

Analyzing the Design of the Rocker Bogie Suspension System and Determine Its Feasibility for Use in Front-Loading Vehicles

Vandana Chodhary¹, Rekha Kumari²

Associate Professor¹, Student²

Department of Mechanical Engineering

Jorhat Engineering College

Corresponding Author's E-mail: Kumarirekha9818@gmail.com

Abstract

When the value of gravity remains lower than the earth's own gravitational coefficient, the current suspension system fails to achieve the intended outcomes as the quantity and method of shock absorption changes. NASA and the Jet Propulsion Laboratory collaborated on a suspension system dubbed the rocker-bogie Suspension System to counteract anti-gravity effects. It's essentially a suspension system for mechanical robotic vehicles used for space exploration. The rocker-bogie suspension based rovers have been successfully implemented for the Mars Pathfinder, Mars Research Rover (MER), and Mars Science Laboratory (MSL) missions carried out by the world's top space exploration organisations. Every space exploration firm engaged in the business of space research is presently favouring the suggested suspension mechanism. The goal of this study is to learn about the mechanical design and benefits of the Rocker-Bogie suspension system in order to see whether it can be used in traditional loading trucks to improve efficiency and reduce maintenance costs.

Keywords: *Laboratory collaborated Exploration, Efficiency, Mission, Rocker-Bogie, and Suspension System*

INTRODUCTION

The development of the rocker bogie suspension system, which was especially

developed for space exploration vehicles, has a long history. As these rockers are linked to each other and the vehicle chassis

via a selectively adjusted differential, the word "rocker" indicates the rocking aspect of the bigger links located on either side of the suspension system and balance the bogie.

When one rocker moves up-ward, the other moves down-ward in line with the motion to maintain the vehicle's centre of gravity. The chassis is important in maintaining the average pitch angle of both rockers by enabling them to move as needed. One end of a rocker is connected with a driving wheel, while the other end

is pivoted to a bogie, which gives the necessary motion and degree of freedom, according to the acute design.

The term "bogie" refers to the conjoining links in the system that contains a driving wheel at either end. Bogies were frequently employed as idlers for army tanks' tracks, spreading the weight across the ground. Bogies were also frequently employed on semi trailer truck trailers at the period, since the vehicles would be carrying considerably larger loads.

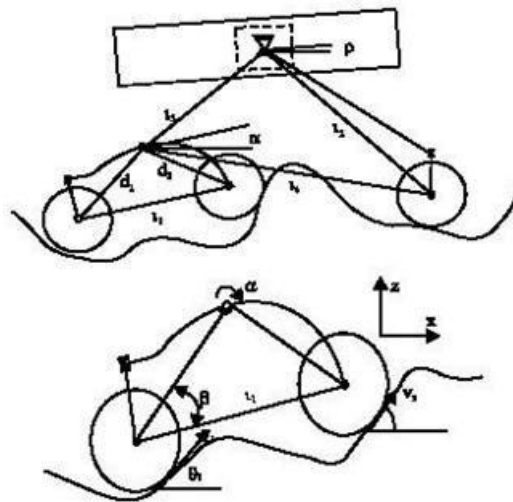


Fig: encounter area of rocker bogie suspension system.

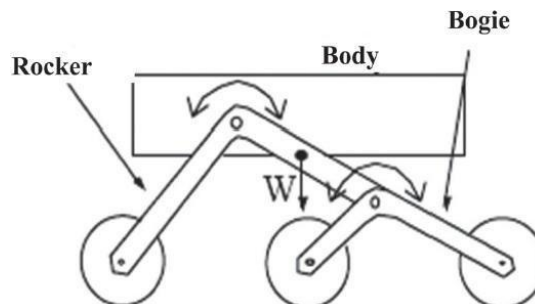


Fig: 2D Line diagram of Rocker-bogie suspension system and its motile joints.

