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DESIGN AND PERFORMANCE ANALYSIS OF SHOCK ABSORBERS IN TWO WHEELERS

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Abstract: Automobile suspension arrangement plays a significant role for the comfort and stability of the vehicle. A suspension system or shock absorber is a mechanical device which is designed to smooth out impulse and dissipate kinetic energy. Shock absorber is a critical part of suspension system, which is used to connect the vehicle to the wheels. It contributes to the vehicles control providing safety and ease by absorbing the energy through bumps and pot holes on the road while providing smooth ride. The main purpose is to design and to do performance analysis of different shock absorber profiles using structural analysis. Modelling is done on CATIA and performance analysis is done for the different profiles for the shock absorbers using ANSYS software. The results are compared for different profiles of shock absorbers by applying different loads and stress, strain, deformation in static structural analysis is calculated.

***Keywords* – Shock absorbers, CATIA, ANSYS, suspension system, stress, strain, deformation.**

I. INTRODUCTION

Shock absorbers: A shock absorber or damper is a mechanical or hydraulic device designed to absorb and damp shock impulses. It does this by converting the kinetic energy of the shock into another form of energy (typically heat) which is then dissipated. Most shock absorbers are a form of dashpot (a damper which resists motion via viscous friction). There are four types of shock absorbers. Twin-tube. Position sensitive damping. Acceleration sensitive damping. Coil over. The types are explained as follows: Twin Tube: Basic twin-tube: It is also known as a “two-tube” shock absorber, this device consists of two nested cylindrical tubes, an inner tube that is called the “working tube” or the “pressure tube”, and an outer tube called the “reserve tube”. At the bottom of the device on the inside is a compression valve or base valve. When the piston is forced up or down by bumps in the road, hydraulic fluid moves between different chambers via small holes or “orifices” in the piston and via the valve, converting the “shock” energy into heat which must then be dissipated. Twin-tube gas charged: Variously known as a “gas cell two-tube” or similarly-named design, this variation represented a significant advancement over the basic twin-tube form. Its overall structure is very similar to the twin-tube, but a low-pressure charge of nitrogen gas is added to the reserve tube. The result of this alteration is a dramatic reduction in “foaming” or “aeration”, the undesirable outcome of a twin-tube overheating and failing which presents as foaming hydraulic fluid dripping out of the assembly. Twin- 2 tube gas charged shock absorbers represent the vast majority of original modern vehicle suspension installations. Position sensitive damping: Often abbreviated simply as "PSD", this design is another evolution of the twin-tube shock. In a PSD shock absorber, which still consists of two nested tubes and still contains nitrogen gas, a set of grooves has been added to the pressure tube. These grooves allow the piston to move relatively freely in the middle range of travel (i.e., the most common street or highway use, called by engineers the "comfort zone") and to move with significantly less freedom in response to shifts to more irregular surfaces when upward and downward movement of the piston starts to occur with greater intensity (i.e., on bumpy sections of roads— the stiffening gives the driver greater control of movement over the vehicle so its range on either side of the comfort zone is called the "control zone"). The next phase in shock absorber evolution was the development of a shock absorber that could sense and respond to not just situational changes from "bumpy" to "smooth" but to individual bumps in the road in a near instantaneous reaction. Coilover: Coilover shock absorbers are usually a kind of twin-tube gas charged shock absorber inside the helical road spring. They are common on motorcycles and scooter rear suspensions, and widely used on front and rear suspensions in cars.

