

# Design Optimization of Stabilizer Bar Link Used In Sedan Vehicles

Farhan E M<sup>1</sup>, Dr.S.Sankar<sup>2</sup>, Tedy Thomas<sup>3</sup>, Deepak.V.K<sup>4</sup>

PG Student, Dept. of Mechanical Engineering, Nehru College Of Engineering and Research Centre, Thrissur,  
Kerala,India<sup>1</sup>

HOD, Dept. of Mechanical Engineering, Nehru college of engineering and Research Centre, Thrissur, Kerala, India<sup>2</sup>

Assistant Professor, Dept. of Mechanical Engineering, Nehru college of engineering and Research Centre, Thrissur,  
Kerala, India<sup>3</sup>

Assistant Professor, Dept. of Mechanical Engineering, Nehru college of engineering and Research Centre, Thrissur,  
Kerala, India<sup>4</sup>

**ABSTRACT:** Suspension is the system of tyres, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two. Suspension systems must support road holding, handling and ride quality, which are at odds with each other. Normally the ball joints on stabilizer bar link at either end deteriorate and develop lost movement which can be heard as a rattling or knocking noise. If this is ignored and the link rod actually breaks, the anti-roll bar becomes completely ineffective. In this project, an existing model of stabilizer bar link is designed in SolidWorks 2016 Edition, and analyzed the same in Ansys15.0. Then two modified designs are modeled with change in shape of the link rod and introduction of spring in ball joint housing. Modified designs are analysed and compared with the existing design. Three different materials such as Stainless steel, Titanium alloy and Grey cast iron has been analysed in order to find out the best suitable material for the stabilizer bar link. A suspension system is also designed according to the specification of a common sedan car, where the existing and modified stabilizer bar link is installed to and analysed. Static structural and modal analysis are done on the designed models and results are compared. From the results it can be concluded that spring introduced stabilizer bar link applied with stainless steel is the best choice for application in the suspension system of sedan vehicles.

**KEYWORDS:** Stabilizer bar link, Sway bar link, Ball joint, Titanium alloy, Stainless steel, Grey cast iron

## I. INTRODUCTION

A sway or stabilizer bar prevents the car body from leaning too much and keeps the vehicle stable when driving in turns. Most of the cars have one sway bar in the front and another separate sway bar in the rear suspension. Some cars have only one sway bar in the front suspension. Sports cars have thicker sway bars for better stability when cornering. A sway bar is connected via rubber bushings to the car body or frame in the middle. Outer ends of the sway bar are connected to the parts of the vehicle suspension that holds the wheel (struts or control arms). The part that connects the outer ends of the sway bar to the suspension component is called a sway bar link. In most cars a sway bar link has two small ball joints at each end. Over time, the sway bar link ball joints wear out. The first sign of a worn-out sway bar link is a knocking noise from the suspension when driving slow over road bumps. In rare cases, if the grease inside the sway bar link joints dries up, it may also make a creaking noise when the suspension is moving up and down. Your mechanic can check the sway bar links while performing a regular service with the car on the lift. A worn-out sway bar link will show a free play when pushed up or down. An extremely worn out sway bar link can separate. This will cause your car

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to lean excessively in turns and feel less stable and secure on the road. A worn-out sway bar link must be replaced to keep your vehicle safe.

## II. DESIGN PROCEDURE

This section deals with the process of modeling. Model is a representation of an object, a system, or an idea in some form other than that of the entity itself. Modeling is the process of producing a model; a model is a representation of the construction and working of some system of interest. A model is similar to but simpler than the system it represents. Generally, a model intended for a simulation study is a mathematical model developed with the help of simulation software. Softwares commonly used for modelling are SolidWorks, Creo, Catia, Unigraphics etc. In this project SolidWorks 2016 edition is used for the modelling process.

