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Finite Element Analysis of Anti-Roll Bar to Optimize the Stiffness of the Anti-Roll Bar and the Body Roll

Prof. Anup M.Gawande[1] Mr. Mandar.G.Dhage[2]

[1] Asst. Prof. Mechanical Engg Dept, STC SERT, Khamgaon, Maharashtra, India

[2]UG Student of Mechanical Engg, STC SERT ,Khamgaon, Maharashtra, India

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Abstra- *The objective of this paper is to analyze the main geometric parameters which affecting the stiffness of anti-roll anti-roll bar Finite Element software ANSYS is used. The deflection for the change in internal angle, arm length, moment of inertia, distance between bushes found by static analysis. To calculate the body roll angle equation used from the literature survey, however they haven't taken all the suspension characteristics in the calculation of moment caused by the suspended and non-suspended masses. The equilibrium condition is considered between the moments of the force acting on the suspended and non-suspended masses and moments of reaction of the springs and anti-roll bar used in suspensions. The comparison of different anti-roll bar is based on the basis of stiffness per weight. The anti-roll bar which having more ratio of stiffness per weight can be used in the vehicle. As it will improve the stiffness of bar with small increase in weight, which will result in the improving roll stability of the vehicle.*

1. Introduction

Automobile industry focus on producing element which give handling and performance of the vehicle better than today's vehicle but such element should not produce the extra cost and also it should be improve the comfort level of the vehicle that is to the passenger. Anti roll bar is one of the inventions in the automobile industry which is also called as sway bar or stabilizer bar. Structure of such anti roll bar are U shaped bar which connect two wheel that is left and right wheel and bar is fixed to the chassis of the vehicle by bush .Anti roll bar may be solid or hollow tube. The main function of anti roll bar is reducing body roll motion when the vehicle is at the cornering condition. Body roll condition occurs due to the load transfer and changes takes place in the camber of vehicle which directly affect the steering behaviour of the vehicle and vehicle loses its stability therefore to eliminate the roll effect in case of under steer and over steer anti roll bar is used. Anti roll bar give comfort in driving condion and safety in case of such roll situation.

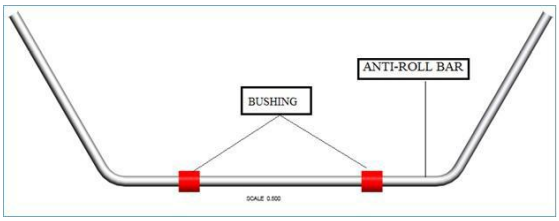

Fig-1 anti-roll bar with bus

When both the suspension affected simultaneously then the effect of the anti roll bar is eliminated. when one of the wheel moves opposite of the other then anti roll bar acts like the torsion spring and it will provide the torque such that it will oppose the motion of the vehicle so that tilting motion of the vehicle will

2. Methodology

To achieve target of the paper we have done different geometrical variation in anti-roll bar that is we have variation in length of bar, variation in the distance of bush, variation in the angle between two arms of bar, varying the moments of inertia of the bar and by using the different cross section at the end of ant-roll bar. For analysis we have used simple geometry of anti-roll bar and to calculate the stiffness of the anti-roll bar we have used the finite element method that is by using software. In this paper we consider the use of anti-roll bar at the rear suspension of the vehicle.

In this paper we have considered the geometrical variation of anti-roll bar and considered the response in terms of deformation by applying the load which having magnitude of 1KN after applying this load deflection is found in software. We have considered the absolute value of deflection only. The main purpose to find the deflection of the anti roll bar is found out the rigidity of the anti roll bar. In this analysis we have draw simple model of anti-roll bar which mean that obtained result will not be result in the reality that

is we can get the variation in the stiffness of bar and roll motion of the vehicle.

In first case we have considered the following parameters 1. α (alpha) = 600. 2. S = 350 mm. 3. A and B: solid geometry having an outer diameter of 20 mm, Ao = 314.2 mm2, I = 7854 mm4 e, J =15708 mm4. 4. Different weights of the anti-roll bar
Whereas I is moment of inertia, Ao is the outer diameter of the bar and J is the polar moment of inertia. The profile of the anti roll bar, moment of inertia, area of cross section is same in case of the analysis of first case. We can get the weight increase of the anti-roll bar which is due to the increase in the length of bar.

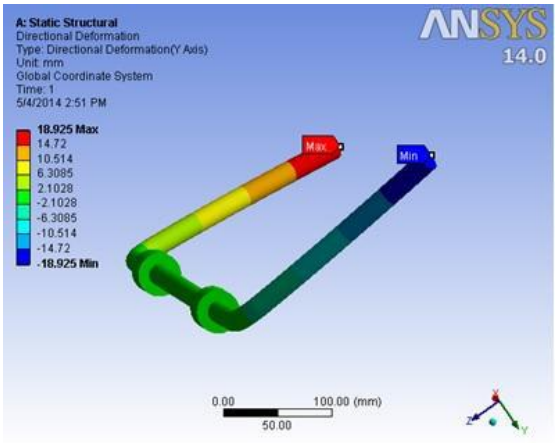

Fig.2 Anti-roll bar analysis

This topic focuses the work did in the software's for the analysis of the antiroll bar used in the vehicle. A Maruti Alto K10 model was used as the test vehicle to verify the results of the simulations. Nylon is used as alternative material for anti-roll bar with, anti-roll bar of nylon material has diameter 1.5 times diameter of anti-roll bar of mild steel material. The 3D model of the anti-roll bar is developed in the CATIA V5 R20 as depicted in The model is developed after measuring the dimensions of the anti-roll bar in the 3D modelling environment.
1. The boundary conditions and the constraints are applied on the model to simulate actual condition