II. LITERATURE REVIEW:

A. Chinna Mahammad bhasha et.al [1] “Design and Analysis of Shock Absorber”. In this journal, they talk about the model is also changed by changing the thickness of the spring. Structural analysis and modal analysis are done on the shock absorber by varying different spring materials. Spring materials are Spring Steel, Phosphor bronze, Beryllium Copper and Titanium alloy. To validate the strength of the model, the structural analysis on the helical spring was done. The analysis is done by considering loads, bike weight, and single, double riding. Modal analysis is done to determine the displacements for different frequencies for number of modes. Finally, comparison is done for different materials to verify best material for spring in Shock absorber. Modelling is done in CATIA and analysis is done in ANSYS. Syed Qubullah et.al [2] "Analysis of Rear Shock Absorber spring of a Two-Wheeler". In this journal, they talk about a two-wheeler rear suspension spring is studied related to the uniform load effect and its life. Model of the two-wheeler suspension spring is demonstrated using the existing design of bullet bike with modelling software CATIA. This study deals with the analysis of spring using ANSYS 17.0. Results are compared based on static structural and life results obtained. Further results using another material is compared. Vamsi Krishna et.al [3] "Structural and Modal Analysis of Two-Wheeler Shock Absorber". In this journal, they talk about when a vehicle is traveling on a level road and the wheels strike a bump, the spring is compressed quickly. The weight of the vehicle will then push the spring down below its normal loaded height. The design of spring in shock absorber is very important. Structural analysis and modal analysis are done on the shock absorber using ANSYS software by varying material for spring (i.e.) carbon steel and beryllium copper and phosphor bronze. Structural analysis is done to validate the strength and modal analysis is done to determine the displacements for different frequencies for number of modes. Pinjarla.Poornamohan et.al [4] "DESIGN AND ANALYSIS OF A SHOCK ABSORBER". In this journal, they talk about 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. When a vehicle is traveling on a level road and the wheels strike a bump, the spring is compressed quickly. The compressed spring will attempt to return to its normal loaded length and, in so doing, will rebound past its normal height, causing the body to be lifted. Comparison is done for two materials to verify best material for spring in Shock absorber. V. Hari Prasad et.al [5] "DESIGN AND ANALYSIS OF SHOCK ABSORBER SPRING FOR AUTOMOBILES". In this journal, they talk about the necessity for dampers arises attributable to the roll and pitches related to vehicle manoeuvring, and from the roughness of roads. The speedily increasing power obtainable from the interior combustion engine created higher speeds routine. Shock absorbers area unit devices that disembarrass AN impulse toughened by a vehicle, and fitly dissipate or absorb the K.E. M. Sivasankar et.al [6] "Design and Optimization of Two-Wheeler Damper Spring and its Structural Components". In this journal, they talk about the connection between the tyres and 10 the vehicle body. It can return to their original shape when the force is released. Structural analysis is done to validate the strength and optimization is done to determine the better dimension of spring to carry applied load. Optimization is done for different dimensions to verify best size for spring in Shock absorber. Bhanu Prakash Bhavare et.al [7] "Design and Analysis of Two-Wheeler Suspension System Using Different Materials on ANSYS". In this journal, they talk about the use of shock absorbers in vehicles leads to comfort in ride. A two-wheeler suspension system joins the vehicle chassis to the tires. In this we are trying to find out the best material for a two-wheeler suspension system by comparing the deformations and stresses produced in each material under identical loading conditions. P. Karunakar et.al [8] "Comparative Design Analysis of Two-Wheeler Shock Absorber". In this journal, they talk about varying the material for spring as Stainless Steel (ASTM-A316), Inconel X750, Nickel 200. Finally, as per our analysis we investigated the best suited material for the spring of the shock absorber is Inconel X750. Therefore, the 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. Johnson et.al [9] "Design and Analysis of a Shock Absorber". In this journal, they talk about the standard product design, featuring industry-leading productivity tools that promote best practices in design. Structural analysis is done in 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. Analysis is done on the shock absorber by varying material for spring: Spring Steel and Beryllium Copper. Raviraj. N et.al [10] "Design and analysis of a two-wheeler shock absorber coil spring". In this journal, they talk about the problem happens while driving on bumping road condition so the rider feels uncomforted. Hence the design of spring in shock absorber is very important. In this, the spring is designed and the 3D model is created using modelling software CATIA. Static analysis is done on the spring by varying materials as oil tempered spring steel and beryllium copper. In this analysis, maximum shear stress and total deformation is calculated using ANSYS software and the comparison is made on two materials.

By using these literature surveys, we can say that there are different types of loads are acting on the shock absorbers and different types are used. These journals help us to design, modelling and analyse the different forces applied on shock absorber and reduce the loads for different to use it conveniently.

III. DESIGN AND ANALYSIS

1. MODELING:

To draw the sketch of the part, click on start, select mechanical design and select part design. Options to open part design. Firstly, we need to select the plane on which sketch is needed to draw. Firstly, open the CATIA software and then select a new part in the generative shape design workbench. In that took the YZ axis plane and then draw a point at 25mm from the axis and Exit from the current workbench. Then select the helix curve in the wire frame and then give the helix curve definitions values as height of 100mm and pitch value as 12.5mm, then preview and then ok. Click the top end of the helical curve and then select the helix curve and then give the dimensions as revolutions is 3 and the distance is 20mm and then select the reference plane then click the preview and then ok. Then select the helix curve in the wire frame and then give the helix curve definitions values as height of 100mm and pitch value as 12.5mm, in the reverse direction from the axis then preview and then ok.

By taking the values of the shock absorber of the Honda CB Shine, Yamaha, TVS Star City bikes and we can draw the shock absorber in CATIA V5 software in the figures 1, 2, 3 and 4.

