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# Design Modification and Analysis of Two Wheeler Rear Shock Absorber by Using Composite Materials

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**ABSTRACT**

***Now a day's every roads there are many pot holes, damaged road Surfaces, bumps and all other obstacle of comfort which make long rides very jerky. Shock absorber major affect for those which perform their Business or Duties for more than two hours driving on bike may felt pain at the end of day. So, to avoid this problem to designing the shock absorber properly and selecting the suitable material .In the present work is to increase the comfort level by measuring force transmission at both ends of helical compression spring and reducing the weight of shock absorber by using composite materials S-Glass Epoxy and E-Glass Epoxy Material in Helical compression Spring instead of steel. Design modification and analysis of the Shock absorber by varying the wire diameter of the coil spring and to reduce the coil springs. Design and Analysis is done by using CATIA and ANSYS respectively.***

## I. INTRODUCTION

### 1.1 INTRODUCTION TO SHOCK ABSORBER

A shock absorber or damper is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy.

In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. Without shock absorbers, the vehicle would have a bouncing ride, as energy is stored in the spring and then released to the vehicle, possibly exceeding the allowed range of suspension movement. Control of excessive suspension movement without shock absorption requires stiffer (higher rate) springs, which would in turn give a harsh ride. Shock absorbers allow the use of soft (lower rate) springs while controlling the rate of suspension movement in response to bumps. They also, along with hysteresis in the tire itself, damp the motion of the unstrung weight up and down on the springiness of the tire. Since the tire is not as soft as the springs, effective wheel bounce damping may require stiffer shocks than would be ideal for the vehicle motion alone. Spring-based shock absorbers commonly use coil springs or leaf springs, though torsion bars can be used in tensional shocks as well. Ideal springs alone, however, are not shock absorbers as springs only store and do not dissipate or absorb energy. Vehicles typically employ springs or torsion bars as well as hydraulic shock absorbers. In this combination, "shock absorber" is reserved specifically for the hydraulic piston that absorbs and dissipates vibration.

### 1.2 Applications

Shock absorbers are an important part of automobile and motorcycle suspensions, aircraft landing gear, and the supports for many industrial machines. Large shock absorbers have also been used in structural engineering to reduce the susceptibility of structures to earthquake damage and resonance. A transverse mounted shock absorber, called a yaw damper, helps keep railcars from swaying excessively from side to side and are important in passenger railroads, commuter rail and rapid transit systems because they prevent railcars from damaging station platforms. The success of passive damping technologies in suppressing vibration amplitudes could be ascertained with the fact that it has a market size of surround $ 4.5 billion.

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## MATERIAL SELECTION

Due to the high density of steel, the weight of the component is also high. So it is necessary to reduce the weight of the component by considering high strength to weight ratio materials like E-Glass epoxy and S-Glass epoxy. The materials properties of these alternatives are shown in table 1.

| Material | Density (g/cc) | Young's modulus (MPa) | Poisson's ratio |
|---|---|---|---|
| STEEL | 9.01 | 31700 | 0.34 |
| E Glass Epoxy | 1.90 | 34000 | 0.36 |
| S-Glass Epoxy | 2.46 | 86900 | 0.28 |

Table 1: Material Properties

## II. MODELING

### 2.1 INTRODUCTION TO CATIA

CATIA is a one of the worlds leading high-end CAD/CAM/CAE software packages. CATIA (Computer Aided Three dimensional Interactive Application) is a multi-platform PLM/CAD/CAM/CAE commercial software suite developed by Dassault Systems and marketed world-wide by IBM.CATIA is written in the C++ programming language. CATIA provides open development architecture through the use of interfaces, which can be used to customize or develop applications. The application programming interfaces supported Visual Basic and C++ programming languages.

Commonly referred to as 3D Product Lifecycle Management (PLM) software suite, CATIA supports multiple stages of product development. The stages range from conceptualization, through design (CAD) and manufacturing (CAM), until analysis (CAE). Each workbench of CATIA V5 refers an each stage of product development for different products. CATIA V5 features a parametric solid/surface-based package which uses NURBS as the core surface representation and has several workbenches that provide KBE (Knowledge Based Engineering) support.

