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EXPERIMENTAL AND NUMERICAL APPROACH FOR SUSPENSION SYSTEM USED IN TWO WHEELER

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Abstract

A suspension system or shock absorber is a mechanical device designed to smooth out and dissipate kinetic energy. The shock absorbers function is to absorb or dissipate energy. In a vehicle, it reduces the effect of traveling over rough ground, leading to improve ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. Almost all suspension systems consist of springs and dampers, which tend to limit the performance of a system due to their physical constraints. Suspension systems, comprising of springs and dampers are usually designed for passenger's safety and do little to improve passenger comfort. The need for Dampers arises because of the roll and pitches associated with vehicle/bike maneuvering and from the roughness of roads. The purpose of a shock absorber, within any moving object, is to dissolve the kinetic energy evenly while eliminating any decelerating force that may be destructive to the object. Shock absorbers are an important part of automobile and motorcycle suspensions, aircraft landing gear, and the supports for many industrial machines.

Keyword- *Suspension system, Shock Absorber, composite material, weight reduction, torsional strength*

I.INTRODUCTION

A suspension system or shock absorber is a mechanical device designed to smooth out and dissipate kinetic energy. The shock absorbers function is to absorb or dissipate energy. In a vehicle, it reduces the effect of traveling over rough ground, leading to improve ride quality, and increase in comfort due to substantially reduced amplitude of disturbances. Basic safety and also traveling ease and comfort to get a car's motorist are usually equally influenced by the particular vehicle's suspension method. Safety refers to the vehicle's handling and braking capabilities. Shock absorbers are a critical part of a suspension system, connecting the vehicle to its wheels. Basically shock absorbers tend to be products which lessen a good behavioral instinct skilled with an automobile, as well as properly absorb the actual kinetic power. Almost all suspension systems consist of springs and dampers, which tend to limit the performance of a system due to their physical constraints. Suspension systems, comprising of springs and dampers are usually designed for passenger's safety and do little to improve passenger comfort. One particular strategy to this can be the application of productive suspension devices, wherever highway circumstances are generally found employing detectors, plus the technique in a flash adapts on the placing. A shock absorber is a device which is designed to smooth out sudden impulse responses, and dissipate kinetic energy. Any moving object possesses kinetic energy, and if the object changes direction or is brought to rest, it may dissipate kinetic energy in the form of destructive forces within the object. The purpose of a shock absorber, within any moving object, is to dissolve the kinetic energy evenly while eliminating any decelerating force that may be destructive to the object. 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. A transverse mounted shock absorber, helps keep railcars from swaying excessively from side to side and are important in passenger railroads systems because they prevent railcars from damaging station platforms. In a vehicle, it reduces the effect of traveling over rough ground, and leading to improved ride quality. 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.

A typical shock absorber may simply comprise of a compression spring that is capable of absorbing energy. Commonly shock absorbers are known as dashpots, which is simply a fluid filled cylinder with an aperture through which fluid could escape under controlled conditions. The dashpot is the building block for pneumatic and hydraulic shock absorbers. These shock absorbers essentially consist of a cylinder, filled with air or fluid, with a sliding piston that moves to dissipate or absorb energy, and in these cases the energy is usually dissipated as heat. 100 million units per annum with a retail value well in excess of one billion dollars per annum. A typical European country has a demand for over 5 million units per year on new cars and over 1 million replacement units. The US market is several times that and India is not behind these countries for demand and consumption of shock absorbers. If all is well, these shock absorbers do their work quietly and without fail. Drivers and passengers simply want the dampers to be trouble free. In contrast, for the designer they are a constant interest and challenge. The need for Dampers arises because of the roll and pitches associated with vehicle/bike maneuvering and from the roughness of roads. In India, road quality is generally below average and poor for smaller towns. As there is growing demand for quality shock absorbers in India, design and construction of shock absorbers are demanding tasks that require advanced calculations and theoretical knowledge [1]. There are two basic shock absorber designs in use today: the two-tube design and the mono-tube design [2]. Main components of shock absorber consist of following part (see Fig. 1) [3].

