Altair

HyperWorks

Altair MotionView 2019 Tutorials

MV-8100: Tire Modeling

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MV-8100: Tire Modeling

Introduction

The tire models describe the interface between the wheel and the road. For this tire interface, the tire parameters and properties are set by a Tire Property File with the extension (`.tir`) while the road interface is described by a Road Property File with the extension (`.rdf`). One Body, one Point, and two Marker connections are needed to define the tire interface. In addition, physical properties of the tire such as the unloaded radius, aspect ratio, width, mass, and moment of inertia's that need to be specified. The purpose of this tutorial is to show the process of how to build a tire model in the MotionView interface and to interpret the results. In this tutorial, you will learn how to:

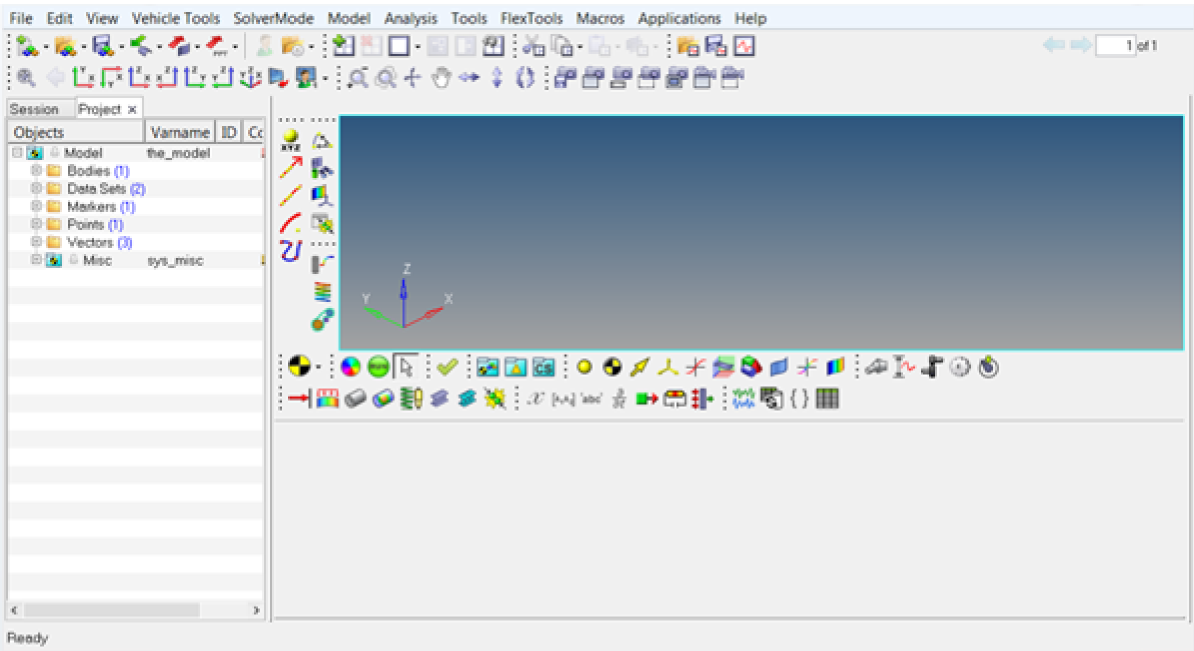
- Launch MotionView and load the MBD-Vehicle Dynamics Tools preference file
- Build a Tire model
- Run the model in MotionSolve
- View the simulated results

Step 1: Launching MotionView.

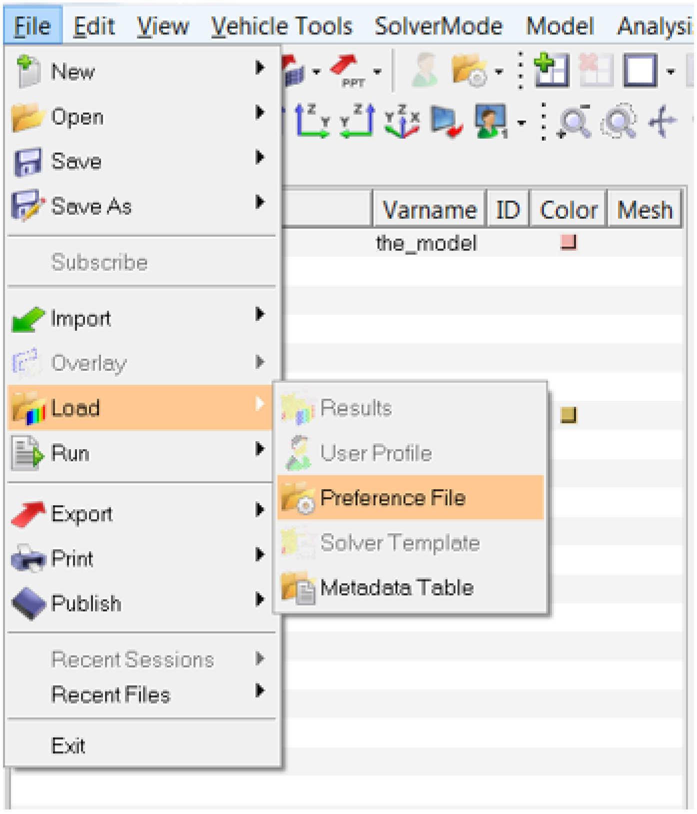
To build an AutoTire entity, you must first load the **MBD-Vehicle Dynamics Tools** preference file in MotionView. Once loaded, HyperWorks remembers and automatically loads the **MBD-Vehicle Dynamics Tools** preference file each time you start HyperWorks. To load the **MBD-Vehicle Dynamics Tools** preference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

1. Start a new MotionView session.

   The MotionView window is displayed.

