NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 2, ISSUE 1 JAN-2015

Static stress analysis of Mahindra Alfa front mud-guard and its comparison with FRP mud-guard

Deepak Dubbawar
Assistant Professor, Department of Mechanical Engg. Gharda Institute of Tech, Lavel
Dr. Milind Patil
Associate Professor, Department of Mechanical Engg. J.T. Mahajan COE, Faizpur

Abstract

The Mud-guard of the vehicle is used to keep off mud, pebbles, and other road debris from splashing on and scratching the coat of the vehicle and it is weakly designed. The present work focuses on experimental and finite element stress analysis of the Three-Wheeler (Mahindra Alfa) front mud-guard under repair and maintenance loading conditions. The objective of present work is to carry out finite element stress analysis of front mud-guard of three-wheeler and experimental validation of the stress and comparison with the manufactured Fiber Reinforced Plastic (FRP) fender, The analysis will provide knowledge of stress distribution across the whole mud-guard due to load.

Introduction

Three wheeler vehicles play very important role in transportation of goods, materials and also for public transport. The front mud-guard is used to keep off mud and other road debris from splashing on and scratching the coat of the vehicle, designed in different sizes, shapes and colors for different vehicles depending upon specific vehicle requirements. Various materials are used for mud-guard based on the strength and life requirements of it and to meet this, different manufacturing methods are used with respect to material used.

Apart from normal loads the mud-guard is subjected to different handling conditions during repair and maintenance of the vehicle. In case of tyre puncture of the vehicle the procedure of removing the front wheel is very tedious. Currently the whole vehicle has to be tilted to one side or lifted from front side till the serviceman fix the problem occurred. However it is not desirable to keep the vehicle in such position. Due to this the mud-guard is subjected to additional loads. The front mud-guard is not designed to take the lifting load of vehicle, so the structural strength has to be estimated.

FE Analysis

The geometry of mud-guard is created in the modeling software CATIA and imported in ANSYS 13.00. The model was discritised into small finite elements to analyze the structure. All the components are modeled using shell element at mid surface. Based on the geometry the thickness property is applied to the corresponding element. For meshing of the front fender 2d SHELL63 element is selected for analysis.

The material of three wheeler front mud-guard is Polypropylene Copolymer (PPC) MI 3530 which is currently used in most of the three wheeler vehicle.

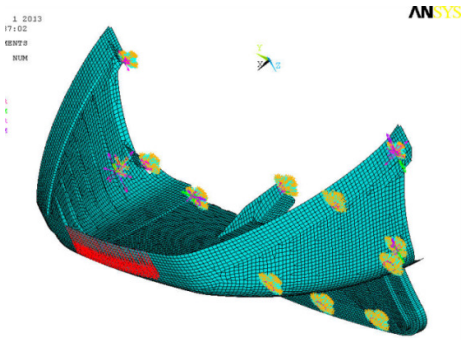


Figure 1: Boundary conditions

There are total eleven mounting locations to attach front mud-guard with the vehicle front. Therefore all degrees of freedom of nodes around the holes are constrained.
The load is applied in Z direction at the nodes on the edges of mud-guard at same location and position as per the actual loading condition. The analysis is for two different cases viz. Side Loading and Front Loading. Application of load is along Z axis while X & Y axes are along other two sides of modeled mud-guard. Load is applied in the steps of 20 Kg i.e. 20 Kg, 40 Kg, and 60 Kg and so on. After appropriate application of boundary conditions and loads the solver is selected and RUN is executed. Sparse Matrix solver is selected as it is quickest and simplest solver for conducting static structural finite element analysis.

Experimental set-up and procedure

Suitable fixture is fabricated and mounted on a rigid wall. For the sake of convenience the mud-guard is mounted in reverse position i.e. upside down. Then mud-guard is subjected to dead weights so that applied dead weights gives situation similar to actual lifting load condition. A Pan is clamped to the mud-guard with the help of a chain at the predefined points and weights are added in the pan to increase load.

