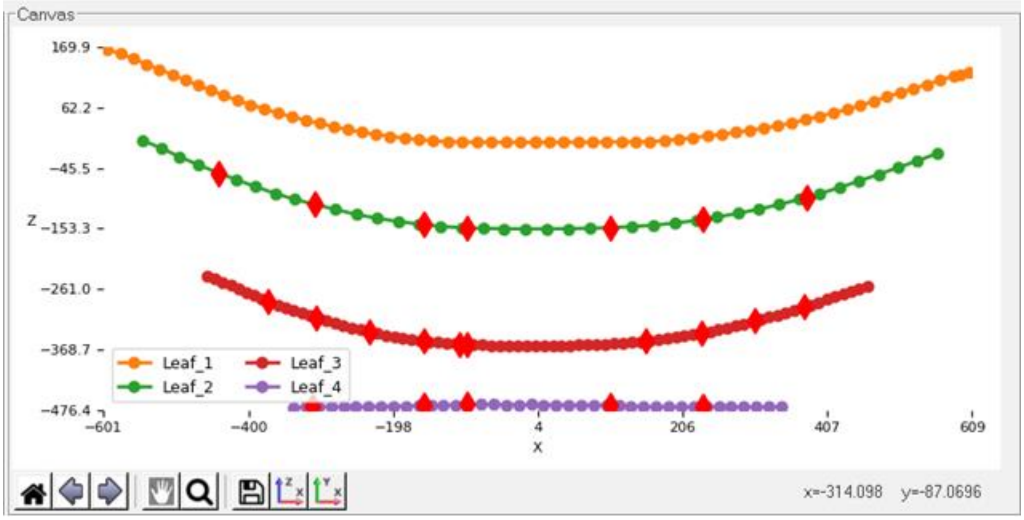
22. Click on the ***Contacts*** tab and enter the value 8 in the **Total number of Contact points** field and hit **Enter**.

23. Enter the following data into the **Contacts** table.

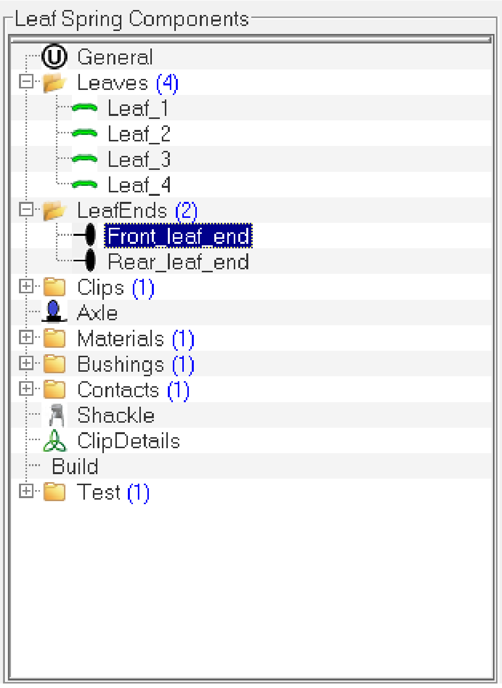
S. No	Direction	Distance	Contact Type
1	Front	95	METAL_METAL
2	Front	155	METAL_METAL
3	Front	234	METAL_METAL
4	Front	311	METAL_METAL
5	Rear	105	METAL_METAL
6	Rear	155	METAL_METAL
7	Rear	234	METAL_METAL
8	Rear	311	METAL_METAL



24. The entered contact points are plotted on Leaf 4 as shown in the following image in the **Canvas** section.

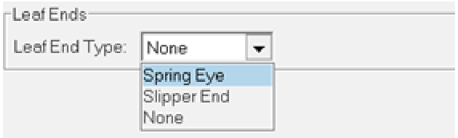


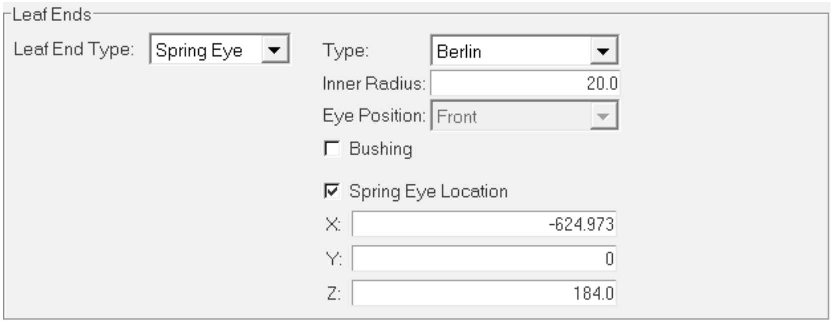
Leaf Ends: Leaf ends parameters provide the details about the eye hook types at front and at the rear ends. Three spring eye types are supported.



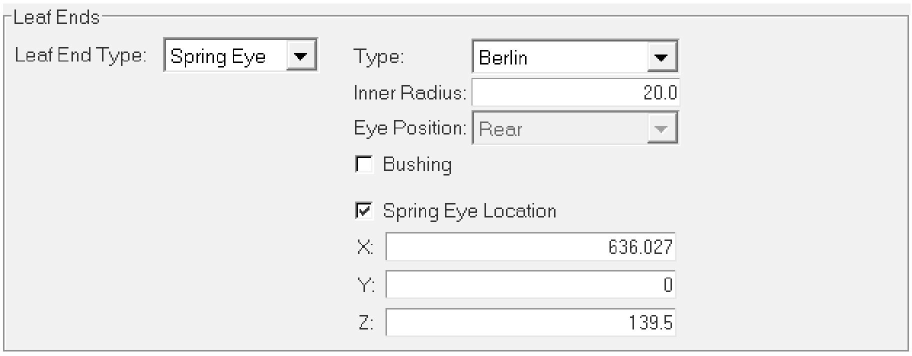
25. Click on the ***Front_leaf_end*** option and enter the following data in the **Leaf Ends** section.

