DESIGN AND ANALYSIS OF TWO-WHEELER SHOCK ABSORBER FOR DAMPING LOADS

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ABSTRACT:
A suspension system or shock absorber is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. The shock absorbers duty is to absorb or dissipate 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. 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. The weight of the vehicle will then push the spring down below its normal loaded height. This, in turn, causes the spring to rebound again the design of spring in suspension system is very important. In this project a shock absorber is designed (helical type spring and wave spring) and a 3D model is created using CREO. Structural analysis and modal analysis are done on the suspension system by varying material for spring, Spring Steel and chromium vanadium steel. The analysis is done by considering loads, bike weight, single person and 2 persons. Structural analysis is done to validate the strength and modal analysis is done to determine the displacements for different frequencies for number of modes. Comparison is done for two materials to verify best material and best model for spring in suspension system. Analysis done in ANSYS In this thesis the random vibration analysis is determine the directional deformation, shear stress and shear stain for which is the best material for spring.

I.INTRODUCTION

WAVE SPRING

Wave spring peak to peak wave springs work as a heap bearing gadget, using a bowing minute as opposed to depending on torsion. Giving an indistinguishable power and redirection from customary springs, wave spring innovation eliminates material utilization by up to half, leaving a light-weight, flexible item that can take care of issues and improve new item plan

DIFFERENT TYPES OF WAVE SPRINGS:

Crest-to-Crest Wave Springs – diminish spring tallness by up to half.

Crest-to-Crest Wave Springs + Shim Ends – diminish tallness and give 360° surface contact.

Single Turn Wave Springs – hole and cover styles to supplant stamp wave washers.

Wave Springs – round wire rather than level, gives higher powers than single turn wave springs.

Linear Springs – straight lengths to get hub weight.

Nested Wave Springs – Pre-stacked springs from a solitary constant fiber**.**

Edge curling spring-tempered level wire to frame our Single Turn Springs is more strong, exact, and repeatable than its stamped partners. For some applications having an alternative to fit the spring precisely to the correct distances across enhances execution and can frequently help the gathering procedure.

Springs are made from only one wire, and in this manner couldn't be more straightforward in many regards, yet they hold the bright structure to be dynamically utilitarian, reliable and completely essential to numerous components. From helical loops to more strange shapes and outlines, the modest spring is a significant segment that numerous enterprises couldn't manage without.

Figure 1 different types of springs

At European Springs, our capacity to do quality spring make is famous all through numerous nations, and we generally endeavor to maintain that solid notoriety to the best of our capacity. We can supply clients with an extensive variety of top notch items, and furthermore needs the absolute best client benefit at very focused costs. In any case, what truly separates us from different producers is our development, as our cutting edge fabricating offices can make totally bespoke outlines in mass and at speed.

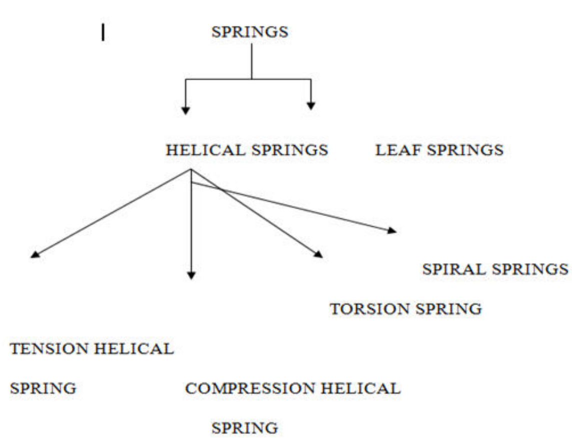
Our strong spring plans are versatile for use in any industry, and ranges, for example, the electric, electronic, engine, seaward, and pharmaceutical and media transmission areas depend on our springs and pressings essentially. Along these lines, our standard indexes and stocks are all around furnished with more than 700 items to meet an assortment of basic needs, however when a more individual touch is required we can likewise outline and in this way fabricate springs that are straightforwardly as per a client's details and necessities.

SPRING:

Springs are elastic bodies (generally metal) that can be twisted, pulled, or stretched by some force. They can return to their original shape when the force is released. In other words it is also termed as a resilient member

CLASSIFICATION OF SPRINGS:

Based on the shape behavior obtained by some applied force, springs are classified into the following ways:



HELICAL SPRINGS: It is made of wire coiled in the form of helix

CROSS-SECTION: Circular, square or rectangular

CLASSIFICATION:

- Open coil springs (or) Compression helical springs
- Closed coil springs (or) Tension helical springs

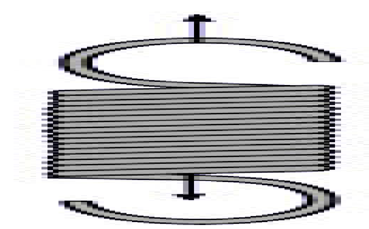


Figure: tension helical spring

Figure: types of end hooks of a helical extension spring

TORSION SPRINGS CHARACTERISTICS:

It is also a form of helical spring, but it rotates about an axis to create load.

