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EXPERIMENTAL ANALYSIS OF TRACTOR TROLLEY CHASSIS

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ABSTRACT

This paper aims to redesign a modified chassis for tractor trolley by keeping the material and dimension similar and using 'I' cross section area instead of 'C' resulted in more safer stresses than 'C' and the material used is mild steel. The chassis frame has to withstand the stresses developed as well as deformation occurs in it and to withstand the shock, twist vibration and other stresses. Its principle function is to carry the maximum load for all designed operating condition safely that should be within a limit. On chassis, frame maximum shear stress and deflection under maximum load are important criteria for design and analysis. The experimentation performs on universal testing machine by keeping the load vs. deformation.

KEYWORDS: Stress Analysis, Universal Testing Machine, Chassis Beam, etc.

INTRODUCTION

Tractor Trolley

Tractor Trolleys are very popular and cheaper mode of goods transport in rural as well as urban area. Trolleys are widely used for transporting agriculture product, building construction material and industrial equipment. The main requirements of trolley manufacturing are high performance, easy to maintain, longer working life and robust construction. In this work, the tractor trolleys are used for the agriculture work and sometimes used for transporting building construction material. These trolleys are divided into two types as two wheeler and four wheeler. The varieties of trolleys are available and use of particular trolleys depends upon their application. They are available in various capacities like 3 tonne , 5 tonne, 6 tonne ,8 tonne etc.

Chassis

A chassis is one of the key components of the trolley. It consists of an internal frame work that supports the container of tractor trolley in its construction and use. It is a dead vehicle which is connected to the tractor to carry the load. It serves as a frame work for supporting the body. It should be rigid enough to withstand the shock, twist, and other stresses & its principle function is to carry the maximum load for static and dynamic condition safely. An important consideration in chassis design is to have adequate bending stiffness along with strength for better handling characteristics. The Chassis is used to support the container on which the load is to be carried out .The trolley chassis main frame is supported at two points over the axle.

Functions of Chassis

- To carry load of the goods carried in the body.
- To withstand the forces caused due to the sudden braking or acceleration.
- To withstand the stresses caused due to the bad road condition.

(a)

(b)Fig. A chassis of 6 tonne 2 wheeler trolley

In the present market scenario, cost reduction technique is playing signified role to meet the competition in the market. Weight reduction and simplicity in design are application of industrial engineering etc, 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. 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. Though tractor trolleys are manufactured in various capacities by various industries, still there is a large variation in manufacturing methods, component design etc. The trolley chassis manufacturers do not have a proper design of trolley. For this project work, a chassis of 6 tonne 2wheeler tractor trolley chassis manufactured by Awchat Industries Pvt. Ltd wardha is selected. The existing trolley chassis designed by industry uses 'C' Cross section having dimension of the section is 200mm x75mm x7mm and the material used is mild steel. The main aim of this project is to help the company in suggesting best suitable design for chassis.

FINITE ELEMENT ANALYSIS

The finite element method is a numerical method for solving problems of engineering and mathematical physics. Typical problem areas of interest in engineering and mathematical physics that are solvable by use of the finite element method include structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. For problems involving complicated geometries, loadings, and material properties, it is generally not possible to obtain analytical mathematical solutions. Analytical solutions are those given by a mathematical expression that yields the values of the desired unknown quantities at any location in a body (here total structure or physical system of interest) and are thus valid for an infinite number of locations in the body. These analytical solutions generally require the solution of ordinary or partial differential equations, which, because of the complicated geometries, loadings, and material properties, are not usually obtainable. Hence we need to rely on numerical methods, such as the finite element method, for acceptable solutions. The finite element formulation of the problem results in a system of simultaneous algebraic equations for solution, rather than requiring the solution of differential equations. These numerical methods yield approximate values of the unknowns at discrete numbers of points in the continuum. Hence this process of

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modelling a body by dividing it into an equivalent system of smaller bodies or units (finite elements) interconnected at points common to two or more elements (nodal points or nodes) and/or boundary lines and/or surfaces is called discretization. In the finite element method, instead of solving the problem for the entire body in one operation, we formulate the equations for each finite element and combine them to obtain the solution of the whole body. Briefly, the solution for structural problems typically refers to determining the displacements at each node and the stresses within each element making up the structure that is subjected to applied loads. In non-structural problems, the nodal unknowns may, for instance, be temperatures or fluid pressures due to thermal or fluid fluxes.