1. Piston rod: It is made of high tensile steel harden and corrosion resistant.
2. Main bearing: Its main function is lubrication of total shock absorber.
3. Piston ring: It is hardened for long life.
4. Pressure chamber: It is made from hardened alloy steel machined from solid with closed rear end to with stand internal pressure up to 1000 bar.
5. Outer body: It is heavy duty one piece fully machined from solid steel to ensure total reliability.

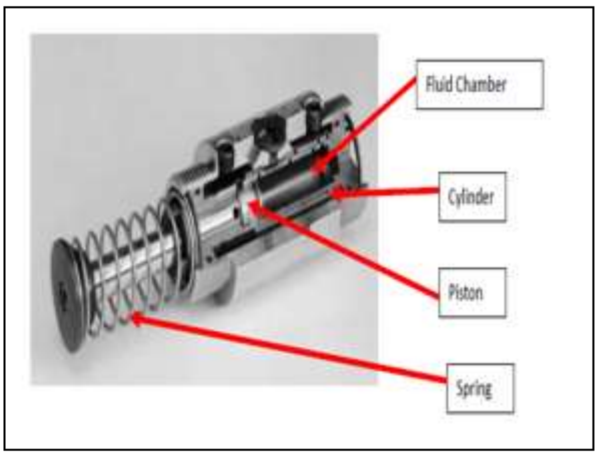

Fig.1 Cutway View Of Hydraulic Shock Absorber

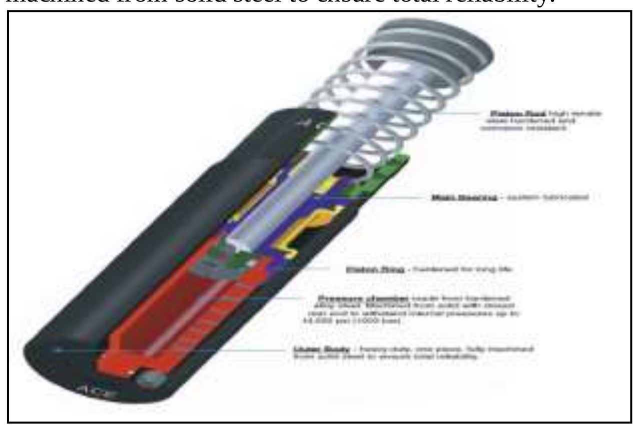

Fig.2 Components of Typical Shock Absorber

A.OBJECTIVES:

1) To replace the existing spring material with composite material carbon fibre helical composite spring without affecting natural frequency, stress values & geometry of existing spring.
2) To get required comfort, by increasing stiffness & mechanical properties.
3) Performing validation using physical experimentation as alternative methodology.
4) Recommendation for improved life of suspension system.

II. LITERATURE SURVEY

1. J.M. Gallardo discovered that Fracture had occurred at the head of the damping device through a welded zone at the piston-rod/ring junction irrespective of time.[1]A.K. Samantaray given preloaded liquid spring/damper based shock isolation systems are suitable for heavy load military applications. [2]Choon-Tae Lee, had discovered, a new mathematical dynamic model of shock absorber is proposed to predict the dynamic characteristics of an automotive system. [3]Ping Yang, discovered that there are some vibrations and impact in moving vehicles for road environments. Therefore, shock absorber is significant in protection of electronic equipment in moving vehicles. [4]Chang-Hsuan using composites, instead of metal materials, will bring about new problems in the design and manufacture of composite springs. [5]

III. DESIGN CALCULATION

Material: Steel (modulus of rigidity) G = 78600N/mm^2

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 = 170Kgs
Considering dynamic loads it will be double W = 340Kgs = 3335N.
For single shock absorber weight = w/2= 1667N = W
We Know that,
Compression of spring $(\delta) = \frac{8FC^3n}{Gd^4}$
C = spring index = 7.75 = 8
(δ) = 138.212mm
Solid length,

