iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.42804

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

Design and Analysis of Multipurpose Relief Vehicle

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Abstract: ***The rocker bogie suspension system has all the tough capabilities so that it can work in rough terrain because of its weight distributing property on all its 12 wheels. The only disadvantage of the mechanism is that its speed is slow. In this project during research we have deeply focused on the 12 wheels mechanism & its design which has certain advantages of linear bogie motion in defending the whole system or assembly from getting disengaged and rollover during working in high speed operations. This has magnificently increased the chances of dependability of structure on uneven surface & also its high speed examination with hurdle height capacity as double the diameter of the wheels .The requirement to develop a highly steady suspension system capable of operating in multi terrain surfaces while keeping all the wheels in contact with the ground. To design a machine that can navigate terrains where the left and right rockers independently climb different obstacles.***

Keyword: Rocker bogie mechanism, Rover, Multipurpose

I. INTRODUCTION

Recently NASA started a motivated study on a very sophisticated device called Mars Pathfinder. This is a primary rover explorer during the program. The future rovers will have to be made in such a way that they would travel several kilometer over a long period of months and handle uneven samples. They must are going to be somewhat independent. They are being made likely for the missions that are dynamic and moderately difficult. The designing of the rover must be methodical and should relate to environment that is vital. Manufacturing prototype are very important for rover development. Modest flexible of rocker bogie device are developed and are used as valuation.

Cultivating the acts of an easier four wheel rover has also been discovered .In this effort, actuator idleness and also the location of the Centre of mass of a vehicle is demoralized to develop power. The strategy rely on real-time dimensions of wheel contact forces, which are hard to live in preparation. Traction can even be upgraded by checking the sliding of the rover. This research defines a physical model of a rocker-bogie rover, the Lightweight Survivable Rover. A proficient method of cracking its opposite kinematics and its quasi-static force analysis is drawn. The methods contain the properties of the rover's manipulator, actuator saturation and tire-slip reflections. A graphical interface that improves the sympathetic of the physics of the model is additionally defined.

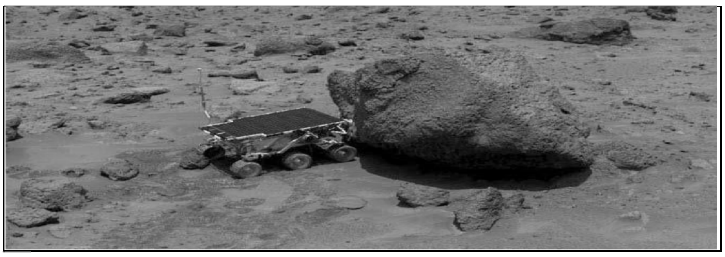


Figure 1: Sojourner examining the rock

An orange colored big ball softly bounced on the surface of Mars on July 4, 1997, with an uncommon robotic vehicle inside. This was the primary planetary mission which has been extensive public interest after first man on the moon. Small rover "Sojourner" conducted scientific experiments for 83 Sols and took many photographs. Travelling on another planet came from vision to real by the assistance of science and chronic motivated research. The operative mission cheered the scientists and NASA to continue the exploration with newly developed rover. Many rovers developed with different structures and scientific purposes after Sojourner. The 2 rovers were landed on Jan 2004 on different location on mars named Spirit and Opportunity. The study and the scientific effect were more powerful that the larger physical dimension of the vehicle. The space agency are now going to be continuing the robotic geologist in future all the three robots are the proof of their success.

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Volume 10 Issue V May 2022- Available at www.ijraset.com

II. LITERATURE REVIEW

The whole concept of our research work is to form a system driven by rocker bogie mechanism that is supported and used by NASA. NASA has already developed the rocker bogie suspension suspension rover & was used within the Mars pathfinder and Sojourner rover. The actual working of the mechanism is that it keeps all the 12 wheels of the robot to bear with the bottom even or uneven surface. This creates a brilliant traction & maneuverability. The rocker bogie suspension mechanism used by NASA in the current space program mission and was a approved design for wheeled mobile robot because it had a steady or resilient capabilities to cater obstacles and since it is uniformly distribute the payload over12 wheels in the slightest degree times. Our project of multipurpose relief vehicle is predicated on this rocker bogie mechanism. It can also be used for transporting military supplies and arms to battle field and also to assist the injured army personnel which is operates in a rough track & to climb on steps. It absolutely has plenty of advantages but in all the most important disadvantage is that rotation of the device when required. By providing individual motors the rotation are possible which arises the cost & complexity in the design. Here in our project we kept it as manual multipurpose relief vehicle which simplifies the planning additionally as reduces the whole cost and disbursement of mechanism. During work, the entire mechanism was designed and the modelling was wiped out on SOLIDWORKS software and therefore the same was tired 2D in AutoCAD Software. The researchers discusses the concept and parameter of design of a multipurpose relief vehicles, capable of transporting military supplies to the battle field and also to assist the injured army personnel to succeed in the medical destination. Together with establishing an idea design, robust design parameters were set to reduce performance variation. The Grey- based Taguchi Method was adopted for providing an optimal setting for the look parameters of the vehicle. The geographical area of Malaysia faced an enormous flood from heavy downpour, resulting in huge flood damage and caused irreparable loss to life and property. This case gives difficulty to task force bearing aids during the post disaster management. So during this situation our prototype multipurpose relief vehicle supported rocker bogie mechanism can get picture. It helps the injured people to produce urgent treatment and destination and also helps the folks that lost their life during this natural calamity. The research paper proposed an intelligent inclined motion control of a motor vehicle while moving on uneven terrain surface. The research paper deals with the designing and modelling of auto climbs the steps, uneven terrain and also a battle field supported the well-known rocker bogie mechanism in SOLIDWORKS and AutoCAD. The vehicle sometimes gets suffer from many undesired conditions or phenomenon that generally happens during testing and inspection like slipping, sticking and floating while used in climbing the steps and uneven terrain that can affect in the performance of the vehicle.

