ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Design and Analysis of Two Wheeler Shock Absorber Coil Spring

K.Yuvaraj Sekhar
Department of Mechanical Engineering,
Viswanadha Institute of Technology and Management,
Visakhapatnam, Andhra Pradesh 530017, India.

T. Babu Rao
Department of Mechanical Engineering,
Viswanadha Institute of Technology and Management,
Visakhapatnam, Andhra Pradesh 530017, India.

P. Kesava Jogi Naidu
Department of Mechanical Engineering,
Viswanadha Institute of Technology and Management,
Visakhapatnam, Andhra Pradesh 530017, India.

Y. Mohan Sai Kumar
Department of Mechanical Engineering,
Viswanadha Institute of Technology and Management,
Visakhapatnam, Andhra Pradesh 530017, India.

Mr. A.Murali Krishna
Department of Mechanical Engineering,
Viswanadha Institute of Technology and Management,
Visakhapatnam, Andhra Pradesh 530017, India.

ABSTRACT:

In a vehicle, shock absorbers reduce the effect of traveling over rough ground, leading to improved ride quality and vehicle handling. In this project a shock absorber is designed and a 3D model is created using CATIA v5. Structural analysis is done on the shock absorber by varying material for Standard carbon fiber, inconel750x and Molybdenum. The analysis is done by considering loads, bike weight, single person and double persons. Structural analysis is done to validate the strength and to determine the displacements for different frequencies for number of modes. Comparison is done for four materials to verify best material for spring in Shock absorber. Modeling is done in CATIA and analysis is done in ANSYS 16.0. CATIA v5 is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design.

Key Words: ***Shock Absorber, inconel x750, carbon fiber St. and Molybdenum,ansys 16.0, catia v5.***

INTRODUCTION

A shock absorber or damper is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. 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. This bouncing process is repeated over and over, a little less each time, until the up-and-down movement finally stops. If bouncing is allowed to go uncontrolled, it will not only cause an uncomfortable ride but will make handling of the vehicle very difficult.

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

Cite this article as: K.Yuvaraj Sekhar, T. Babu Rao, P. Kesava Jogi Naidu, Y. Mohan Sai Kumar & Mr. A.Murali Krishna, "Design and Analysis of Two Wheeler Shock Absorber Coil Spring", International Journal & Magazine of Engineering, Technology, Management and Research, Volume 6 Issue 3, 2019, Page 31-38.

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

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. 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.

RELATED WORK:

An exhaustive literature review is carried out to know the recent practices and theories in shock absorber design. It will also help to obtain a superior understanding of internal flows that had been designed and modeled in the past. The purpose of the shock absorber in a vehicle's suspension system is to reduce the vehicle's vibration by dissipating the vibration energy. 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. This bouncing process is repeated over and over, a little less each time, until the up-and-down movement finally stops. If bouncing is allowed to go uncontrolled, it will not only cause an uncomfortable ride but will make handling of the vehicle very difficult.

Normally, helical spring failure occurs due to high cyclic fatigue in which the induced stress should remain below the yield strength level and also with poor material

K Pagan Kumar et.al. (2013) discussed about the static analysis of primary Pro/E and analysis in ANSYS of primary suspension spring with two materials Chrome Vanadium is a existing material and 60Si2MnA steel is a new material, the conventional steel helical spring 60Si2MnA is proved as best material for helical spring by reduction of deflection and overall stress.

Midi Bakhshesh3 etal.(2012) worked on optimum design of steel helical spring related to light vehicle suspension system under the effect of a uniform loading has been studied and finite element analysis has been compared with analytical solution. This spring has been replaced by three different composite helical springs which are made of E-glass/Epoxy, Carbon/Epoxy and Kevlar/Epoxy. The optimum design based on the parameters of weight, maximum stress and deflection and has been compared with steel helical springs. It has been shown that spring optimization by material spring changing causes reduction of spring weight and maximum stress considerably.

Prince Jerome Christopher J.1, Pavendhan R.2 worked onDesign and Analysis of Two Wheeler Shock Absorber Coil Spring .The Shock absorber coil spring is designed by using the modeling software Pro/ENGINEER Wildfire 4.0. In modeling the time is spent in drawing the coil spring model and the risk involved in design and manufacturing process can be easily minimized. So the modeling of the coil spring is made by using Pro/ENGINEER. Later this Pro/ENGINEER model is imported to ANSYS for the analysis work. The ANSYS software is used for analyzing the component by varying the load applied on it at different conditions with different materials and the results are observed.

