Finite Element Analysis of Shock Absorber

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Abstract – *In vehicles problem happens while driving on bumping road condition. The objective of this study is to analyze the performance of Shock absorber. Shock absorber is an important part of mechanical system. The Shock absorber which is one of the Suspension systems is designed mechanically to handle shock impulse and dissipate energy. It decreased the amplitude of disturbances leading to increase in comfort and improved ride quality. The spring is compressed quickly when the wheel strikes the bump. The compressed spring rebound to its normal dimension or normal loaded length which causes the body to be lifted. The spring goes down below its normal height when the weight of the vehicle pushes the spring down. This, in turn, causes the spring to rebound again. The spring bouncing process occurs over and over every less each time, until the up-and-down movement finally stops. The vehicle handling becomes very difficult and leads to uncomfortable ride when bouncing is allowed uncontrolled. Hence, the designing of spring in a suspension system is very crucial. The analysis is done by considering bike mass, loads, and no of persons seated on bike. Modeling and Analysis is done using Solid Works and ANSYS Software.*

Key Words: shock absorber, dissipation, analysis, suspension system, ANSYS.

1. INTRODUCTION

Shock absorbers are a critical part of a suspension system, connecting the vehicle to its wheels. The need for dampers arises in common with carriages and railway because of the roll and pitches associated with locomotives, most early motor vehicles used leaf springs. In the mid nineteenth century, road that the friction between the leaves offered a quality was generally very poor. Shock absorbers are devices that smooth out an impulse experienced by a vehicle, and appropriately dissipate and absorb the kinetic energy. One of the problems is that the vehicle bounces continuously more than one times and it is called bouncing problems. There are various instruments are available for converting a collision into relatively smooth contact such as Metal spring, Rubber Buffer, Hydraulic Dashpot etc. The main function of the shock absorber is to absorb the shocks and damp them as soon as possible so that a smooth ride can be obtained. It limits vehicle body movement and it stabilizes our ride. It stabilizes vehicle tires which are disturbed due to sudden shock, hence it is one of the important factor for safety purpose also

2. DESIGN CALCULATIONS FOR HELICAL SPRINGS FOR SHOCK ABSORBERS

Material Used - Spring Steel
Modulus of rigidity (G) - 78600 N/mm2
Maximum Force - 3355 N
Ultimate Tensile Strength - 2000/d0.17 N/mm2
Yield strength - 1200/d0.17 N/mm2
Number of turns - 6

1. Allowable Shear Stress:
Take Factor of Safety (FOS) Nf =1.5.
The allowable shear stress for spring material (carbon steel) is given by allowable shear stress = Yield strength /FOS
= 1200/d0.17 x 1/1.5
= 800/d0.17 N/mm2

2. Wire Diameter:
Let us assume c=5.

$$K_w = \frac{4C-1}{4C-4} + \frac{0.615}{C} = \frac{(4\times5)-1}{(4\times5)-4} + \frac{0.615}{5}$$

=1.3105

Shear stress induced is τ = Kw [8FmaxC]/ [πd2]

$800/d^{0.17} = 1.3105 \times 8 \times 3355 \times 5/\pi d^2$
d = 10 mm

3. Mean Coil Diameter:
D = Cd = 5 x 10 = 50

4 Inside diameter of coil:
D1 = D - d = 50 - 10 = 40 mm

5. Stiffness of spring:

$K = G \cdot d/8C^3n = (78600 \times 10)/(8 \times (5)^3 \times 6)$
K = 131 N/mm

6. Solid Length:

Ls = (n + 2)*d = (6 + 2) x 10 = 80mm

7. Free Length:

LF = solid length + max compression + total clearance
= 80 + 46.91 + (46.91 x 0.15)
= 133.94 mm

8. Pitch:

LF = p*n + 2d
133.94 = p x 6 + 2 x 10
p = 18.99 mm

9. Helix Angle:

Helix angle is α = tan-1 (p/πd)
tan-1(18.99/π x 50) = 6.89

10. Solid Stress
Expected compression of spring at solid length is,
δ = δmax + 0.15δmax
= 46.91 + 0.15 x 46.91
= 53.94 mm
Force acting on spring at solid length,
Fs = K x δs
= 131 x 53.94
= 7062.21 N
Shear stress induced in spring at solid length
is, τs = Kw [8FsC]
[πd2]
= 1.3105 x 8 x 7062.21 x 5
3.14 x (10)2
= 1178.38 N/mm2
Yield strength in shear for spring material,
Syt = 811.29 N/mm2
Available FOS,
Nfs = 1178./811.29 = 1.452

Hence, spring is safe at solid stress.

