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A New Design of Suspension System

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Abstract:

A Suspension system of an automobile which separates heel/axel system from the body. The primary function of a suspension system is to isolate a body due to shocks and vibrations due to irregularities of road system. Now at present all suspension systems used in automobiles are using "Springs "and "High viscosity lubricant oil". By in my project I am going to use an incompressible gas and spring mechanism in designing new suspensions

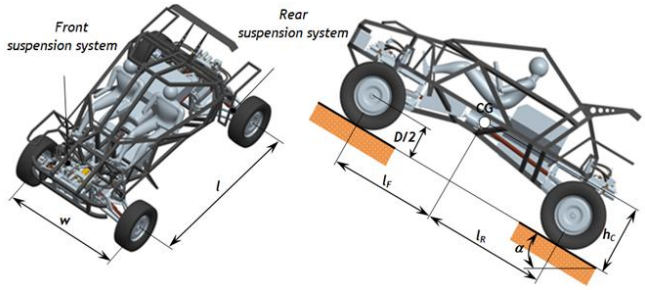
Keywords:

In compressible gas, spring piston, direction of application of force.

I.INTRODUCTION:

The primary function of the suspension system of the vehicle should fulfill pretentious requirements about stability, safety and maneuverability. The suspension system of the vehicle performs multiple tasks such as maintaining the contact between tires and road surface, providing the vehicle stability, protecting the vehicle chassis of the shocks excited from the unevenness terrain, etc. [1]. The suspension system works together with the tires, wheels, frame, suspension linkages, wheel hubs, brakes systems as well as steering system to provide driving comfort, stability, etc. This system is the mechanism that physically separates the vehicle body from the wheels of the vehicle.

The performance of the suspension system has been greatly increased due to the continued advancements in automobiles in the recently years. The suspension system will consider ideal if the vehicle body isolate from uneven road and inertial disturbances associated during situation of cornering, braking and acceleration. The design of the vehicle suspension system may be different for front and rear axis (independent or dependent suspension). The main aim in this research is to conceive and design the suspension system for a terrain vehicle with four wheels drive and four wheels steer intended to use for recreational purpose. The terrain vehicle it is designed to operate mostly in roughness terrain as well as in paved roads. The design of the terrain vehicle is modeled in Pro/ENGINEER environment and is shown in Figure 1.



II. Background and Literature survey

SUSPENSION SYSTEM:

It is the term of given to the system of spring, shock absorbers and linkages that connects a vehicle to its wheels. Serve a dual purpose of contributing to the vehicle's handling and Braking and Protects the

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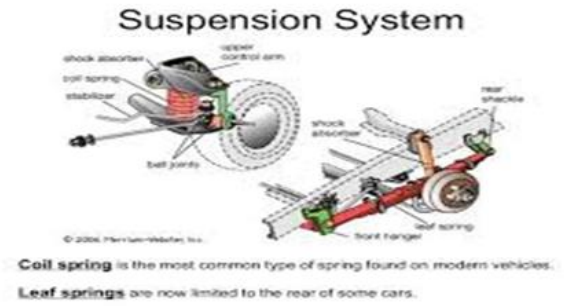
vehicle itself and any cargo or luggage from damage and wear.



Suspension System – Components

- Spring
- coil springs
- leaf springs
- Damper shock absorber
- Need for damper
- Mathematical Model
- Quarter car model with asymmetric damping

- Components: a) Sprung mass
  b) Un-sprung mass

- Sprung mass : m1=sprung mass k1=stiffness coefficient of suspension k2=stiffness of tire b1=damping coefficient of suspension b2=damping co-efficient of tire
- Damping coefficient of tire is usually negligible in comparison with that of spring.

CLASSIFICATION OF THE SUSPENSION SYSTEM:

The suspension system is always derived by some mechanical way. Generally speaking, the designs of the suspension systems are classification in two main groups:

- Dependent suspension system (solid axle) and
- Independent suspension system.

Each group can be functionally quite different and they are studied and discussed accordingly. Recently, both suspension systems can be found on ordinary vehicles and commercial vehicles.

The dependent suspension system:

The dependent suspension system is known as solid axle, when both wheels (left and right) are mounted the same solid axle .In this case, any movement of any wheel will be transmitted to the opposite wheel causing them to camber together. Solid drive axles usually are used on the rear axle of many passenger cars, trucks and on the front axle in many four wheel drive vehicles.The advantage of solid axles is considered the camber angle which is not affected by rolling of the vehicle body. Therefore, produce little camber in cornering, except for that which arises from slightly greater compression of the tires on the outside of the turn. In addition, wheel alignment is readily maintained, which contribute to minimize tire wear. The disadvantage of solid steerable axles is their susceptibility in shimmy steering vibrations, heavy mass, etc. The most types of solid axles are:

- Hotchkiss,
- Four link
- De Dion.

