MODELING AND ANALYSIS OF VARIABLE TRACKED SELF LEVEL BALANCING ROCKER SUSPENSION OF AN AUTOMOBILE

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Abstract: The rocker suspension mainly use in the planet exploration rover as the key part which connects the body and wheel, bearings weight load of the body. Research on key technologies of rover has important significance in theory and engineering application of suspension. The objective of design is to obtain variable wheel track and self-levelling chassis adapted to various track widths and off road conditions. The balance rocker suspension is a novel mechanism which ensures full-time four-wheel drive in a complex road environment while maintaining the main body level always parallel to the ground.

The design consists of balance rocker suspension mechanism i.e. wobble wheel, balance lever, rod, guide rail, side plate, centre hinge, and driving axle, driving axle holder. Static and explicit dynamic analysis is performed on the model to verify its static and dynamic loading conditions and the results showed that the design is safe. Mechanism is also created to verify the model is self-adjusting or not during uneven road conditions. The design is done in Creo Parametric 2.0 modeling software and Analysis is done in Ansys 15.0.

Keywords: Explicit dynamic analysis, Mechanism, Rocker suspension, Self-leveling chassis, Variable Track

I. INTRODUCTION

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 derails the rhythm to absorb the shocks generated by wheels which remain the result of two factors. First, in order 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 of10cm/s through uneven terrain.

After optimizing the ground profile it can be assumed that each of the rocker working with specified angle of inclination α, but can be changed by the users demand. The Genetic Algorithm evaluates of the fitness of each arm in the population and therefore justifies the goodness of each of these specific combinations of link lengths and variable angles of the rocker-bogie suspension mechanism.

Ground clearance is a critical factor in several important characteristics of a vehicle. For all vehicles, especially cars, variations in clearance represent a trade-off between handling and practicality. A higher ground clearance means that the center of mass of the car is higher, which makes for less precise and more dangerous handling characteristics (most notably, the chance of rollover is higher). However, it also means that the car is more capable of being driven on roads that are not level, without the road scraping against and likely damaging the chassis and under body.

Load Balancing is the practice of distributing a workload across multiple computers for improved performance. Load balancing distributes work among resources in such a way that no one resource should be overloaded and each resource can have improved performance, depending on the load balancing algorithm. Items such as network traffic, SSL requests, database queries, or even hardware resources such as memory can be load balanced. This practice is commonly used in server farms where multiple physical boxes are coordinated to fulfill the requests of many end users.

Load balancing can be accomplished through software but is usually achieved with the help of a dedicated hardware appliance due to the speed requirements. A load balancer can use many different algorithms. The most basic method is round-robin, which sends a request to each server in the cluster successively. More sophisticated techniques make decisions based on CPU usage, number of requests queued, average response time or even number of lost packets. One problem with load balancing is that a user's session is likely not replicated across the whole server cluster so typically a single user's requests will be "sticky" and always be routed to the same backend server.

Another, more global, method of load balancing is any cast. Any cast is an addressing strategy often used in DNS where hosts in multiple geographical locations represent the same IP address. This balances workload because any request is routed to the closest host (as determined by the routing protocol). In the event of one of the hosts going offline the request is then routed to the next closest available host. Routing requests to the nearest host has the added benefits of increasing response time and reliability.

II. LITERATURE REVIEW

Journal papers and patents explored here are related directly or indirectly to the proposed area of work that is design and analysis of variable wheel track self-adjusting balance rocker suspension system of an off road vehicle. These papers are to support and enlighten the whole process of design in the specific area.

GaoQiaoming [1], in his paper stated that the objective of design is to achieve a variable ground clearance, variable wheel track and self-leveling chassis adapted to the various types of crop grown ridge section and height. The V2-HVPC design consists of the main body, the balance rocker suspension, two driving axles and the steering system. Those assemblies form an H-type chassis structure where both sides of the driving axle and the main body are connected to power transmission. The ground clearance and wheel track have the adjustable function.