A solver mode in ANSYS software calculates the stresses and their relation without manual interventions thereby reducing the time compared with the manual theoretical work.Now in this project a Shock absorber is designed and a 3D model is created using CATIA. Structural analysis and modal analysis are done on the shock absorber carbon fiber, and molybdenum. 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 for spring in Shock absorber. Modeling is done in CATIA V5r20 and analysis is done in ANSYS 16.0.

Scope of Applications:

Mechanical Engineering: CATIA enables the creation of 3D parts, from 2D sketches, sheet metal, composites, moulded, forged or tooling parts up to the definition of mechanical assemblies. The software provides advanced technologies for mechanical surfacing and BIW. CATIA provides a wide range of applications for tooling design, for both generic tooling and mould and die. In the case of Aerospace engineering an additional module named the aerospace sheet metal design offers the user combine the capabilities of generative sheet metal design and generative surface design. CATIA offers a solution to shape design, styling, surfacing workflow and visualization to create, modify, and validate complex innovative shapes from industrial design to Class-A surfacing with the ICEM surfacing technologies. CATIA supports multiple stages sf product design whether started from scratch or from 2D sketches (blueprints).

Electrical Systems CATIA V5 offers a solution to formulate the design and manufacturing of electrical systems spanning the complete process from conceptual design through to manufacturing. Capabilities include requirements capture, electrical schematic definition, interactive 3D routing of both wire harnesses and industrial cable solutions through to the production of detailed manufacturing documents including form boards.

Fluid Systems: CATIA offers a solution to facilitate the design and manufacturing of routed systems including tubing, piping, Heating, Ventilating & Air Conditioning (HVAC). Capabilities include requirements capture, 2D diagrams for defining hydraulic, pneumatic and HVAC systems, as well as Piping and Instrumentation Diagram (P&ID). Powerful capabilities are provided that enables these 2D diagrams to be used to drive the interactive 3D routing and placing of system components, in the context of the digital mock up of the complete product or process plant, through to the delivery of manufacturing information including reports and piping isometric drawings.

Automotive: Many automotive companies use CATIA to varying degrees, including BMW, Porsche, McLaren Automotive, Chrysler, Honda, AudiJaguar Land Rover, Volkswagen, SEAT, Skoda, Bentley Motors Limited, Volvo, Renault, Toyota, Ford, Scania, Hyundai , Tesla Motors, Rolls-Royce Motors, Valmet Automotive, Proton,Elba,Tatamotors and Mahindra & Mahindra Limited. Goodyear uses it in making tires for automotive and aerospace and also uses a customized CATIA for its design and development. Many automotive companies use CATIA for car structures – door beams, IP supports, bumper beams, roof rails, side rails, body components because of CATIA's capabilities in Computer representation of surfaces. Bombardier Transportation of Canada is using this software to design its entire fleet of Train engines and coaches.

Shipbuilding: Dassault Systems has begun serving shipbuilders with CATIA V5 release 8, which includes special features useful to shipbuilders. GD Electric Boat used CATIA to design the latest fast attack submarine class for the United States Navy, the Virginia class. Newport News Ship building also used CATIA to design the Gerald R.Ford class of super carriers for the US Navy. In 2004, it has been adopted by the Beneteau Group for development of new sailing and leisure motor boats.

Industrial equipment: CATIA has a strong presence in the Industrial Equipment industry. Industrial Manufacturing machinery companies like Schuler and Metso use CATIA, as do heavy mobile machinery and equipment companies like Claus, and also various industrial equipment product companies like Alston Power and ABB Group. Michelin is also using CATIA for its production.

PROPOSED SYSTEM

The proposed research work is intended to exploit the advantages of using different materials in the design of coil spring and different properties of them are studied both theoretically and numerically. This provides basic understanding the behavior of the various materials and response in the following aspects are studied:

Variations in their Deflection and Tensile stresses of the various materials and comparing one on another.

- Von Misses stress of the materials.
- Deformations of the materials.

