BIKE SPIRAL SPRING (STEEL) ANALYSIS

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Abstract— This paper contains the study of design and analysis the Shock absorber performance by considering different wire diameters of the spring. The Shock absorber being Suspension system is designed to handle the impulsive shock and kinetic energy. The disturbance of the amplitude of reduced which certainly improve ride quality and provide comfort while riding. When the vehicle moves on any irregular roads such as bumps quick compression of the spring takes place and reaches back to its normal position which leads in lifting the body. Based on the weight of the bike, loads applied and the number of persons sitting on the bike the analysis is made. Hence, by considering the different wire diameters of the spring coil the comparison is made to verify the best dimension for the spring coil in shock absorber. CATIA V5 is used for modeling and ANSYS is used for analysis.

Keywords—Spiral spring, FEA, Impulsive shock, Static analysis, CATIA V5, ANSYS,

I. INTRODUCTION

Now a day all the vehicle carries suspension systems from horse-drawn carriage which has four flexible leaf springs fixed in the corners to complex control algorithms in the modern automobiles. The road vehicle suspension designed considering two main objectives: 1. Isolating the body of the vehicle from the irregularities of the road. 2.To maintain contact of the wheels with the roadway. Objective of the proposed work is to design and analyze spiral spring with different wire diameters, pitch, etc for structural strength, stiffness, compression strength, tensile strength load carrying capacity. The approach of the project work is optimization of spiral spring for same strength that of current design of springs used in bikes. The new designed spring with optimization in costing, weight, etc can be used in motorcycles for better efficiency of bike & its mileage with good suspension system. Also comfort to the rider & pillion. It also may enable to reduce overall manufacturing costsof the motorcycles. Hence increase in overall profit of the manufacturer.

Table 1.0 Design Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Design1</th>
<th>Design2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight of bike</td>
<td>Kg</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>Let weight of 1person</td>
<td>Kg</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>Weight of 2 persons</td>
<td>Kg</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>Weight of bike + persons</td>
<td>Kg</td>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td>Rear Suspension will carry 60% of total weight</td>
<td>Kg</td>
<td>165</td>
<td>165</td>
</tr>
<tr>
<td>Considering dynamic loads it will be double, w</td>
<td>Kg</td>
<td>330</td>
<td>330</td>
</tr>
<tr>
<td>w</td>
<td>N</td>
<td>3237</td>
<td>3237</td>
</tr>
<tr>
<td>For single shock absorber weight, W=w/2</td>
<td>N</td>
<td>1619</td>
<td>1619</td>
</tr>
</tbody>
</table>
II. DESIGN CALCULATION

The analytical calculation parameters that are considered for calculation are shown in the table 2.0.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>Design1</th>
<th>Design2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shear modulus</td>
<td>MPa</td>
<td>77000</td>
<td>77000</td>
</tr>
<tr>
<td>Mean diameter of a coil,D</td>
<td>mm</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>Diameter of wire,d</td>
<td>mm</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Total no of coils, n1</td>
<td></td>
<td>-</td>
<td>15</td>
</tr>
<tr>
<td>Height, h</td>
<td>mm</td>
<td>200</td>
<td>200</td>
</tr>
<tr>
<td>Pitch of coil, P = (Lf–2d) / i</td>
<td></td>
<td>-</td>
<td>14.2</td>
</tr>
<tr>
<td>Outer diameter of spring coil, D0=D +d</td>
<td>mm</td>
<td>58</td>
<td>60</td>
</tr>
<tr>
<td>No of active turns, n</td>
<td></td>
<td>-</td>
<td>13</td>
</tr>
<tr>
<td>Weight of bike</td>
<td>Kg</td>
<td>125</td>
<td>125</td>
</tr>
<tr>
<td>Let weight of 1 person</td>
<td>Kg</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
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<td>Kg</td>
<td>150</td>
<td>150</td>
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</tr>
<tr>
<td>Considering dynamic loads it will be double, w</td>
<td>Kg</td>
<td>330</td>
<td>330</td>
</tr>
<tr>
<td>w</td>
<td>N</td>
<td>3237</td>
<td>3237</td>
</tr>
<tr>
<td>Compression of spring, δ= WD^3n/G.d</td>
<td>mm</td>
<td>67</td>
<td>27</td>
</tr>
<tr>
<td>Spring index, C=D/d</td>
<td></td>
<td>-</td>
<td>6</td>
</tr>
<tr>
<td>Solid length, Ls =n1xd</td>
<td>mm</td>
<td>120</td>
<td>150</td>
</tr>
<tr>
<td>Free length of spring,Lf = solid length + maximum compression + clearance between adjustable coils</td>
<td>mm</td>
<td>203</td>
<td>184</td>
</tr>
<tr>
<td>Spring rate, K = W/δ = 35.74</td>
<td>N/mm</td>
<td>24</td>
<td>59</td>
</tr>
<tr>
<td>Stresses in helical spring: maximum shear stress induced in the wire, τ = Ks × 8WD/π.d^3</td>
<td>MPa</td>
<td>500</td>
<td>270</td>
</tr>
<tr>
<td>Ks = 4C-1/4C-4 + 0.615/C</td>
<td></td>
<td>-</td>
<td>1.24</td>
</tr>
</tbody>
</table>