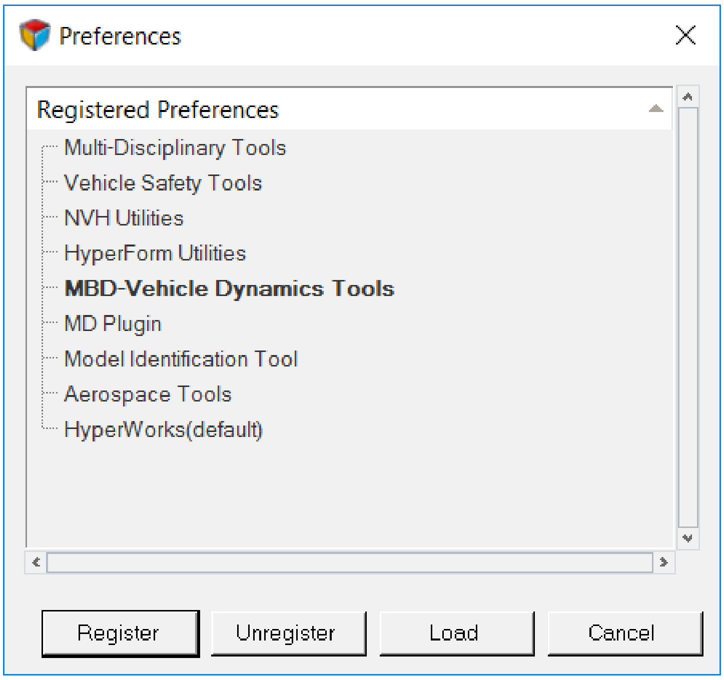


2. Click ***File > Load > Preference File*** from the MotionView **Menu** bar.



The **Preferences** dialog is displayed.

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

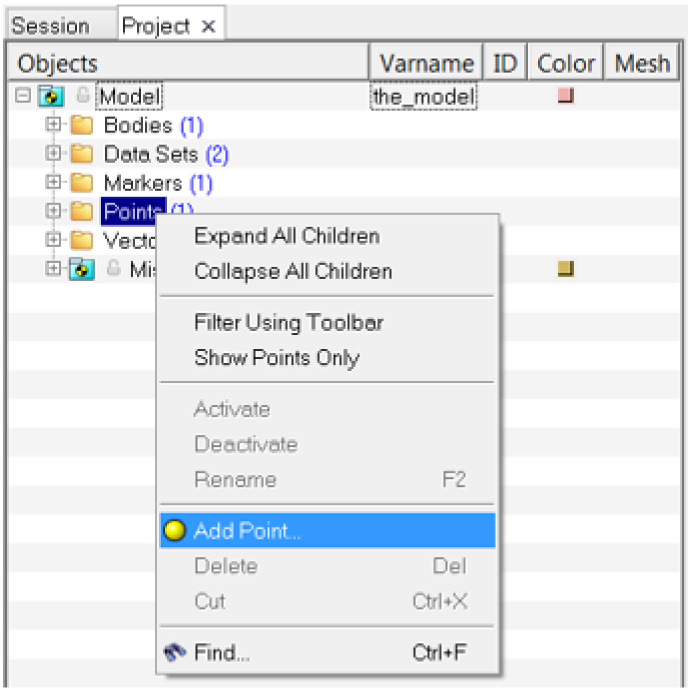


Step 2: Building a Tire Model.

Follow the steps below to create a tire model in the MotionView interface.

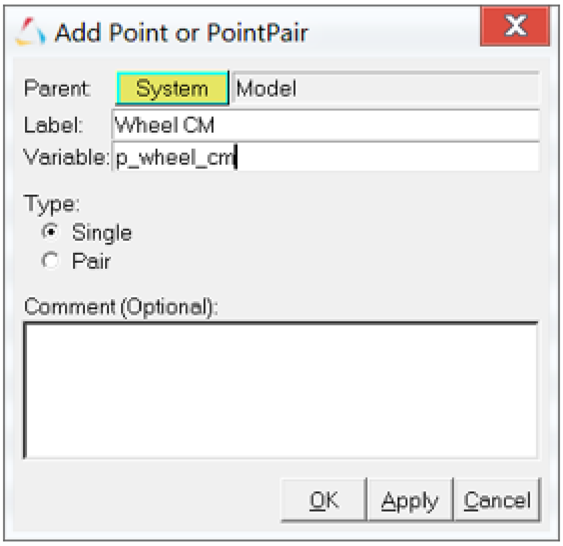
Adding a Point to the Model

1. Create a point for the model by right-clicking the ***Points*** folder in the **Project** browser. Click on the ***Add Point*** option from the context menu.

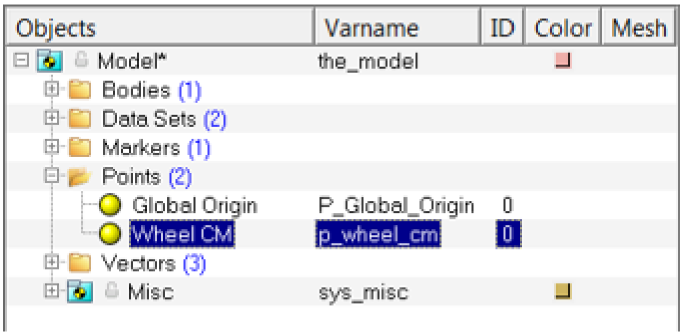


The **Add Point or PointPair** dialog is displayed.

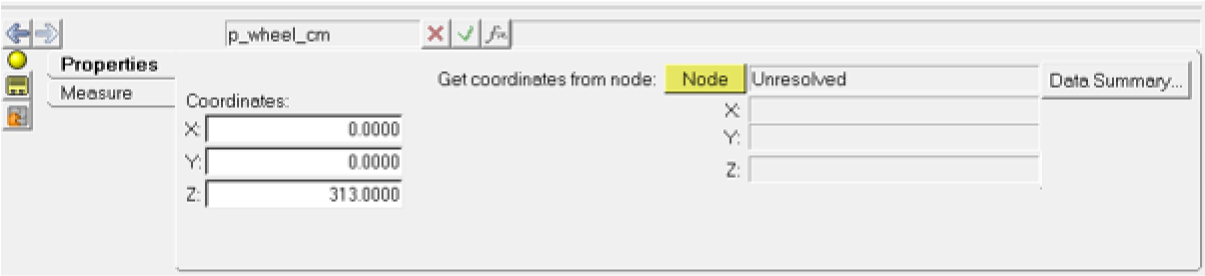
2. Enter `Wheel CM` as the **Label** and `p_wheel_cm` as the **Variable** and click ***OK***.