III. METHODOLOGY

A. Principle

The mechanism consists of the components that has no springs and Stub axle on their wheels which allow the chassis of the vehicle to climb on any obstacles like rock, sewer, sand, steps etc. that are two times the diameter of wheels also keeping all wheels on bottom entrance time, on comparison to other mechanical system, the stability is prescribed by the peak CG and also the proposed system that is identical. The main advantage for any heavy loading depends on CG of weight of any vehicle that is developed. On the premise of rocker bogie suspension that can withstand a lean of a minimum 60 degree in any of direction without overturning.

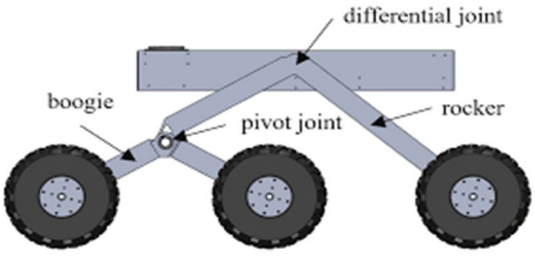


Fig 2 Diagram of RBM

The mechanism is intended to be used in low speed vehicle like heavy trucks, cranes, bulldozers which generally works at slow speed which is around 100 mm per second. As aspect to motion to keep the CG of a car when the rocker goes down the opposite moves upward. The chassis of vehicle plays vital role to take care of typical pitch angle of the rocker by permitting both rockers to maneuver as per matters. As per the design one of the end of rocker bogie gets fit with the driver wheel & therefore the end one is pivoted to a bogie that provides the motion as degree of freedom required.

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B. Working

According to the analysis the findings are that the rocker bogie system decreases the motion by half of the other suspension system as each bogie has 12 wheels and has an autonomous system for motion in which there are two front wheels and 2 rear wheels have a separate system of steering which permits it to maintain a 0 degree turning ratio. For working/climbing on a sand and scrambling on rocks with an ease the vehicle has grip that is provided by thick cleats. The front wheels are always forced in opposite direction to the obstacle by the rear and central wheel through which extreme essential torque is generated.

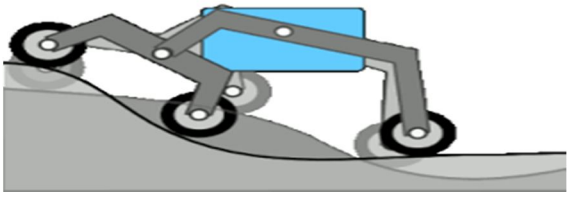


Fig. 3 RBM on Uneven Path

The time until when the wheel is lifted up and over the middle wheel is pushed against the hurdle by rear wheel and is got pulled against by the two front wheels Both the front 2 wheels pull the rear wheel over the hurdle by applying pulling force. During each wheel's traversal of the obstacle, forward progress of the vehicle is slowed or completely stopped which finally keep mechanism Centre of gravity. The strategy on 12 wheel drive system applied is provided so as to extend the advantage of the mechanism.

C. Calculation

Design of Wheels

$$V=\pi DN/60$$

Assume required speed is 100 mm/s

$$100=\pi DN/60\ DN$$

$$DN=1909.86$$

Let, D=140 mm

N=13.64 rpm

Drafting of wheel is done on solidworks with wheel diameter of 140 mm

Fig 4 Design of Links

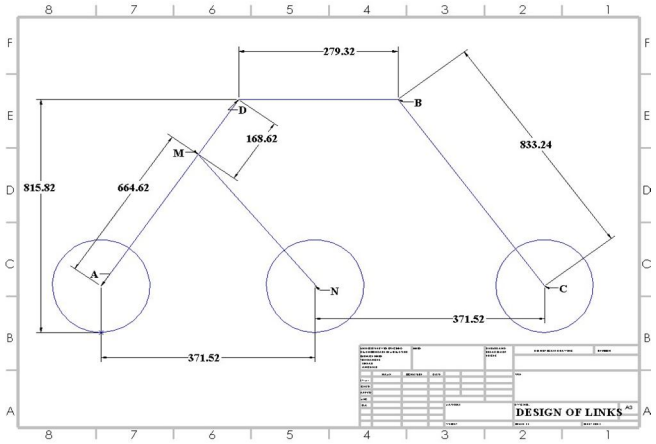


Fig 4 Design of Links

Design of Link

If horizontal length of stair is 500 mm.

