



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

# IJRSET

International Journal of Innovative Research in  
**SCIENCE | ENGINEERING | TECHNOLOGY**



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 12, Issue 5, May 2023



Impact Factor: 8.423



# Design and Analysis of Suspension Systems in Bikes

Ayyappan S<sup>1</sup>, Santhosh G<sup>2</sup>, Chandru P<sup>3</sup>, Rahul D<sup>4</sup>.

Assistant Professor, Department of Mechanical Engineering, Sri Balaji Chockalingam Engineering College, ARNI,  
Tamil Nadu, India

<sup>2,3,4</sup>UG students Department of Mechanical Engineering, Sri Balaji Chockalingam Engineering College, ARNI,  
TamilNadu, India

**ABSTRACT:** Shock absorbers are a critical part of a suspension system, connecting the vehicle to its wheels. The need for dampers arises because of the roll and pitches associated with vehicle maneuvering, and from the roughness of road. This led to make the ride quality for the people very uncomfortable which led to invention and innovation of shock absorbers. Shock absorbers are devices that smooth out an impulse experienced by a vehicle, and appropriately dissipate or absorb the kinetic energy. **SHOCK ABSORBERS** have become such an essential component of an automobile. Suspension system is the main part of the vehicle which is used for comfort and for better ride through rough roads. It absorbs shocks and vibration by providing smooth functioning to the vehicle. Currently there are different types of suspension in the market. In this study, we considered **MONO SUSPENSION AND DUAL SUSPENSION**. We compare the ride quality of mono suspension and dual suspension of two-wheeler vehicles to know how they differ from each other by performing **STATIC STRUCTURAL ANALYSIS** under different loading conditions by designing 3D model of suspension system using software like **SOLID WORKS** and **ANSYS** for performing analysis. We have also performed for the same and have depicted the convergence of the simulation with the design clearly.

**KEYWORDS:** Shock Absorbers, Mono and Twin Suspension, Static Structural Analysis.

## I. INTRODUCTION

A motorcycle's suspension serves a dual purpose- contributing to the vehicle's handling and braking and providing safety and comfort by keeping the vehicle's passengers comfortably isolated from road noise, bumps and vibrations.

Shock absorber is a mechanical device designed to smooth out or damp shock impulse and dissipate kinetic energy. In this work, suspension system is designed and a 3D model is created using **SOLID WORKS**. Structural analysis is done on the shock absorber by varying different types of materials and loading conditions. Suspension types considered in this analysis are mono suspension and twin suspension systems. To validate the strength of the model, the structural analysis on the design of suspension systems is performed. The analysis is done by considering different loading conditions like bike weight, bike weight with single, and double rider. Finally, comparison is done for different suspension systems by varying different materials such as stainless steel, aluminium alloy, magnesium alloy.

**WORKING:** The primary goal of motorcycle suspension is to keep vehicle tires in contact with the ground. Without proper suspension, tires would lose traction when encountering bumps, dips or other ground imperfections. We can't forget about braking, acceleration or cornering forces either. Motorcycle suspensions use a spring and damper combination to isolate the chassis and rider from road imperfections. On-road motorcycle suspension systems work to minimize the effect of potholes, bumps, cornering and acceleration/deceleration forces. Off-road motorcycle suspension systems handle roots, rocks, jumps, ledges and more.

Without suspension, any impact between a vehicle tire and a ground imperfection is at best uncomfortable, and at worst, the cause of a dangerous crash. Basic motorcycle suspension lacks adjustability. It works fairly well in a wide variety of circumstances, whereas more premium suspension is tunable to rider weight and intended riding type. Cruisers or dual sport motorcycles have vastly different needs than a dedicated sport bike. Adjustability can include ride height (under load), fine tuning how quickly springs compress or rebound as well as preloading spring tension to accommodate differing weight for different riding styles, such as riding with a passenger and/or luggage. The most

common suspension systems found on motorcycles use a coil spring and hydraulic damper setup. Air springs and other types of suspension exist.

## 1. APPLICATIONS OF SUSPENSION SYSTEMS

Suspension systems 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.

## 2. MATERIALS USED:

Steel alloys are the most used spring materials. The most popular alloys include high-carbon (such as the music wire used for guitar strings), oil-tempered low-carbon, chrome **silicon**, chrome vanadium, and stainless steel other metal alloys are also used such as aluminium alloy, chromium, magnesium alloy etc.