The **Wheel CM** point is added in the **Project** browser.

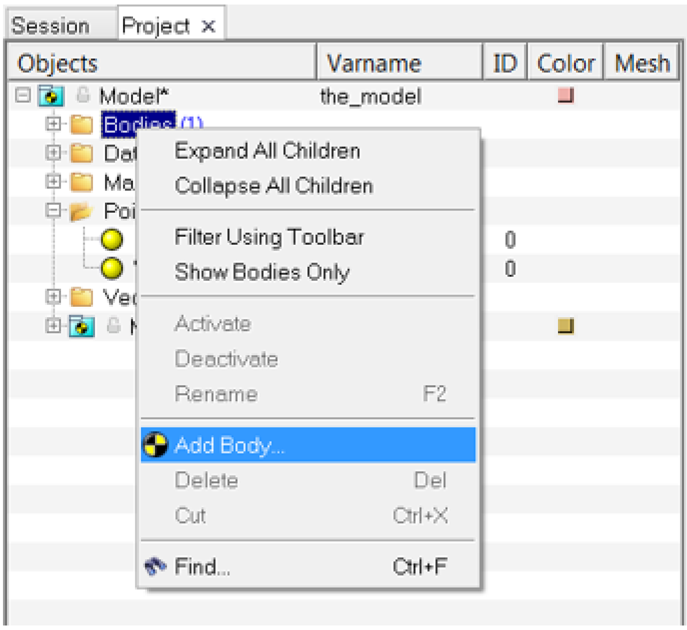


3. Enter the value of `313` for **Z** coordinate in the **Properties** tab as shown in the image below.



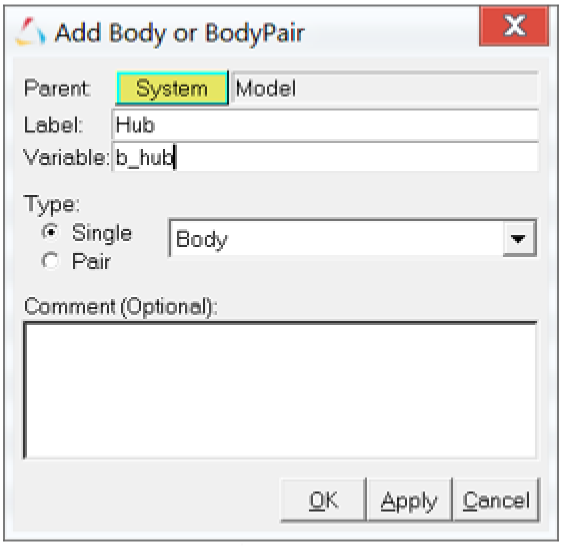
Adding a Body to the Model

4. Create a Hub body by right-clicking the ***Bodies*** folder in the **Project** browser. Click on the ***Add Body*** option from the context menu.

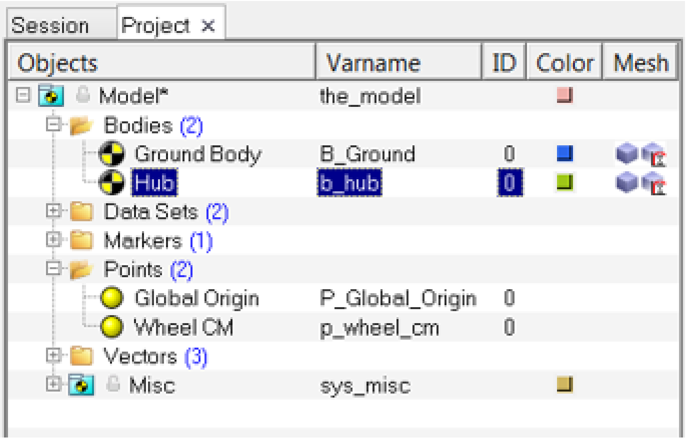


The **Add Body or BodyPair** dialog is displayed.

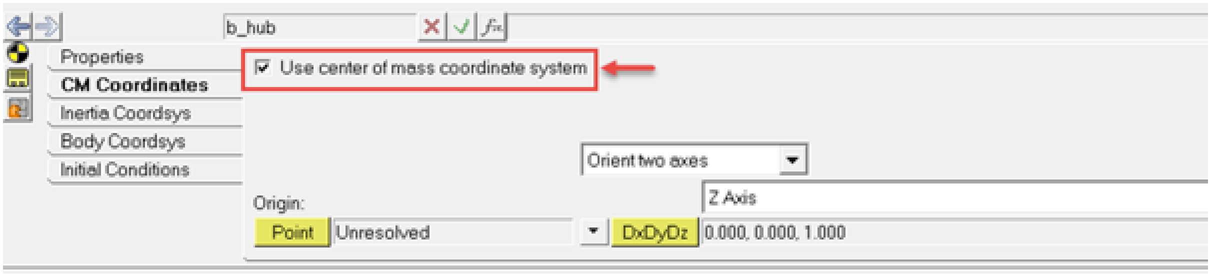
5. Enter `Hub` as the **Label** and `b_hub` as the **Variable** and click ***OK***.



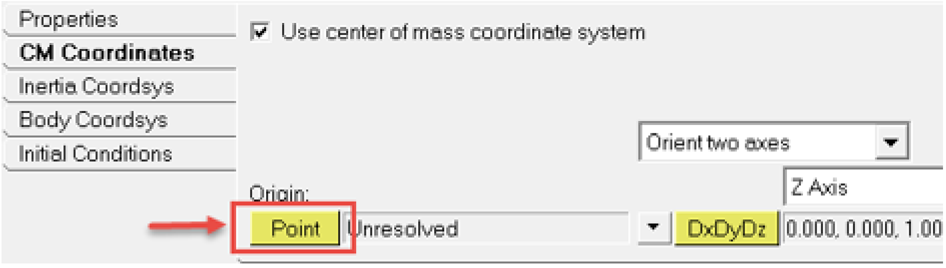
6. The **Hub** body is added in the **Project** browser.