    – Select ***Spring Eye*** from the **Leaf End Type** drop-down menu.

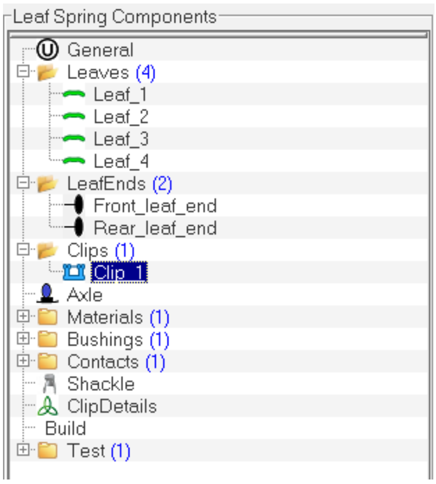




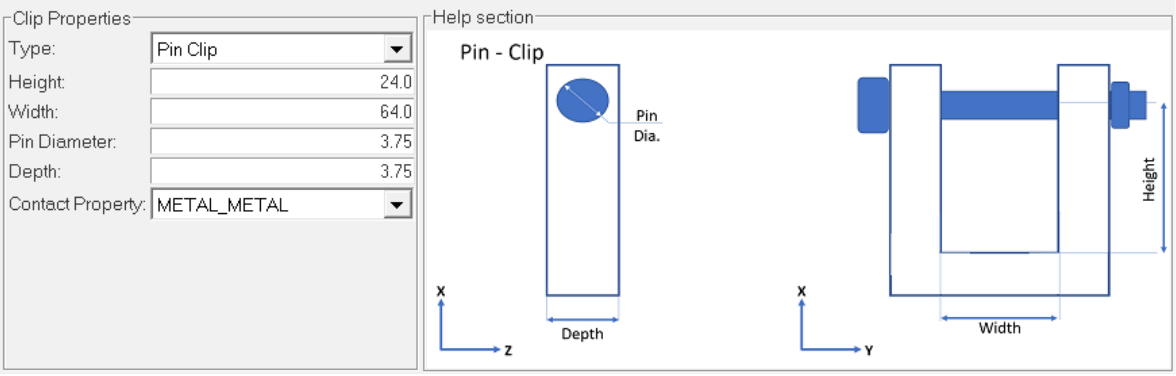
26. Click on the ***Rear_leaf_end*** option and enter the following data in the **Leaf Ends** section.



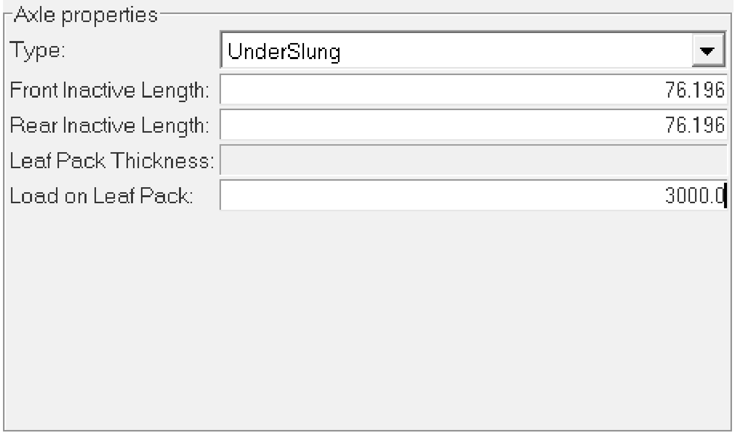
Clip: Clip parameter is used to define the Clip properties. The number of clips added in the clips parameter are reflected in the **Clip Details**.



