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WEIGHT OPTIMIZATION OF BAJAJ MAXIMA “C” CHASSIS

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ABSTRACT

Chassis is an important part of an automobile. The chassis serves as supportive member for body and other parts of automobile. As it acts as supportive member, it becomes important, while designing chassis that it should withstand the shock, vibrations, twits and other stresses. Along with strength and important consideration in chassis model must have sufficient bending stiffness for better handle characteristics. This project work focused towards the optimization of the bajajmaxima C chassis long member, with constraints of weight, stress and deflection of chassis under various loads. So, a proper finite element model of the Bajaj maxima-C chassis is developed by using various parameters. The chassis is made in Solidedge ST5.

Index Terms- Chassis, Deflection, FEA (Finite Element Analysis), Stress,Weight.

I.INTRODUCTION

Automobile chassis is considered as a foundation or backbone. The frame carries vehicle’s suspensions, axels, wheels and tires. Pay load is alsoconsider as important factor other than gross weight of vehicle, etc during design. The frame must be rigid enough to support or carry all loads and forces that the vehicle is subjected to in operation. A frame must be flexible enough to handle shock loads and the twists, bends that it encounters under different road or load conditions. The elasticity property of chassis material is able to return to its original shape when loads or forces are removed. A weight reduction of 50 Kg represents a fuel saving of between 0.3 – 0.50 liters for every 100 Km driven according to industrial record[5]. The main objective of the project is to reduce the weight of Bajaj maxima-C chassis frame. This optimum design is being constraint to the maximum strength and stiffness requirements. The chassis frame is manufactured from two side member joined with series of cross members. As the chassis frame is analyzed using the finite element techniques, appropriate model of frame is developed. The weight reduction is achieved by changing the parameter (size optimization) of side members and cross members.

The design of chassis with stiffness and strength requirement with optimum weight is important. In this study weight optimization of Bajaj maxima-C has been focused.

II LITERATURE REVIEW

The aim of the chassis design is to achieve optimum weight of components and satisfying requirements of loads, stiffness etc. The process of producing a best structure having optimum structural performance is termed as structural optimization. Structural system like chassis can be analyzed for the stress and stiffness etc. are the

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constraints for optimization. MohdAziziet;al; had conducted stress analysis of low loader chassis, the study was carried using the different boundary conditions (i.e. application of load at different location of chassis). It was concluded that stress analysis can be successfully done using finite element method to determine high stress values, maximum deflection and its location on low loader chassis. With this studies, we can say that by knowing stress values at various location of chassis it is possible to optimize the design with respect to it[1]. Mohammad Raziket; al; had studied to reduce weight of cross member of chassis using 3D model and FEA analysis. In this study it was found that, by reducing height of cross member weight of chassis was reduced by 8.72% [6]. As studying various papers on weight optimization chassis we found that some researchers concentrate their work on particular area like stresses acting on structure, deflection, stiffness, boundary conditions also applied for chassis. This all studies are carried with the help of 3D modeling and analysis can done by the software. After completing mathematical calculation, analytical result and mathematical result can compared and conclude on that basis. During the study we found that most of researchers did their work on heavy duty vehicle so it was decided to carry weight optimization of LMV chassis (Low Load Motor Vehicles) with different parameters. Chassis undergoes varying load conditions so the study need to be conducted their various load cases and boundary conditions for stress analysis. The aim of stress analysis is to find out stress concentration zone on chassis. So that, by knowing stress zone design optimization can be done to meet requirement of safer chassis with desired constraints.Dr. M.G. Bhatt et; al; have studied on heavy vehicle chassis using commercial finite element package ANSYS workbench was used for the solution of problem by conducting numerical result in conjunction with finite element analysis[4]. Patel Vijaykumaret; al; had considered in chassis design is to have adequate bending stiffness for better handling characteristics. So maximum stress, deflection are important criteria for the design of the chassis[2].N.R.Patil et al; says that Themaximum deflection is determined by performing staticanalysis. Computed results are then compared to analyticalcalculation, where it is found that the location of maximum deflection agrees well with theoretical approximation butvaries on magnitude aspect[8].