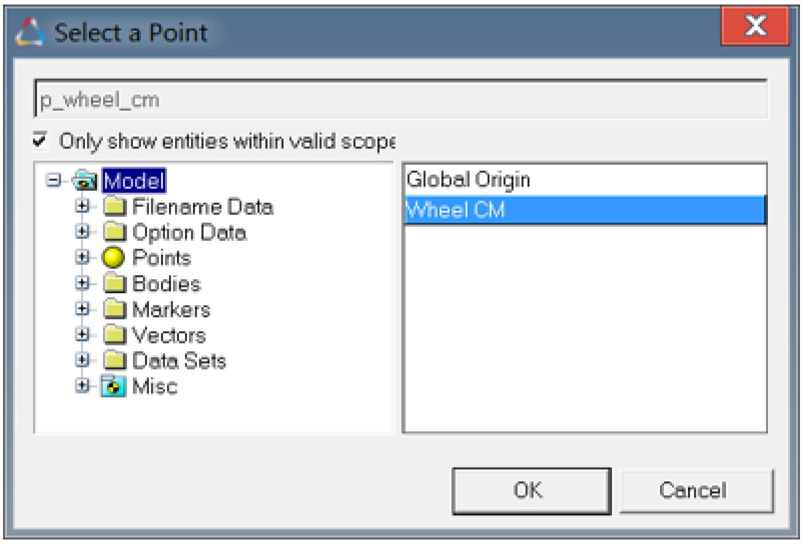
7. Click on the **CM Coordinates** tab of the **Hub** body to use the wheel center as the center of this body. Select the **Use center of mass coordinate system** check box.



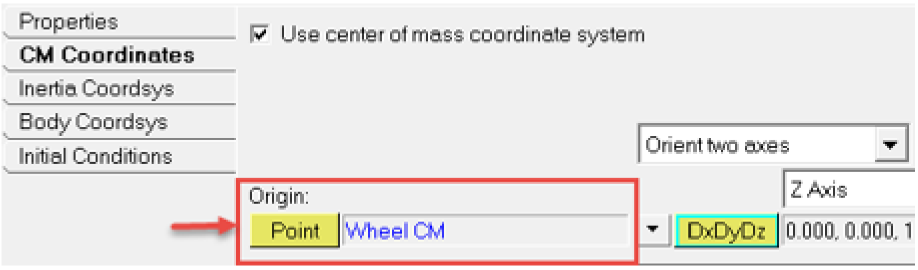
8. Double click the ***Point*** collector button in the panel area.



The **Select a Point** window opens. Select the ***Wheel CM*** point and click ***OK***.

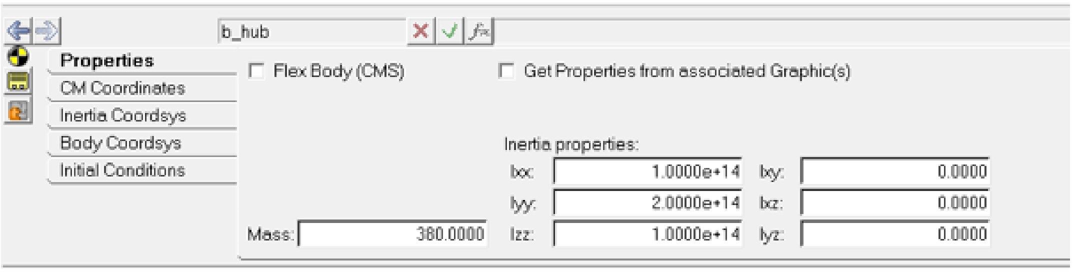


The wheel center is used as the center of the hub body.



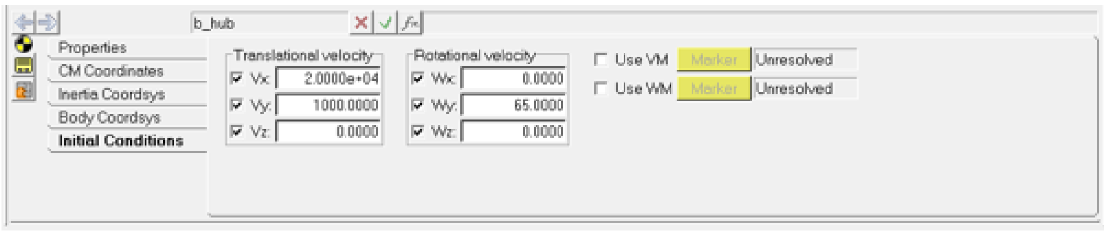
Updating Mass and Inertia Properties of the Hub Body

9. From the **Properties** tab enter the following data as shown in the image below to set the mass and inertia of the hub body.



Setting Initial Conditions to the Hub Body

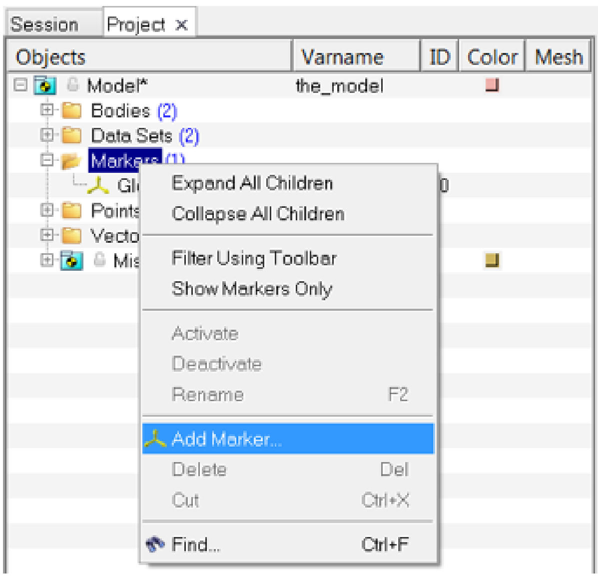
10. Enter the following data in the **Initial Conditions** tab as shown in the below image to set the initial conditions.