### Design of stabilizer bar link

Table 1 Dimensions of stabilizer bar link with spring



Fig.1 Stabilizer bar link with spring

S.no	Description	Dimensions(mm)
1	Length of the rod	230
2	Radius of the ball bearing	8
3	Radius of the flange	7
4	Length of the screw	21
5	Radius of the screw	4.25
6	Angle of the bend	20 <sup>0</sup>
7	Length of the spring	5
8	Radius of the bush	9.38

### Design of suspension system

Table 2 Dimensions of suspension system

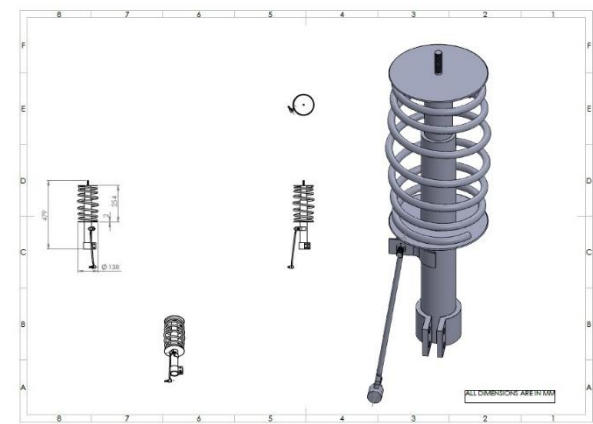


Fig.2 Suspension system

S.no	Description	Dimensions(mm)
1	Length of the spring	254
2	Radius of the spring wire	5
3	Total length of system	479
4	Radius of the flange	69
5	Thickness of the flange	2

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### III. ANSYS PROCEDURE

This section deals with the analysis of the designed model. The model that is in STEP format is analysed. Static structural analysis of both stabilizer bar link and suspension system is performed by applying the working load and number of supports used is two. The model is imported to Ansys and meshing is performed. The mesh size used is 4.4 mm. From the results obtained optimal design is selected. Suitable materials are applied to three different models of stabilizer bar link and modal analysis is performed. Different softwares such as Comsol, Radioss solver, Abaqus, Hypermesh, Ansys etc. are used for analysis. In this project Ansys R15.0 is used for design analysis.

#### Design analysis

The figure shown below represents the meshed image of total suspension system and the force application in the stabilizer bar link

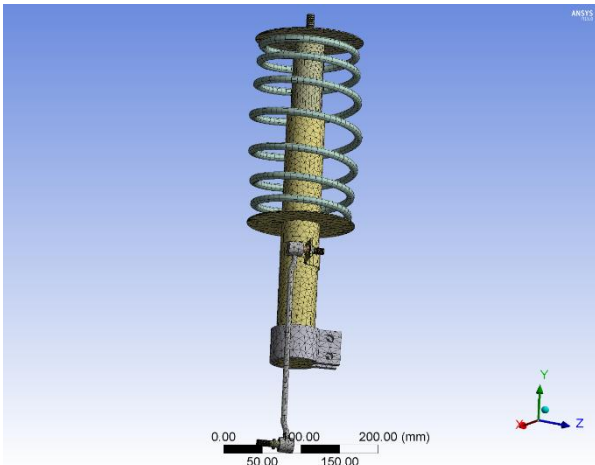


Fig.3 Meshed image of total suspension system

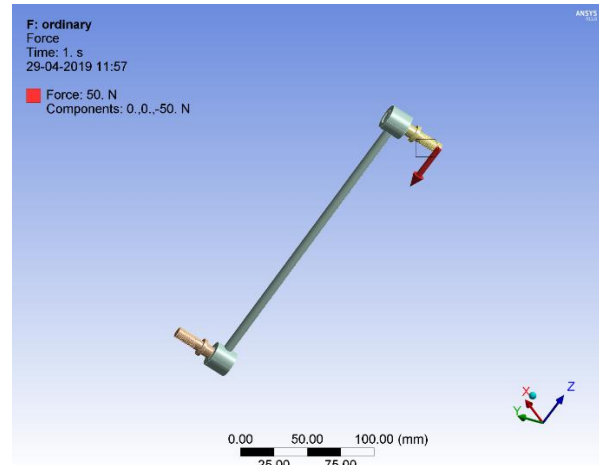


Fig.4 Force application in stabilizer bar link

The figure shown below represents the total deformation in the stabilizer bar link with spring