III METHODOLOGY

The main objective of the study is to optimize the weight and to analyze the chassis member with the load condition that is considered. In this study the focus was on to optimize the weight after getting suitable results with respect to loads and stress distribution on a chassis member. The numerical method with standard formulation has been adopted to calculate the stress and deflection of chassis member, fig 1shows the load condition on chassis member

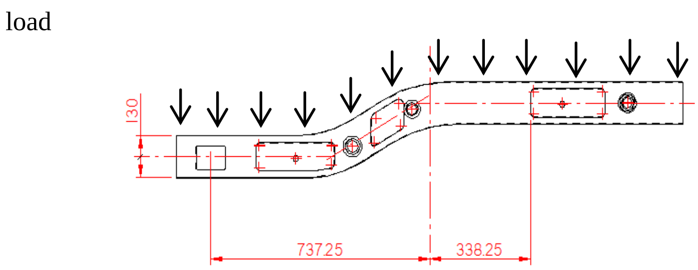

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Figure 1.Loading condition

A. C Channel

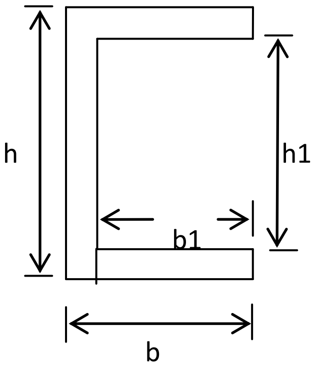

Figure 2. C Channel

$$\sigma_{max} = \frac{My}{I}$$

$$= \frac{336.95 \times 10^3 \times 68}{2.28 \times 10^6} \quad \text{......................(1)}$$

= 10.05 MPa

$$Y = \frac{wL(b-L)[L(b-L)+b^2-2(c^2+a^2)-2b^{-1}\ \{c^2L+a^2(b-L)\}]}{24\ EI} \quad \text{................(2)}$$

=0.55mm.

The fig.3shows the process through which the study has been conducted

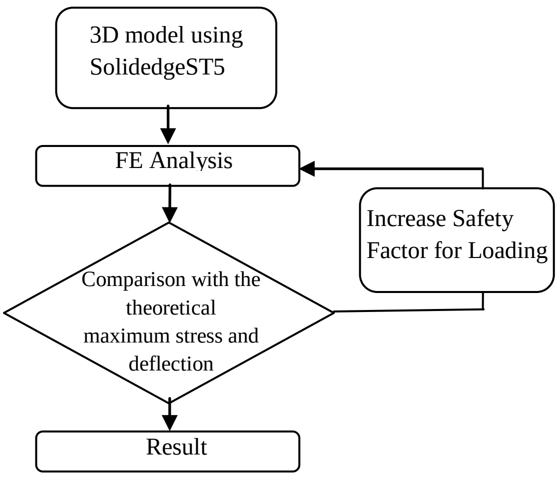

Figure 3. Process Flow

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B. Modeling

3D model was done by using solidedge ST5 software; the fig.4ashows the model of overall chassis and chassis member. The model shows in fig 4b is used for FE

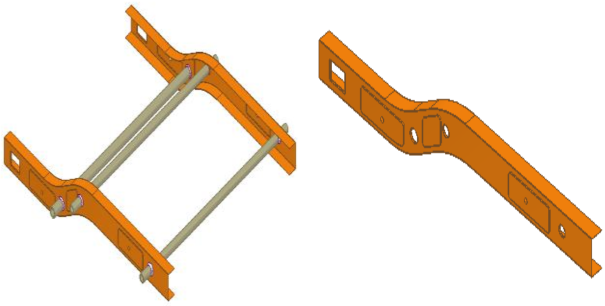

Figure 4a.overall chassis **Figure 4b. long member**

Analysis.

