© 2018 IJSRSET | Volume 4 | Issue 7 | Print ISSN: 2395-1990 | Online ISSN : 2394-4099
Themed Section : Engineering and Technology

Structural Analysis of Rocker Bogie Using Different Materials

Banken K. Chauhan[1], Jenish S. Morawala[2], Shivam A. Anjeerwala[3], Abhi V. Gandhi[4]
Department of Mechanical Engineering, Faculty of Engineering Technology and Research, Isroli, Gujarat, India

ABSTRACT

In this paper the authors discuss about the Structural analysis of Rocker-Bogie Mechanism using different materials. It is clear that rovers are significant vehicles of today's solar system exploration. Most of the rover designs have been recognized for Mars and Moon surface in order to recognize the geological history of the territory. Their various mechanisms have found a prevalent usage in mobile robotics. Among these we have discussed about Rocker-Bogie mechanism, which can be used for rover suspension design. We have analyzed and obtain values of deformation.

Keywords : Structural Analysis, Rocker-Bogie, Rover.

I. INTRODUCTION

The rocker bogie mechanism, which is exactly intended for space investigation vehicles have vast history rooted in its growth. The term "rocker" says the appalling feature of the longer links stands individually both side of the suspension system and stable the bogie as these rockers are linked to each other and the buggy chassis through an electively altered differential.

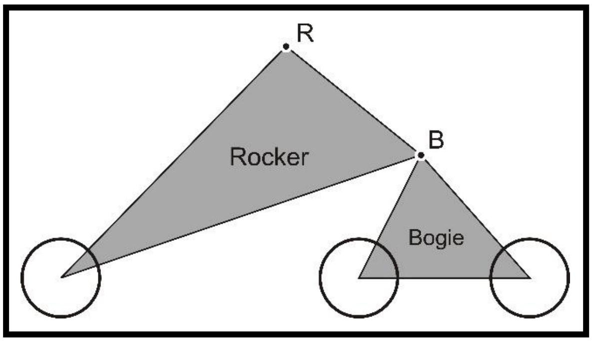

Figure 1. Rocker-Bogie

This mechanism has 6 wheels with symmetric assembly for both sides. Each side has 3 wheels which are linked to each other with two links. Main connection named rocker has two joins. While first joint linked to front wheel, other joint accumulated to another connection called bogie, which is similar to train carriage suspension member. The assembly between symmetrical lateral mechanisms is delivered by a differential mechanism which is located inside the body. Every portion of the Rover had to be built from the strong materials, and It should be ensuring that the material was taken for the mechanism is perfect and durable for rover. The chassis will also strong enough to take over the pay loads which are on the Rover. Parts does not buckle or fail under this type of condition. In the mars 2020 rover the legs or rocker bogie finished from the titanium tubing. Wheel made from the aluminum. Spokes made of from Titanium.

Failure of suspension be contingent upon the design of suspension, Material used for manufacturing, Load applied on it.

CAD MODEL

CAD model of this rocker bogie mechanism for rover is created in CAD software.

