DESIGN AND FABRICATION OF PNEUMATIC SUSPENSION SYSTEM

A PROJECT REPORT

Submitted by

SHOBAN.C.D	**211715114117**
SHYAM SUNDAR.U	**211715114118**
SIVACHANDRAN.B	**211715114119**

in partial fulfillment for the award of the degree

of

BACHELOR OF ENGINEERING

IN

MECHANICAL ENGINEERING

RAJALAKSHMI INSTITUTE OF TECHNOLOGY

ANNA UNIVERSITY: CHENNAI 600 025

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BONAFIDE CERTIFICATE

Certified that this project report **"DESIGN AND FABRICATION OF PNEUMATIC SUSPENSION SYSTEM"** is the bonafide work of "**SHOBAN.C.D (211715114117), SHYAM SUNDAR.U (211715114118), SIVACHANDRAN.B (211715114119)"** who carried out the project work under my supervision.

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

We express our gratitude towards our chairperson **Dr.(Mrs.)Thangam Meganathan,** our chairman **Mr.S.Meganathan, B.E., F.I.E.**, Director Dr.M.Haree Shankar Meganathan, and our beloved principal **Dr.M.Velan,** who have constantly encouraged us in all aspects and chiseling us as a successful engineer.

We express our heartfelt thanks to **Dr.S.Dinesh Kumar,M.E,MBA,Ph.D, Professor and Head, Department Mechanical Engineering** for giving valuable guidance, constant support and encouragement to complete our project successfully.

We express our heartfelt thanks to **Prof.P.S.Rajeswaran, Dean (Academics) and Dr.S.Selvaraju, Dean, Mechanical Engineering** for providing us valuable inputs and guidance to complete our project successfully. We are highly indebted to our project Supervisor **Mr.N.Lingaraj, M.E , Assistant Professor, Department of Mechanical Engineering** for his valuable guidance and suggestion in every stage four project and to make our project a successful one.

Our sincere thanks to our project coordinators**, Mr.C.Murugan, Mr.R.Franklin Merlin, Dr.S.K.Rajesh Kanna, Department of Mechanical Engineering** for his valuable suggestions and modifications in our project.

We would like to appreciate the guidance given by the other supervisors as well as the panel members especially in our project presentation that has improved our presentation skills by their comment and tips.

Last but not the least, we express our gratitude towards **Anna University, Chennai** for the opportunity.

Also we thank **our beloved parents** for their valuable contribution and guidance towards the success of our project.

ABSTRACT

The objective of this work is to design and fabricate pneumatic suspension system. Pneumatic suspension is a type of automobile suspension that runs by a pneumatic compressor. The purpose of pneumatic suspension is to provide a smooth and constant ride quality. In this system I will pump the air into a flexible bellows made from reinforced rubber with compressor. This pneumatic pressure inflates the bellows, and raises the chassis from the axle. It carries the load on each axle with a pressurized pneumatic bag. Thus I will provide the smoothest and most shock-free ride of any known vehicle suspension system. The pneumatic bags will be constructed by using a tire and high strength cords which will be encapsulate in rubber. The system adjusts pneumatic pressure in the pneumatic bag so that the trailer always rides at the same height, whether it may be lightly loaded or heavily loaded. Each axle is independently supported by its own pneumatic bag, this suspension is an independent suspension system. Trailer suspension increases pneumatic pressure if the ride height is too low, by turning on pneumatic compressor. If the ride height is very high, the vent valve vents excess pneumatic pressure. The advantages of using pneumatic suspension is as it will increase the driving comfort, reduces wind resistance effectively, it is specially designed to moderate shock and minimize vibration, it offers better road handling and stability of the truck and trailer.

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LIST OF SYMBOLS

	SYMBOL	DESCRIPTION
1.	K	Vertical spring rate in lbs/inch
2.	P_g	Gauge pressure at design height (lbs/in^2)
3.	A_c	Effective area at inch below design height (in^2)
4.	A_e	Effective area at inch above design height (in^2)
5.	V_1	Internal volume at design height (in^3)
6.	V_c	Internal volume at inch below design height (in^3)
7.	V_e	Internal volume at inch above design height (in^3)
8.	C	Spring index
9.	τ	Helical coil spring rate in N/mm^2
10.	δ	Defection in spring length in mm

CHAPTER 1

INTRODUCTION

Suspension system is the major part in an automobile to maintain ride quality and comfort. Suspension system used now is a helical coil spring type suspension which does not provide a good ride quality and comfort to the passengers. The spring is the flexible component of the suspension. Basic types are leaf springs, coil springs. Modern passenger vehicles usually use light coil springs. Light commercial vehicles have heavier springs than passenger vehicles, and can have coil springs at the front and leaf springs at the rear. Heavy commercial vehicles usually use leaf springs. The air bags are sometimes referred to as air springs or bellows. Suspensions that have steel or torsion springs that are supplemented by the use of air bags are not considered air suspensions. There are combination systems that have both air and steel springs. So to avoid these difficulties from the helical type of suspension, pneumatic suspension system is designed to provide better ride quality and comfort. Pneumatic suspension uses rubber type of material for bellows that is completely closed and filled by compressed air from the compressor to the bellows of particular pressure. This compressed air can withstand the load of the passengers and other load and provides a good comfort. This suspension system will provide better ride quality, comfort and better suspension when compared with the conventional systems. An air suspension supports the vehicle on the axles with an arrangement of air bags instead of some type of steel spring, leaf or coil, or some type of torsion spring arrangement. The air bags are sometimes referred to as air springs or bellows. Suspensions that have steel or torsion springs that are supplemented by the use of air bags are not considered air suspensions. There are combination systems that have both air and steel springs. Usually the air suspension components are used on the rear of the vehicle.

1.1 AIR BELLOWS

Air-bellows act as an active component and semi-active shock absorber, by applying a pneumatic Vibroisolation for the model. Air spring, load-carrying component of an air suspension system used on machines, automobiles, and buses. A system used on buses consists of an air compressor, an air-supply tank, levelling valves, check valves, bellows, and connecting piping. Basically, an air-spring bellows is a column of air confined within a rubber and fabric container that looks like an automobile tire or two or three tires stacked on top of one another. The check valves admit additional air to the bellows from the air-supply tank to maintain vehicle height when the load is increased, and the levelling valves vent excess air from the bellows when the vehicle rises because of unloading. The vehicle thus remains at a fixed height regardless of load.

1.2 WORKING OF AUTOMOBILE SUSPENSION SYSTEM

The job of a car suspension is to maximize the friction between the tires and the road surface, to provide steering stability with good handling and to ensure the comfort of the passengers. If a road were perfectly flat, with no irregularities, suspensions wouldn't be necessary. But roads are far from flat. Even freshly paved highways have some imperfections that can interact with the wheels of a car. It's these imperfections that apply forces to the wheels. A bump in the road causes the wheel to move up and down perpendicular to the road surface. The magnitude, of course, depends on whether the wheel is striking a giant bump or a small. Either way, the car wheel experiences a vertical acceleration as it passes over an imperfection. Without an intervening structure, all of wheel's vertical energy is transferred to the frame, which moves in the same direction. In such a situation, the wheels can lose contact with the road completely. What you need is a system that will absorb the energy of the vertically accelerated wheel, allowing the frame and body to ride undisturbed while the wheels follow bumps in the road.

1.3 TYPES OF SUSPENSION SYSTEMS

A basic suspension system consists of springs, axles, shock absorbers, arms, rods, and ball joints. The spring is the flexible component of the suspension. Basic types are leaf springs, coil springs, and torsion bars. Modern passenger vehicles usually use light coil springs. Light commercial vehicles have heavier springs than passenger vehicles, and can have coil springs at the front and leaf springs at the rear. Heavy commercial vehicles usually use leaf springs, or air suspension. There are eight different types of suspension system in use.

1.3.1 Leaf springs

Semi elliptic leaf springs are used in almost all commercial vehicles. It is also used in cars for rear suspension. This spring consist of a number of leaves called blades. The blades vary in length and connected together as shown in the figure. These springs based on the theory of beam of uniform strength. This spring is mounted on the axle by the U bolt. The one end of spring is mounted on the frame and other is connected with a shackle which allows to change in length between eye of spring when the vehicle come across projection of road and upward movement of wheel.