STRESS ANALYSIS OF CHASSIS USING ANSYS TOOL

Analysis of existing "C" cross section chassis

Figure shows Force Diagram created in ANSYS showing 5000N uniform load applied on the Beam.

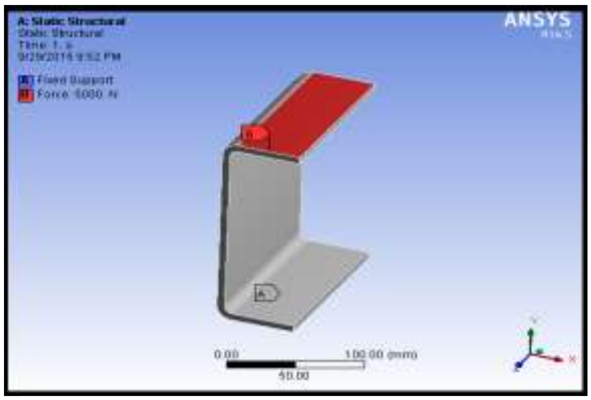

Fig. Force Diagram

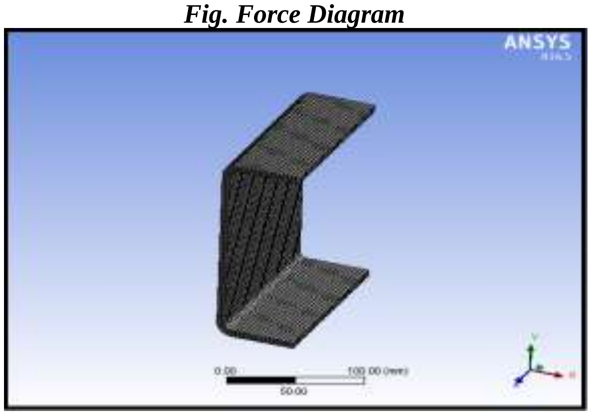

Fig. Meshing

Figure shows Total Deformation of Beam when the load is applied. Red color shows the maximum stress and blue color shows minimum stress generated on the Beam.

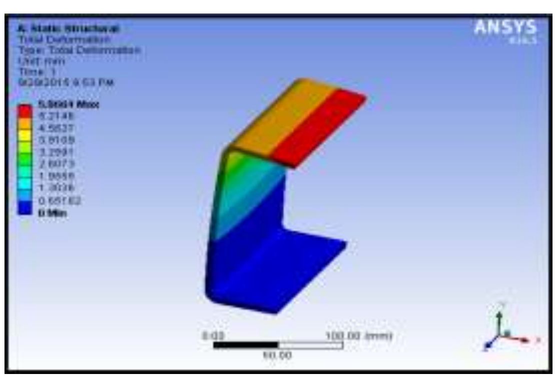

Fig. Total Deformation

Figure shows Total Deformation of chassis when the load is applied. Red color shows the maximum stress and blue color shows minimum stress generated on the Chassis.

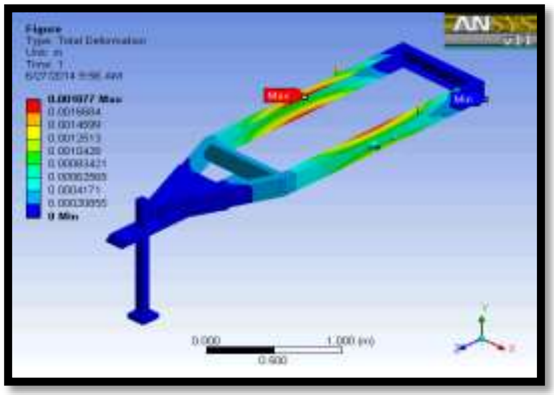

Fig. Total Deformation

Analysis Of Suggested 'I' Cross Section Chassis

Figure shows Force Diagram created in ANSYS showing 15000N load applied on the Beam.