SmayantakHokale [2], says the handling of vehicle is depends number of parameters, center of gravity of that vehicle is one of them. For sport car it always keeps low but for the passenger car it compromises with its ground clearance. To provide the appropriate ground clearance is need of designer to reduce the destructive damage of bottom component of vehicle. CG is important parameter to vehicle for handling and dynamic stability at high speed. In advanced vehicle there are active and semi-active suspensions to give stability to the vehicle. Here, this paper introducing various techniques used to provide ability to the vehicle for more stability and road holding capacity.

According to Mr. Hrishikesh V Deo [3], the design of existing suspension systems typically involves a compromise solution for the conflicting requirements of comfort and handling. For instance, cars need a soft suspension for better comfort, whereas a stiff suspension leads to better handling. Cars need high ground clearance on rough terrain, whereas a low center of gravity (CG) height is desired for swift cornering and dynamic stability at high speeds. It is advantageous to have low damping for low force transmission to vehicle frame, whereas high damping is desired for fast decay of oscillations.

III. MODELING OF THE VAIABLE TRACKED SELF BALANCING SYSTEM

Creo Parametric is a computer graphics system for modeling various mechanical designs and for performing related design and manufacturing operations. The system uses a 3D solid modeling system as the core, and applies the feature-based, parametric modeling method. In short, Creo Parametric is a feature-based, parametric solid modeling system with many extended design and manufacturing applications.

Creo Parametric is based on a single data structure, with the ability to make change built into the system. Therefore, when a change is made anywhere in the development process, it is propagated throughout the entire design-through-manufacturing process, ensuring consistency in all engineering deliverables.

Creo Parametric's features are process plans with imbedded intelligence and are easy to use, while at the same time, powerful enough to fillet, round, and shell even the most complex geometry. These features contain non-geometric information, such as manufacturing processes and associated costs, as well as information about location and relationships.

This means that features do not require coordinate systems for placement, and they "know" how they are related to the rest of the model. As a result, changes are made quickly and always adhere to the original design intent.

IV. COMPUTATIONAL ANALYSIS OF THE COMPLETE SYSTEM

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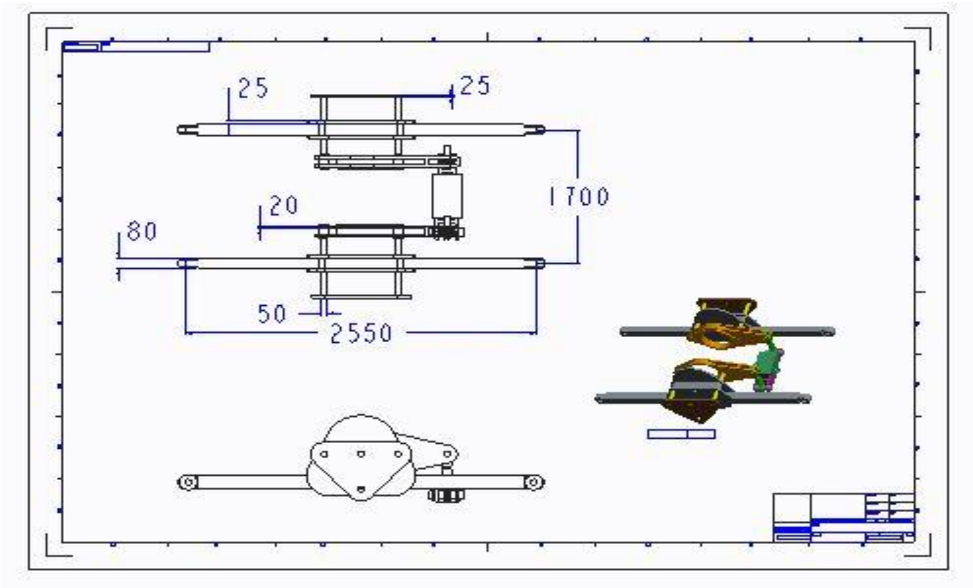