1.3.2 Helical coil springs

We all have seen coil springs many times. The helical spring used is suspension system is same as we see. It is mainly used in the independent suspension. It is also used in the conventional rigid axle suspension as they can be well accommodated in restricted spaces. The energy stored per unit volume is almost double in the case of coil spring than the leaf springs. These spring do not have noise problems but they does not take torque reaction and side thrust for which alternative arrangement have to be provided.

1.3.3 Torsion bars

It is simply a rod which acting under the torsion and taking shear stresses. It is often used with independent suspension. One end of the bar is fixed to the frame and the other end is fixed to the end of the wheel arm and supported in the bearing. The other end of the wheel arm is connected to the wheel hub. When the wheel strikes a bump, it start vibrating up and down, thus torque on the torsion bar start acting as a springs.

1.3.4 Rubber springs

The rubber springs are also used in suspension because it store greater energy per unit weight than the steel. So it is more compact than other springs. It has also excellent vibration damping property. One more advantage of using rubber is that it is not suddenly fail like steel so there is less risk.

1.4 PROJECT BACKGROUND

1.4.1 Ride Comfort

Ride comfort is term as one of suspension characteristics. It task is to provide passenger comfort in the vehicle or in other words, it is inversely proportional with body acceleration.

1.4.2 Vehicle Handling

Vehicle handling is another suspension term to increase vehicle stability or road handling the effective character to improve vehicle handling is damping number. In a passive suspension, high handling will come off with increasing damping number.

1.5 PASSIVE SUSPENSION

In passive suspension, characters of comfort and handling are in a differential relation. That means a suspension with a week damper has high comfort performance and low body acceleration. In other hand, a suspension with a high damping has high stability and handling. However, it doesn't allow a free rapid motion in the wheel and this cause more acceleration in the body part, which reduces the term of ride comfort. Even a good design for a passive suspension cannot give both performances at the same time, but also it can only optimize one set of the driving conditions by driver selection. Fig 1.1 shows the comfort vs damping graph.

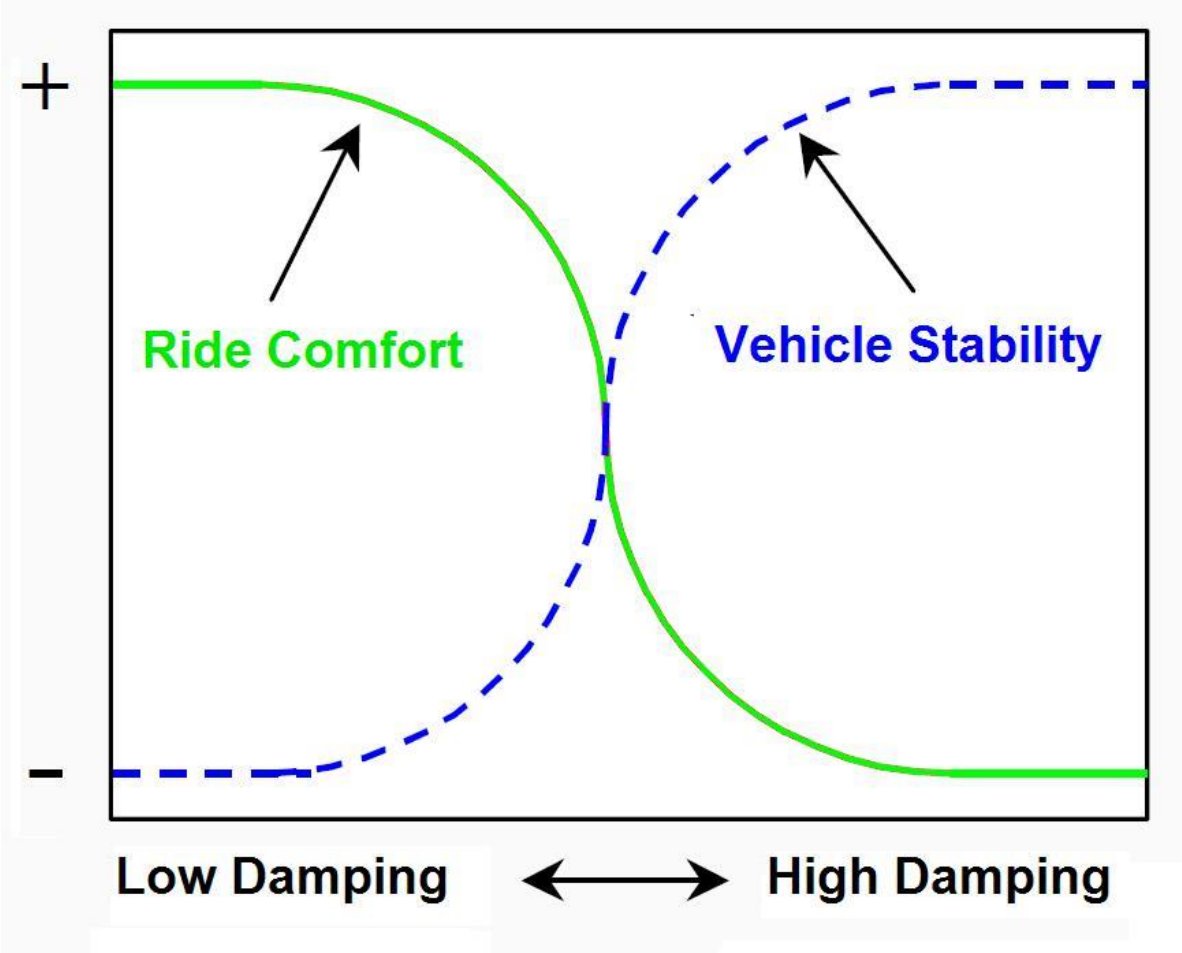

Figure 1.1 Comfort vs damping graph

1.6 ACTIVE SUSPENSION

1.6.1 Semi active suspension

A good example for adaptive suspension which regulates damping number is a semi-active suspension system with adjustable shock absorber and Continuously Controlled Electronic Suspension (CES). Where the damping coefficients for each wheel are continuously adjusted in real time to ensure that the best compromise between comfort and stability is always achieved. Fig 1.2 shows the spring travel vs. time graph.

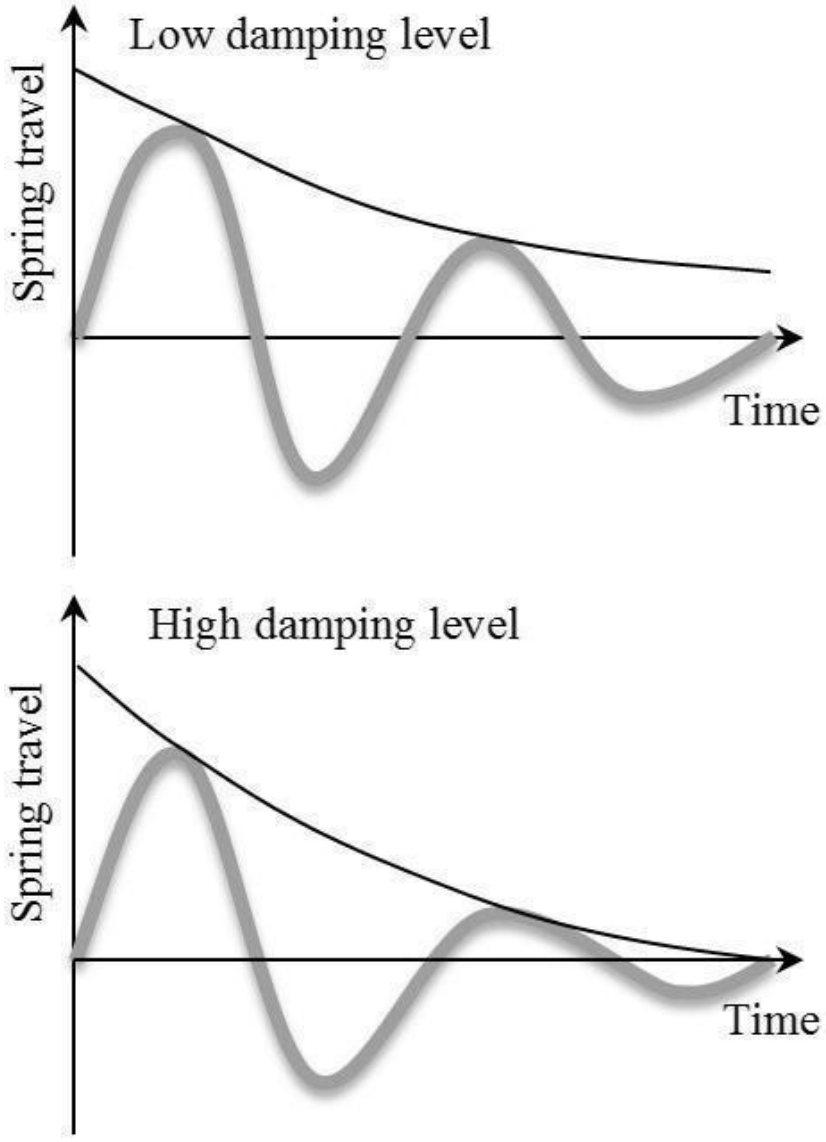

Figure 1.2 Spring travel vs time graph

1.6.2 Fully active suspension

The main difference in active suspension is its capability to inject force to the system. This force is generated by force actuators and it placed directly between wheel and body. In performing a control for an active suspension system, the time force function F (t) applies on the suspension system.