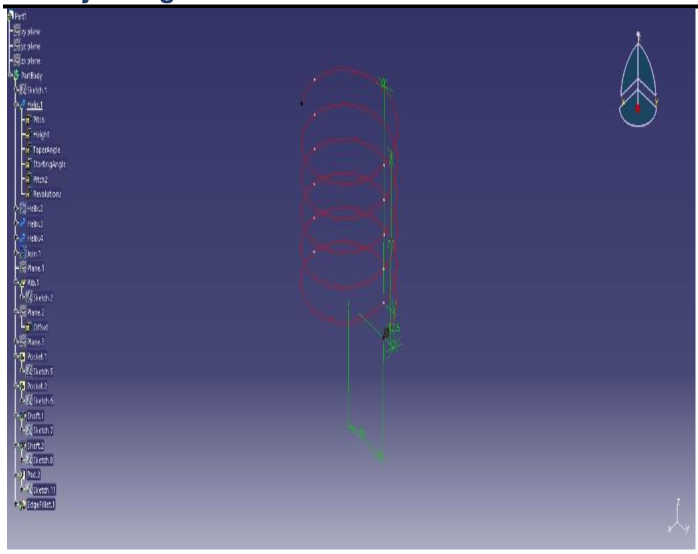

Fig 1: Helix of shock absorber

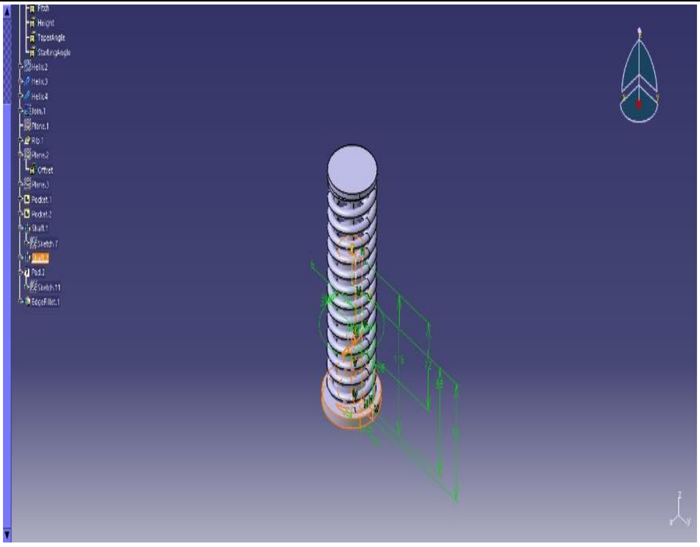

Fig 2: Rib of shock absorber

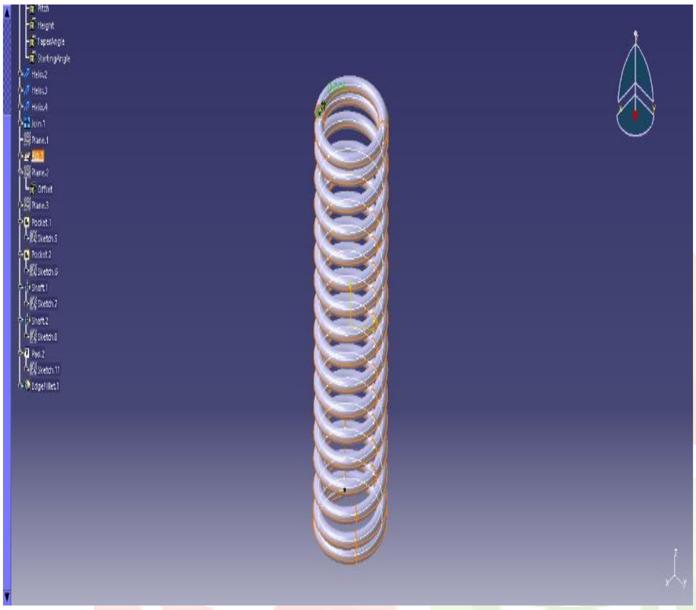

Fig 3: Pocket of shock absorber

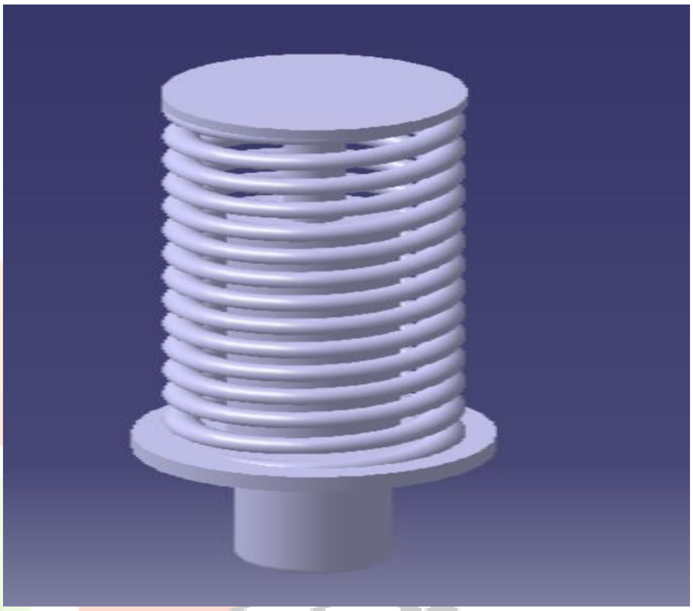

Fig 4: Assembly part of shock absorber

2. **STATIC STRUCTURAL ANALYSIS:** First, we can draw the shock absorbers in CATIA and then imported into ANSYS workbench software. In the static structural analysis, we calculate the total deformation, strain and stress of shock absorbers. The shock absorber is imported into ANSYS and generate a mesh in figures 5,6. Calculate the stress, strain and deformation as shown in figures 7, 8, 9, 10, 11, 12, 13, 14 and 15.

