# Self Leveling and Self Adaptive Power Chassis In Tractor

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*Abstract*: **The absence of self-adaptive and self- levelling power chassis mechanism in tractor leads our project research to develop a better suspension that are present now a day. Our projects aim to develop a suspension based on the combination of Rocker Bogie Suspension Mechanism and see saw mechanism. Rocker Bogie suspensions are advanced mechanism used in Mars where uneven land surface is present, and gravity is less as compared to Earth. Tractors are the widely used heavy duty vehicle on uneven surface like agriculture land. So, Rocker Bogie suspension influenced our project. The motive of this project initiation is to understand mechanical design and to find alternative solutions of higher stability suspension in tractor and analyze the design in software's like Ansys, CPS, and SOLIDWORKS. The entire system is mounted on V2-HVPC transmission system. The main body of suspension relates to big cylindrical roller bearing, and two driving axles. Those assemblies form an H-type chassis structure where both side of drive axles and the main body are connected to power transmission like chain drive system and shaft drive system. The power transmission is done by the help of chain drive mechanism which is present inside of the side arm of the mechanism this gives the system ability to move freely without breaking the power. This suspension system is a novel mechanism which ensures the full time 4 wheeled drive in a complex road environment while maintaining the main body level always in angle bisector of two driving axle. The topology diagram and power transmission system diagram are all given correspondingly. Moreover, simulation analysis and basic experiments have been carried out to verify the mobility and dynamic performance of the entire system. This result shows that the concept of our system is approved reasonable, and the design and the testing methods are feasible and practical. This testing is done with the help of software.**

*Keywords*: **Rocker bogie suspension, ANSYS, V2-HVPC, transmission, simulation.**

## LITERATURE REVIEW

The ideology of our project is to design highly stable power chassis. The concept has been taken from the highly stable Rocker Bogie suspension. The Rocker Bogie suspension consists of two links named as 'Rocker' and 'Bogie'. The Rocker Bogie suspension was developed in1988 for NASA'S Mars Rover Sojourner. The term "rocker" describes the rocking aspect of the larger links present each side of the suspension system and balance the bogie as these rockers are connected to each other and the vehicle chassis through a modified differential. In the system, "bogie" refers to the conjoining links that have a drive wheel attached at each end. Bogies were commonly used to bare loading as tracks of army tanks as idlers distributing the load over the terrain. Bogies were also quite commonly used on the trailers of semitrailer trucks as that very time the trucks will have to carry much heavier load as accordance with the motion to maintain center of gravity of entire vehicle, when one rocker moves up- ward, the other goes down. This NASA's Sojourner was 6 wheeled robots. Our project focused on designing the 4-wheel drive system by removing the rocker part of the Rocker Bogie Suspension. Hence there will be no rocker in our design. Tractors are commonly manufactured in 4 wheeled drive system, in changes to that we are replacing rear two Tyres of tractors with our 4 wheeled design. So, integrating all the wheels, we will get the tractor of 6 wheel from which only rear 4 wheels will have transmitting power. Those 4 rear wheels will be known as self-adaptive and self levelling power chassis mechanism. The type of design we are implementing on tractors is already present in Grader machine vehicle.

The need to implement the self-adaptive and self levelling power chassis in tractor is to increase the stability. As this type of design does not consist of springs nor stub axles in each wheel which allows the chassis to climb over huge obstacles keeping all the others wheels on the ground maximum time. Due to implementation of extra self-adaptive and self levelling power chassis in tractor, the vehicles size might get bigger which leads to more weight of vehicle, but this problem can be tolerated if research will happen on this. In this work, the proposed self-adaptive and self levelling power chassis mechanism was designed and fabricated. Modelling was done on Solid work and the same design is analyzed in Ansys and CPS. This type of mechanism can also be applied to different terrain and heavy-duty vehicle.

## AIM AND OBJECTIVES

To design and develop a self- adaptive and self- levelling vehicle power chassis mechanism. The focus is on enhancing the efficiency of tractor to deal with uneven landmass and rough terrain. To achieve low cost and low maintenance suspension which will last for entire life of vehicle. Conduct the analysis to see the dynamic aspect of the suspensions on fields. To reduce the backbone injures of the farmer while doing the agriculture assignments. Complete removal of bumping of Tyres on road at high speed.