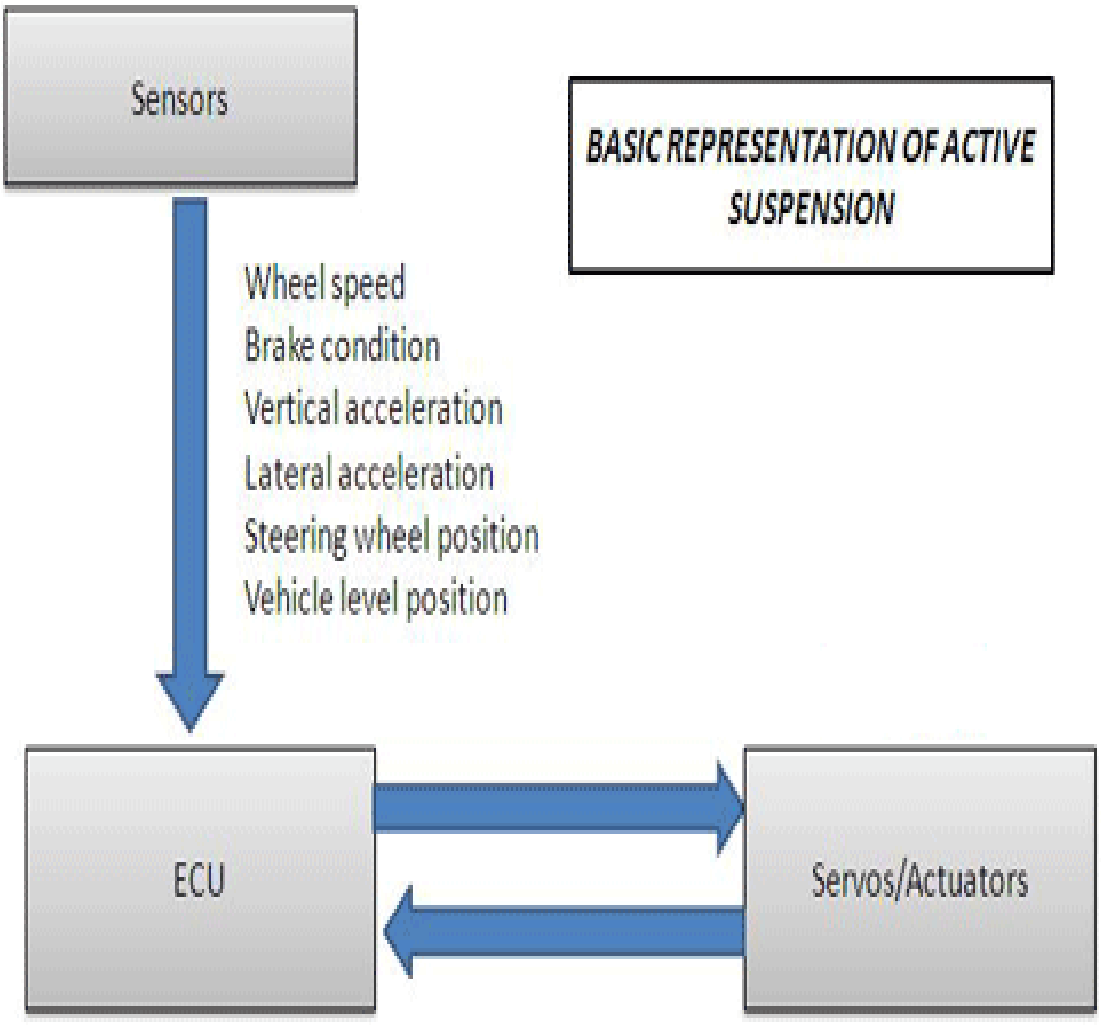

Figure 1.3 Representation of an active air-suspension system

1.7 PNEUMATIC VIBROISOLATION

Pneumatic Vibroisolation is term of pneumatic control with the aim of ground vibration isolation. The main idea in this vibration control method is using a pneumatic chamber such as air spring, and vibration isolation can be done by pressure variation inside air-spring chamber. In this approach the controller is adjusting the air pressure with the aim of reducing acceleration in sprung mass. These pressure variations are applying by an air-valve, which is controlling the air flow inside the chamber.

1.7.1 Coil spring shock absorber

Coil spring shock absorbers are used nowadays in most of the commercial two wheelers. This type of shock absorber consists of spring steel helical coil and piston with hydraulic type. It is generally made by open coil helical spring for compression purpose. Hence it is known as compression coil spring suspension.

Figure 1.4 Coil spring shock absorber

1.8 AIR SUSPENSION BELLOWS

Depending on the levelling valve's control, the air suspension bellows are designed to take up the required pressure in the bellows' volume, depending on the load carried on the vehicle. Air suspension bellows are used as elastic constructional elements between the axle and the vehicle's superstructure. Since its internal friction is less than that of mechanical suspension systems, the air sprung vehicle has to have shock-absorbers fitted. The types of bellows are:

1.8.1 Rolling lobe air spring

Rolling lobe air springs incorporate a piston which allows the flexible member to roll along the piston's surface.

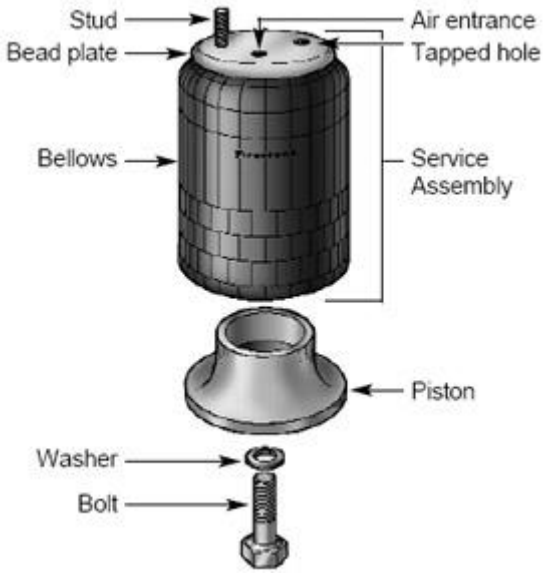

Figure 1.5 Rolling lobe air spring

1.8.2 Sleeve type rolling lobe

Sleeve type rolling lobe air springs employ a flexible member without an internally molded bead. The flexible member is attached to the end retainers pinching the material between the end retainers and exterior crimp rings which are then swaged to the proper diameter.

Figure 1.6 Sleeve type rolling lobe

1.8.3 Bellows type air spring

Bellows air springs have one, two or three convolutions in the flexible member. There are two styles of bellows; crimped design and sleeve type. With the crimped design, the end retainers are permanently attached by mechanically crimping the retainer around the built-in bead wire of the flexible member.

Figure 1.7 Bellows type air spring

1.8.4 Sleeve type bellows

Sleeve type bellows offer similar characteristics to the crimped design bellows, but, as with the sleeve type rolling lobe the flexible member is constructed without internally moulded bead wires. The end retainers are permanently attached by pinching the flexible member between the end retainers and external crimp rings which are then swaged to the proper diameter. Sleeve type bellows offer the lowest force to compress of any type of air spring.