It releases the load in an arc around the axis as shown in figure.

Mainly used for torque transmission

The ends of the spring are attached to other application objects, so that if the object rotates around the center of the spring, it tends to push the spring to retrieve its normal position.

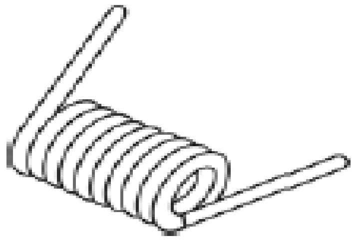


Figure: torsion spring applications:

II.LITRATURE REVIEW

In this section, literatures survey study gathered regarding the information about the various factors of the helical compression spring and wave springs. The researchers throughout the years had given various research methods such as Theoretical, Numerical and Experimental. Researchers employ the Theoretical, Numerical and FEM methods. Study concludes Finite Element method is the best method for numerical solution and calculating the stress, life cycle and shear stress of helical compression spring designed a shock absorber of 150cc bike in pro/engineer software, compared spring steel and beryllium copper for finding best material in a present design and a modified design of the spring. To validate the design modal and structural analysis was performed in Ansys. By analyzing the results, analyzed stress values came out less than yield stress values and stress value is less for spring steel than Beryllium copper. In modified design, 2 mm diameter of the spring is was reduced and analysis is done which results in reduction of spring weight and again stress values comes out less for modified design as compared to present design. The results showed that best material for spring was spring steel and modified design was safe to use used filament winding technique to design the spring in which they adopted process of fabrication and various procurements were used. Principles of rule of mixture were used to measure fiber volume fraction and mass fraction. observations from the load-deflection curves shows that there was uneven behavior of deflection with respect to loads which may be due to brittle nature of glass fiber and small crack inside the spring but not damaging the whole composite spring. Stiffness was calculated from the curves which showed that composite helical spring stiffness is 43.76% less compared to conventional metal spring. Though the stiffness of composite spring was less, spring is designed with fewer coils to increase stiffness without effecting load carrying capacity. The weight of the composite spring was 42.63% less than conventional spring. The theoretical results concluded that composite helical spring can store more strain energy than conventional which is essential for suspension.

P.R. Jadhav1, N.P.Doshi ,U.D. Gulhane [1] the investigation of elastomeric covering effect on powerful thunderous anxieties esteems in spring is introduced in this paper. The fitting conditions deciding the viability of dynamic anxiety lessening in thunderous conditions as an element of covering parameters were determined. It was demonstrated that elastic covering won't perform in attractive way because of its low modulus of versatility in shear. It was likewise shown that about reverberation regions of expanded anxieties are more extensive and more extensive alongside the progressive resonances and accomplish critical esteems even everywhere separates from the reverberation frequencies.

Dr. Dhananjay. R. Dolas , Kuldeep. K. Jagtap [2] Long haul exhaustion tests on shot peened helical pressure springs were directed by methods for an extraordinary spring weariness testing machine at 40 Hz. Test springs were made of three diverse spring materials – oil solidified and tempered Si Cr-and Si Cr V-alloyed valve spring steel and stainless steel. With an uncommon test procedure in a trial, up to 500 springs with a wire distance across of d = 3.0 mm or 900 springs with d = 1.6 mm were tried at the same time at various anxiety levels. In view of weakness examinations of springs with d = 3.0 mm up to various cycles N = 109 an investigation was done after the test was proceeded to N = 1.5 - 109 and their outcomes were looked at. The impact of various shot peening conditions were researched in springs with d = 1.6 mm. Broken test springs were analyzed under optical magnifying lens, filtering electron magnifying instrument (SEM) and by methods for metallographic smaller scale segments keeping in mind the end goal to examinations the break conduct and the disappointment components. The paper incorporates a correlation of the consequences of the diverse spring sizes, materials, number of cycles and shot peening conditions and layouts encourage examinations in the VHCF-area.. For examination the outcomes for the springs with d = 1.6 mm and d = 3.0 mm and Ps = 98% are abridged Except for springs made of the stainless steel wire, the exhaustion quality of springs with d = 3.0 mm is higher than for springs with d = 1.6 mm. The size impact would suggest higher exhaustion quality for littler wire distances across

III.METHODOLOGY

3.1 WAVE SPRING DESIGN GENERAL CONSIDERATIONS

If a spring is intended for static application, ensure that the % worry at working tallness is under 100%. Spring will take a set if subjected to a higher anxiety.

If a spring is intended for dynamic application, ensure that the % worry at working stature is fewer than 80%. Spring will take a set if subjected to a higher stress.

