Design and Development of Tractor Trolley Axle for Cost Minimization

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Abstract- *In India Tractor trolley or trailers are very popular and cheaper mode of goods transport in rural as well as urban area. But these trailers are manufactured in small scale to moderate scale industry. Especially in the small- and middle-scale agricultural machinery industry, insufficient use of new technology and new design features can cause problems such as breakdowns and failures during field operations. The existing trolley designed by the industry uses heavy axle without considering static and dynamic loading conditions which in turn leads to higher factor of safety increasing the overall cost of the axle. In this study, existing trolley axle is redesigned considering the static and dynamic load conditions.*

In this project we tried to optimize the hollow axle for the ultimate value so that the strength should be maintained with the reduction in cost and weight and we find the weight is reduce 40 to 60 %.The design is optimized based on the manufacturing cost of the axle. The failure analysis is performed on the axle of trolley used in agricultural area. These results provide a technical basis to prevent future damage to the location axle.

Keywords-dynamicload,axledesign,optimization,stress analysis

I. INTRODUCTION

In the present market scenario, cost reduction technique is playing signification role to meet the competition in the market. Weight reduction, simplicity in design and application of industrial engineering etc. are the sources of the technique which are used.

Various components or products used in rural areas are mostly manufactured in small scale industries such as farming machinery, thrashers, tractor trolleys etc. 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. These products are getting improved by means of feedback of failure as and when it occurs. 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 manufacturers are having no proper design of trolley chassis, leaf spring, axle and other components of the 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 tacking large factor of safety.

II. PROBLEM STATEMENT

The axle that is used in aditya agro industry currently is a solid axle whose manufacturing is a tedious work which leads to an increase in weight which directly impacts on its cost. We have tried to optimize the design of axle in order to reduce its cost and weight.

- Redesign the axle.
- Use of minimum size of cross section for the axle to reduces the weight.
- Standardization of component to incorporate simplicity of manufacturing for reducing manufacturing cost.

Methodology

- To find the stress, strain, total deformation and factor of safety of the existing axle using ANSYS.
- Development of alternative axle.
- To find the stress, strain, total deformation and factor of safety of the suggested axle using ANSYS.
- Compare all the above factors of suggested axle to the existing axle.

Table 1.1 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)	

III. LOAD ANALYSIS

The total capacity of the trolley is 60 KN but self weight of trolley and the axle assembly is 13 KN. So we consider the gross weight come over the 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.

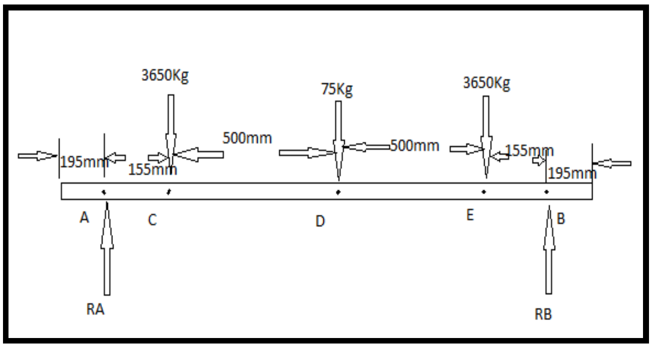

Figure 3.1 Load diagram

IV. SHEAR FORCE AND BENDING MOMENT

First we find the reactions at support i.e. R_A and R_B. By taking the moment at point A

$\therefore \quad \sum M_A = 0$

$\therefore \quad - R_B \times 1310 + 36.5 \times 1155 + 0.75 \times 655 + 36.5 \times 155 = 0$