Figure 1.8 Sleeve type bellows

1.8.5 Types of convoluted bellows

The three types of convoluted bellows are,

i) Single convoluted bellows

ii) Double convoluted bellows

iii) Triple convoluted bellows

1.9 PROS AND CONS OF AIR SUSPENSION SYSTEM

1.9.1 Advantages

Air adjustable**:** A little obvious, but this is the major plus that a non-air kit can never overcome, the ability to adjust your truck to the desired ride height. Hook up your trailer, truck sags a few inches, no problem.
Inflate the air springs until your truck is level. Done towing and just using the truck for the daily commute? Simply remove the air pressure until air springs are at the minimum required air pressure, and you're good to go.

Level Side-to-Side: Have a motor home with a tank full of water on one side, or a pickup with a slide in camper and your leaning to one side? With air springs, you have the option of running a "T" fitting and inflating both the air springs equally, or running the air lines separately to each bag which allows you to increase the pressure on one side over the other. This allows you to level out the side with the water tank, etc.

1.9.2 Disadvantages

Using air to level your truck is a major plus, and the advantages do outweigh the disadvantages, but air does require more attention and opens the door for cons that a non-air load levelling kit will never experience. When dealing with air, you have the potential to run into leaks, damaged air line, holes in air springs etc. These problems can all be easily repaired, and are not very common in the big picture, but they do happen. If you're planning on extensive travel, it's never a bad idea to have a spare air spring and some air line. Replacement air springs and air line are readily available and not very expensive.

1.10 RISK ASSESSMENT

Of concern with this new suspension was the vehicle response with operational and worn out shock absorbers, and the response to an airbag failure. Tests of simulated airbag failures were undertaken at speed around a roundabout and at 100 km/h in straight ahead travel. These showed that the vehicle dropped uniformly onto the bump stops and that there was no unusual or difficult to control vehicle behavior. This is because the loss of air on the burst airbag side is so rapid that, as the airbags on the other side cannot then support the load they collapse almost as rapidly. Similarly the removal of shock absorbers created no problems. Around 10% of damping comes from the suspension bushes and the tyres, and 7% from internal damping. So the balance of the required 20% damping for road friendly air suspensions from the shock absorbers is only 3% so there is little effect on performance. And this low requirement for damping from shock absorbers means that light single acting shock absorbers can be used for these suspensions.

1.11 COMMON AIR SUSPENSION PROBLEMS

1.11.1 Air bag or air strut failure

It is usually caused by wet rust, due to old age, or moisture within the air system that damages it from the inside. Air ride suspension parts may fail because rubber dries out. Punctures to the air bag may be caused from debris on the road. With custom applications, improper installation may cause the air bags to rub against the vehicle's frame or other surrounding parts, damaging it. The over-extension of an air spring which is not sufficiently constrained by other suspension components, such as a shock absorber, may also lead to the premature failure of an air spring through the tearing of the flexible layers.

Failure of an air spring may also result in complete immobilization of the vehicle, since the vehicle will rub against the ground or be too high to move. However, most modern automotive systems have overcome many of these problems.

1.11.2 Air line failure

It is a failure of the tubing which connects the air bags or struts to the rest of the air system, and is typically DOT-approved nylon air brake line. This usually occurs when the air lines, which must be routed to the air bags through the chassis of the vehicle, rub against a sharp edge of a chassis member or a moving suspension component, causing a hole to form. This mode of failure will typically take some time to occur after the initial installation of the system, as the integrity of a section of air line is compromised to the point of failure due to the rubbing and resultant abrasion of the material. An air-line failure may also occur if a piece of road debris hits an air line and punctures or tears it, although this is unlikely to occur in normal road use. It does occur in harsh off-road conditions but it still not common if correctly installed.

1.11.3 Air fitting failure

It usually occurs when they are first fitted or very rarely in use. Cheap low quality components tend to be very unreliable. Air fittings are used to connect components such as bags, valves, and solenoids to the airline that transfers the air. They are screwed into the component and for the most part push-in or push-to-fit DOT line is then inserted into the fitting.

1.11.4 Compressor failure

It is primarily due to leaking air springs or air struts. The compressor will burn out trying to maintain the correct air pressure in a leaking air system. Compressor burnout may also be caused by moisture from within the air system coming into contact with its electronic parts.

This is far more likely to occur with low specification compressors with insufficient duty cycle which are often purchased due to low cost. For redundancy in the system two compressors are often better options.

1.11.5 Dryer failure

The dryer, which functions to remove moisture from the air system, eventually, becomes saturated and unable to perform that function. This causes moisture to build up in the system and can result in damaged air springs and or a burned out compressor.

Figure 1.9 Air strut failure

CHAPTER 2

LITERATURE REVIEW

"MONO AIR SUSPENSION FABRICATION IN TWO WHEELERS" by **Pranav Badole**

In this paper it describes the usage of bellow tube air suspension will provide better ride quality and solace to the riders and the passengers. In this project, mounting of on-board compressor and off-board compressor to the mudguard of the rear wheel. By using off-board compressor, inflation of bellow tube is done. Another valve is used for pressure relief during compression. This will increase the solace for the riders.

"DESIGN AND ANALYSIS OF A SHOCK ABSORBER" by **Poorna Mohan**

In this journal she designed a 150cc bike shock absorber in pro-E and made structural and modal analysis in ANSYS for two different spring material spring steel and beryllium copper. By analysing the result beryllium copper is better than the spring steel.

"ANALYSIS OF SHOCK ABSORBER USING DIFFERENT MATERIAL OF SPRING" by ***G. R.*** **Chavhan**.

In this paper it describes the usage of different spring material like carbon fiber, beryllium copper and steel spring in the shock absorber to calculate the better spring material for the vehicle. They made an analysis of deflection and stress in CATIA and verified that carbon fiber (5.6mm&2.7GPa) is better than beryllium copper (4.2mm&2.9GPa) and steel spring (2.3mm&3GPa).

“MAGNETIC SUSPENSION SYSTEM FOR TWO WHEELER” by **Shende Vignesh**

It explains by using electromagnets as passive dampers to reduce displacement of sprung mass in order to increase ride comfort. It can absorb more shocks and vibrations to increase accuracy. It is done by two magnets of same pole facing each other when they come into contact the repulsion force makes the magnet to separate by repulsive force. Since it is using magnets there is no leakage of oil like hydraulic suspension and making it maintenance free. Since the magnet power can be rechargeable it can be used for longer duration. We came to conclusion of not using magnet for effective cost.

“ANALYSIS OF SEMI-ACTIVE SUSPENSION SYSTEM WITH BINGHAM MODEL SUBJECTED TO RANDOM ROAD EXCITATION USING MATLAB/SIMULINK” by **Mr. Amit A.Hingane**

In this journal it describes the analysis result of semi-active suspension system with Bingham model for MR model. The ride and handling performance of a specific vehicle with semi-active suspension system is compared with passive suspension system. The simulation results shows that semi-active suspension system with Bingham model gives lower value of maximum sprung mass acceleration for given random road excitation. Hence suspension model with semi-active suspension provides good passenger comfort and vehicle stability than passive suspension system.

CHAPTER 3

METHODOLOGY

3.1 Identification of problems

Suspension system is the major part in an automobile to maintain ride quality and comfort. Suspension system nowadays uses helical coil spring type suspension which doesn't provide a good ride quality and comfort to the passengers. Hence to come up with the vibration problems we desired to install pneumatic bellows which is made of rubber for better damping and more comfort.