Literature Review

The origins of the rocker bogie suspension system may be traced back to the creation of planetary rovers, which are mobile robots built specifically to travel on the surface of a planet. Early rovers, such as the Lunokhod I, were teleoperated, while more modern rovers, such as FIDO, Discovery, and the newly built Curiosity Mars exploration rover, are completely autonomous. The rovers had to be very tough and dependable since they had to resist dust, high winds, corrosion, and drastic temperature fluctuations in unknown circumstances. The majority of rovers are powered by batteries that are replenished by solar panels placed on their surface throughout the day.

The rovers' locomotion mechanism is still critical for them to reach target locations, perform research, gather data, and position themselves according to demand. Wheeled, legged, and caterpillar locomotion are the three major kinds of rover locomotion that have been created so far. The kind of locomotion mechanism is the primary distinction between the various types of planetary robots. Despite the development of many legged and hybrid robots, most researchers continue to concentrate on wheeled locomotion for rovers because to its locomotive simplicity and benefits, and

among wheeled locomotion designs, the rocker bogie suspension system remains the most popular. For maximum suspension and ground clearance, the ancient FIDO rover and the Sojourner had six independently steered and powered wheels hung on a rocker-bogie system. Rocky Seven Rover has a similar suspension setup, but the front wheels are different. To overcome obstacles and huge holes, the Nanorover and Nomad Rovers feature four steered wheels hung from two bogies, while the CRAB Rover has two parallel bogie systems on each side. In terms of the original study, software optimization finds an optimum in a limited solution space given an initial solution, and Dr. Li et al. develop a mathematical model to generalize rover suspension parameters that determine the rocker-bogie system's shape. The goal of the rocker bogie suspension system's development is to create a system that reduces energy consumption, vertical displacement of the rover's centre of mass, and pitch angle. Our goal in this study is to transfer the rocker bogie system's main benefits to conventional vehicles, in order to eliminate the pain and difficulties associated with traditional suspension systems in general, and heavy vehicle suspension systems in particular.

Principle

The rocker-bogie design, which has no springs and stub axles in each wheel, enables the chassis to climb over any obstacles up to twice the diameter of the wheel while maintaining all wheels on the ground for the greatest amount of time. The tilt stability of any suspension system is restricted by the height of the centre of gravity, and the suggested system is no exception.

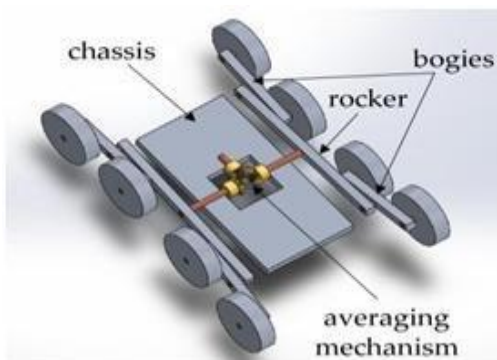


Fig: SOLIDWORKS 3D Model of Rocker Bogie system.

During an obstacle course, systems with springs tend to tilt more readily when the laden side gives. Either vehicle built on the basis of Rocker bogie suspension can sustain a tilt of at least 50 degrees in any direction without overturning, depending on the centre of overall weight, which is the greatest benefit for any heavy loaded vehicle. The technology is intended to be used in low-speed working vehicles such as big trucks and bulldozers that travel at a speed of approximately 10 centimetres per

second (3.9 in/s) in order to reduce dynamic shocks and vehicle damage while overcoming large obstacles.

METHODOLOGY

According to the research, the rocker bogie system reduces motion by half when compared to other suspension systems because each of the bogie's six wheels has its own independent mechanism for motion, and the two front and two rear wheels each have their own steering systems, allowing the vehicle to turn in place at a 0 degree turning ratio.

Every tyre also features large cleats that offer enough traction to easily climb through soft sand and scramble over boulders.

The front wheels are pushed against the obstruction by the centre and rear wheels, which produce the greatest necessary torque, in order to overcome vertical obstacle faces. The revolution of the front wheel raises the vehicle's front end up and over the obstacle and overtaken obstacle.