Note These initial conditions applied at the Hub body represent a tire+rim with an initial forward velocity **Vx** of *20000mm/s* and rotating at *65rad/s*.

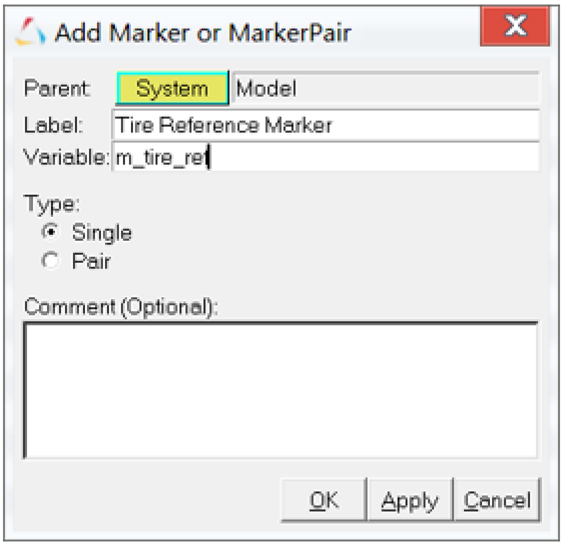
Adding a Marker to the Model

11. Right-click on the ***Markers*** folder in the **Project** browser and click on the ***Add Marker*** option from the context menu.

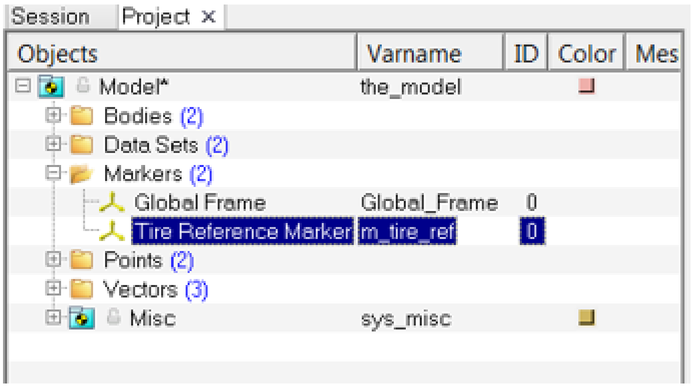


The **Add Marker or MarkerPair** dialog is displayed.

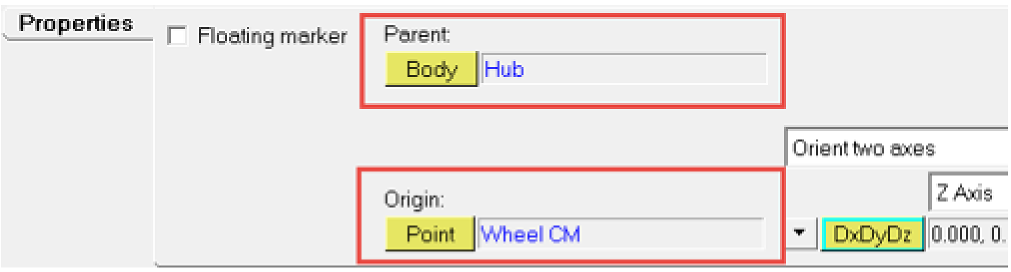
12. Enter `Tire Reference Marker` as the **Label** and `m_tire_ref` as the **Variable** and click ***OK***.



13. The **Tire Reference Marker** is added in the **Project** browser.

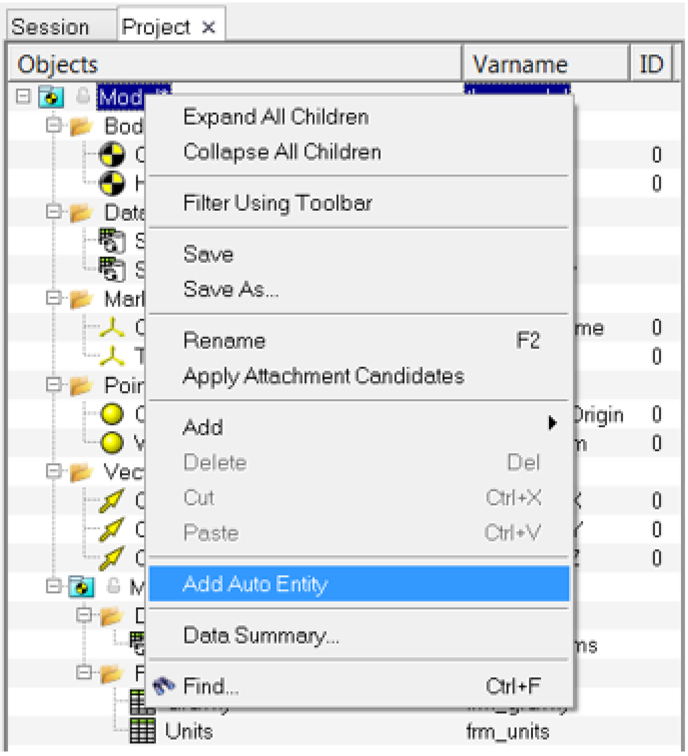


14. Use the **Body** and **Point** collector buttons in the **Properties** tab in the panel area to define the attachments for the marker by selecting the ***Hub*** as the body and ***Wheel CM*** as the origin.

