

Design and analysis of Tractor trolley rear axle for Weight reduction

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ABSTRACT

Farm tractor is an off road vehicle, used as a portable machine to do various useful works such as farming haulage, heavy earthmoving & transportation. An off-road vehicle is considered to be any type of vehicle which is capable of driving on and off paved or gravel surface. Off road condition includes uneven agricultural field surfaces and bumpy village roads on which the tractor has to operate. These ground irregularities leads to unexpected loads coming on the tractor components. Tractor trolley or Trailers are widely used for transporting agriculture product, building construction material, industrial equipment & many other types of goods. Many varieties are available in trailer and use of particular trailer depends upon the application. The main requirements of trailer manufacturing are high performance with longer working life and robust construction. Tractor trolleys used for transportation are manufactured in small to moderate scale industries. Though tractor trolleys are manufactured of various capacities by various industries, there is a variation in manufacturing methods. The axle of a tractor trolley is one of the major and very important component and needs to be designed carefully, science this part also experiences the worst load condition such as static and dynamic loads due to irregularities of road, mostly during its travel on off road. Therefore it must be resistant to tolerate additional stress and loads. Trolley axle under consideration is a supporting shaft on which a wheel revolves. The axle is fixed to the wheels, fixed to its surroundings & a bearing sits inside the hub with which a wheel revolves around the axle. A trolley axle is also called as beam axle which is typically suspended by leaf springs as shown in fig 1. Its drawbacks are that it does not allow each wheel to move independently in response to bumps, and the mass of the beam is part of the un-sprung weight of the vehicle, which can further reduce ride quality.

Keyword: - Finite Element Analysis, Model Analysis, Dynamic Load

1. INTRODUCTION:

Trolley axle under consideration is a supporting shaft on which a wheel revolves. The axle is fixed to the wheels, fixed to its surroundings & a bearing sits inside the hub with which a wheel revolves around the axle. A trolley axle is also called as beam axle which is typically suspended by leaf springs as shown in fig 1. Its drawbacks are that it does not allow each wheel to move independently in response to bumps, and the mass of the beam is part of the un-sprung weight of the vehicle, which can further reduce ride quality. In the present market scenario, cost reduction techniques play a signified role in meeting the competition in the market. Weight reduction and simplicity in design are applications of industrial engineering etc., are used as source of technique. Various components or products used in rural areas are mostly manufactured in small scale industries such as farming machinery, thrashers, tractor trolley etc. It has been observed that these rural products are not properly designed. Tractor trolleys are manufactured in small to moderate scale industries. Though tractor trolleys are manufactured of various capacities by various industries, still there is a large variation in manufacturing methods, component design etc..

2.