27. Click on the ***Clips*** component and enter the following data in the **Clip Properties** section.

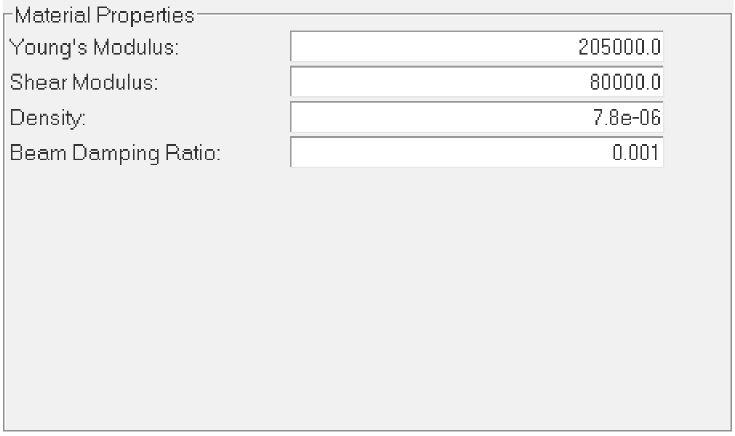


28. Click on the ***Axle*** component and enter the following data in the **Axle Properties** section.



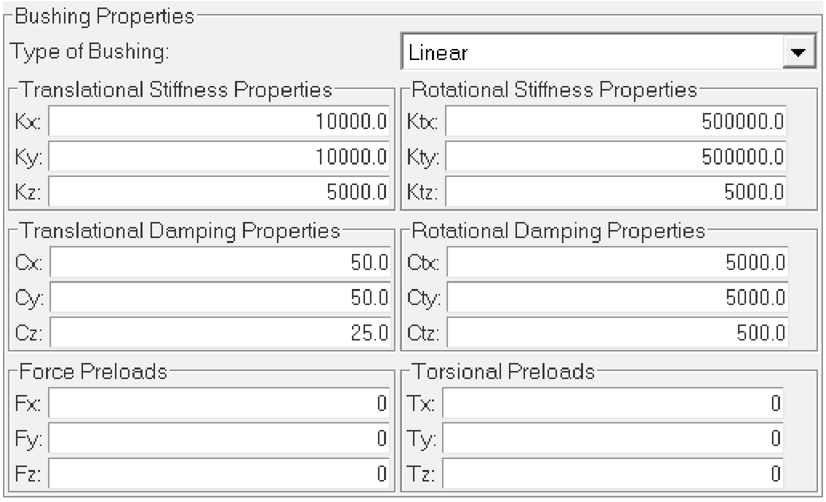
Materials

29. Click on the ***Materials*** component and enter the following data in the **Material Properties** section.



Bushings

30. Click on the **Bushings** component and use the default values under **Bushing Properties**.

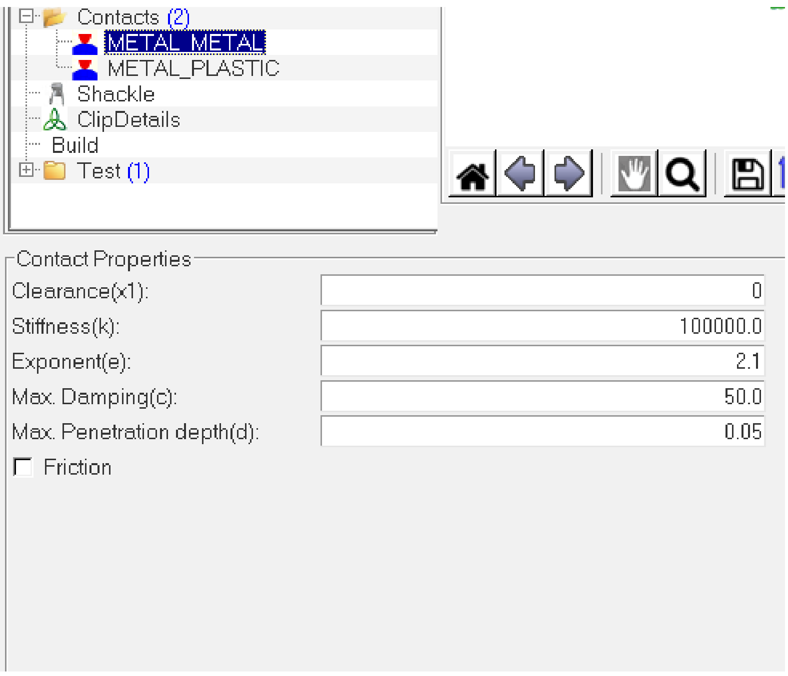


Contacts

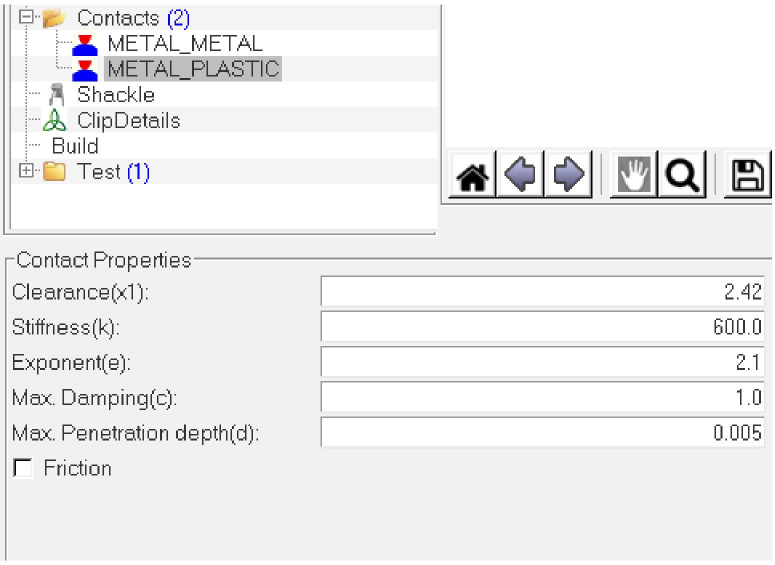
31. Click on the ***Contacts*** component (by default there is only one contact **METAL_METAL**). Right-click on the ***Contacts*** component and add one more contact named `METAL_PLASTIC`.

Note Right-click to rename the contact after you have added it.