Few things to recollect:

If the work stature per turn is under (2 * Wire Thickness), the spring will work in a 'non-straight' range and real loads might be higher than ascertained

Number of turns must be in the vicinity of 2 and 20

Number of waves per turn (N) must be in ½ increases

Min. Spiral divider = (3 * Wire Thickness)

Max. Spiral Wall = (10 * Wire Thickness)

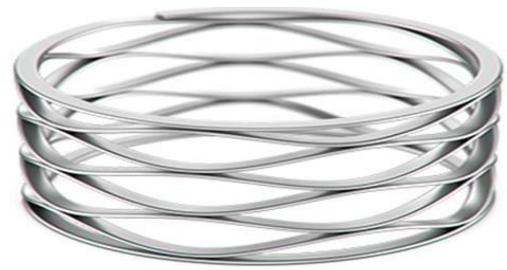
It is NOT prescribed to pack a wave spring to strong

OD extension and OD resistance must be considered while outlining a spring to fit in a drag as well as finished a pole

3.2 BASIC PRINCIPLE OF WAVE SPRING:

- Wave springs lessen spring stature by half
- Same power and diversion as common loop/pressure springs
- Wave springs fit tight outspread and hub spaces

Over 4,000 standard springs in carbon and stainless steel (.188" to 16", 5 mm to 400 mm breadths) No Tooling Charges™ on specially crafts (.157" to 120", 4 mm to 3000 mm distances across) Exotic combinations accessible Smalley Wave Springs (Flat Wire Compression Springs) offer the special favorable position of space investment funds when used to supplant curl springs. By lessening spring working stature, wave springs additionally create a diminishing in the spring hole. With a littler get together size and less material utilized as a part of the assembling procedure, a cost investment funds is figured it out



3.1 CREST-TO-CREST WAVE SPRINGS WITH SHIM ENDS

Rest-to-Crest Wave Springs are additionally accessible with squared-shim closes. Shim closes give a 360° contact surface when contrasted with the wave point contact of plain closures. The shim-closes under load, all the more equally appropriate the springs drive upon contiguous segments. This component is like the idea of twofold plate granulating springs for a level surface. Shim closes have additionally been utilized to fasten springs to mating parts, as a level finding surface that might be appended by different strategies in the get together Wave springs operate as load bearing devices. They take up play and compensate for dimensional variations within assemblies. Where by loads fabricate either progressively or unexpectedly to achieve a foreordained working tallness. This builds up an exact spring rate in which stack is relative to avoidance. Utilitarian prerequisites are important for both dynamic and static spring applications. Exceptional execution qualities are independently incorporated with each spring to fulfill an assortment of exact working conditions. Ordinarily, a wave spring will possess an amazingly little territory for the measure of work it performs. The utilization of this item is requested, yet not restricted to tight hub and spiral space imperative

MODEL OF WAVE SPRING:

