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Altair MotionView 2019 Tutorials

MV-3023: Optimization of a Suspension

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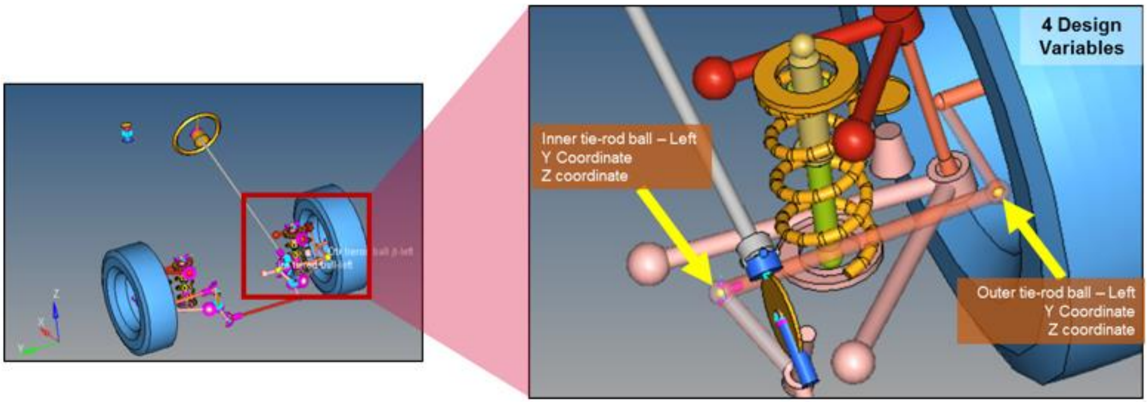
MV-3023: Optimization of a Suspension

In this tutorial you will learn how to setup an optimization problem using MotionView's Optimization Wizard for a suspension model. This model is taken from MotionView tutorial MV-3010. You will learn about:

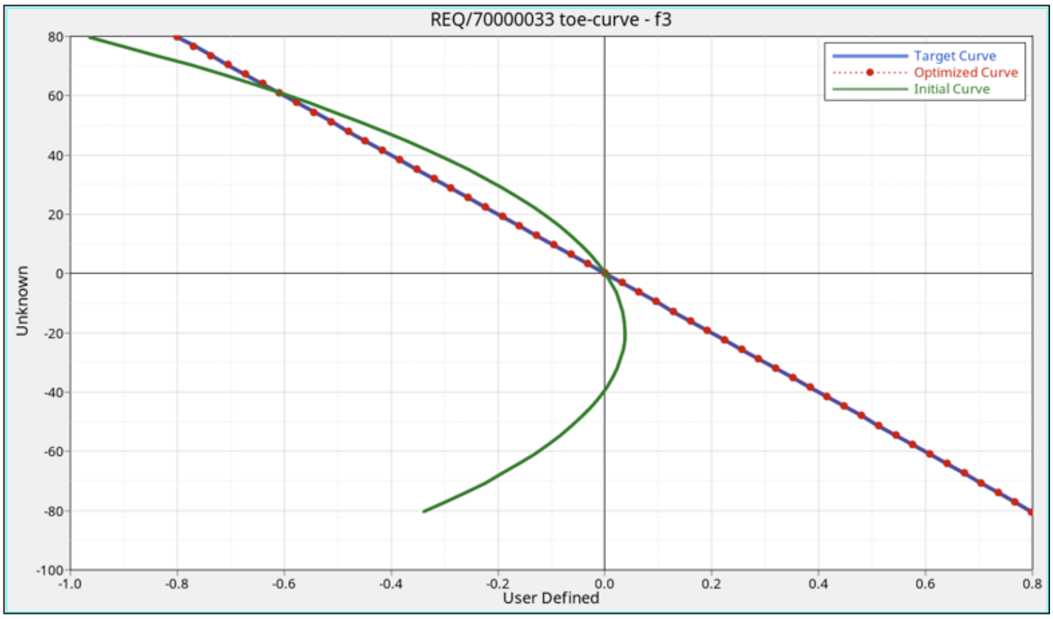
- Defining point coordinates as design variables
- Defining a response type 'Root Mean Square Deviation' for matching curve
- Using the responses as objectives
- Running the optimization and comparing the results in HyperGraph

Introduction

In this tutorial, you will reproduce the suspension optimization problem in MV-3010 (Optimization using MotionView - HyperStudy). The location (y and z coordinates) of both inner tie-rod ball joint and outer tie-rod ball joint are changed so that the toe vs. ride height curve matchs a given desired target curve.