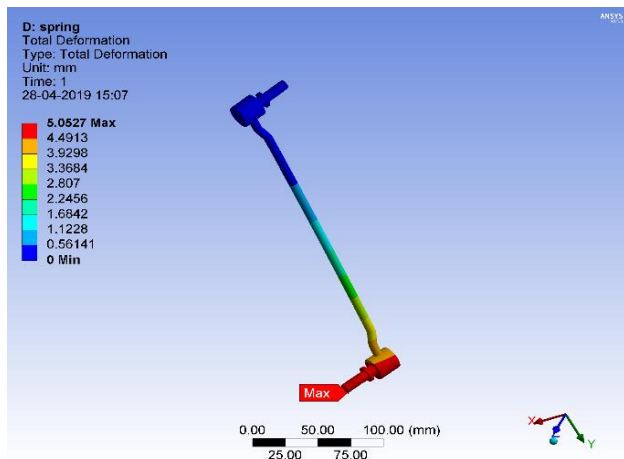


Fig.5. Total deformation of stabilizer bar link with spring

Table 3 Overview of analysis results

Sl.No	Stabilizer bar link	Total deformation(mm)
		Max
1	Ordinary	12.388
2	With change in shape	8.3413
3	Spring	5.0527

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From the analysis results it can be concluded that the stabilizer with introduction of spring have the least value of maximum total deformation. Hence stabilizer bar link with spring is selected for further analyses. The figure shown below represents the total deformation of suspension system with spring introduced stabilizer bar link

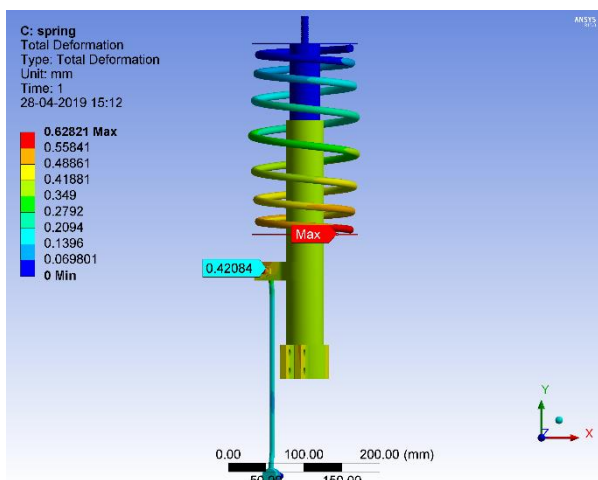


Fig.6 Total deformation of suspension system with spring introduced stabilizer bar link

Table 4 Overview of analysis results

Sl.No	Suspension system	Total deformation(mm)
		Max
1	With ordinary stabilizer bar link	1.3146
2	With shape changed stabilizer bar link	1.1602
3	With spring introduced stabilizer bar link	0.62821

From the analysis results it can be concluded that the suspension system with spring introduced stabilizer bar link have the least value of maximum total deformation. Hence suspension system with spring introduced stabilizer bar link is selected as the best suitable system.

### IV. MATERIAL OPTIMISATION

Table 5 Overview of analysis results of the stabilizer bar link using three different materials

Design parameter		Stainless steel	Titanium Alloy	Grey cast iron
Total deformation (mm)	Max	3.897	5.7353	5.0527
	Min	0	0	0
Directional deformation (mm)	Max	3.5731	5.1838	4.5908
	Min	0.031693	0.02174	-0.020947
Equivalent stress (MPa)	Max	309.75	589.98	541.49
	Min	0.0025005	0.0047771	0.0040365
Equivalent elastic strain	Max	0.0016135	0.0048922	0.0043833
	Min	3.1246e-8	6.8763e-8	5.7885e-8

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The above shown table represents analysis results of the stabilizer bar link using three different materials. Three different materials are applied to the stabilizer bar link with spring and the analysis results are compared to select the most suitable material. The three different materials used for analyses are Stainless Steel, Titanium Alloy, Grey Cast Iron.

### V. MODAL ANALYSIS

Table 6 Comparison of the natural frequencies of the three different models of stabilizer bar link      Table 7 Comparison of the natural frequencies of stabilizer bar link applied with different materials

Sl.No	Mode	Ordinary	Change in shape	With spring
1	1	22.082	25.32	30.066
2	2	24.047	25.681	31.487
3	3	247.3	250.93	240.77
4	4	253.13	256.91	241.26
5	5	344.15	311.87	350.93
6	6	466.47	460.54	508.87

Sl.No	Mode	Stainless Steel	Titanium Alloy	Grey Cast Iron
1	1	34.515	32.236	30.066
2	2	34.69	34.225	31.487
3	3	278.97	271.26	240.77
4	4	280.74	275.04	241.26
5	5	423.55	363.62	350.93
6	6	526.27	575.4	508.87

By comparing the results of modal analysis listed in the Table 6 and 7, it can be clearly understood that the spring introduced stabilizer bar link applied with stainless steel is the best suitable for the suspension system.