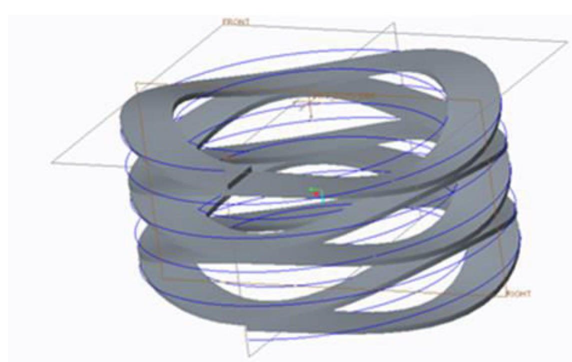


Figure: 3D model view of wave spring

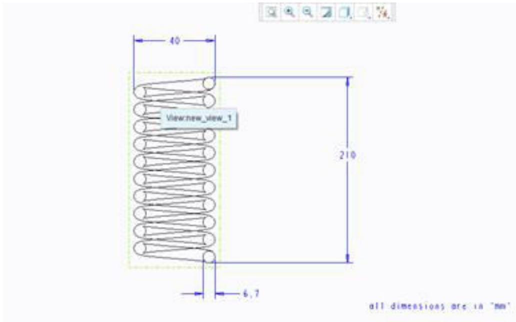


Figure: Geometric view

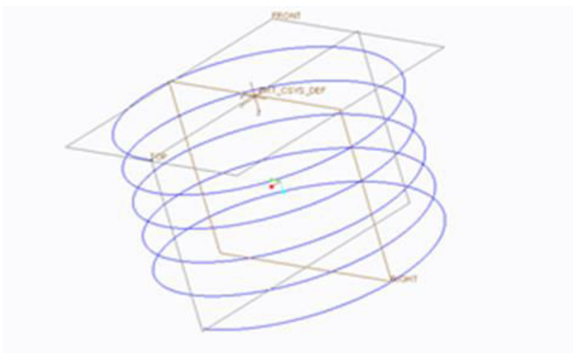


Figure: Inner cylindrical coil

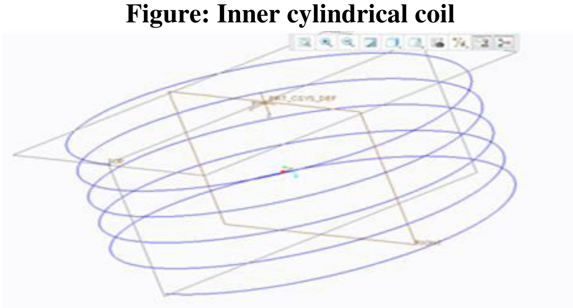


Figure: outer cylindrical coil

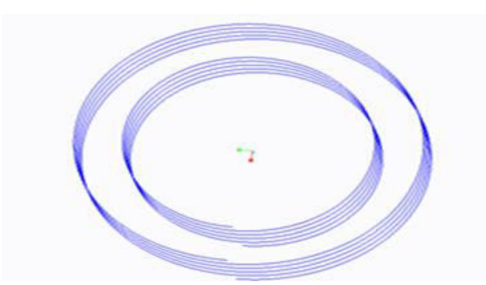


Figure: both cylindrical coils

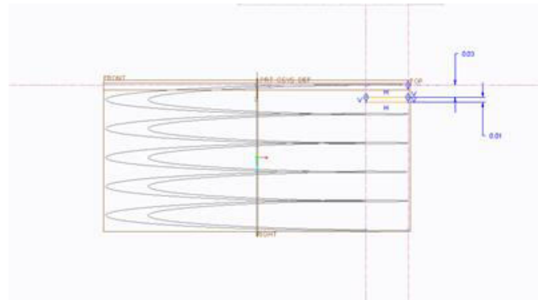


Figure: section for wave spring

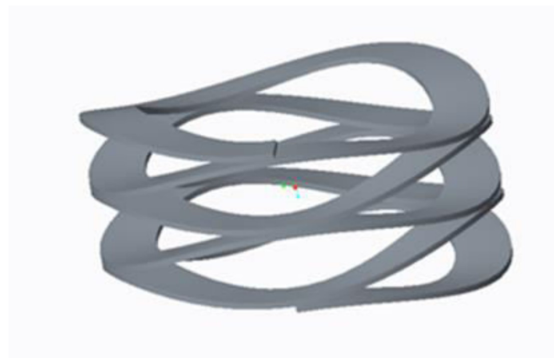


Figure: wave spring

INTRODUCTION TO FEA:

Finite element analysis is a method of solving, usually approximately, certain problems in engineering and science. It is used mainly for problems for which no exact solution, expressible in some mathematical form, is available. As such, it is a numerical rather than an analytical method. Methods of this type are needed because analytical methods cannot cope with the real, complicated problems that are met with in engineering. For example, engineering strength of materials or the mathematical theory of elasticity can be used to calculate analytically the stresses and strains in a bent beam, but neither will be very successful in finding out what is happening in part of a car suspension system during cornering.

One of the first applications of FEA was, indeed, to find the stresses and strains in engineering components under load. FEA, when applied to any realistic model of an engineering component, requires an enormous amount of computation and the development of the method has depended on the availability of suitable digital computers for it to run on. The method is now applied to problems involving a wide range of phenomena, including vibrations, heat conduction, fluid mechanics and electrostatics, and a wide range of material properties, such as linear-elastic (Hookean) behavior and behavior involving deviation from Hooke's law (for example, plasticity or rubber-elasticity).

Many comprehensive general-purpose computer packages are now available that can deal with a wide range of phenomena, together with more specialized packages for particular applications, for example, for the study of dynamic phenomena or large-scale plastic flow. Depending on the type and complexity of the analysis, such packages may run on a microcomputer or, at the other extreme, on a supercomputer. FEA is essentially a piece-wise process. It can be applied to one-dimensional problems, but more usually there is an area or volume within which the solution is required. This is split up into a number of smaller areas or volumes, which are called finite elements. Figure 1 shows a two-dimensional model of a spanner that has been so divided: the process is called discretization, and the assembly of elements is called a mesh.

