DESIGN AND FABRICATION OF

IMPACT ABSORBER

A DESIGN AND FABRICATION PROJECT REPORT

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INTERNAL EXAMINER	**EXTERNAL EXAMINER**

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I. ABSTRACT

In India five in one family will have a 4-wheel transport vehicle, and however owning a car is not a tough hardship than maintaining it in a perfect way. Our Engineering team have designed a new product to minimize the damage caused at the outer body and stop you from paying unnecessary expenses. Being involved in an auto collision is a stressful experience and the most unfortunate thing is that a rear-end collision is a type of accident that is frequently caused. A rear end collision can, not only damage your car, but it can also cause injuries to the passengers. Rear-end collisions typically result in direct or indirect damage. Direct damage is one that is visible to the naked eye while the indirect damage is not visible. You might have the visible damage restored but there are some hidden vehicle damages that you might not see. The Car accidents are happening every day. Hence, improvement in the safety of automobiles is prerequisite to decrease the numbers of accidents. Automobile bumper is a structural component of an automobile vehicle which contributes to vehicle crashworthiness or occupant protection during front or rear collisions. The bumper system also protects the hood, trunk, fuel, exhaust and cooling system as well as safety related equipment. Bumper beams are usually made of steel, aluminum, plastic, or composite material. Bumper beams are also the backbone of the energy absorbing systems located at both front and rear on automobiles. This energy absorber which looks like a shock absorber, functions as a connecting member between a bumper and front cross member for the purpose of damping load and the shock load during a low speed collision between the motor vehicle and an obstacle. Under the bumper impact situation these energy absorbers are loaded in compression or tension as well as the bumper moves from a designed outer position toward the vehicle body and are operative to absorb the energy of the impact. After impact, these energy absorbers recover at various rates to return associated with bumper assembly toward its original pre-impact position

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IV. LIST OF ABBREVIATIONS

ABBREVIATIONS	EXPANDED FORM
E	Young's Modulus
δ	Deflection
σ	Stress
e	Strain
P	Load
G	Rigidity modulus
SAE	Society of Automotive Engineer

CHAPTER 1

INTRODUCTION

1.1 .BACKGROUND

Bumper as the name suggests, offers protection to a vehicle by bumping off anything that collides into it. Bumpers in an automobile are designed to survive the collision without causing much damage to the vehicle's frame even after the vehicle has bumped into another vehicle. Brush guards; push bars, etc. were introduced later to provide additional protection to the vehicle. Bumpers were originally made from heavy steel. Later they came to be made from rubber, plastic or painted light metal thus making them vulnerable to damage from even a minimal contact. Most vehicles having bumpers cannot push or be pushed by any another vehicle. Modern day automobile industry has developed a variety of new guards to guard the vulnerable modern bumpers...If you are stopped at a traffic light or stop sign or if you are driving down the road when you are hit from behind, you know the impact can be severe. Such an impact can lead to heavy body damage and even mechanical damage to your vehicle. Motor damage will not result from a rear-end collision, but there are damages that can impact your car's drive train. The impact can damage the exhaust system forward, which can then cause damage to the exhaust manifold, catalytic converter, engine mounts, or a "Y" pipe which runs into your car's engine. Therefore to absorb the impact usually metal guard has been employed in cars, but however it will also cannot absorb the impact and transfers the impact directly to the frame , so our engineering team had decided to rectify the issue by using two optimized design of shock absorbers. These shock absorbers plays a vital role in absorbing sudden shocks at the rear end.

1.2 PROBLEM STATEMENT

Problems that are usually occurred in rear end due to sudden hit are listed below

- **ALIGNMENT PROBLEMS**

If you are driving your car and you notice a difference in the way it handles the road, its alignment might be off. Common signs of misalignment include the vehicle pulling to one side, vibrations and a steering wobble. While misalignment might be the worst that could happen, it can cause additional stress to the tires, brakes, suspension and other car parts causing them to wear out faster than usual. Misalignment does not just cause premature wear and tear, but it can also pose safety hazards.

- **TRANSMISSION ISSUES**

Rear-end collisions not only causes damage to the car body but also impacts the vehicle’s mechanics. Rear-wheel-drive and all-wheel-drive vehicles have transmission components located near the rear of the vehicle making them prone to damage in the event of a collision. You should look out for transmission slipping after your accident. When the transmission starts to slip, you will have a hard time accelerating while on the road. You will notice your vehicle is struggling to gain speed.

Other signs of transmission issues you should look out for include difficulty shifting and leaking transmission fluid.