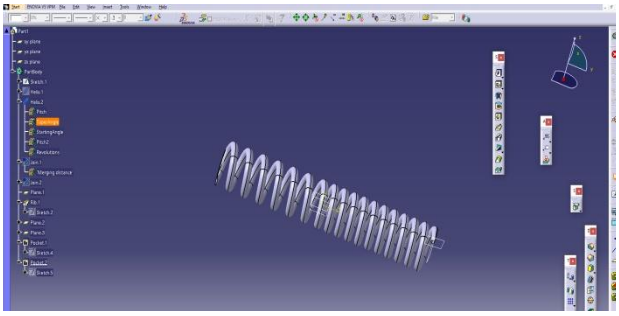
PRODUCT REALIZATION PROCESS:

The product realization process can be roughly divided into two phases; design and manufacturing. The design process starts with identification of new customer needs and design variables to be improved, which are identified by the marketing personnel after getting feedback from the customers. Once the relevant design information is gathered, design specifications are formulated. A feasibility study is conducted with relevant design information and detailed design and analyses are performed. The detailed design includes design conceptualization, prospective product drawings, sketches and geometric modeling. Analysis includes stress analysis, interference checking, kinematics analysis, mass property calculations and tolerance analysis, and design optimization.

The quality of the results obtained from these activities is directly related to the quality of the analysis and the tools used for conducting the analysis. The manufacturing process starts with the shop-floor activities beginning from production planning, which uses the design process drawings and ends with the actual product. Process planning includes activities like production planning, material procurement, and machine selection. There are varied tasks like procurement of new tools, NC programming and quality checks at various stages during the production process. Process planning includes planning for all the processes used in manufacturing of the product.

DEVELOPMENT TOOLS

CATIA: CATIA (computer aided three dimensional interactive application) is a multiple form CAD/CAM/CAE commercial software suite developed by French company Dassault systems. The software was created in late 1970s to develop Dassault's Mirage fighter jet, but was subsequently adapted in aerospace, automotive ship building, and other industries.



DESIGN CALCULATIONS OF PRESENT DESIGN

Material: Spring Steel

Modulus of rigidity (G) = 78600N/mm2

Mean diameter of a coil, D=33.3mm

Diameter of wire, d = 6.7mm

Total no of coils, n1= 17

Height, h = 210mm

Outer diameter of spring coil, D0 = D +d =40mm

No of active turns, n= 15

Weight of bike = 113kg

Let weight of 1person = 75Kg

Weight of 2 persons = 75×2=150Kg

Weight of bike + persons = 263Kg

Rear Suspension = 65% (65% of 263 = 171Kg)

Considering dynamic loads it will be double W = 342Kg = 3355N

For single shock absorber weight = w/2= 1677N = W

We Know that, compression of spring (δ) = WnD*3/G.d4

C = spring index = D/d = 5

(δ) = 46.91

Solid length, Ls =n1×d=17×6.7=113.9mm

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Free length of spring, Lf = (solid length + maximum compression + clearance between adjustable coils)

=113.9 + 46.91 + (46.91 ×0.15) = 167.8mm

Spring rate, K = W/ δ = 35.74

Pitch of coil, P =Lf/(N-1)

Stresses in helical spring: maximum shear stress induced in the wire

τ = Ks × (8WD/π.d3)

Ks = [(4C-1)/(4c-4)] + [0.615/C] = 1.3105

τ = 619.62

Buckling of compression spring:

Crippling load under which a spring may buckle

KL = 0.1 (for hinged end spring)

The buckling factor for the hinged end and built -in end spring

Wcr = q × KL × Lf = 35.74 × 0.1× 167.8 = 599.71N

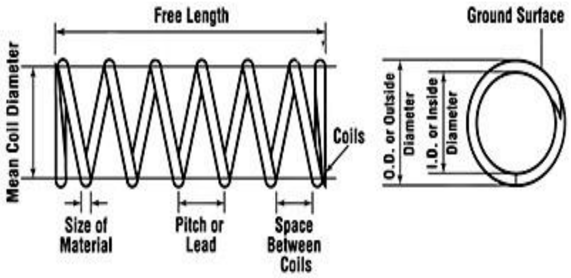


Figure: Internal and outer look

PRESENT DESIGN:

Structural Analysis for bike weight (113kg)

Material : Spring Steel (ASTM A227)

