Structural Static Analysis of Shock Absorber

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Abstract- *In a vehicle, shock absorbers reduce the effect of traveling over rough ground, leading to improved ride quality and vehicle handling. While shock absorbers serve the purpose of limiting excessive suspension movement, their intended sole purpose is to damp spring oscillations. In this project a shock absorber is designed and a 3D model is created using CATIA. Structural analysis is done on the shock absorber by varying material for grey cast iron and steel. The analysis is done by considering loads, bike weight, single person and double persons. Structural analysis is done to validate the strength. Comparison is done for two materials to verify best material for spring in Shock absorber. Modeling is done in CATIA and analysis is done in ANSYS 15. CATIA is the standard in 3D product design, featuring industry-leading productivity tools that promote best practices in design.*

Keywords- Shock Absorber, Spring Steel and Molybdenum, ANSYS 15.0, CATIA

I. INTRODUCTION

In common with carriages and railway locomotives, most early motor vehicles used leaf springs. One of the features of these springs was that the friction between the leaves offered a degree of damping and in a 1912 review of vehicle suspension the lack of this characteristic in helical springs was the reason it was "impossible" to use them as main springs. However the amount of damping provided by leaf spring friction was limited and variable according to the conditions of the springs, and whether wet or dry. It also operated in both directions. Motorcycle front suspension adopted coil sprung Druid forks from about 1906, and similar designs later added rotary friction dampers, which damped both ways - but they were adjustable (e.g. 1924 Webb forks). These friction disk shock absorbers were also fitted to many cars. One of the problems with motor cars was the large variation in sprung weight between lightly loaded and fully loaded, especially for the rear springs. When heavily loaded the springs could bottom out, and apart from fitting rubber 'bump stops', there were attempts to use heavy main springs with auxiliary springs to smooth the ride when lightly loaded, which were often called 'shock absorbers'. Realising that the spring and vehicle combination bounced with a characteristic frequency, these auxiliary springs were designed with a different period, but were not a solution to the problem that the spring rebound after striking a bump could throw you out of your seat. What was called for was damping that operated on the rebound.

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. Shock absorbers 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. A transverse mounted shock absorber, helps keep railcars from swaying excessively from side to side and are important in passenger railroads systems because they prevent railcars from damaging station platforms. In a vehicle, it reduces the effect of travelling over rough ground, and leading to improved ride quality. Without shock absorbers, the vehicle would have a bouncing ride, as energy is stored in the spring and then released to the vehicle, possibly exceeding the allowed range of suspension movement. A prototype shock absorber capable of significantly reducing vibrations, such as those experienced while driving, has been developed by German researchers. The device can also convert vibrations into energy, meaning it has the potential to power inaccessible sensors. Shock absorbers are devices that dampen unwanted vibrations. Most are passive in nature and made of materials called elastomers that are yielding and malleable. The main advantage over the friction disk dampers was that it would resist sudden movement but allow slow movement, whereas the rotary friction dampers tended to stick and then offer the same resistance regardless of speed of movement. There appears to have been little progress on commercializing the lever arm shock absorbers until after World War I, after which they came into widespread. A suspension system or shock absorber is a mechanical device designed to smooth out and dissipate kinetic energy. The shock absorbers function is to absorb or dissipate energy. In a vehicle, it reduces the effect of traveling over rough ground, leading to improve ride quality, and increase in comfort due to substantially reduced amplitude of disturbances.

Fig 1: Shock absorber

The shock absorbers duty is to absorb or dissipate energy. One design consideration, when designing or choosing a shock absorber, is where that energy will go. In most dashpots, energy is converted to heat inside the viscous fluid. In hydraulic cylinders, the hydraulic fluid will heat up, while in air cylinders, the hot air is usually exhausted to the atmosphere. In other types of dashpots, such as electromagnetic ones, the dissipated energy can be stored and used later. In general terms, shock absorbers help cushion cars on uneven roads.