Wheel base = Horizontal length of stair - (Rf + Rr)

Rr = rear wheel radius

Rf = front wheel radius

So, Wheel base=1828-(70+70)

= 1688 mm

Let angle be 60°

In ΔBNC,

NC = NB

$NC^2 + NB^2 = BC^2$

$BC^2 = 2(NC^2)$ ---------- eq^n 1

$= 2(371.52^2)$

= 833.24 mm

BC = 833.24 mm

Substituting in equation 1

$833.24^2 = 2(NC^2)$

NC = 371.52 mm

NC=AN=371.52 mm

In triangle AMN, angle AMN = 90°

$AM^2 + MN^2 = AN^2$

$2(AM^2) = AN^2$

$2(AM^2) = 371.52^2$

AM = 664.62 mm

AM = MN = 664.62 mm

$Height^2 = BC^2 – NC^2$

$=833.24^2-371.24^2$

= 745.82 mm

New height = height + radius of wheel

= 745.82+70

= 815.82 mm

AD = AM+MD

MD = AD-AM

= 833.24-664.62

MD = 168.62 mm

D. Selection of Material

Selection of material is important step in designing of a vehicle.

The most important of fabric selection are:

- Reliability.
- Price.
- Optimization of the material.

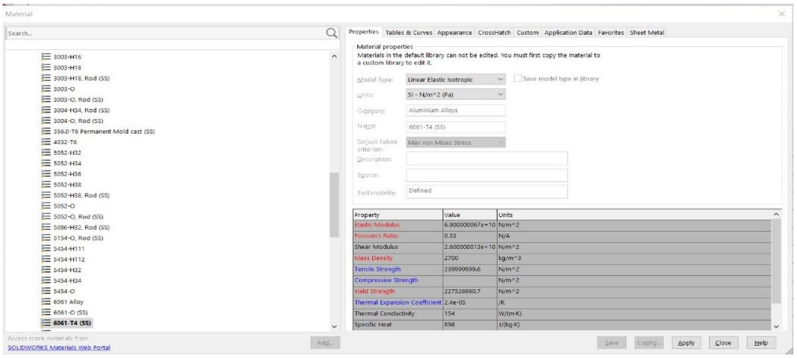


Fig 5 Data of Aluminium Alloy

Aluminium pipe is light weight, corrosion resistant and is as strong as steel, which makes aluminium piping a highly regarded industrial metal. 6061 Aluminium pipe is created from one in all the foremost widely used heat treatable aluminium alloys available. • T4 temper 6061 has an ultimate durability of a minimum of 180 MPA or 210 MPa and yield strength of a minimum of 110 MPa. It's elongation of 10-16%. • It's excellent corrosion resistance, good workability and good machinability

E. Design of Components

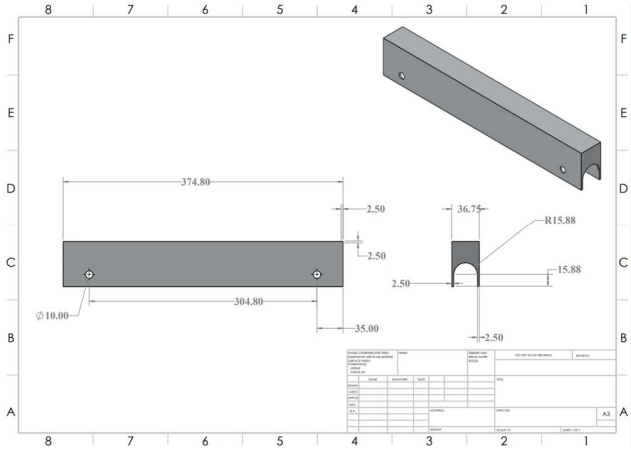


Fig 6 Adjoin Supporter

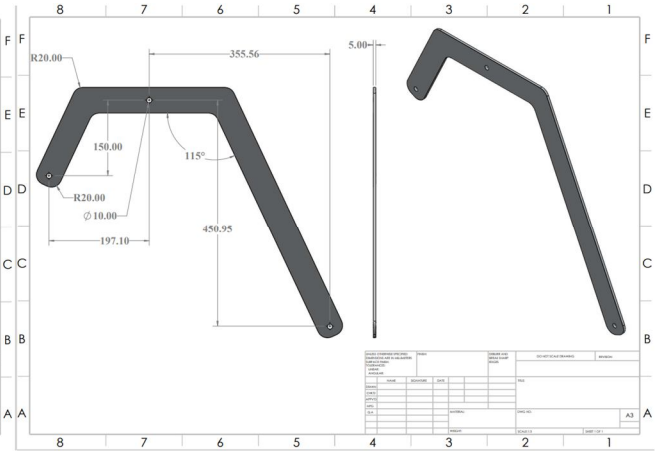


Fig 7 Primary Link

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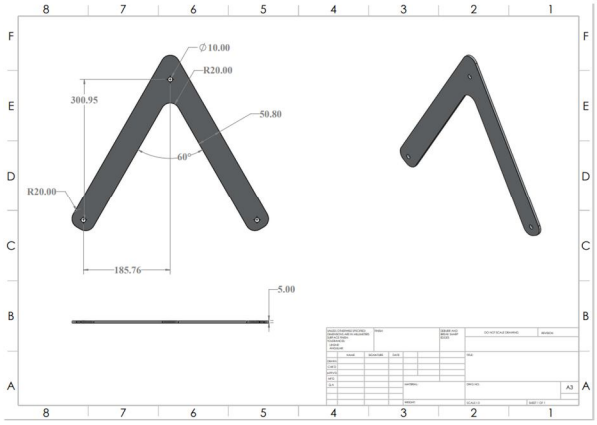


