Comparative Design Analysis of Two Wheeler Shock Absorber

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Abstract- Shock absorbers are main part of a suspension system used in two wheelers. In this investigation a shock absorber is designed and a 3D model is created using software CREO. Structural analysis is done on the shock absorber spring in ANSYS by varying the material for spring as Stainless Steel (ASTM-A316), Inconel X750, Nickel 200. Static analysis is made on above materials to compare the stress values and displacements to verify the best material for spring in Shock absorber. Finally, as per our analysis we investigated the best suited material for the spring of the shock absorber is Inconel X750. Therefore in this Paper the main focus is to develop new correlated methodologies that will allow us more effectively and improve the working conditions of shock absorber by using FEM based tool.

Keywords: Shock Absorber, CREO and ANSYS (FEA)

I. Introduction

A shock absorber or damper is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. Shock absorbers reduce the effect of traveling over rough ground, leading to improved ride quality and vehicle handling. While shock absorbers serve the purpose of limiting excessive suspension movement, their intended sole purpose is to damp spring oscillations. Shock absorbers use valving of oil and gasses to absorb excess energy from the springs. Spring rates are chosen by the manufacturer based on the weight of the vehicle, loaded and unloaded. Some people use shocks to modify spring rates but this is not the correct use. Along with hysteresis in the tire itself, they damp the energy stored in the motion of the unsprung weight up and down. Effective wheel bounce damping may require tuning shocks to an optimal resistance These devices are similar to the hydraulic dashpot type except that a number of orifices are provided allowing different degrees of restriction throughout the stroke. These devices are engineered to bring the moving load is smoothly and gently to rest by a constant resisting force throughout the entire shock absorber stroke. The load is decelerated with the lowest possible force in the shortest possible time eliminating damaging force peaks and shock damage to machines and equipment

A. Creo: formerly known as Pro/ENGINEER is a parametric, integrated3D CAD/CAM/CAE solution created by Parametric Technology Corporation (PTC). CREO is a feature based, parametric solid modeling program. As such, its use is significantly different from conventional drafting programs. In conventional drafting various views of a part are created in an attempt to describe the geometry. Each view incorporates aspects of various features but the features are not individually defined. In feature based modeling, each feature is individually described then integrated into the part. The other significant aspect of conventional drafting is that the part geometry is defined by the drawing. If it is desired to change the size, shape, or location of a feature, the physical lines on the drawing must be changed then associated dimensions are updated. When using parametric modeling, the features are driven by the dimensions. To modify the diameter of a hole, the hole diameter parameter value is changed. This automatically modifies the feature wherever it occurs – drawing views, assemblies, etc. Another unique attribute of CREO is that it is a solid modeling program. The design procedure is to create a model, view it, assemble parts as required, then generate any drawings which are required. It should be noted that for many uses of Pro/E, complete drawings are never created. A typical design cycle for a molded plastic part might consist of the creation of a solid model, export of an SLA file to a rapid prototyping system use of the SLA part in hands on verification of fit, form, and function, and then export of an IGES file to the molder or toolmaker. A toolmaker will then use the IGES file to program the NC machines which will directly create the mold for the parts.

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B. Ansys: is general-purpose finite element analysis (FEA) software package. Finite Element Analysis is a numerical method of deconstructing a complex system into very small pieces (of user-designated size) called elements. The software Implements equations that govern the behavior of these elements and solves them all; creating a comprehensive explanation of how the system acts as a whole. These results then can be presented in tabulated or graphical forms. This type of analysis is typically used for the design and optimization of a system far too complex to analyze by hand. Systems that may fit into this category are too complex due to their geometry, scale, or governing equations

II. Experimental Procedure

C. Design calculation for helical spring of shock absorber: In this present paper the design of the helical spring shock absorber was done in creo taking the following data

Material: Steel

Modulus of rigidity, G = 77000 N/mm² Mean diameter of a coil, D=62mm
Diameter of wire, d = 8mm
Total no of coils, n_1= 16
Height, h = 220mm
Outer diameter of spring coil,
D_o = D +d =70mm
No of active turns, n= 14
Weight of bike, W= 125kgs

Let weight of 1 person = 75Kgs Weight of 2 persons = 75x2=150Kgs Weight of bike + persons = 275Kgs Rear suspension = 65%
65% of 275 = 165Kgs
Considering dynamic loads it will be double,
W = 330Kgs = 3234N
For single shock absorber weight, w= W/2=1617N
We Know that, compression of spring (δ) = $(8FD^3i)/(Gd^4)$
C = spring index = D/d = 7.75 = 8
(δ) = $8*1617*(62)^3*14/77000*(8)^4$
= 136.8mm
Solid length, Ls=n1×d=16×8=128mm
Free length of spring, L_f = solid length + maximum compression + clearance between adjustable coils
L_f = 128 + 136.8+ (0.15 x 136.8)
= 297mm
Spring rate, K = F/δ = 1617/136.8
= 11.82N/mm
Pitch of coil, P = $(L_f - 2d)$ / i
= (297-2*8)/14 = 20.07 = 20
Pitch of coil, P = 20

Stresses in helical springs**:** maximum shear stress induced in the wire
$\tau_{max} = \tau_T + \tau_F$
$= 8FD/\pi d^3 * (1+1/2C)$
= 529.78N/mm²

D. Modeling and Drafting of Shock Absorber

Modeling and drafting is done for the all the parts

Figure 1. a) Bottom Part b) Top Part c) Helical Spring d) Total Assembly e) Exploded View

III. Results and Disscusions

E. **Static Analysis**

In shock absorbers, spring is the main part of it. The total suspension will depends upon the spring. So analysis is done only on spring by placing plates at both ends and two springs are analysed here to validate our design. To import a model from any design software to ANSYS its format should be portable for ANSYS. The portable format of CREO model for ANSYS is “iges”. Meshing of model is done in hyper mesh and imported to ANSYS as “cdb” file.

