Design and Analysis of Load Body Side Channel Weld Bracket of EICHER 909ex Truck

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Abstract- *In an automotive vehicle, the load body rest on skeleton of vehicle and the load body connected with the main frame or skeleton with the side channel weld bracket. Hence during running condition of such long vehicle the side channel bracket supports to upper body and skeleton on which the body rests. This causes discomfort to the body or might even damage the weld bracket or main frame of chassis. Also at high operating frequencies noise become damage. This deflection should be within permissible limit. The main aim of this project is to reduce manufacturing cost of load body side channel weld bracket by changing design for easy manufacturing. This load body vehicle consists of 36 number of weld bracket, if we reduce the weight of this bracket within the permissible limit the overall weight is also reduces. By keeping same material D513 steel constant weight reduction done by reducing thickness for modified bracket. Total weight reduction is 30.70 %. The baseline model of the side channel weld bracket is created by using solid modelling software and then for further analysis also made by software provided. The present study used to reduce cost and weight of side channel weld bracket by keeping factor of safety within permissible limit.*

Key words: **Load body side channel weld bracket, FEA, Static analysis, Modal analysis.**

1. INTRODUCTION

Improvement in each and every part of automobile part is the main aim as a design engineer. Automobile industry continued improving since from many years with the efforts conducted for the purpose of modification of the mechanical parts of vehicles in order to improve their performance. This Engine as well as the load body of heavy vehicle is one of the most important components of a road vehicle such as trucks, buses, long heavy vehicle etc. High performance such types of vehicle has their load body supported by bracket. Basically, it plays an important role in improving the comfort & work environment of a long loaded vehicle. Basically it is necessary to design proper side channel weld bracket for vehicle.

Design and analysis of load body side channel bracket consists of the analysis using the FEA (Finite element analysis). It becomes a practical analysis/method of predicting stresses and deflection for loaded structures. FEA accurately identifies the load which can be difficult using complex structures. Also the main important aim of the project is to minimize the weight and design cost of the weld bracket. Then for the easy way of understanding and simplest way to implement the design process we are going to use the finite element analysis.

Bracket is an architectural element which is a structural member. In mechanical engineering a bracket is any intermediate component for fixing one part to another. Here we are going to design the side channel bracket of EICHER 909 EX truck model which is a HCV widely used for heavy transportation. This bracket connects to the upper body of vehicle and main frame, and it shares the load coming from upper body to the main skeleton frame. In a working condition due to shock absorption and vehicles own displacement the deformation may be takes place in such bracket or it may got cracks. This is the failure of load body side channel weld bracket. In this paper we are going to analyze the result of existing bracket with the new modified bracket.

Fig-1: Location of side channel weld bracket

The side channel weld bracket connects the two channels i.e. main frame skeleton and upper body by welding. The side channel weld bracket is made by hot rolled sheet material and then it is folded for required dimensions. The bracket is as shown in the figure.