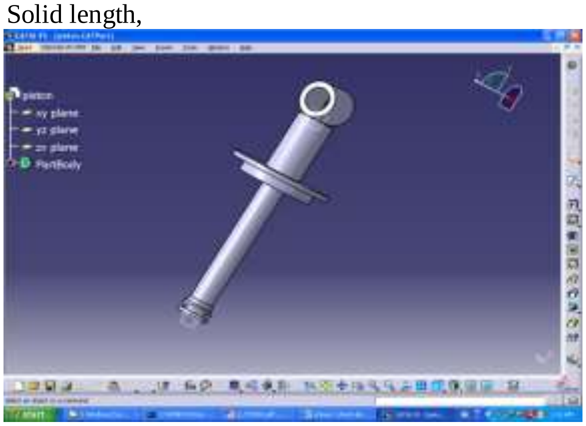

Fig.3 Bottom Part

Fig.4 Top Part

Ls=n1×d=18×8=144 mm
Free length of spring,
Lf = solid length+ maximum compression + clearance between adjustable coils X 0.15
= 144 + 138.212 + 0.15 × 138.212 = 302.943 mm
Spring rate, K.=F/δ = 26 N/mm
Pitch of coil, P. = 19 mm
Stresses in helical springs:
Maximum shear stress induced in the wire τ = 514.04 N/mm^2
Values of buckling factor KB= 7.5
K = 0.05 (for hinged and spring)
The buckling factor for the hinged end and built-in end springs.
Wcr=26×0.05×302.943=393.825N

IV. MODELING OF SHOCK ABSORBER

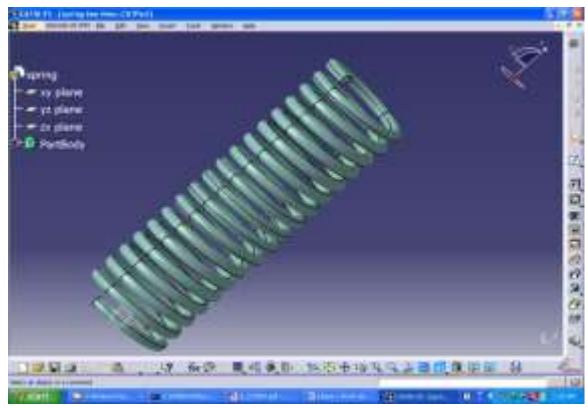

Fig.5 Helical Spring

Fig.6 Total Assembly

V. SOFTWARE ANALYSIS.

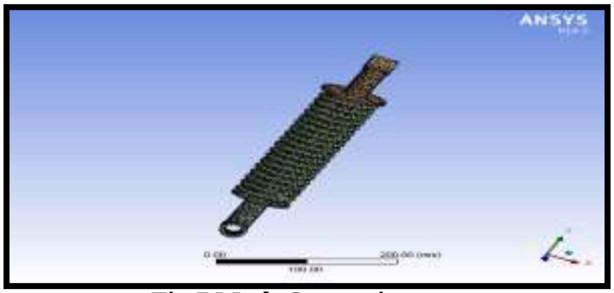

Fig.7 Mesh Generation.

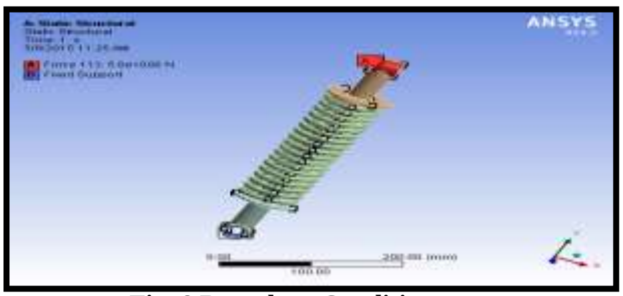

Fig. 8 Boundary Condition.