IV.RESULTS

4.1 STATIC ANALYSIS OF HELICAL SPRING:

Used software for this project work bench

Open work bench in Ansys 14.5

Select static structural>select geometry>import IGES model>OK

Figure 4.1: Imported model

Details of geometry	
source	spring helical
type	edges
length of units	meters
element control	programed control
display style	body color
boundary box	-

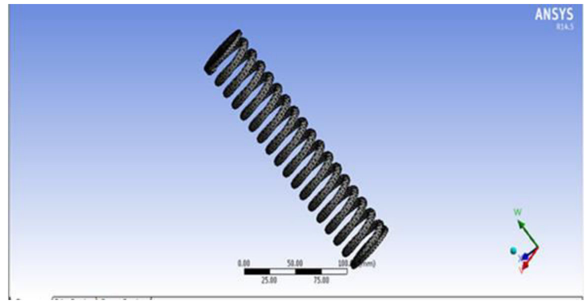


Figure 4.2: meshed model

Details of mesh	
physics preference	mechanical
relevance	0
sizing	meters
relevance center	fine
element size	default
transactions	fast
medium edge length	0.593960mm

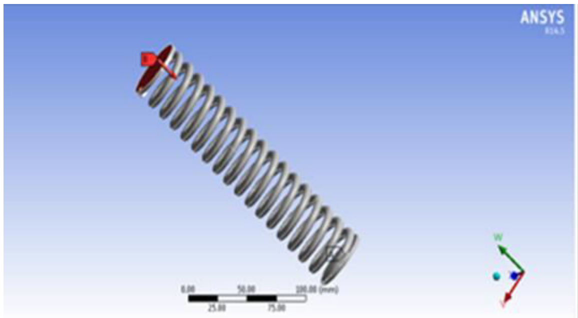


Figure 4.3: boundary conditions

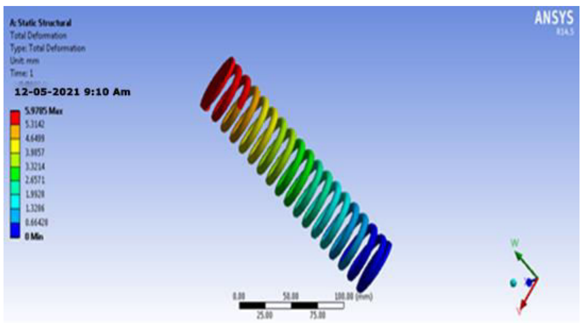


Figure 4.4: material – spring steel load – bike load 113kg deformation

Details of deformation	
scope	
scoping method	geometry selection
geometry	all bodies
display time	last
minimum	0 mm
maximum	5.9735mm

