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# "A Review Study on Car Safety Through Bumper, Roll Cage And Spring"

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## ABSTRACT

*This Paper focuses on the design of bumper, spring and roll cage for lesser weight and better performance. Also it describes about the stress analysis on a car frontal protection system (bumper) simulations. To achieve that, we analyze the basic concepts for improving the safety on the car by doing analysis on the car bumper and roller cage. It is important to know their mechanical properties and their failure mechanism during the impact. This analysis was carried out by using market Finite Elements analysis software for structural physics that could simulate static (stationary) , dynamic (moving) and thermal (heat transfer ) problems [ANSYS] to evaluate the behaviour of bumper system and roller cage. Another additional innovative step for improving crashworthiness is the use of material to produces the part to absorb energy during the process of a crash and that part is spring. Research concentrates on polymer composite material. It is considering their function, geometry, and other parameters that influence the compatibility of the bumper and roller cage In future research, these parts will face the static test and analysis will be done on their load distributions by applying the variation of load and locations. Here we will use spring on the front side of the vehicle to absorb the energy of sudden impact and this will secure the driver as well as produce less injury to the person outside. How the load applied effect the stress distribution.*

***KEYWORDS :*** *Bumper, Sprung, Roll cage, Ansys, Structure.*

## I. INTRODUCTION

Nowadays, in development of technology especially in engineering field make among the engineers more creative and competitive in designing or creating new product. They must be precise and showing careful attentions on what they produce. Here, we concentrate on automotive industry. The greatest demand facing the automotive industry has been to provide safer vehicles with high fuel efficiency at minimum cost. Current automotive vehicle structures have one fundamental handicap, a short crumple zone for crash energy absorption.

One of the options to reduce energy consumption is weight reduction. However, the designer should be aware that in order to reduce the weight, the safety of the car passenger must not be sacrificed. A new invention in technology material was introduced with polymeric based composite materials, which offer high specific stiffness, low weight, erosion free, and ability to produce complex shapes, high specific strength, and high impact energy absorption.

Substitution of polymer based composite material in car components was successfully implemented in the quest for weight and fuel reduction. Among the components, in the automobile industry substituted by polymer based composite materials are the spoiler, bumper fascia, bumper beam, pedal box system, connecting rod and door inner panel. The bumper system consists of three main components, namely energy absorber, bumper beam and energy fascia.

The automotive body is one of the critical subsystems of an automobile, and it carries out multiple functions. It should hold the parts of the vehicle together and serve to filter vibration and noise. Additionally, it should be able to protect its occupants when accidents happen. To do this, the automotive body designer should design a structure with significant levels of stiffness, strength and energy absorption.

Here we will take a step to modify and implement our idea of using spring on the front side of the car to take the load , to absorb the energy and as we all know spring is a good shock absorber so using spring on front side will keep the occupants of car as well as driver safe or will reduce the risk of serious crash and accidents. Analysis on the structure of roll cage is also being done here by using ANSYS.

## II. LITERATURE REVIEW

**B. Pyttel, Brunner, et al.** states Long-term fatigue tests on shot peened helical compression springs were conducted by means of a special spring fatigue testing machine at 40 Hz. Test springs were made of three different spring materials – oil hardened and tempered SiCr- and SiCrV-alloyed valve spring steel and stainless steel. With a special test strategy in a test run, up to 500 springs with a wire diameter of d = 3.0 mm or 900 springs with d = 1.6 mm were tested simultaneously at different stress levels. Based on fatigue investigations of springs with d = 3.0 mm up to a number of cycles N = 109 an analysis was done after the test was continued to N = 1.5 _ 109 and their results were compared. The influence of different shot peening conditions were investigated in springs with d = 1.6 mm. Fractured test springs were examined under optical microscope, scanning electron microscope (SEM) and by means of metallographic micro-sections in order to analyse the fracture behavior and the failure mechanisms. The paper includes a comparison of the results of the different spring sizes, materials, number of cycles and shot peening conditions and outlines further investigations in the VHCF-region.. For comparison the results for the springs with d = 1.6 mm and d = 3.0 mm and Ps = 98% are summarised in Fig. 1. Except for springs made of the stainless steel wire, the fatigue strength of springs with d = 3.0 mm is higher than for springs with d = 1.6 mm. The size effect would imply higher fatigue strength for smaller wire diameters.

**Wei Li, Tatsuo Sakai, et al.** state that Very high cycle fatigue (VHCF) properties of a newly developed clean spring steel were experimentally examined under rotating bending and axial loading. As a result, this steel represents the duplex S–N property only for surface-induced failure under rotating bending, whereas it represents the single S–N property for surface-induced failure and interior inhomogeneous microstructure induced failure under axial loading. Surface small grinding defect-induced failure is the predominant failure mode of this steel in VHCF regime.