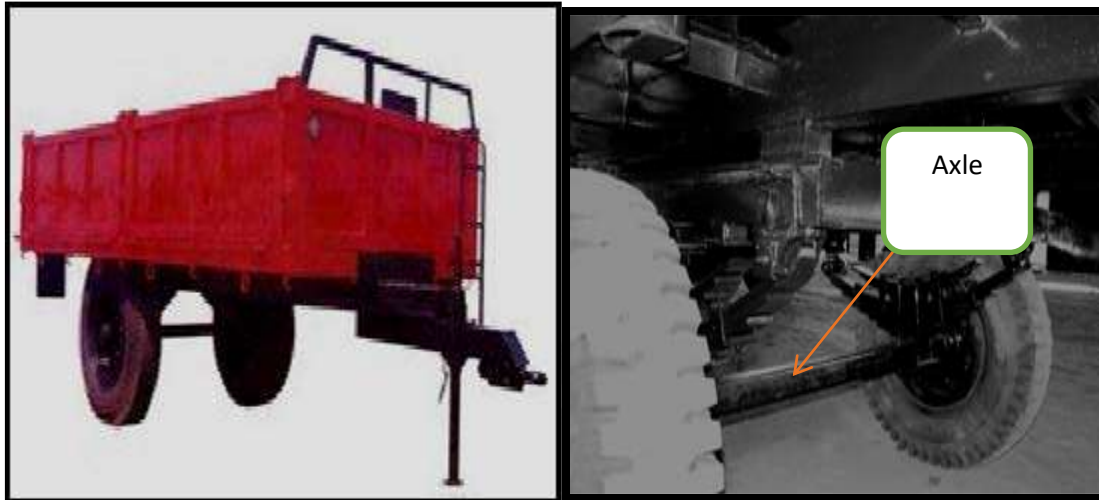


Fig-1 Tractor Trolley

Fig-2 Rear Axle Fitting

The trolley axle is a central shaft for rotating wheels. The wheels are fixed to the axle, with bearings or bushings provided at the mounting points where the axle is supported. The axle maintains the position of the wheels relative to each other and to the vehicle body. The axle of a tractor trolley is one of the major and very important components and needs to be designed carefully, since this part also experiences the worst load condition such as static and dynamic loads due to irregularities of road, mostly during its travel on off road. Therefore, it must be resistant to tolerate additional stress and loads. Trolley axle under consideration is supporting shaft on which a wheel revolves. The axle is fixed to the wheels, fixed to its surroundings and a bearing inside the hub with which a wheel revolves around the axle. Trolley axle is also called as beam axle which is typically suspended by leaf springs as shown in Fig-1 and Fig-2

1.1 Problem Definition:

Tractor Trolleys are cheaper modes of goods transport vehicle on off road. These trolleys are manufactured in small scale industry, due to which design of trolley axle is at primary level. As design of axle is not properly done according to the stress analysis, the various type of failure occurs so vehicle owner can't afford the replacement of the axle. Due to the self-weight of axle and improper design failure occurs. As the axle design is not proper and excess material is used to overcome the failure, the self-weight of the axle gets increases to increases the capacity of trolley. Due to which, the cost of the axle also get increases. The Self-load of trolley applied on the chassis, leaf spring and axle of the trolley causes failure in Dynamic condition. Failure such as breakage of axle hub assembly, axle bending occurs. And these problems are indirectly related to capacity of the trolley. To overcome these problems, a proper redesigning of axle according to the stress strain analysis is required. Trolley axles are manufactured in Square sections and weight of the same is on higher sides. So there is scope or requirement for less weight and high strength axles which performs without failure. So work is to be carried out for reducing the weight of axle and that too without failure, hence Tractor trolley axle is selected for current work.

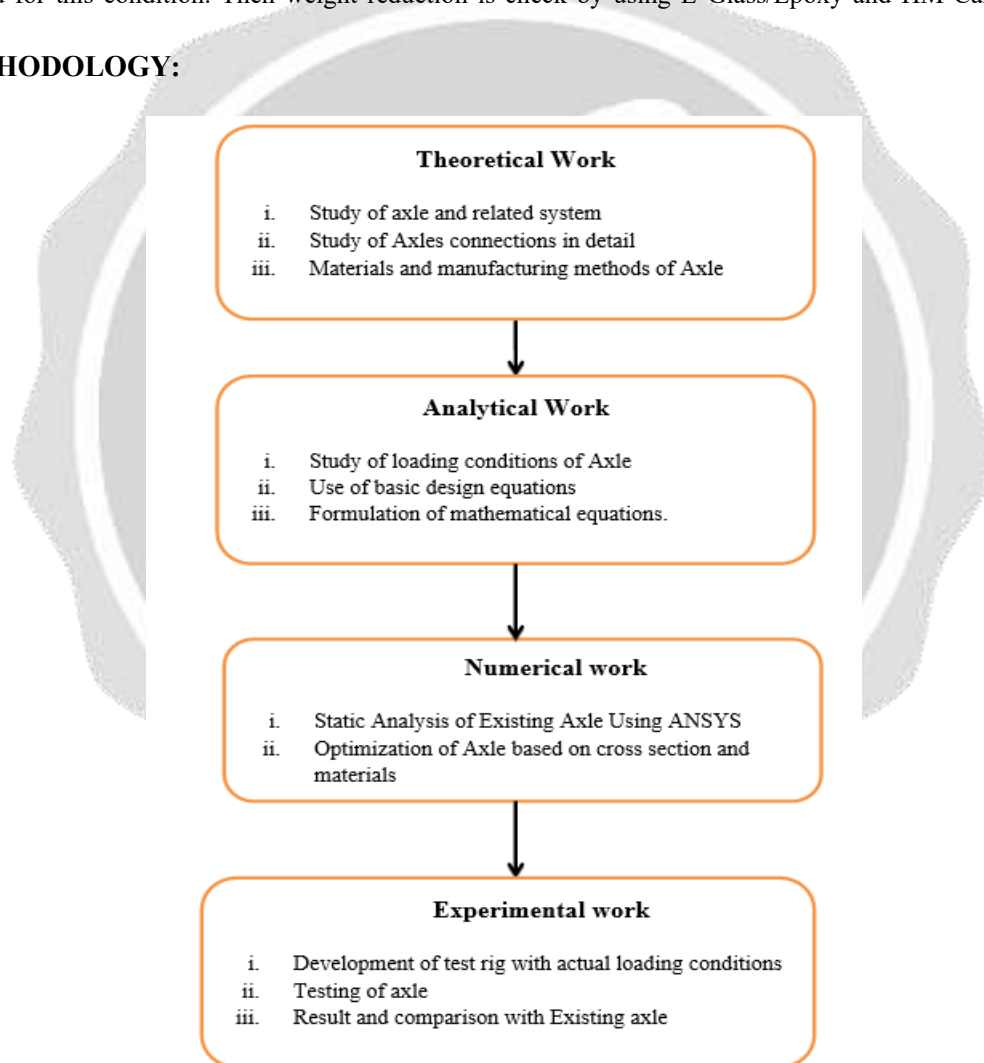
3. LITERATURE REVIEW:

P. Manasaet. al. Most of the tractor trolley axle used today is rectangular cross section type which in turn leads to increase in the weight of tractor trolley and axle. The solid modelling of axle is developed by CATIA-V5. Analysis is done using ANSYS work bench. In their work an attempt has made by replacing rectangular cross section with circular section. Further static analysis is done to determine on-misses stress, equivalent elastic strain, and maximum shear stress, total deformation. Finally the results of rectangular section axle with circular section axle are compared which result in reducing the 20% weight of the circular axle. Finally, the stress induced in the tractor trolley axle is less than the allowable stress (i.e., 430 MPa). So the design is safe under given loading condition.

Sanjay Aloni In his work finite element analysis approach is used to modify existing rear axle of tractor trolley. Fatigue failure of the rear axle finite element model was predicted after the dynamic load was imposed on it. For analysis, a 6.0 ton 2 wheeler tractor trolley i.e. semitrailer manufactured by Awachat Industries Ltd., Wardha is selected. The finite element analysis of existing rear axle of tractor trolley revealed the stresses distribution on rear axle. So, an effort is made to modify the design of existing rear axle along with change of material so that advantage of weight reduction along with safe stress can be obtained.

Rakesh A Oza drive shaft is most important component to run the application, because of failure of shaft tends to stop the production line or manufacturing of the components. A Drive shaft is a rotating shaft that transmits power from the motor to the gear box. Drive shaft must operate in high and low power transmission of the fluctuating load as required in eccentric mechanical press. Due to this type of fluctuating load drive shaft is fail. Thus it is important to make this shaft as per load requirement to avoid this failure. In this paper, first the model is prepare on the pro/Engineer software and after that the analysis work on the ANSYS for comparing the different such as bending stress, shear stress, and deflection of the shaft for existing condition as well as the new design which one developed for this condition. Then weight reduction is check by using E-Glass/Epoxy and HM-Carbon / Epoxy materials.

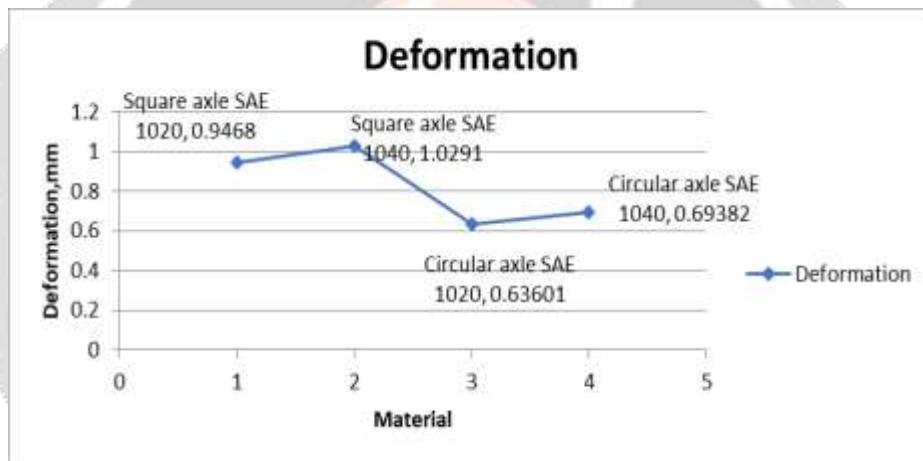
4. METHODOLOGY:



4. RESULT AND DISCUSSION:

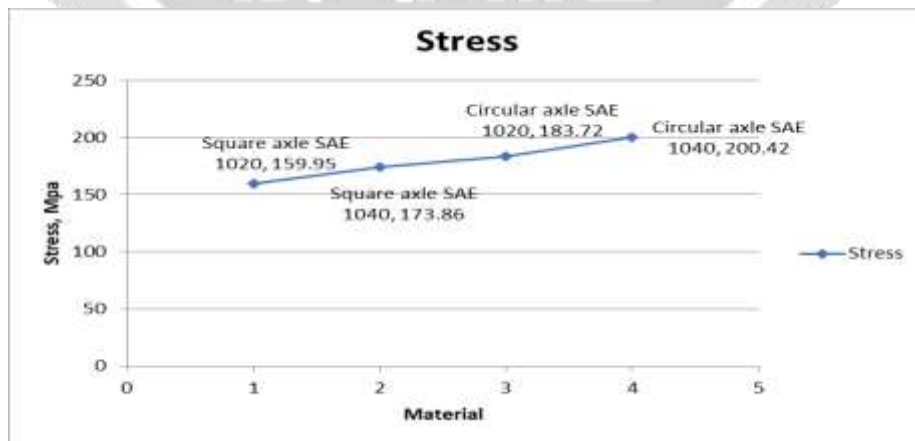
Content	Square axle SAE 1020	Square axle SAE 1040	Circular axle SAE 1020	Circular axle SAE 1040
Deformation	0.9468	1.0291	0.63601	0.69382
Stress	159.95	173.86	183.72	200.42
FOS	1.563	1.4379	1.3608	1.2474
Weight	33.81	29.612	30.247	27.102

From above results we can see that Circular axle with SAE 1040 material gives us better result, and can be used as best option for further testing.