## II. LITERATURE REVIEW

### Study and Design of Advance Suspension System for Two Wheeler

Shubham Kadu, Kailas Gaware, Tushar Kale, Harshal. D. Patil, International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 08 | Aug 2018. Now a day's various types of suspension are available in market but for optimizing the better and efficient cushioning effect. It is a need of today to improve and advancement in suspension system. In This research literature they thoroughly studied design parameters required to design magnetic suspension system and gives information about various types of rear suspension of two-wheeler. Research literature describes techniques for the design, construction of magnetic suspension system.

### Experimental investigation of mono suspension spring.

Vidya S.Visave, J.R.Mahajan (IRJET) checked the convenient method of replacing metal coil spring with the composite coil spring using composite materials like carbon fiber , glass fiber and combination of Carbon fiber and glass fiber. Using composite material it will reduce the weight of the coil spring, according to experimental result the spring rate of the carbon fiber is 34% more than the glass fiber and 45% more than the glass fiber/carbon fiber spring. The cost of glass fiber springs are 25% more than steel springs and cost of the carbon fiber spring is 200% more than steel springs. The stiffness of composite spring is less than steel springs and hence its application is limited to light vehicles.

### Comparison between Dual Suspension and Mono Suspension of Two Wheelers

Pratik G. Chute, Nayan M. Chauhan, Aditya N. Palkar, *Mechanical Engineering, D.Y. Patil College of Engineering, Pune, India.* International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 09 | Sep 2018. Suspension system is the main part of the vehicle which is used for comfort and for better ride through rough roads. It absorbs shocks and vibration by providing smooth functioning to the vehicle. So, currently there are different types of suspension in the market. So, let us consider mono suspension and dual suspension. Now a days, we see that mostly all the two-wheeler have mono suspension. So, there should be difference between mono suspension and dual suspension. So, we compare mono suspension and dual suspension of two-wheeler vehicle to know how they differ from each other. Also, we discuss any type of change in the stability of vehicle. The Changes which will be feel by passenger, difference between them and the working of suspension system are included in this paper.

### Design and Analysis of Two-Wheeler Shock Absorber Coil Spring

Prof. Prince Jerome Christopher J, Pavendhan R of J.J College of Engineering &Technology, Trichy *IJMER*. The objective of this project is to design and analyze the performance of Shock absorber by varying the wire diameter of the coil spring. They collected theoretical information and working of the shock absorbers and then performed the design calculations of helical spring of shock absorber. They designed the shock absorber using PRO/ENGINEER software with calculated dimensions. They then performed analysis on the design using ANSYS software for finding displacement, loading and Von stresses on the spring.



### Design and Analysis of helical springs in two-wheeler Suspension System

K. Vinay kumar, R.Rudhra abhi Ramu & CH. Siva Rama Krishna. IMPACT: International Journal of Research in Engineering & Technology (IMPACT: IJRET) Vol. 4, Issue 7, Jul 2016, Impact Journals. The present work is carried out on modeling, and analysis of suspension spring is to replace the existed steel helical spring used in popular two wheeler vehicle. The stress and deflections of the helical spring is going to be reduced by using the new materials. The comparative study is carried out between existed spring and new material spring. Static analysis determines the stress and deflections of the helical compression spring in finite element analysis. The analytical modal is used to test the spring under different loading conditions. Finite element analysis methods (FEA) are the methods of finding approximate solutions to a physical problem defined in a finite region or domain.

### III. DESIGN AND MODELING OF SUSPENSION SYSTEMS USING SOLIDWORKS

Modeling can be done in various methods such as wireframe modeling, surface modeling, solid modeling, etc. the easiest way is chosen for modeling. Here we have chosen solid modeling method of creating a solid. There are many packages for modeling, out of which SOLIDWORKS has been selected for its ease of availability and as it is user friendly.