Fig 8 Secondary Link

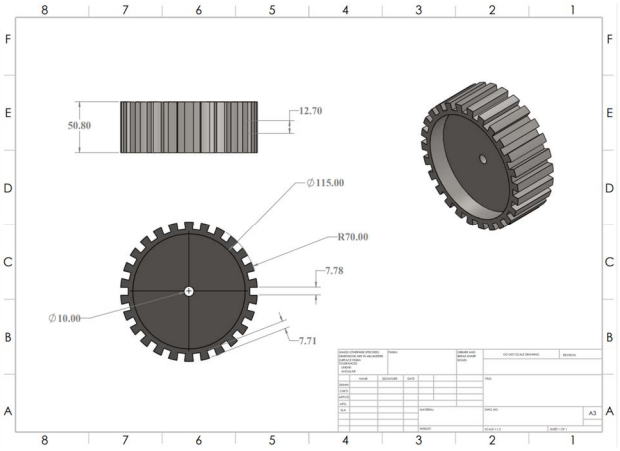


Fig 9 Wheel

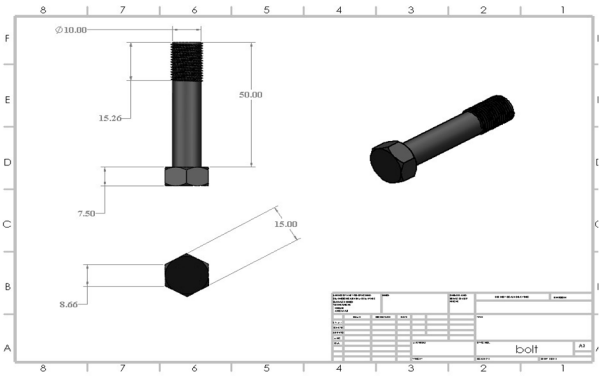


Fig 10 Bolt

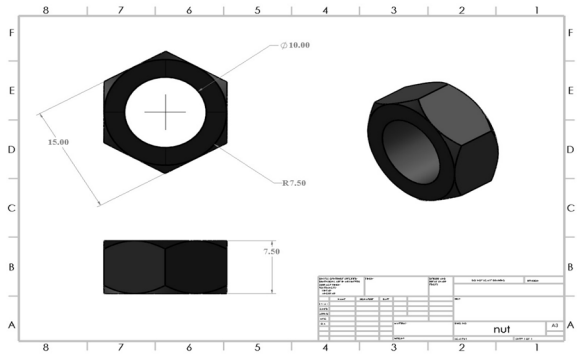


Fig 11 Nut

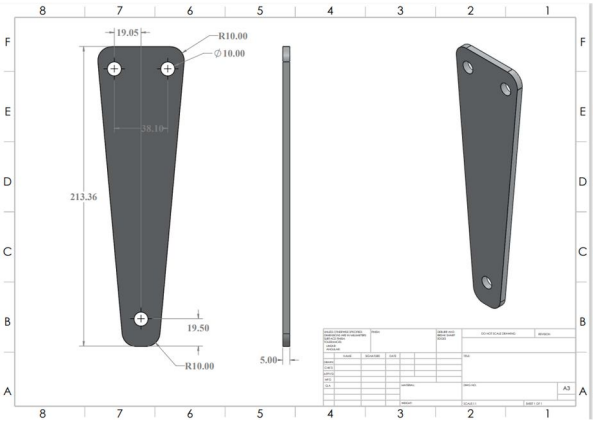


Fig 12 Supporter

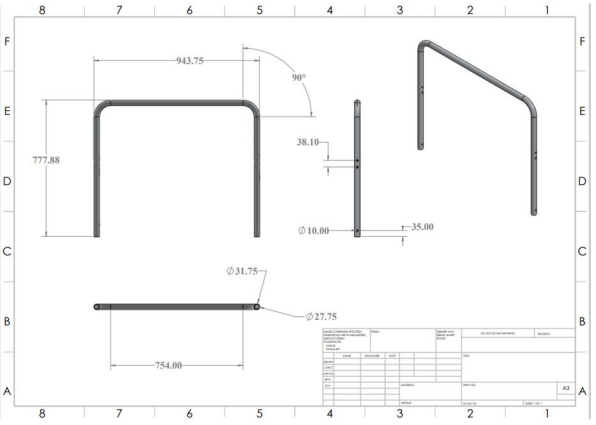


Fig 13 Pipe

F. Analysis

Following are the steps performed for the analysis:

-CAD Modelling in SOLIDWORK

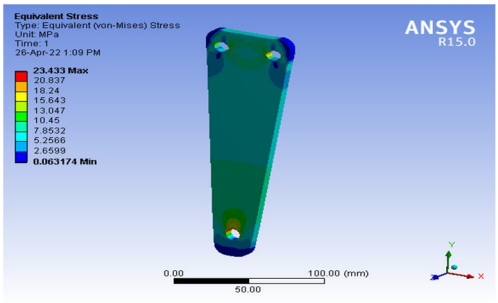
-Structural Analysis in ANSYS15

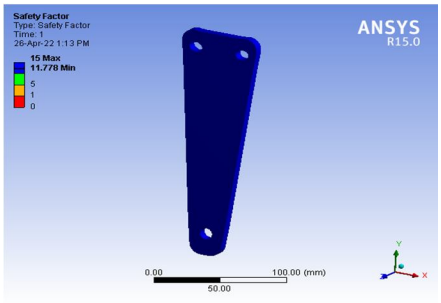
- Select Structural analysis system in ANSYS
- Add Engg Material Data
- Import Geometry
- Mesh: Use the insert drop down, choose part, browse to the newly saved solidwork file containing your mesh body and select open.
- Modelling setup (Static Structural setup)

