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DESIGN AND ANALYSIS OF AUTOMOTIVE SHACKLE

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Abstract
Shackle as a part of suspension system, this help to enhance the leaf spring flexibility. The arrangement tends to tensile, bending, shear and proof loads. This will cause the failure of suspensions system.Finite element analysis (FEA) is carried out at static condition of the shackle, so that stress distribution can be observed for analysis of high stress zones. Solid works model is carried out in the analysis. The analysis is to compare the various loading condition and the overall stress distribution zones have been studied.

Keywords- *EN 45 materials, Finite element method, Stress analysis.*

1. INTRODUCTION

A shackle is a simple form of spring commonly used for the suspension in wheeled vehicles originally called a laminated or carriage spring, and sometimes referred to as a semi – elliptical spring or cart spring or flat plate. The shackle is based on the theory of a beam of uniform strength. Shackle can serve locating and to some extent damping as well as springing functions. While the interleaf friction provides a damping action, it is not well controlled and results in station in the motion of the suspension. For this reason manufacturers have experimented with mono- shackle.

In this present work, an attempt is made to replace the existing steel shackle with EN45 shackle used in light vehicle, shackle is designed to analysis the behaviour of bending stress, deflection and stress at various loads is applied over the mono shackle. Weight reduction can achieve by the 80% after using carbon fibre composite shackle.

Increasing competition and innovations in automobile sector tends to modify the existing products or replacing old products by new and advanced material products. A suspension system of vehicle is also an area where these innovations are carried out regularly. There is almost a direct proportionality between the weight of the vehicle and its fuel consumption. This paper is mainly focused on the implementation of composite materials by replacing steel in conventional shackle of a suspension system. Automobile-sector is showing an increased interest in the area the introduction of the paper should explain the nature of the problem, previous work, purpose, and the contribution of the paper. The contents of each section may be provided to understand easily about the paper. of composite material-leaf springs due to their high strength to weight ratio. Therefore analysis of composite material shackle has become essential in showing the comparative results with conventional shackle.

2. THEORETICAL CALCULATION

The Specification of Tata sumo car is taken for calculating the heat flux created during maximum speed condition. The maximum friction force created will be found to find the deceleration to find the time taken to stop the vehicle.

3. SUNPENSION SYSTEM:

Suspension = spring + shock absorber + linkage connecting shackle vehicle to its wheel. System = Assemblage or combinations of things or parts.

Thus, Suspension system is a mechanical system which consists of springs and shock absorbers. The automobile chassis is mounted on the axles, not direct but some form of springs.

4. DESCRIPTION OF THE PROBLEM:

As weight plays an important role in deciding the efficiency of an automobile. The shackle used generally is made of steel which are quite bulky and one of the potential items for weight reduction in automobiles because it accounts 10-20% spring weight carried by its own.

. This work Figure1, is mainly focused on the implementation of thermoplastic polyimide with EN45 materials by replacing the excising conventional steel material shackle of a suspension system to reduce product weight, improving the safety, comfort and durability.

Figure no1: Problem description material.

5. SPECIFICATION OF THE SHACKLE:

The shackle input dimensions are followed by "universal shackle design".

Table no. 1 Design Parameter for composite Shackle

s.no	Parameters	Dimensions
1	Total Length shackle(body)(mm)	110
2	Width of shackle(mm)	40
3	Max. Load given on shackle	1500 N
4	Weight of the body	0.87kg

6. MATERIAL FOR SHACKLE:

Generally shackles are made of various fine grade alloy steel. The test steel shackle used for experimentation purpose is made up of EN 45. The composition of material is 0.60 C%, 2.00 SI%, 1.00 Mn%, 0.05 P%, 0.05 S%. The parabolic shackle is used in the TATA SUMO GOLD vehicle, for Rear Suspension. Following are the parameters for the EN 45 steel.