- **PROBLEMS WITH THE TRUNK**

Your trunk should open and close without an issue, however, after a rear collision the rear cabin components might be damaged, and your trunk can start having problems. While a damaged trunk might not affect the handling of the car, it has a negative impact on the resale value of the car. It can also pose a safety risk if the trunk suddenly opens as you drive.

- HIDDEN BODY DAMAGE

In some cases, it might appear that your vehicle made a lucky escape after a rear-end collision, but it might have collision damage that is not visible. There might be damage underneath the surface. In most cases, the frame behind the bumper might get damaged because the bumper is plastic and does not offer much protection.

1.3. OBJECTIVE

Our project, “Design and Fabrication of IMPACT ABSORBER”, is to demonstrate how the employment shock absorber will save the rear end of the car.

Usually in modern car metal guard is fixed , but however it cannot absorb the impact and transfers the impact directly to the frame , so our engineering team had decided to rectify the issue by using an optimized design of shock absorbers.

CHAPTER 2

MECHANISM

2.1. OVERVIEW

The Shock absorber which is one of the Suspension systems is designed mechanically to handle shock impulse and dissipate kinetic energy. It reduces the amplitude of disturbances leading to increase in comfort and improved ride quality. Hence, the designing of spring in a suspension system is very crucial. Design is an important industrial activity which influences the quality of the product.

2.2. SHOCK ABSORBER

All hydraulic shock absorbers work by the principle of converting kinetic energy (movement) into thermic energy (heat). For that purpose, fluid in the shock absorber is forced to flow through restricted outlets and valve systems, thus generating hydraulic resistance

A shock absorber or damper is a mechanical device designed to smooth out or damp shock impulse, and dissipate kinetic energy. Pneumatic and hydraulic shock absorbers commonly take the form of a cylinder with a sliding piston inside. The cylinder is filled with a fluid (such as hydraulic fluid) or air. This fluid-filled piston/cylinder combination is a dashpot. The shock absorbers duty is to absorb or dissipate energy. These are an important part of automobile 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 and resonance. In a vehicle, it reduces the effect of traveling over rough ground, leading to improved ride quality, and increase 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. Damp the motion of the upspring weight up and down on the springiness of the tire. Since the tire is not as soft as the springs, effective wheel bounce damping may require stiffer shocks than would be ideal for the vehicle motion alone. Spring-based shock absorbers commonly use coil springs or leaf springs, though torsion bars can be used in tensional shocks as well. Ideal springs alone, howver, are not shock absorbers as springs only store and do not dissipate or absorb energy. Vehicles typically employ springs and torsion bars as well as hydraulic shock absorbers.

2.3. SPRING MECHANISM

A **spring** is an elastic object that stores mechanical energy. Springs are typically made of spring steel. There are many spring designs. In everyday use, the term often refers to coil springs.

When a conventional spring, without stiffness variability features, is compressed or stretched from its resting position, it exerts an opposing force approximately proportional to its change in length (this approximation breaks down for larger deflections). The rate or spring constant of a spring is the change in the force it exerts, divided by the change in deflection of the spring.

Hooke's law

“It states that within the limit of elasticity, the stress induced (σ) in the solid due to some external force is always in proportion with the strain (ε). In other words the force causing stress in a solid is directly proportional to the solid's deformation.”

Consider a spring with a spring constant *k* that is stretched with a force *F* extends to a distance *x* with reference to the initial position.

Force required for deformation *x* is given by $F = -k \cdot x$

Plot the graph for the stress (σ) versus strain (ε) for a metal rod acted upon by trending tensile force.

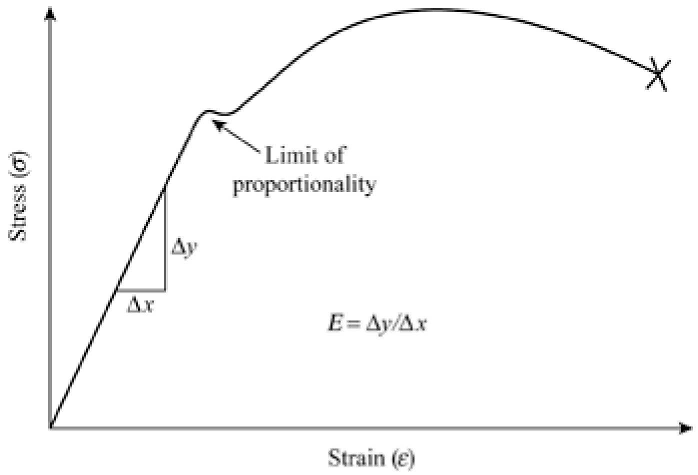

Figure 1: stress vs strain curve

The determination of elastic modulus *E* from the tensile experiment results is depicted in the figure.