Suspension Topology to Optimize



'Toe-ride height' curve of initial design, optimized design and target design

You can compare the difference between MotionSolve optimization and MotionView + HyperStudy optimization and learn the benefits of each method.

Model Setup

Copy the file `mv_3023_initial_susp_opt.mdl` and `target_toe.csv` located in the `mbd_modeling\motionsolve\optimization\MV-3023` into your `<working directory>`.

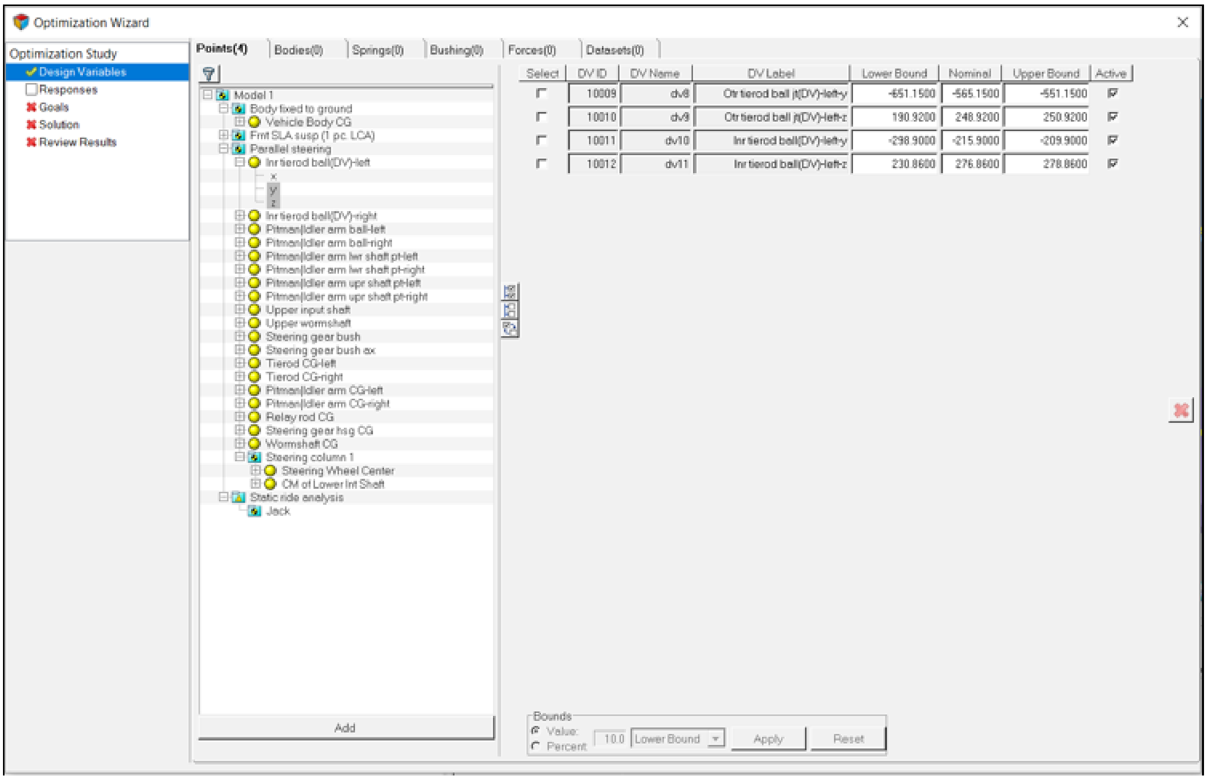
Step 1: Adding Design Variables.

1. Open `mv_3023_initial_susp_opt.mdl` in MotionView.
2. Right-click on ***Model*** in the browser and launch the **Optimization Wizard**.
3. Under **Design Variable**, click on the ***Points*** tab.

   All points listed are shown below.
4. Make the y and z coordinates of inner tie-rod ball joint and outer tie-rod ball joint designable.
   a. Go to point **Otr tierod ball jt - left** under the **Frnt SLA susp (1 pc LCA)** system. Expand the data member of it and select y and z. Click ***Add***.
   b. Similarily, add y and z data members of point **Inr tierod ball - left** under the **Parallel steering** system.
   c. Change the upper and lower bound of Dvs based on the table below.