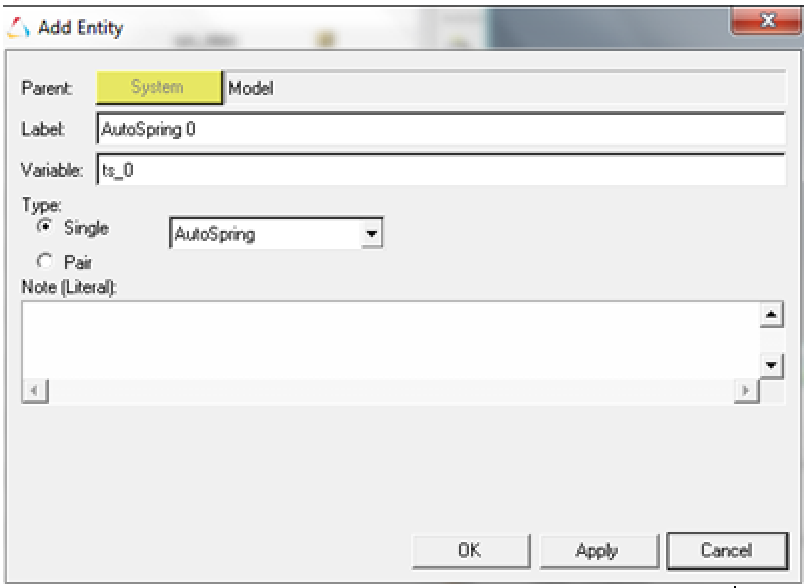


Adding an AutoTire Entity to the Model

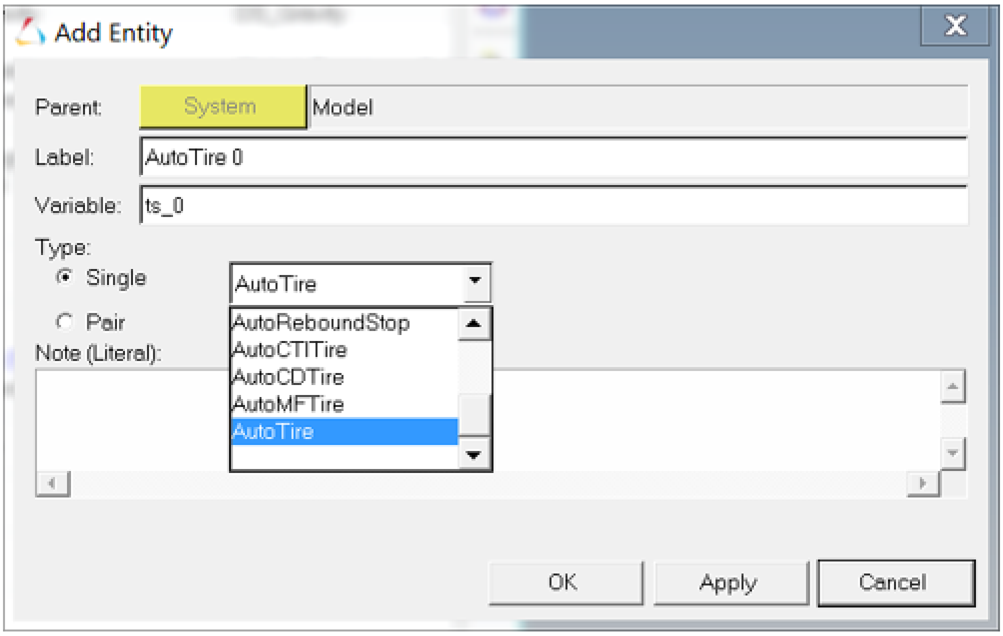
15. Right-click on the ***Model*** in the **Project** browser and select ***Add Auto Entity*** from the context menu.



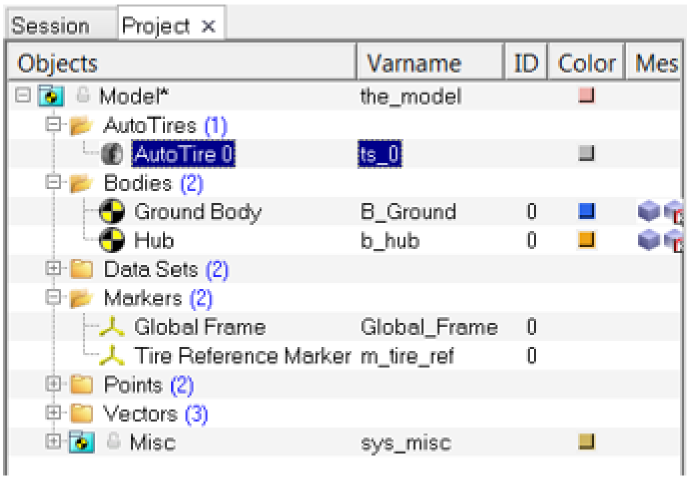
16. The **Add Entity** window opens.



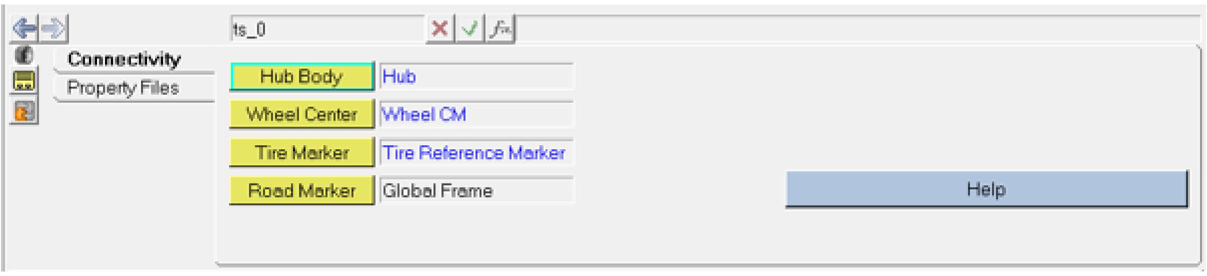
17. Select the ***AutoTire*** entity from the drop-down menu and click ***OK***.



18. The **AutoTire** panel is displayed in the panel area and the added auto entity is created in the **Project** browser.