Present Design

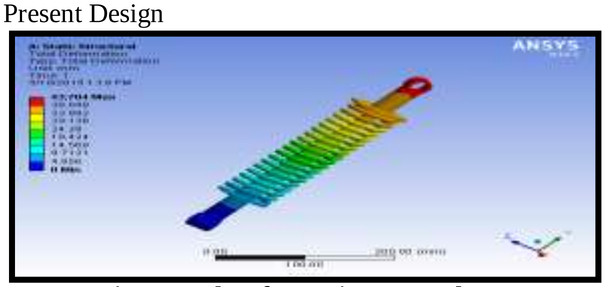

Fig.9 Total Deformation At 113kg

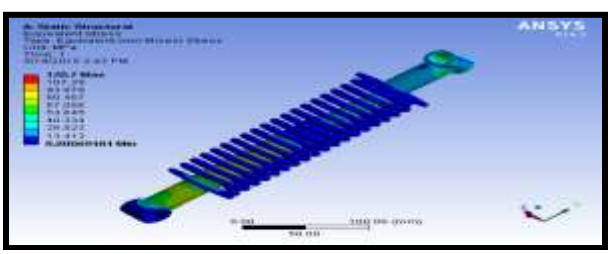

Fig.10 Von Mises Stress At 113 Kg.

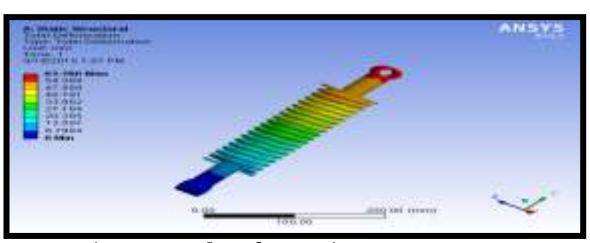

Fig.11 Total Deformation At 188 Kg.

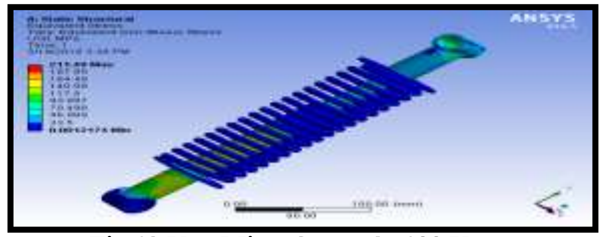

Fig.12 Von Mises Stress At 188 Kg.

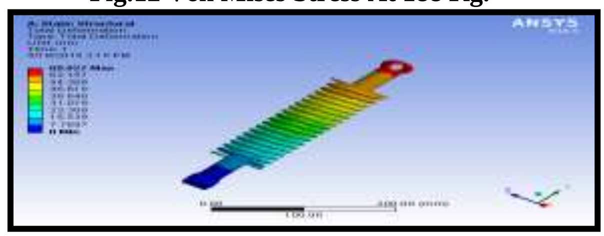

Fig.13 Total Deformation At 263kg.

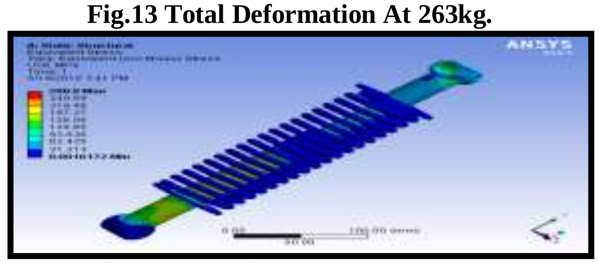

Fig.14 Von Mises Stress At 263 Kg.

GLASS FIBER DESIGN

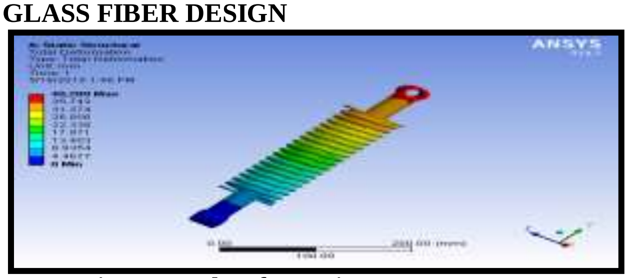

Fig.15 Total Deformation At 113 Kg.

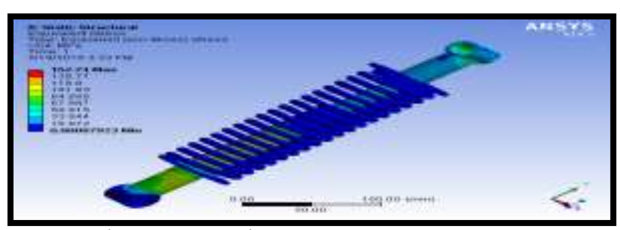

Fig.16 Von Mises Stress At 113 Kg.