Those wheels in the centre are then pushed against the obstruction by the back wheels and pulled against the obstacle by the front wheels until the obstacle is lifted up and over. Finally, owing to the application of pull

force, the rear wheel is dragged over the barrier by the front two wheels. The vehicle's forward movement is delayed or totally stopped during each wheel's traverse of the barrier, which maintains the vehicle's centre of gravity.

The aforementioned technique has been shown in practise by applying it on an eight-wheel-drive ATV system in order to maximise the benefits of the rocker bogie system.

Observation

The major issue with existing suspension systems in heavy-loading vehicles rovers (even those with active and semi-active suspension systems) is their sluggish speed of motion, which limits the system's ability to absorb shocks produced by wheels, which are caused by two causes. To pass over obstacles, the vehicle must first be geared down sufficiently to provide adequate torque to lift the vehicle's mass. As a result, total speed is reduced, which is not acceptable in the case of heavy-loading trucks.

Second, if the vehicle is travelling at a high speed and comes over an obstruction (height more than 10% of wheel radius), a significant shock will be transferred through the chassis, potentially damaging

the suspension or bringing the vehicle to a halt. As a result, today's heavy-loading trucks move at a speed of 10cm/s across uneven terrain. The momentum and efficiency associated utilities are described in a cumulative way by the software based testing of the rocker bogie suspension system.

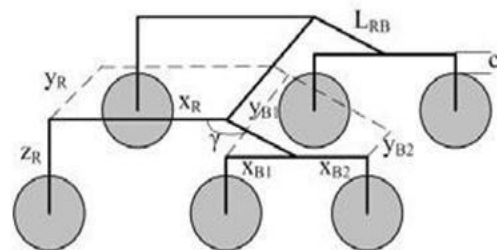


Fig: Geometry of Rocker Bogie.

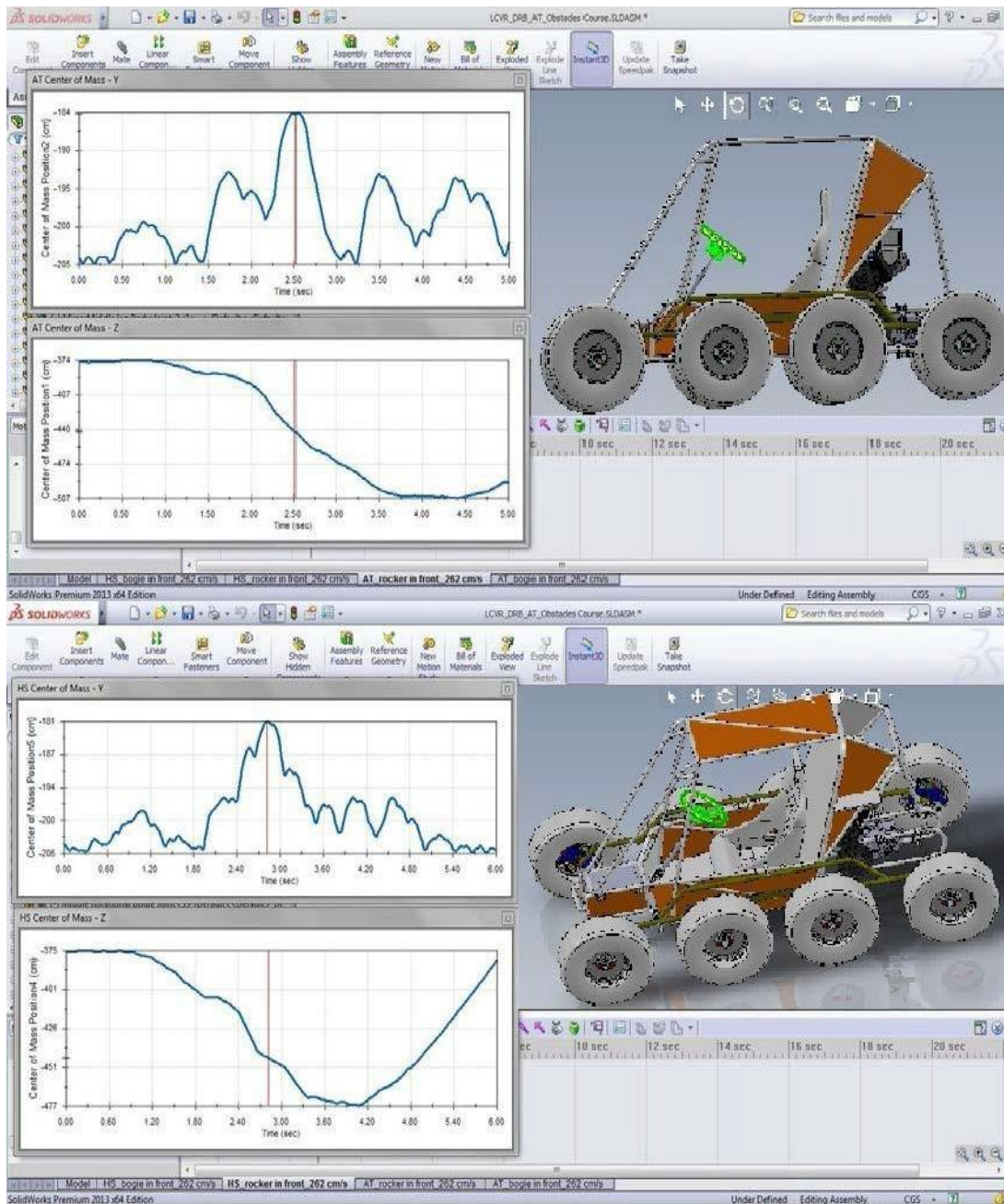
Following the optimization of the ground profile, it may be expected that each of the rockers will operate at a certain angle of inclination α , which can be adjusted at the request of the user. The Genetic Algorithm necessitates a determination of each arm's fitness in the population, which supports the usefulness of each of these unique combinations of link lengths and variable angles in the rocker-bogie suspension mechanism.