DV	Lower Limit	Upper Limit
Otr tierod ball jt(DV)-left-y	-651.15	-551.15
Otr tierod ball jt(DV)-left-z	190.92	250.92
Inr tierod ball(DV)-left-y	-298.9	-209.9
Inr tierod ball(DV)-left-z	230.86	278.86

The optimization wizard should look like the following image after creating design variables:



Optimization Wizard after creating design variables

Now, the Response Variables can be added.

Step 2: Adding Response Variables.

The objective of the optimization is to make the toe vs. ride height curve match a target design. The model already has the desired target curve defined and it will be used in the response being created.

1. Go to the ***Responses*** page. Add a response variable using the  button.
2. In the response variable panel that appears choose ***Response Type***, ***Root Mean Square Deviation***.

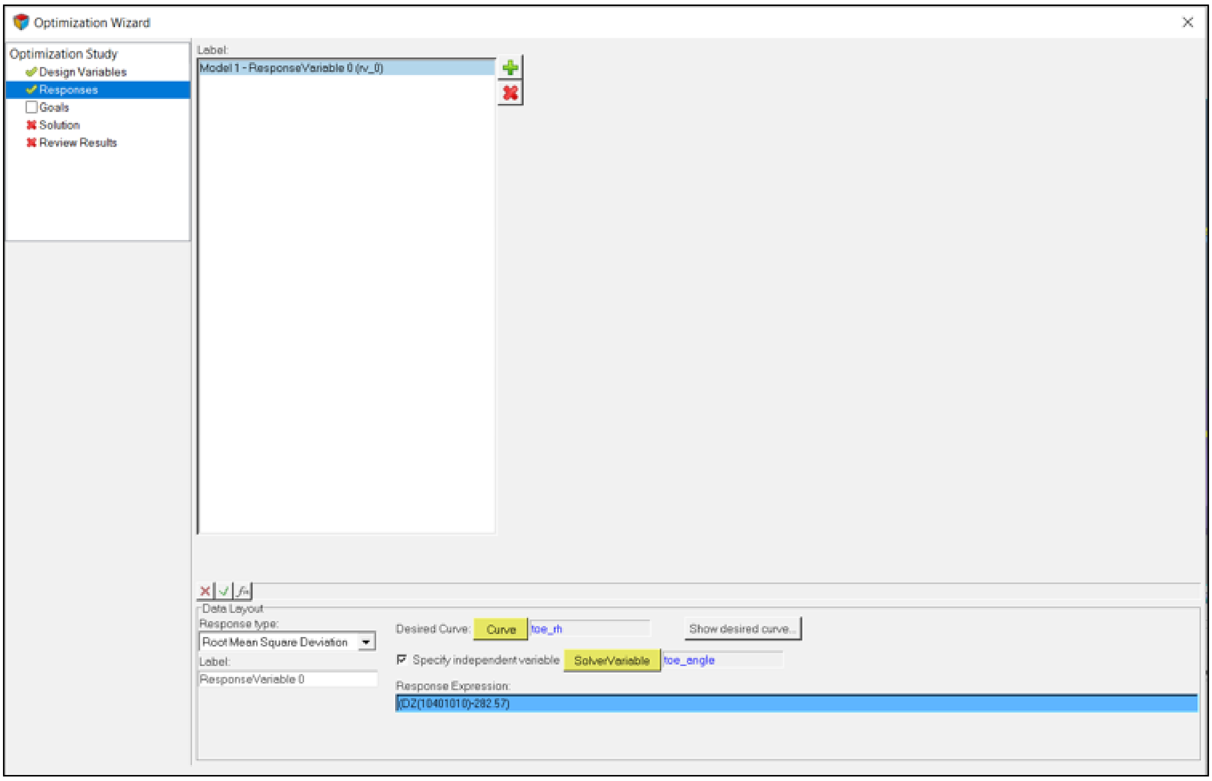
   This response needs three inputs from the user:

   - Desired Curve – This is the target curve.
   - Response Expression – This is the value we measure.
   - Independent Variable – This defines the independent variable used to calculate the target value.
3. Choose '***toe_rh***' for **Desired Curve** by clicking on the ***Curve*** button.
4. Activate the ***Specify independent variable*** check box. Select SoverVariable ***toe_angle*** by clicking ***SolverVariable***.