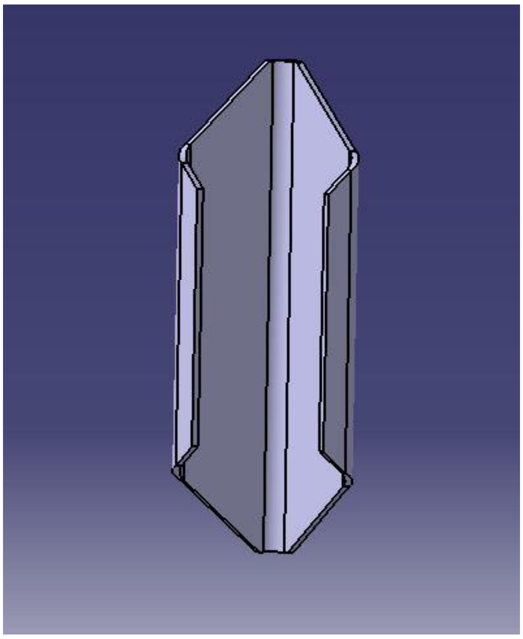

Fig-2: Side channel weld bracket

2. LITERATURE REVIEW

Michael A. Weaver in his thesis Finite element analysis has became a practical procedure for finding out stresses and deflection of a loaded structure. Finite element analysis shell element model are effective for finding loads in weld elements fabricated from sheet, plates, structural shape. This journal shows a method to drive the loads at weld joints from the stress results of FEA shell element models[1]. Monali Deshmukh et.al discusses engine mounting bracket plays a vital role in reducing noise, vibration and harshness for improving vehicle drive comfortable. The bracket from the frame which supports the engine undergo high static and dynamic stresses with the huge amount of vibration. At here they described that, existing bracket is optimized and modified model was proposed to reduce weight of rib of engine mounting bracket as well the harmonic response in terms of acceleration is checked to ensure that the proposed model will not result to noisy operations[2]. Teo Han Fui et.al discussed discusses the load truck chassis plays an important role as chassis is the structural backbone of a commercial vehicle. The main role of chassis is to supports the components which are rests on it and payload upon it. In a running condition the chassis is subjected to induced vibration by roughness and excitation by vibrating components mounted on it. They presented in his journal that the study of vibration characteristics of the truck chassis that induced the natural frequencies and mode shapes. The modes shapes results shows the suitable mounting locations of components like engine and suspension system[3].Prof. Dr. Santosh G. et.al discusses in the automotive industries as per the safety standard this is very important to design light weight component,. The location of air conditioner in car is mounted on bracket in the bonnet. This study intends to analyze the bracket and optimize the weight by keeping same material constant, weight reduction will not only reducing the cost of raw material, but also increase in efficiency, through very minute[4].

3. PROBLEM DEFINATION AND OBJECTIVES

In recent studies some problems are observed and they are,

- Weight of bracket is more
- Geometry of weld brackets increases the weight.
- The tooling cost of production of these weld bracket is more.

In order above mensioned problems, main aim of the project is summerize bellow;

- To reduce the weight of the existing bracket.
- Redesign the bracket for reduction in weight.
- To make bracket shape simple and easy manufacturing process and hence to reduce production cost.

4. MATHEMATICAL CALCULATIONS

The existing load body capacity is 9.6 ton

Total capacity of load body= 9.6* FOS

= 9.6*1.3

= 122428.8 N

No of bracket present = 36

Load on each bracket channel = 122428.8/36

= 3400.8 N

Transverse fillet weld is used here for calculating shear stress in weld;

In order to determine shear stress of fillet joint, it is assumed the section of fillet is a right angled triangle.

t = Throat thickness

s = Thickness of plate= 3mm

l = Length of weld= 140 mm

For thickness of throat = s * sin 45
= 3 * sin 45
= 2.12 mm
Area of throat = Throat thickness * length of weld
= 2.12 * 140
= 296.8 mm^2
Shear stress = Load / area of throat
= 3400.8/ 296.8
= 11.48 N/mm^2.
Similarly for 2 mm thickness shear stress= 17.18N/mm^2
Allowable shear stress= Yield stress/ FOS
= 240/3= 80N/mm^2
Electrode used having following typical mechanical properties;
Yield strength= 420 N/mm^2
Ultimate tensile strength= 490 N/mm^2
Allowable yield strength= 2/3* Yield strength
= 2/3*420
= 280 N/mm^2

Here the existing bracket having 11.48 N/mm2 of shear stress and reducing thickness to 2mm shear stress is 17.18 N/mm^2. In that case allowable shear stress is 80 N/mm^2 and allowable yield strength of bracket with electrode used is 280 N/mm2. We can reduce the weight by reducing its thickness we can achieve the shear stress within allowable limit.

5. METHODOLOGY

At the first theoretical study of bracket is done. Key areas of bracket with their work are identified. The main task in this study is to do static analysis of bracket and to reduce deflection and stress of side channel weld bracket. 3D model is prepared for bracket. Different modification of bracket in shape and design is done and static analysis is carried out in hyper mesh.

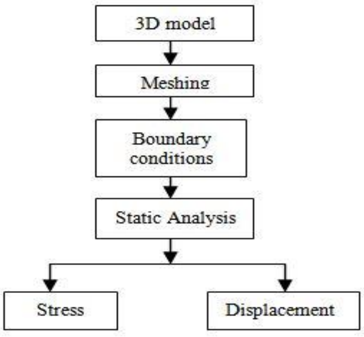

Fig-3: Flow chart

6. ANALYSIS OF LOAD BODY SIDE CHANNEL WELD BRACKET

6.1 Analysis of existing side channel weld bracket

The 3D model is made to mesh the component for analysis. Hex meshing is done because dimensions of bracket are comparable to each other and also in order to obtain accurate results. The following figure shows the meshing of weld bracket with connected with other 2 channels.

Dimensions of Existing weld bracket:
Vertical Length= 200 mm
Thickness= 3 mm
Weight= 489.1 grams
The sheet was made and folded to required shape for the required positioning.

