

# Design and Investigation Of Suspension System Of Ambulance

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**Abstract :** Discussion on converting the old suspension system into advance one in ambulance resulted us to design a new suspension system in ambulance to provide maximum comfort ride with better stability to the patient and the passengers. In this paper, we discuss hydro-pneumatic suspension system which helps to provide improved safety in running condition of ambulance vehicles from road bump and various disturbances.

**Index Terms -** Converted, Suspensions System, Comfort Ride, Hydro-pneumatic, Improved safety.

## I. INTRODUCTION

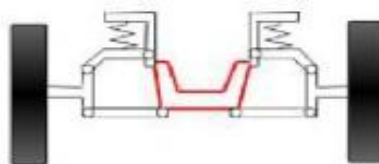
In automobile industry, there are many suspension systems. The main objective of a suspension system is to maintain the stability of a running vehicle when sudden disturbances and irregularities occur and to keep the tires on road all the time without transmitting shock directly to the passengers. Ideally, the suspension should allow the wheels to move up and down according to the road bump. The main element of the suspension system is spring used in different shapes as per the requirement. The spring absorbs road impacts by oscillating and maintains wheel moves vertically and keep tires on road contact related to the body. The spring is resilient member that acts as reservoir of energy. This energy is released subsequently with the action of damper and it is converted into heat to avoid bounce and return to original position slowly.

Suspension control is highly difficult control problem due to complicated relationship between its component and parameter [1], modern vehicle suspension system, shock absorber is crucial component in vehicle suspension system which reduces the effect of traveling over rough ground thus achieving good ride quality [2], Suspension system is designed as per the general design procedure that is first need definition as importance of hydro-pneumatic suspension system [3].

## II. TYPES OF SUSPENSION SYSTEM

### DEPENDENT SUSPENSION SYSTEM:

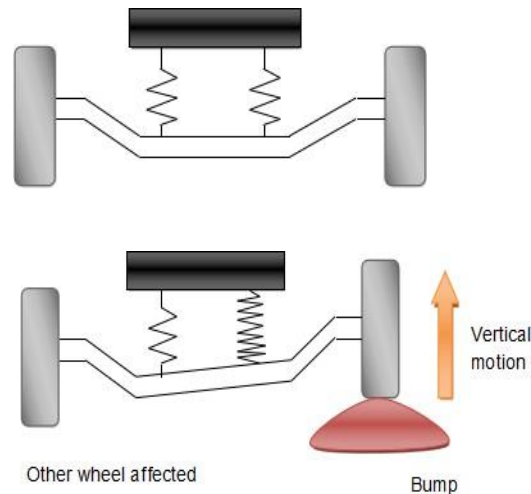
A suspension system, in which both right and left wheels of front and rear pair of wheels are connected with the solid axle, results in such a way that if one wheel of the front or the rear wheels lifts upward then it causes the other wheel to slightly lift. This type of suspension system is used in many old trucks in which the solid axle is used to connect the front and rear pairs of the wheels.



### INDEPENDENT SUSPENSION SYSTEM:

A suspension system in which all four wheels of a vehicle are free. It means there is no relative motion between the front and the rear pairs of the wheels and all are connected independently with frame. When wheels either right or left side of the vehicle comes over any bump, the wheel in contact with the bump moves upward without lifting any other wheel.

### III. NEED OF SUSPENSION SYSTEM



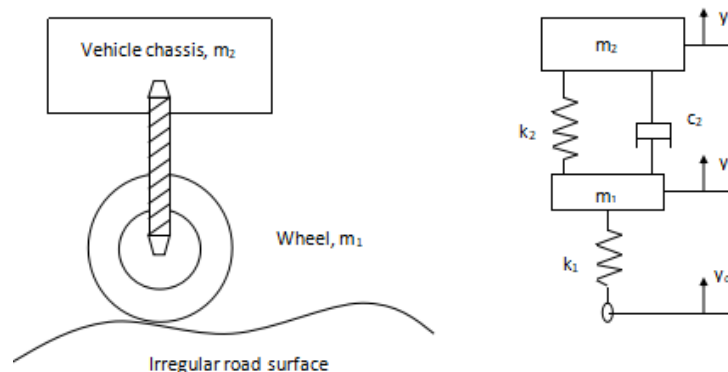
There is a need of flexible connection between the main frame and the wheels of the vehicle in dynamic condition that enables the relative motion between them without causing deformation to the main structure or any other components of the vehicle. To support the overall weight of the main frame that includes weight of all mounted components along with the passenger's weight. To maintain a firm contact between tires and road in turn provides stability to vehicle. When a vehicle is taking a sharp turn, there is a chance of rollover of the vehicle along its lateral axis which should be prevented. The suspension system prevents the vehicle from excess rolling. It provides isolation to vehicle body from vibrations and irregularities of the road surfaces.