$\therefore \quad R_B = 36.87$ KN

$\therefore \quad R_A - 36.5 - 0.75 - 36.5 + R_B = 0$ KN

$\therefore \quad R_A - 36.5 - 0.75 - 36.5 + 36.87 = 0$ KN

$\therefore \quad R_A = 36.87$ KN

Shear force diagram

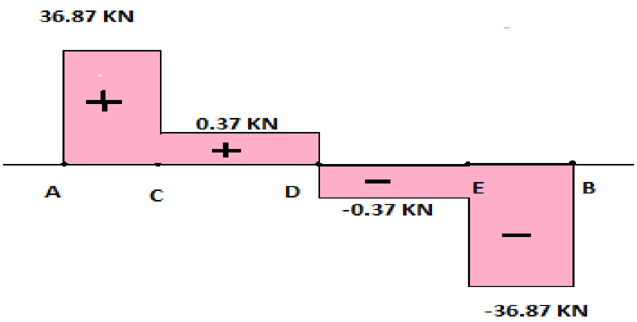

Figure 4.1 Shear force diagram

Bending moment diagram

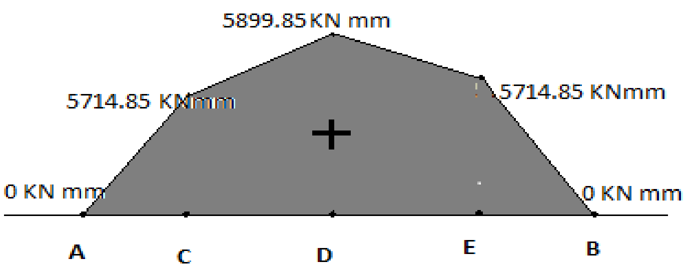

Fig. 4.2 Bending Moment Diagram

V. DESIGN OF EXISTING AXLE

A trolley axle is a stationary machine element and is used for the transmission of bending moment only. Trolley axle shaft will be designed based on its strength and subjected to bending stresses. The existing axle is a combination of hollow & square shafts as shown in the figure 5.1

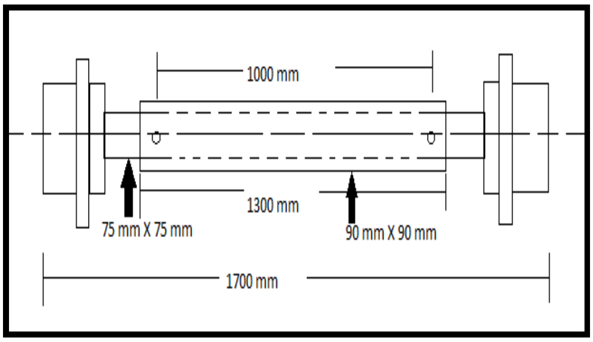

Figure 5.1 Existing axle

Check for bending strength:-

The combination axle has to be checked for the developed bending stress due to load of 36.5 KN.

f_b developed = M / z

M_{max} = 5899.85 X 2.65 (dynamic factor) KN mm

Z = 64 X 10^3 mm^3

F_b =244.29 N / mm^2

The bending stress is less than the permissible value hence combination axle is safe.

VI. ANALYSIS USING ANSYS TOOL

The existing axle geometry is generated in ANSYS by selecting toolbox where various commands like draw, dimensioning, constraints, extrude, generate, rotate etc. are used. Then mesh is generated on the model and after that load points are defined and load values are given. Then the results are generated automatically for stress, strain and deformation in solution phase.

STEPS

• Model
• Geometry
 Part 1
• Mesh
• Static Structural
 Analysis Settings
 Loads
 Supports
• Solution
 Stress
 Strain
 Total Deformation
• Results