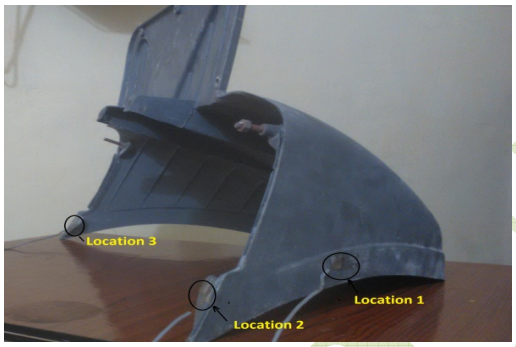


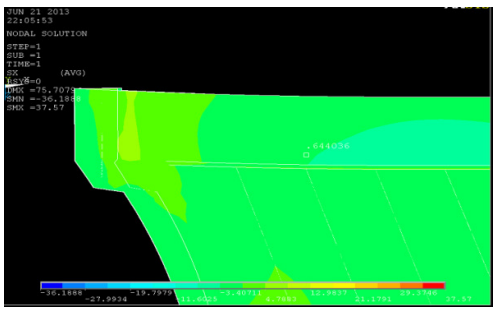
Figure 2: Location of strain gauges

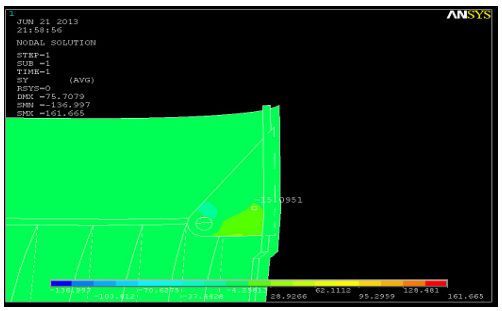

Figure 3: Experimental set-up

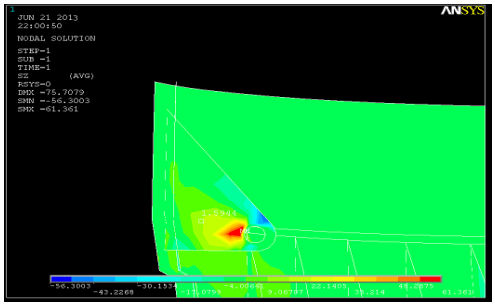
The stress values are obtained by using unidirectional strain gauges and strain gauge indicator. Unidirectional foil type Strain Gauges of gauge length 5 mm are bonded on the mud-guard at predefined locations along X axis, Y axis and Z axis. Mud-guard is then loaded in the steps of 20 kg in front loading and side loading conditions. Subsequently strain induced is recorded on strain indicator. The stresses are then calculated by using the basic formula of Young's modulus, = .

Results and discussion

From FEA analysis it is observed that uniform distribution of stress acts along the wall of the fender with minor variation throughout the surface. It describes maximum stress regions occurring near mounting points i.e. holes. Also we have picked a particular location on this mounting point for X, Y and Z directional stress and strain values to validate with experimental observed values.


(a) X direction at location 1


(b) Y direction at location 2



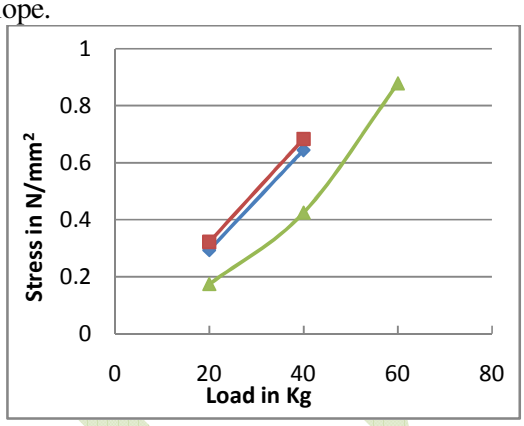
(a) Z direction at location 3

Figure 4: Stresses in Mud-guard

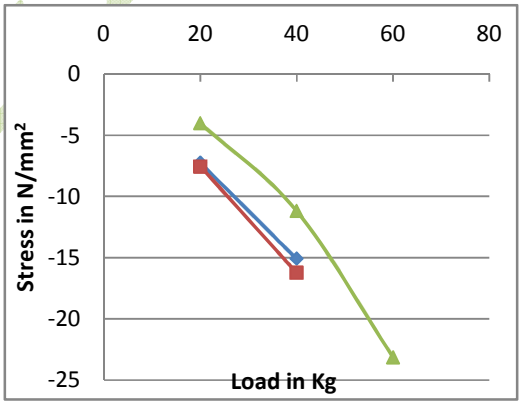
Table 1: Comparison of FEA and experimental results for existing mud-guard