### IV. COMPONENTS OF THE SUSPENSION SYSTEM

1. **Wheel and Tires:** Tires are not always considered as the part of suspension system but they are arguably the most important component of it. Tires provide traction for acceleration, braking, and cornering, and they absorb small bumps.
2. **Springs:** Spring is a mechanical element which is used to support for the tensile and compressive nature in the system. Spring supports the weight of a vehicle and permits the wheel to move up and down.
3. **Shock Absorbers or Dampers:** Shock absorbers or dampers are used to damping the motion of the spring after bump and keeping the vehicle from bouncing excessively.
4. **Linkages:** Every suspension consists various rods and other connecting pieces that collectively keep wheels where they are supposed to be related to the rest of the vehicle.
5. **Bushings and Bearings:** The most of the parts of suspension system are movable and various linkages are connected by flexible connections. These include bushing and bearings which allow small amount of twisting and sliding.

### V. CONVENTIONAL SUSPENSION SYSTEM:

Normally, the conventional suspension system is known as spring, damper suspension system. This arrangement consists of a coil spring connected to hub of wheel with knuckle and damper supporting the springs. The springs take up the load of the vehicle including weight of passengers and luggage. The spring is important if we do not provide spring in suspension system then the axle of vehicle gets hurt and may be get destroyed and also, we cannot control the vehicle properly. The damper on the other side is used to support and guide the spring motion. The dampers control the excess bounce of the spring. The damper has a type of fluid in it which gets compressed with the help of piston arrangement connected with wheel struts. When damper compresses the fluid some heat energy is generated, this energy then dissipated in the atmosphere.



Where:

$m_1$  = mass of the wheel

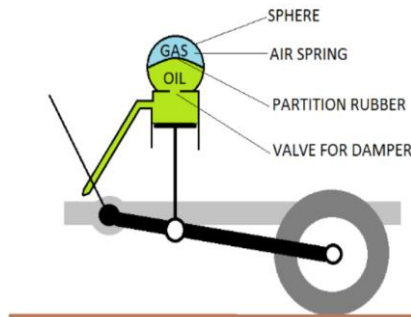
$m_2$  = mass of the vehicle body

$k_1$  = stiffness of the tire material

$k_2$  = stiffness of the springs

$c_2$  = damping coefficient of the damper

## VI. PROPOSED IDEA



We decided to use “Hydro-pneumatic Suspension System” that can compress gas instead of fluid which results to achieve a smooth ride. A typical hydro-pneumatic system consists of system of spheres with pipes to give good ride quality. The sphere can either be mounted on suspension system or as per the space demands. The spheres of hydro-pneumatic system have two parts - the first part is filled with some gas such as Nitrogen and the other part is filled with hydraulic fluid as shown in the figure. The two parts of the sphere is separated with help of rubber diaphragm. Hence, with the help of this design we get a sphere that is half gas and half liquid. The tube has a piston inside which is connected to the suspension strut from where the piston take up the movement. In uncompressed state, both the parts gas and fluid have equal space in the sphere. When the vehicle experiences any bump, hollow or any irregularities from road surface then the piston moves up and as we know the fluids cannot be compressed hence here in our arrangement the gas gets compressed as we can see in the figure.

### TYPE OF FLUID USED:

We use oil as hydraulic fluid because we cannot compress the oil. The oil consists of mainly carbon (83-87%), hydrogen (12-14%) and complex hydrocarbon mixture like paraffin, naphthene, aromatic hydrocarbon, gaseous hydrocarbon (from CH<sub>4</sub> to C<sub>4</sub>H<sub>10</sub>). Besides oil, it also contains small amount of non-hydrocarbons (Sulphur compounds, nitrogen compounds, oxygen compounds) and minerals heavier crudes contains higher Sulphur.

### TYPE OF GAS USED:

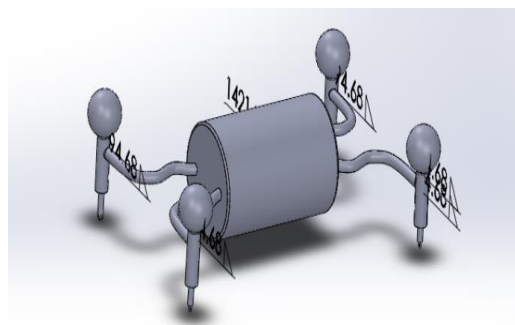
As per the reference of papers, we use nitrogen gas which has nearly negligible effect of temperature on its volume. The Nitrogen gas does not exert an aggressive impact on the accumulator.

### DIAPHRAGM MATERIAL:

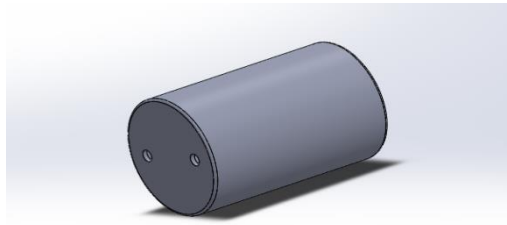
Diaphragm is a type of rubber which cannot exceed or brake by force. The role of diaphragm is a very important in suspension system.