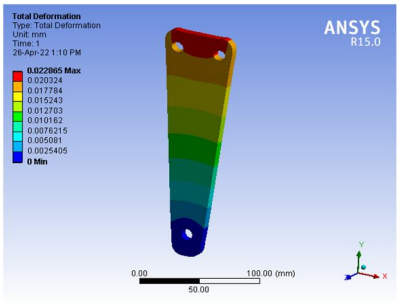
i.e a) Fixed Surface
b) Apply Load

- Solution
- Results. Then Generate Report

1) Supporter





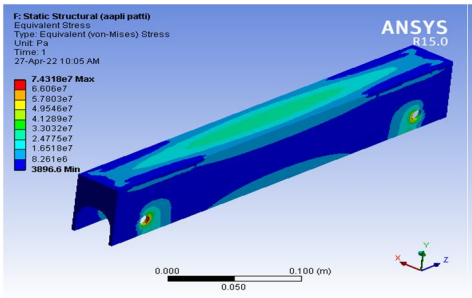


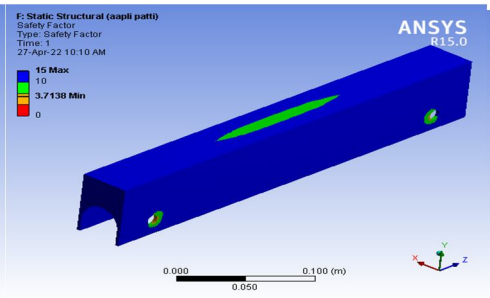
We applied load of 250 kg.

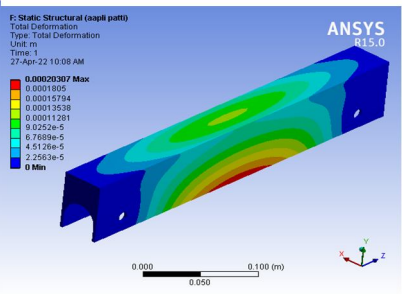
Initial Yield Stress MPa	Maximum yield strength MPa	Tensile Yield strength MPa	Tensile ultimate strength MPa	Load (N)
290	680	276	310	2450

	Minimum	Maximum
Equivalent Stress	0.063174 MPa	23.433 MPa
	Minimum	Maximum
Safety Factor	11.778	15
	Minimum	Maximum
Total Deformation	0	0.022865 mm

2) Adjoin Horizontal Plate





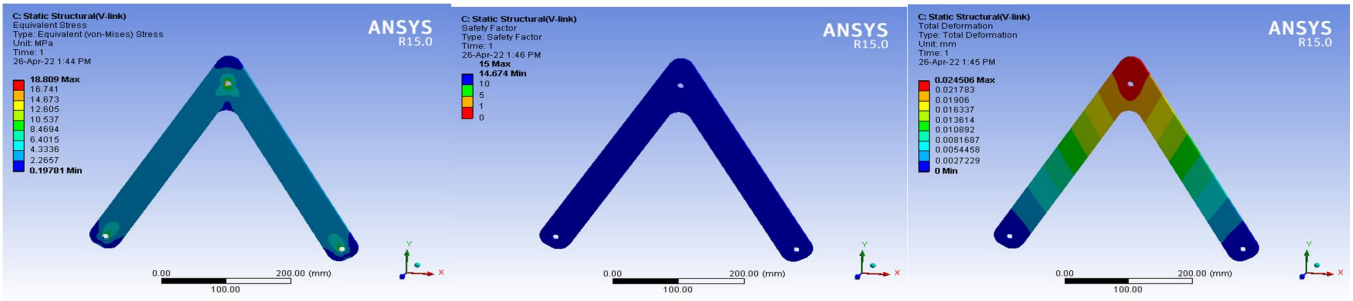


We applied load of 250 kg.

Initial Yield Stress MPa	Maximum yield strength MPa	Tensile Yield strength MPa	Tensile ultimate strength MPa	Load (N)
290	680	276	310	2450

	Minimum	Maximum
Equivalent Stress	0.0038966 MPa	74.318 MPa
	Minimum	Maximum
Safety Factor	3.7138	15
	Minimum	Maximum
Total Deformation	0	0.00020307 mm

3) Secondary Link

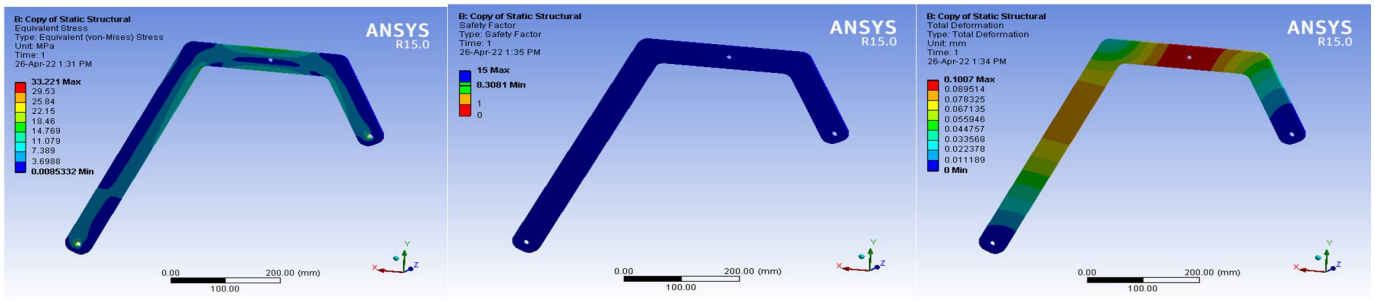


We applied load of 250 kg.