## INTRODUCTION

**Chassis**: - It is the main support structure of the vehicle which is also known as ‘Frame’. It bears all the stresses on the vehicle in both static and dynamic conditions. In a vehicle, it is analogous to the skeleton in living organisms. The origin of the word Chassis lies in the French language. Every vehicle whether it is a two-wheeler or a car or a truck has a chassis-frame. construction. This is the most used chassis right now due to the number of advantages of has over the other two chassis. Tubular chassis Tubular chassis were mainly used in race cars due to the unrivalled safety they provide. These were an upgrade from the ladder chassis as they were three dimensional and were stronger than ladder chassis. They employed the use of a strong structure below the doors to get more overall strength. Tubular chassis are rarely used on passenger cars.

**The various functions of tractor chassis are listed below: -**

· The load of assemblies like engine, transmission, steering etc. is aptly supported by chassis frame design.

· The rear and front wheels are connected to each other using tractor chassis.

· The load of implements is also carried easily by this frame.

· The working on an uneven field normally causes more load production. This extra load is managed by the frame efficiently.

· The load incurred when tractor is working on the field along with an implement is also managed by this frame.

· The load produced by sudden application of brakes or acceleration is also managed.

· The cornering forces are nicely negotiated by these frames.

**Figure 1: Vehicle Chassis**

**SUSPENSION SYSTEM: -** Suspension is the system of tires, tire air, springs, shock absorbers and linkages that connects a vehicle to its wheels and allows relative motion between the two. Suspension systems must support both road holding/handling and ride quality, which are at odds with each other. The tuning of suspensions involves finding the right compromise. It is important for the suspension to keep the road wheel in contact with the road surface as much as possible, because all the road or ground forces acting on the vehicle do so through the contact patches of the tires. The suspension also protects the vehicle itself and any cargo or luggage from damage and wear.

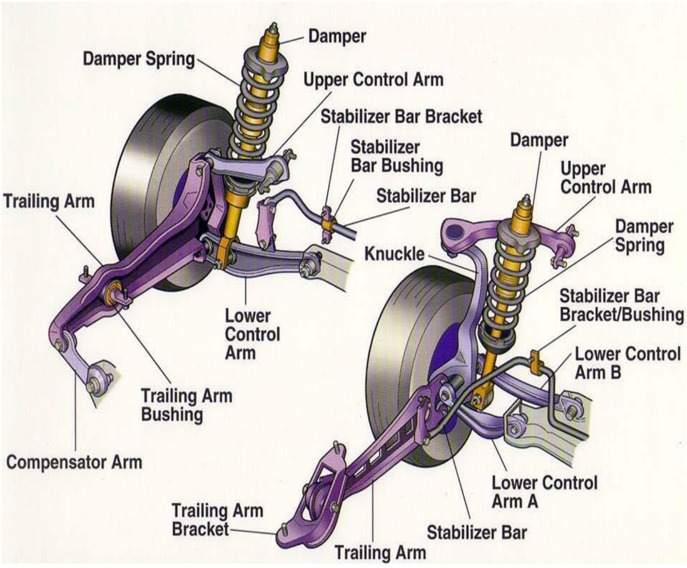



**Figure 2: Vehicle suspension**

## PROBLEM IDENTIFICATION

The main problem associated with current suspension systems installed in heavy loading vehicles rovers (including those with active and semi active suspension systems) is their slow speed of motion which derail the rhythm to absorb the shocks generated by wheels which remain the result of two factors.

First, to pass over obstacles, the vehicle must be geared down significantly to allow for enough torque to raise the mass of the vehicle. Consequently, this reduces overall speed which cannot be tolerated in the case of heavy loading vehicles.

Second, if the vehicle is travelling at a high speed and encounters an obstacle (height greater than 10 percent of wheel radius), there will be a large shock transmitted through the chassis which could damage the suspension or topple down the entire vehicle.