## VII. Full Suspension Model

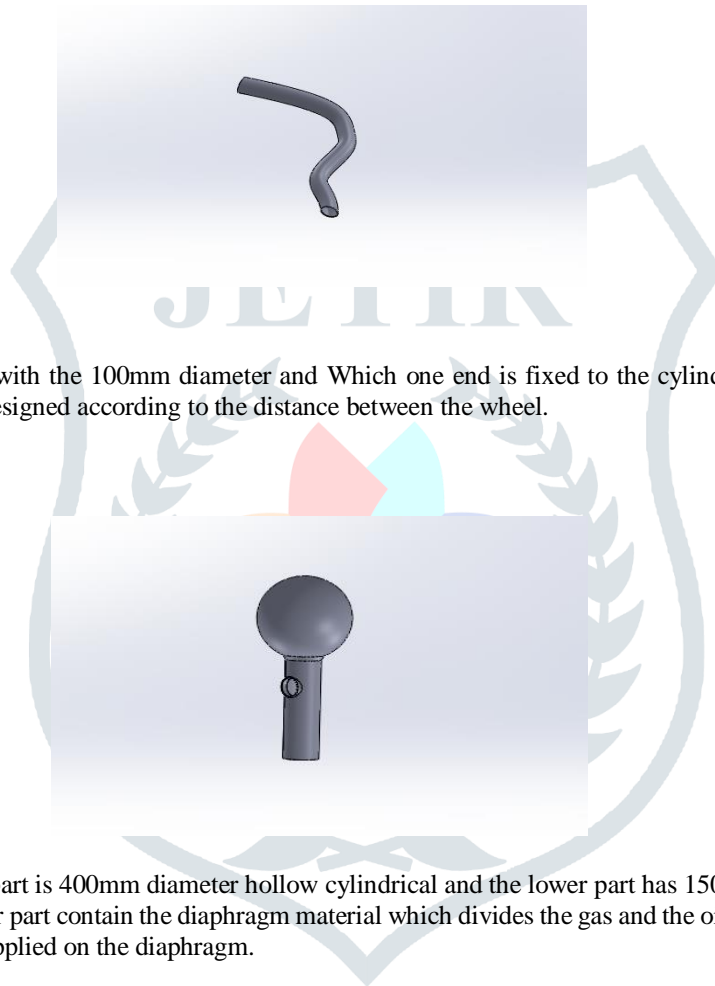
We designed suspension model according to the standard dimension of the force ambulance model.



### Component and Dimension of Hydro pneumatic suspension model

**Cylinder:**

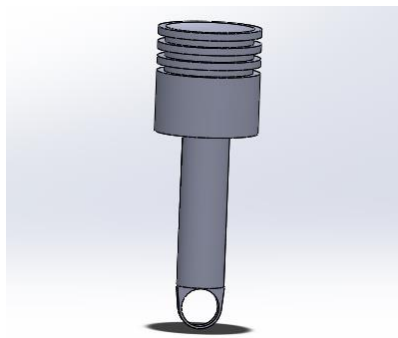
The cylinder we build have length 1500mm and diameter 987.5mm hollow cylinder. The cylinder have two hole on both sides which is required for the pipe. Cylinder is completely filled with the fluid which is oil.

**Pipe:**

Pipe is hollow cylindrical with the 100mm diameter and Which one end is fixed to the cylinder and other end is fixed to the accumulator. The pipe is designed according to the distance between the wheel.

**Accumulator:**

Accumulator which upper part is 400mm diameter hollow cylindrical and the lower part has 150mm diameter. Hole is provided to attach the pipe. The upper part contain the diaphragm material which divides the gas and the oil. The stability of the suspension is depend on the pressure applied on the diaphragm.

**Piston:**

Piston which is adjusted according to the road bump which has 140mm diameter. When road bump is created during the running position of vehicle piston moves upward which force the flow of oil towards diaphragm.

### VIII. CAPABILITIES OF HYDRO-PNEUMATIC SUSPENSION SYSTEM

Progressive characteristics of elasticity provides great driving comfort as well as possibility of placing a considerable load on the vehicle. Compressed nitrogen gas, sealed in the sphere using an elastic diaphragm, which provide more driving comfort. Hydro-pneumatic suspension is self levelling which is adjusted according to road surface. It is a low cost for mass production. This suspension gives possibility to increase the road clearance that provides higher cross-country driving capability. Suspension serves the possible safety to passengers of the vehicle. In various cases, there is lower unsprung mass of vehicle. - Suspension serves the possible safety to the passengers in the vehicle. Due to all above capabilities of suspension it perform a very important role in the comfortableness of the ambulance vehicle. Also this suspension model is compact casing of Accumulator and it gives better stability in the minimum cost.

### IX. Drawbacks of the Hydro-pneumatic Suspension System

Hydro-pneumatic suspension system required proper maintenance. Repair of the suspension model is costly and damage Of this suspension system may not give better stability.

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