III. METHODOLOGY

The proposed methodology consist of three main phase. In phase I, a problem definition was stated i.e. modification & effect of wire diameter in bikes & limitations of existing dimensions.

The problem under consideration will be modeled through three approaches:

A. CAD Modeling using CATIA V5
B. Preprocessor using Ansys
   i. Meshing
   ii. Boundary Condition and load condition
C. Postprocessor using Ansys
   i. Stress plot result
   ii. Deformation plot result

3.1 Cad Modeling

3D model is prepared by using CATIA V5. There are two design created by using CAD software.

1. Design 1 : Design is made for a wire of 8 mm diameter
2. Design 2 : Design is made for a wire of 10 mm diameter
3.2 Preprocessor
   3.2.1 Meshing

In meshing the entire body is divided into number of elements. Elements will be small pieces of entire body. This process is done with meshing. Free meshing tool is very helpful, which creates the meshing of the body automatically and also covers all parts including curved edges, therefore the shape of the object doesn’t change. For meshing we have to select appropriate mesh size. Since thickness of the material is less than 15 mm, we can use the shell elements. Therefore shell 181 element is used. Meshed model is shown in figure 2.0
3.2.2 Boundary condition
Bottom faces of spring are constrained in all direction & 1619N force is applied on top faces of spring as shown in below figures 3.0.
The helical spring is required to constrain or fix at some point for the analysis. Fig 4.0 shows that the spring is constrained at the bottom.

**Figure 4.0 Loading Conditions**

### 3.3 Postprocessor

The static analysis is performed in Ansys and through applying boundary conditions and forces which are calculated using kisssoft/Kisssys or analytical calculation. Static analysis of the spiral spring to find out the total amount of stresses and deformation of structural component

#### 3.3.1 Stress plot result For Design 1 (diameter 8mm)

**a)** Von-mises stress plot

**Figure 5.0 Von Mises stress plot**
3.3.2 Stress plot result For Design 2 (Diameter 10mm)

(a) Von-mises Stress plot

(b) Deformation plot

Figure 6.0 Deformation Plot

Figure 7.0 Von Mises stress plot
IV. RESULT DISCUSSION

4.1 Static Analysis Results

Table 3.0 Comparison Between The Results For 8mm Spring Diameter

<table>
<thead>
<tr>
<th>Design1: 8mm wire diameter</th>
<th>Compression of spring (mm)</th>
<th>Bending Stress (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical</td>
<td>67</td>
<td>500</td>
</tr>
<tr>
<td>FEA</td>
<td>70.7</td>
<td>552.9</td>
</tr>
<tr>
<td>% change</td>
<td>-5.5%</td>
<td>-10.6%</td>
</tr>
</tbody>
</table>

Table 4.0 Comparison Between The Results For 10mm Spring Diameter

<table>
<thead>
<tr>
<th>Design2: 10mm wire diameter</th>
<th>Compression of spring (mm)</th>
<th>Bending Stress (MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analytical</td>
<td>27</td>
<td>270</td>
</tr>
<tr>
<td>FEA</td>
<td>29.0</td>
<td>315</td>
</tr>
<tr>
<td>% change</td>
<td>-7.3%</td>
<td>-16.7%</td>
</tr>
</tbody>
</table>

The analysis was carried out for spring on both compression and bending at different diameters of the spring coil. The results obtained for the spring with diameter of 8mm are shown in the table 3.0 and the results obtained for the spring with diameter 10mm are shown in the table 4.0. The results of analysis are compared with the analytical results for both compression and bending.
V. CONCLUSION

• Higher wire diameter (10mm) deflection & stresses are observed to be lesser than smaller diameter (8mm) for same material, hence recommended using 10mm wire spiral spring for current two wheeler.

• In future, DOE can be done to optimize the mass & other parameter by changing material to composite & changing geometric parameters.

AKNOWLEDGEMENT

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