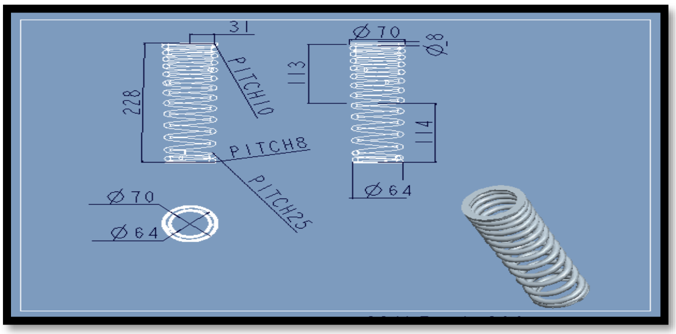



Fig (2a): 2D Drawing of Existing shock absorber helical compression spring

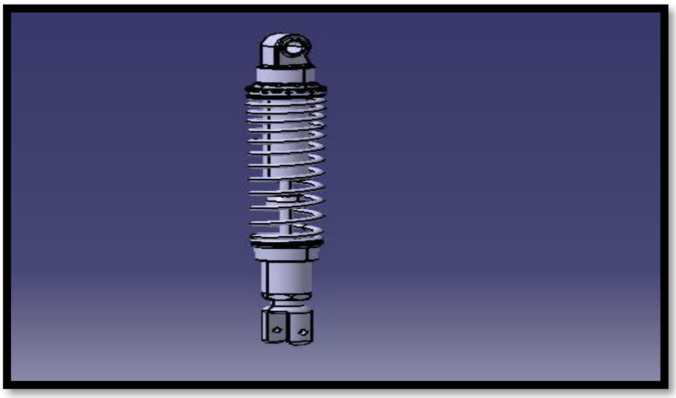


Fig (2b): Existing shock absorber total assembly

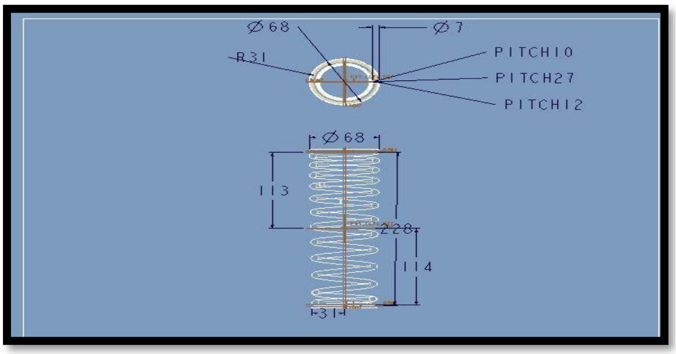
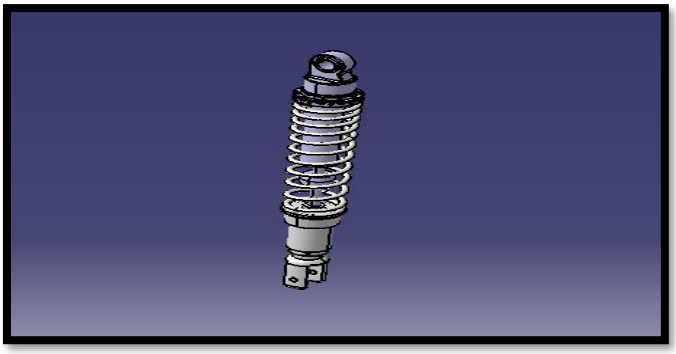



Fig (2c): 2D Drawing of modified shock absorber spring



Fig(2d): Modified shock absorber total assembly

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## III. DESIGN CALCULATIONS

Design calculations of compression spring as shown in below

**ORIGINAL MODEL**

Mean diameter of a coil D=62mm
Diameter of wire d = 8mm
Total no of coils n1= 18
Height h = 228 mm
Outer diameter of spring coil D0 = D +d =70mm
No of active turns n= 14
Weight of bike acting on suspension = 113kgs
Let weight of 1 person = 75Kgs.
Weight of 2 persons = 75×2=150Kgs.
Weight of bike + persons = 263Kgs
Rear suspension = 65% of 263 = 171Kgs
Considering dynamic loads it will be double
W=342Kgs = 3355N.
For single shock absorber weight
= w/2= 1677N =W
We Know that,
Compression of spring (δ) = $\frac{8WD^3n}{G.d^4}$
G = 82000N/mm²
C = spring index = 7.75=8
(δ) = 133.276mm
Solid length,
Ls=n1×d=20×7=144 mm
Free length of spring,
Lf = solid length+ maximum compression
+Clearance between adjustable coils X 0.15
= 144 + 133.276+ 0.15 × 133.276 = 297.267 mm
Spring rate, K. =W/ δ = 12.852N/mm
Pitch of coil, P. = 19 mm