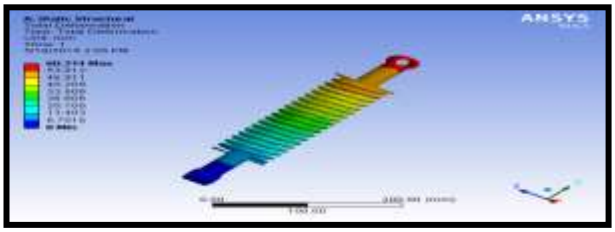

Fig.17 Total Deformation At 188 Kg.

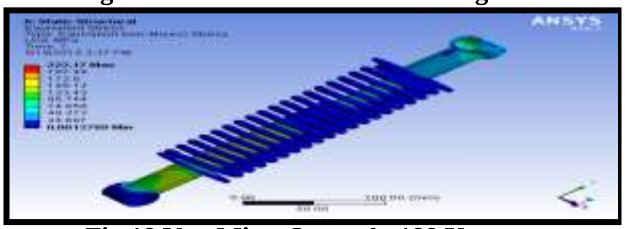

Fig.18 Von Mises Stress At 188 Kg.

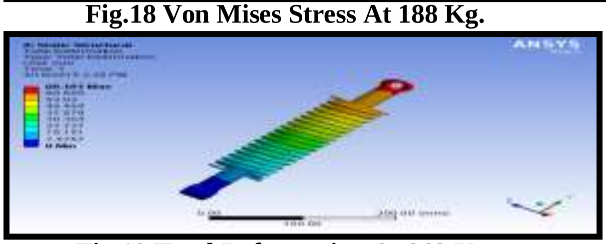

Fig.19 Total Deformation At 263 Kg.

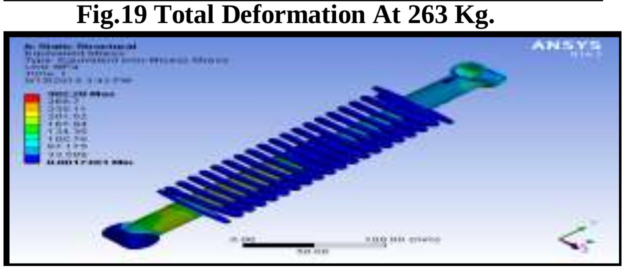

Fig.20 Von Mises Stress At 263 Kg.

CARBON EPOXY DESIGN

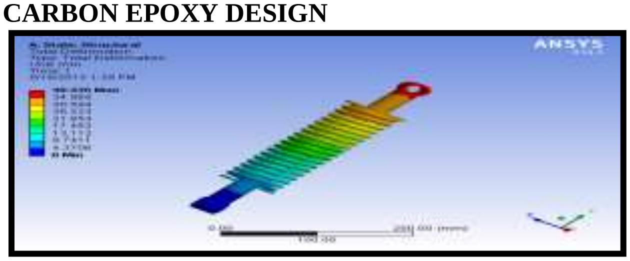

Fig.21 Total Deformation At 113 Kg.

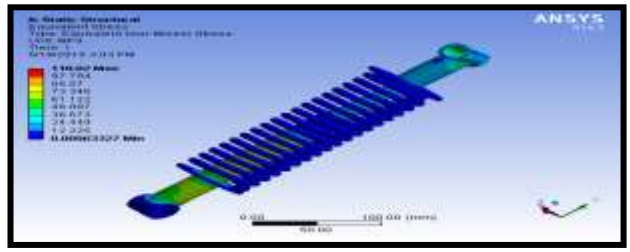

Fig.22 Von Mises Stress At 113 Kg.

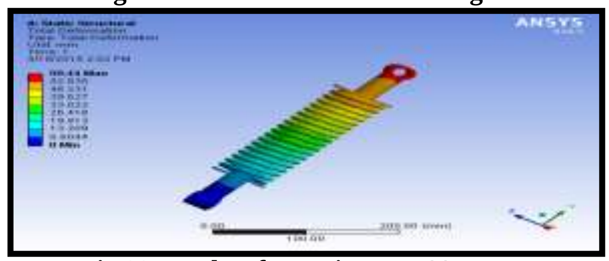

Fig.23 Total Deformation At 188 Kg.

