

A Simulation App to Calculate Stiffness of Stabilizer Bar

COMSOL
CONFERENCE
2019 BANGALORE

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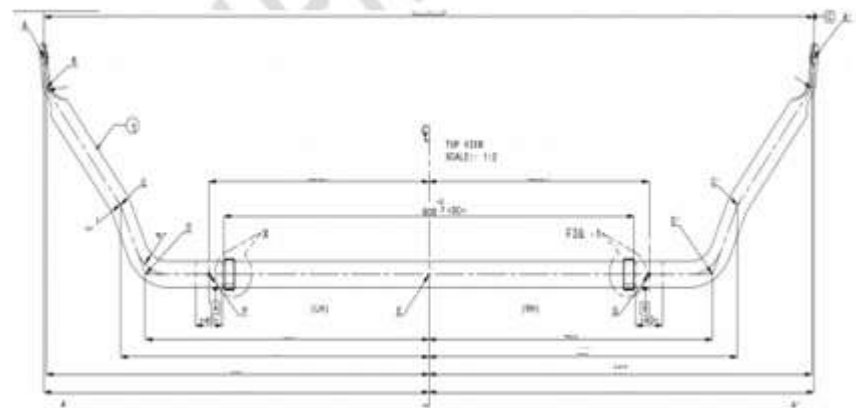
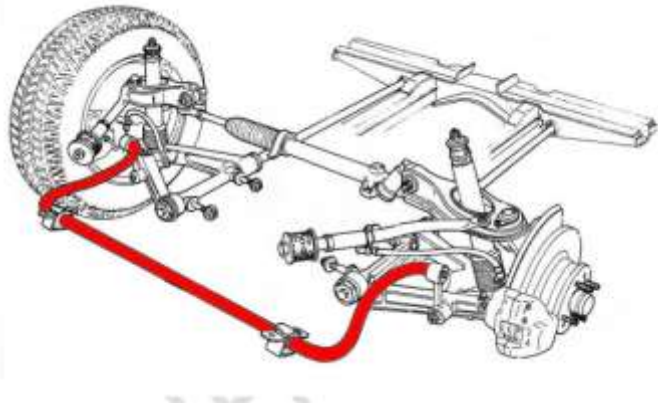
29th November 2019

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Introduction

- Anti-Roll Bars are the part of suspension system, its purpose is to resist the body roll during the cornering of the vehicle and prevent vehicle from waddling due to road surface providing ride comfort to passenger



- To achieve the required roll gradient, we have to target roll stiffness which in turn decides the Stabilizer bar stiffness

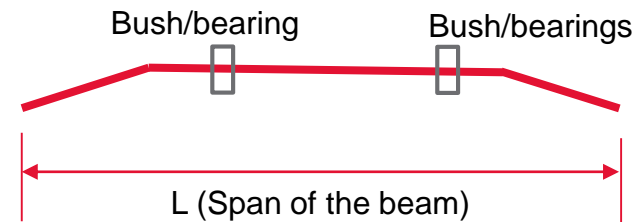
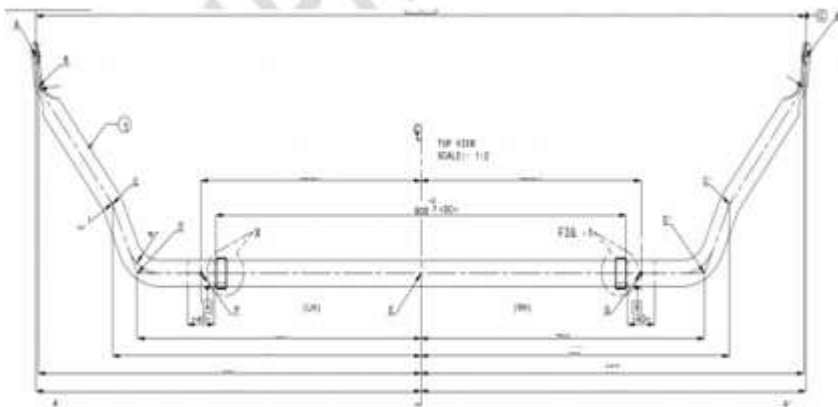