#### SOLIDWORKS :

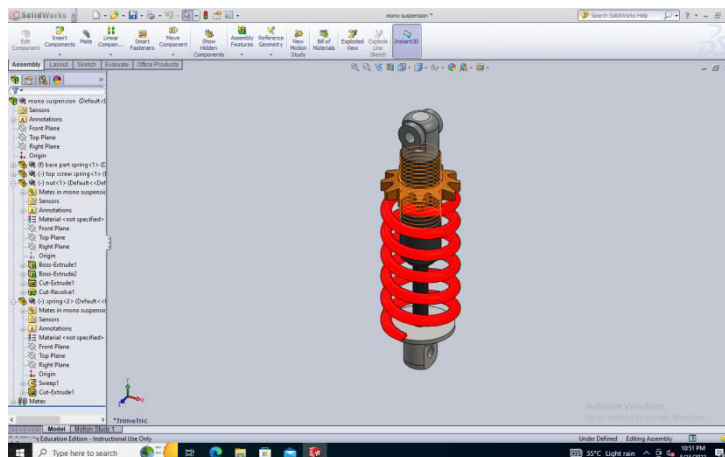
SOLIDWORKS is among the very few software which has its application in about every industrial sector. It is mostly used by the designer team. The designer team of any organization needs to create a digital copy of any object which has to be manufactured. This digital copy can be created with much ease by using SOLIDWORKS . It is mostly found in companies who are associated with design and manufacturing of products.

#### PART MODELLING:

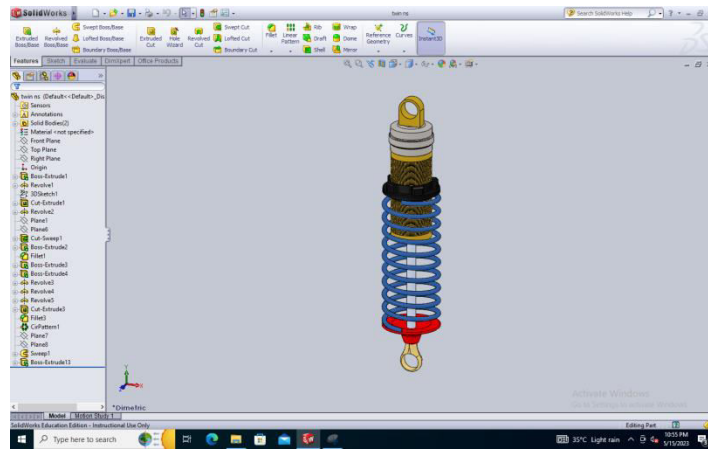
**Mono suspension:** In this suspension system there are four main parts Spring, base , top screw and a nut. These four parts are designed using sketcher and part design modules.

#### Twin Suspension:

This suspension system is an assembly of multiple parts and the main parts present in this assembly design are Spring, piston rod, top part , strut , and washers. These parts are designed using sketcher and part design modules.



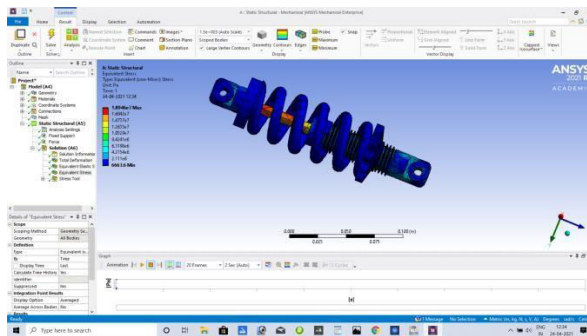
Mono Suspension System



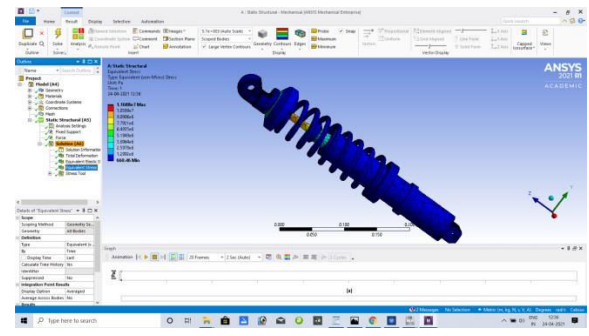
Twin Suspension System

**IV. PERFORMANCE ANALYSIS OF SUSPENSION SYSTEM USING ANSYS**

The Ansys finite element solvers enable a breadth and depth of capabilities unmatched by anyone in the world of computer-aided simulation. Thermal, Structural, Acoustic, Piezoelectric, Electrostatic and Circuit Coupled Electromagnetics are just an example of what can be simulated. Regardless of the type of simulation, each model is represented by a powerful scripting language. A user may start by defining the dimensions of an object, and then adding weight, pressure, temperature and other physical properties.