5. For **Response Expression**, type in the expression for ride height:

   ```
   `(DZ({MODEL.sys_frnt_susp.b_wheel.l.cm.idstring})-282.57)`
   ```

This completes the creation of the response. The user interface should appear as shown below.



Optimization Wizard after creating response variable

Step 3: Adding Objectives and Constraints.

The problem has only one objective: matching the toe-ride height curve with the target design.

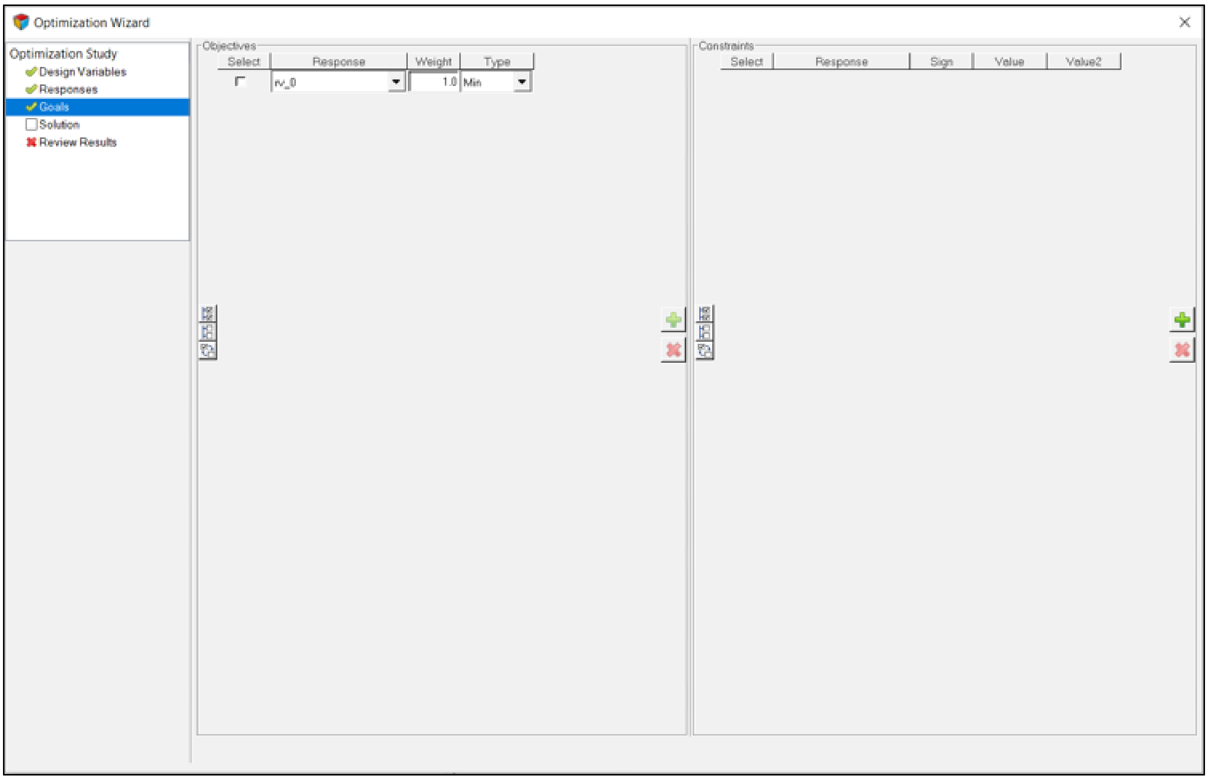
We can add responses that have been created in the previous section as objectives.

1. Go to the **Goals** page. There are two sections: **Objectives** and **Constraints**.

2. Click on the  button under **Objectives**.

   An objective is added with response **rv_0**.

The model setup is now complete and it is ready to be run.