The independent suspension system:

The independent suspension system, allows one wheel to move upward and downward with a minimum effect on the other wheel (Figure 3). Mostly of the passenger cars and light truck use independent front suspension system, because provide much more space for installing vehicle engine, allow much more displacement of wheel, better resistance in steering vibration (wobble and shimmy) as well as offer higher performance in passenger comfort. As disadvantages of the independent suspension system can be considered the complexity of the design and manufacturing cost due to increasing number of parts. Recently, the multi-link suspension system seems to be the best independent system for vehicle, because offers the best compromises between comfort, stability and maneuverability. Moreover, such suspension system allows vehicles to get better performance compared

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with other types. Probably, would be good solutions to equip a terrain vehicle, with such system.

The multi-link suspension system has advantageous for the designer who enable to change one parameter without influencing the entire assembly. This is a major difference compared to a double wishbone suspension. By taking into consideration all of good things, the multi-link suspension system is more complex to design and has higher manufactures cost. To get better performance of the vehicle, the suspension geometry should to be checked carefully by adequate software. As disadvantage of the already described suspension systems, is considered basically fact that they not allow enough the vertical movement of wheels in order to get good performance and characteristics of the terrain vehicles. It requires to be developed such suspension system.

System Architecture:

Typically a vehicle designer is operating within a set of constraints. The suspension architecture selected for each end of the vehicle will have to obey those constraints. For both ends of the car this would include the type of spring, location of the spring, and location of the shock absorbers.For the front suspension the following need to be considered

- The type of suspension (MacPherson strut or double wishbone suspension)
- Type of steering actuator (rack and pinion or recirculating ball)
- Location of the steering actuator in front of, or behind, the wheel centre

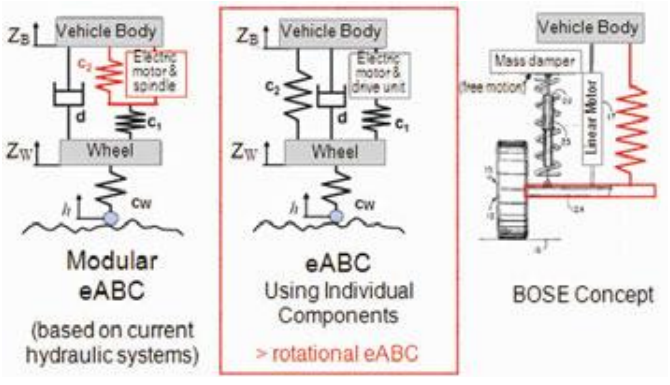
GEOMETRY OF THE INDEPENDENT SUSPENSION SYSTEM

Nowadays, as well as in the past, the development process for suspension systems of the vehicle has shown great interest by designers and manufacturers of the vehicles. During development process should be considered design constraints and requirements provided in the conceptual design, analyses different aspects of the suspension kinematics, behavior of structures of mechanical systems, etc.

All these investigations relation to the suspension system will be exploited to obtain the optimal suspension geometry in order to equip a terrain vehicle with suitable suspension system.

The suspension geometry:

The suspension geometry is important factor during design process, which helps us to identify the vertical wheel motion and how is position of the wheel in such motion. The suspension geometry not only dictates the path of the wheel, but also controls the forces that are transmitted between sprung and un-sprung mass.The design of the suspension mechanism for a terrain vehicle will be same for the front and rear axle which in an advanced model of the double wishbone. This model is ranking in the multi-link suspension system and is discussed previously. During design should be paid attention for that suspension mechanism to allow sufficient vertical wheel motion in order the vehicle to negotiate with roughness terrain. In case, when a tire contact a bump and the suspension mechanism does not allow sufficient vertical motion, the tire will continue to move upward, taking the frame with same high velocity and result on causing large acceleration in driver.



DESIGN OF THE SUSPENSION MECHANISM

The state-of-the-art for design of the suspension system of the terrain vehicle is based on three fundamental principles:

- design simplest and robust,
- By using the best proven performance that

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offered reviewed suspension system and

- Continuing refining the design until it is optimized to fulfill submitted requirement.

Actually, by advent and using personal computer has made possible to analyse suspension geometry without needs to cut and weld its structures. By applying the available knowledge for using of computer simulations, it is possible to get predefined requirements. The only thing what is required to do is to decide what the suspension system to behave and then activate the computer to precede the design variables and to get desired design.