1. Mono Suspension Meshing



2. Twin Suspension Meshing

**MATERIAL PROPERTIES OF MONO & TWIN SUSPENSION SYSTEM ALUMINIUM ALLOY MATERIAL PROPERTIES**

S.NO	PROPERTIES	VALUES
1.	Modulus of rigidity (G)	27× 10 <sup>3</sup> Mpa
2.	Modulus of elasticity (E)	70× 10 <sup>3</sup> Mpa
3.	Tensile yield strength	310 Mpa
4.	Compressive yield strength	310 Mpa
5.	Density	2.7 g/cm <sup>3</sup>

**MATERIAL PROPERTIES OF MONO & TWIN SUSPENSION SYSTEM STAINLESS STEEL MATERIAL PROPERTIES**

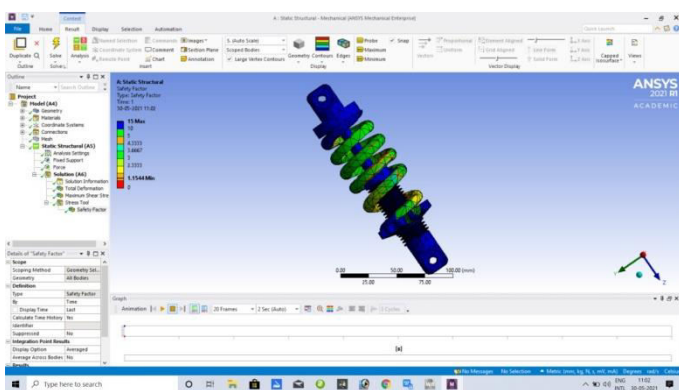
S.NO	PROPERTIES	VALUES
1.	Modulus of rigidity (G)	77.2× 10 <sup>3</sup> Mpa
2.	Modulus of elasticity (E)	210× 10 <sup>3</sup> Mpa
3.	Tensile yield strength	505 Mpa
4.	Compressive yield strength	505 Mpa
5.	Density	7.83 g/cm <sup>3</sup>



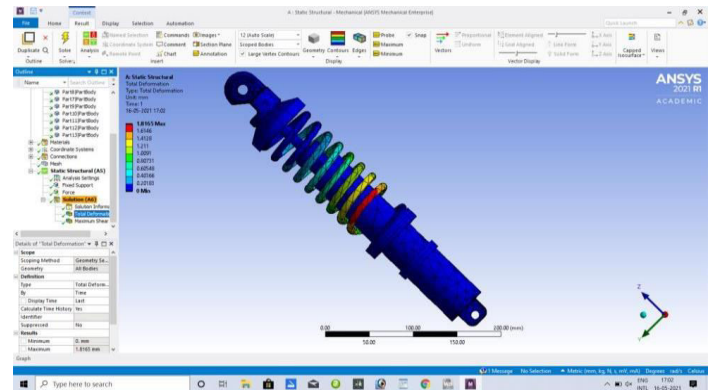
**ANALYSIS OF BRAKE SYSTEM**

- 1.) Build Geometry: Construct a two or three dimensional representation of the modeled and tested using the work plane coordinates system within ANSYS.
- 2.) Define Material Properties: Now that the part exists, define a necessary material that compose the object (or project) being modeled. This includes thermal and mechanical properties.
- 3.) Generate Mesh: At this point ANSYS understand the makeup of the part. Now define how the modeled system should be broken down into finite pieces.
- 4.) Apply Loads: Once the system is fully designed, the last task is to burden the system with constraints, such as physical loadings or boundary conditions.
- 5.) Obtain Solution: This actually a step, because ANSYS needs to understand within what state (steady state, transient thermal...etc.) the problem must be solved.
- 6.) Present the Result: After the solution has been obtained,there are many ways to present ANSYS’ result,choose from many options such as tables,graphs,and contourplots.