3. DESIGN OF PISTON ROD

Material: Steel - C-45 (%C: 0.40%-0.50%)
Tensile Strength: 670 N/mm2
Yield Stress: 360 N/mm2
Maximum Force on Piston Rod: 3355 N
Diameter of Piston Rod: 10 mm
Consider the failure of piston rod due to tension
σt = F/A,
σt: Tensile Strength
F= Force Applied
A= Area
A =(∏/4)* d^2
= ∏/4 * 10^2
A = 78.5 mm2
σt= F/A
=3355/78.5
σt = 42.74 N/mm2
∵ σt < Tensile Stress
∴ The Piston Rod is safe under failure due to tension

4. RIGID DYNAMICS

Rigid-body dynamics studies the movement of systems of interconnected bodies under the action of external forces. The assumptions state that the bodies are rigid, which means that they don't deform under the action of applied forces, simplifies the analysis by reducing the parameters that describe the configuration of the system to the translation and rotation of reference frames attached to each body.

4.1 Parametric Modelling

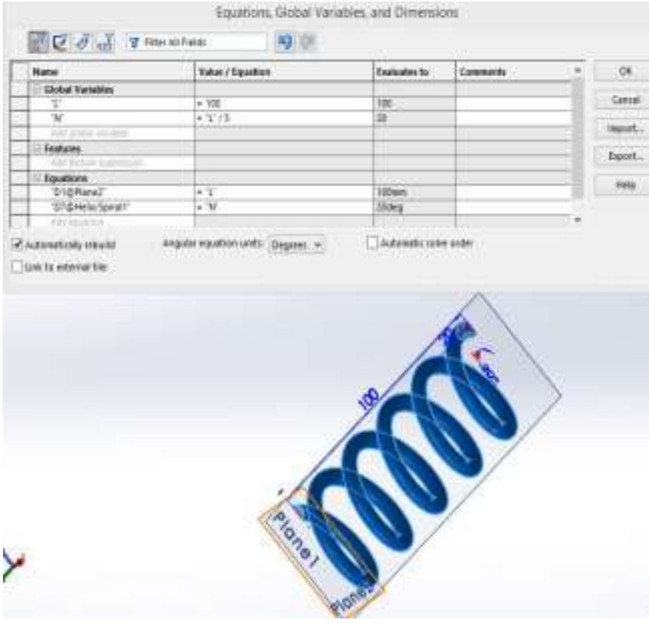

Fig -1: Spring Optimization results

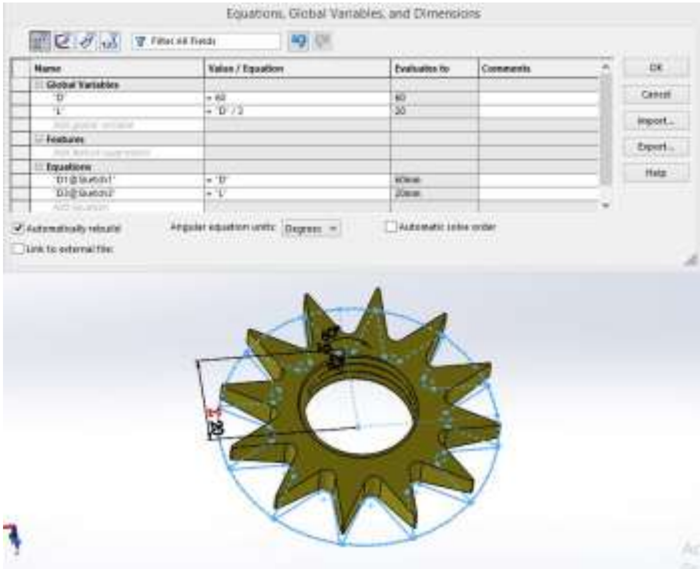

Fig -2: Nut Optimisation results

4.2 Mass Properties

Various mass properties like density, mass, volume, principle axis of inertia etc are calculated using SolidWorks which is a type of cad software. The calculated mass properties are according to the material selected for the assembly.