That is why current heavy loading vehicles travel at a velocity of 10cm/s through uneven terrain. The software based testing of rocker bogie suspension system describes the momentum and efficiency related utilities in cumulative manner.

## IMPLEMETATION OF SELF LEVELING AND SELF ADAPTIVE POWER CHASSIS MECHANISM IN TRACTORS

To increase the stability of tractors suspension we are introducing the self-adaptive and self-leveling power chassis mechanism. Present suspensions available on tractors are good and quite stable but are limited to some situations. So, our research work is based on the increasing the stability of the vehicle and climb the obstacles smoothly.

For design and development of self-adaptive and self-leveling power chassis mechanism we are modifying six wheeled Rocker bogie suspension into 4 wheeled drive suspensions. In changes to Rocker Bogie mechanism, we are removing rear rockers from that suspension and taking angle between left over links which are called as bogies as 180 degrees permanently.

All the 4 wheels in our mechanism will drive independently to each other. So, our design of self-adaptive and self-leveling power chassis mechanism consist of 4 wheels where 2 wheels of each side is connected to 180-degree link. Also, the links will have hole in middle where bearings will be fixed. In a fabrication of our project work simple shaft is placed between the two bearings. But in real conditions, the shaft is replaced by differential from which a power is distributed to all 4 wheels. The mechanism is made in such a way that when one wheel is climbing the obstacles, the other wheels will remain in touch with the.

## METHODLOGY

### METHOD TO PERFORM

Our Goal as a team firstly to construct a rocker bogie system.

· In changes to the original Rocker bogie drive system, we are making 4-wheel drive rocker bogie system that will have individual steering system.

· To perform in sturdy, harsh and robust environmental conditions accurately, we are making a prototype of our project. In prototype we are simply constructing a Rocker Bogie System.

· After the observation and calculation, we will move on to the final project where tractor is going to assembled at the top of the whole Rocker Bogie Drive system.

As per the research it is find that the rocker bogie system reduces the motion by half compared to other suspension systems because each of the bogie's six wheels has an independent mechanism for motion and in which the two front and two rear wheels have individual steering systems which allow the vehicle to turn in place as 0 degree turning ratio. Every wheel also has thick cleats which provides grip for climbing in soft sand and scrambling over rocks with ease. To overcome vertical obstacle faces, the front wheels are forced against the obstacle by the rear wheels which generate maximum required torque. The rotation of the front wheel then lifts the front of the vehicle up and over the obstacle and obstacle overtaken. At last, the rear wheel is pulled over the obstacle by the front two wheels due to applying pull force. During each wheel's traversal of the obstacle, forward progress of the vehicle is slowed or completely halted which finally maintain vehicles Centre of gravity. The above said methodology is being practically proved by implementing it on four-wheel drive self-adaptive and self levelling power chassis mechanism.

### DESIGNING OF COMPONENTS: -

We have used solid work software which helps us to design the component of our project with immense accuracy this is used to develop mechatronics systems from beginning to end. At the initial stage, the software is used for planning, visual ideation, modeling, feasibility assessment, prototyping, and project management. The software is then used for design and building of mechanical, electrical, and software elements also. Design of component is done based on calculation which is present in chapter 4 we have calculated length of each component and then proceeded for further design.

We have designed component like: -

- Guide Rail
- Rod
- Balance lever
- Wobble wheel
- Rocker
- Bogie Pivot
- Output Shaft
- Rocker Pivot
- Modified Differential
- Free revolution joint

- Nut and bolt
- High performance bearing

**Material selection**

We have selected certain material such like structural steel, cast iron and many more for our project but after researching about material we have considered some parameters which leads our project requirements in future.