**V. STATIC STRUCTURAL ANALYSIS OF MONO & TWIN SUSPENSION SYSTEM OBSERPTION OF TOTAL DEFORMATION**

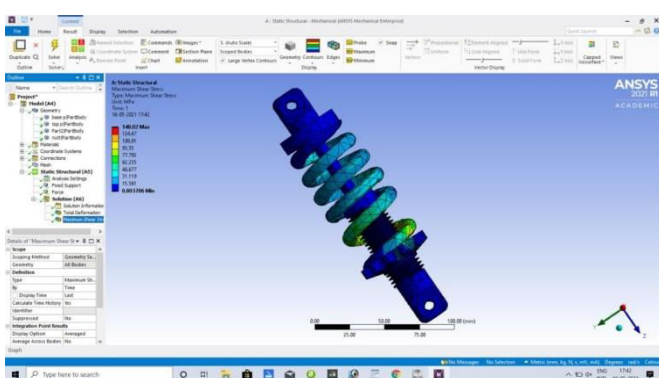


1. Mono Suspension Meshing

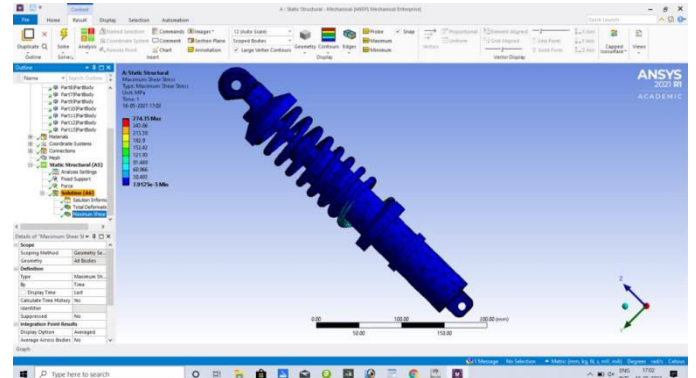


2. Twin Suspension Meshing

**STATIC STRUCTURAL ANALYSIS OF MONO AND TWIN SUSPENSION SYSTEM OBSERPTION OF MAXIMUM SHEAR STRESS**



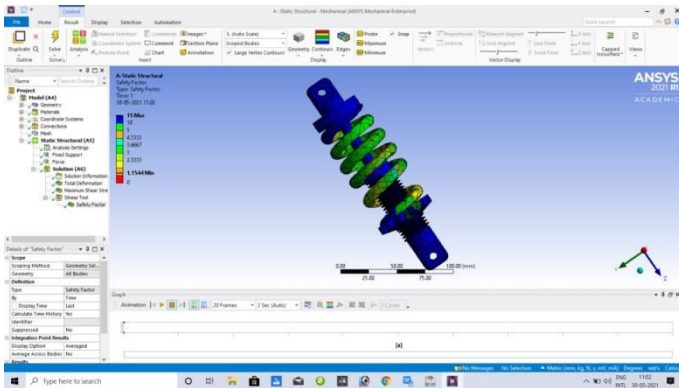
1. Mono Suspension Meshing



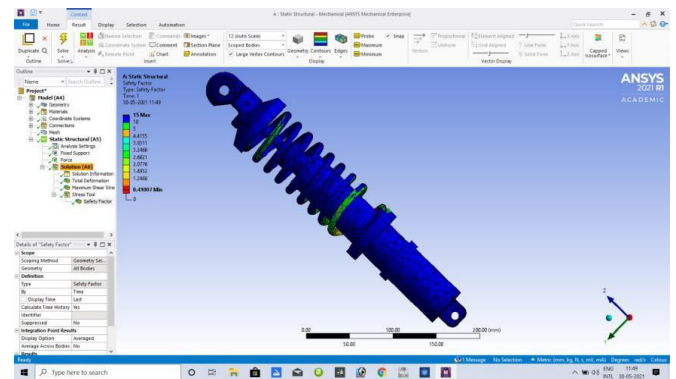
2. Twin Suspension Meshing



**STATIC AND STRUCTURAL ANALYSIS OF MONO & TWIN SUSPENSION SYSTEM OBSERPTION OF FACTOR OF SAFETY**



1. Mono Suspension Meshing



2. Twin Suspension Meshing

**THEORETICAL CALCULATIONS:**

**Mono Suspension:**

$$\text{Mean coil diameter}(D) = \frac{D_i + D_o}{2} = 36\text{mm}$$

$$\text{Spring index } (C) = \frac{D}{d} = 3.27$$

$$\text{Wahl's Stress Factor } (K) = \frac{4c-1}{4c-4} + \frac{0.615}{c} = 1.51$$