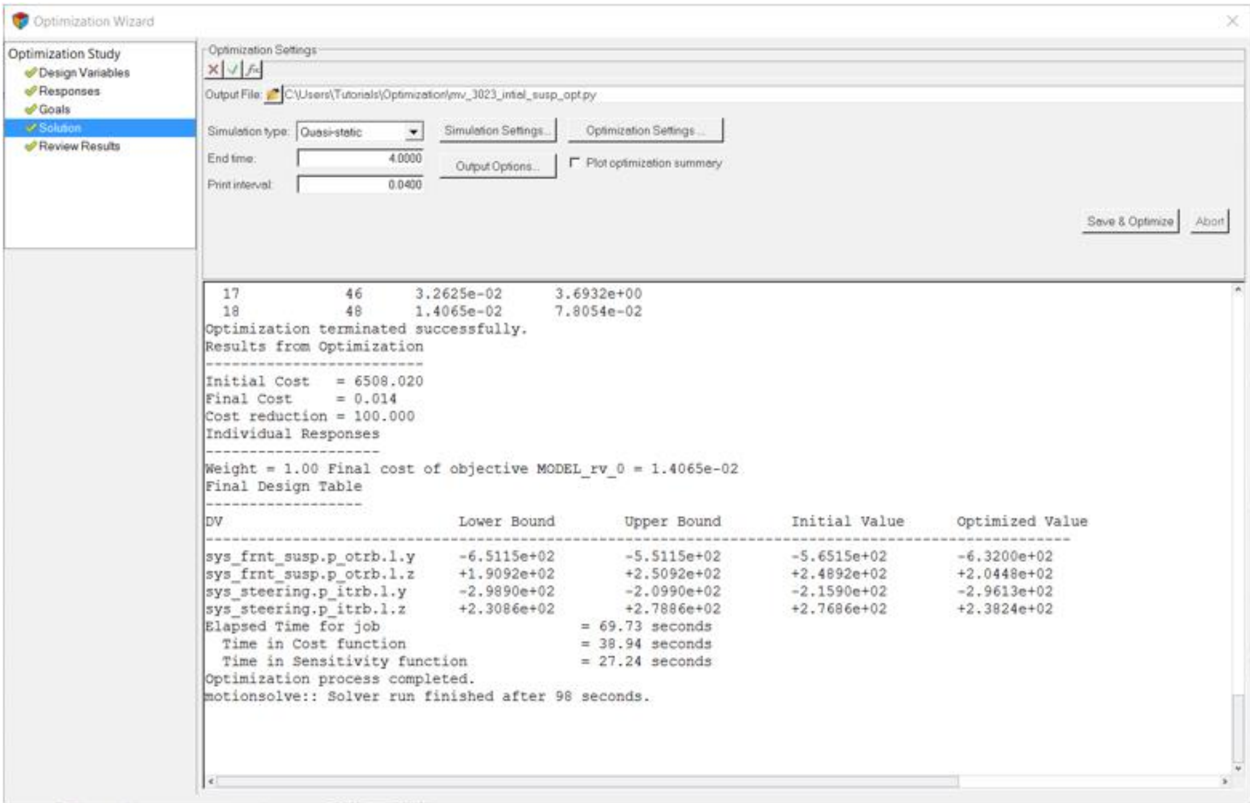


Defining objectives

Step 4: Running the Optimization.

In the Solution page, we can specify optimization settings and run the analysis. Please note that the model is saved before running, and if you do not want the optimization settings to be saved in the model, you can choose to save an mdl file in a different name before starting the optimization. This can be done by closing the wizard, saving the model with a different name and returning to the Solution page of the wizard.