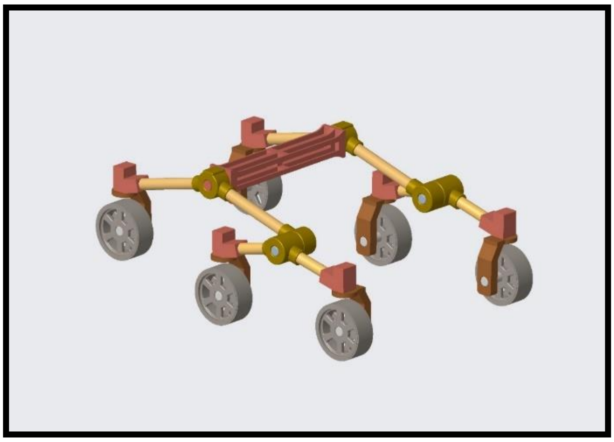

Figure 2. CAD Model of Rocker-Bogie

II. MATERIAL USED FOR ANALYSIS

For the Static structural analysis, we have used material properties of such four materials, firstly we used properties of Stainless steel (SS 304L), then we used properties of Aluminum (A6061) and Titanium alloy (Ti-6 Al-4V) which are widely useful for aerospace components, then also used properties of the Cupronickel (C71640). From the chosen material, SS 304L is used in automotive and aerospace structure, heat exchanger, food processing equipment, chemical containers etc. due to its corrosion resistance, High ductility, outstanding drawing, forming and spinning properties. Aluminum A6061 is light weight material so, it is suitable for Aerospace and aircraft structure, yacht construction, bicycle framing, scuba tanks etc. Titanium alloy Ti-6 Al-4 V very useful for aerospace industry, it is used for marine application, Gas turbine, Chemical industry etc. Cupronickel C71640 is having good corrosion resistance, tensile strength and good ductility when annealed, so it is used in bulletproof jackets, marine engineering, coinage etc.

III. STRUCTURAL ANALYISIS

Firstly, designed CAD model of the Roker-Bogie mechanism. Using relevant CAD software. Here final CAD model is in IGES format. Then this CAD model is analyzed in analysis software. The archived result of the structural analysis through the software are given below. Given load on the mechanism is 1250 N on the top most surface of the mechanism. All wheels are fixed.

Analyzed four materials SS 304L, Aluminum alloy A6061, Titanium alloy Ti-6 Al-4V and Cupronickel C71640.

Values of maximum deformation in the mechanism,

Material	Maximum Deformation (m)
SS 304L	4.8546 e-5
Aluminum A6061	14.35 e-5
Titanium Alloy Ti-6 Al-4V	8.7527 e-5
Cupronickel C70640	7.0623 e-5

These values archived by the analysis by the software. Also completed calculation for the same mechanism by analytically.

For analytically conditions are same. Applied load is 1250 N and all wheels fixed.

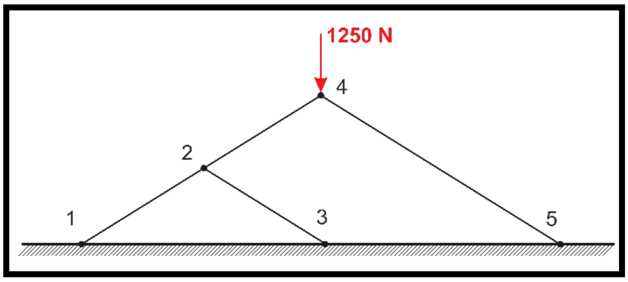

Figure 3. Structural diagram of Rocker-Bogie

The values of the analytical calculation are mention below,

Material	Maximum Deformation (m)
SS 304L	4.904 e-5
Aluminum A6061	14.449 e-5
Titanium Alloy	8.810 e-5

Ti-6 Al-4V	
Cupronickel C70640	7.111 e-5

Rocker-Bogie is a mechanism which keep all six wheels in contact with surface and the pressure will be equilibrated on the ground which acting through wheel. We may provide analysis data for the further research or analysis of present mechanism. We analyzed this mechanism with the help of analysis software and also through the analytical calculation. By the software lowest deformation of SS 304L which is $4.8546 \times 10^{-5}\ m$ (By software) and $4.904 \times 10^{-5}\ m$ (By analytical calculation).

Values from the software analysis and analytical calculation are approximately nearer. For the steady condition and considering the less deformation SS 304L is performing good under the given condition.

IV. FUTURE SCOPE

Rocker-Bogie is a favored design of the all-terrain vehicle and rover suspension mechanism. In future the mechanism may be analyzed by making it from composite material or MMC. Analysis data will may help to select material for the desired condition.

V. ACKNOWLEDGEMENT

We are grateful to Miss. R. R. Patel, Assistant professor, Mechanical department, Faculty of Engineering Technology and Research, Isroli, Bardoli. We are very thankful to her for sharing knowledge, sincere and valuable guidance and inspiration extended to us.