$$\text{Maximum shear stress } (\tau) = \frac{k8pd}{\pi D^3} = (1.51 * 8 * 36 * 1402 / \pi * 11^3) = 143.06 \text{ MPa}$$

$$\begin{aligned} \text{Error} &= [(143.06 - 140.02) / (143.06)] * 100 \\ &= 0.0211 \\ &= 2.1\% \end{aligned}$$

$$\text{Factor of safety} = \frac{310}{140.02} = 2.21$$

**Twin Suspension:**

$$\text{Mean coil diameter}(D) = \frac{D_i + D_o}{2} = 60\text{mm}$$

$$\text{Spring index } (C) = \frac{D}{d} = 7.69$$

$$\text{Wahl's Stress Factor } (K) = \frac{4c-1}{4c-4} + \frac{0.615}{c} = 1.19$$

$$\text{Maximum shear stress } (\tau) = \frac{k8pd}{\pi D^3} = (1.19 * 8 * 701 * 60 / \pi * 7.8^3) = 268.57 \text{ MPa}$$

$$\begin{aligned} \text{Error} &= [(268.57 - 265.22) / (268.57)] * 100 \\ &= 0.0124 \\ &= 1.24\% \end{aligned}$$



$$\text{Factor of safety} = \frac{310}{140.02} = 1.16$$

**VI. RESULTS**

**SHEAR STRESS OF MONO & TWIN SUSPENSION SYSTEMS:**

Type of material	Load applied in N	Maximum shear stress (theoretical) MPa	Maximum shear stress (Ansys Simulation) MPa	Percentage convergence
Aluminium alloy	W1=1402 N	143.06	140.02	97.9 %
Stainless steel	W1=1402 N	143.06	140.36	98.1 %

Type of material	Load applied in N	Maximum shear stress (theoretical) MPa	Maximum shear stress (Ansys Simulation) MPa	Percentage convergence
Aluminium alloy	W1=701 N	268.57	265.22	98.76%
Stainless steel	W1=701 N	268.57	274.35	97.9 %

**FACTOR OF SAFETY OF MONO & TWIN SUSPENSION SYSTEMS**

Type of material	Load applied in N	Factor of safety (Theoretical)	Factor of safety (simulation)
Aluminium alloy	W1=1402N	2.213	2.33
Stainless steel	W1=1402N	3.59	3.66

Type of material	Load applied in N	Factor of safety (Theoretical)	Factor of safety (simulation)
Aluminium alloy	W1=701N	1.16	1.3
Stainless steel	W1=701N	1.84	2.07

**TOTAL DEFORMATION OF MONO & TWIN SUSPENSION SYSTEM**

Type of material	Total Deformation in mm
	<b>W1 = 1402 N</b>
Aluminium alloy	2.09 mm
Stainless steel	0.761 mm

Type of material	Total Deformation in mm
	<b>W1 = 701 N</b>
Aluminium alloy	4.99 mm
Stainless steel	1.81 mm

**VII. CONCLUSION**

The suspension systems used in bikes have been designed using SOLIDWORKS software. The designs were then imported into ANSYS workbench to perform analysis. Theoretical calculations have also been performed to validate the simulation which was performed in ANSYS workbench. After comparison, the results were determined to be closer to the real time design conditions by which the simulation can be taken into consideration at different loading conditions. Later, analysis using ANSYS workbench has been performed on both the suspension systems by adding





different materials at different loading conditions and required results such as static stress, total deformation and factor of safety are determined for different loading conditions. After validating the results, the conclusion of the project is made by considering the values of factor of safety, total deformation and type of material used for above specified loading conditions. From this project we conclude “MONO SUSPENSION SYSTEM” with stainless steel material is best suited and has good factor of safety. Mono suspension system has low total deformation and convincing factor of safety which shows that the system can absorb more load and has higher strength for above specified loading conditions.