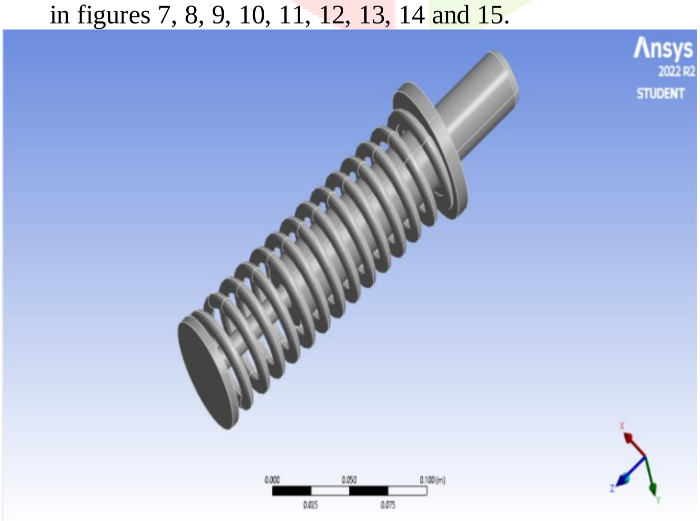

Fig 5: Importation of geometry in ANSYS

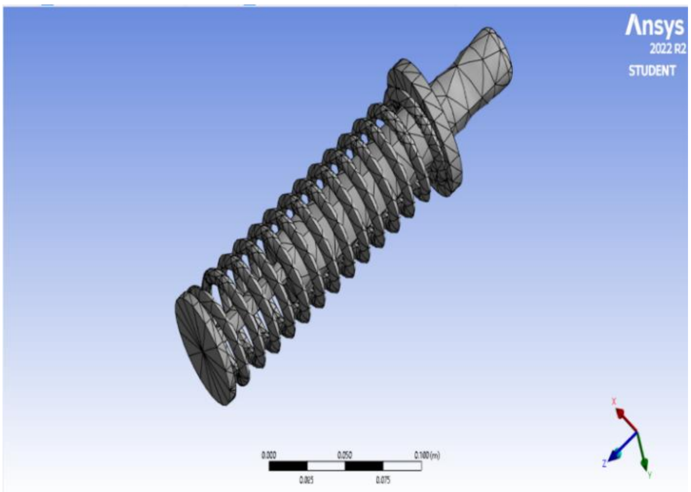

Fig 6: Generation of mesh of shock absorber

1. **HONDA CB SHINE:**

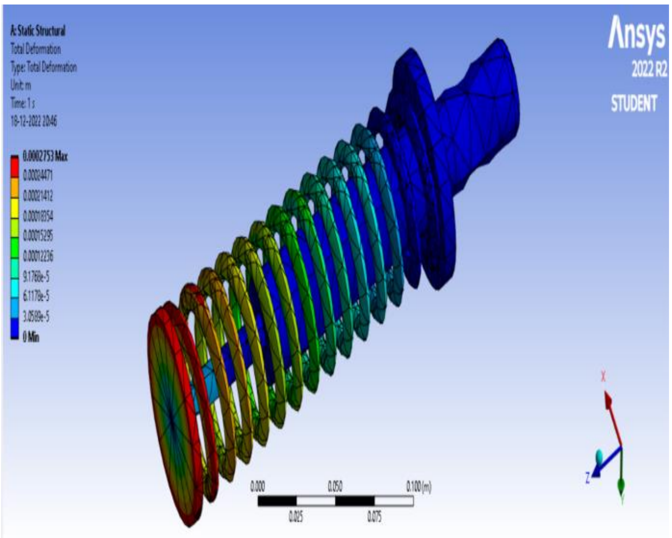

Fig 7: Total deformation for Honda CB shine shock absorber

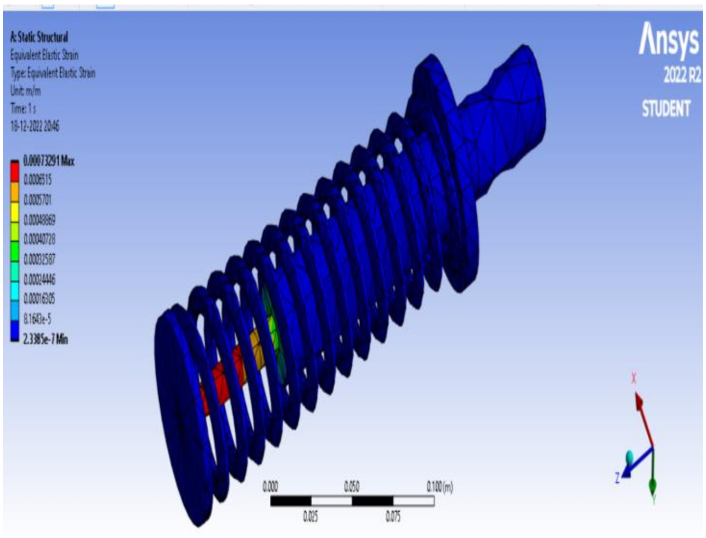

Fig 8: Strain for Honda CB shine shock absorber

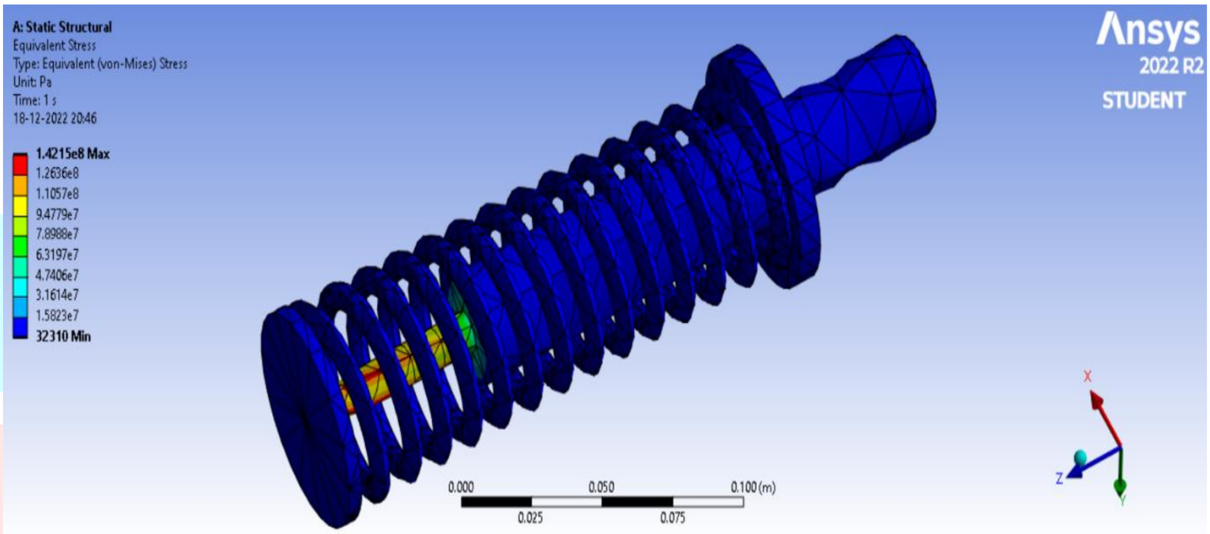

