



FINITE ELEMENT ANALYSIS FOR FRONT AXLE OF TWO-WHEELER

Rajlalan Agnihotri* & Ashutosh Dwivedi

*Mechanical Engineering Department, Vindhya Institute of Technology and Science Satna (M.P.) India

DOI: [10.5281/zenodo.1156258](https://doi.org/10.5281/zenodo.1156258)

Keywords: FEM, Equivalent (Von-mises) stress, Principal Stress, Directional Deformation, Shear Stress

Abstract

An axle is a shaft for a rotating element like wheel or gear. On wheeled vehicles, the axle may be fixed to the wheels, rotating with them, or fixed to the vehicle, with the wheels rotating around the axle. In the former case, bearings or bushings are provided at the mounting points where the axle is supported. In the latter case, a bearing or bushing sits inside a central hole in the wheel to allow the wheel or gear to rotate around the axle. For the present study the existing axle material i.e., mild steel grade (300) was replaced by the composite material glass fiber epoxy resin. Further analysis of both the material was conducted using finite element method. Results obtained through the analysis were studied to make distinguish comparison with respect to various desirable properties which were shown in the form of contour trends and tabulated manner. Conclusions were made from present studies showing the various desirable effects of using composite to replace axle material. Scope for the future work was also included in the subsequent part of this thesis.

Introduction

An axle is a central shaft for a rotating wheel or gear. On wheeled vehicles, the axle may be fixed to the wheels, rotating with them, or fixed to the vehicle, with the wheels rotating around the axle. In the former case, bearings or bushings are provided at the mounting points where the axle is supported. In the latter case, a bearing or bushing sits inside a central hole in the wheel to allow the wheel or gear to rotate around the axle. Sometimes, especially on bicycles, the latter type axle is referred to as a spindle.

Objective of Work

For the present study usually, a two-wheeler axle which is made of mild steel grade (300) was replaced by a composite material made of glass fiber epoxy resin that was expected to give better mechanical properties as compared to current traditional material used. In this, various stresses were checked through the Ansys 14.0 software and results were compared with traditional material. Various strengths were compared according to the load applied on the axle which was in the form of circular rod. Composite materials are commonly used in structure that demands a high level mechanical performance. In glass fiber we can easily detect damage which is important to identify the factor that contributes to the permanent deformation. Having these damages go undetected could be very dangerous for the end use of various fields e.g., automobiles. Objective of the present study was arrived considering these factors

Figure



Figure-1 Front wheel Axle of Honda Shine



Design and Specification

Following are the dimension consideration for the axle study listed below-
 Load applied on a circular rod (P) = 1000 N
 Diameter of the circular rod (D) = 10 mm
 Length of the circular rod (L) = 100 mm
 Factor of safety = 2-2.5

Material Selection

As shown below in table-1 strength of both the materials are listed for further use and analyzed by taking them into account.

Table -1 Material Properties

Mild Steel grade (300)		Glass fiber epoxy resin	
Yield Stress	Tensile Strength	Yield Stress	Tensile Strength
835.57 (N/mm ²)	938.47 (N/mm ²)	362.38 (N/mm ²)	699.44 (N/mm ²)