### VIII. FUTURE SCOPE

In future this project can be further modified by performing other type of analysis like explicit dynamics under different loading conditions, thermal analysis can also be performed on the suspension systems as they are in continuous working when the vehicle is in motion which might affect the suspension systems due to change in temperature. Further the three-dimensional assembly design of the suspension systems can also be fabricated using a 3-D printer for any other practical purposes.

### REFERENCES

- [1]. **Study and Design of Advance Suspension System for Two-Wheeler.** Shubham Kadu, Kailas Gaware, Tushar Kale, Harshal, D. Patil, International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 08 | Aug 2018.
- [2]. **Experimental investigation of mono suspension spring.** Vidya S.Visave, J.R.Mahajan International Journal of Engineering Research & Technology (IRJET) 16/sep2016.
- [3]. **Comparison between Dual Suspension and Mono Suspension of Two Wheelers.** Pratik G. Chute, Nayan M. Chauhan, Aditya N. Palkar, *Mechanical Engineering, D.Y. Patil College of Engineering, Pune, India.* International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 09 | Sep 2018.
- [4]. **Design and Analysis of Two-Wheeler Shock Absorber Coil Spring.** Prof. Prince Jerome Christopher J, Pavendhan R of J.J College of Engineering & Technology, Trichy *IJMER*.
- [5]. **Design and Analysis of Shock Absorber.** Mr. Sudarshan Martande, Mr. Y.N. Jangale, Mr. N.S. Motgi of Design Walchand Institute of Technology, Solapur *IJAITEM Volume 2, Issue 3, March 2013.*
- [6]. **Suspension Systems: A Review.** Dishant, Er. Parminder Singh, Er.Mohit Sharma. Dept. Of Mechanical Engineering, DIET, Kharar, India. International Research Journal of Engineering and Technology (IRJET). Volume: 04 Issue: 04 | Apr -2017.
- [7]. **Modelling and analysis of two-wheeler Suspension Spring.** T.R Sydanna, Chittetu Maheshwara Reddy INTERNATIONAL JOURNAL OF PROFESSIONAL ENGINEERING STUDIES Volume VIII /Issue 4 / APR 2017.
- [8]. **Design and Analysis of helical springs in two-wheeler Suspension System.** K. Vinay kumar, R.Rudhra abhi Ramu & CH. Siva Rama Krishna. IMPACT: International Journal of Research in Engineering & Technology (IMPACT: IJRET) Vol. 4, Issue 7, Jul 2016, Impact Journals.
- [9]. **An Experimental Study on Dynamic Characteristics of Twin Accumulator Suspension System.** M. M. M. Salem, Ali M. Abd-El-Tawwab, M. H. Abd-El-Aziz, K. A. Abd El-gwwad. International Journal of Advanced Science and Technology Vol. 29, No.0 3, (2020).
- [10]. **Comparison between Dual and mono Suspension of two wheelers.** Mr. Kommalapati Rameshbabu and Mr. Tippa Bhimasankara Rao.
- [11]. **Experimental Study on Dynamic Characteristics of Mono Suspension System.** Prof. Sagar S Khatavkar, Mr. Shrikant Dabekar, Ms. Namrata Bhokare, Ms. Nikita Dhandhukia and Ms. Shilpa Bafna.
- [12]. V.B. Bhandari, “Design of Machine Elements”, Third edition, Tata McGraw Hill publishers.
- [13]. “Design Data”, data book by M/s Kalaikathir Achchagam, compiled by PSG college of technology, Coimbatore.
- [14]. <https://youtu.be/OZZucX4O21Y> Dual suspension Assembly in SOLIDWORKS
- [15]. <https://youtu.be/u81SNL6h2rc> Mono suspension Assembly in SOLIDWORKS
- [16]. [https://youtu.be/3uV\\_M7KwsPc](https://youtu.be/3uV_M7KwsPc) shock absorber analysis in ANSYS workbench.
- [17]. [https://en.m.wikipedia.org/wiki/Shock\\_absorber](https://en.m.wikipedia.org/wiki/Shock_absorber).
- [18]. [https://en.wikipedia.org/wiki/Motorcycle\\_suspension](https://en.wikipedia.org/wiki/Motorcycle_suspension).



Impact Factor: 8.423



# INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

 9940 572 462  6381 907 438  [ijirset@gmail.com](mailto:ijirset@gmail.com)



[www.ijirset.com](http://www.ijirset.com)

Scan to save the contact details