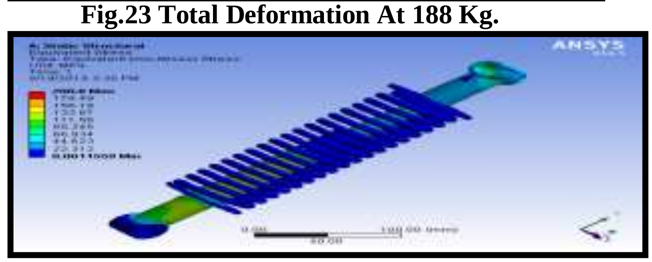

Fig.24 Von Mises Stress At 188 Kg.

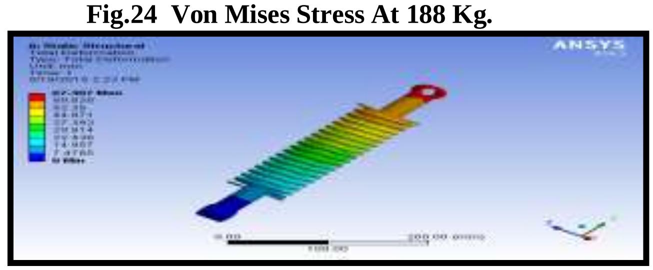

Fig.25 Total Deformation At 263 Kg.

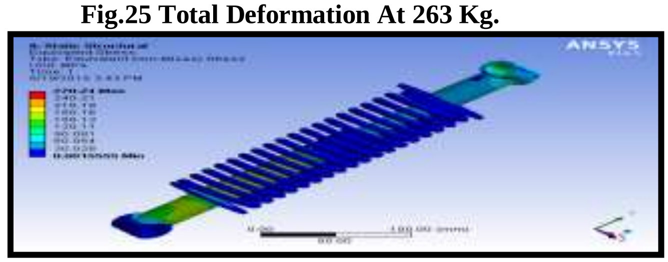

Fig.26 Von Mises Stress At 263 Kg.

VI.EXPERIMENTAL APPROACH

Fig.27 Static Test Set Up For Both Composite And Steel Shock Absorber.

Fig.28 Load Vs Deformation Curve For Steel

Fig.29 load Vs Deformation Curve for Carbon Fiber

VII.RESULTS & DISCUSSIONS.

Comparison Of Weight:

The weight reduction of unsparing mass of an automobile will improve the riding quality. The suspension System contributes 10% - 20% of the unsprung mass. Hence, the riding comfort of an automobile is increased due to the replacement of the steel shock absorber by composite shock absorber. The total weight of suspension system with composite spring is 700 gm. The weight of a convectional steel spring assembly is around 1500 gms. So, around 46 % of weight reduction is achieved. Thus the objective of reducing the unsprung mass is achieved to a larger extent.

1.1 Weight Comparison between Conventional And Composite Spring.

Table 7.1 Difference between stiffness values obtained theoretically, analytically & practically.

SR. NO	LOAD KG	THEROTICAL		ANALYTICAL		PRACTICAL	
		Present Design	Modified Design	Present Design	Modified Design	Present Design	Modified Design
1	113	21.03	38	25.36	28.18	24.91	35.16
2	188	24.12	44.806	30.142	31.027	28.17	31.78
3	263	26.08	47	36.89	38.33	37.24	37.36

VIII.CONCLUSION

- In section we have designed a shock absorber used in a 150cc bike. We have modeled the shock absorber by using CATIA V5.
- To validate the strength of our design, we have done structural analysis analysis on the shock absorber. We have done analysis by varying spring material.
- By comparing the results for present design and modified design, the stress and displacement values are less for modified design.
- By comparing the results for both materials, the stress value is less for composite Spring .
- A comparative study has been made between composite and steel spring with respect to varying parameter;
- The Experimental results were compared with FEA and the results show good agreement with test results;
- From the results, it is observed that the composite spring Shock absorber is lighter and more economical than the conventional steel spring Shock absorber with improved stiffness.

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