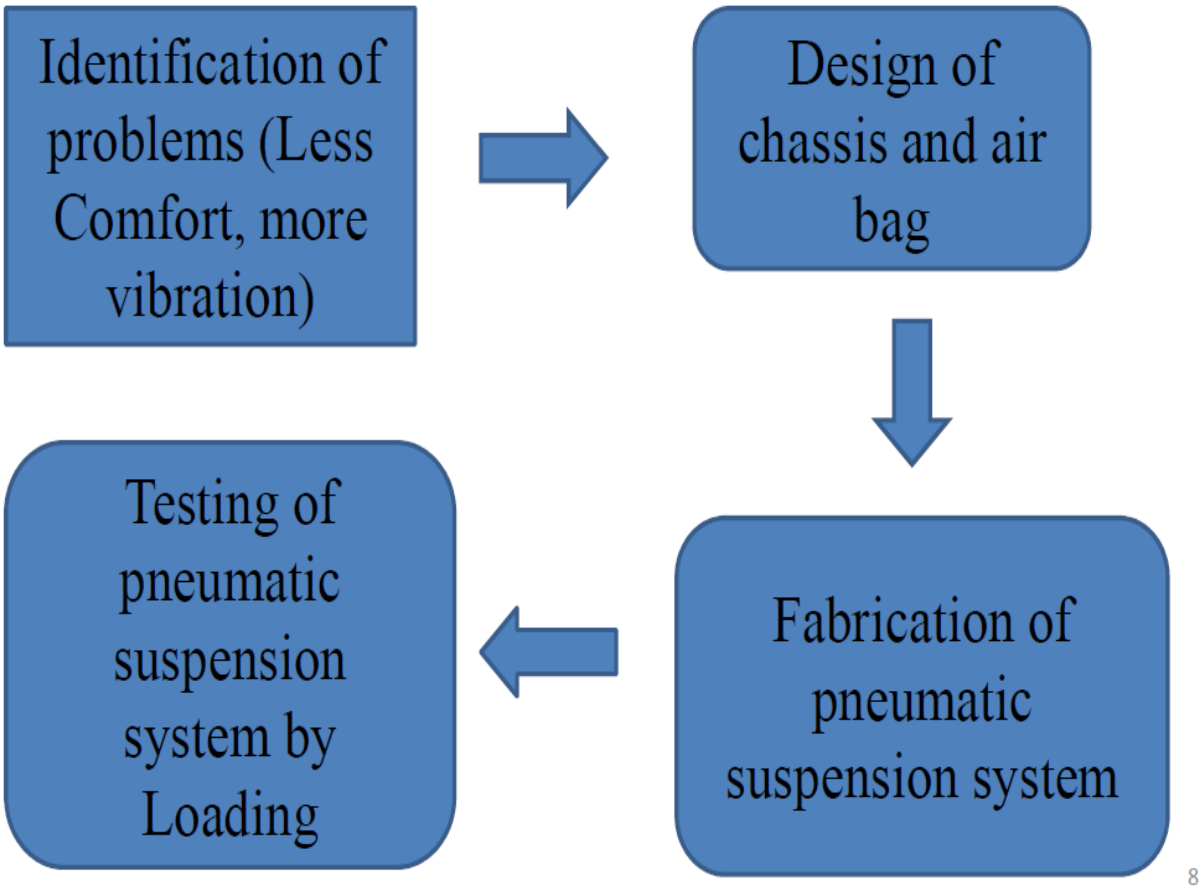

Figure 3.1 Flow chart

CHAPTER 4

DESIGN CALCULATIONS

I. Design calculations for helical coil spring suspension

Type of spring used: Helical Coil Spring with squared and ground ends

Material selected: Steel

Table 4.1 Helical coil properties&dimensions

PROPERTIES	VALUES
Young's modulus	$E=2x10^5 N/mm^2$
Modulus of Elasticity	$G=0.8\times10^5$ N/mm^2
Wire Diameter	d=7mm
Outer Diameter	D_0=45mm
Inner Diameter	D_i=31mm
Mean Diameter	D=38mm
Pitch of the Coil	p=20mm
Number of turns	n=13
Spring Index	C=5.5
Helix angle	$a=22^0$
Weight of the automobile	w_1=50Kg
Load	w_2=20Kg

Total weight, W=(50+20)= 70Kg

Rear Suspension will have 70% of total weight, W=0.70×70=49kg

For the dynamic load, assume the load will be doubled

W=49×2=98kg

P=98×10=980N

For single coil suspension,

P=490N

Compression of spring, $\delta = (8PD^3/d^4\cos a)*((2\sin^2 a/E)+(\cos^2 a/G))$

$\delta=(8x490x38^3/7^4\cos 22)*((2\sin^2 22/2x10^5)+(\cos^2 22/0.8x10^5))$

δ=15.26mm

Solid Length, $L_s=d_n+2d=(7x13)+(2x7)$

L_s=105mm

Free Length, $L_f=pn+2d=20\times13+2\times7$

L_f=274mm

Spring rate, $K=P/\delta$

K=490/15.26

K=32.109 N/mm

II. Design calculations for air bellow

Material: Butyl rubber

Dynamic Spring Rate(psi/inch),

$K=\{(P_g+14.7)[A_c(V_1^{1.38}/V_c^{1.38})-A_e(V_1^{1.38}/V_e^{1.38})]-14.7(A_c-A_e)\}$

Where,

K=Vertical spring rate in lbs/inch

P_g=Gauge pressure at design height (lbs/in^2)

A_c=Effective area at inch below design height (in^2)

A_e=Effective area at inch above design height (in^2)

V_1=Internal volume at design height (in^3)

V_c=Internal volume at inch below design height (in^3)

V_e=Internal volume at inch above design height (in^3)

P_g=40 psi A_c=38.2 in^2

A_e=13.6 in^2 V_1=151.5 in^3

V_c=94.9 in^3 V_e=176.7 in^3

$$K=\{(40+14.7)[38.2(151.5^{1.38}/94.9^{1.38})-13.6(151.5^{1.38}/176.7^{1.38})]-14.7(38.2-13.6)\}$$

K=3021.12 lbs/inch

K=529.1 N/mm

CHAPTER 5

DESIGN IN 2D&3D

5.1 Design of air bellow and chassis

Air bellow is designed specifically to fit with the chassis as a model in SOLIDWOKS software. AutoCAD software is used to design and overview the desired model. These are one of the top modelling software widely used in the industries. SolidWorks is a solid modeler, and utilizes a parametric feature-based approach which was initially developed by PTC to create models and assemblies.