**MODIFIED MODEL**

Mean diameter of a coil D=61mm
Diameter of wire d = 7mm
Total no of coils n1= 20
Height h = 228 mm
Outer diameter of spring coil D0 = D +d =68mm
No of active turns n= 12
Weight of bike acting on suspension = 113kgs
Let weight of 1 person = 75Kgs.
Weight of 2 persons = 75×2=150Kgs.
Weight of bike + persons = 263Kgs
Rear suspension = 65% of 263 = 171Kgs
Considering dynamic loads it will be double
W=342Kgs = 3355N.
For single shock absorber weight
= w/2= 1677N =W
We Know that,
Compression of spring (δ) = $\frac{8WD^3n}{G.d^4}$
G = 82000N/mm²
C = spring index = 8.71
(δ) = 185.604mm
Solid length,
Ls=n1×d=20×7=140 mm
Free length of spring,
Lf = solid length+ maximum compression
+Clearance between adjustable coils X 0.15
= 140 + 185.604+ 0.15 × 185.604 = 353.444 mm
Spring rate, K. =W/ δ = 9.035N/mm
Pitch of coil, P. = 27 mm

## IV. ANALYSIS

### 4.1 INTRODUCTION TO ANSYS

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 behaviour 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.

By using selected material properties to analyze the existing and modified shock absorbers as follows

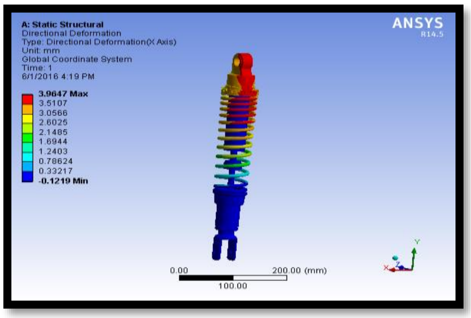
### 4.2 STRUTURAL ANALYSIS

Structural analysis is probably the most common application of the finite element method as it implies bridges and buildings, naval, aeronautical, and mechanical structures such as ship hulls, aircraft bodies, and machine housings, as well as mechanical components such as pistons, machine parts, and tools.

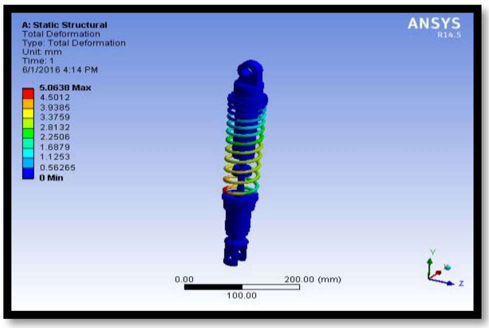
### (A) STEEL:

Material properties
Density:9.1g/cc
Young's modulus: 317 Gpa
Possion's Ratio:0.34

**Existing model**
**Total deformation**



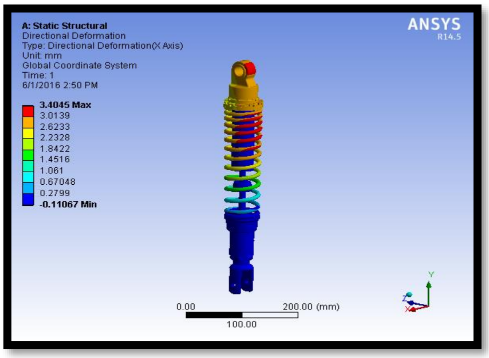

**Modified model**
**Total deformation**




### (B) E-Glass epoxy

Density: 1.90g/cc
Young's Modulus: 34000Mpa
Possion's Ratio: 0.36

**Existing model**
**Total deformation**



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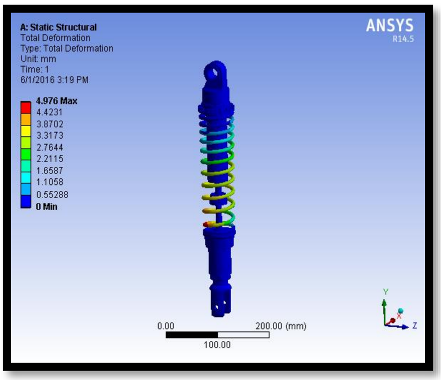
### Modified model
### Total deformation