Table no. 2 Parameter for EN45 composite Shackle

Grade	C%	Mn%	Si%	Cr%	S,P%
EN45	**0.45 - 0.55**	**0.50 - 0.80**	**0.50 - X**	**0.80 - 1.20**	**0.050***

7. MODELLING:

The modelling of the shackle profile is done using solid works13. The conventional designed shackle is various profiles have been generated as the same area is selected for other profiles.

Fig2. Dimension is first modelled in the SOLID WORKS 13.

8. ELEMENT TYPE:

8 Node Brick 185: SOLID185 is used for the 3-D modelling of solid structures. The element is defined by

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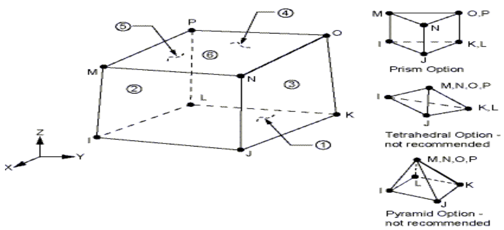
eight nodes having three degrees of freedom at each node: translations in the nodal x, y, and z directions.



The geometry and node locations for this element are shown in Figure3.

The element is defined by eight nodes and the orthotropic material properties. The default element coordinate system is along global directions. You may define an element coordinate system using ANSYS, which forms the basis for orthotropic material directions.

9. MESHING (SOLID MESH):

The meshing of the shackle profile is done using solid works13.The number of nodes 98755 and number of elements 64699 for the selected meshing statics.

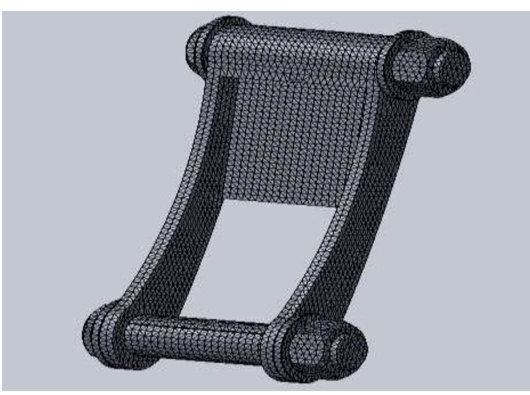


Fig4. Meshed view in the SOLID WORKS 13.

10. BOUNDARY CONDITION:

The front end of the shackle is coupled with a pin to the frame so that the eye can rotate freely about the pin show in Figure5.

- The rear ends of body have the flexibility to slide along the X-direction.
- The front end of the shackle body is constrained as UX, UY, UZ, rotation motion at ROTX, ROTY is fixed.
- The rear end of the shackle body is constrained as UY, UZ, is fixed and ROTX, ROTY is giving rotation motion and the Z-direction is free.
- A uniformly distributed load is applied on the shackle in vertically upward direction. The range of loading is 1500N.

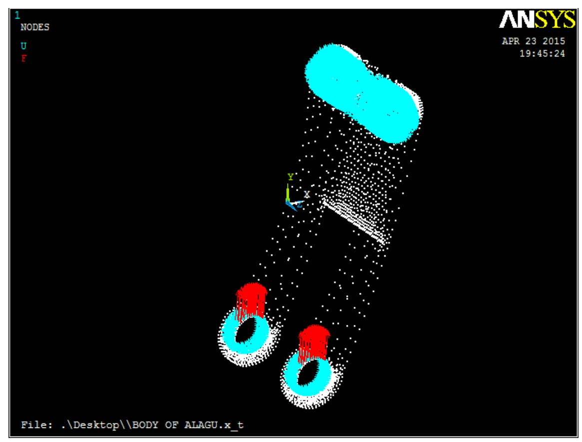


Fig5.Loading conditions.

11. ANALYSIS:

Modeling is done using Analysis is carried out by using ANSYS 14.0 software for better understanding. SOLID185 element is a higher order 3-D, 8-node element.