Fig 9: Stress for Honda CB shine shock absorber

2. **YAMAHA:**

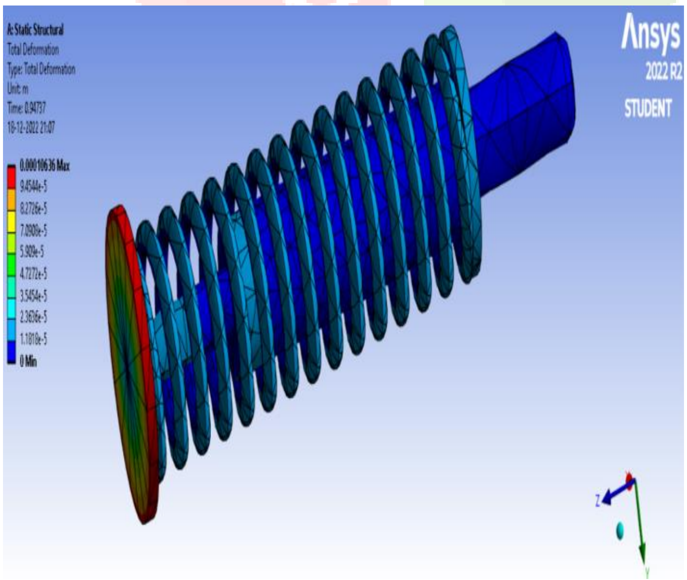

Fig 10: Total deformation for Yamaha shock absorber

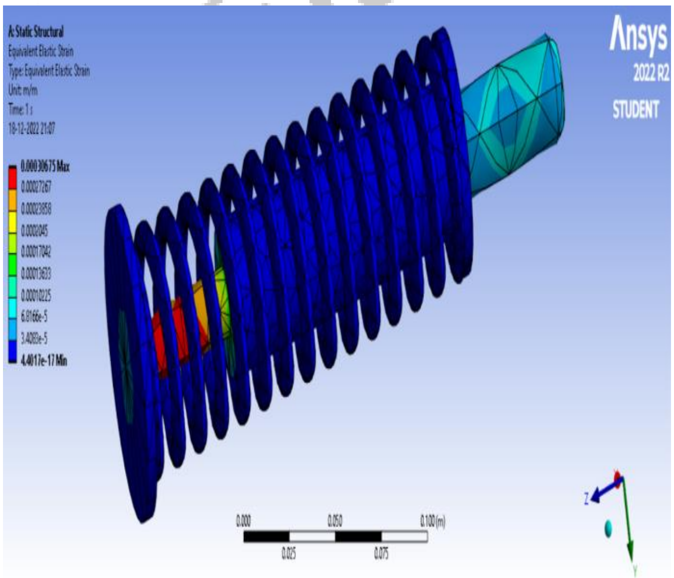

Fig 11: Strain for Yamaha shock absorber

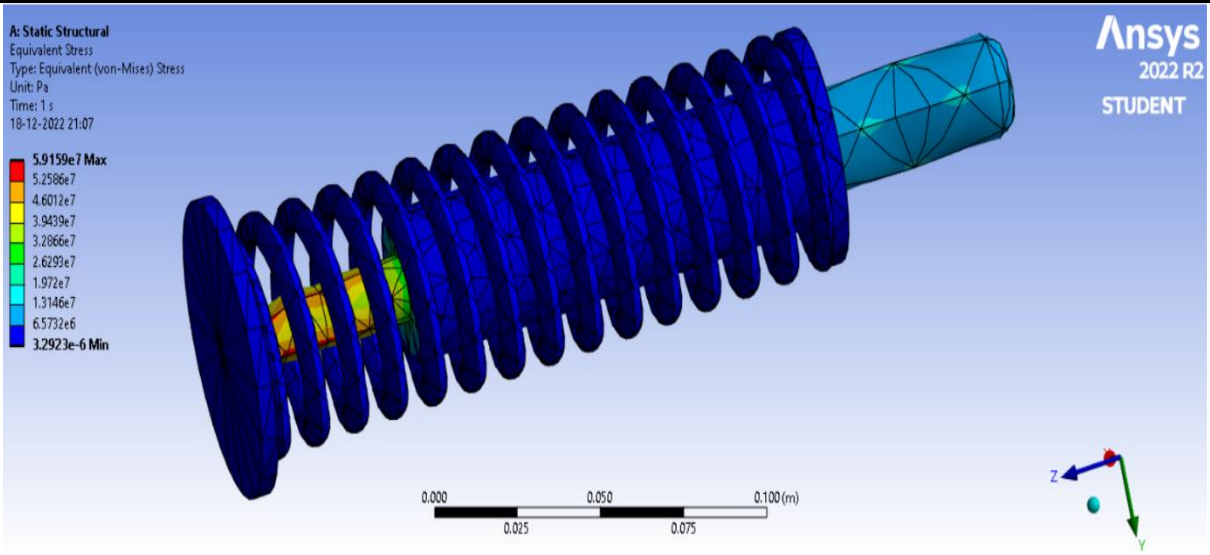

Fig 12: Stress for Yamaha shock absorber

3. **TVS STAR CITY:**

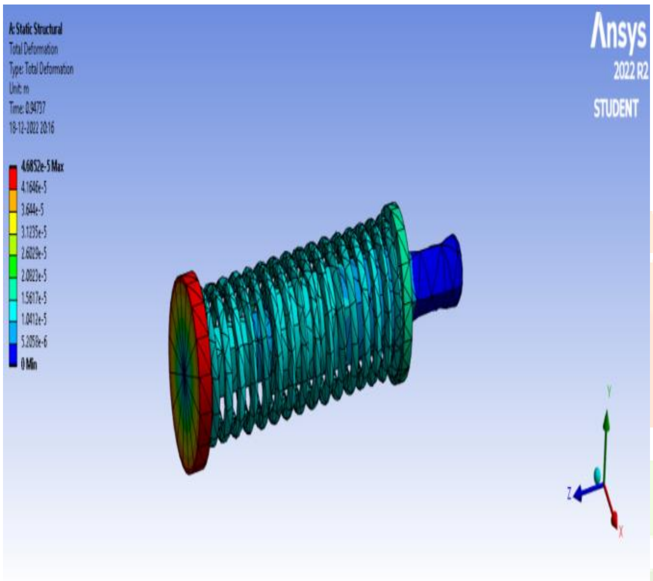

Fig 13: Total deformation for TVS Star city shock absorber