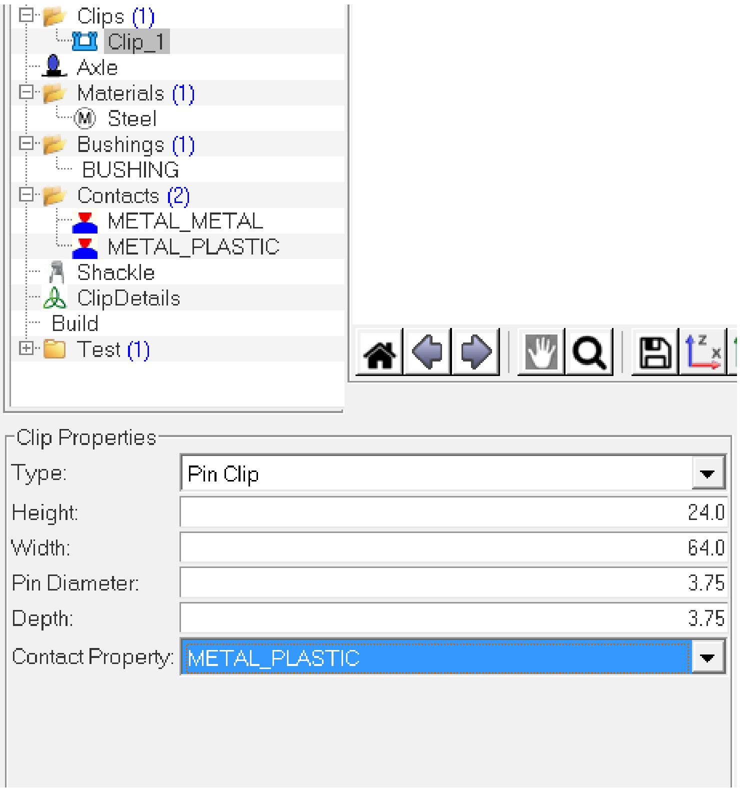
32. Click on the ***METAL_METAL*** contact and enter the following data in the **Contact Properties** section.



33. Click on the ***METAL_PLASTIC*** contact and enter the following data in the **Contact Properties** section.

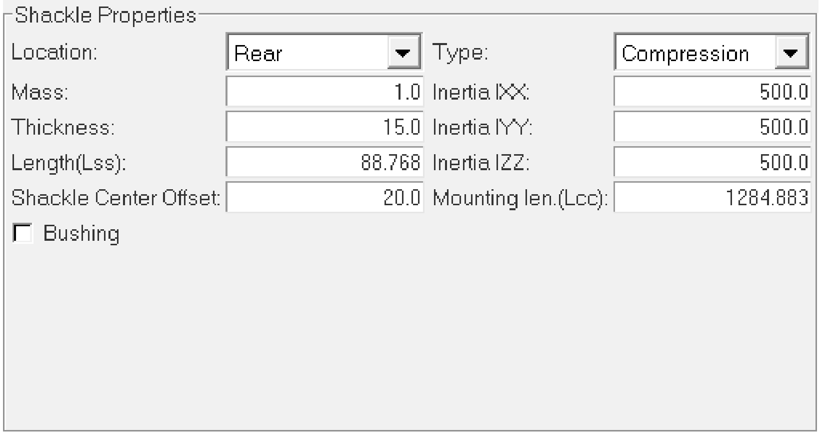


34. Now for this example, go back to the **Clips** component and click on the ***Clip_1*** option and update the **Contact Property** to the ***METAL_PLASTIC*** contact.



Shackle

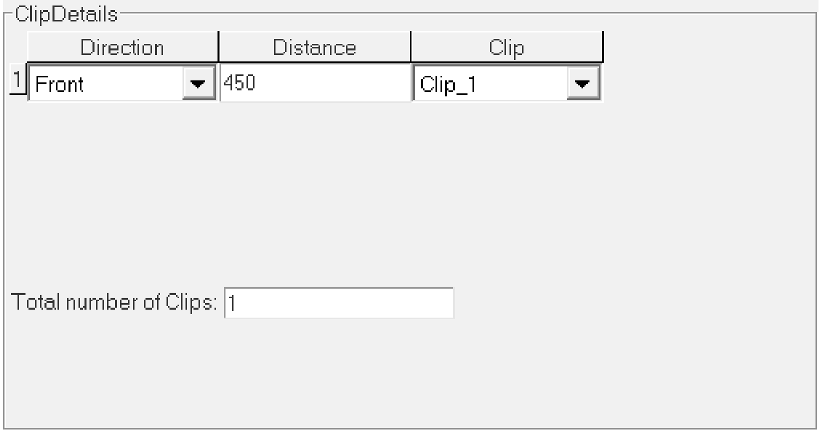
35. Click on the ***Shackle*** component and enter the following data in the **Shackle Properties** section.



Clip Details

36. Click on the ***ClipDetails*** option and enter `1` in the **Total number of Clips** field, with respect to the number of clips added in the **Clips** component.

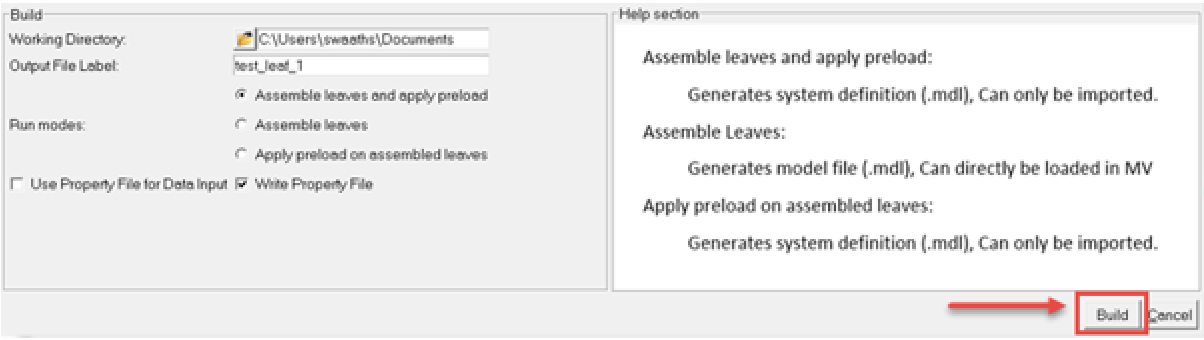
37. Enter the following data for the **Clip 1** component.