The Surface morphology of the interior inhomogeneous microstructure with distinct plastic deformation is much rougher than that of the ambient matrix, which means the stress concentration resulted from the strain inconsistency between the micro structural in homogeneity as soft phase and the ambient matrix as hard phase plays a key role in causing interior crack initiation. Considering the effect of surface compressive residual stress, the threshold stress intensity factor for surface small defect-induced crack propagation of this steel is evaluated to be 2.04 MPam1/2, which means that the short crack effect plays a key role in causing the surface small defect-induced failure of this steel in the VHCF regime. From the viewpoint of defect distribution, surface and interior failure probabilities are equivalent under a fixed characteristic value of defect density. If the interior defect size is less than or even equal to the surface defect size, surface defect-induced failure will become the predominant failure mode in VHCF regime, especially under rotating bending

**Sid Ali Kaouaa, Kamel Taibia, et al. said** This paper presents a 3D geometric modeling of a twin helical spring and its finite element analysis to study the spring mechanical behavior under tensile axial loading. The spiraled shape graphic design is achieved through the use of Computer Aided Design (CAD) tools, of which a finite element model is generated. Thus, a 3D 18-dof pentaedric elements are employed to discrete the complex ‘‘wired-shape” of the spring, allowing the analysis of the mechanical response of the twin spiraled helical spring under an axial load. The study provides a clear match between the evolution of the theoretical and the numerical tensile and compression normal stresses, being of sinusoidal behavior. The overall equivalent stress isovalues increases radially from 0_ to 180_, being maximal on the internal radial zone at the section 180_. On the other hand, the minimum stress level is located in the centre of the filament cross section.

**A. González Rodríguez, J.M. Chacón, et al.** state that An adjustable-stiffness actuator composed of two antagonistic non-linear springs is proposed in this paper. The elastic device consists of two pairs of leaf springs working in bending conditions under large displacements. Owing to this geometric non-linearity, the global stiffness of the actuator can be adjusted by modifying the shape of the leaf springs. A mathematical model has been developed in order to predict the mechanical behavior of our proposal. The non-linear differential equation derived from the model is solved, obtaining large stiffness variations. A prototype of the actuator was INTERNATIONAL JOURNAL OF RESEARCH IN AERONAUTICAL AND MECHANICAL ENGINEERING Vol.2 Issue.7, July 2014. Pgs: 76-83 Supriya Burgul 81 fabricated and tested for different load cases. Experimental results were compared with numerical simulations for model verification, showing excellent agreement for a wide range of work.

**Matjazˇ Mršnik, Janko Slavicˇ, et al.** publish paper on A stranded wire helical spring (SWHS) is a unique cylindrically helical spring, which is reeled by a strand that is formed of 2∼16 wires. In this paper, a parametric modeling method and the corresponding 3D model of a closed-end SWHS are presented based on the forming principle of the spring. By utilizing a PC + PLC based model as the motion control system, a prototype machine tool is designed and constructed, which improves the manufacturing of the SWHS. Via the commercial CAD package Pro/Engineering, numerical simulation is carried out to test the validity of the parametric modeling method and the performance of the machine tool. The scheme of the tension control system is analyzed and the control mechanism is set up, which have achieved the constant tension of each wire. A human machine interface is also proposed to achieve the motion control and the tension control. Experimental results show that the tension control system is well-qualified with high control precision.

## III. METHODOLOGY

- Firstly we selected a vehicle on which safety test and implementation will be analyzed. ( Indica Vista)
- Then we decided to identify key areas of improvement in car safety which are bumper Material, Roll cage inclusion, and a spring mechanism.
- For bumper Material we analyzed Aluminum Alloy 6061-T6 and Steel.
- For Spring Mechanism we analyzed Stainless Steel and Chrome Silicon.
- For Roll cage also extensive analysis is done.
- And at last all the results are arranged in suitable format.

## IV. CONCLUSION

1. For the Bumper, Aluminium Alloy 6061-T6 has the lesser Total Deformation and Equivalent von-mises Stress than the Stainless Steel. Therefore, Alumnium Alloy is selected for best material for the bumper design.
2. For the spring, Stresses for Stainless steel calculated at 35 m/s are under safe limit.
3. For the Roll Cage, Copper Alloy suits the best as per analysis. Copper Alloy has lesser Total Deformation and Equivalent Elastic Strain at 35 m/s and 50 m/s both.
4. Hence, we take Aluminium Alloy 6061-T6 for Bumper, Stainless steel for Spring and Copper Alloy for Roll Cage Design.
5. It was found that the use of helical spring and roller cage leads to lesser deformation in the bumper as compared to the roller cage without springs.
6. The crash test undergone implies that the use of heavy helical spring (take up axial load) and roll cage with better load carrying capacity is the best way to use it as shock absorber during crash.

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