VI. REFERENCES

[1]. Nitin Yadav, BalRam Bhardwaj and Suresh Bhardwaj, "Design analysis of Rocker Bogie Suspension System and Access the possibility to implement in Front Loading Vehicles," IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), 2015.

[2]. Franziska Ullrich, Ali Haydar Goktogan and Salah Sukkarieh, "Design Optimization of a Mars Rover's Rocker-Bogie Mechanism using Genetic Algorithms," Australian Centre for Field Robotics (ACFR), J04, University of Sydney, Sydney NSW 2006, Australia..

[3]. US. Department of Transportation, "Chapter - 5 Aircraft Materials, Processes, and Hardware," in Aviation Maintenance Technician Handbook—Airframe, FEDERAL AVIATION ADMINISTRATION (Flight Standards Service), 2012.

[4]. C Leyens and M. Peters, Titanium and Titanium Alloys Fundamentals and Applications, Germany: WILEY-VCH Verlag GmbH & Co. KGaA, Weinheim, 2003.

[5]. Piotr Ptak, Maciej Pierzgalski, Dawid Cekus and Krzysztof Sokól, "Modeling and stress analysis of a frame with a suspension of a Mars rover," Elsevier Ltd., p. 7, 2017.

[6]. Brian D. Harrington and Chris Voorhees, "The Challenges of Designing the Rocker-Bogie Suspension for the Mars Exploration Rover," Pasadena, CA: Jet Propulsion Laboratory, National Aeronautics and Space Administration, 2004.

[7]. Ted Iskenderian, "Deployment Process, Mechanization, and Testing For the Mars Exploration Rovers," Pasadena, CA : Jet Propulsion Laboratory, National Aeronautics and Space Administration., 2004.

[8]. Randel A. Lindemann and Chris J. Voorhees, "Deployment Mars Exploration Rover Mobility Assembly Design, Test and Performance," in IEEE International Conference on Systems, Man and Cybernetics, Waikoloa, 2005.

[9]. Wang Yongming, Yu Xiaoliu and Tang Wencheng, "Analysis of Obstacle-climbing Capability of Planetary Exploration Rover with Rocker-bogie Structure," in International

Conference on Information Technology and Computer Science, Ukraine, 2009.

[10]. AZoNetwork UK Ltd., [Online]. Available: www.azom.com.

[11]. C. Veiga, J.P. Davim and A.J.R. Loureiro, "PROPERTIES AND APPLICATIONS OF TITANIUM ALLOYS," Reviews on advanced materials science, 2012.

[12]. M. Peters and C. Leyens, "AEROSPACE AND SPACE MATERIALS".

[13]. Max Bajracharya, Mark W. Maimone and Daniel Helmick, "Autonomy for Mars Rovers: Past, Present, and Future," IEEE Computer Society, 2008.

[14]. Nildeep Patel, Richard Slade and Jim Clemmet, "The ExoMars rover locomotion subsystem," Journal of Terramechanics, 2010.

[15]. A. S, U. VJ, S. T. Kalathil, A. Simon, H. CM, D. P. Mathew, M. Menon, P. Basil, R. Ramachandran, A. Sengar, A. Balakrishnan, K. Dutt, A. Murali, C. K. Tilak, A. Suresh, A. Suresh and Ganesha Udupa, "Design and Development of an Intelligent Rover for Mars Exploration," in The 18th Annual International Mars Society Convention, 2015.

[16]. Tomás de J. Mateo Sanguino, "50 Years of Rovers for Planetary Exploration: A Review for Future Directions," Robotics and Autonomous Systems, 2017.

[17]. Panel on Small Spacecraft Technology, Commission on Engineering and Technical Systems, Division on Engineering and Physical Sciences and National Research Council, Technology for Small Spacecraft, National Academies Press, 1994.