Structural Analysis of Two-Wheeler Front Axle Using Finite Element Method

Amit Kumar & Kavita Joshi*

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

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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

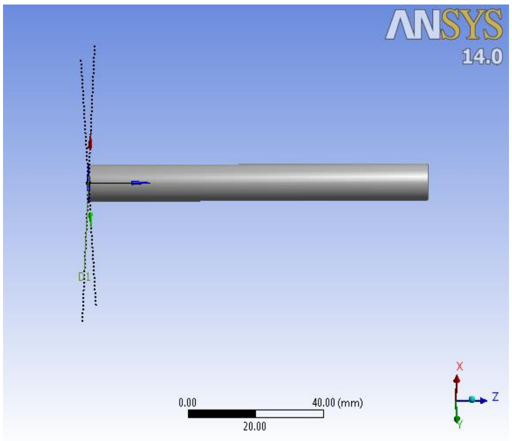
Material Selection

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



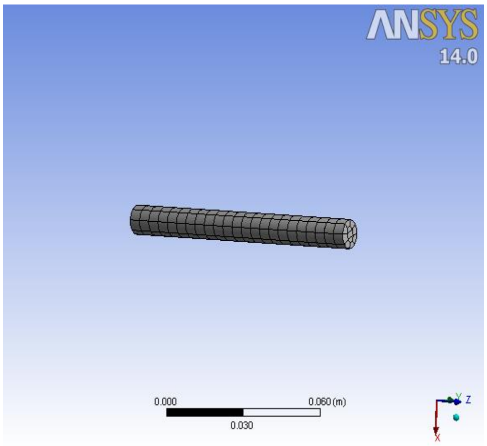


Figure-2 Modeling view of axle ***Figure -3 Meshing of axle***

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**

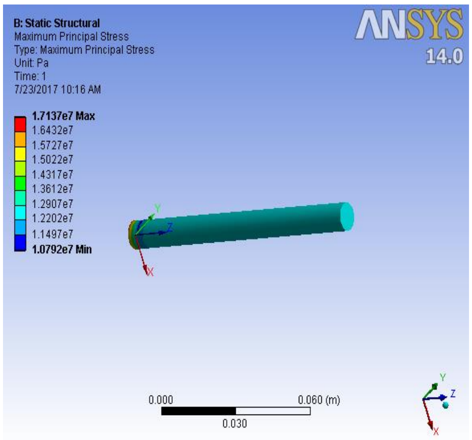


Figure-4 Maximum principal stress (MS300)

VS

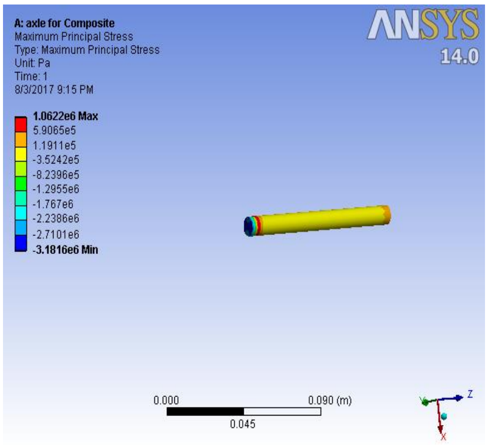
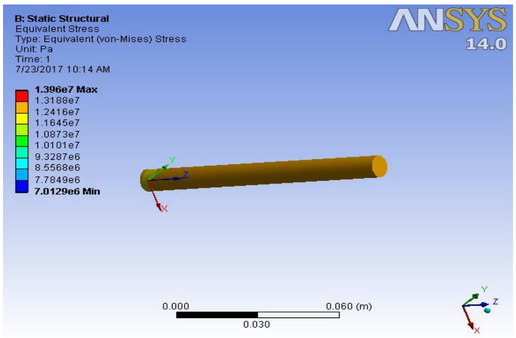


Figure-5 Max Principal stress (Composite)



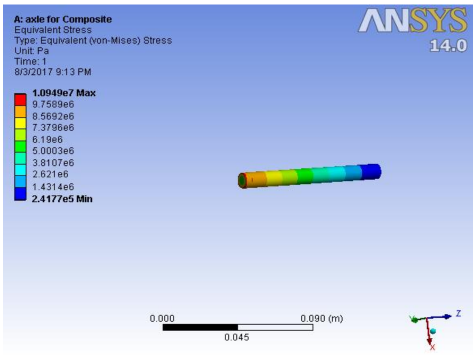


Figure-6 Equivalent (Von-mises) stress (MS300) **VS** *Figure-7 Equivalent (Von-Mises) Stress (Composite)*

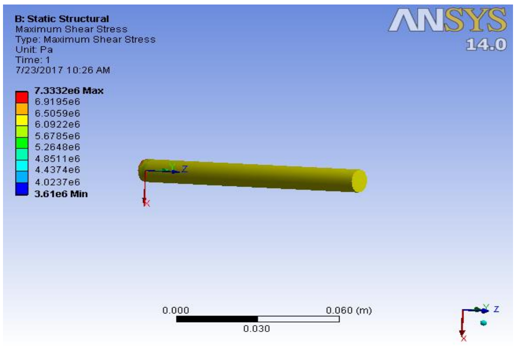


Figure-8 Maximum shear stress (MS300)

VS

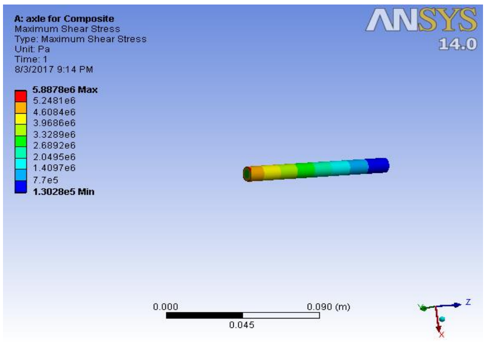
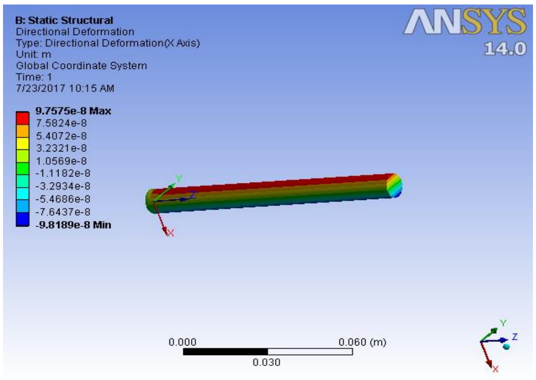


Fig-9 Maximum Shear Stress (Composite)



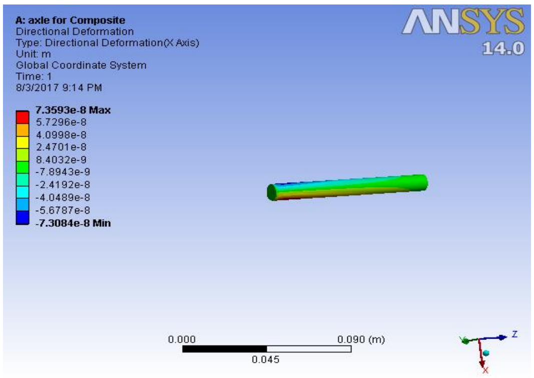


Figure-10 Directional deformation (MS300) **VS** ***Fig-11 Directional deformation (Composite)***

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.

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