It can be seen from the graph that the curve of stress versus strain is linear within the limit of elasticity of the material. It is inferred that for the load below the limit of elasticity, the stress induced is in proportion with the strain in the solid.

$$\sigma \propto \varepsilon$$

$$\sigma = E\varepsilon$$

$$E = \frac{\sigma}{\varepsilon}$$

Here young's modulus or proportionality limit is E.

Simple harmonic motion

Simple harmonic motion can serve as a mathematical model for a variety of motions, such as the oscillation of a spring. In addition, other phenomena can be approximated by simple harmonic motion, including the motion of a simple pendulum as well as molecular vibration. Simple harmonic motion is typified by the motion of a mass on a spring when it is subject to the linear elastic restoring force given by Hooke's Law. The motion is sinusoidal in time and demonstrates a single resonant frequency. For simple harmonic motion to be an accurate model for a pendulum, the net force on the object at the end of the pendulum must be proportional to the displacement. Since force is equal to mass, m, times acceleration, a, the force equation for a spring obeying Hooke's law looks like:

$$From\ Newton's\ Second\ Law\ of\ Motion$$

$$ma = -kx$$

$$So, ma + kx = 0\ or\ a + \frac{k}{m}x = 0$$

$$But\ a = \frac{d^2x}{dt^2} = \ddot{x}\ and\ let\ \omega_0^2 = \frac{k}{m}$$

$$So\ \frac{d^2x}{dt^2} + \omega_0^2 x = 0$$

$$Or\ \ddot{x} + \omega_0^2 x = 0$$

Thus the above equation is known as differential equation or fundamental equation of S.H.M.

Pneumatic cylinder:

In our working project, we are setting up a pneumatic cylinder in order to indicate the working of our impact absorber and to test the working of it.

Pneumatic cylinder(s) (sometimes known as **air cylinders**) are mechanical devices which use the power of compressed gas to produce a force in a reciprocating linear motion. These pneumatic cylinders works on the principle of PASCALS LAW.

It is a principle in fluid mechanics that states that "pressure at a point has infinite direction, and thus a pressure change at any point in a confined incompressible fluid is transmitted throughout the fluid such that the same change occurs everywhere"..

CHAPTER 3
COMPONENTS

3.1. FRAMES AND METAL BUMPER

The model in our project consist of steel cylinder bar which acts as the metallic rear bumper for car.

Steel is an alloy, consisting mainly of iron, with a carbon content of 0.2% to 2.1% by weight. Though the use of carbon is most common for the production of this metal alloy, other alloying materials like tungsten, chromium and manganese are also used. The proportions and forms in which these elements are used, affect the properties of the steel that is produced - increasing the carbon content for instance, increases its strength. This fact is particularly useful for making different types of steel for different purposes - the strength of steel needed to make a beverage can, is obviously different from the one needed to make railway tracks. There are various types of steel, and the use of this alloy is widespread across industries and infrastructure owing to its many useful properties and characteristics.

CONCENTRIC SPRINGS

Definition: A spring may be defined as an elastic member whose primary function is to deflect or distort under the action of applied load; it recovers its original shape when load is released.

or

Springs are energy absorbing units whose function is to store energy and to restore it slowly or rapidly depending on the particular application.

Important types of springs are:

There are various types of springs such as

(i) helical spring: They are made of wire coiled into a helical form, the load being applied along the axis of the helix. In these type of springs the major stresses is torsional shear stress due to twisting. They are both used in tension and compression.

Derivation of the Formula :

In order to derive a necessary formula which governs the behaviour of springs, consider a closed coiled spring subjected to an axial load W.

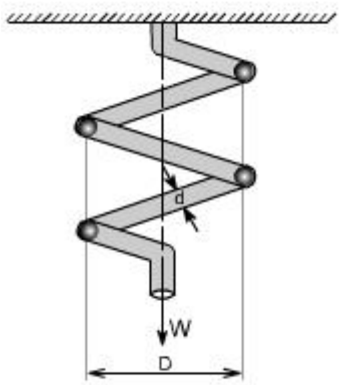

Figure 2 represents tensile load acting on spring

Let

W = axial load

D = mean coil diameter

d = diameter of spring wire

n = number of active coils

C = spring index = D / d For circular wires

l = length of spring wire

G = modulus of rigidity

x = deflection of spring

q = Angle of twist

when the spring is being subjected to an axial load to the wire of the spring gets be twisted like a shaft.