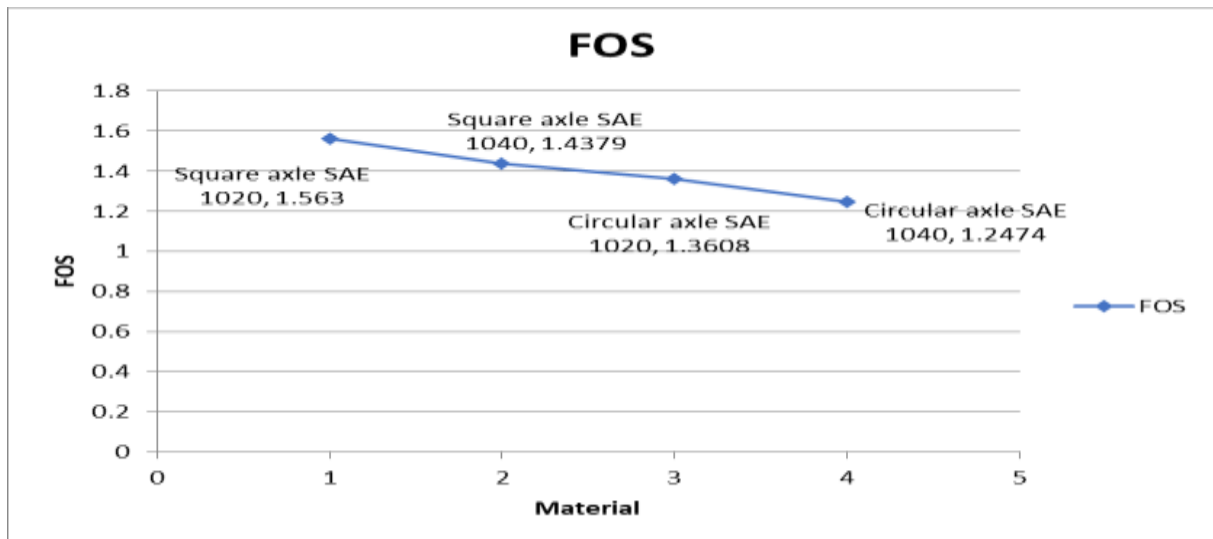


Graph-1

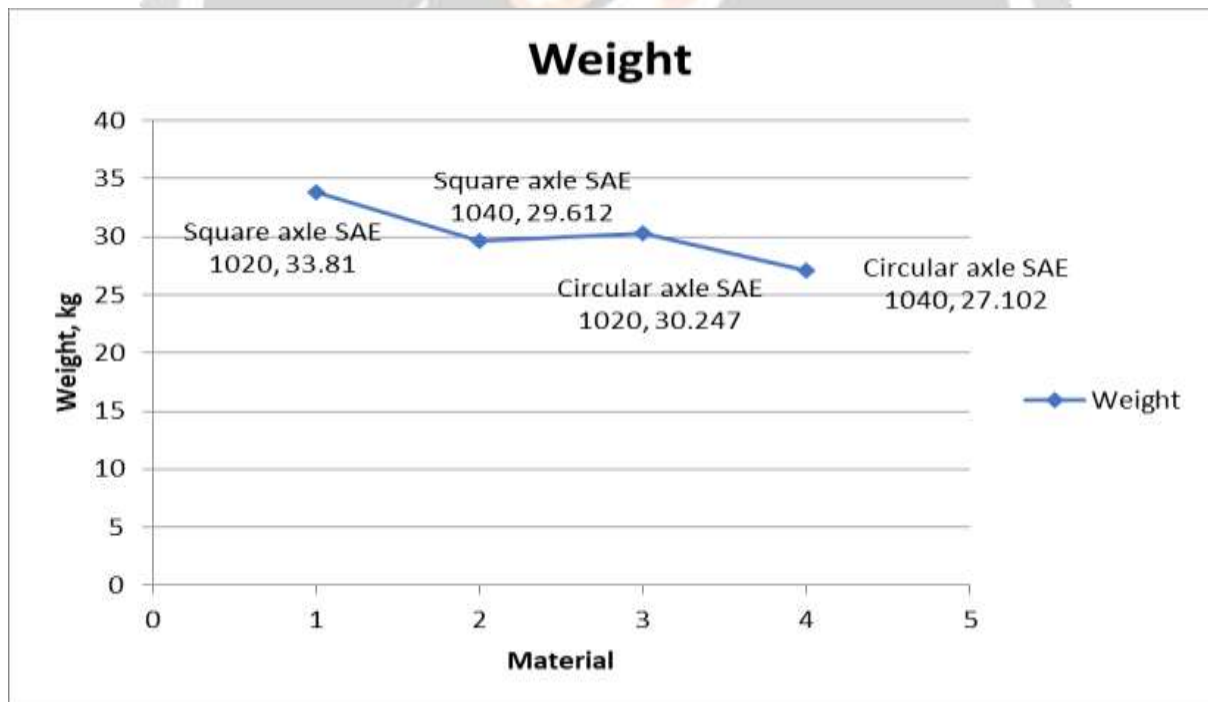
Deformation of different materials



Graph-2 Stresses in different materials



Graph-3 FOS for different materials



Graph-4 Weight of different materials

From the above results we can see that circular cross section with SAE 1040 material gives better results in FOS and Weight. Though deformation and stresses developed are more but are within permissible limit.

Parameters	Existing Square Axle SAE 1020	Suggested Circular Axle SAE 1040
Material	SAE 1020	SAE 1040
Von-Mises Stress	278.18 MPa	200.42 MPa
% Change in Stress	Circular axle has 27.95 % less Stress than Square axle	
Deformation	1.6466 mm	0.69382 mm
% Change in Deformation	Circular axle has 57.86 % less deformation than Square axle	
Weight	35.5 kg	27.102 kg
% Change in Stress	Circular axle has 23.65 % less weight than Square axle	

Table-1 Result Comparison for existing and optimized Axle

5. CONCLUSION

Circular cross section with SAE 1040 material is having more positive points and less weight (23.65 %) compare to existing square cross section and SAE 1020 material. Stresses are reduced by 27.95%.

The new selected material is safe in strength and is concluded through both Analysis and in working also. Circular cross sections are comparatively easy to manufacture and also more options are available for circular sections manufacturing.

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