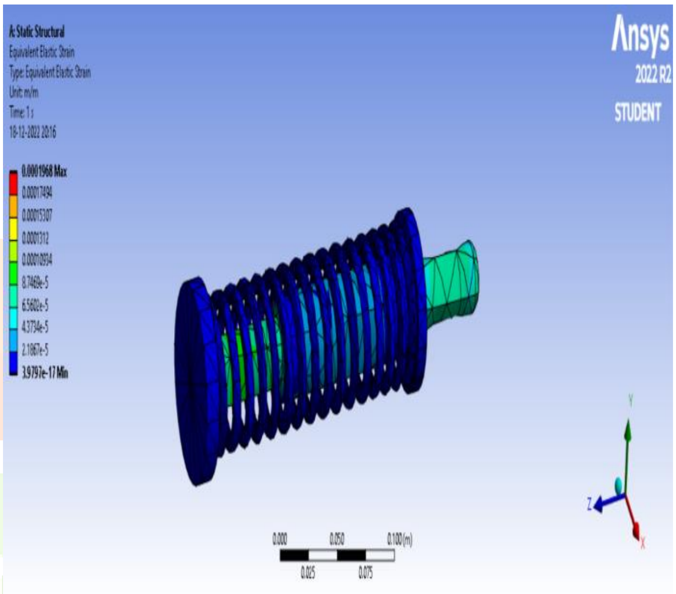

Fig 14: Strain for TVS Star city shock absorber

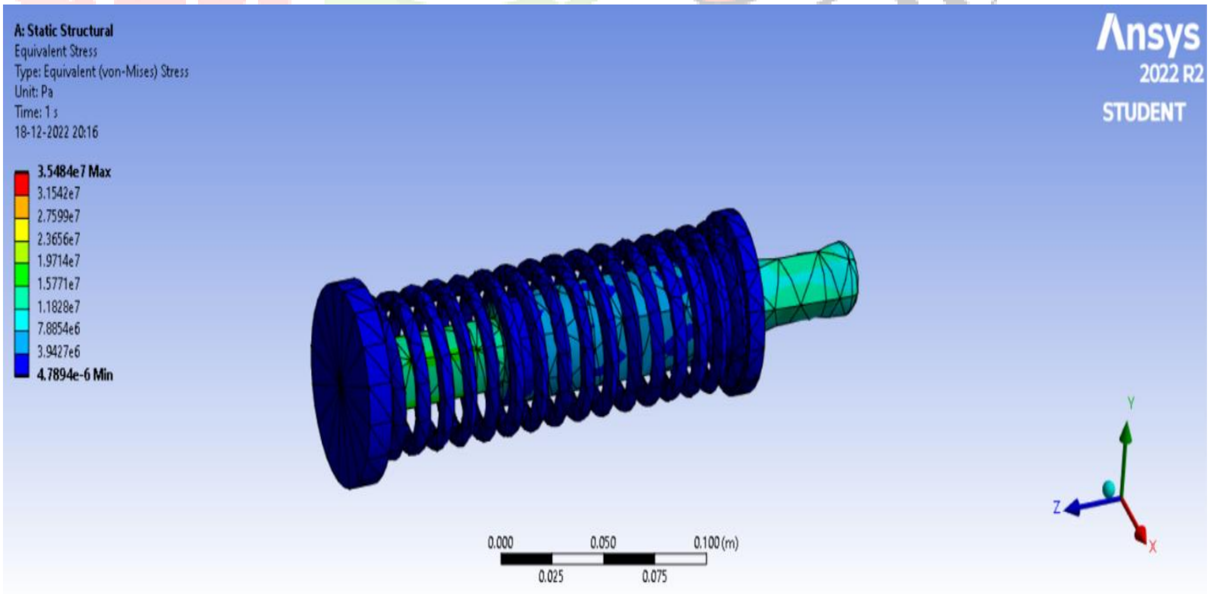

Fig 15: Stress for TVS Star city shock absorber

IV. RESULT AND DISCUSSION:

In this work the comparison of different shock absorbers by applying different loads. We can calculate the stress, strain and total deformation of the three different types of shock absorbers as shown in table 1,2 and 3.