If q is the total angle of twist along the wire and x is the deflection of spring under the action of load W along the axis of the coil, so that

x = D / 2 . q

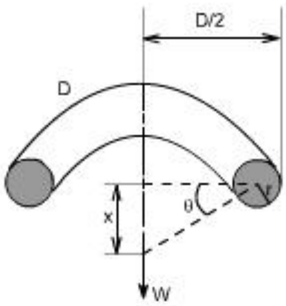

Figure 3 represents cross section on the wire helical spring

Using the torsion formula i.e

$$\frac{T}{J} = \frac{\tau}{r} = \frac{G.\theta}{l}$$

$$\text{and substitituting } J = \frac{\pi d^4}{32}; T = w.\frac{d}{2}$$

$$\theta = \frac{2.x}{D}; l = \pi D.x$$

SPRING DEFLECTION

$$\frac{w.d/2}{\frac{\pi d^4}{32}} = \frac{G.2x/D}{\pi D.n}$$

Thus,

$$x = \frac{8w.D^3.n}{G.d^4}$$

Spring striffness: The stiffness is defined as the load per unit deflection therefore

$$k = \frac{w}{x} = \frac{w}{\frac{8w.D^3.n}{G.d^4}}$$

Therefore

$$k = \frac{G.d^4}{8.D^3.n}$$

Shear stress

$$\frac{w.d/2}{\frac{\pi d^4}{32}} = \frac{\tau_{max^m}}{d/2}$$

$$\text{or } \tau_{max^m} = \frac{8wD}{\pi d^3}$$

WAHL'S FACTOR :

In order to take into account the effect of direct shear and change in coil curvature a stress factor is defined, which is known as Wahl's factor

K = Wahl' s factor and is defined as $K = \frac{4c-1}{4c-4} + \frac{0.615}{c}$

Where C = spring index

= D/d

if we take into account the Wahl's factor than the formula for the shear stress becomes $\tau_{max^m} = \frac{16.T.k}{\pi d^3}$

Strain Energy : The strain energy is defined as the energy which is stored within a material when the work has been done on the material.

In the case of a spring the strain energy would be due to bending and the strain energy due to bending is given by the expansion

$$U = \frac{T^2L}{2EI}$$

$$L = \pi Dn$$

$$I = \frac{\pi d^4}{64}$$

so after substitution we get

$$U = \frac{32T^2Dn}{E.d^4}$$

The design analysis of concentric spring shown in is based on the following assumptions:

(i) The springs are made of the same material.

(ii) The maximum torsional shear stresses induced in outer and inner springs are equal.

(iii) They have the same free length.

(iv) Both springs are deflected by the same amount and therefore, have same solid length.

The following notations are used in the analysis:

d1 = wire diameter of outer spring

d2 = wire diameter of inner spring

D1 = mean coil diameter of outer spring

D2 = mean coil diameter of inner spring

P1 = axial force transmitted by outer spring

P2 = axial force transmitted by inner spring

P = total axial force

y1 = deflection of outer spring

y2 = deflection of inner spring

The adjacent coils of the concentric spring are wound in opposite directions to eliminate any tendency to bind.If the same material is used, the concentric springs are designed for the same stress. In order to get the same stress factor (K), it is desirable to have the same spring index (C).

3.1.1. PROPERTIES OF STEEL

1.Tensile Strength

Tensile strength is the amount of stress that a substance can take before becoming structurally deformed. The tensile strength of steel is comparatively high, making it highly resistant to fracture or breakage, which is a key point in its use in infrastructure building.

2.Ductility

One of the useful mechanical properties of steel, is its ability to change shape on the application of force to it, without resulting in a fracture. This property is known as ductility, which enables it to be used in the making of different shapes and structures ranging from thin wires or large automotive parts and panels.

3.Malleability

Malleability is closely linked with ductility, and allows steel to be deformed under compression. It allows this alloy to be compressed into sheets of variable thicknesses, often created by hammering or rolling.

4.Durability

The hardness of this alloy is high, reflecting its ability to resist strain. It is long-lasting and greatly resistant to external wear and tear. Hence it is considered a very durable material.

5.Conductivity

Steel is a good conductor of heat and electricity. These properties make it good choice for making domestic cookware, as well as electrical wiring.

6.Luster

One of the physical properties of steel is its attractive outer appearance. It is silvery in color with a shiny, lustrous outer surface.