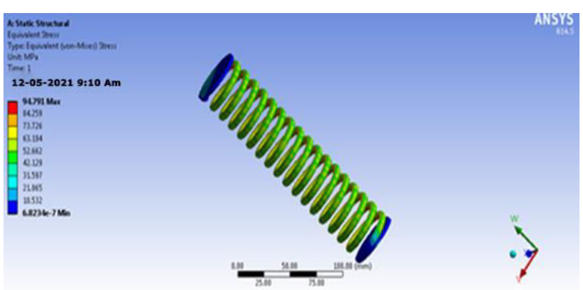


Figure 4.5 equivalent stress

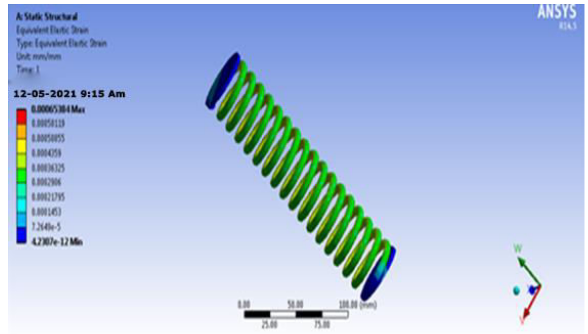


Figure 4.6 Equivalent elastic strains

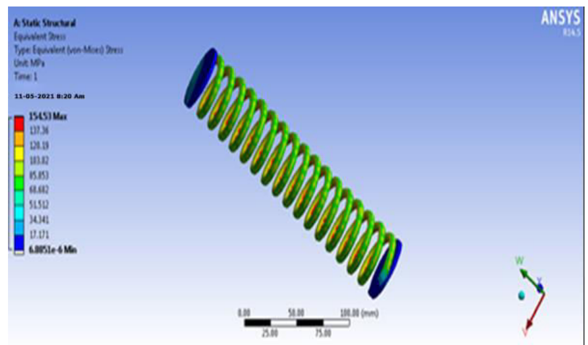


Figure: Equivalent stress

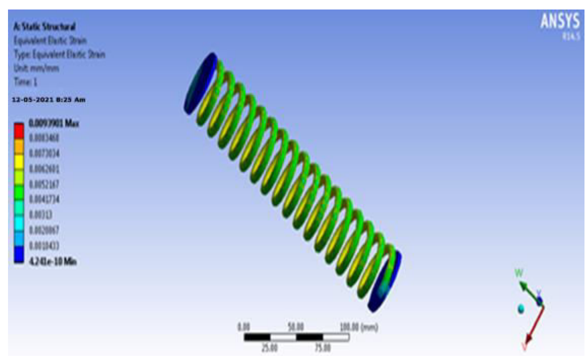


Figure: Equivalent elastic strain

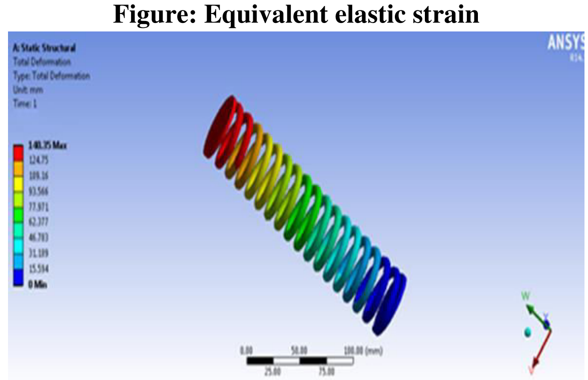


Figure: Load – bike load 113kg + 2 person weight deformation

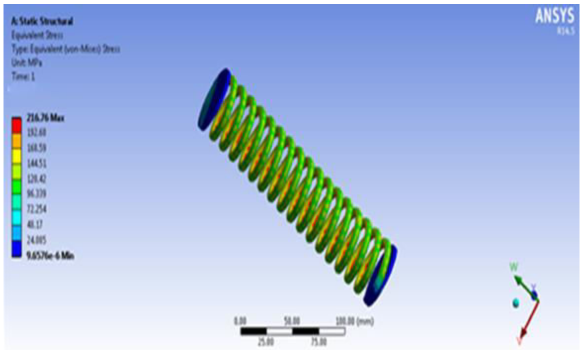


Figure: Equivalent stress

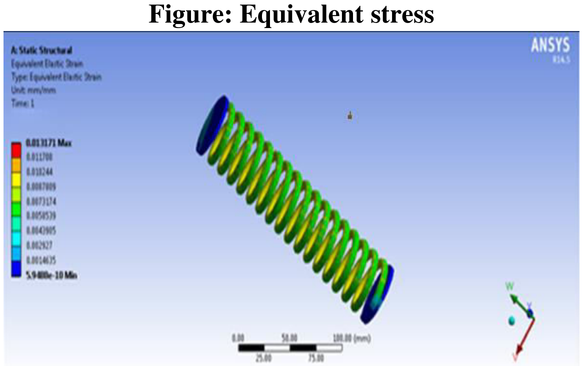


Figure: Equivalent elastic strain

STATIC ANALYSIS OF WAVE SPRING:

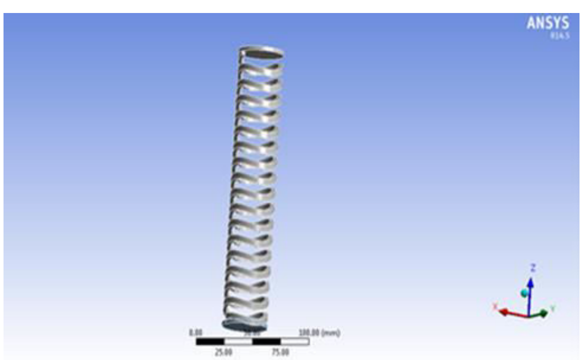


Figure: Imported model

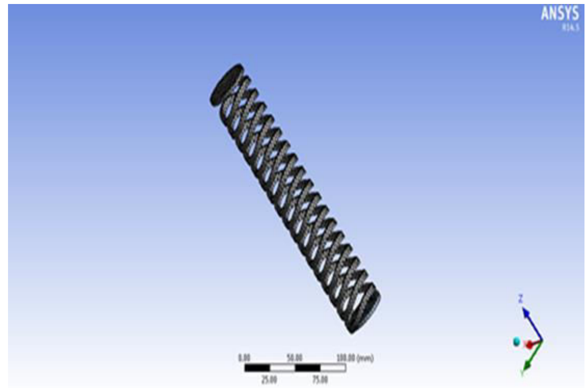


Figure: meshed model

Z- DIRECTION DEFORMATION

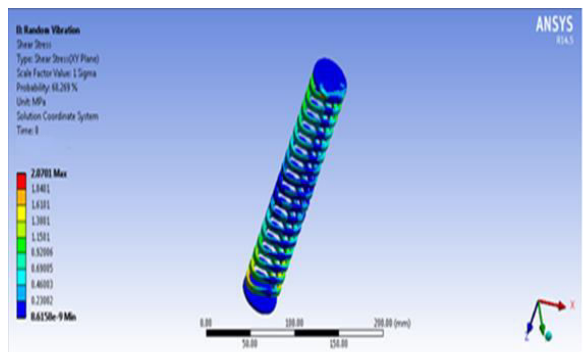


Figure: shear stress

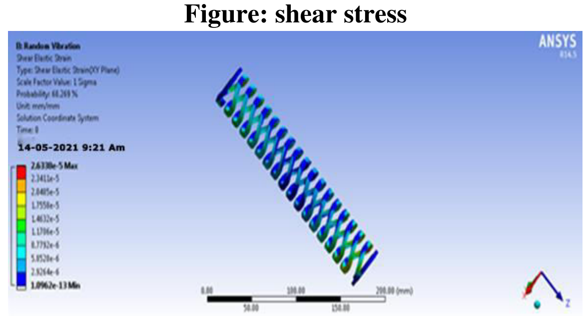


Figure: shear strain

Table: static analysis helical spring result

Models	Loads (N)	Materials	Deformation(mm)	Stress(N/mm2)	strain
Helical spr	Bike load (113kg	Spring steel	5.9785	94.791	0.00065384

ing	)	Chromium vanadium steel	55.96	86.429	0.0052517
	Bike load (113kg)+ 1 person weight (75kg)	Spring steel	9.9465	157.71	0.0010878
		Chromium vanadium steel	100.06	154.53	0.0093901
	Bike load (113kg)+ 2 person weight (75kg+(75kg))	Spring steel	13.915	220.62	0.0015218
		Chromium vanadium steel	140.35	216.76	0.013171

Table: static analysis wave spring result

Models	Loads (N)	Materials	Deformation(mm)	Stress(N/mm2)	strain
Wave spring	Bike load (113kg)	Spring steel	7.5178	89.106	0.0004576
		Chromium vanadium steel	70.987	81.015	0.0038747
	Bike load (113kg)+ 1 person weight (75kg)	Spring steel	12.888	152.75	0.00078452
		Chromium vanadium steel	122.01	139.24	0.0066597
	Bike load (113kg	Spring steel	17.184	203.67	0.001046

	)+ 2 person weight (75kg+(75kg))	Chromium vanadium steel	177.47	202.54	0.0096869

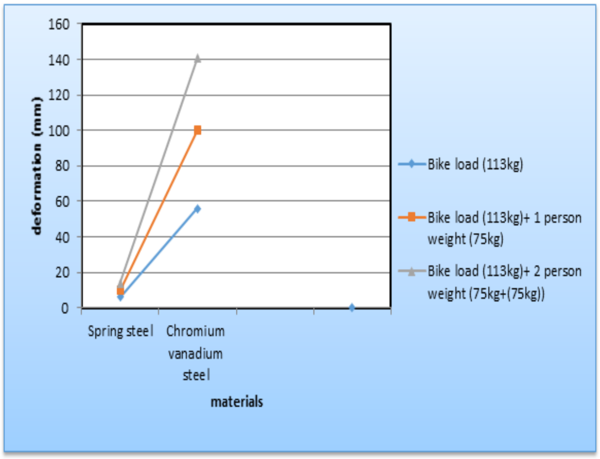
MODAL ANALYSIS WAVE SPRING AND HELICAL RESULTS:

Models	Materials	Mode shapes	Deformation(mm)	Frequency (Hz)
Helical spring	Spring steel	1	75.696	8.8715
		2	75.776	8.9021
		3	58.95	42.168
	Chromium vanadium steel	1	76.01	2.8422
		2	76.09	2.8527
		3	58.921	13.144
Wave spring	Spring steel	1	87.766	10.099
		2	86.672	10.289
		3	82.221	29.925
	Chromium vanadium steel	1	87.905	3.2196
		2	87.066	3.2765
		3	82.525	9.3457

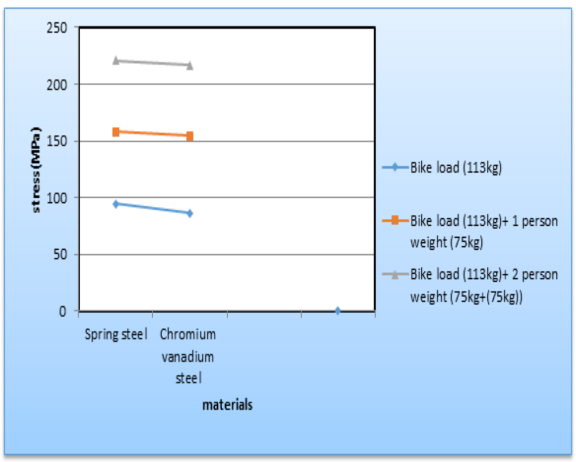
RANDOM VIBRATION ANALYSIS

Models	Material	Deformation (mm)		Shear stress(N/mm^2)	Shear strain
Helical spring		X-Axis	161.85	57.381	0.007618
		Y-Axis	25.39		
		Z-Axis	12.635		
Wave spring		X-Axis	0.72712	2.0701	2.6338e-5
		Y-Axis	0.021105		
		Z-	0.1008		