Initial Yield Stress MPa	Maximum yield strength MPa	Tensile Yield strength MPa	Tensile ultimate strength MPa	Load (N)
290	680	276	310	2450

	Minimum	Maximum
Equivalent Stress	0.19781 MPa	18.809 MPa
	Minimum	Maximum
Safety Factor	14.674	15
	Minimum	Maximum
Total Deformation	0	0.024506 mm

4) Primary Link

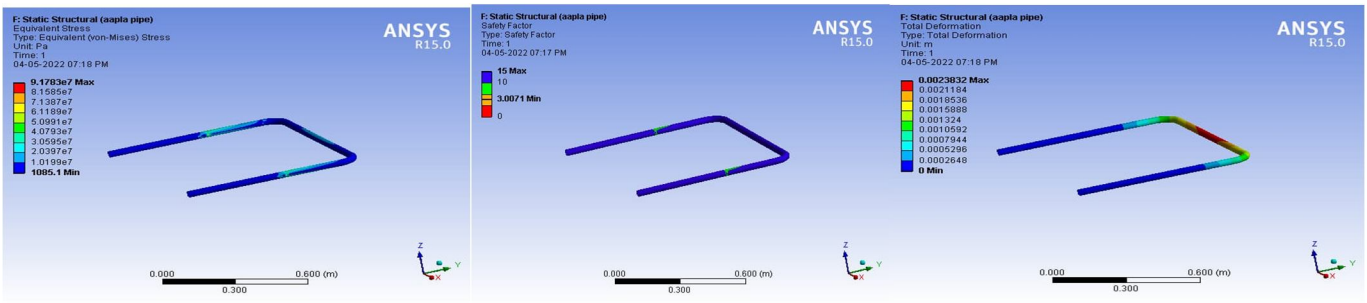


We applied load of 250 kg.

Initial Yield Stress MPa	Maximum yield strength MPa	Tensile Yield strength MPa	Tensile ultimate strength MPa	Load (N)
290	680	276	310	2450

	Minimum	Maximum
Equivalent Stress	0.0085332 MPa	33.221 MPa
	Minimum	Maximum
Safety Factor	8.3081	15
	Minimum	Maximum
Total Deformation	0	0.1007

5) Pipe

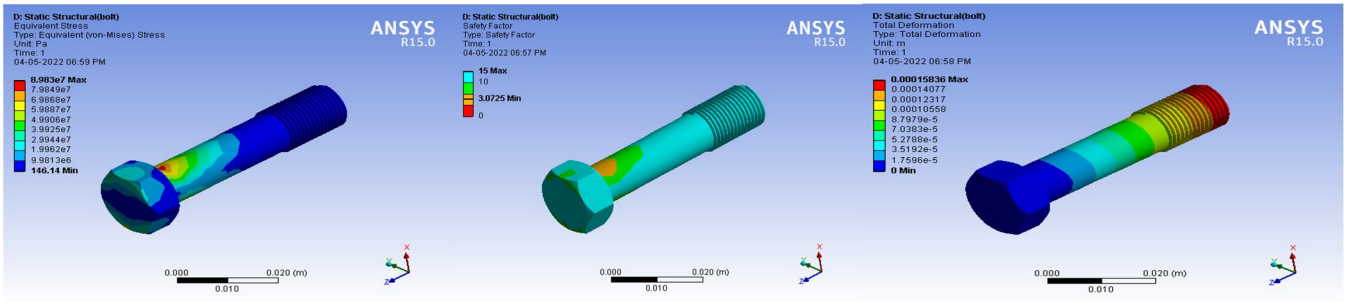


We applied load of 250 kg.

Initial Yield Stress MPa	Maximum yield strength MPa	Tensile Yield strength MPa	Tensile ultimate strength MPa	Load (N)
290	680	276	310	2450

	Minimum	Maximum
Equivalent Stress	0.00010851 MPa	91.78 MPa
	Minimum	Maximum
Safety Factor	3.0071	15
	Minimum	Maximum
Total Deformation	0	0.0023832 mm

6) Bolt

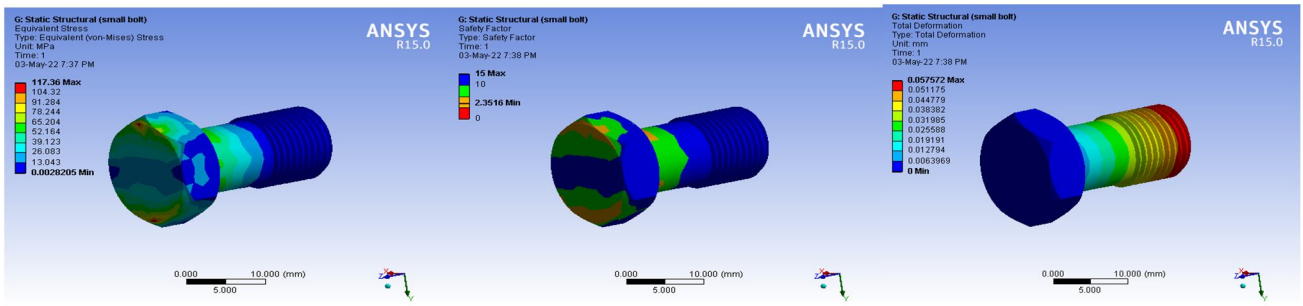


We applied load of 250 kg.