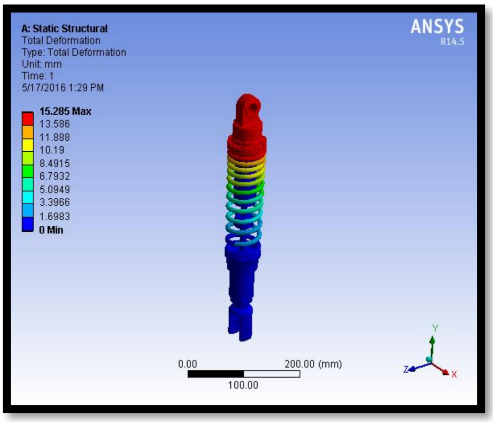

### (C)S-Glass Epoxy

Density:2.46g/cc

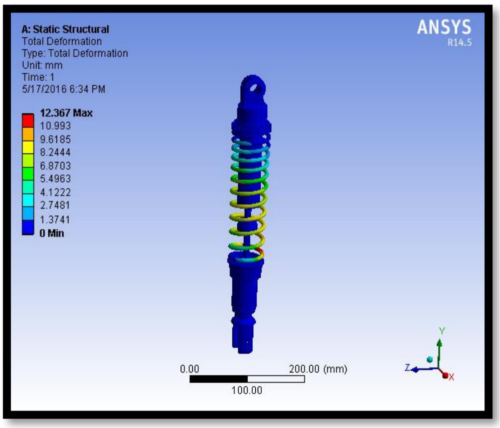
Young's Modulus:86900Mpa

Possion;s Ratio:0.28

### Existing model
### Total deformation




### Modified model
### Total deformation




### 4.3 MODAL ANALYSIS

A modal analysis is typically used to determine the vibration characteristics (natural frequencies and mode shapes) of a structure or a machine component while it is being designed. It can also serve as a starting point for another, more detailed, dynamic analysis, such as a harmonic response or full transient dynamic analysis. Modal analyses, while being one of the most basic dynamic analysis types available in ANSYS, can also be more computationally time consuming than a typical static analysis. A reduced solver, utilizing automatically or manually selected master degrees of freedom is used to drastically reduce the problem size and solution time.