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. Without shock absorbers, the vehicle would have a bouncing ride, as energy is stored in the spring and then released to the vehicle, possibly exceeding the allowed range of suspension movement. Control of excessive suspension movement without shock absorption requires stiffer (higher rate) springs, which would in turn give a harsh ride. Shock absorbers allow the use of soft (lower rate) springs while controlling the rate of suspension movement in response to bumps.

II. LITERATURE REVIEW

Tongyi Xu et.al studied the twoterminal mass (TTM) based vibration absorber with variable moment of inertia (VMI) for passive vehicle suspension is proposed. The VMI of the system is achieved by the motion of sliders embedded in a hydraulic driven flywheel. The moment of inertia increases in reaction to strong vertical vehicle oscillations and decreases for weak vertical oscillations. The hydraulic mechanism of the system converts the relative linear motion between the two terminals of the suspension into rotating motion of the flywheel. In the case of stronger vehicle vertical oscillation, the sliders inside the flywheel move away from the center of the flywheel because of the centrifugal force, hence yielding higher moment of inertia. The opposite is true in the case of weaker vehicle oscillation. As such, the moment of inertia adjusts itself adaptively in response to the road conditions. `

The performance of the proposed TTM-VMI absorber has been analyzed via dynamics modeling and simulation and further examined by experiments.

Ryabov et. al presents the analytical proof of the presence of two inefficient areas in vehicle suspension oscillation cycle in linear shock absorber work. It derived on the basis of analysis of the dynamics equations for the linear single-support single-mass vibrating system with fixed elastic and damping characteristics at harmonic kinematic disturbance. Expressions of the full, efficient and inefficient work of the linear damper in one oscillation cycle are derived.

Mr. Sudarshan Martande et.al 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 roads. In the mid nineteenth century, road quality was generally very poor. The rapidly increasing power available from the internal combustion engine made higher speeds routine; this, plus the technical aptitude of the vehicle and component designers, coupled with a general commercial mood favoring development and change, provided an environment that 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.

A.K. Samantaray Preloaded liquid spring/damper based shock isolation systems are suitable for heavy load military applications. In this paper, mathematical models are developed for passive liquid spring shock absorbers. The preloading is achieved by mounting the load between two liquid spring/dampers. Dynamics of such shock absorbers involve coupled hydrodynamic and thermodynamic phenomena. The energy dissipated through orifice due to hydrodynamic losses heats up the working fluid and consequently the heat is dissipated to environment. Such multienergy domain interaction is well represented in this paper by using bond graph models. Moreover, the developed model accounts for the strain-rate dependent damping offered by the compressible working fluid in the liquid spring.

III. DESIGN AND MODELLING PSD SHOCK ABSORBER USING SOLIDWORKS DESIGN TOOL

To simulate and designing the PSD shock absorber with available hero Honda bike data and also it consists of top rod with stainless steel, piston rod with forged steel, spring with carbon steel and screw with stainless steel materials. For designing and modeling of PSD shock absorber using solidworks design tool and the designed PSD shock absorber is exported to IGES or .STEP file to analyze the performance of PSD shock absorber at various loading conditions. For evaluating the performance of PSD shock absorber using ANSYS workbench tool, by using this tool modal and static structural analysis are performing later stage.

IV. PERFORMANCE ANALYSIS OF PSD SHOCK ABSOBER USING ANSYS

Once the modeling and assembly of PSD shock absorber completed using solidworks, the FEM analysis has been performed in workbench to identify the load carrying capacity of the PSD shock absorber at various loading conditions.

Material properties of grey cast iron

Properties	Grey cast iron	Steel
Density	7.2 g/m^3	7.8g/m^3
Poisson ratio	0.3	0.3
Yield strength	276 MPa	250 MPa
Ultimate strength	414 MPa	410 MPa
Youngs modulus	120 GPa	200 GPa