Modeling and Meshing

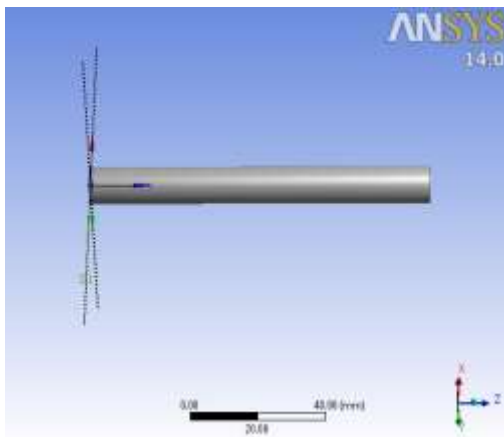


Figure-2 Modeling view of axle

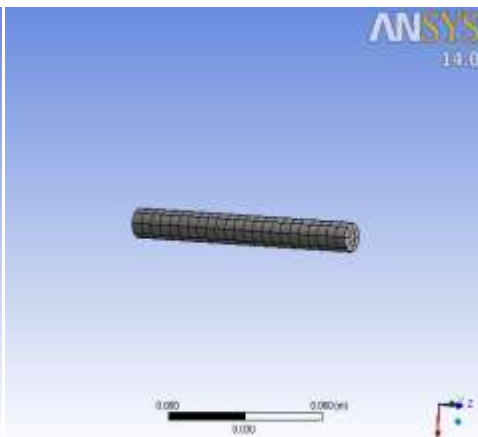


Figure -3 Meshing of axle

The number of nodes and elements incorporated for the present studies are 1376 and 253 respectively.

Result and Discussion

In this section analysis has been carried out for both the materials for mild steel grade (300) and the composite material that is glass fiber epoxy resin with taking parameters which was already mentioned above. The comparisons are shown below for various stresses and deformation.



Analysis for mild steel (300)

Analysis for Composite

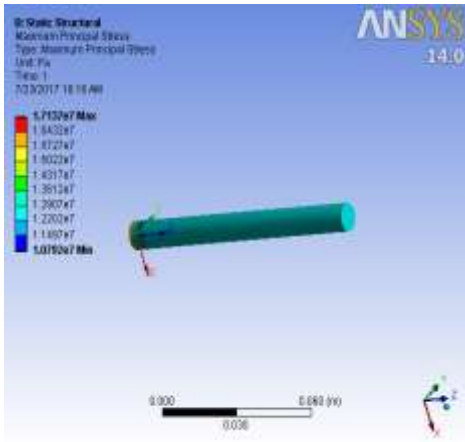


Figure-4 Maximum principal stress (MS300)

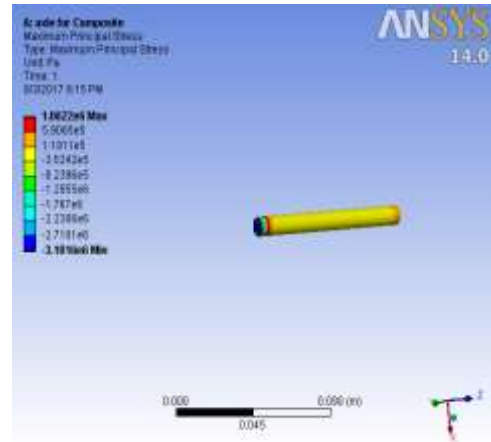


Figure-5 Max Principal stress (Composite)

VS

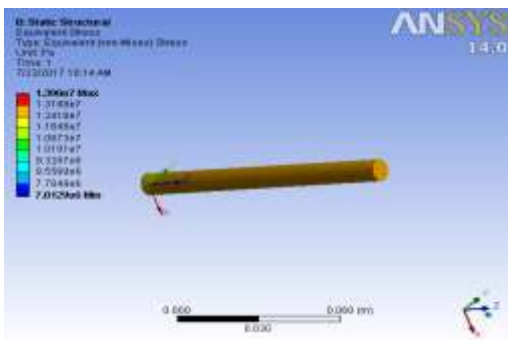


Figure-6 Equivalent (Von-mises) stress (MS300)

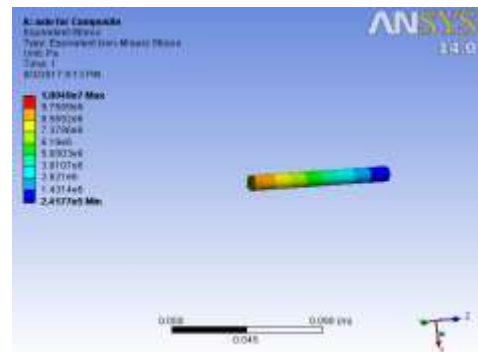


Figure-7 Equivalent (Von-Mises) Stress

VS

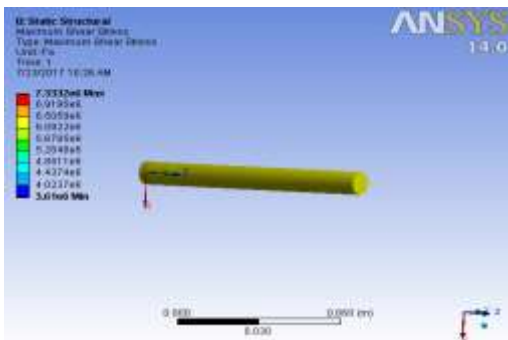


Figure-8 Maximum shear stress (MS300)

