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ANALYSIS OF EXISTING TROLLEY AXLE USING ANSYS

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Abstract: 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.
Keywords: Axle design, CAD modeling, stress analysis.

1. INTRODUCTION

Reduction in the product cost is playing an important role in the market competition. For the reduction of the product cost proper design, simplicity in machining operations and self weight reduction are sources of technique, used in industrial application. The number of product such as farming machinery, thrashers, tractor trolleys etc., are used in rural areas which is mostly manufactured in small scale industries. It has been observed that these rural products are not properly designed. These products are manufactured as per need, by trial and error methods of manufacturing. Big industrial sectors have not yet entered in manufacturing of these products; hence no significant development in design of rural product has been done so far. Thus most of rural products are manufactured without availability of design. Tractor trolleys are manufactured in small to moderate scale industries.

Through tractor trolleys are manufactured of various capacities by various industries, still there is a large vibration in manufacturing methods, component design etc. The trolley axle manufacturers are having no proper design of trolley, through these trolleys are to be certified by R.T.O. authority. It is observed that most of the trolleys are design for static conditions by

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tacking large factor of safety. Local Industries in MIDC, Wardha, is presently the leading manufacturers of tractor trolleys producing about 2000 trolleys per annum. The analysis and discussion with owner of local Industries in MIDC, Wardha, revealed that with proper design approach the cost of trolley axle can be reduced. As there is lot of competition in the market, reduction in cost is necessary.

2. TYPES OF LOAD

The total load of trolley is acted at two points over the axle through the support of leaf spring. The trolley is connected to wheel axle through isolator leaf spring and to the tractor coupling. The leaf spring is the mediator of main frame and to the axle on this leaf spring transfer the total load to the axle.

2.1. STATIC LOAD

The fully loaded trolley at stationary position, the static load is to be calculated. The total load on axle is shown in load diagram. The total load of trolley considering capacity of trolley, self weight of trolley, self weight of leaf spring and axle is 73 KN. So the total weight of trolley is pointy distributed on axle. As the leaf spring is used as isolator so point load conditions are considered, and the shear force and bending moment diagram are drawn.

2.2. *DYNAMIC LOAD*

As we know that tractor is a off road vehicle, it runs at moderate speed i.e. up to 35 km per hour. On full load conditions the speed is 20 to 25 km per hour maximum. Due to bumping dumping road condition at moderate speed the axle is directly subjected to dynamic loads which are nonlinear in nature. The shocks due to sudden velocity change may cause impact loading. The isolators are must for reducing such a high impact which may be the cause for failure. All these conditions have been considered while preparing its dynamic load model.

3. ANALYSIS OF STATIC LOAD

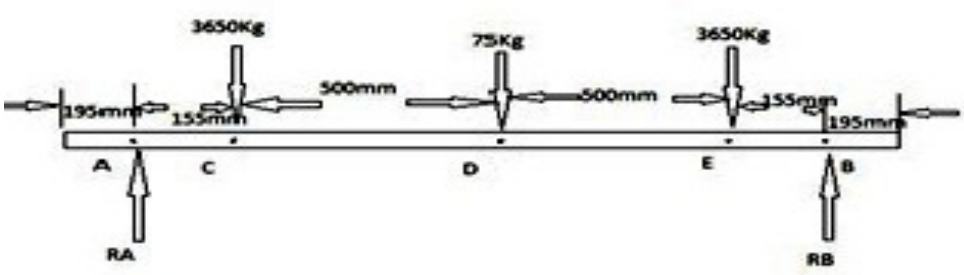
Total load acted on axle by considering the capacity of trolley and self weight of trolley, leaf spring and axle is 73 KN. As the leaf spring is used as the isolator and whole weight of the trolley is mounted over there. Due to leaf spring the total weight of the trolley is transferred over the axle at two point C and E as shown in load distribution diagram.