Simulation Objective

- The objective of this application is to compute the stiffness of Stabilizer Bars under different load cases with and without bushing
- To reduce the iterations in the FEM to achieve target metrics during the design at concept stage
- To design the geometrical aspect of bar with determining number of bends using parametric study during packaging
- Build a Comsol application in Mathapps web based platform using Comsol server and custom developed methods

Modelling in Comsol

- The Anti-Roll bar is modelled in Comsol as beam with 6 combination of cases with loading at the ends, bushing/ bearing at the mid-way



- The roll gradient is formulated as:

$$\text{R.G. (deg/g)} = \frac{Mr}{Kr} \quad ; Mr = \text{Roll Moment}; Kr = \text{Roll Stiffness}$$

$$Mr = Fz * L;$$

- The calculated Roll gradient which is the target will be then used for further analysis

Modelling in Comsol

■ Parametrization of Geometry

No of Bends:

Parametrization Load cases and Bushing properties

Select the number of Bends: 2 Bends

Note: Solution time scales with number of bends

Note: All dimensions and coordinates are in mm

	X	Y	Z	Fillet
Point 1 (Eye LH):	-570.2	249.7	83.4	
Point 2:	-567	215	80	30
Point 3:	-457	80	74	50
Point 4 (Eye RH):	-420	0	0	

The application requires the co-ordinates of the two eye point of the ARB along with the Bends

■ Load Cases and Bushing

Select Load Cases: Load Case 1: Applied load with bushing

Applied Load: 1000 N

Bushing properties

Form

X Coordinate of LH Bushing: -315 mm

Width of LH Bushing: 30 mm

X Coordinate of RH Bushing: 315 mm

Width of RH Bushing: 30 mm

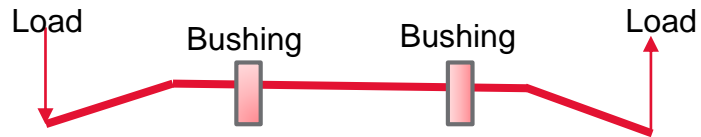
Translational Bushing Stiffness			Rotational Bushing Stiffness				
	LH Side	RH Side		LH Side	RH Side		
K_{xx}	3187	0	N/mm	K_{θ}	0	0	Nm/rad
K_{yy}	3187	3187	N/mm	K_{β}	0	0	Nm/rad
K_{zz}	2278.96	4095.05	N/mm	K_{γ}	0	0	Nm/rad

Note
Kindly refer the geometry for the coordinate nomenclature. Theta, beta and gamma are rotations about the X, Y and Z axis, respectively.

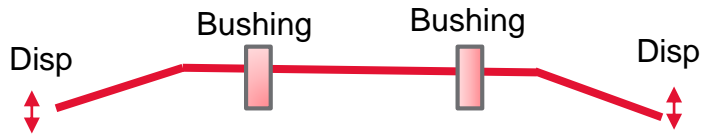
Several Load Cases and Bushings properties are defined to set boundary condition

Load Cases and Bushing

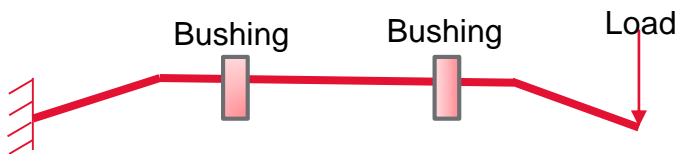
1. Load at both the ends and bushing applied