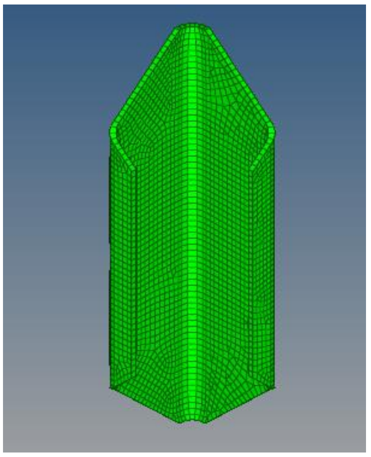

Fig-4: Meshing of existing bracket

The displacement load body side channel weld bracket is as shown below. In this bracket we used following material for arriving solutions which is existing.

Material: D513 steel
D513 is having low carbon steel and easily available material. It is normally used in the form of sheets which are formed products by a sheet forming process. It is most popular steel forming process available to manufacturers since it offers outstanding forming characteristics and good resistance to ageing.

Table 1: Mechanical Properties of D513 Steel

Density	7800 Kg/m3
Yield stress	240 MPa
Young's Modulus	210 GPa
Poisson's Ratio	0.25
% Elongation	23.0

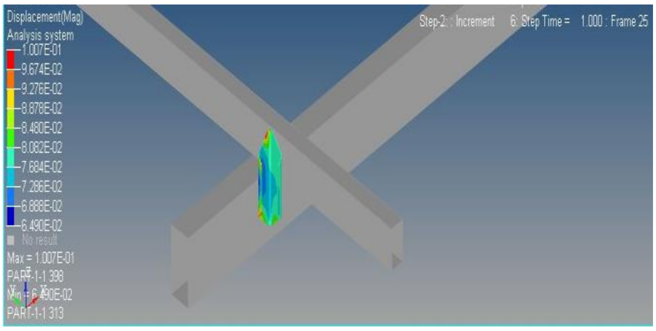

Fig-5: Displacement of existing bracket

The displacement of load body side channel weld bracket with above design is 0.1 mm.

Shear stress at loading condition of load body on the weld of side channel bracket is 14.12 N/mm^2.

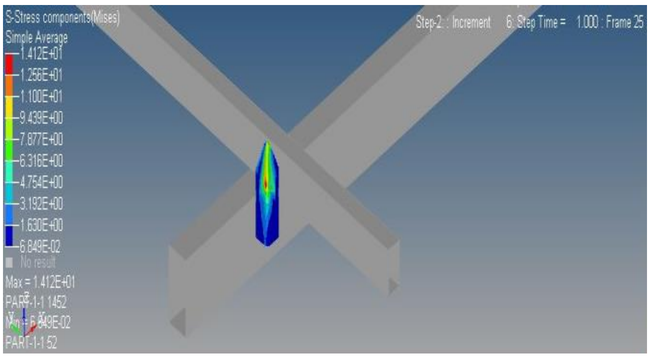

Fig-6: Stress analysis of existing bracket

6.2 Model analysis of Existing Bracket

Modal analysis determines the vibration characteristics of a particular component in the form of natural frequencies and its mode shapes. In this analysis only linear behavior is valid. Applied load and damping is not considered in modal analysis. This analysis was done for to find out natural frequencies and mode shapes of the bracket.

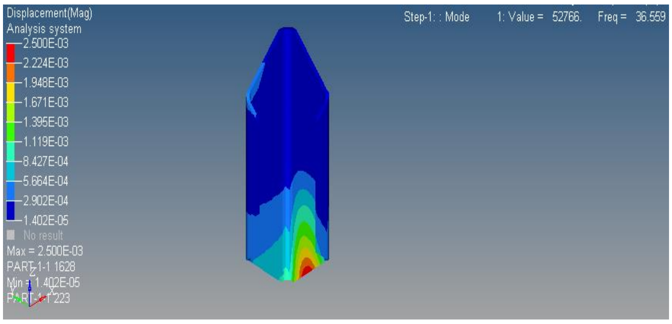

Fig-7: Mode 1 (36.55 HZ)

Figure 7 shows the first mode of vibration for particular 36.55 HZ. Figure 8 shows the second mode of vibration and the frequency of this particular mode is 43.7 HZ.

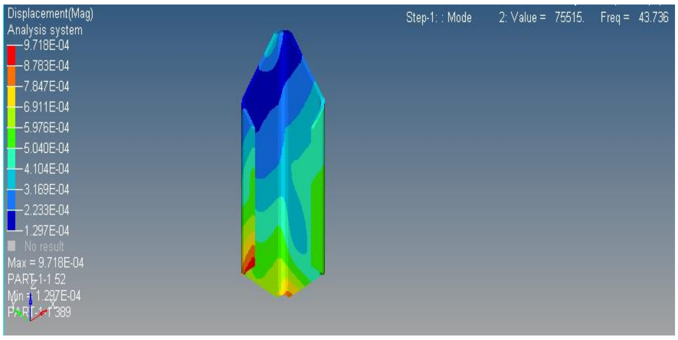

Fig.-8: Mode 2 (43.73HZ)

Figure 9 shows the third mode of vibration. The frequency of vibration for this particular mode is 45.83 HZ.