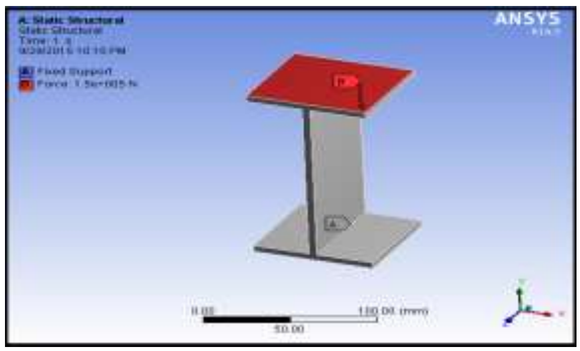

Fig . Force Diagram

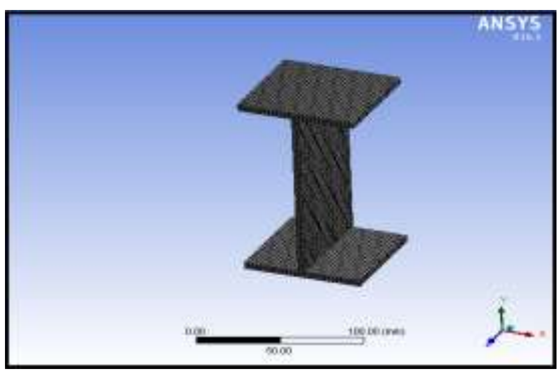

Fig. Meshing

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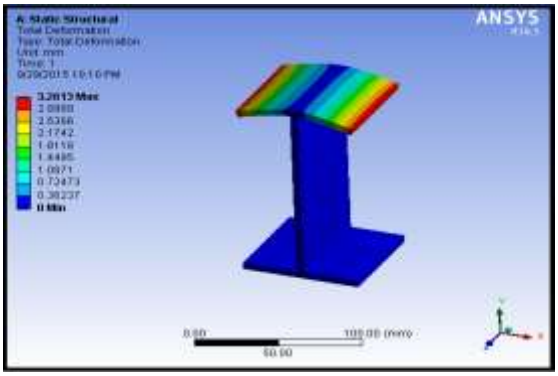

Fig. Total Deformation

Figure shows Total Deformation of chassis when the load is applied. Red color shows the maximum stress and blue color shows minimum stress generated on the Chassis.

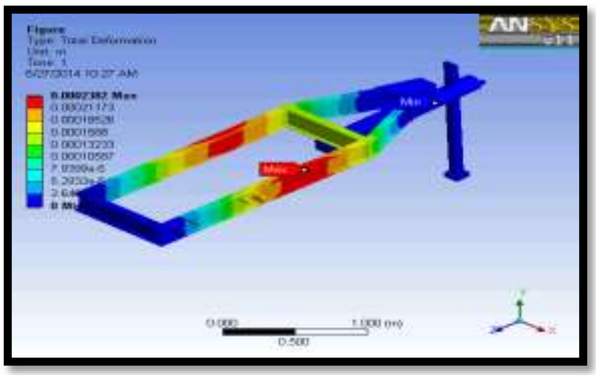

Fig . Total Deformation

EXPERIMENTAL STATIC STRESS ANALYSES

Method of Testing

Initial Adjustment: - before testing adjust the pendulum with respect to capacity of the test i.e. 8 Tones; 10 Tones; 20 Tones; 40 Tones etc. For ex: - A specimen of 6 tones capacity gives more accurate result of 10 Tones capacity range instead of 20 Tones capacity range. These ranges of capacity are adjusted on the dial with the help of range selector knob. The control weights of the pendulum are adjusted correctly. The ink should be inserted in pen holder of recording paper around the drum & the testing process is started depending upon the types of test as mentioned below.

Compression Test

Compression test is just opposite in nature to tensile test. Nature of Deformation and fracture is quite different from that in tensile test. Compressive load tends to squeeze the specimen brittle material are generally week in tension but strong in compression. Hence the test is normally performed on cast iron, cement concrent etc. but ductile material aluminum and mild steel which are strong in tension, are also tested in compression.