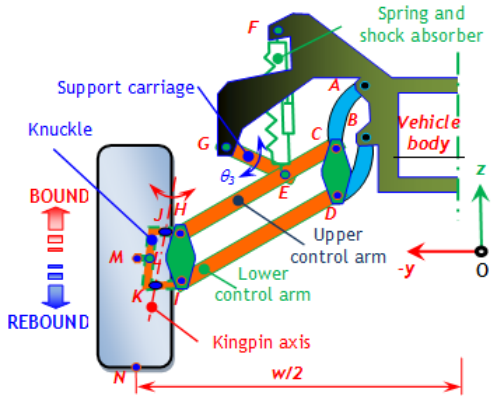

Figure – Quarter of multi-link suspension system in 2D

The design of the suspension system is based on analyzing of the performance that provide double wishbone with longer equal control arm. This type of suspension allows a relatively large vertical motion of wheel which corresponding by small change in angular movement of the control arm. This configuration facilitates the suspension geometry. Developed suspension system it is categorized as multi-link suspension system .For further developing process it is focused that lateral motion of the tire and camber angel to have smaller values in boundary positions during vertical wheel motion caused on bound or rebound motion. Point O is centre of coordinative system -yOz with coordinates O (0, 0). Axis -yO go through centre of the wheel (rest position), while Oz is centers of vehicle – front view. For evaluation of the performance that provides this suspension system is required to make geometric modeling.

Modeling of multi-link suspension system in Working Model 2D environments is done. Results from simulation are presented in following diagrams. All simulations are make under assumption the vehicle body is fixed and motion parts are considering wheel with its devices which usually is called un-sprung mass.

- To provide good ride and handling performance –
  a) vertical compliance providing chassis isolation
  b) ensuring that the wheels follow the road profile
  c) very little tire load fluctuation
- To ensure that steering control is maintained during maneuvering – wheels to be maintained in the proper position wart road surface
- To ensure that the vehicle responds favorably to control forces produced by the tires during
  a) longitudinal braking
  b) accelerating forces,
  c) lateral cornering forces
  d) braking and accelerating torques
  e) this requires the suspension geometry to be designed to resist squat, dive and roll of the vehicle body
- To provide isolation from high frequency vibration from tire excitation
  a) requires appropriate isolation in the suspension joints
  b) Prevent transmission of ‘road noise’ to the vehicle body

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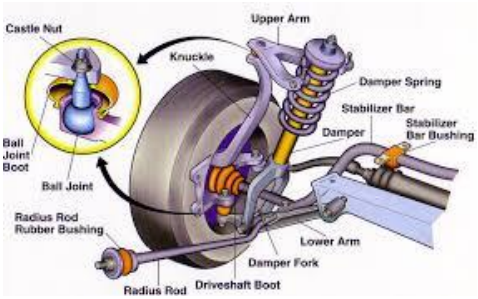


Suspension system – functions:

- to isolate the vehicle from disturbances so that the driver can keep control of the vehicle, without causing discomfort to passengers
- System should minimize vertical motion, as well as pitch and roll movements, as the vehicle passes over an irregular road, performs turning manouvres, and is accelerated or braked heavily.
- Apart from these basic operational aspects, the suspension should also provide a good level of comfort for the passengers, minimizing the movements and accelerations imposed on and perceived by them.
- The level of comfort is increasingly seen as one of the main contributing factors for purchase decision and satisfaction
- The disturbances can be caused by irregularities on the road, or caused by loads inherent of the operation of the vehicle, such as acceleration, braking and turning, as well as aerodynamic loads.

III.EXISTING SYSTEM:

PRESENT TECHNOLOGIES:

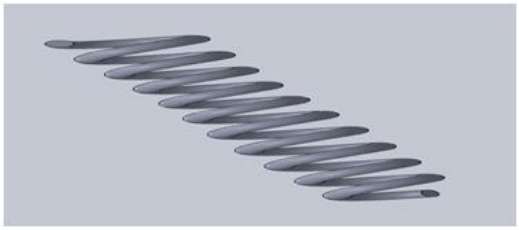
At present using automobiles are using coil springs, leaf springs and air and gas springs**.**

COIL SPRINGS:

It is made up of a special spring steel wire. This spring is generally circular cross section and of suitable diameter to have desired stiffness. The wire is wound around the shaft of the coil. The spring is formed at high temperature and shaft of the coil. The spring is formed at high temperature and then cooled by heat treatment to obtain perfect elastic [3]. character.[1.2-R.K.RAJPUT]

MATERIAL USED:

These coil springs are mainly made up of following material.



Energy stored per unit volume is double when compared to leaf springs.

AIR OR GAS SUSPENSIONS:

In these springs compressed air or gas is filled in cylinder or bellows against which the wheel moment is transmitted through a diaphragm. As soon as the wheel passes over the road irregularities the compressed air pressure returns the system to its original position.

GAS USED:

The gases which are used in these suspension systems are as follows.