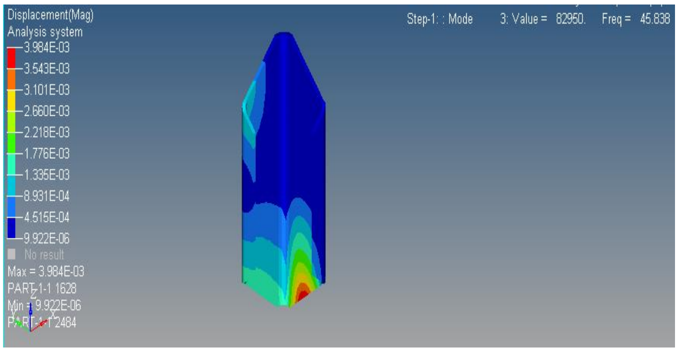

Fig-9: Mode 3 (45.83 HZ)

6.3 Analysis of modified bracket

The model shown in figure 8 is the modified model. After studying the result analysis of side channel weld bracket, certain changes have been made here. Here in this modified model thickness is reduced to obtain the weight reduction and shape for proper mounting and welding considerations. Suggested modified model has added the notch for to get strength. Hence results in to weight reduction of overall bracket.

But to finalize the optimized model, it is necessary to analyze the bracket with same boundary condition applied to previous model. And results obtained falls within the limit then the modified model design can be finalized.

It was decided to mesh a component CAD model. Hex meshing is done. Meshing was done criteria provided by R&D team. The figure shows meshing of new modified model. Simple and easy model for modification is made for better result and to avoid complications, by considering its position and geometry.

Dimensions of modified weld bracket:
Vertical Length=190 mm
Side vertical length=100 mm
Total Width= 80 mm
Thickness= 2 mm
Weight= 338.9 grams

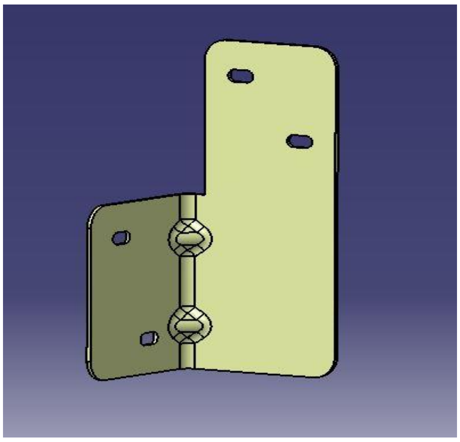

Fig-10: Modified CAD Model

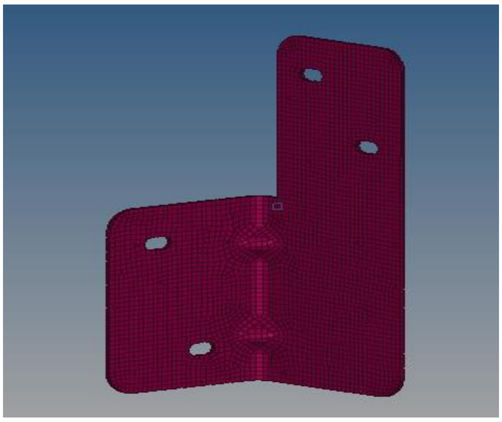

Fig-11: Meshing of modified bracket

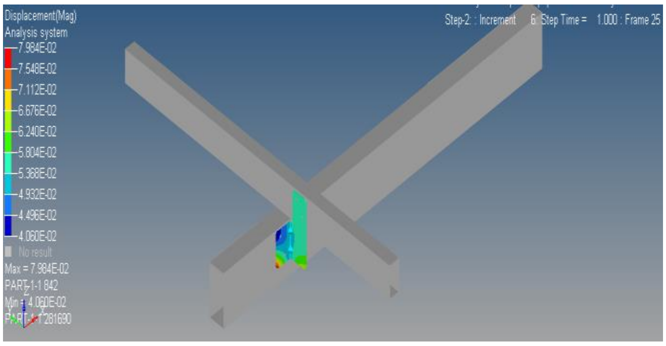

Fig-12: Displacement of modified bracket

The displacement of load body side channel weld bracket with above design is 0.0796 mm.

Shear stress loading condition of load body on the weld of side channel bracket is 24.94 N/mm^2.

