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Review on Coil Spring

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A B S T R A C T

In the automobile sector suspension system plays an important role as it absorbs the shocks and makes the vehicle stable. The suspension system is usually classified into Dependent and Independent suspension systems. The independent suspension system has independent suspension on all the wheels. The independent system uses swing axles but the modern system uses Chapman or Macpherson struts, trailing arms, multilink, and wishbones. Among various components of the suspension, spring plays an important role along with the shock absorber. Various springs are used among leaf spring, torsion spring, Belleville spring, and many more the coil spring is a commonly used spring for suspension systems. In this review paper, there will be a comparison between the design modeling and static analysis of the primary suspension coil spring.

Keywords: Coil Spring, helical spring, geometrical comparison, material comparison, spring design

1. INTRODUCTION

The suspension system plays a vital role in a comfortable ride posture for passengers in addition to protecting the chassis and other working parts from getting damaged due to road shocks. A basic suspension system consists of the parts springs, axles, shock absorbers, arms rods, and ball joints. In a suspension system, the chassis supports components such as transmission, body, and engine of the vehicle.

The spring in the suspension system plays an important role as it absorbs shocks coming from roads. The spring is the flexible component of the suspension. As springs are the elastic element that undergoes significant deformation when loaded due to their flexibility they enable them to store recoverable mechanical energy.

A mechanical device that is used for storing energy and releasing it, absorbing shock, or maintaining a force contacting surface is called a 'coil spring'. It is made up of elastic material formed into the shape of a helix, which returns to it to natural length when loaded. Generally, the coil spring is made of hardened steel.

2. LITERATURE REVIEW

[1]Arvind katayayn and Chitta Rajan Tripathy investigated about helical spring of the suspension system. Considering various geometrical parameters and loads they designed and analyzed the helical spring of the passenger vehicle on CATIA V5. They considered three shapes open-end cylinder, open-end

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conical coil, and open variable outer diameter, and designed according to geometric parameters. After the design, they analyzed for load 2750 N using FEM(Finite Element Method) and calculated deflection and stress for spring. After comparing all the shapes considering all the parameters they concluded variable outer diameter coil spring has better and safer geometry than the other two geometries.

[2]Akash Bhatt, Anil Devani, and Parth Zalavadiya investigated the conventional helical spring which was manufactured of steel. They designed and analyzed the combination of steel and composite material due to the weight of steel there was a hindrance inefficiency. The composite material consists of a mixture of E-glass. So they carried out the design and analysis of the spring using ANSYS. The values of deflection and stress were found within permissible limits. After experimental analysis, it was found that the new material can withstand up to 1000N axial loads.

[3]N. Lavanya, P. Sampatrao, M. Pramod Reddy researched the static analysis of helical spring by considering different two materials for springs which are Chromium vanadium steel and low carbon structural steel. They designed using Pro-E software and analyzed is done by using ANSYS 12.0 software. Considering geometric specification, all loads, and behavior of spring they analyzed and compared both materials. They concluded that the value of low carbon structural steel was less than as compared to Chromium Vanadium steel material. Based on designing and analysis of helical spring according to different low carbon structural steel is better than Chromium Vanadium Steel for production of helical spring for the suspension system.

[4]Dr. Htay Htay Win, Dr. New Ni TUN, Maung Yone Kyin Thang researched on rear coil spring design of Landcruiser Prado. The existing design of coil spring was made of stainless steel. After analysis among different materials, Chrome Vanadium Steel was suitable material as it holds optimized functions and properties compared to other materials. The optimized coil spring has a coil spring index of 7.489, a spring rate of 67.56 N/m, a free length of 244.56 mm, and a pitch of spring wire was 0.04 m. The maximum shear stress of the optimized design was 614 MPa which was less than the existing design.

3. COMPARISON BASED ON MATERIALS

The modeling and analysis have been carried out on different materials for helical springs. The considered materials were chrome vanadium steel and low carbon structural steel.

For Chromium vanadium steel material properties were Young's modulus =207000MPa, Poisson ratio =0.27, Density =7860kg/m3.

For low carbon structural steel material properties were Young's modulus =198000MPa, Poisson ratio =0.37, Density =7700 kg/m3.

The coil spring was designed using PRO-E software as per required specifications and analyzed on ANSYS software. The spring behavior was observed by applying different material loads, to maximum stresses and selected the best material. The structural analysis consisted of linear and non-linear models. The linear model includes parameters and assumed that the material is not deformed physically. The stresses in the material vary with the amount of deformation that takes place.

4. COMPARISON BASED ON GEOMETRY

The various geometrical design of coil spring is generated for application of passenger vehicles.

They have studied the shape of the springs is better to suspension system according to geometrical parameters and dimensions designed on CATIAV5.After they designed they considered three shapes of the spring 1)open-end coil spring 2)open-end conical coil spring 3)open-end variable diameter coil spring after modeling this spring according to their shapes. The file is imported into the ANSYS and analysis is done according to the loads which were applied on spring are given below 1)Total Deformation 2)Directional Deformation 3)Von-mises Stress 4)Maximum Principal Stress 5)Factor of Safety.

After analysis by considering the analyzed values of given loads on spring according to different shapes of the spring. Therefore by analysis, it was found that variable outer diameter coil spring has 7.4% and 37.4% low von-mises stress and maximum principal stress respectively. Thus reduced stress in the spring increases the factor of safety by 8%. Therefore open-end variable diameter coil spring is safer compared to other shapes.

5. COMPARISON BASED ON DESIGN

Static structural analysis is used for coil springs to predict maximum stress and deflection acting on the coil. They considered three materials Stainless Steel ASTM-A313, Carbon Steel ASTM-A227, Chrome Vanadium Steel ASTM-A231. After comparing the properties the Chrome Vanadium Steel was finalized due to its material properties and designed on Solidworks and analyzed on ANSYS.

Fig. 1- Three dimensional model of helical spring

After the selection of material, they considered two boundary conditions for statical structural analysis. Spring mass acts on the top of the spring and the bottom is fixed to the base end of the coil spring which is attached to the chassis or frame of the vehicle and mounted on the axel of an automobile.

After applying both the conditions on the spring on ANSYS they found the maximum shear stress coming on spring and allowable stress. The spring behaves safely when the stress is applied on Chrome Vanadium Steel.

6. CONCLUSION

The main purpose of the authors' work in all research papers was to design the helical coil spring for various materials and various coil geometry. For designing the helical spring authors used FEA(Finite Element Analysis) and software like CATIA and the ANSYS. By studying and resulting in all parameters for helical spring the result for by reducing the number of turns the load carrying capacity is increases hence by reducing no of turns the weight of coil is reduced hence it is beneficial for efficiency of fuel of the car. The Open-end variable outer diameter shape is suitable for helical spring because this shape for spring reduces the stress in the spring with an increase the factor of safety. For the helical spring, the best material is low carbon steel for the production of spring because by considering all properties and their result through ANSYS the low carbon steel having good suitable properties for spring comparatively other materials. By review of the all papers, we find the which design parameter is considered for spring, the shapes of the spring, and the best material for spring.

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