### VI. RESULT AND DISCUSSION

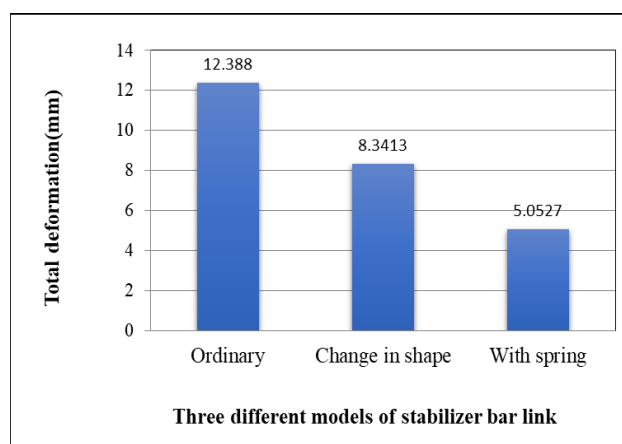


Fig. 7 Total deformation of three different models of stabilizer bar link

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From the above graph, we can see that the total deformation has reduced by 32.67% when the shape of the stabilizer bar link was changed compared to the ordinary shape. We can also see that the total deformation has reduced by 59.21% when a spring is introduced in the ball bearing housing compared to the ordinary one.

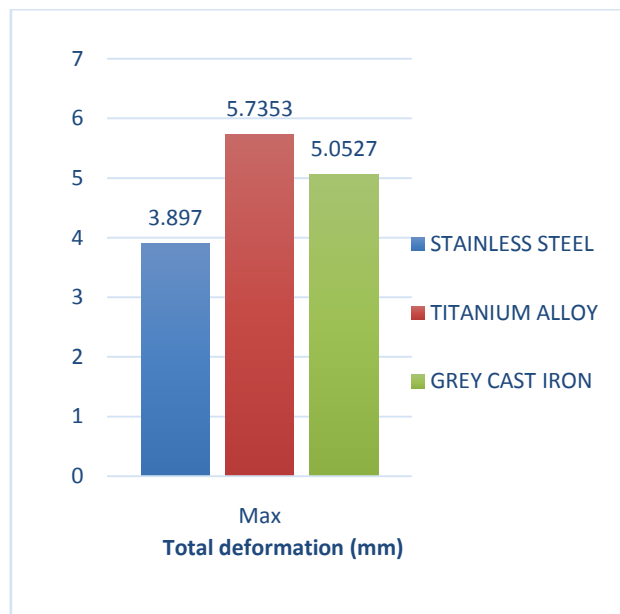


Fig 8 Comparison of spring introduced stabilizer bar link applied with three different materials.

From the above graph, we can see that the total deformation of the stabilizer bar link has reduced by 11.90% when it is applied with Grey cast iron compared to Titanium alloy. We can also see that the total deformation has reduced by 32.05% when it is applied with Stainless steel compared to Titanium alloy.

### VII CONCLUSION

In this project three different models of stabilizer bar link were designed using SolidWorks 2016 edition and the designed model was analysed using ANSYS R15.0. From the analysis results it was found out that stabilizer bar link with spring introduced in the ball bearing housing has minimum total deformation. Then a suspension system was designed according to the specification of a common sedan vehicle and was subjected to a force of 500N and it is here where the stabilizer bar link acts. After analysis it is found that the suspension system with spring introduced stabilizer bar link has the least total deformation. From the three different materials such as Stainless Steel, Titanium alloy and Grey cast iron applied, analysis results shows that the stabilizer bar link applied with Stainless steel provides least total deformation. Results on modal analysis show that stabilizer bar link with spring exhibits higher natural frequency. Modal analysis on spring introduced stabilizer bar link with three different materials such as Stainless steel, titanium alloy and Grey cast iron also proves that Stainless steel have higher natural frequency. From above results we can conclude that spring introduced stabilizer bar link applied with Stainless steel proves to be the best choice for improved performance in sedan vehicles.

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