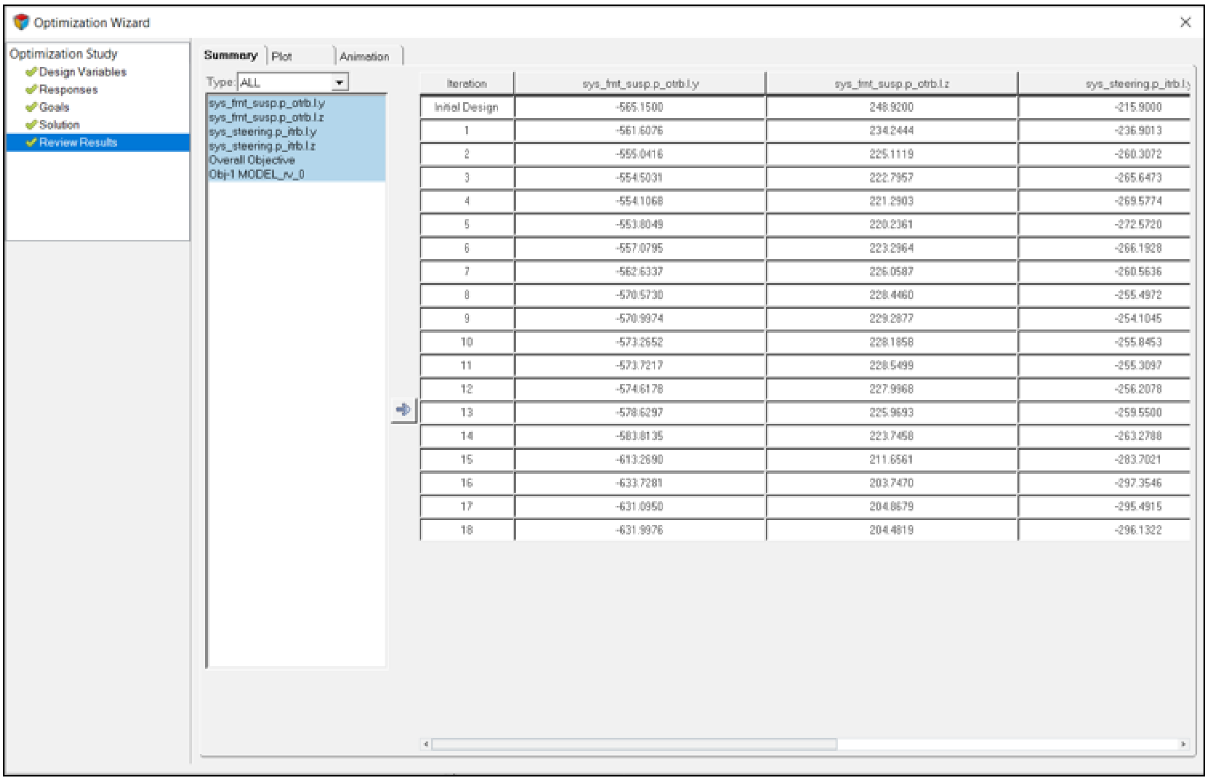
1. Click on ***Save & Optimize*** to run the optimization.



Solution Settings

Step 5: Post-processing

1. Once the optimization process is complete, review the result by clicking on ***Review Results*** page. The summary window should look like the following:



Iteration	sys_fmt_susp.p_otrb.l.y	sys_fmt_susp.p_otrb.l.z	sys_steering.p_itrb.l.y
Initial Design	-565.1500	248.9200	-215.9000
1	-561.6076	234.2444	-236.9013
2	-555.0416	225.1119	-260.3072
3	-554.5031	222.7957	-265.6473
4	-554.1068	221.2903	-269.5774
5	-553.8049	220.2361	-272.5720
6	-557.0795	223.2964	-266.1928
7	-562.6337	226.0587	-260.5636
8	-570.5730	228.4460	-255.4972
9	-570.9974	229.2877	-254.1045
10	-573.2652	228.1858	-255.8453
11	-573.7217	228.5499	-255.3097
12	-574.6178	227.9968	-256.2078
13	-578.6297	225.9693	-259.5500
14	-583.8135	223.7458	-263.2788
15	-613.2690	211.6561	-283.7021
16	-633.7281	203.7470	-297.3546
17	-631.0950	204.8679	-295.4915
18	-631.9976	204.4819	-296.1322

Optimization Summary of MV-3010

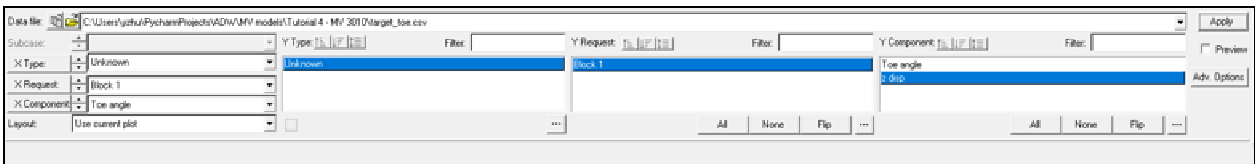
2. You can also review the plots and animation by going to the **Plot** and **Animation** pages as we demonstrated in previous tutorials. For this optimization, it is worthwhile to plot the toe – ride height curve for different iterations and see how the curve approaches the target one.

   a) Close the Optimization Wizard.

   b) Add an HyperGraph page to the session.

   c) Open the file `target_toe.csv`.