19. From the **Connectivity** tab select the **Hub Body** as ***Hub***, **Wheel Center** point as ***Wheel CM***, **Tire Marker** as ***Tire Reference Marker***, and **Road Marker** as ***Global Frame*** to define the tire interface as shown in the image below.

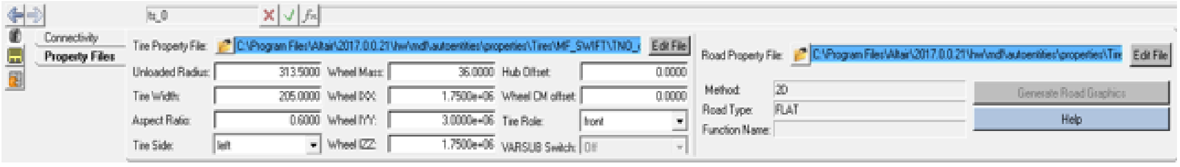


Note The AutoTire is defined by a **Hub Body**, **Wheel Center**, **Tire Marker**, and **Road Marker** where:

- **Hub Body**: The wheel body on which the tire forces act.
- **Wheel Center**: Point where the tire will be attached, usually the wheel center.
- **Tire Marker**: Reference marker which determines the direction in which the tire forces act.
- **Road Marker**: Reference marker of the road, it is the marker with respect to which the road is positioned and oriented for the simulation.

20. The Tire model is displayed in the MotionView graphics area.

21. From the **Property Files** tab, review the tire properties.



The AutoTire entity allows you to modify the tire properties as desired by editing the **Tire Property File**.

The graphic tire representation can be modifying by editing the properties field, such as **Unloaded Radius**, **Tire Width**, **Aspect Ratio**, and **Hub Offset**. Once the tire property file is loaded, some of the fields will automatically get filled.

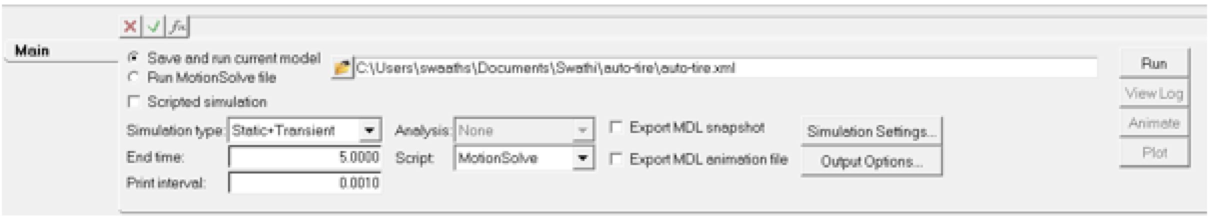
Note Changing the value in entry field will not change the values in tire properties file. These entry fields are meant to create tire graphic.

If you want to make changes to the file using the **Edit File** button, it is recommended that you save it with a different name and reload the file so that the graphic attributes get automatically filled in the graphical user interface.

Step 3: Running the Model in MotionSolve.

Once the tire model is created, it is now ready to run.

1. Save your model as **`Auto-Tire.mdl`**.
2. Click on the ***Run Solver*** toolbar icon, and rename the MotionSolve input to **`Auto-Tire.xml`**.
3. Select the ***Static + Transient*** option from the **Simulation** type drop-down menu and enter `0.001` in the **Print interval** field.

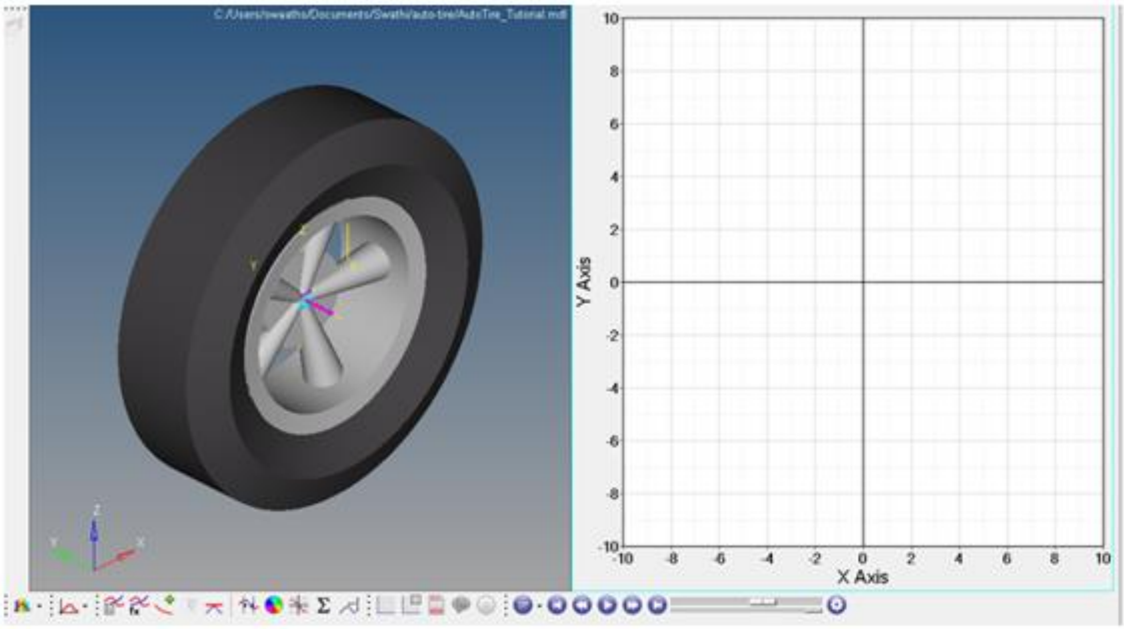


4. Click the ***Run*** button.
5. After the MotionSolve is complete, the **View Log**, **Animate**, and **Plot** buttons are enabled. These buttons allow you to plot results, look at an animation, or examine tabular results.

Step 4: Viewing the Simulated Results.