Fig. 1 Modeling and dimensioning of Complete System

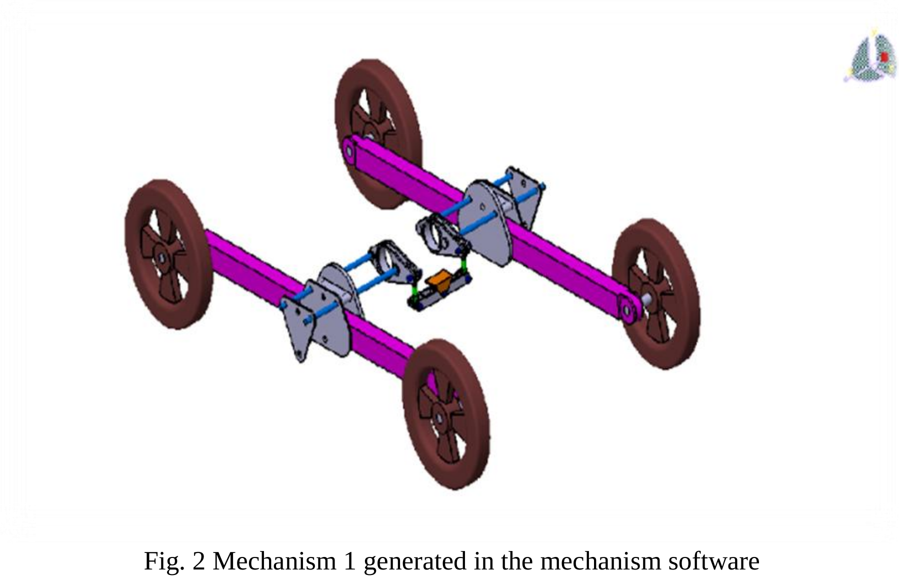

Fig. 2 Mechanism 1 generated in the mechanism software

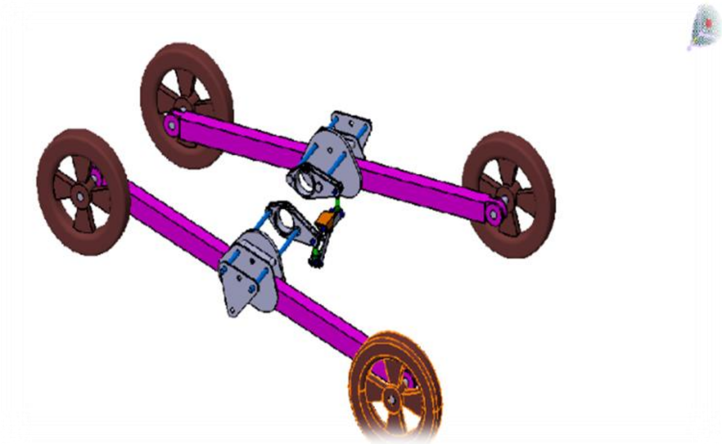

Fig. 3 Mechanism 2 generated in the mechanism software

Static Analysis of balance rocker suspension system:
The geometric model for the balance rocker suspension system is as shown in the Fig. 4