The parameters are: -

- Strength
- Weight
- Durability
- Flexibility
- Resistance to heat
- Corrosion
- Machinability

| Property of material | Value |
|---|---|
| Density | 7.8e-006Kg mm^-3 |
| Coefficient of Thermal Expansion | 1.2e-005 C^-1 |
| Specific Heat | 4.34e+005mJ Kg^-1 C^-1 |
| Thermal Conductivity | 6.05e-002 W mm^-1 C^-1 |
| Resistivity | 1.7e-004 ohm mm |

**Table no 1: - Structural steel**

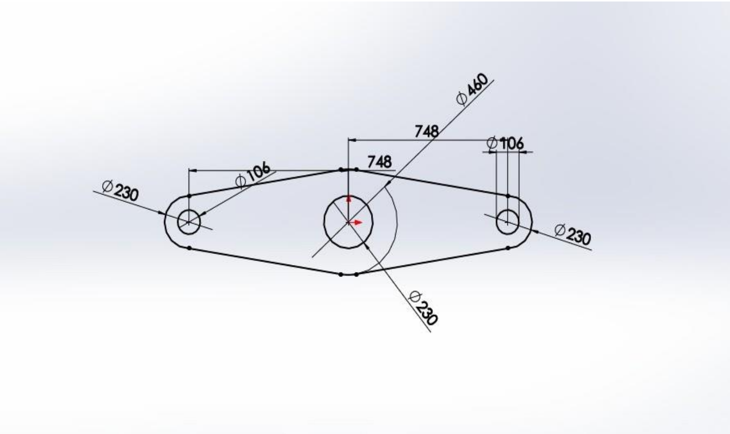
**Material Selected**

Material which we have selected for our project is structural steel just because of their property which is perfectly suited for manufacturing and according to our parameters and we done some market survey for our material at last cost evaluation is done.

| Property of material | Value |
|---|---|
| Compressive Yield Strength | 250MPa |
| Tensile Yield Strength | 250MPa |
| Tensile Ultimate Strength | 460MPa |
| Reference Temperature | $22^0$ |
| Relative Permeability | 10000 |