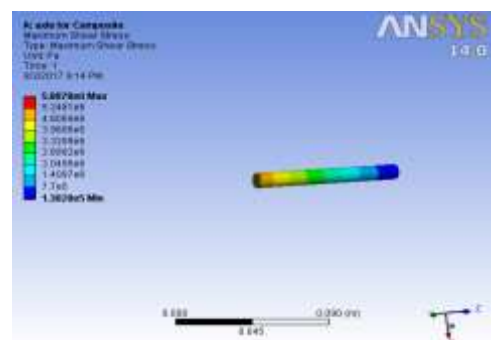


Fig-9 Maximum Shear Stress (Composite)

VS

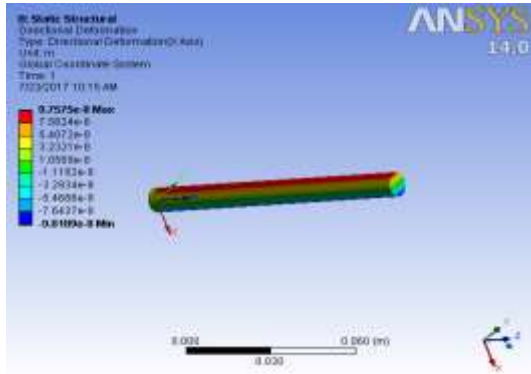


Figure-10 Directional deformation (MS300)

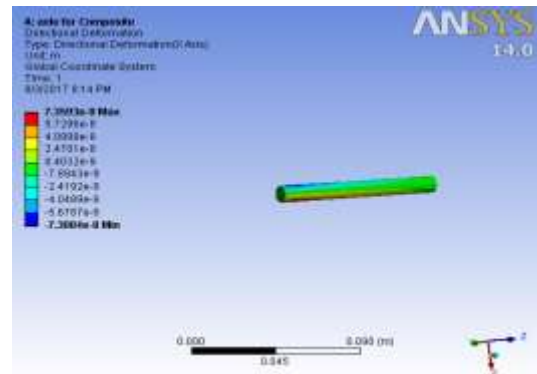


Fig-11 Directional deformation (Composite)

Table-2 Result

Stress/ Deformation	Mild Steel Grade (300)	Composite
Max Principal Stress (pascal)	1.7137e7	1.0622e6
Equivalent(Von-Mises) Stress(pascal)	1.396e7	1.0949e7
Max Shear Stress(pascal)	7.3332e6	5.8878e6
Directional Deformation (micron)	0.09	0.07

Conclusion

- Improved mechanical properties
- Weight reduced
- Reliability s increased
- Economical

Future scope

For the present work the analysis is based on the finite element method where various load conditions were considered. The result obtained showed a better trend for various mechanical properties considered. On a positive note, it is expected that the outcome from the present study can be very helpful for various field of application where axle is used ex., automobile industries.

Acknowledgment

Firstly, I would like to express my deep gratitude to my research advisor **Professor Ashutosh Dwivedi** for his guidance and encouragement, towards the realization of this thesis. His dedication and criticism towards quality of research has inspired me during the course of this investigation. I am grateful to have been given this opportunity to work in his area of research and his promptness discussion and during the preparation of this thesis. I am equally thankful to all supporting faculty and staff members of mechanical Engineering Department for their co-operation and valuable suggestions in completion of my dissertation. I will be failing in my duty, if I do not express my thanks to my dear best friend **Vishnu Prasad Sharma** and colleagues for their timely help and support. Above all, I am thankful to my Parents. **Sri Vishnu Kant Agnihotri & Smt. Geeta Agnihotri** and relatives to bear with me and showing all their love and affection that helped me to do well in my task. Finally, I want to sincerely thank all the people (If I am missing anyone because of my so called long –lasting memory) who have shown their co-operation in my research directly or indirectly