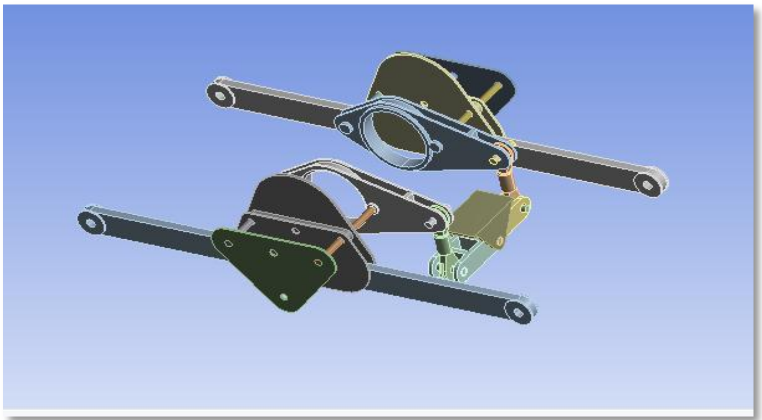

Fig. 4 Geometry of the balance rocker suspension system

6.1.2 Meshed Model:
The meshed model for the balance rocker suspension system is as shown in the Fig. 5

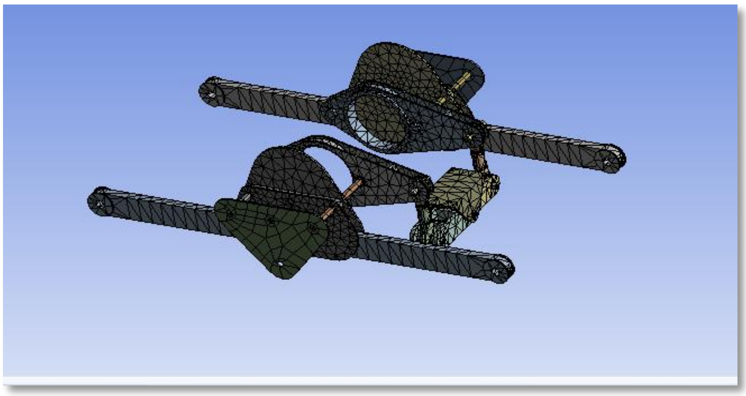

Fig. 5 Meshed model of the balance rocker suspension system

Factor of safety of structural steel:
The Factor of safety for the balance rocker suspension system made of structural steel is as shown in the Fig. 6

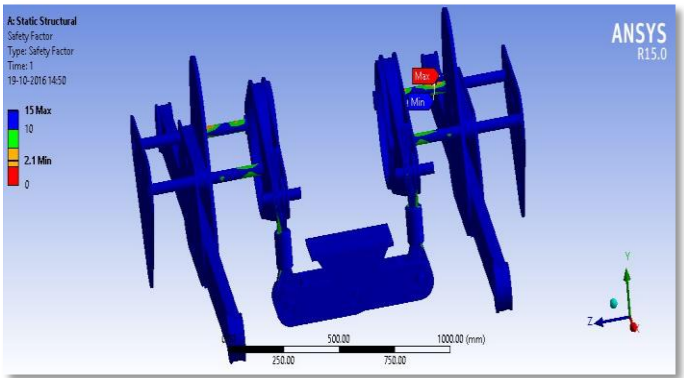

Fig. 6 Factor of safety for balance rocker suspension system made of structural steel

Factor of safety of cast iron:
The Factor of safety for the balance rocker suspension system made of cast iron is as shown in the Fig. 7

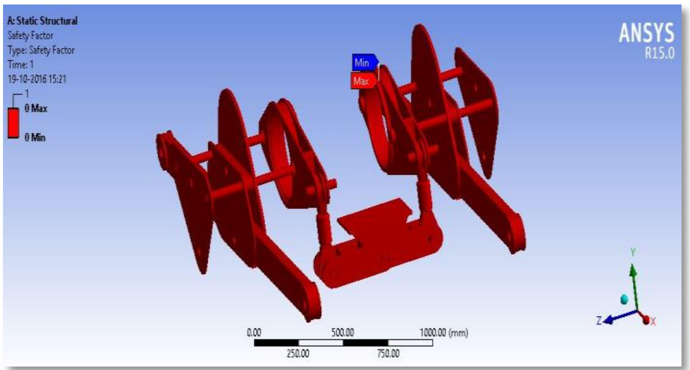

Fig. 7 Factor of safety for balance rocker suspension system made of cast iron

Factor of safety of Aluminium:
The Factor of safety for the balance rocker suspension system made of Aluminium is as shown in the Fig. 8