7.Rust Resistance

The addition of certain elements, makes some types of steel resistant to rust. Stainless steel for instance contains nickel, molybdenum and chromium which improve its ability to resist rust.

In addition to the above, the following is an indicative properties chart, which illustrates the differences in the properties of different types of steel. Steel is identified by grades, which are defined by specific organizations that set standards for grading.

MATERIAL FOR SPRINGS

Spring steel is a name given to a wide range of steels[1] used in the manufacture of springs, prominently in automotive and industrial suspension applications. These steels are generally low-alloy manganese, medium-carbon steel or high-carbon steel with a very high yield strength. This allows objects made of spring steel to return to their original shape despite significant deflection or twisting.

3.1.2. ADVANTAGES OF STEEL

The advantages of steel over metals are:

- Steel can bear tons of loads for a longer period of time as compared to other metals.
- It has a relatively higher fatigue life in comparison to metals like iron, aluminium, etc.
- Stainless steel does not rust in contrast to iron.
- Similarly, rust resistant rebars [1] are better to be used in construction of houses, sky scrapers, etc.
- Steel has approximately same coefficient of thermal expansion like that of concrete, thus making it the most appropriate material to be used in construction.
- Steel is ductile yet strong enough to be used for construction purpose, a property most of the metals fail.

CHAPTER 4

DESIGN AND CALCULATION

4.1. CALCULATION OF DIMENSIONS OF SHOCK ABSORBER

Figure 4 represents the shock absorber

The spring used is of coaxial helical compression spring

By using the following assumptions and we had found the dimensions of shock absorber by measuring using a suitable device, therefore

MEAN COIL DIAMETER

Outer diameter D1=64mm

Inner diameter D2=48mm

WIRE DIAMETER

Outer wire diameter d1=8mm

Inner wire diameter d2=6mm

TOTAL NUMBER OF ACTIVE COILS

Outer coil n1=8

Inner coil n2=14

Rigidity modulus of steel=81370 N/mm^2 (from data table)

Table1

S.No.	Parameters	Internal dimensions	External Dimensions
1.	Mean coil Diameter	48 mm	64 mm
2.	Wire Diameter	6 mm	8 mm
3	Total number of coils	16	10

Table 1 represents the dimensions of the coaxial spring used

By using the following assumptions we have found that shear stress of the material always remain constant .

$$Ʈ_1=Ʈ_2$$

$Ʈ_1$- shear stress on the outer spring

$Ʈ_2$- shear stress on the inner spring

$$\frac{P_1 * D_1}{d_1^3}=\frac{P_2 * D_2}{d_2^3}$$

P_1- load acting on the outer spring

P_2- load acting on the inner spring

$$\frac{P_{1*}\,64}{8^3}=\frac{P_2 * 48}{6^3}$$

$$P_1=P_2(1.78)$$

Since the total load acting on both the spring

$$P=P_1+P_2$$

$$P=P_2*2.78 \qquad (1)$$

Since the load is applied by the pneumatic cylinder in our project let us the maximum pressure exerted by the cylinder be 10bar.

The dimensions of the pneumatic cylinder is given as

Diameter of the cylinder=32mm

Stroke length =100mm

Maximum Pressure exerted by the cylinder =10 bar

Force exerted by the pneumatic cylinder = $P_{max}*(\frac{\pi d^2}{4})$

Force exerted by the pneumatic cylinder =$10*10^5(\frac{\pi*0.032^2}{4})$

$$P= 804.24N$$

Therefore from equation (1) we have got

Total load $\qquad P=P_1+P_2$

$$804.24=2.78P_2$$

$$P_2=289.29N$$

And then by using the relation we get, $P_1=514.94N$

Spring Index, C = $\frac{D}{d}=\frac{64}{8}$ = 8

Shear stress on the outer spring is given by the formula

$$\tau_1=\frac{k_s*8*P_{max}*D}{3.14*d^3}$$

$$\tau_1=\frac{k_s*8*514.94*64}{3.14*8^3}$$

K = Wahl' s factor and is defined as $K = \frac{4c-1}{4c-4} + \frac{0.615}{c}$

$$K_s = \frac{4*8-1}{4*8-4} + \frac{0.615}{8}$$

K_s=1.184

Then shear stress $\tau_1 = \frac{1.184*8*514.94*64}{3.14*8^3}$=194.07 $N/_{mm^2}$

The above assumption denotes that

$\tau_1 = \tau_2$ =194.07 N/mm ^{2} (eq.2)