Initial Yield Stress MPa	Maximum yield strength MPa	Tensile Yield strength MPa	Tensile ultimate strength MPa	Load
290	680	276	310	2450

	Minimum	Maximum
Equivalent Stress	0.00014614 MPa	89.83 MPa
	Minimum	Maximum
Safety Factor	3.0725	15
	Minimum	Maximum
Total Deformation	0	0.00015836 mm

7) Nut

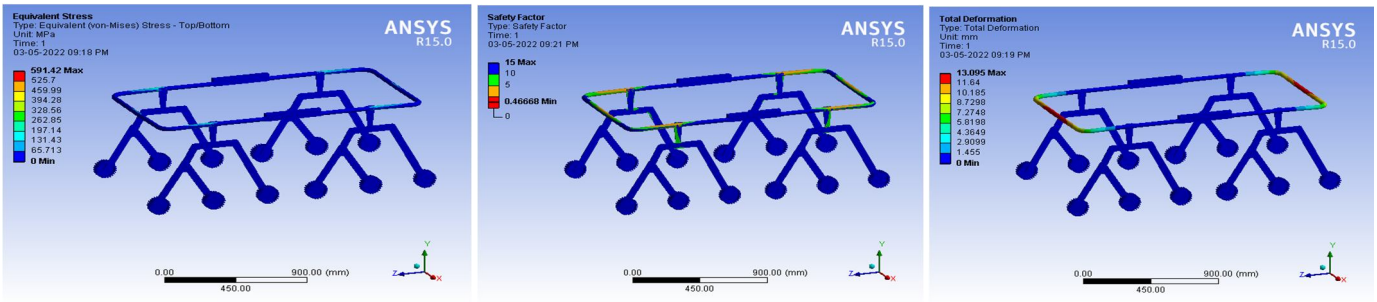


We applied load of 250 kg

Initial Yield Stress MPa	Maximum yield strength MPa	Tensile Yield strength MPa	Tensile ultimate strength MPa	Load (N)
290	680	276	310	2450

	Minimum	Maximum
Equivalent Stress	0.0028205 MPa	117.36 MPa
	Minimum	Maximum
Safety Factor	2.3516	15
	Minimum	Maximum
Total Deformation	0	0.057572 mm

8) MRV



We applied load of 1000 kg.

Initial Yield Stress MPa	Maximum yield strength MPa	Tensile Yield strength MPa	Tensile ultimate strength MPa	Load (N)
290	680	276	310	9800

	Minimum	Maximum
Equivalent Stress	0 MPa	591.42 Mpa
	Minimum	Maximum
Safety Factor	0.46668	15
	Minimum	Maximum
Total Deformation	0	13.095 mm

G. Assembly of Components

The Rocker has a link to bogie with a free pivot joint. The joint is a hinge joint which is not fixed. Both the links are connected to each other with a differential through which RBM moves on rough easily. All 12 wheels are connected with the help of pivot joint to rocker & bogie.

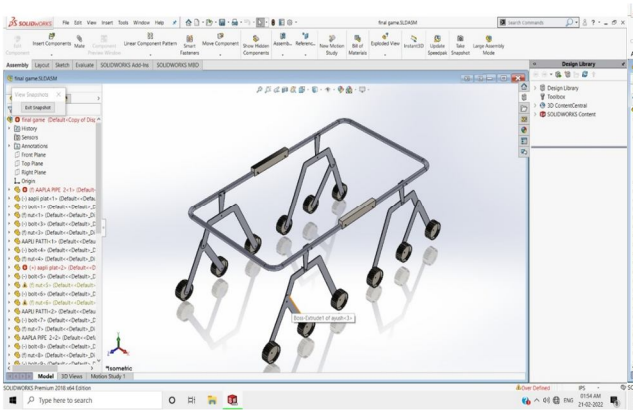


Fig.14 3d View of RBM

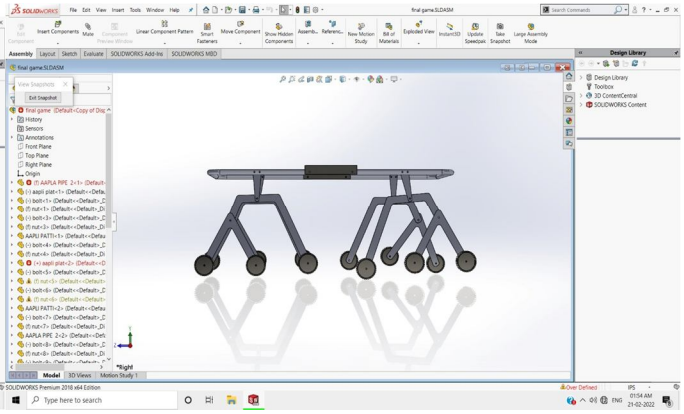


Fig.15 Side View of RBM



Fig.16 Multipurpose Relief Vehicle

IV. CONCLUSION

Presented is the situation that was always faced presenting the two modes of operation having a same working principle which is the Rocker Bogie System which has a unique as well as a robust obstacles traverse features and also another is that an expanded hexagon which is achieved by the rotations of the bogies of each side of vehicle.