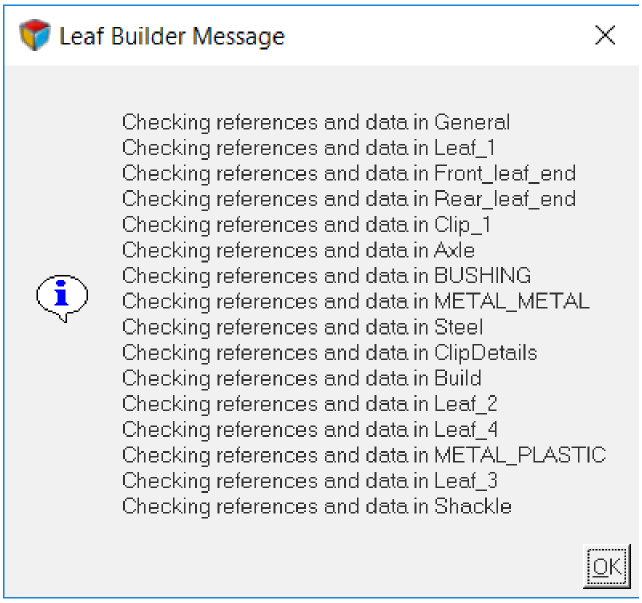
Step 3: Importing the Leaf Spring Model into MotionView.

The Leaf Spring Builder saves the data in an `.lpf` file. The file can be saved and loaded in the Leaf Spring Builder interface. The file is readable and is in TiemOrbit format. To make model changes, edit the spring data in the interface and build a new leaf spring system definition.

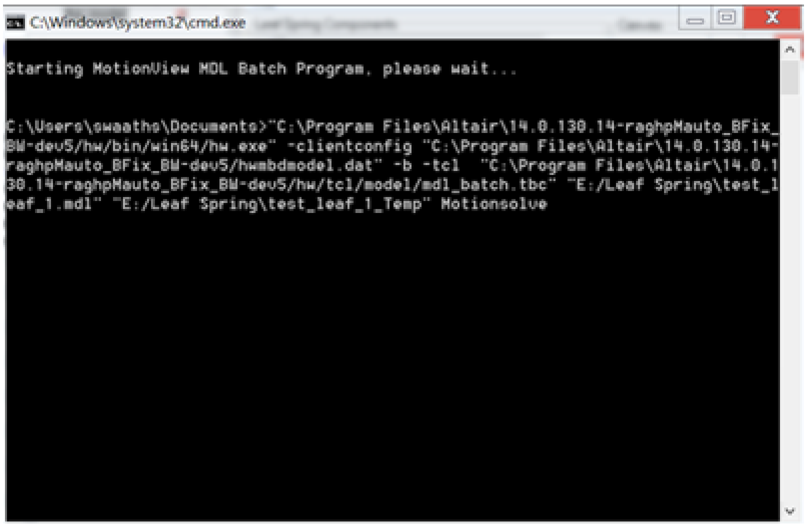
1. Click on the ***Build*** option and browse and locate the required path for the `<working directory>`. Enter `test_leaf_1`, as the file name in the **Output File Label** field and view the choices available for building the leaf spring model.
2. Select the ***Assemble leaves and apply preload*** radio button and the ***Write Property File*** check box and click on the ***Build*** button.



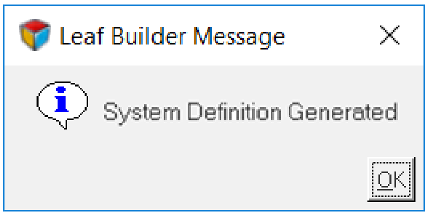
3. The **Leaf Builder Message** window opens. The message window shows the model checks that are performed before the test job is submitted to the MotionSolve.
4. Click **OK** to exit the window.



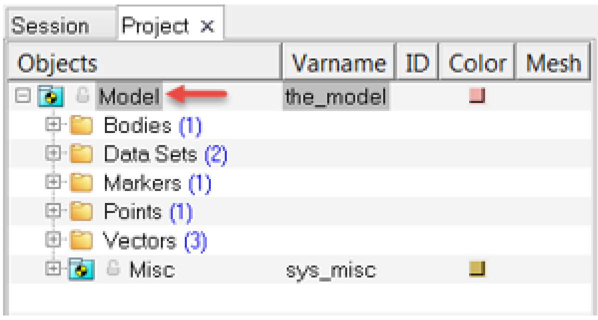
5. MotionSolve is invoked in the background and it displays several windows as it runs, in order to generate the leaf spring MDL system definition file.



6. Once the MotionSolve process is done, close the **Leaf Spring Builder** dialog.
7. The **Leaf Builder Message** window is displayed.