The deflection on the both the internal and external of the concentric springs are the same , therefore

$$y_1 = y_2$$

$$y_1 = \frac{8 * P_1 * D_1^3 * n_1}{G * d_1^4}$$

$$y_1 = \frac{8 * 514.94 * 64^3 * 8}{81370 * 8^4}$$

$$y_1 = 25.92mm = 2.5cm$$

Thus from the assumption made we have got the both the deflection at the external and internal spring are same so $y_1 = y_2$=2.5cm

Stiffness of the spring

External Stiffness $q_1 = \frac{G*d1}{8*C^3*n} = \frac{81370*8}{8*8^3*8}$=19.86 N/mm

Internal Stiffness $q_2 = \frac{G*d2}{8*C^3*n} = \frac{81370*6}{8*8^3*14}$=8.513 N/mm

For series of springs

$$\frac{1}{q} = \frac{1}{q_1} + \frac{1}{q_2}$$

$$\frac{1}{q} = \frac{1}{19.86} + \frac{1}{8.513}$$

Overall stiffness for the coaxial helical spring q= 5.95 N/mm

The experimental springs are assumed as squared and ground therefore

Solid length, L_s = (d*n)+(2*d)=(8*8)+(2*8)=80mm

To check whether the spring is safe or not, we must the check the shear stress

By using cast steel value from data book Pg.N0:1.40

Cast steel: Grade 1 we get, ultimate tensile strength(σ_u)=550 N/mm^2

From Data Book Pg.No:1.42, we get for carbon steel,

$$Shear\ stress\ \ \tau_0 = 2 * \tau_{-1}$$

Then endurance shear stress τ_{-1}= 1.0*(0.5*σ_u)= 1.0*(0.5*550)= 275 N/mm^2

Therefore from above relation shear stress $\tau_0 = 2 * 275$=550 N/mm^2

Then from hooke's law considering the yield stress (σ_u) factor of safety = 2

Then, factor of safety = $\frac{\text{ultimate shear stress}}{\text{working shear stress}} = \frac{550}{\tau} = 2$

Then working shear stress = 275 N/mm^2

Thus from the above equation (2) the calculated stress is less than the working stress ,[275 N/mm^2>194N/mm^2] **hence the concentric spring is safe.**

Spring Calculation when it is subjected to real case scenario:-

Let us assume the obstruction is car with a certain velocity

Mass of the car = 1500kg ;

Low speed = 5 km/hr   Velocity = 1.38m/s

Kinetic Energy = ½ mv_{car}^2 = ½ *1500*1.38^2

m = mass; v = Velocity

K.E = 1428.3 N.m

Strain energy of the spring =kinetic energy of the car

Strain Energy of spring = (½ P$*\ \delta$), P = load; δ = Deflection.
(singleshockAbsorber)

Equating the kinetic energy and strain energy , we get

$$1428.3*10^3=\frac{1}{2}*P*\delta$$

Since we know stiffness q=$\frac{load\ (P)}{deflection(\delta)}$

$$\delta = \frac{load\ P}{stiffness\ q}$$

Strain energy=$\frac{1}{2}*P^2\ *\frac{1}{q}$

Kinetic energy =strain energy=$\frac{1}{2}*P^2*\frac{1}{5.95}=1428.3*10^3$

P=4122.69 N

Thus for the load acting on the two springs $P=P_1+P_2$

From the above relation (1.)

$2.78P_2 = P = 4122.69$

Then P_2=1482.98N

Thus from the relation we get P_1=2639.7 N

Therefore shear stress $\tau_1=\pi*\frac{d1^2}{4}*P_1=\frac{2639.7}{(\pi*8^2/4)}$=52.51 N/mm^2 < 275N/mm^2(steel)

Similarly the induced shear stress will be less than the shear strength of the steel material

Steel wire Ultimate Tensile Strength (Sut) = 1250 N/mm2 (High Tensile cast steel) Data book

Modulus of Rigidity (G) = 80000 N/mm^2 (0.79*10^5-0.85*10^5) steel.

Table 2

S.No	Materials	Density(kg/m^3)	Modulus of Elasticity	Modulus of Rigidity	Poisson's ratio
1.	Aluminium	2710	0.675*10^5	0.260*10^5	0.34
2.	Steel	7850	2*10^5	0.83*10^5	0.33

Table 2 represents the properties of the spring used

4.2 Design Calculation of cylindrical guard:

Material used: STEEL

- Dimensions

  Length of the rod=80cm

  Diameter of the guard=3.5cm

Design of the guard when subjected to impact loading:

Mass of the car = 1500kg ;

Low speed = 5 km/hr Velocity = 1.38m/s

(let us consider it as rate of change of velocity per unit time)

Shear stress on the material $=\tau= \frac{P}{\pi * \frac{d^2}{4}} = \frac{1500*1.38}{(\pi*35^2/4)}$ = 2.15 N/mm^2 < shear strength

Hence design is safe.