The Design and analysis of multipurpose relief vehicle is a module that can be used in several factors that are related with the human co-operation. The whole vehicle have the strength, stability, and the load bearing capacity in terms of the purpose that it is made for. The factors that are mentioned are tested under several parameters on different platforms that are essential for the vehicle designing and manufacturing. The vehicle provides the mobility that is the must requirement of any of the vehicle in terms of a safety factors**.**

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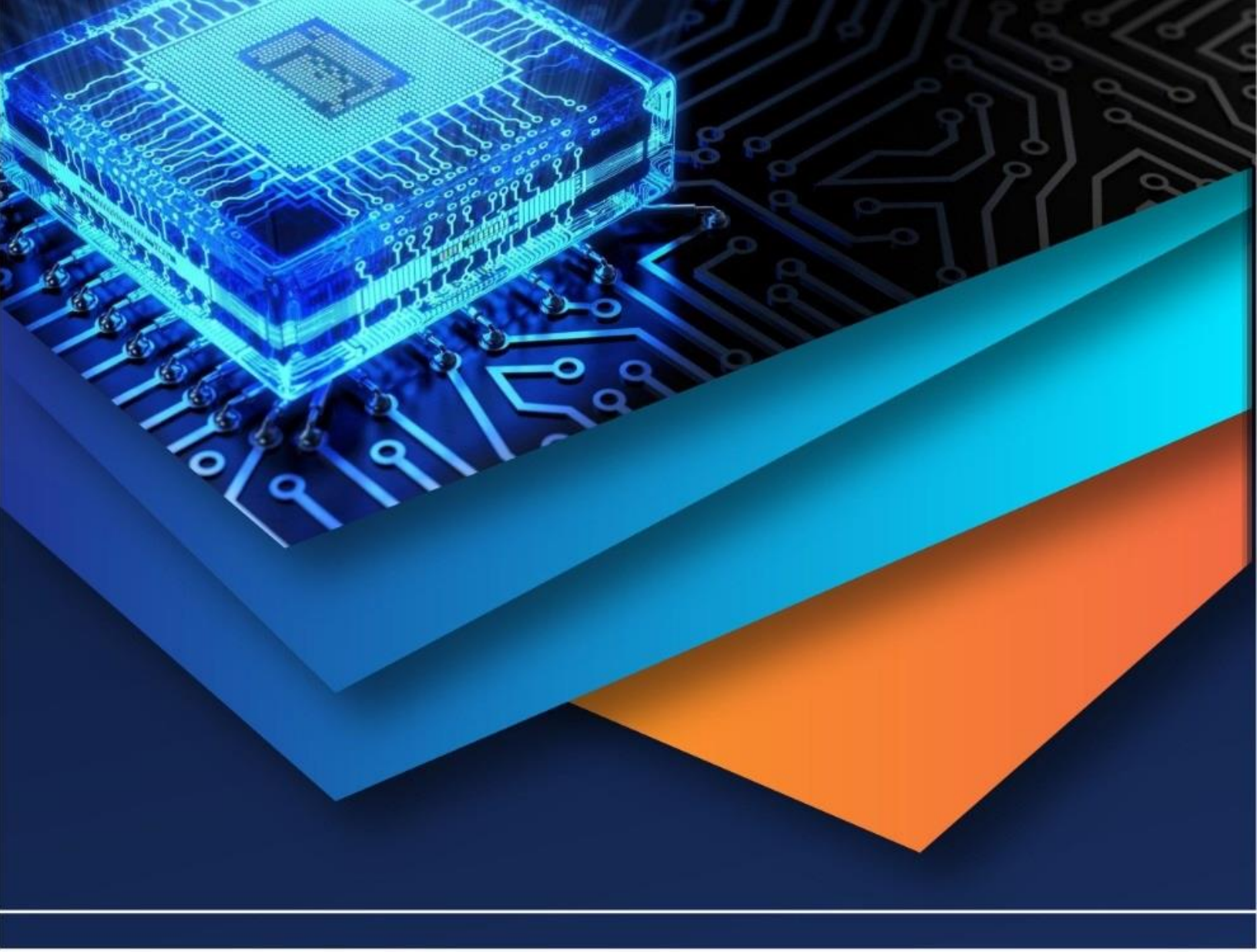
V. FUTURE SCOPE

It will be utilized in rovers made for diggings purposes in coal mines. It will be utilized in rovers that act as spy robots and for military operations too because of ability of working in rough conditions. It are often employed in heavy machinery cranes and bulldozers for ease in traversing through rough terrains.

The Rocker Bogie Mechanism is design vehicle which is specifically as all-terrain vehicle that does not utilize any of suspension which in terms is a great of creating a rover with the agricultural fields. It is a low maintenance moreover as a cost efficient Vehicle/mechanism hence also cheaper. The rover is used to resolve the issue with farming as a driverless mechanism that will help in saving energy and labour cost within the circulation of seed process fields. Rocker is additionally installed with a solar panel and a rechargeable battery instead of a conventional sources like diesel .So, the rocker-bogie mechanism will be driverless reducing the labour cost, and also suspension less which can reduce overall cost of the Machinery making it more at risk of this particular industry.

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