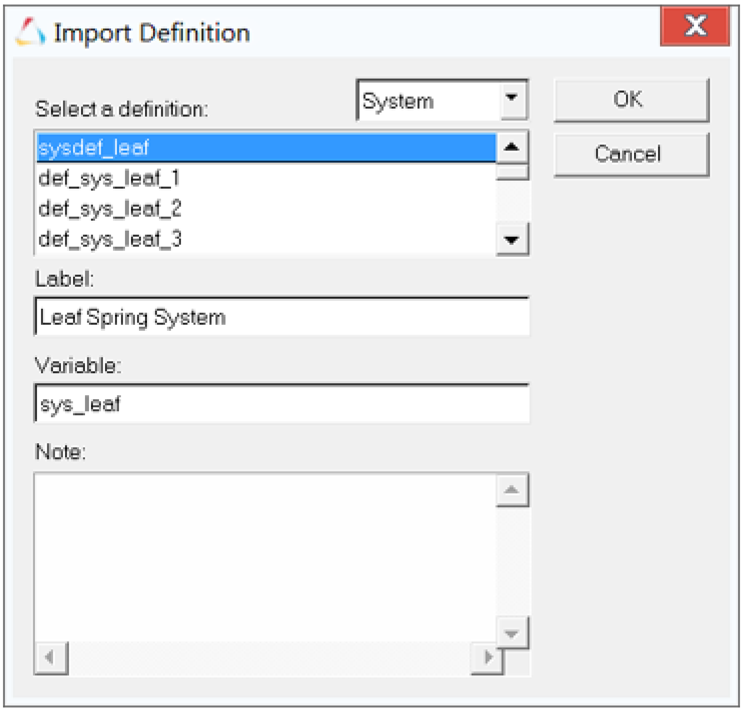
8. Click the ***OK*** button in the **Leaf Builder Message** dialog.
9. From the **Project** browser, click on the ***Model*** as shown in the following image.



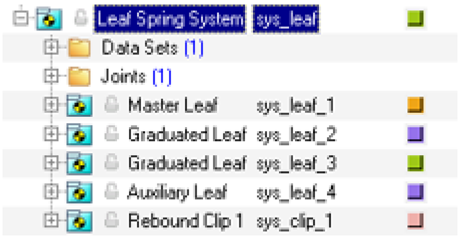
10. Click on the ***Import/Export*** tab in the panel area.

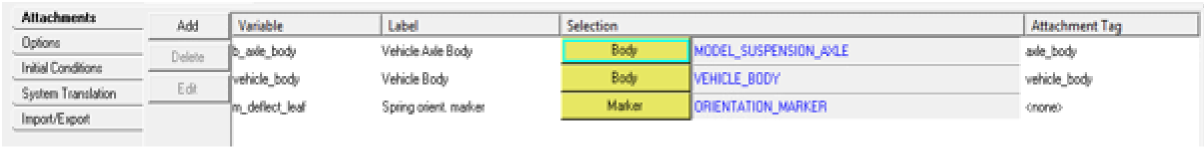
11. Use the **Select file** browser and locate the generated `.mdl` file from the `<working directory>` and click ***Import***.