Modulus of Rigidity G = 78600N/mm2

Properties: Young's Modulus (E)1.965×105N/mm2

Poisson's Ratio (PRXY): 0.25

Density:7.86×10-6kg/mm3

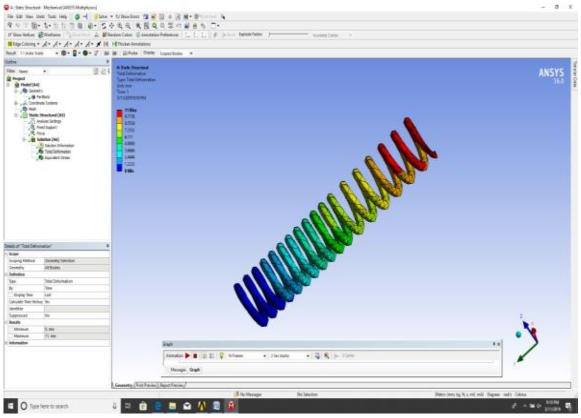
LOAD: 113kg *0.32*9.81

ONAPPLYING LOAD**: 360N**

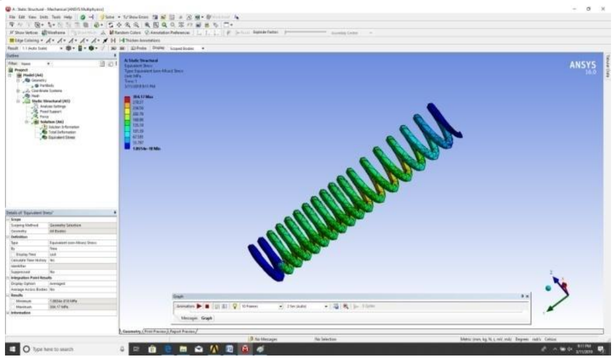
ANSYS

Ansys is an American public company based in Canonsburg, Pennsylvania. It develops and markets engineering simulation software. Ansys software is used to design products and semiconductors, as well as to create simulations that test a product's durability, temperature distribution, fluid movements, and electromagnetic properties. The software creates simulated computer models of structures, electronics, or machine components to simulate strength, toughness, elasticity, temperature distribution, electromagnetism, fluid flow, and other attributes.

Total deformation :spring steel at360N



Equivalent (Von-Mises)Stress :



Spring steel	MINIMUM	MAXIMUM
DEFLECTION (mm)	1.222	11
STRESS (mpa)	33.797	305

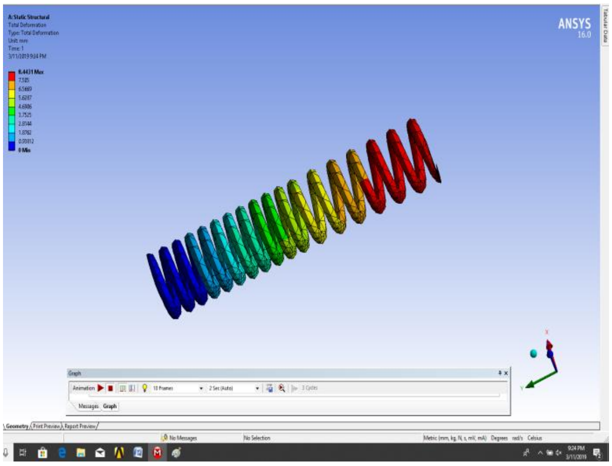
RESULTS:

Inconel x-750

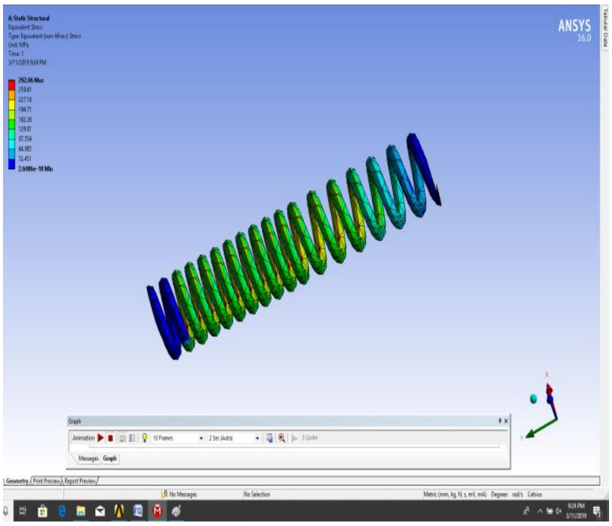
Considering the bike load 113kg i.e. at 360N