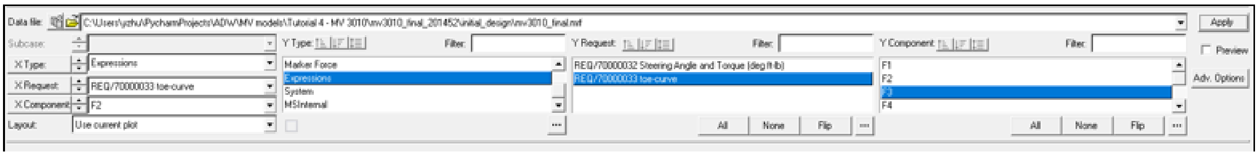
   d) In the plotting panel, change the 'type', 'request' and 'component' of both x and y as follows:



Settings to plot target curve

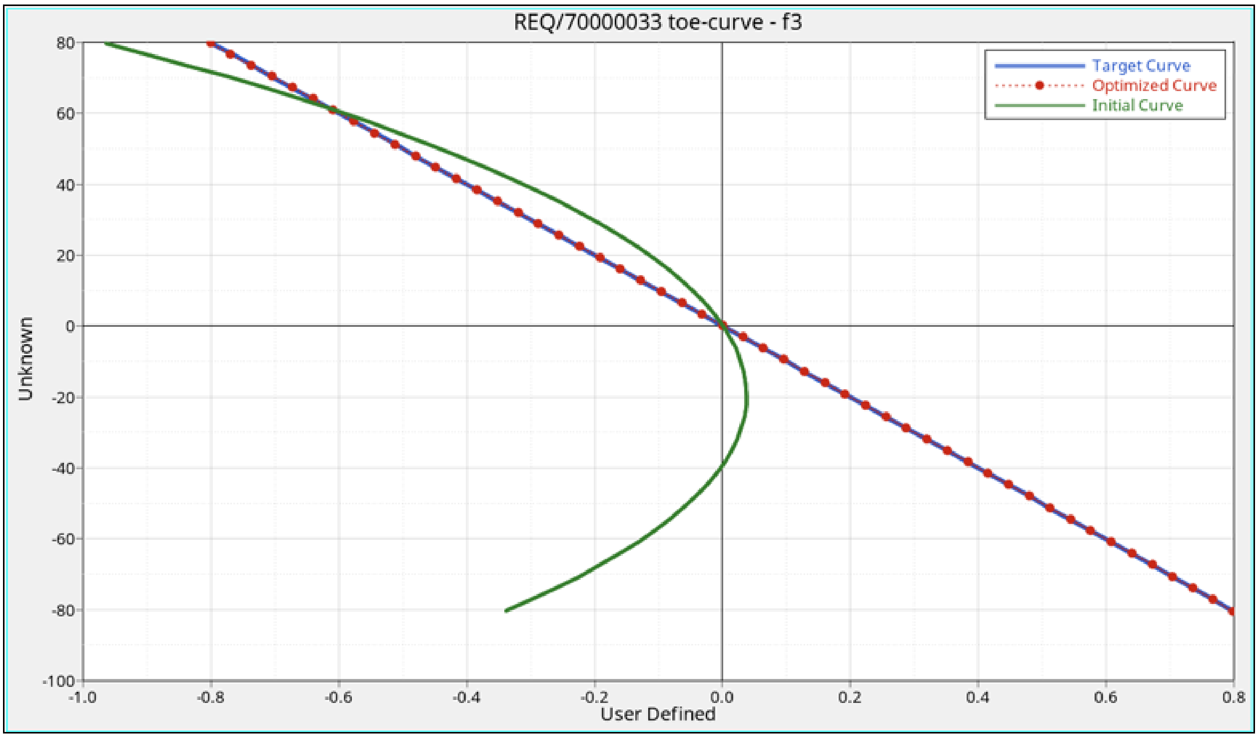
You should see a straight line in the plotting window.

3. Next, go to the subfolder **initial design** and load the mrf file in it.
4. Change the 'type', 'request' and 'component' of both x and y as follows:



Settings to plot initial design

5. Click ***Apply*** and you should see a convex curve representing the 'toe-ride height' of the initial design.
6. Now, go to the subfolder 'iter-18' (the last iteration).
7. Import the mrf file and plot the curve with the same setting.
8. The 'toe-ride height' curve of optimized design overlaps with the target curve.



Target curve, initial design and optimized design of MV-3010