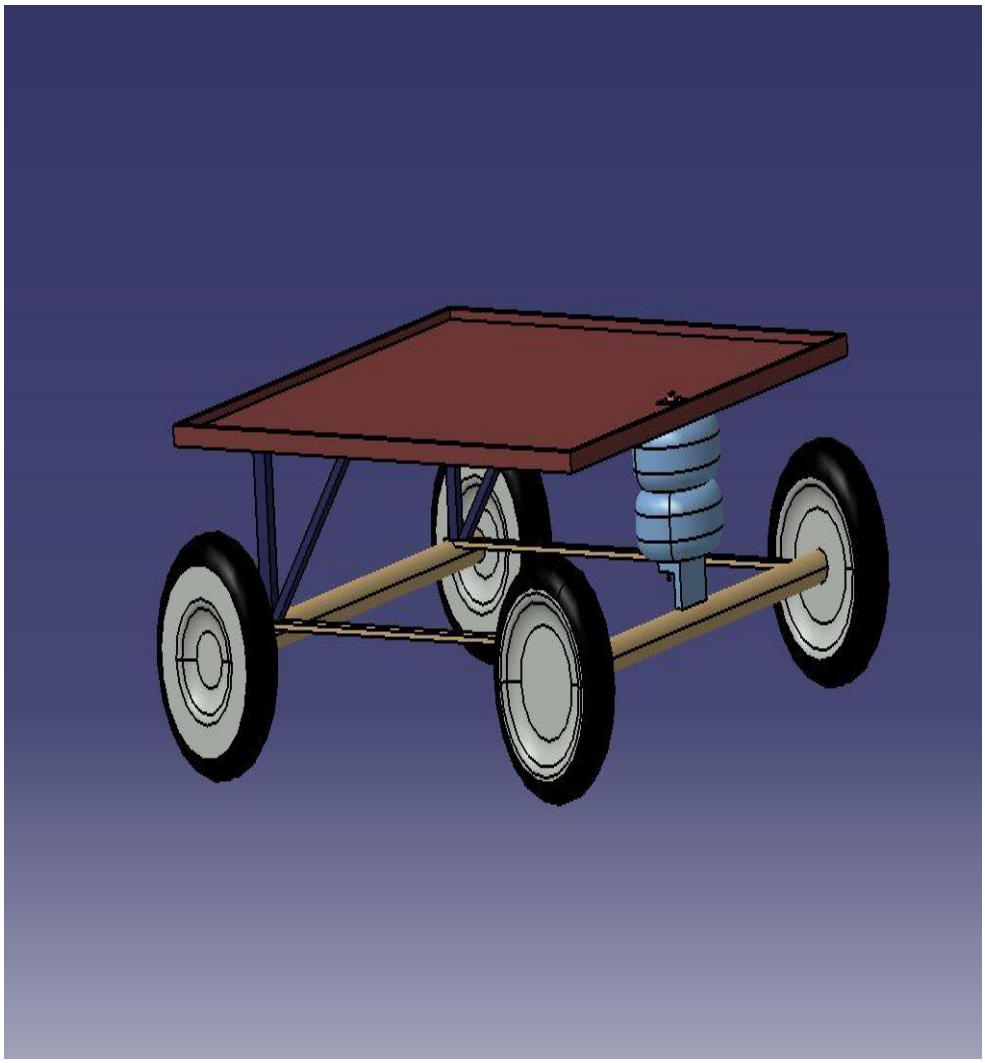

Figure 5.1 Solidworks model of pneumatic suspension system

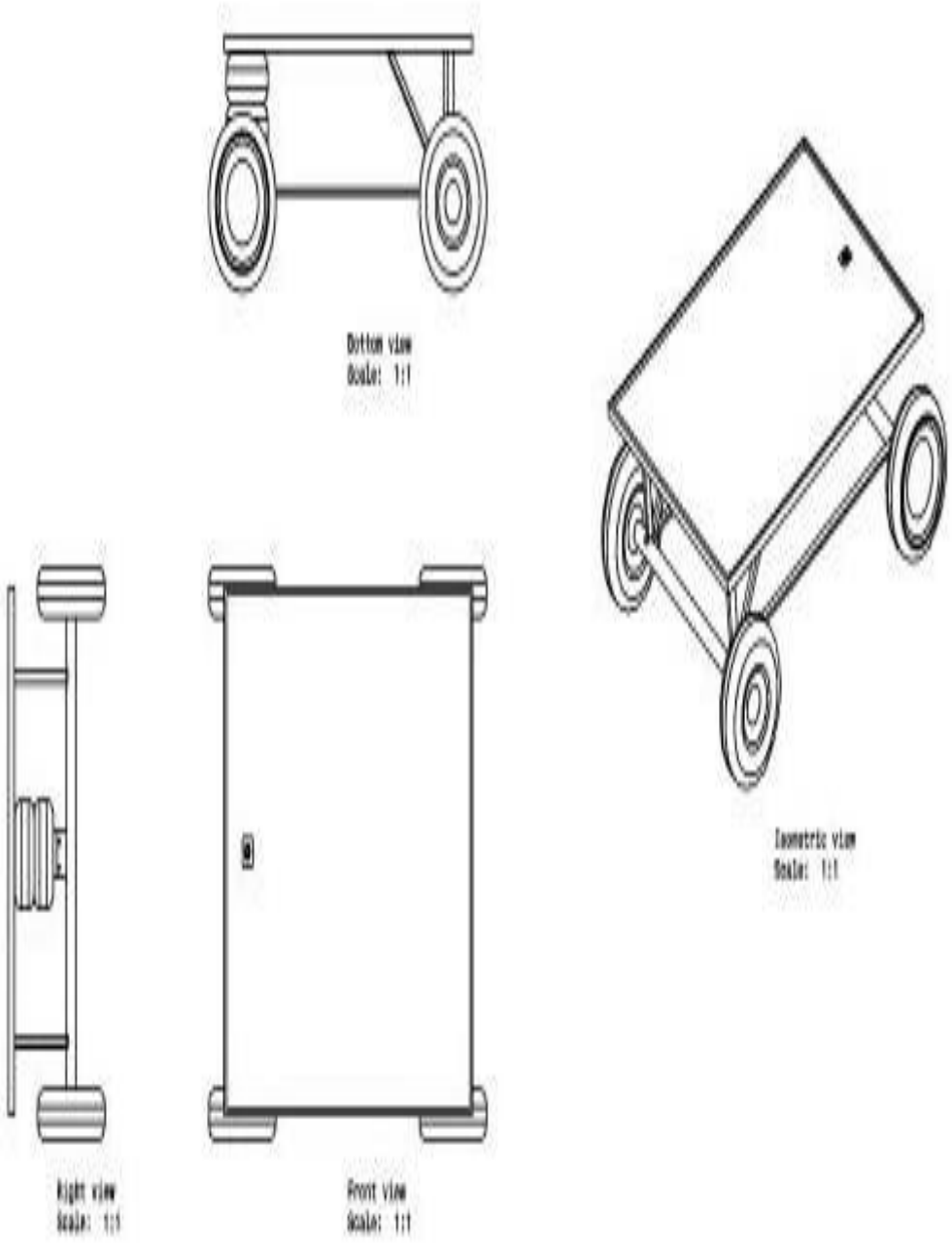

Figure 5.2 2D diagram of overall model

CHAPTER 6

FABRICATION PROCESS

6.1 MACHINING

It is the broad term used to describe removal of material from a work piece, it covers several processes, which we usually divide into the following categories: Cutting, generally involving single-point or multipoint cutting tools, each with a clearly defined geometry. Abrasive processes, such as grinding. Cutting generally involving single point multi point cutting tool each with a clearly defined geometry. Abrasives processes, such as grinding. Nontraditional machining processes utilizing electrical chemical and optimal sources of energy.

6.2 CUTTING

Machining is any process in which a cutting tool is used to remove small chips of material from the work piece (the work piece is often called the "work"). To perform the operation, relative motion is required between the tool and the work is shown in the figure 5.1

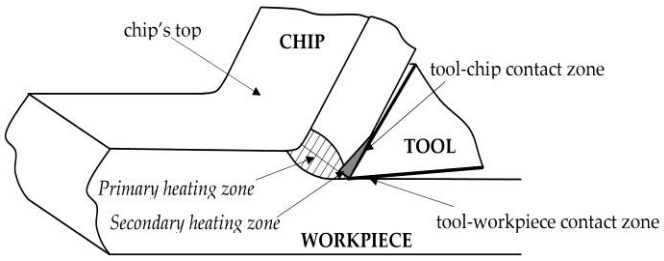

Figure 6.1 Cutting operation

6.3 REAMING

Reaming is a finishing operation performed with a multi-edge tool giving high-precision holes.

High surface finish, superb hole quality and close dimensional tolerance are achieved at high penetration rates and small depths of cut is shown in the figure 5.2

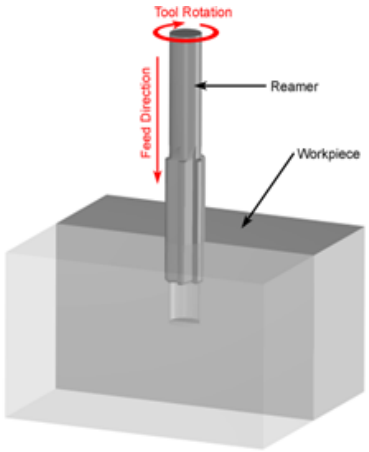

Fig 6.2 Reaming operation

6.4 DRILLING

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 multipoint. The bit is pressed against the work piece and rotated at rates from hundreds to thousands of revolutions per minute.

In rock drilling, the hole is usually not made through a circular cutting motion, though the bit is usually rotated. Instead, the hole is usually made by hammering a drill bit into the hole with quickly repeated short movements. horizontal drilling are called drifter drills is shown in the figure 5.3

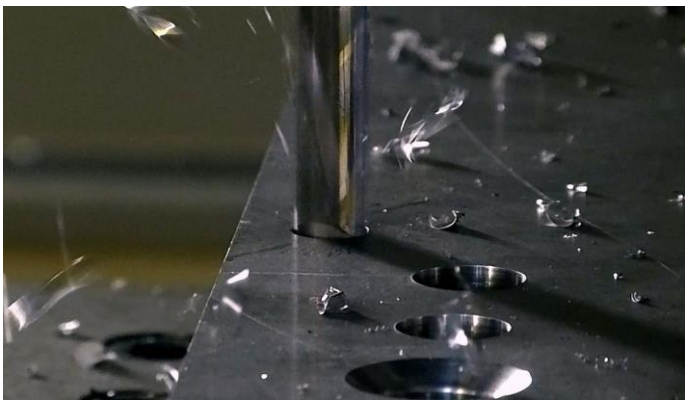

Figure 6.3 Drilling operation

6.5 WELDING

Welding is a fabrication or sculptural process that joins materials, usually metals or thermoplastics, by causing fusion, which is distinct from lower temperature metal-joining techniques such as brazing and soldering, which do not melt the base metal. In addition to melting the base metal, a filler material is typically added to the joint to form a pool of molten material (the weld pool) that cools to form a joint that is usually stronger than the base material. Pressure may also be used in conjunction with heat, or by itself, to produce a weld.