ISSN No: 2348-4845
International Journal & Magazine of Engineering, Technology, Management and Research
A Peer Reviewed Open Access International Journal

Total deformation :

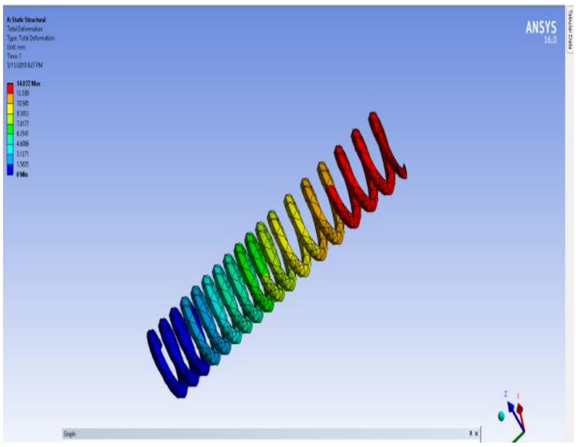


Equivalent(von-mises)stress:

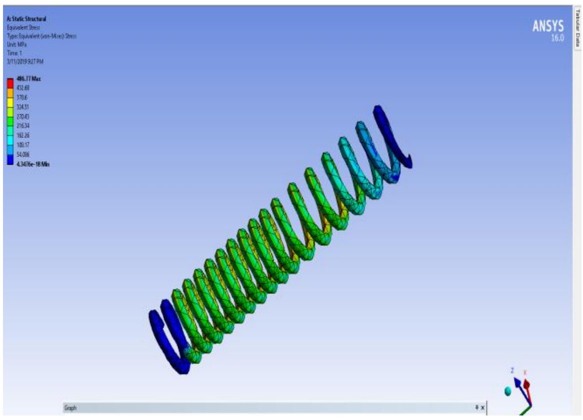


Considering the bike load + single person. i.e. at 600N

Total deformation:



Equivalent(von-mises)stress:



AT 360 N

MATERIAL	MINIMUM DELFECTION (mm)	MAXIMUM DEFLECTION (mm)	MINIMUM STRESS (mpa)	MAXIMUM STRESS (mpa)
CARBON FIBER STD.	0.826	7.4602	32.439	291.52
MOLYBDENUM	0.733	6.7983	33.812	304.31
INCONEL X-750	0.93812	8.4431	32.451	292.06
SPRING STEEL	1.222	11	33.797	305

AT 600 N

MATERIAL	MINIMUM DELFECTION (mm)	MAXIMUM DEFLECTION (mm)	MINIMUM STRESS (mpa)	MAXIMUM STRESS (mpa)
CARBON FIBER STD.	1.3815	12.434	54.066	486.59
MOLYBDENUM	1.259	11.331	56.354	507.18
INCONEL X-750	1.5625	14.072	54.086	486.77
SPRING STEEL	2.037	18.333	56.328	506.95

AT 840 N

MATERIAL	MINIMUM DELFECTION (mm)	MAXIMUM DEFLECTION (mm)	MINIMUM STRESS (mpa)	MAXIMUM STRESS (mpa)
CARBON FIBER STD.	1.9341	17.407	75.692	681.23
MOLYBDENUM	1.7626	15.863	78.895	710.05
INCONEL X-750	2.189	19.701	75.72	681.48
SPRING STEEL	2.0518	25.666	78.859	709.73

CONCLUSION

We have designed a Shock Absorber and modeled it using 3D parametric software called CATIA V5 R20. The shock absorber design is modified by varying the materials and stress analysis is performed. The deflection and stress value is lesser in our designed spring than in original which adds an advantage to our design. By comparing the results from previous design and modified design, the stress and displacement values are less for modified design. It is observed from the results, the two materials carbon fiber and inconel x750 have obtained same values. Considering the cost and weight ratio for the two materials, carbon fiber have less weight and slight variations in cost.

So, we can conclude that as per our analysis using material carbon fiber for spring is best and also our modified design is safe.

FUTURE SCOPE:

An extended work can be carried out on the topic by performing harmonic response and model analysis. So that we can predict the steady state dynamic response and its characteristics subjected to sinusoidally varying loads that are applied on the spring.