12. The **Import Definition** window is displayed. Use the default options in the window and click **OK**.

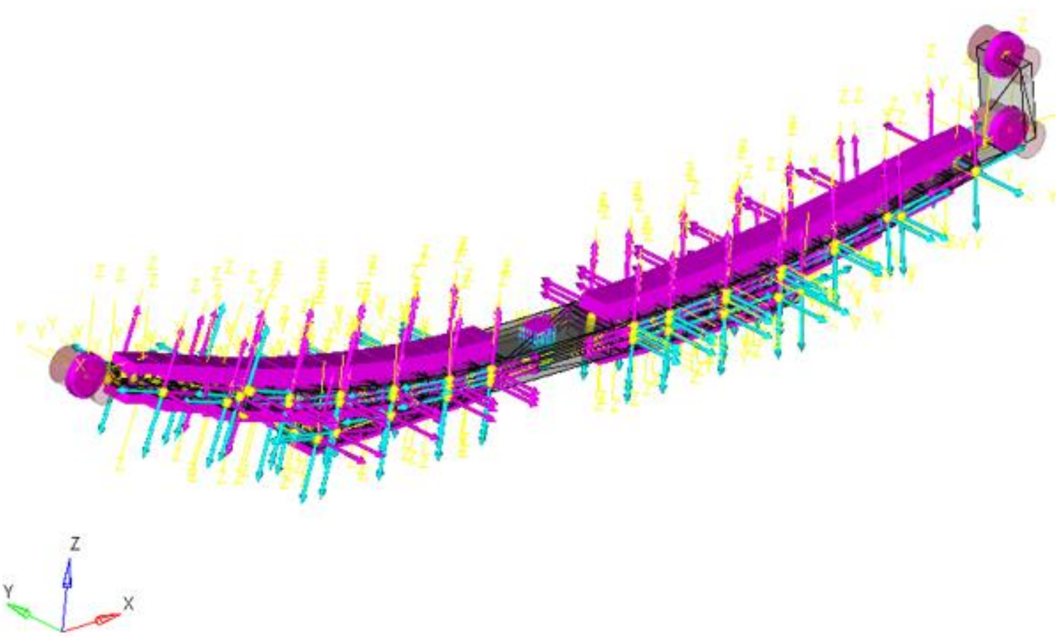


13. Leaf Spring system is shown in the **Project** browser. Click on it and resolve the attachments.





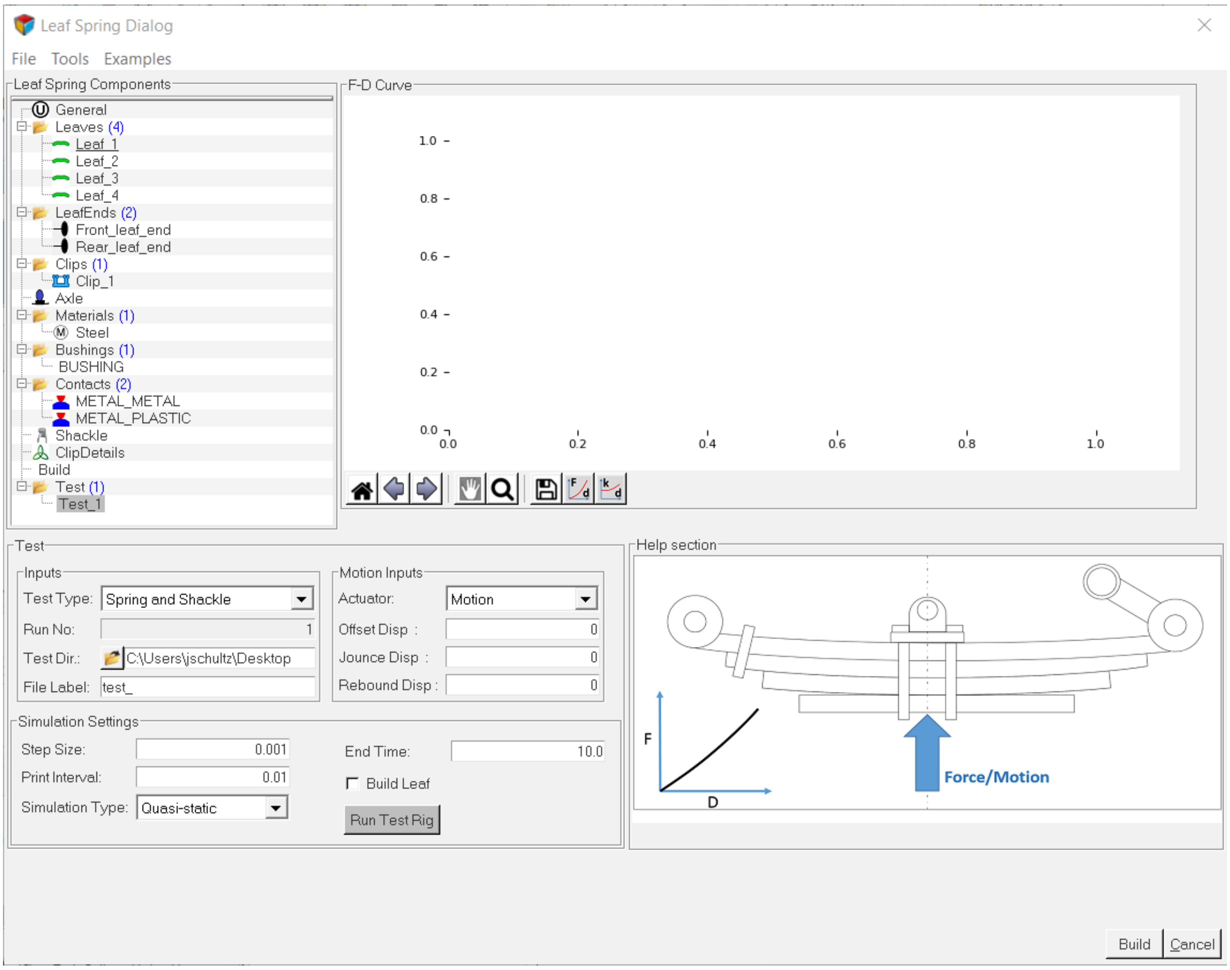
14. The Leaf Spring is displayed in the MotionView graphics window.



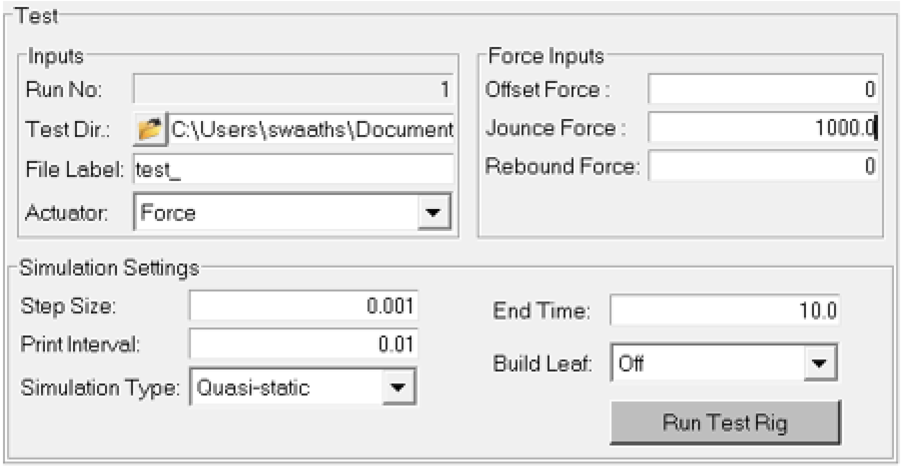
Step 4: Testing the Leaf Spring Model.

Testing can be performed with either force or motion applied at the axle center, and can be run in quasi-static or transient analysis simulations. Quasi-static analysis is used as an example in the following.