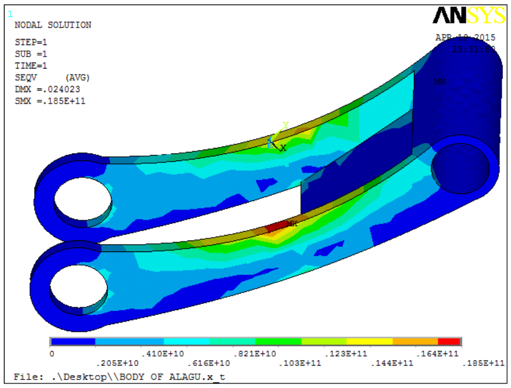
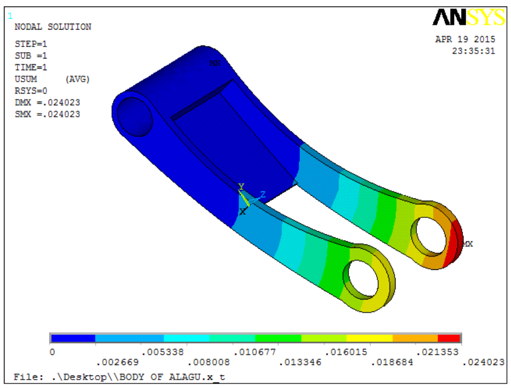
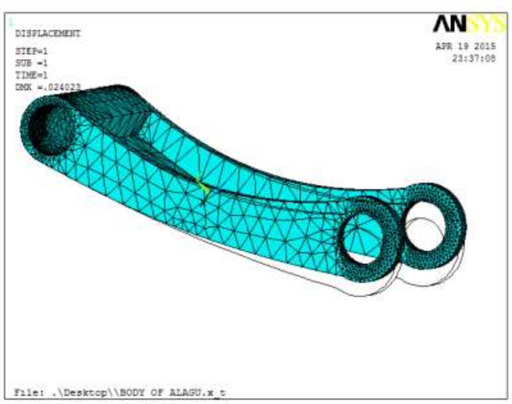


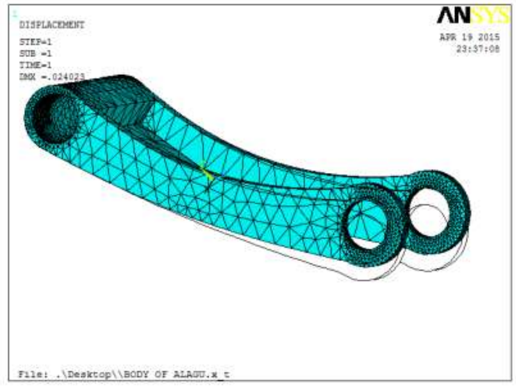
Fig.5 A. Von Mises Stress at load of 1500 N



B. Load vs. Deflection for EN45 Shackle



C. Load vs Deformation for EN45 shackle



D. Load vs Deformation for Steel shackle.

12. RESULT AND DISCSSION:

From the result of static analysis of steel and EN45, it is seen that the maximum bending stress in EN45 steel about 86N/mm2 when gives 1500N load on Shackle shown in figures. Were in EN45 having safe bending stress over steel Shackle.

Table no3.FEA Results of materials

Parameter	FEA Result of EN45 shackle	FEA Result of Steel shackle.
LOAD ,N	1500	1500
Bending Stress,N/mm2	86	112
Total Defletion,mm	160	182

13. CONCLUSION:

- In this present work, the bending stress, deformation and deflection were analyzed for the Conventional Steel shackle of TATA SUMO Car and research material EN 45.

- The Optimum bending stress value of EN 45 by analyzing is found to be 86 N/mm^2 which is lesser than Conventional steel shackle of 112 N/mm^2. The lower bending stress results in increased life of the material EN 45 as compared to existing material.
- The deflection value of conventional steel and EN 45 is found to be 182mm and 160mm. The material EN 45 subjected to lesser deflection, it indicates the better strength as comparing to existing material.
- The Deformation of EN 45 is 0.24307mm whereas for conventional steel it is found to be 0.4162mm.
- Therefore, the analyzed results indicate that EN 45 may be selected for the shackle material due to their lesser stress, deflection and deformation as compared to the existing material.

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