Maximum load which can withstand will be when $\tau = 550\ N/mm^2$

Then ,550 N/mm^2 $= \frac{P}{962.112}$

Therefore maximum load it can withstand will be P=529,161.6 N

4.3 Design of BOLT:

Material Used: Carbon Steel

Diameter of the bolt=12mm

Double shear will take place when the bolt is subjected the loading

Shear stress on the material $=\tau= \frac{P}{\pi * \frac{d^2}{4}} = \frac{1500*1.38}{\left(\pi*\frac{12^2}{4}\right)*2}$ =9.151 N/mm^2

Thus 9.151 N/mm^2 < shear strength of carbon steel

Therefore Design is safe

CHAPTER-5

FABRICATION

5.1. DRILLING

Drilling is the process of cutting holes in metals by using a drilling machine. Drills are the tools used to cut away fine shavings of material as the drill advances in a rotational motion through the material.

A drill bit is a multi-point tool and typically has a pointed end. A twist drill is the most common type used. The twist drill or drill bit is made from High Speed Steel, tempered to give maximum hardness throughout the parallel cutting portion. Flutes are incorporated to carry away the chips of metal and the outside surface is relieved to produce a cutting edge along the leading side of each flute.

Twist drills are available with parallel shanks up to 16mm diameter and with taper shanks up to 100mm diameter and are made from high-speed steel. Standard lengths are known as jobber-series twist drills, short drills are known as stub series, and long drills as long series and extra long series. Different helix angles are available for drilling a range of materials.

Drilling is a cutting process that uses a drill bit to cut a hole of circular cross-section in solid materials. The drill bit is usually a rotary cutting tool, often multi-point. The bit is pressed against the work-piece and rotated at rates from hundreds to thousands of revolutions per minute. This forces the cutting edge against the work-piece, cutting off chips (swarf) from the hole as it is drilled.

In our project, drill is done in the guard with diameter=**12cm.**

Fig.5 Drilling

CHAPTER-6

CONSTRUCTION

- Initially the solid metal rear bumper is taken.
- Drill is held in the middle of the metal rear bumper
- Shock absorber of suitable design is chosen and it is tightened with bolt, nut and washer.
- And the other end of the shock absorber is also bolted to the frame.

WORKING

- Single absorbers are located between the rear cross member and the rear bumper reinforcement. During a rear end impact, the energy absorbers shorten, just like a shock absorber. Following the impact, if the impact is not beyond the designed limits of the energy absorbers, they return to their original length. This action of forces hydraulic fluid to flow around the metering pin and through the orifices in the end of the piston tube. As the piston tube continues to move the flow of hydraulic fluid into the piston tube pushes the floating piston to the left. This compresses the oil in the piston tube; automotive bumper plays a very important role in absorbing impact energy for original purpose of safety and styling stand point/aesthetic purpose. Now days, automotive industry concentrates on optimization of weight and safety

CHAPTER-7

MERITS OF IMPACT ABSORBER

7.1. ADVANTAGES OF IMPACT ABSORBER

- By providing better suspension , the frictional contact between the tyres and the road surface increases those providing a better traction, acceleration and braking of the vehicle.

- Increases the stability of the vehicle and provide better steering and driver control and prevent accidents

- Provide jerk-less movement and ensure better safety to the vehicle and to the passengers.

7.2. APPLICATIONS OF IMPACT ABSORBER

Vehicle collisions are occurred in different possible modes. It may be head-on collision, rear end collision, and side collision and roll overs. Of these modes, head-on collision is mostly occurred one and causes severe damage to both vehicle and passengers. We cannot totally avoid these types of vehicle collisions. Instead of preventing these accidents which is not possible, collision effects can be reduced by providing Bumpers in the rear side of vehicles. Thus in this project, effects of collision is much reduced by implementing the several units of Hydraulic Shock Absorber with spring in bumper of vehicles. The spring due to designed with stand 5 km/hr and remaining fluid action. Thus the development of smart materials will be an essential task in many fields such as energy, transportation, safety engineering and military technologies.