RESULT & DISCUSSION

Following the completion of the simulation, the results were generated and analysed, comparing the disturbances in the ATV's Center of Gravity position in each of the two operating modes, and

contrasting the response of these two distinct configurations of the rocker-bogie suspension to upcoming obstacles that may be present along the system generated

obstacles and roadblocks. These tests were place on a 10-square-meter platform with a single cylindrical bumper. The overall mass of the simulated rover is 260 kg.



**Fig: Dynamic rocker-bogie high-speed ATV configuration
SOLIDWORKS simulation results.**

CONCLUSION

When high-speed traversal is needed, the suggested article develops a new design to increase the rocker-bogie mobility system in traditional heavy-load vehicle behaviour. The scenario presented two ways of operation, one of which is a rocker-bogie system with strong obstacles traversal characteristics, and the other of which is an extended support hexagon accomplished by rotating the bogies on either side of the vehicle. When comparing the SSF measure with 3D model simulations done in SOLIDWORKS, the suggested change improves the stability margin and proves with useful and lucrative results. If the technology is implemented in large trucks and traditional off-road vehicles in the future, the complexity and power needs to maintain bumping will be significantly reduced.

REFERENCES

1. D.A. Mada, Sunday Mahai. Spray Equipment and Calibration. Spray Equipment and Calibration. International journal of Engineering Research and technology. June 2009. 72:412-425p.
2. Hong-an Yang, Luis Carlos Velasco Rojas*, Changkai Xia,

Qiang Guo, School of Mechanical Engineering, Northwestern Polytechnic University, Xi'an, China, Dynamic Rocker-Bogie: A Stability Enhancement for High-Speed Traversal- Vol. 3, No. 3, September 2014, pp. 212~220 ISSN: 2089-4856.

3. R.E. Moore, Interval analysis (Englewood Cliffs, NJ: Prentice-Hall, 1966). (8)
4. Brooks Thomas; Graham Gold; Nick Sertic; DARK ROVER ROCKER-BOGIE OPTIMIZATION DESIGN, The University of British Columbia, Project Number 1076 January 18, 2011.