INTERNATIONAL JOURNAL OF RESEARCH SCIENCE & MANAGEMENT

References

- [1] **B.Vijaya Lakshmi, I. Satyanarayana**, “*Static and dynamic analysis on composite leaf spring in heavy vehicle*” International Journal of Advanced Engineering Research and Studies E-ISSN2249–8974,IJAERS, Vol. II, Issue I, 80-84, Oct.-Dec.,2012
- [2] **Beardmore P, Johnson CF**, “*The potential for composites in structural automotive applications*”. Comp Science and Technology; 26:251–81, 1986
- [3] **Bulan Abdulla**, “*Mechanical properties of paste carburized ASTM A516 Steel*” The Malaysian international tribology conference 68,525-530, 2013
- [4] **D. Ansoorge, R.J. Godwin**, “*The effect of tyres and a rubber track at high axle loads on soil compaction*”, Bio systems Engineering, Volume 104, Issue 2, Pages 278-287, October 2009
- [5] **Dara Ashok, M.V. Mallikarjun and Venkata Ramesh Mamilla**, “*design and structural analysis of composite multi leaf spring*” International Journal of Emerging trends in Engineering and Development, ISSN 2249-6149,Issue 2, Vol.5, July 2012
- [6] **Daugherty RL**, “*Composite leaf springs in heavy truck applications*”, In: Composite Materials, Proceedings of Japan–US Conference, Tokyo, p. 529–38, 1981
- [7] **Devendra. K Damor, K. D Kothari** “*Design and Analysis of Glass Fiber Reinforced Polymer Leaf Spring*” IJAR Volume: 3, Issue 8, ISSN - 2249-555X. Analysis of Glass Fiber Reinforced Polymer Leaf Spring” Indian Journal of Applied Research, Aug 2013
- [8] **Ghodake A. P., Patil K.N.** “*Analysis of Steel and Composite Leaf Spring for Vehicle*” IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684 Volume 5, Issue 4, PP 68-76, Jan. - Feb.2013
- [9] **H Shivam**, “*Experimental evaluation of strength and stiffness of fiber reinforcement composite under flexural loading*”. IJEIT 2, 7, 2277-3354, 2013
- [10] **Hameed N, Francis B, Yang W**, “*Morphology, dynamic, Mechanical and thermal studies of poly modified epoxy resin*”, Part A 38,2422-2432, 2007
- [11] **Kumar N K, Kumar M P**, “*Experimental investigation on mechanical properties of coal ash reinforcement glass fiber polymer matrix*”, International journal of emerging technology 3, 8, 2250-2459, 2013
- [12] **LubosNahlik, Pavel Pokorny**, “*Engineering Failure Analysis*”, Volume 73, Pages 139-157 Fatigue lifetime estimation of railway axles, March 2017
- [13] **M.M. Patunkar**, “*Modeling and Analysis of Composite Leaf Spring Load Condition by Using FEA*”,(IJMIE) International Journal of Mechanical & Industrial Engineering, Volume 1 Issue 1-2011.
- [14] **M.Venkatesan** “*Design and Analysis of Composite Leaf Spring In Light Vehicle*”, International Journal of Modern Engineering Research (IJMER) Vol.2, Issue.1, pp-213-218 ISSN: 2249-6645, Jan-Feb 2012
- [15] **Mahajan G V**, “*Composite material, a review over current development and automobile application*”, IJRSM 2,11,2250.
- [16] **Malaga. Anil Kumar, T.N.Charyulu, Ch.Ramesh**, “*Design Optimization Of Leaf Spring*” International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622 www.ijera.com Vol. 2, Issue 6, pp.759-765, November- December 2012
- [17] **Maroua Hammami, Ramiro Martins, Mohamed Slim Abbes, Mohamed Haddar, Jorge Seabra**, “*Axle gear oils: Tribological characterization under full film lubrication*”, Feb 2017
- [18] **Morris CJ**. “*Composite integrated rear suspension. Comp Structure*”;5:233–42, 1986