1. HONDA CB SHINE:

Table1: Honda CB Shine

S. No	PARAMETER	LOADS	CALCULATED VALUE
1	Stress	At p = 490 N	11864.4 N/m^2
		At p = 588 N	14237 N/m^2
		At p = 686 N	16610N/m^2
		At p = 784 N	18983N/m^2
2	Strain	At p = 490 N	56.3
		At p = 588 N	67.6
		At p = 686 N	78.9
		At p = 784 N	90.2
3	Total deformation	At p = 490 N	13.22 mm
		At p = 588 N	15.86 mm
		At p = 686 N	18.50 mm
		At p = 784 N	21.15mm

2. YAMAHA:

Table2: Yamaha

S. No	PARAMETER	LOADS	CALCULATED VALUE
1	Stress	At p = 490 N	11460 N/m^2
		At p = 588 N	13752 N/m^2
		At p = 686 N	16045 N/m^2
		At p = 784 N	18337 N/m^2
2	Strain	At p = 490 N	54.5
		At p = 588 N	65.4
		At p = 686 N	76.4
		At p = 784 N	87.3
3	Total deformation	At p = 490 N	11.36 mm
		At p = 588 N	13.63 mm
		At p = 686 N	15.91 mm
		At p = 784 N	18.18 mm

3. TVS STAR CITY:

Table3: TVS Star City

S. No	PARAMETER	LOADS	CALCULATED VALUE
1	Stress	At p = 490 N	11777 N/m^2
		At p = 588 N	14133 N/m^2
		At p = 686 N	16489 N/m^2
		At p = 784 N	18844 N/m^2
2	Strain	At p = 490 N	56.0
		At p = 588 N	67.3
		At p = 686 N	78.5
		At p = 784 N	89.5
3	Total deformation	At p = 490 N	11.38 mm
		At p = 588 N	13.66 mm
		At p = 686 N	15.94 mm
		At p = 784 N	18.21 mm

1. **STRESS:** The figure 16 says that the comparison of the stress in between Honda CB Shine, Yamaha, TVS Star City.

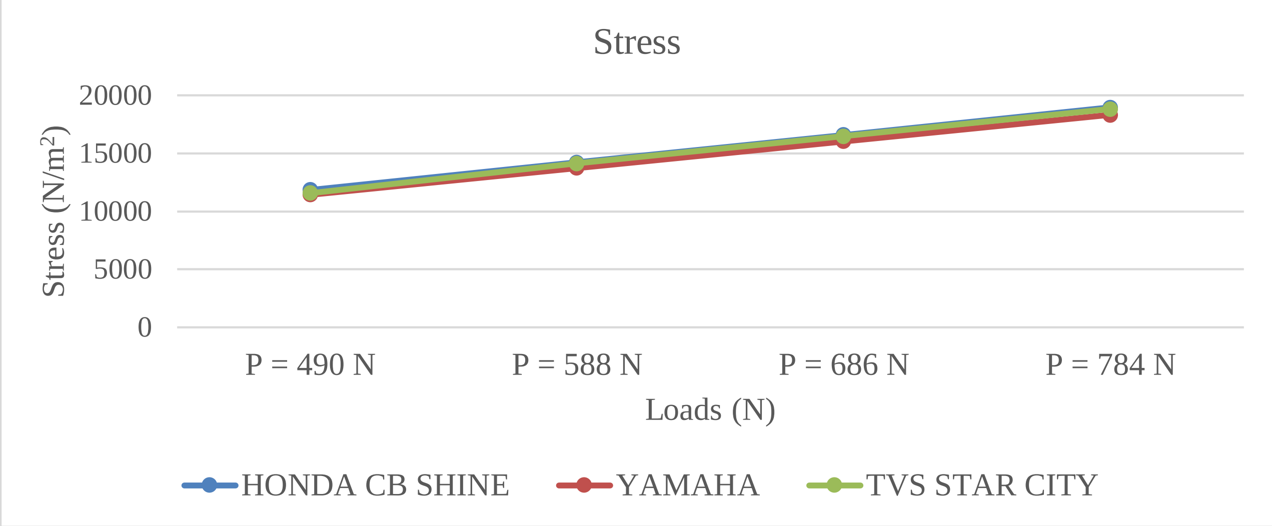

Fig16: Comparison of stress

2. **STRAIN:** The figure 17 says that the comparison of the strain in between Honda CB Shine, Yamaha, TVS Star City.