The Camber angle:

Is angle between the vertical axis of the wheel and the vertical axis of the vehicle viewed from the front or rear site. When vehicle operate during different road, wheels will move upward and downward and vertical wheel center will be changed. This change is known as the camber angle (□). According to the configuration of the suspension mechanism, camber angle has three possible positions such as positive camber, zero camber and negative camber (Figure .a).

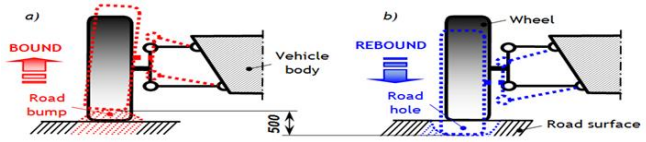


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Figure – Suspension motions; a) upward and b) downward

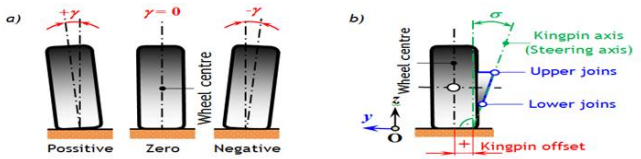
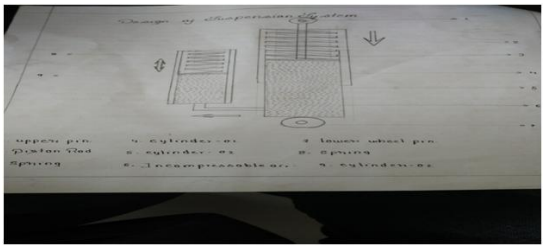


Figure – Suspension geometry; a) camber angle (front view) and b) kingpin inclination angle and kingpin offset (front view)

IV.PROPOSED SYSTEM

According to my thoughts why don't we make a suspension by using a incompressible gas by using a spring and piston mechanisms**.**

- **INCOMPRESSIBLE GAS:** The gas which do not compressible on the application of load.
- **GAS USED:** The gas which is mainly used in this suspension is as follows.
- **DESCRIPTION:** In my design I used to take 2 cylinders which have an inner arrangement of spring mechanism.



- **Cylinder-01:** This cylinder consists of a piston around it on helical spring is wounded, which is applied from upwards then the helical spring gets elongated due to application of load. It consists of incompressible gas as a working medium.
- **Cylinder-02:** It is a reservoir for the incompressible gas. Whenever the shocks are produced due to the bumping motion and vibrations the incompressible gas is collected in the cylinder 02.

Vehicle level targets: A partial list would include:

- Maximum steady state lateral acceleration (in understeer mode)
- Roll stiffness (degrees per g of lateral acceleration)
- Ride frequencies
- Lateral load transfer percentage distribution front to rear
- Roll moment distribution front to rear
- Ride heights at various states of load
- Understeer gradient
- Turning circle
- Ackermann
- Jounce travel
- Rebound travel

Once the overall vehicle targets have been identified they can be used to set targets for the two suspensions. For instance, the overall understeer target can be broken down into contributions from each end using a Bundorf analysis.Mainly Proposed One aims to avoid compromise in any direction, but inevitably some criteria will be given priority over others. The most important of these are:

- Installation stiffness
- Car packaging (aerodynamics, chassis structure and regulation requirements)
- Cg height
- Unsprung weight
- Cooling (brakes and bearings).
- Cost
- Ergonomics
- Design resources
- Motion ratio
- Geometry

Working Method:

Whenever the shocks are produced then the gas present in the cylinder 01 is under the application of load in order to overcome this problem the gas tends to move to the cylinder O2 and collected their when there is no load is applied due to spring elastic principle it want to regain its original position thus by this method stability of an automobile is achieved**.**

Proposed Advantages:

1. Long life of a suspension.
2. Recyclable.

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3. Easy manufacturing.
4. Low cost.
5. High efficiency

CONCLUSION:

This paper present design of the suspension mechanism intended to use in a terrain vehicle with four wheels steer and four wheels drives. The main aims are concentrated to design an independent suspension system to provide better contact of tire with road surface and less lateral displacement of the tire. Following are derived some important conclusions, such as:

- Designed suspension system provides 45% less displacement of the wheel in lateral motion. When wheel is pushed upward situation is better and provides 72.6% less displacement compared with same double wishbone suspension system,
- Designed suspension system provides relatively small values of camber angel nearly to zero which influence to have better contact of the tire with road surface. This improve, is a result that suspension mechanism allow wheel respectively tyre to acts perpendicular in road surface.

Acknowledgment: This paper is heartily dedicated to my knowledge bank and whose name is end over supporter Sri.Dr.V.V.Kesavarao sir.

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