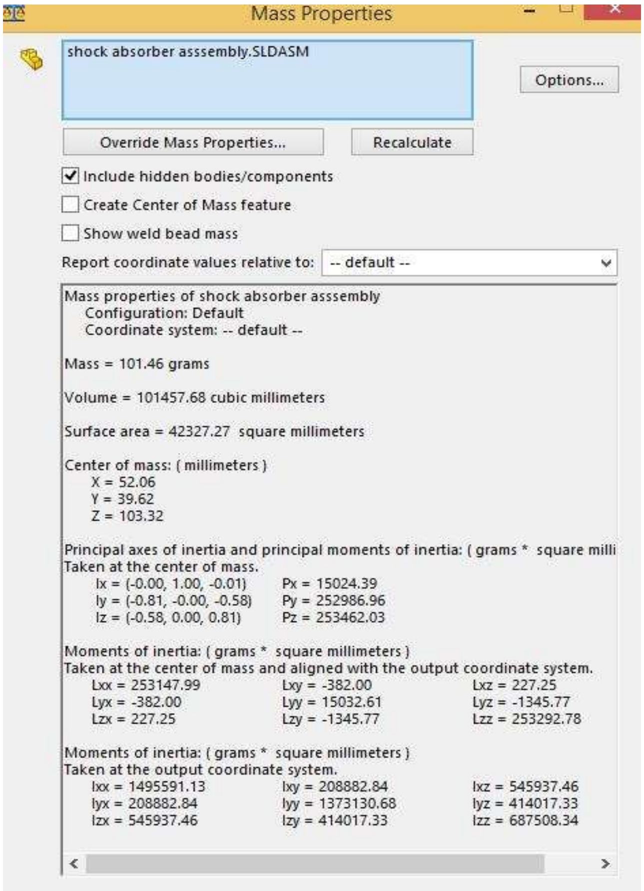

Fig -3 Mass properties

5. STRUCTURAL ANALYSIS

Finite element analysis is a numerical method of discretising a complex system into very small pieces called elements. Software implements the equation to find the behaviour of elements.