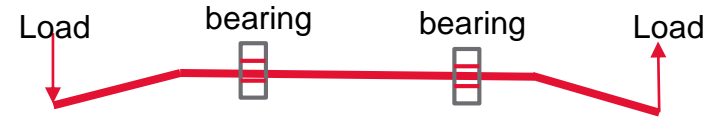
2. Displacement at both the ends and bushing applied



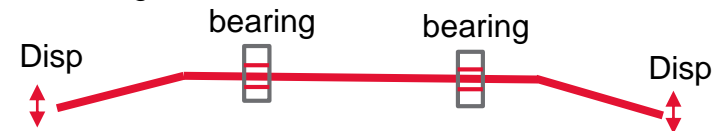
3. Load applied at one end, one end fixed and bushing applied



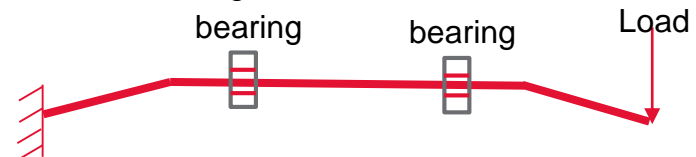
4. Load applied at both the end without bushing



5. Displacement applied at both the ends without bushing



6. Load applied at one end, one end fixed and without bushing



Application GUI in Comsol server

Stiffness Analysis of Stabilizer Bar

Parametrization: Load cases and Bushing properties

Select the number of Bends:

Note:
Solution time scales with number of bends.

Note: All dimensions and coordinates are in mm

	X	Y	Z	Filet
Point 1 (Eye LH):	-570.2	249.7	83.4	
Point 2:	-567	215	80	30
Point 3:	-457	80	74	50
Point 4 (Eye RH):	-420	0	0	

Select type of Stabilizer Bar:

Diameter of: mm

Material properties

Youngs Modulus: GPa

Poisson's Ratio:

Density: kg/m³

Geometry: Deformation Plot: Stress Plot

Results

Displacement, Stiffness and Reaction Force

Total displacement of the tip:

Stiffness of the Stabilizer Bar:

Information

? Solution not yet available.

Expected Computation Time:

Last Computation Time:

Application GUI in Comsol server

The screenshot displays the Comsol server application GUI with the following sections:

- Advanced Search:** Includes a search bar with the text "Search All Applications" and a "Search" button.
- QUICK LAUNCH:** A grid of application tiles:
 - Aerodynamic Forces and Moments
 - Braking Performance- Brake Proportionating
 - Braking Performance- Braking Efficiency
 - Data Resampling
- TESTIMONIALS:** A testimonial from Babasaheb Shinde (Brakes) stating: "Methods applications helps us to predict the braking performance at very early stages in design thereby saving time by more than a week. Moreover, the applications developed are easier to use and we expect to develop more analytical tools like this for aiding our design processes in future."
- BROWSE ALL APPLICATIONS:** A navigation panel with three columns:
 - BUSINESS UNIT:** Includes ADPD, FDPD, PTD, Common Utility Applications, Construction Equipment, and Powerol.
 - APPLICATION GROUP:** Includes Body Systems, Brakes, CAE-Crash, CAE-Durability, CAE-Dynamics, and CAE-PTD.
 - APPLICATION NAME - [9]:** Includes Body System Weight Distribution, Bowden Cable Load Efficiency, and Crush Space Calculator.