### (A) STEEL:

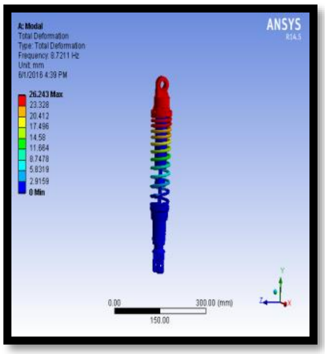
Material properties

Density :9.01g/cc

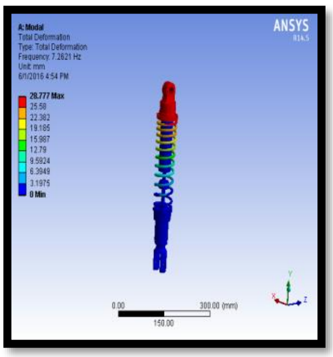
Young's modulus: 317 Gpa

Possion's Ratio: 0.34

### Existing model
### Mode1




### Modified model
### Mode1



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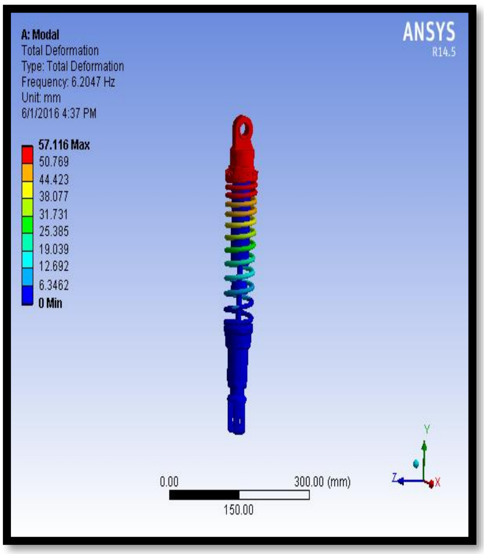
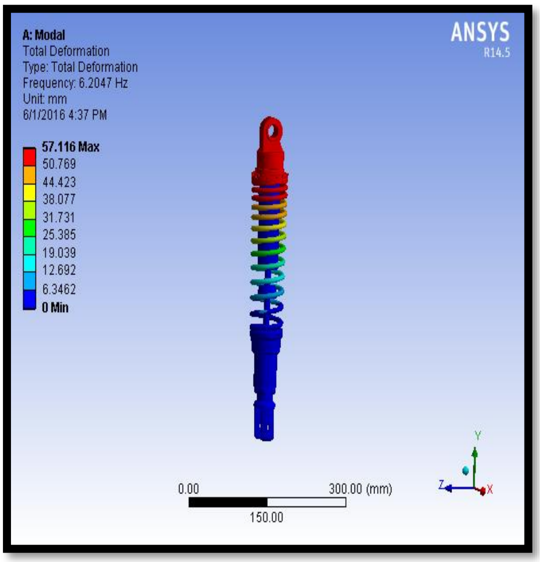
### (B) E-Glass epoxy

Density: 1.90g/cc
Young's Modulus: 34000Mpa
Possion's Ratio: 0.36

### Existing model
### Mode1



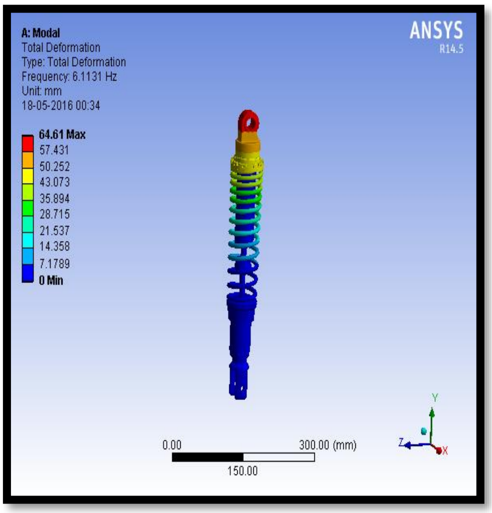

### Modified model
### Mode1



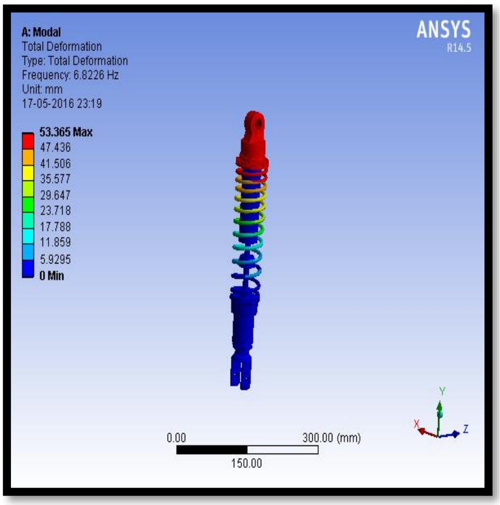

### (C)S-Glass Epoxy

Density:2.46g/cc
Young's Modulus:86900Mpa
Possion;s Ratio:0.28

### Existing model
### Mode1




### Modified model
### Mode1




### 4.4 COMPARING STRUTURAL ANALYSIS RESULTS
### EXISTING MODEL

| Material | Deformation(mm) | Stress(N/mm²) | Strain |
|---|---|---|---|
| S-Glass | 15.285 | 171.08 | 0.0020795 |
| E-Glass | 3.4045 | 197.12 | 0.0065412 |
| STEEL | 3.9647 | 229.73 | 0.00072647 |

Table(4.4)a:Comparison of Stress Strain and Total deformation

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## MODIFIED MODEL

| Material | Deformation(mm) | Stress(N/mm²) | Strain |
|---|---|---|---|
| S-Glass | 12.367 | 115.24 | 0.0091556 |
| E-Glass | 4.976 | 124.6 | 0.0098941 |
| STEEL | 5.0638 | 129.18 | 0.0039107 |
| | | | |