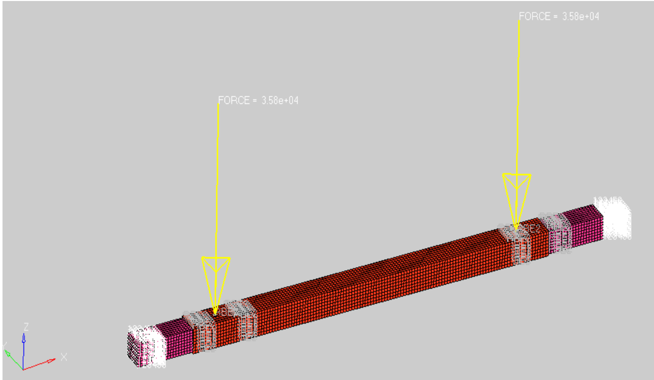

Figure 6.1 Mesh generated of Existing axle in ANSYS

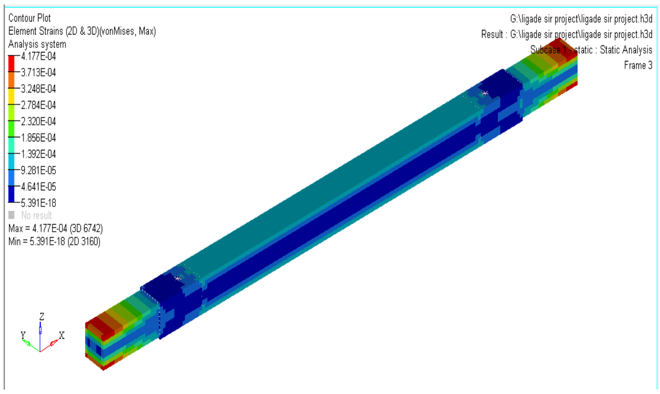

Figure 6.2: Equivalent strain in existing axle

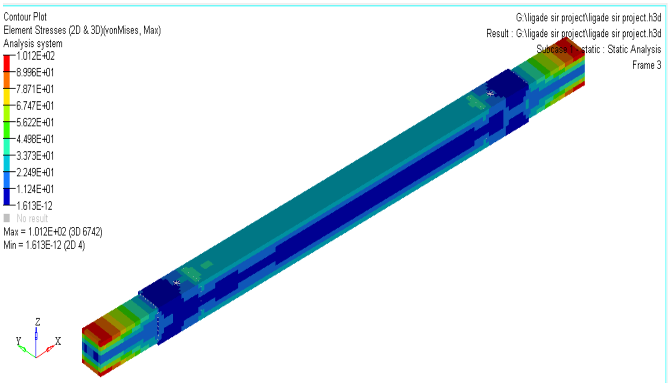

Figure 6.3: Equivalent Stress in existing axle

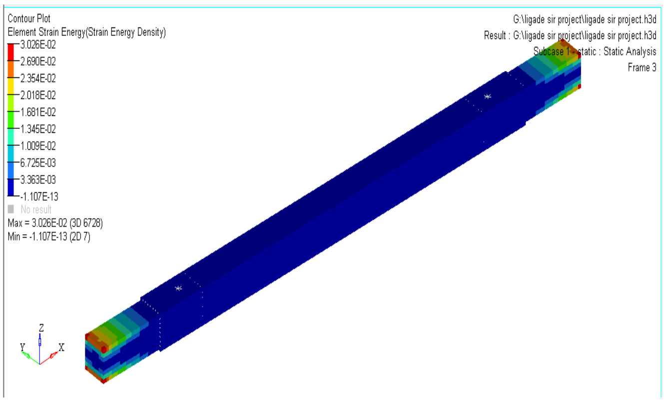

Figure 6.4:Equivalent strain energy density in existing axle

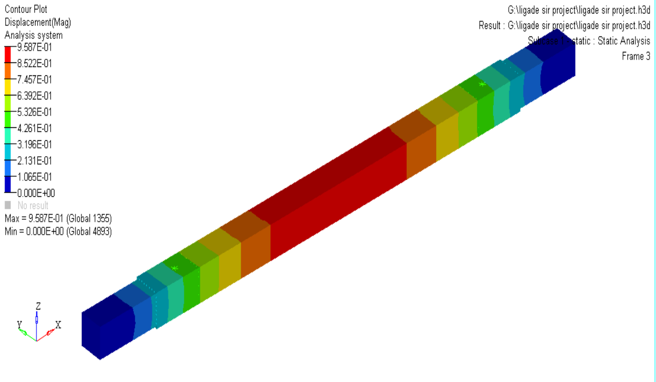

Figure 6.5: Deformation in existing axle

The red colour shows the maximum and blue colour shows the minimum values for stress, equivalent strain and total deformation in the existing axle.

VI. CONCLUSION

1. The dimension of the existing axle is change to be reduced as it proved by mathematical calculations.
2. There is assembly problem in hub on the axle as the dimension of the axle is change.
3. As the dimensions are reduced, the assembly problem is occurred so other solution is given as the hollow shaft, which exist the earlier dimensions for the hub assembly on the newly designed axle.
4. This newly designed axle reduces the 22.85%.
5. Also reduces in the cost of trolley axle as the weight of the axle reduces.
6. Manufacturing time of axle is also reduces.
7. The weight of axle is reduced.

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REFERENCES

[1] W. R. Garrott, P. A. Grygier "Methodology for validating the national advanced driving simulators vehicle dynamics".

[2] Manish S Lande "Comparative Analysis of Tractor Trolley Axle by Using FEA".

[3] Sanjoy Aloni, Sandip Khedkar, "Comparative Evaluation of Tractor Trolley Axle by Using FEM Approach", IJEST, Vol 4, Issue 4, April 2012.

[4] Happy Bansal, Sunil Kumar, "Weight Reduction And Analysis Of Trolley Axle Using Ansys", IJEMR, Vol 2, Issue 6, December 2012.

[5] Vishwas Lomate & Prof. Madki S.J. "Dynamic Analysis Of Sugarcane Trolley Axle By Using Ansys" International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 02 Issue: 04 | July-2015

[6] P.Manasa, C.Vijaya Bhaskar Reddy "Modeling and Analysis of Tractor Trolley Axle Using Ansys". IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE) e-ISSN: 2278-1684, p-ISSN: 2320-334X, Volume 6, Issue 5 (May. - Jun. 2013), PP 88-92

[7] Khangar V S and Jaju S B (2012), "A Review of Various Methodologies Used for Shaft Failure Analysis", GHRCE Nagpur, Ind