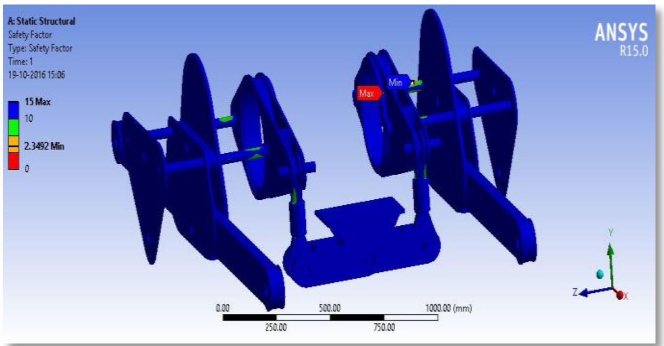

Fig. 8 Factor of safety for balance rocker suspension system made of Aluminium

V. RESULTS AND DISCUSSION

In this project a new balance rocker suspension system is proposed for off road vehicle which is very useful in hilly areas and agriculture purpose. First a model of balance rocker suspension is designed in Creo 2.0 and it was found that the weight of model is very high then design optimization is carried on this model without compromising at strength in order to reduce weight. Static analysis is done on the model before and after optimization with different materials. Explicit dynamic analysis has also been preferred for the proposed model. Both static and explicit dynamic analysis produced good results. The Analysis has been done in Ansys 15.0 and results are as follows.

The results have changed significantly before and after optimization. The results obtained are within the limits without compromising in its strength. Before optimization the weight of the body is 980 kgsi.e for structural steel and after optimization the weight of the body reduces to 580 kgsi.e for structural steel.

When considered structural steel, the stress is 119.05 M Pa and the yield strength is 250 M pa and the factor of safety is 2.1.which is considerable. When compared to other materials structural steel has low stress value, but considering weight, it has more weight i.e 580 kgs. Guide rail is subjected to high stress. The deformation of structural steel is very low i.e 1.1704 mm when comparing to other materials. Maximum deformation occurs in wobble wheel.

When the structural steel is replaced with aluminium, weight of the model reduced to 204 kgs. The stress is 119.19 M Pa and the factor of safety is 2.34 which is acceptable. The deformation of aluminium is large when comparing with structural steel i.e 3.30 mm, but this deformation is in limits. Maximum Deformation occurs in wobble wheel and Maximum stress occurs in guide rail.

When the structural steel is replaced with cast iron the weight of model reduced to 534 kgs and the stress is 118.95 M pa which is in the limits but it has no factor of safety because it is brittle material .The deformation of cast iron is 2.12 mm which is acceptable. Maximum Deformation and Maximum stress occurs in wobble wheel and guide rail. It is not suggested because it is brittle and may fail at any time.

When the structural steel is replaced with epoxy glass composite material the weight is reduced to 194 kgs, which is very low when compared to other materials. But when considered deformation it is very high i.e. 32.70 M pa. Which is very high and it is not suggested, but the stress value is 122.5 M Pa which is within the limits. For this model also Maximum deformation and Maximum stress occurs in wobble wheel and guide rail.

After static analysis in Ansys 15.0 explicit dynamic analysis is also done in Ansys 15.0 in which a wall is created and proposed model is made to hit the wall with low impact velocity i.e 8 km/hr and the deformation in the member is 2.22 mm which is very low and the deformation takes place in center part of the body i.e. wobble wheel, balance lever and rod. The deformation is acceptable and the design is safe in crash analysis.

VI. CONCLUSION

In this project a variable wheel track, self-adjusting balance rocker suspension system is proposed which is very useful in agricultural tractor and off road vehicles. In this project proposed model is created using Creo parametric 2.0 software. Static analysis is done for the proposed model and static analysis results showed that there is need for optimization to reduce its weight and factor of safety. After design optimization the weight of the model reduced drastically. A mechanism is created in CATIA V5 software, in this mechanism variable wheel track and self-adjustment of balance rocker suspension is clearly seen. After optimization again static and explicit dynamic analysis is performed and the results showed that the design is safe.

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