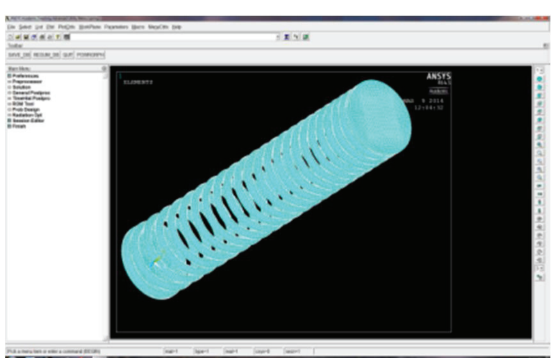

Figure 2. Analysis for helical spring

Case-1: Material: Stainless Steel 316

Element type: SOLID185
Young's Modulus: 195000 N/mm^2 Poisson's ratio: 0.3
Density: 0.0000078 Kg/mm^3
Pressure: 0.0078 N/mm^2

Case-2: Material: Inconel X-750

Element type: SOLID185
Young's Modulus: 215000 N/mm^2
Poisson's ratio: 0.29
Density: 0.0000082 Kg/mm^3
Pressure: 0.0078 N/mm^2

Case-3: Material: Nickel 200

Element type: SOLID185
Young's Modulus: 207000 N/mm^2
Poisson's ratio: 0.31
Density: 0.0000088 Kg/mm^3
Pressure: 0.0078 N/mm^2

Deformed Shapes of various springs

Figure 6. a) Stainless steel 316 b) Inconel X750 c) Nickel 200

Nodal Solutions of Various Springs

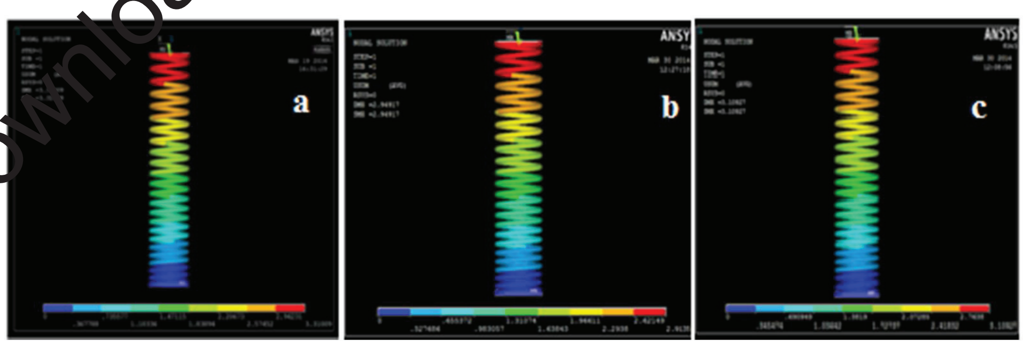

Figure 6. a) Stainless steel 316 b) Inconel X750 c) Nickel 200

Von Mises Stresses

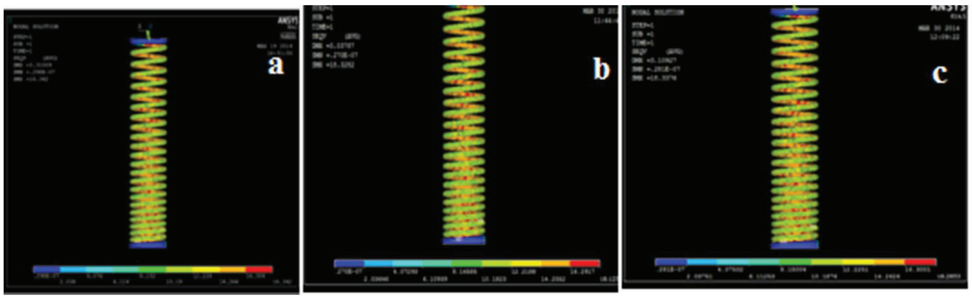

Figure 7. a) Stainless steel 316 b) Inconel X750 c) Nickel 200

Table 1. Results Summary

		Stainless Steel 316	Inconel X750	Nickel 200
Displacement (mm)	Min	0.367	0.327	0.345
	Max	3.31	2.91	3.10
Stress (N/mm^2)	Min	0.298E-7	0.27E-7	0.281E-7
	Max	18.342	18.1252	18.2853
Ultimate Strength (N/mm^2)		707	1100	900

IV. Conclusion

- In this investigation the designed shock absorber is used in a 100cc bike which has been modeled by using 3D parametric software CREO.
- To validate the strength of our design, the structural analysis on the shock absorber spring has been done, the analysis done by varying spring material as Stainless steel, Inconel X750 and Nickel 200 has done
- By comparing the results for both materials, the stress value is less for Inconel X750 than Stainless steel 316.
- Since the cost of Inconel X750 is little higher than stainless steel 316, so it can be used for the higher end vehicles i.e. for sports bikes.
- As per our analysis, Inconel X750 for spring is best and safe

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