**Table No 2: - Property of Structural steel**

**Figure of designed component in 2D: -**



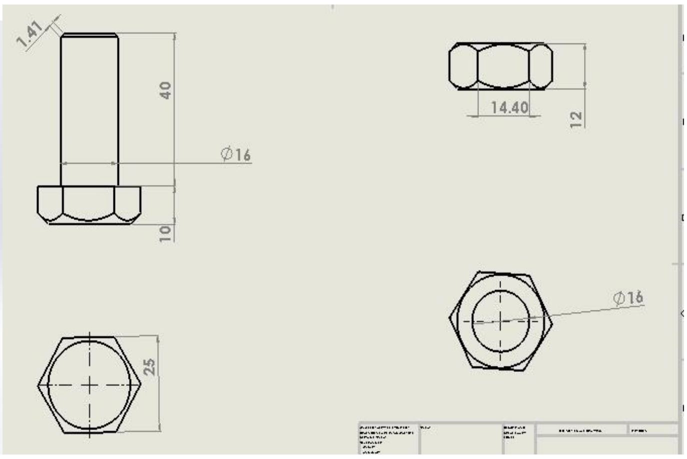




**Fig No 1: - Side pivot arm** **Fig No 2: - Nut and bolt**

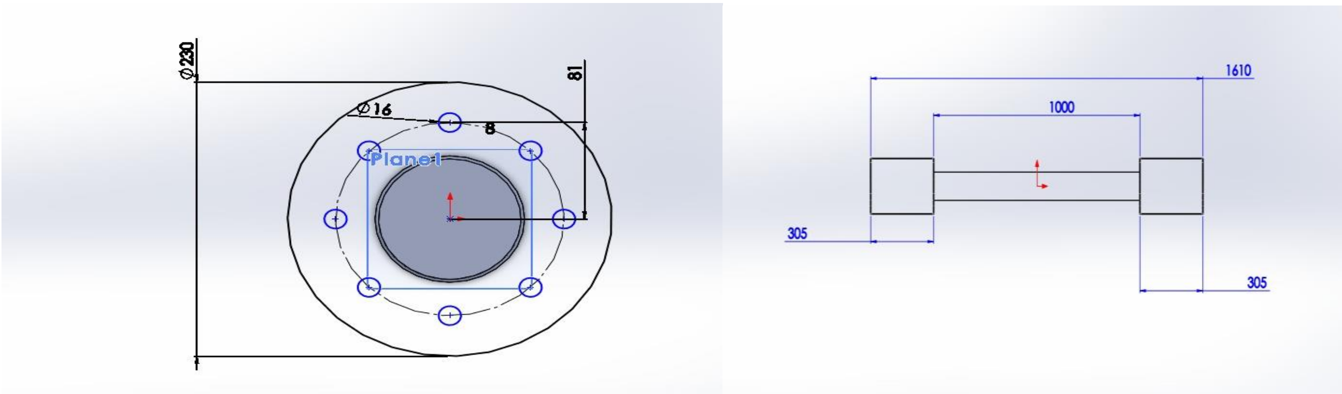



**Fig No 3: - Wheel shaft**

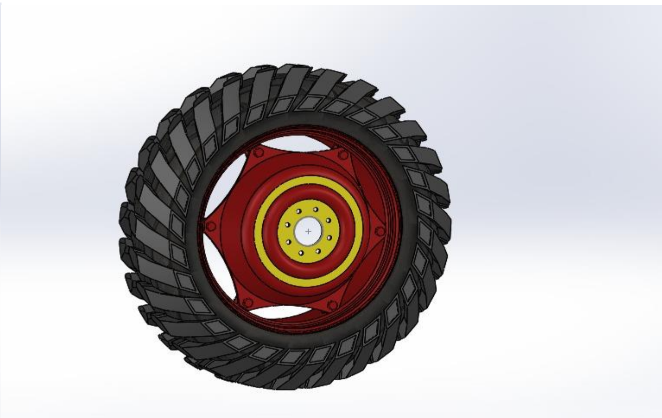


**Fig No 4: - 3D Side pivot arm** **Fig No 5: - 3D wheel shaft**

The 2D and 3D design assembly of component is done in software name solid work this shows how exactly the project would look like in future after fabrication this give the brief information about the mechanism.

**The assembled 2D and 3D images: -**

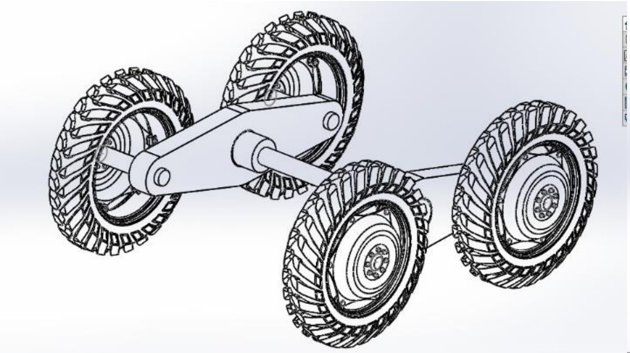


**Fig No 6.: - 2D figure of project** **Fig No7.: - 3D Image of Project**

## RESULT & CONCLUSION

We are successfully able to design and developed the self-adaptive and self levelling power chassis mechanism. As per calculations and data, our model can climb the obstacles. We also analyzed and simulated our project in software's like Ansys and CPS and successfully find it working according to the measured conditions. We also successfully tested our design by moving it in forward and reverse direction. Simulation of our design in CPS software confirms movability of linkage and their relative motion with each other. This research paper produces a novel design in increasing the stability of heavy-duty vehicle tractor. In future if self-adaptive and self levelling power chassis mechanism installed in tractor it will the stability, reduce the bumps and vibrations.

## FUTURE SCOPE

· This type of chassis claims to be more stable.

· This mechanism climbs bigger obstacles.

· It can be used for long period of time.

· Stronger and robust mechanism.

· If this mechanism implements in tractors with V2-HVPC Transmission System, it will be revolution for the drivers of that vehicle, Agriculture tillage, Easy transportation of fragile goods in rough terrain and reduce the maintenance cost of the suspension in heavy road movers.

· Its future application will be assisting astronauts during space operations, it will act as a path finder too. · It can be useful in space mission too, recently it is used in Mars Rover. This mechanism takes consideration on unevenness of the surface it is driving on.

· This rover has larger wheel as compared to obstacles; it can easily operate over most of the Martian rocks. Other important contributions

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