Many different energy sources can be used for welding, including a gas flame, an electric arc, a laser, an electron beam, friction, and ultrasound. While often an industrial process, welding may be performed in many different environments, including in open air, under water, and in outer space. Welding is a hazardous undertaking and precautions are required to avoid burns, electric shock, vision damage, inhalation of poisonous gases and fumes, and exposure to intense ultraviolet radiation**.**

6.5.1 Types of welding

a. Arc welding

b. gas welding

c. Submerged arc welding

a) Arc welding

Arc welding is a process that is used to join metal to metal by using electricity to create enough heat to melt metal, and the melted metals when cool result in a binding of the metals. It is a type of welding that uses a welding power supply to create an electric arc between an electrode and the base material to melt the metals at the welding point. They can use either direct (DC) or alternating (AC) current, and consumable or non-consumable electrodes.

The welding region is usually protected by some type of shielding gas, vapour, or slag. Arc welding processes may be manual, semi-automatic, or fully automated. First developed in the late part of the 19th century, arc welding became commercially important in shipbuilding during the Second World War. Today it remains an important process for the fabrication of steel structures and vehicles is shown in the figure 6.4

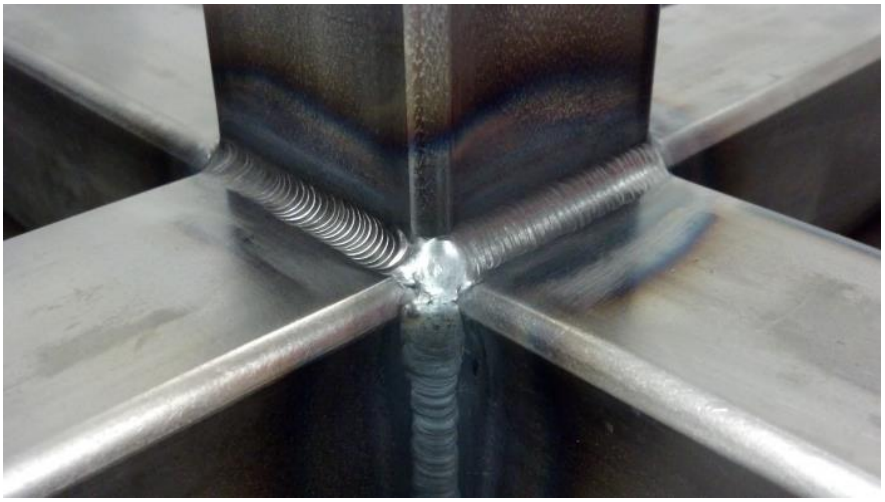

Figure 6.4 Arc welding

6.5.2 Arc shielding

However, joining metals requires more than moving an electrode along a joint. Metals at high temperatures tend to react chemically with elements in the air - oxygen and nitrogen. When metal in the molten pool comes into contact with air, oxides and nitrides form which destroy the strength and toughness of the weld joint. Therefore, many arc-welding processes provide some means of covering the arc and the molten pool with a protective shield of gas, vapor, or slag. This is called arc shielding. This shielding prevents or minimizes contact of the molten metal with air. Shielding also may improve the weld. An example is a granular flux, which actually adds deoxidizers to the weld is shown in the figure 5.5

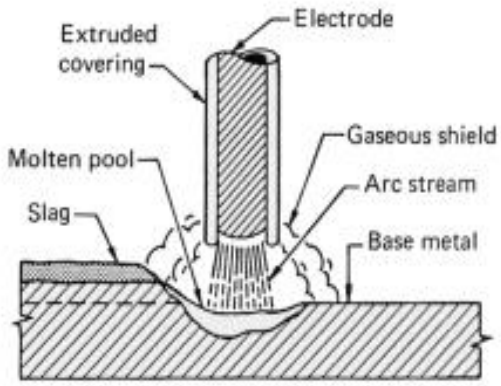

Figure 6.5 Arc shielding

6.5.3 Nature of arc

An arc is an electric current flowing between two electrodes through an ionized column of gas. A negatively charged cathode and a positively charged anode create the intense heat of the welding arc.

If an electrode is consumable, the tip melts under the heat of the arc and molten droplets are detached and transported to the work through the arc column. Any arc welding system in which the electrode is melted off to become part of the weld is described as metal-arc. In carbon or tungsten (TIG) welding there are no molten droplets to be forced across the gap and onto the work. Filler metal is melted into the joint from a separate rod or wire.

Arc welding may be done with direct current (DC) with the electrode either positive or negative or alternating current (AC). The choice of current and polarity depends on the process, the type of electrode, the arc atmosphere, and the metal being welded.

6.5.4 Types of arc welding

a) Gas metal arc welding (GMAW)

b) Gas tungsten arc welding (GTAW)

c) Submerged arc welding (SAW)

d) Plasma arc welding (PAW)

6.6 PUNCHING

Punching is a metal forming process that uses a punch press to force a tool, called a punch, through the work piece to create a hole via shearing. The punch often passes through the work into a die. A scrap slug from the hole is deposited into the die in the process. Depending on the material being punched this slug may be recycled and reused or discarded. Punching is often the cheapest method for creating holes in plate or square tube(mild steel) in medium to high production volumes. When a specially shaped punch is used to create multiple usable parts from a sheet of material the process is known as blanking. In forging applications the work is often punched while hot, and this is called hot punching.

Figure 6.6 Punching machine

6.6.1 Punching process

Punch tooling (punch and die) is often made of hardened steel or tungsten carbide. A die is located on the opposite side of the workpiece and supports the material around the perimeter of the hole and helps to localize the shearing forces for a cleaner edge. There is a small amount of clearance between the punch and the die to prevent the punch from sticking in the die and so less force is needed to make the hole. The amount of clearance needed depends on the thickness, with thicker materials requiring more clearance, but the clearance is always less than the thickness of the work piece. The clearance is also dependent on the hardness of the work piece. The punch press forces the punch through a work piece, producing a hole that has a diameter equivalent to the punch or slightly smaller after the punch is removed. All ductile materials stretch to some extent during punching which often causes the punch to stick in the work piece. In this case, the punch must be physically pulled back out of the hole while the work is supported from the punch side, and this process is known as stripping. The holed walls will show burnished area, rollover, and die break and must often be further processed. The slug from the hole falls through the die into some sort of container to either dispose of the slug or recycle it.

6.6.2 Punching characteristics

A) Punching is the most cost effective process of making holes in strip or sheet metal for average to high fabrication.

B) It is able to create multiple shaped holes.

C) Punches and dies are usually fabricated from conventional tool steel or carbides.

D) Creates a burnished region roll-over, and die break on sidewall of the resulting hole.

E) It's quick.

6.6.3 Applications of punching

1. For instance, the units require very little floor space because they are normally compact pieces of machinery. This is because they do not require an independent feed system or punching press.
2. Some rotary punches can even be mounted on the inside of the existing roll forming equipment, thus taking up no space at all.
3. There is little noise and minimal vibration associated with rotary punching applications.
4. Other punching equipment like high-speed presses need costly and sophisticated feeds, whereas rotary punches are pull-through units, thus making them a cost efficient material punching solution.

6.7 COMPONENTS USED IN PNEUMATIC SUSPENSION SYSTEM

a) Iron Tubes
b) L-Angle iron rod
c) Iron plates
d) 3 jaw drill chuck

6.7.1 Iron tubes

Tubing is more used in structures so it is the important number. The strength of a steel tube depends on the wall thickness. So tubing is specified by the outside diameter and the wall thickness. Steel tubes are also not only supplied in round sections but can be formed into square and rectangular tubes. Each square or rectangular steel tube has a different mother tube, meaning that they are formed from the original round tube.