Table(4.4)b: Comparison of Stress Strain and Total deformation

## 4.5 COMPARISON OF MODAL ANALYSIS RESULTS

## EXISTING MODEL

| Materials | Number of Modes | Deformation(mm) | Frequency(Hz) |
|---|---|---|---|
| S-Glass | Mode 1 | 64.61 | 6.1131 |
| | Mode 2 | 64.644 | 6.1313 |
| | Mode 3 | 50.007 | 21.081 |
| E-Glass | Mode 1 | 57.116 | 6.2047 |
| | Mode 2 | 57.136 | 6.2284 |
| | Mode 3 | 56.205 | 14.651 |
| STEEL | Mode 1 | 26.243 | 8.7211 |
| | Mode 2 | 43.651 | 63.431 |
| | Mode 3 | 44.002 | 63.309 |

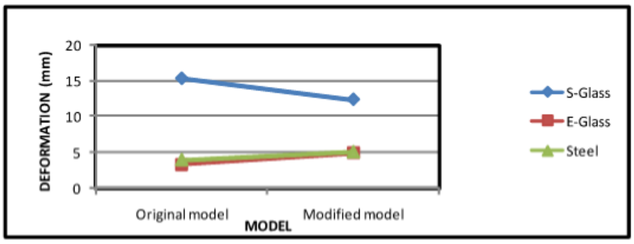
Table(4.5)a:Comparison of Deformation and Frequency

## MODIFIED MODEL

| Materials | Number of Modes | Deformation(mm) | Frequency(Hz) |
|---|---|---|---|
| S-Glass | Mode 1 | 53.365 | 6.8226 |
| | Mode 2 | 53.24 | 7.3378 |
| | Mode 3 | 52.871 | 17.212 |
| E-Glass | Mode 1 | 62.63 | 5.1731 |
| | Mode 2 | 61.096 | 5.3635 |
| | Mode 3 | 59.443 | 12.828 |
| STEEL | Mode 1 | 28.777 | 7.2621 |
| | Mode 2 | 27.3 | 18.071 |
| | Mode 3 | 51.963 | 54.547 |

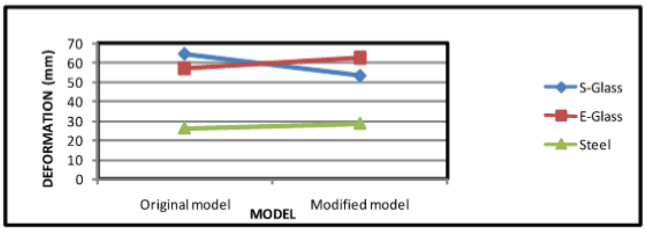
Table(4.5)b:Comparison of Deformation and Frequency

## 4.6 COMPARISON OF DEFORMATION VALUES BETWEEN ALL MATERIALS AND MODELS



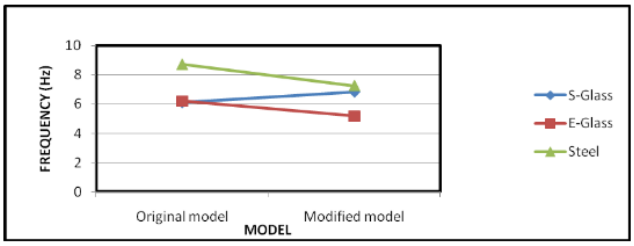

Table(4.6)a:Deformation between all Materials and Models

## 4.7 COMPARISON OF DEFORMATION VALUES BETWEEN ALL MATERIALS AND MODELS FOR MODE 1




Table(4.7)a:Deformation between all Materials and Models for Mode1

## 4.8 COMPARISON OF FREQUENCY VALUES BETWEEN ALL MATERIALS AND MODELS FOR MODE 1




Table(4.8)a:Frequency between all Materials and Models for Mode1

## VI. CONCLUSION

In this study, design and analysis approach is presented to create an innovative design of shock absorber. Finally by observing the structural analysis results, the stress value is less for modified model than original model. The stress values are less for S – Glass is 115.24 N/mm2 than Steel 129.18N/mm2 and E – Glass

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is124.6 N/mm2. And also observing the modal analysis results, the frequencies are less E – Glass for modified model. Due to less frequency, the vibrations of suspension system for modified model using E - Glass are less. So it can be concluded that using S – Glass material is better due to less stresses and more strength.

## VII.FEATURE SCOPE

In future increase the comfort level by measuring force transmission at both ends of helical compression spring and reducing the weight of shock absorber by using Beryllium copper. Design and analysis of the Shock absorber by varying the wire diameter of the coil spring and also varying the coil springs. And Dynamic analysis may be applied.

## VIII. ACKNOWLEDGEMENT

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