Load In kg.	Stress in x-direction σ_x (N/mm^2)		Stress in y-direction σ_Y (N/mm^2)		Stress in z-direction σ_z (N/mm^2)	
	FEA	Experimental	FEA	Experimental	FEA	Experimental
20	0.294	0.3223	-7.2458	-7.5504	0.8236	0.8591
40	0.644	0.6831	-15.095	-16.236	1.5944	1.6687
60	Failure of mud-guard					

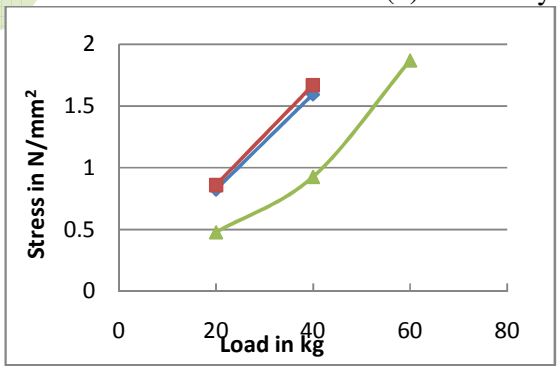
The graphs of comparison of FEA and experimental result of existing and FRP mud-guard are shown in figure 5. Experimental values of existing mudguard show close relation with the predefined FEA values. A small variation in results is may be due to experimental error involved. Nature of FEA, experimental and FRP curves are similar. Initially slope of curve is less up to 40 kg load then curve becomes steeper. All the curves show close linearity with respect to each other. As it is compressive nature of stress, only the figure 5(b) shows negative slope.



(a) Stress in x-direction at location1



(b) Stress in y-direction at location2



(b) Stress in z-direction at location3

FEA result — stresses in existing Mud Guard — stresses in FRP mudguard

Figure 5: Comparisons of FEA and Experimental Results

From experiments, it is found that the existing mud-guard can withstand load upto 40 Kg, beyond 40 kg the mud-guard will fail. But the FRP mud-guard has high strength it can withstand load upto 60 kg or even more.

Table 2: Comparison of experimental results for existing and FRP Mud-guard

Load In kg.	**Stress in x-direction σ_x (N/mm^2)**		**Stress in y-direction σ_Y (N/mm^2)**		**Stress in z-direction σ_z (N/mm^2)**	
	Existing	FRP	Existing	FRP	Existing	FRP
20	0.3223	0.1737	-7.5504	-4.0348	0.8591	0.4778
40	0.6831	0.4247	-16.236	-11.1971	1.6687	0.9267
60	----	0.8784	----	-23.1374	----	1.8678

Table 3 shows that the material cost for FRP mud-guard is greater than the cost of present mud-guard. Similarly the weight of FRP mud-guard is also more because the density of Fiber Reinforced Plastic is more than the Polyprophelene Copolymer (material of present mud-guard).

Table 3: Cost and weight comparison of existing and FRP mud-guard

Parameters	**Existing mud-guard**	**FRP mud- guard**
Material Cost	Rs. 138.00 / Pc	Rs. 180.00 / Pc
Total Weight	1.2 Kg	1.7 Kg

Conclusion

The FEA and Experimental stress analysis proved that front loading condition is unsafe for existing design of the mud-guard. Maximum stress was observed near mounting holes. It is also observed that the stresses induced at these locations increases with the application of lifting load. Further the experimental stress analysis is conducted on new mud-guard which is fabricated by using Fiber Reinforced Plastic (FRP) material keeping the same dimensions of existing Mud-guard. And found that it doesn't fail even more than 60 kg in both side and front loading conditions. But the newly manufactured and tested mudguard is suitable for three wheeler.

References

[1] Arvind Krishna, "Stress analysis of Instrument Panel Knobs", *SAE Paper No.2000-01-0316, 2000.*
[2] Basil Housari, Lian X. Yang, "Experimental Techniques for Strain Measurement and Validation of CAE Model", *SAE Paper No.2005-01-0587, 2005.*
[3] Chi-Hoon Choi, Sang-Sun park, Tae-Won Hwang, "Development of Composite Body Panels for a Lightweight Vehicle", *SAE Paper No.2001-01-0102, 2001.*
[4] Naveen Rastogi, "Stress analysis and Lay-Up Optimization of an All Composite Pick-Up Truck Chassis Structure", *SAE Paper No.2004-01-1519, 2004.*
[5] Rafat Ali, "Finite Element Study of a Composite Material Sump Pan of an I.C. Engine", *SAE Paper No.950942, 1995.*