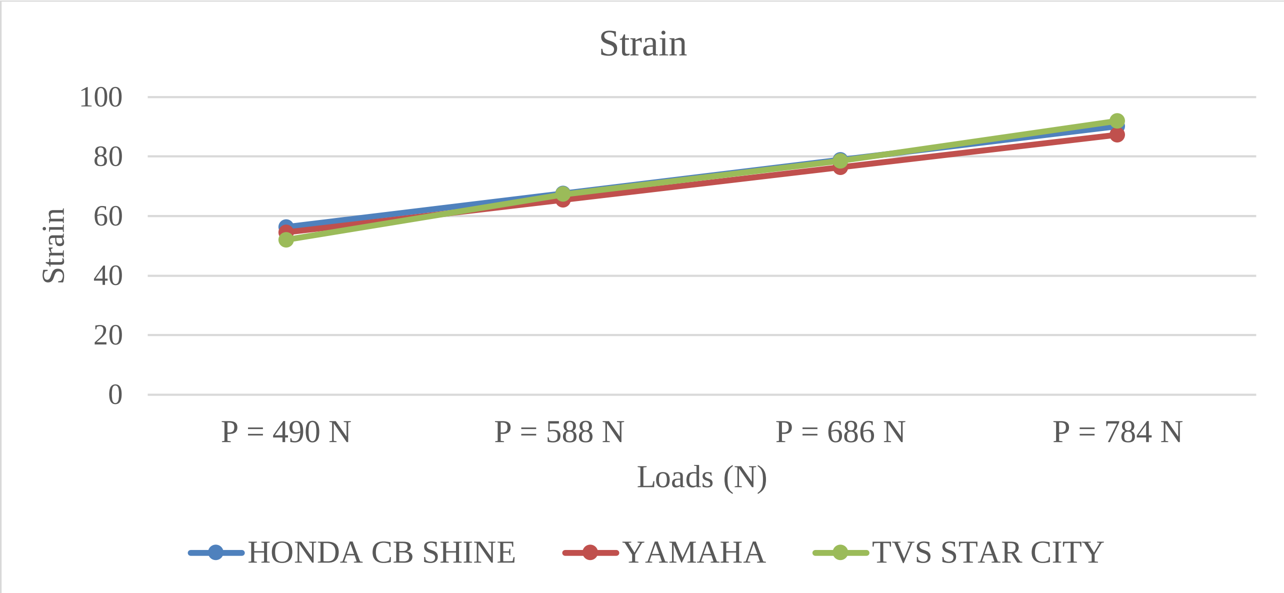

Fig17: Comparison of strain

3. **TOTAL DEFORMATION:** The figure 18 says that the comparison of the total deformation in between Honda CB Shine, Yamaha, TVS Star City.

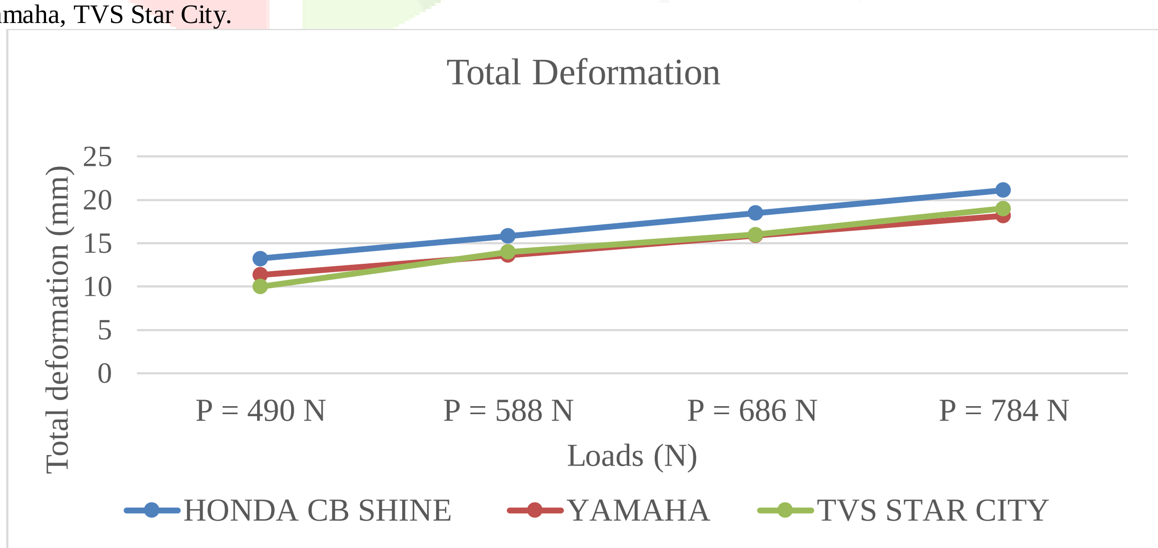

Fig18: Comparison of total deformation

V. CONCLUSION:

In this project, we have modelled three different shock absorbers used in 125cc bikes. The shock absorbers were modelled by using CATIA software and performed different analysis like static structural, model, dynamic and fatigue life. From the analysis results it is clear that the stress, strain and total deformation values are obtained for the three shock absorbers are different. The analysis is done by considering loads. Structural analysis is done to validate the strength and optimization is done to determine the better dimension of spring to carry applied load. The future work is to be done by choosing a specific material to increase the life of the structure. So, we obtained the results where the Yamaha shock absorber is best when compared to other two shock absorbers.

VI. ACKNOWLEDGMENT:

We take immense pleasure in expressing my deep sense of gratitude to our guide for his encouragement all the way during the investigation of the project. His annotations and criticisms are the key behind for successful completion of the project work and our Head of Department, for his able guidance and for the freedom of thought and action, we had enjoyed during the entire course of our project work. We were privileged to experience a sustained enthusiastic and involved interest from his side.

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