Results

After computation the below results values can be analysed

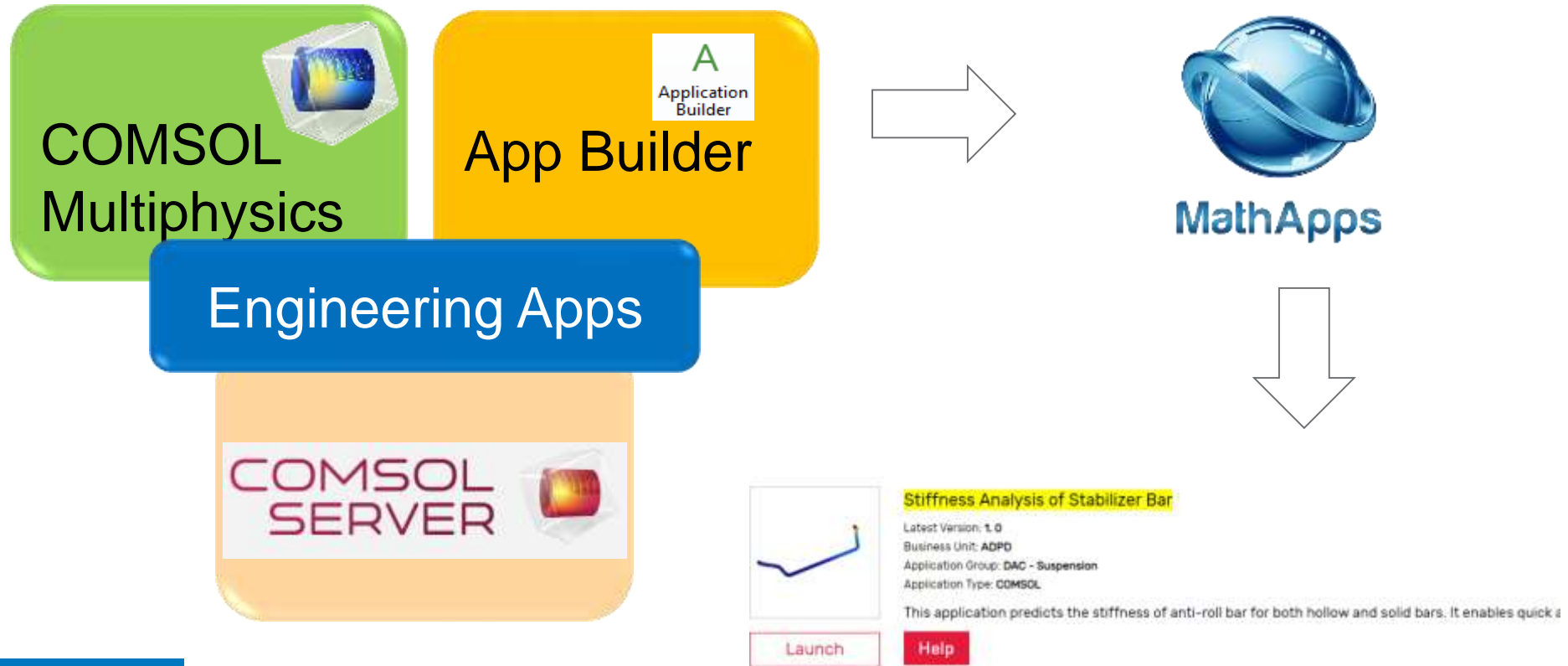
- Displacement at eye of the Stabilizer Bar
- Stiffness of the Stabilizer Bar



The results from this application give about 95% of correlation along with the success in mesh sensitivity analysis with the FEA

Web Based Mathapps GUI

- Deployment of the application on our web based portal across our organization “Mathapps”



Summary

- COMSOL App builder can be used to prepare the customize applications (GUI) based on user requirement
- The Roll stiffness of the vehicle Stabilizer Bar can be evaluated and compared with the target without relying fully to FEA simulation
- The designer can quickly evaluate the stiffness of stabilizer bars just by entering the coordinates, bushing locations, bushing stiffness, stabilizer diameter and thickness, material properties and choose from a pre-defined load cases which is beneficial in decisions related to packaging
- The web based portal deployment via COMSOL server gives access to any of the user across different locations in the organisation

Acknowledgements

- Dr. Akella Sarma SR, Head CAE, Mahindra Research Valley, Chennai
- David Neighuk, Former Employee, Mahindra & Mahindra Ltd.
- Nayak Bhargav, Sr Lead Engineer, Mahindra & Mahindra Ltd.

Thank you

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