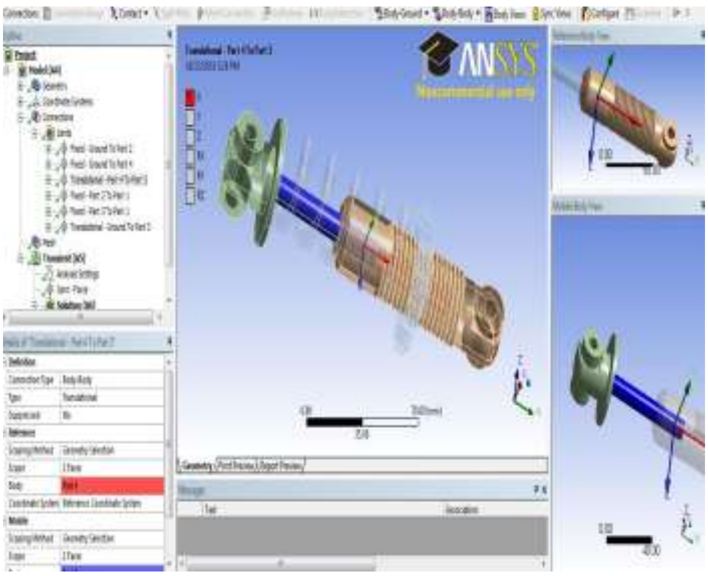

Fig – 4: Kinematic analysis of spring

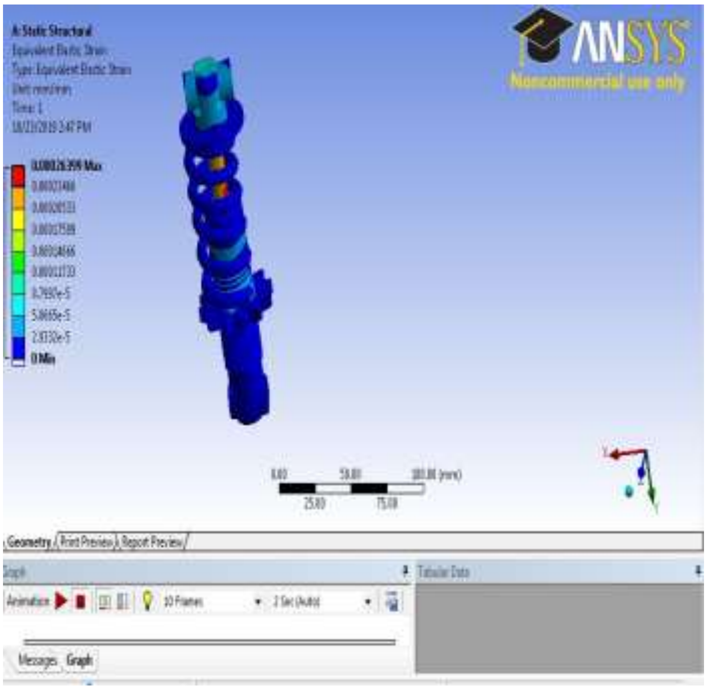

Fig – 5: Strain analysis

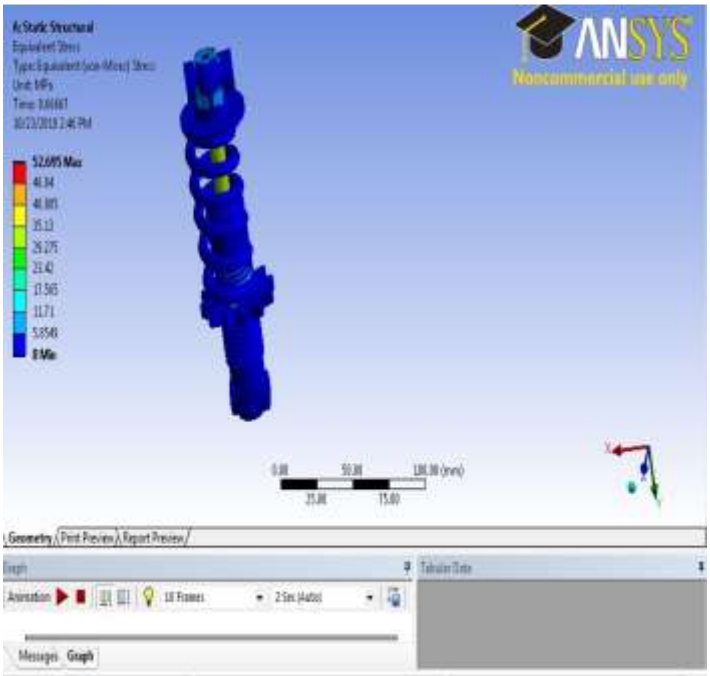

Fig -6 Stress analysis

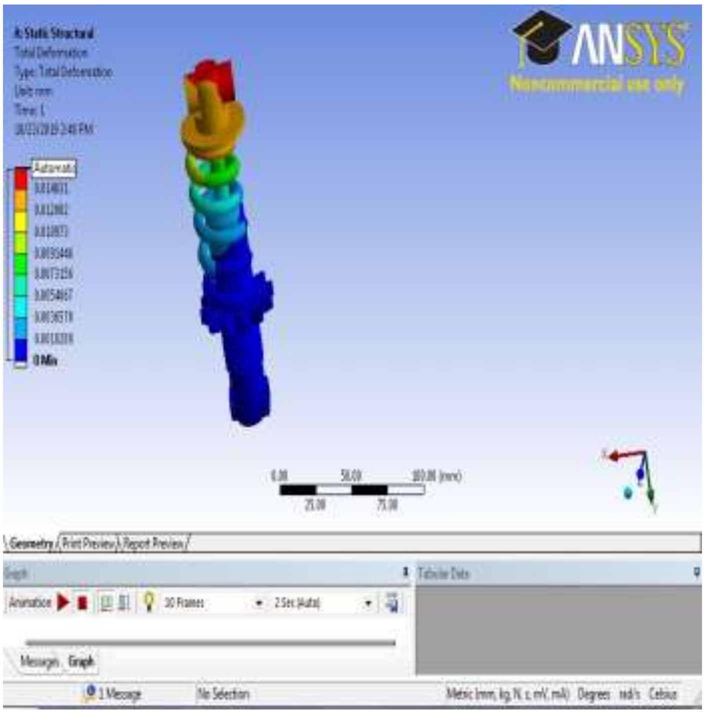

Fig -7 Deformation analysis

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