CHAPTER-8

COST ESTIMATION

Table 3 Cost estimation report

MATERIALS	COST
Metal bumper	Rs.8000
Shock absorber	Rs.1000
Bolt and nut	Rs.50
Washer	Rs.50
TOTAL	Rs.9100

CHAPTER 9

3D VIEW OF SHOCK ABSORBER

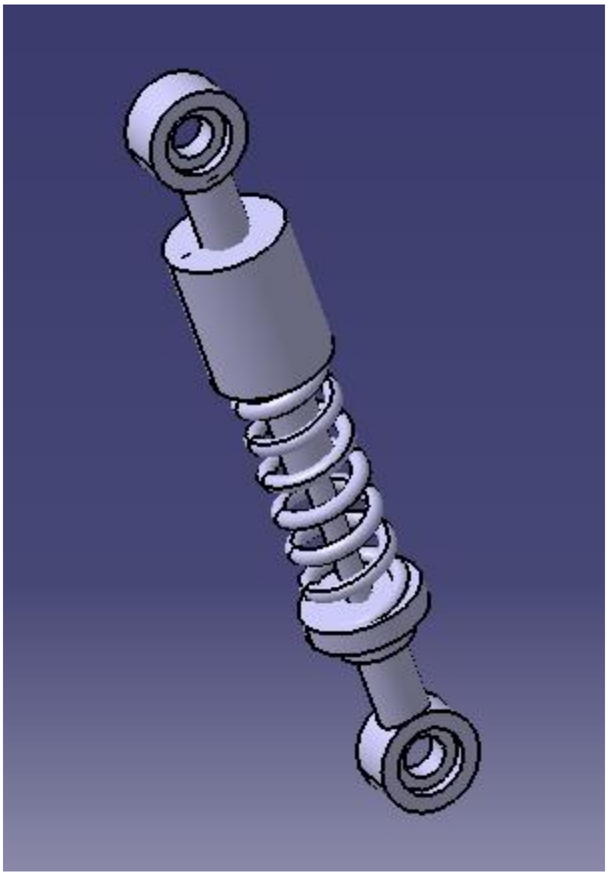

Figure 6 represents the 3D model of shock absorber

FOR FUTURE ADVANCEMENT, usage of double shock absorber

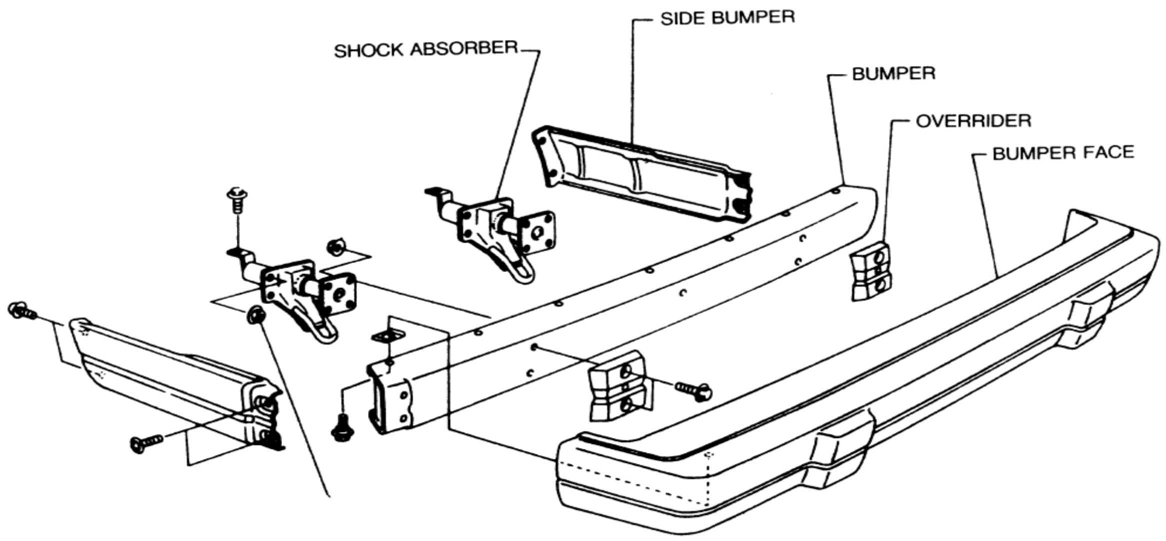

Figure7 represents the dual shock absorber for more effective use

CHAPTER-10

CONCLUSION

The result shows that the objective of this work is fulfilled by reducing the transfer of impact energy through energy absorbing bumper under collision. It also reduced the deformation of beam as well. So, it is conclude that energy absorber not only reduce the transfer of impact force but also promises the reduction in damage cost, in case of collision of a vehicle

CHAPTER-11

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