Table 1. Specification of 6-tonne 2-wheeler trolley

General	Single axle, 2-wheeler box type trolley	
Overall dimensions	Overall length	3100mm (trolley box) 4025mm (chassis)

	Overall width	1900mm (trolley box)
	Overall height	730mm (trolley box) 1700mm above ground
Load capacity	Pay load	60KN
	Unloaded weight	13KN
	Gross load weight	73KN
Axle	One square axle is used presently 75*75 mm square of length 1700mm. Weight of axle assembly 0.75KN	
Tires	Two no. of 9" (width) X 20" (radius)	

Fig. No. 3.1 Load diagram



The axle having the wheel support at point A and B, so reactions are comes at point A and B and it comes to be_

RA = 36.88 KN

RB = 36.87 KN

4. SHEAR FORCE AND BENDING MOMENT ON AXLE

The shear force and bending moment at points A, B, C, D, E on the axle are found to be_

Table 2. Values for shear force and bending moment

Load Point	Shear Force	Bending Moment
A	36.87KN	0KN
C	0.37KN	5714.85KN
D	-0.38 KN	5899.85KN
E	-36.88KN	5709.85KN
B	0KN	0KN

5. DESIGN OF AXLE

An axle is a stationary machine element and is used for the transmission of bending moment only. It simply act as a support for some rotating body such as hoisting drum and in tractor trolley case the axle is supporting of rotating member known as hub for holding the tires. So the axles are used to transmit bending moment only. Thus axles are designed on the basis of bending moment only.

When the axle is subjected to a bending moment only then we get the following data_

* Moment of inertia of cross sectional area of the axle about the axis of rotation (I) is equal to 2636718.75 mm4

* As we selected the material for axle is SAE 1040 having bending stress (fb) (allowable) is 430 MPa.

* Bending moment is found to be 30234375 N mm.

6. STRESS ANALYSIS USING ANSYS

For calculating the stress on existing axle we use the ANSYS software. Software shows the particular area on which the maximum stresses are generated, which causes the axle failure. The following are the images for existing axle from industry shows the equivalent (von-mises) stress, equivalent strain, total deformation and factor of safety by using the steps given bellow also figure shows the color effect which shows effect of load on the axle.

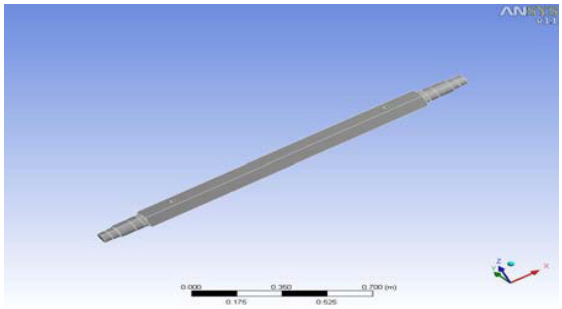
STEPS

- **Model**
  - Geometry
    - Part 1
  - Mesh
  - Static Structural
    - Analysis Settings
    - Loads
    - Solution
      - Solution Information
      - Stress Tool
        - ✓ Results

6.1 ANALYSIS OF EXISTING AXLE IN ANSYS

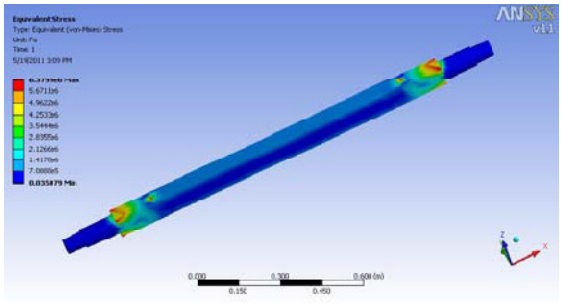
Figure 6.1.1 shows 3D model preparing in CATIA V5 software, convert it into IGS from open in Ansys. In which various types of stress are simulated.