1. Click the **Plot** button to view the simulation results.

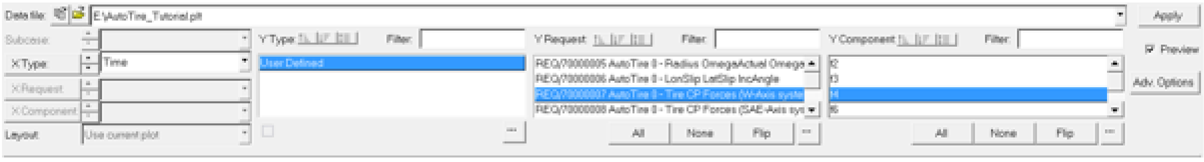
   The plot is displayed in the second window (on the right).



2. Click anywhere in the plot window and click on the ***Expand/Reduce*** button from the toolbar.

3. The plot window is expanded.

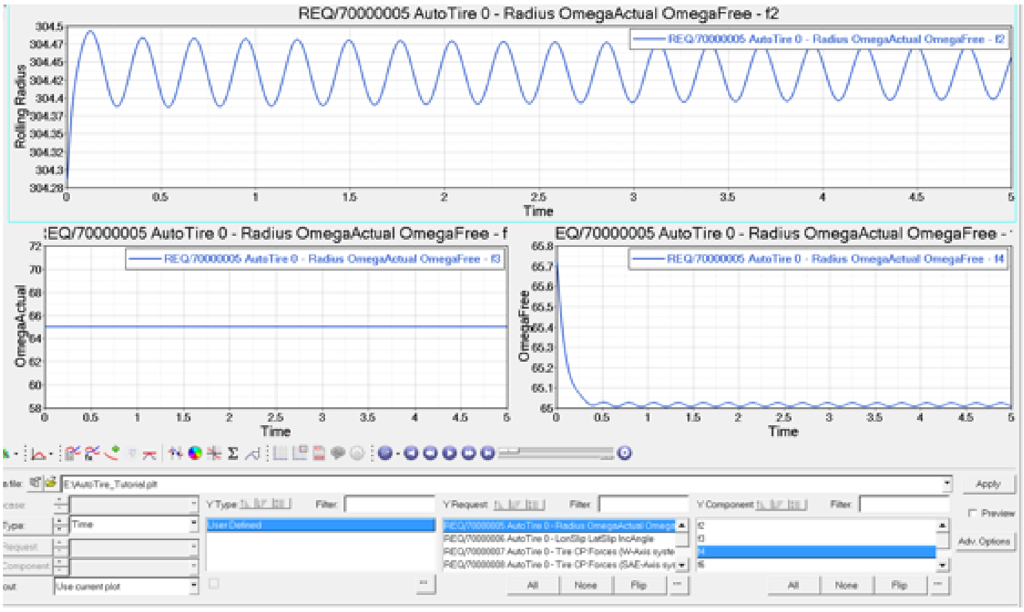
4. The AutoTire entity automatically creates tire outputs based on the simulation, which can be accessed from `.plt` file as shown below.



Output Plots:

Different output plots based on the simulation are explained briefly below.

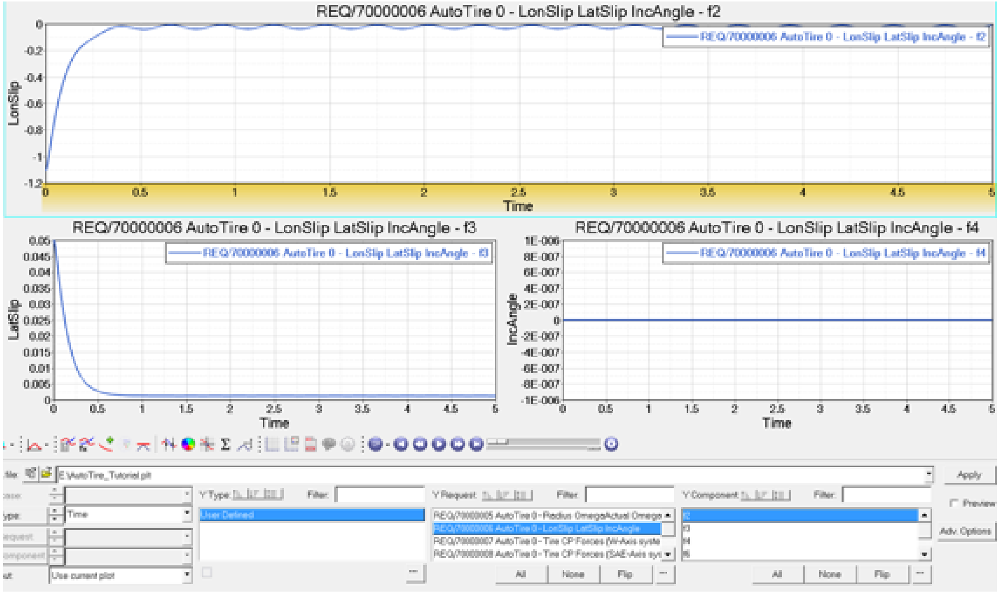
- ***REQ/70000005 Auto Tire0 – Radius OmegaActual OmegaFree***
  - f2 - Radius – Rolling radius of the tire.
  - f3 - OmegaActual – Angular velocity of the tire.
  - f4 - OmegaFree – Angular velocity at which the tire will be having a zero slip ratio.



- ***REQ/70000006 Auto Tire0 – lonSlip latSlip IncAngle***

  The following outputs are available in both ISO and SAE co-ordinate systems. The one shown in plots are in ISO.

  - f2 - LonSlip - Slip Ratio or Longitudinal slip in percentage. In this case the tire is rolling freely therefore the slip ratio is approximately 0.
  - f3 - LatSlip - Lateral slip starts from 0.05 as lateral slip is the ratio of Vy and Vx. In our case Vy/Vx = 1000/20000 = 0.05
  - f4 - IncAngle – Inclination Angle of the tire from XZ plane.



- ***REQ/70000007 Auto Tire0 – Tire CP Forces (W-Axis system)***

  The Tire contact patch forces are available in both W and SAE axis system. The one shown in plots are in W-axis System.