V. RESULTS AND DISCUSSIONS

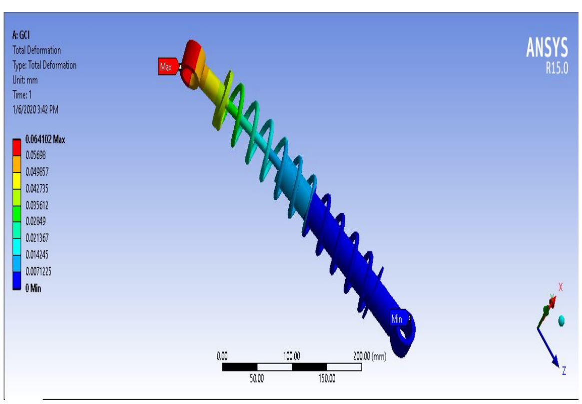

Fig 2: Deformation of G. cast iron

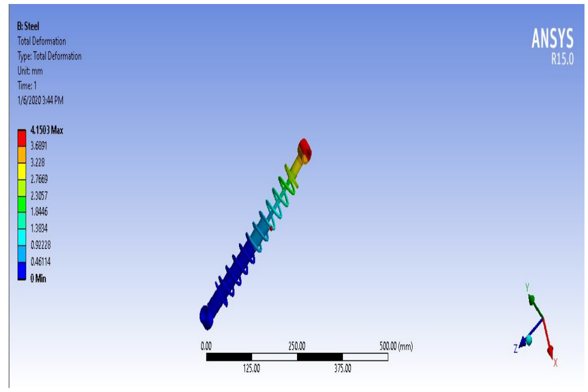

Fig 3: Deformation of steel

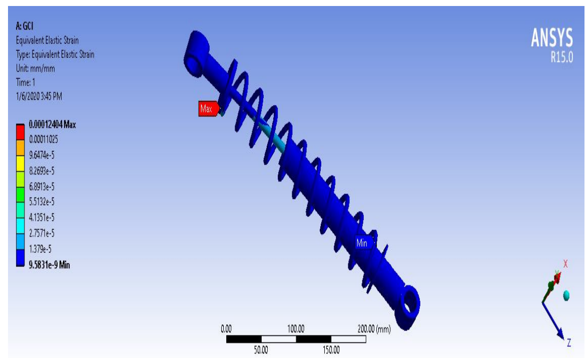

Fig 4: strain results of G. cast iron

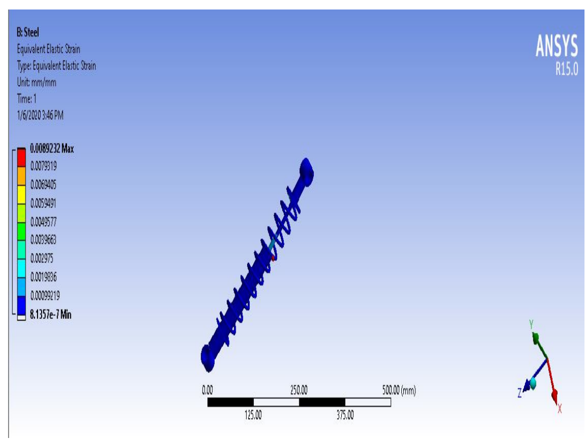

Fig 5: strain rests of steel

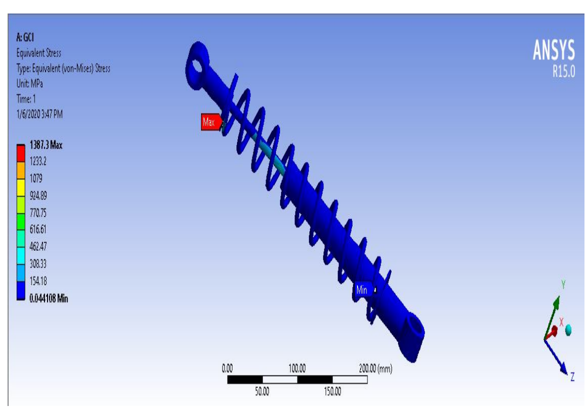

Fig 6: Stress results of G cast iron

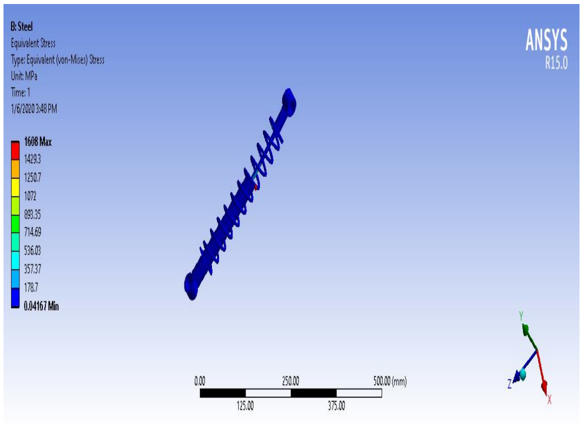

Fig 7: Stress results of steel

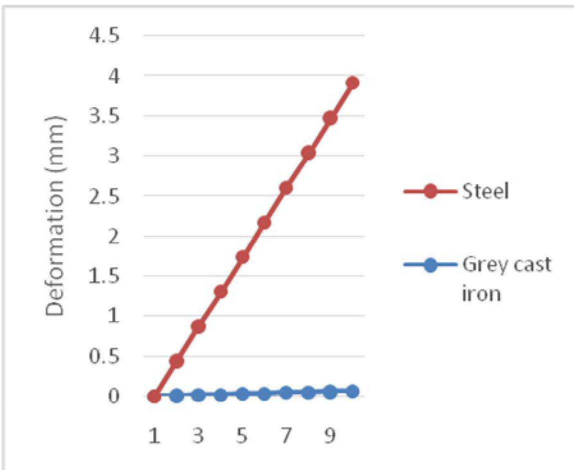

Fig 8: comparison of deformation results

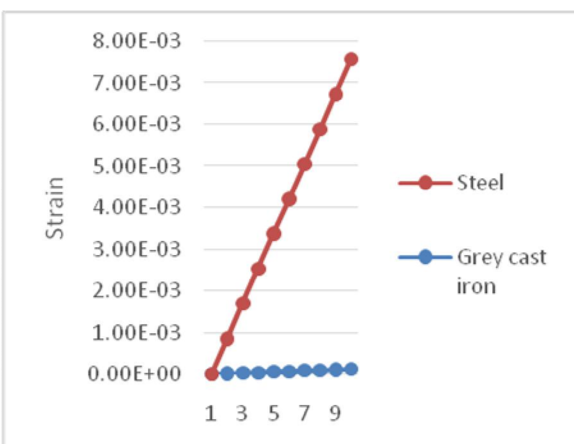

Fig 9: comparison of strain results

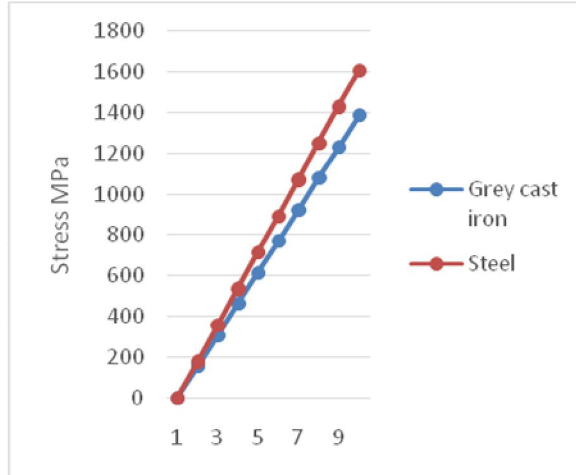

Fig 10: comparison of stress results

VI. CONCLUSIONS

1. shock absorber analyzed under the above conditions for the generation of vonMises strains, total deformation and stress intensity at critical locations. The linear static finite element analysis was performed using FEM.
2. From the deformation comparisons it is clear that, grey cast iron material has less deformation compared to steel.
3. From stress comparisons one can say that, stress induced in the grey cast iron is less than the steel.
4. By the strain comparisons, we can say strain is very less for the grey cast iron materials compared steel.
5. From above conclusions it is clear that grey cast iron is best suited material compare with steel.

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