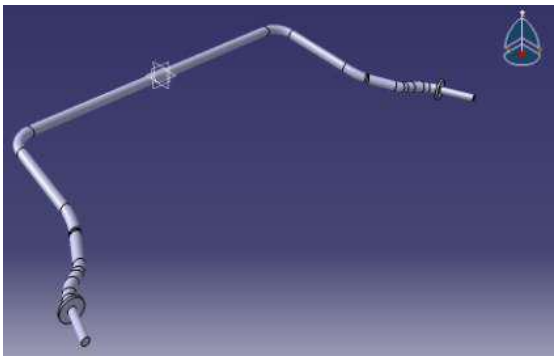

Fig.3- 3D Modelling of Anti-Roll Bar

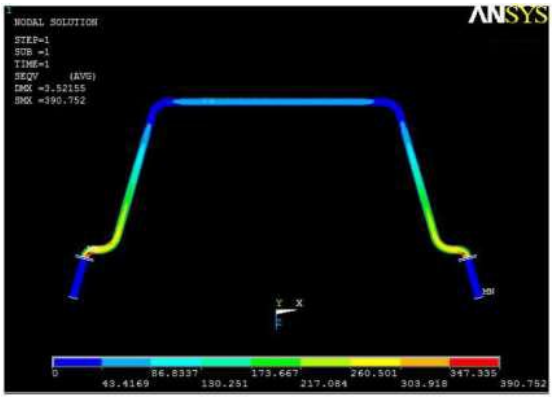

Fig.4- Analysis of Anti-Roll Bar in ANSYS

2. Depicts the finite element modal of the antiroll bar in ANSYS. For meshing 10 circumferential and

3. Radial subsections are used for solid circular cross-section and extruded throughout axis of anti-roll bar. The bar will be meshed with BEAM189 elements. Anti-roll bar only is free to rotate in bushing. Therefore loads are applied at free ends of anti-roll bar to its relative moment

3. Result

Fig. 3 and 4 shows torsion (N.mm) Vs. angular displacement graph of both anti-roll bar. Torque in both graph taken same and effect on angular moment are placed. The ANSYS analysis on anti-roll bar of mild steel of diameter of 22 mm. and effective length of 670 mm. is considered for the analysis. Quarter weight of car is used for applying load on one end of anti-roll bar i.e. 1766 N is applied. The maximum angular displacement on rod is 0.175 red and the results are shown on the Fig.3. The Fig.4 shows the ANSYS results for anti-roll bar of nylon of diameter 33 mm. Same load is applied on one end so maximum angular

displacement on rod is0.0875 rad. Hence it is justified that the Nylon can be used as anti-roll bar

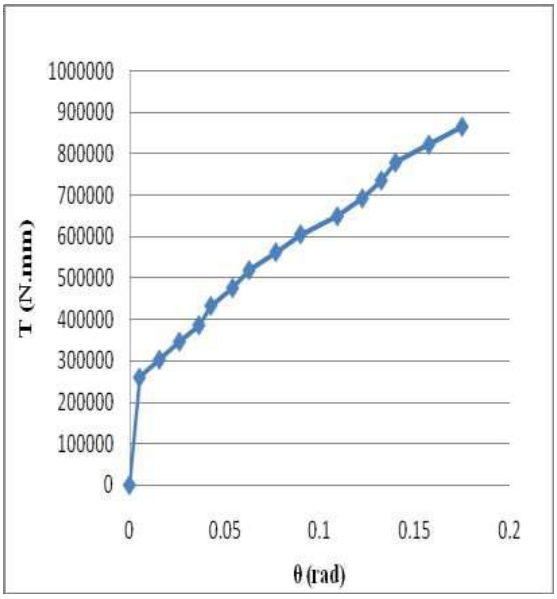

Fig.5- Analysis on Mild Steel Anti-Roll Bar

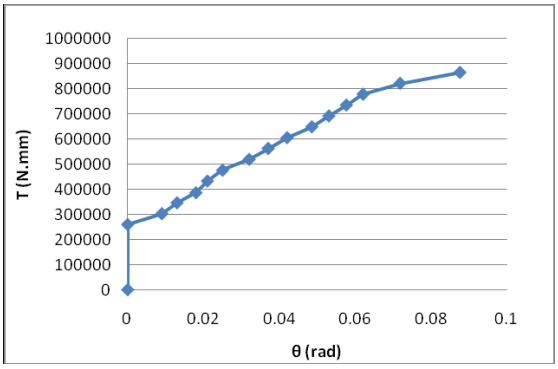

Fig.6- Analysis on Nylon Anti-Roll Bar

4.Conclusion

The ANSYS results of the anti-roll bar shows favourable results to select Nylon as alternative material for anti roll bar. However in practice the anti-roll bar will not be rotated in rotation, it's only produce twisting effect. From ANSYS result it shows tensional stiffness of nylon anti-roll bar is higher than for M. S. , but M. S. is used
due to cost and easy mach inability. From analysis it is seen that though the diameter of nylon anti-roll bar is increased, the angular deflection and weight decreases compare to M.S. anti-roll bar. This reduction in weight often un-sprung mass of the vehicle also helps to reduces fuel consumption

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