FIG 6.1.1 SOLID AXLE



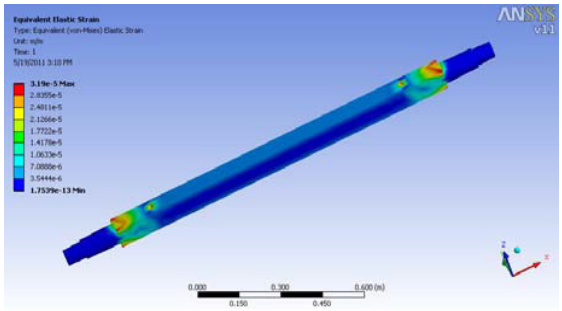
The equivalent stress generated on existing axle shown in figure 6.1.2. Figure shows the maximum stress generated on the axle at near the hub assembly, where the failure occurs. Red color shows the maximum stress and blue color shows minimum stress generated on the axle.

FIG.6.1.2 EQUIVALENT (VON-MISES) STRESS



The equivalent strain generated on existing axle shown in figure 6.1.3. Figure shows the maximum equivalent strain generated on the axle at near the hub assembly, where the failure occurs. Red color shows the maximum stress and blue color shows minimum stress generated on the axle.

FIG.6.1.3 EQUIVALENT STRAIN



As we know that commonly failure of axle is bending. Load of trolley is pointy supported on end of the axle so maximum deformation occurs at middle portion of axle. Figure 6.1.4 shows the Total deformation of axle when the load is applied. Red color shows the maximum deformation occurs on the axle and blue color shows the minimum deformation on the axle.

FIG.6.1.4 TOTAL DEFORMATION

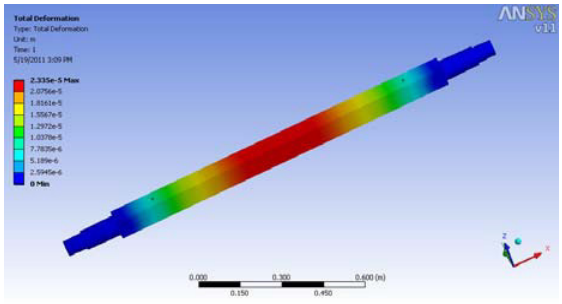
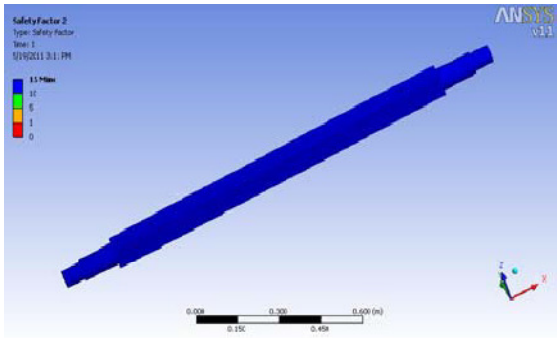


Figure 6.1.5 shows the factor of safety of axle when the load is applied. Blue color shows the maximum factor of safety occurs on the axle and Red color shows the minimum factor of safety on the axle.

FIG 6.1.5 FACTOR OF SAFETY



6.2 RESULTING VALUES OF EXISTING AXLE BY USING ANSYS

Sr. No.	Factors	Values
1.	Equivalent Stress	6.3799 MPa
2.	Equivalent Strain	3.19 X10-5 m/m
3.	Total Deformation	2.335 X 10-5 m
4.	Factor of Safety	15
5.	Mass	69.088 Kg

7. CONCLUSION

The Analysis of existing tractor trolley axle is done in ansys software; it is conclude that though the excess of heavy material is used for increasing the factor of safety to overcome breaking and bending but failure occurs. The maximum stress occurs near hub assembly portion, where breakage failure occurs in existing trolley axle. So it is necessary to redesign tractor trolley axle to overcome the failure and reduction in self weight of trolley axle and cost of axle.

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