Test set-up and Specification of Machine

Fix upper and lower pressure plates to the upper stationary head & lower table respectively. Place the specimen on the lower plate in order to grip. Then adjust zero by lifting the lower table. The upper head moveable while the lower head is stationary. One of the two heads is equipped with a hemispherical bearing to obtain. Uniform distribution load over the test-piece ends. A load gauge fitted for recording the applied load.

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Fig. Universal Testing Machine

Steps of Experimentation

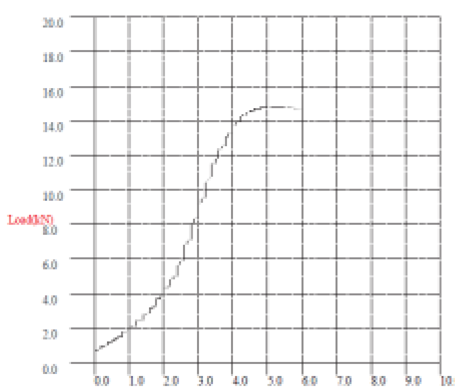
1. Dimension of test peace (C&I section) is measured three different places along its height /length to determine the average cross section area.
2. End of the specimen should be plane. For that the ends are tested on bearing plates.
3. The specimen(C&I section) placed centrally between the two compression plates, such that the centre of moving head is vertically above the centre of specimen.
4. Load is applied the specimen by moving the movable head. (i.e. 73KN)
5. The load and corresponding contraction are measured at different intervals.
6. Load is applied until the specimen fails

Fig. C Cross section

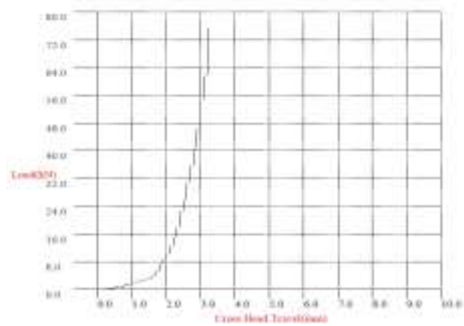
Fig. I Cross Section

Fig. Performing Testing on C cross section

Fig. Performing Testing on I cross section



Graph. C section load vs. displacement



Graph. I section load vs. displacement

The Fig shows the validation setup of chassis for getting the deformation values at given boundary and loading conditions. For measuring the load vs. deformation on test rig one fixture need to develop. In this work, 70 mm length cross section was considered instead of whole chassis, compression test was performed on both cross sections C & I using Universal Testing Machine.

In compression test, fully automatic computerized UTM is utilized which is having capacity 80 tons. The setup and results are given below.
From graph. it shows that at given loads for C-section 15 KN the deformation was found 5.5 mm. But in case of I-section 75.32 KN load is required for 3.3 mm deformation.

RESULT, DISCUSSION & COMPARASION

Following table shows comparative result between existing C-section & suggested I-section. According to stress analysis of existing C-section & suggested I-section is carried out. As per the conditions initially stress range was fixed and then the stress analysis is performed. Stress range of suggested I-section shows a very good match with the stress range of existing C-section. The obtained deformation stress value of existing C-section is in FEA and Experimentally 5.8 & 5.5 mm and for suggested I-section is 3.2, 3.3 mm. As stress range of suggested I-section is within the stress range of existing C-section. Thus, the modified design proves to be safe. More safer stresses are obtained in new suggested design and increase in Factor of Safety obtained in new suggested design. Thus to improve the load carrying capacity of trolley that was reduced by heavy chassis.

Table. Result Analysis

Result Analysis between Existing & Suggested Section		
Type of Analysis	C SECTION	I SECTION
FEA Analysis using ANSYS (For Load-5KN)		
Static Stress Deformation	5.8mm	2.1mm
Experimental Analysis (For Load-15KN)		
Static Stress Deformation	5.5mm	2.2mm

CONCLUSION

1) The newly designed 'I' section Chassis reduces deformation as compared to the existing 'C' section Chassis.
2) More safer stresses are obtained in new suggested design.
3) Increase in Factor of Safety obtained in new suggested design.
4) To improve the load carrying capacity of trolley that was reduced by heavy chassis.

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