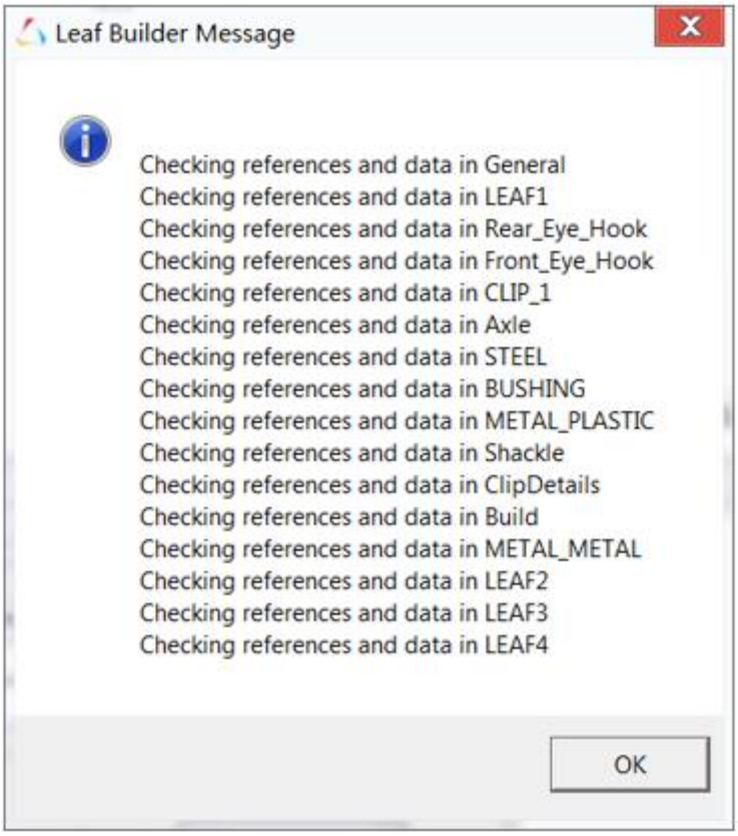
1. Return to the **Leaf Spring Builder** and click on the ***Test*** component in the browser.



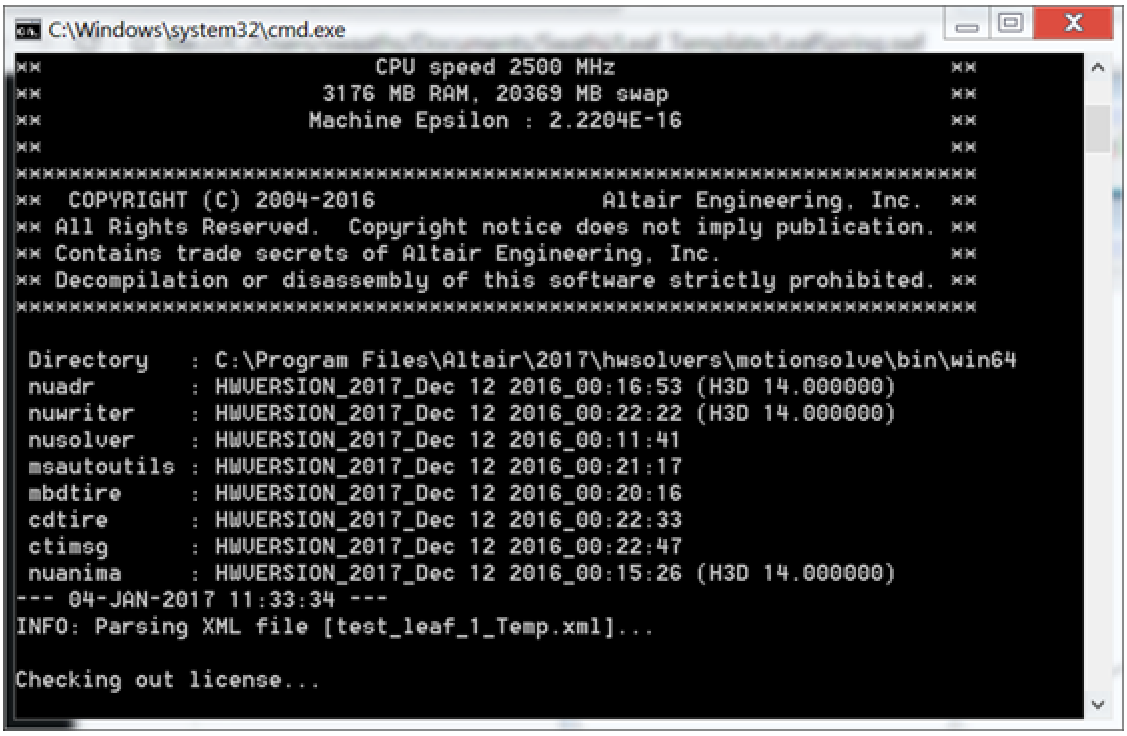
2. Browse and locate the required **Testing Directory** and enter the following data: select ***Force*** as the **Test Rig Type** and the ***Quasi-static*** analysis as the **Simulation Type** (as shown in the following **Test** section). Click on the ***Run Test Rig*** button.



3. The **Leaf Builder Message** window opens. The message window shows the model checks that are performed before the test job is submitted to MotionSolve. Click ***OK*** to exit the window.



4. MotionSolve is invoked in the background and displays several windows as it runs.



5. Once the run process is completed, the following F-D Curve is generated in the Leaf Builder.