Figure 6.7 Iron tubes

6.7.2 L-Angle iron rod

A-iron is stronger than non-structural steel because the two perpendicular flanges work in conjunction to give angle iron cross-sectional structural integrity, resistance to bending from pressure applied from the top or bottom, left or right.

The two flanges that make up the angle create a compound area. A compound area is the location of the axis of a piece of structural steel that is most resistant to the moment of inertia.

Angle iron is relatively resistant to the moment of inertia when the load is applied the top, bottom or either side. However, when pressure is applied in a manner that rotates the A-iron around the axis of the compound area, it will fail with the application of less pressure than when the pressure is applied around the cross section.

Figure 6.8 L-angle iron rods

6.7.3 Iron plates

These properties make it the preferred choice for tasks that cannot be completed using any metal yet do not justify incurring the additional cost of using alloyed steel. It is commonly used in engineering applications where parts are not subjected to heavy stress is shown in the figure 5.7.

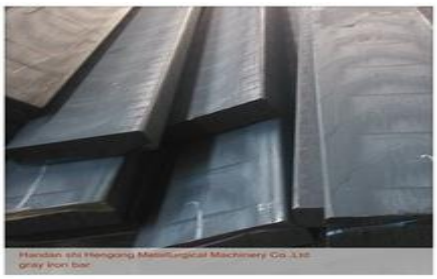

Figure 6.9 : Iron plates

6.7.4 Jaw drill chuck

A chuck is a specialized type of clamp. It is used to hold an object with radial symmetry, especially a cylinder.

In drills and mills it holds the rotating tool whereas in lathes it holds the rotating workpiece. For some purposes (such as drilling) an additional chuck may be mounted on the non-rotating tailstock is shown in the figure 5.8.

Figure 6.10 Jaw chuck & key

6.8 PAINTING/COATING

The objective of painting is to form a coating film on the surface of an object in order to protect the object and give a fine appearance. Painting may also have other special functions. There are various types of painting methods, and spray painting is currently used in many types of industrial painting. A flow diagram of the spray painting process is shown as an example in Fig. 1. “Spray painting” consists of the painting operation itself followed by coated film drying.

The paint used in the painting process is diluted with thinner, and solid portions in the paint form the coating film after the spraying operation. Annual amount of handled Class I Chemical Substances in paints and thinners is calculated based on the content of each chemical in paints and thinners, which should be obtained by MSDS and etc. In the painting operation, various types of painting methods are used according to the shape, size, quality, and quantity of the object(s) to be painted. The “transfer efficiency” differs, in other words, the ratio of the quantity of the coated film formed on the object to the quantity of the paint sludge generated from overspray differs according to the differences in these operational conditions. In “spray painting” inside a coating booth, most of the auxiliary solvent portions in the paints vaporizes to air. The solid portions over-sprayed are collected in the coating booth circulating solution (water or oil), and separated as paint sludge. So, vaporization of solvents in spraying operation and coated film drying process makes air emissions from total painting processes. In some cases, a vent gas from coated film drying process is treated by deodorizing device. Paint sludge caused by overspray is either off-site transferred in waste, or incinerated. Releases to water bodies, or off-site transfers of waste oil occur at the time of renewal of circulating solution. Residual paints and cleaning thinners are on-site or off-site recycled in some cases. Sometimes the (same) solvent is used to dilute paint and also to wash painting lines, so in this manual, the former is designated as thinner and the latter as cleaning thinner.

CHAPTER 7

RESULT AND DISCUSSION

7.1 RESULT

It was observed that the deflection in the helical coil spring suspension was lesser than the pneumatic bellow suspension and so the pneumatic suspension has very higher stiffness than the helical coil suspension system, higher loads can be loaded in this pneumatic suspension system. Thus it gives a very high comfort when compared to helical coil suspension system.

An air suspension supports the vehicle on the axles with an arrangement of air bags instead of some type of steel spring, leaf or coil, or some type of torsion spring arrangement. Suspensions that have steel or torsion springs that are supplemented by the use of air bags are not considered air suspensions. There are combination systems that have both air and steel springs. Usually the air suspension components are used on the rear of the vehicle.

7.2 TESTING OF PNEUMATIC SUSPENSION SYSTEM

First the model with helical coil suspension system is tested by running over the pits and bumps and also verify with the stiffness calculation by loading. Then the model is fitted with the designed pneumatic bellows and followed as the above procedure with the stiffness calculations by loading and tested for its fitness.

Figure 7.1 Pneumatic suspension under load

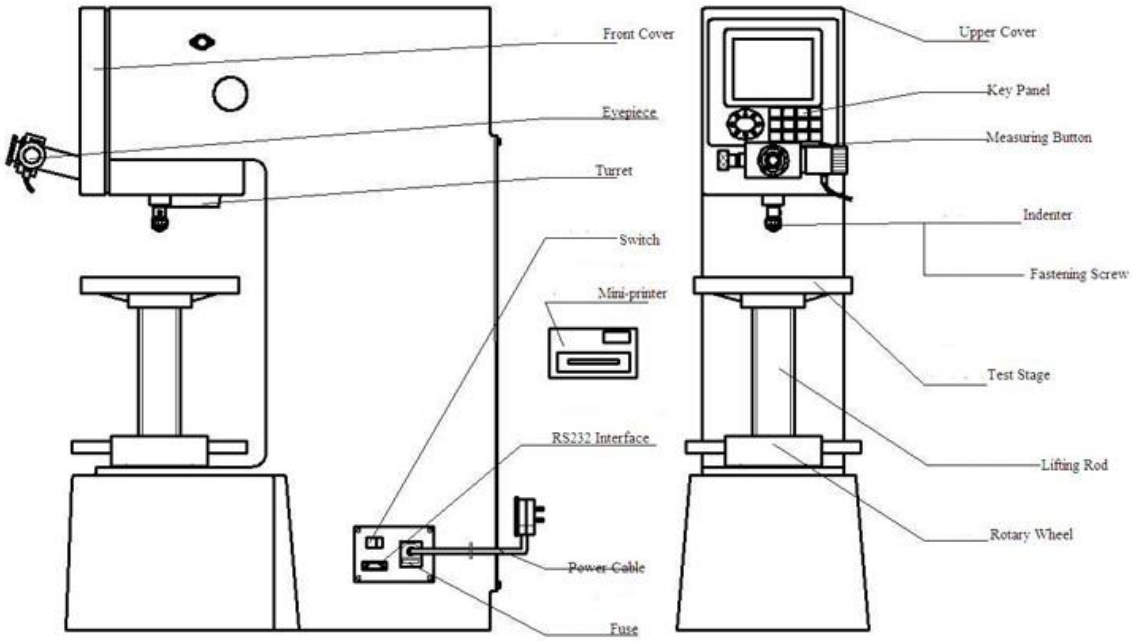

Figure 7.2 Brinell hardness test

CHAPTER 8

CONCLUSION

In this project by comparing the spring rate value and the type of deflection, air suspension will provide better comfort than the helical coil suspension. Air suspension is today mainly feature for luxury vehicle. The Air Suspension System has ability to change the load carrying capacity simply by changing the air pressure. So implementation of air suspension in automobile will provide better suspension to the automobile and increases the ride quality and comfort. By replacement of helical coil with rubber material the cost will not increase as much. So it can be implemented in all type of conventional automobile without peril for cost.

8.1 FUTURE SCOPE

Locating the air spring control valve close to the air spring enhances the overall suspension system response time, which unlocks the countless features and benefits. There are electronic suspension systems currently on the market, but they do not sufficiently utilize all of the vehicle's component capabilities. Also with the future advancements in the field of automobiles will lead to manufacturing of air suspensions which can be actuated without a compressor and may be very compact and effective to a very greater extent in comparison to the one we have now.

ANNEXURE

BILL OF MATERIALS

Table 9.1 : Bill of materials

SL.NO	QUANTITY	MATERIALS	COST IN RUPEES
1.	1 Nos	Double convoluted air bellow	4000
2.	4 Nos	Castor wheels	420
3.	2 meter	Iron tube	700
4.	2 meter	L-Angle iron rod	1100
5.	1meter	Thick iron plate	900
		TOTAL COST	7120

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PHOTOGRAPHIC VIEW

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