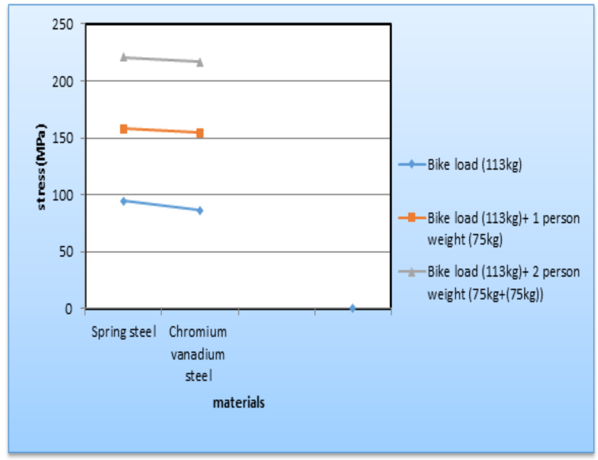
		Axi s	6		



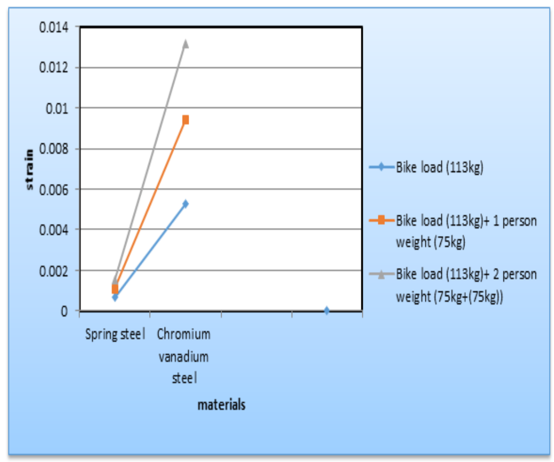
Graphs for helical spring deformation plot



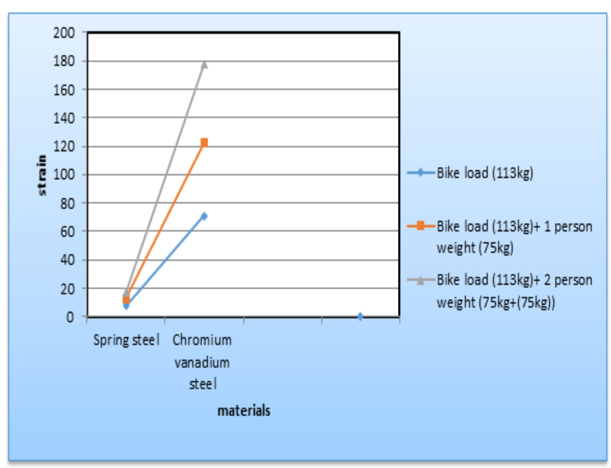
Graphs for helical spring stress plot



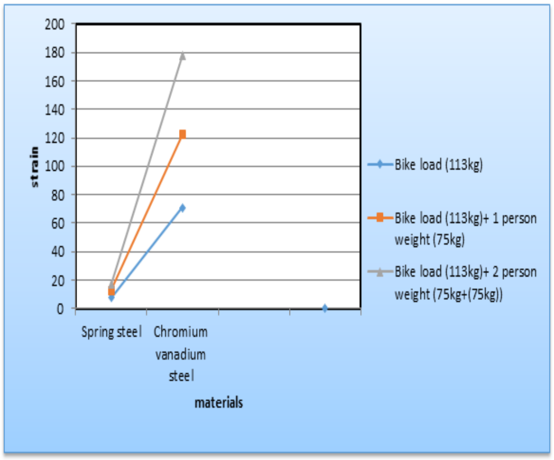
Graphs for helical spring strain plot



wave spring plot deformation plot



Graphs for wave spring stress plot



Graphs for wave spring strain plot

V.CONCLUSION

The design of spring in suspension system is very important. In this project a shock absorber is designed (helical type spring and wave spring) and a 3D model is created using CREO. Structural analysis and modal analysis are done on the suspension system by varying material for spring, Spring Steel and chromium vanadium steel. The analysis is done by considering loads, bike weight, single person and 2 persons. Structural analysis is done to validate the strength and modal analysis is done to determine the displacements for different frequencies for number of modes. Comparison is done for two materials to verify best material and best model for spring in suspension system. Analysis done in ANSYS

In this thesis the random vibration analysis is determine the directional deformation, shear stress and shear stain for which is the best material for spring.By observing the static analysis the load increases by increasing the stress, deformation and strain values. when we compared helical spring and wave spring the stress values are decreased for wave spring with chromium vanadium steel material By observing the modal analysis the deformation increases for wave spring and frequencies decreases for wave spring By observing the static and modal analysis the chromium vanadium steel material is the best material for suspension spring so we have done the random vibration analysis for chromium vanadium steel.

REFERENCES

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