REFERENCES

[1]. Prince Jerome Christopher J.1, Pavendhan R.2 "DesignandAnalysis ofTwo Wheeler Shock Absorber Coil Spring" http://www.ijmer.com/papers/(ICAEM)-2014/IME0133-140.pdf

[2]. Kommalapati. Rameshbabu, Tippa Bhimasankar Rao, "Design Evaluation of a two wheeler suspension system for variable load conditions" International Journal of Computational Engineering Research, Vol 03, Issue 4, pp. 279-283 , 2013

[3]. Gajendra Singh Rathore and Upendra Kumar Joshi, "Fatigue Stress analysis of helical Compression Spring: A Review", International Journal of Emerging Trends in Engineering and Development, ISSN: 2249-6149, Volume: 2, Issue: 3, pp. 512-520, May 2013

[4]. B. Pyttel, I. Brunner, B. Kaiser, C. Berger, M. Mahendran, "Fatigue behaviour of helical compression springs at a very high number of cycles–Investigation of various influences", International Journal of Fatigue (2013), S01421123(13)00017-0, JIJF 3037.

[5]. Brita Pyttel, K K Ray, Isabell Brunner, Abhishek Tiwari, S. A. Kaoua. "Investigation of probable failure position in helical compression springs used in fuel injection system of diesel engines", IOSR Journal of Mechanical and Civil Engineering (IOSRJMCE) ISSN: 2278-1684 Volume 2, Issue 3 (Sep-Oct. 2012), PP 24-29.

[6]. Mehdi Bakhshesh and Majid Bakhshesh., "Optimization of Steel Helical Spring by Composite Spring", International journal of multidisciplinary science and engineering, vol.3, No.6, june 2012.

[7]. B. Kaiser , B. Pyttel, C. Berger, "VHCF-behavior of helical compression springs made of different materials", International journal of fatigue, vol 33,pp. 23-32,2011.

[8]. Yuuji Shimatani, Kazuaki Shiozawa, Takehiro Nakada and Takashi Yoshimoto, "Effect of surface residual stress and inclusion size on fatigue failure mode of matrix HSS in very high cycle regime", Procedia Engineering 2 (2010) 873– 882.

[9]. Y. Prawoto, M. Ikeda , S.K. Manville, A. Nishikawa, "Design and failure modes of automotive suspension springs", Engineering Failure Analysis 15 (2008) 1155–1174.

[10]. L.Del Llano-Vizcaya, C. Rubio-Gonzalez, G. Mesmacque. "Stress relief effect on fatigue and relaxation of compression springs". Material and design 28(2007) 1130-1134.

[11]. Chang-Hsuan Chiu, Chung-Li Hwan, Han-Shuin Tsai, Wei-Ping Lee. "An experimental investigation into the mechanical behaviors of helical composite springs". Composite Structures 77 (2007) 331–340.

[12]. C.Berger, B.Kaiser. "Results of very high cycle fatigue tests on helical compression springs". International journal of fatiuge 28(2006) 1658-1663.

[13]. L. Del Llano-Vizcaya, C.Rubio-Gonzalez, G.Mesmacque ,T. Cervantes-Hernandez. "Multiaxial fatigue and failure analysis of helical compression

springs”.Engineering failure analysis 13 (2006) 1303-1313.

[14]. Dammak Fakhreddine, Taktak Mohamed, Abid Said, Dhieb Abderrazek,Haddar Mohamed. “Finite element method for the stress analysis of isotropic cylindrica helical spring”. Journal of mechanics A/solids 24 (2005).

[15]. B. Ravi Kumar, Swapan K. Das, D.K. Bhattacharya. “Fatigue failure of helical compression spring in coke oven batteries”. Engineering Failure Analysis 10 (2003) 291–296.

[16]. Kotaro Watanabe,Masashi Tamura, Ken Yamaya, Takahiko Kunoh. “Development of a new-type suspension spring for rally cars”. Journal of materials processing technology 111 (2001) 132-134.

[17]. M.T. Todinov. “Maximum principal tensile stress and fatigue crack origin for compression springs”. International Journal of Mechanical Sciences 41 (1999) 357-370 [18] James M. Meagher and Peter Altman. “Stresses from flexure in composite helical implantable leads” S1350-4533(96) 00022-7.

[18]. Pinjarla.Poormohan and Lakshmana Kishore T, “Design and Analysis of a Shock Absorber”, International Journal of Research in Engineering and Technology, ISSN: 2319-1163, Volume: 1, Issue: 4, pp.578-592, December 2012