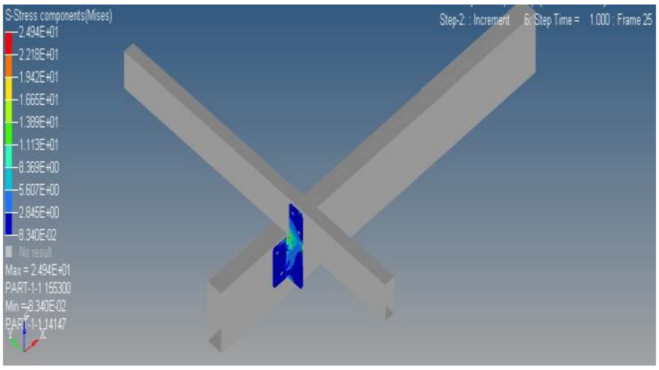

Fig-13: Stress analysis of modified bracket

6.4 Modal analysis of modified bracket

This analysis is done to find out natural frequencies and mode shape of particular bracket component. Figure 14 to Figure 16 shows the mode shapes of modified bracket.

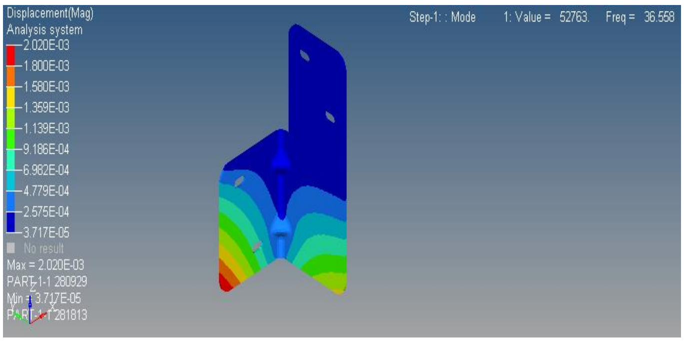

Fig-14: Mode 1 (36.55 HZ)

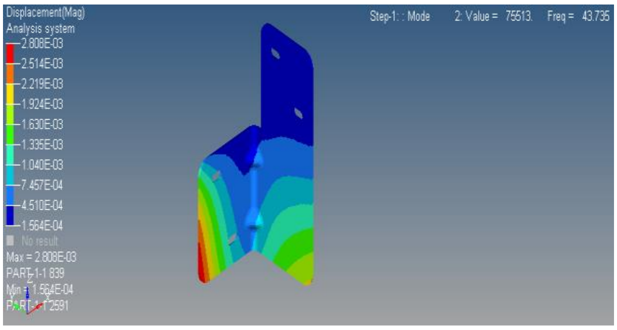

Fig-15: Mode 2 (43.73 HZ)

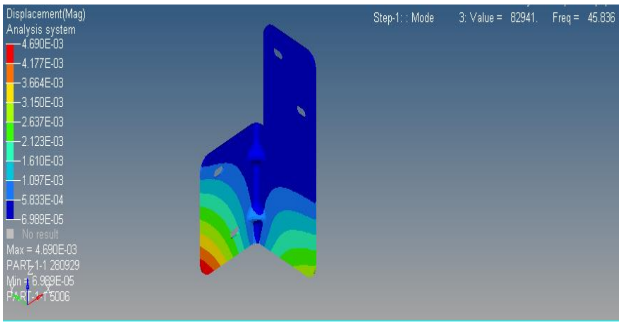

Fig-16: Mode 3 (45.83 HZ)

7. RESULTS AND DISCUSSION

Shear stress for existing bracket is 14.12 N/mm2. Where the bracket is within the allowable limit. Stress for modified bracket is 24.92 N/mm2 which is also within the allowable limit by reducing thickness and weight of bracket. The displacement for existing bracket is 0.1 mm and for modified bracket is 0.079mm which is acceptable. Hence we can use the modified side channel weld bracket with reducing thickness and weight. Weight of existing and modified weld bracket is 489.1 grams and 338.9 grams respectively, therefore total weight reduction is 30.70 %.

Table-2: Results comparison

Parameters	Existing	Modified
Displacement	0.1 mm	0.079 mm
Stress	14.12 N/mm^2	24.94 N/mm^2
Weight	489.1 grams	338.9 grams

8. CONCLUSION

As seen earlier the stress produced is acceptable within the limit. So we can use the modified bracket for current use by reducing its thickness from 3 mm to 2 mm. So the total weight reduced by **30.70 %** for the specified material. Static analysis carried out for the existing and modified bracket under the same loading condition which shows the modified bracket having less stress and displacement so design for it is also safe. Hence by reducing weight we can achieve desired results.

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