C. Chassis Material

The raw material for chassis structure is E34/SS 4012.The property of the material is as shown in table below.

Table 1 Properties of material

Material	E34/SS4012
Modulus of Elasticity E	2.1 x 10^5 MPa
Poisson's Ratio	0.3
UltimateTensile Strength	372MPa
Yield Strength	333 a

Finite Element Analysis

D. Meshing

Meshing of model is carried out using element Solid 185 type. In meshing higher order Tetramesh is used for solid model of chassis long single member, as shown in fig.5

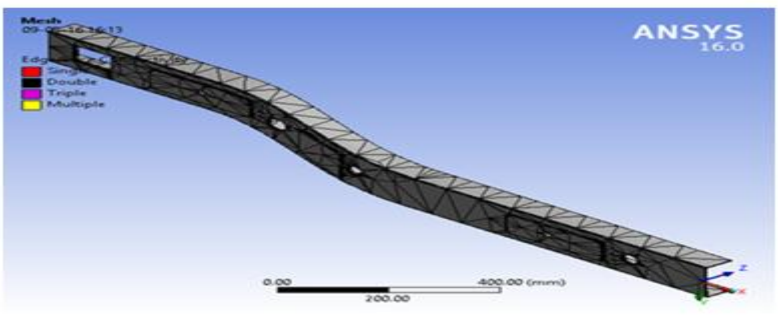

Figure 5. Meshing of Long Member

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E. Boundary Condition

Boundary condition for the model were two area of fixed point applied on model, namely BC1 and BC2.As shown in fig 6. BC1 was applied on contact surface between front of chassis, while BC2 was applied on contact surface between chassis and axle.

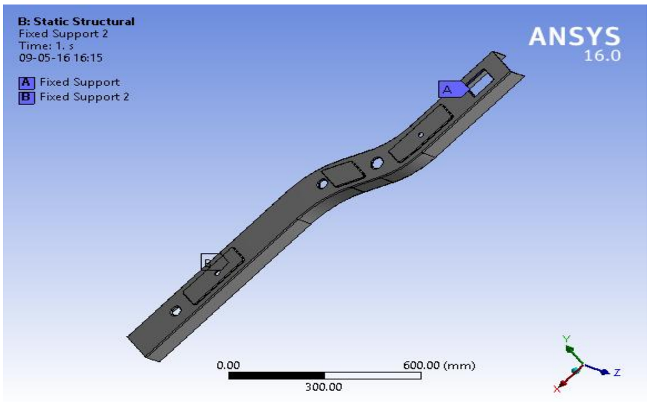

Figure 6. Boundary Conditions BC1 and BC2

F.Loading

The fig 7 shows the loading case on the member of chassis. The overall load on the vehicle trolley (trolley which is mounting on chassis)is 4905 N so the load consider on single side member is half of the overall load 2453N.

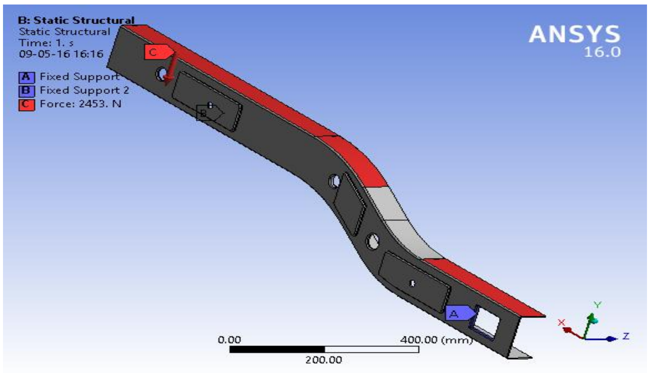

Figure7. Long Member with loading condition

IV RESULT AND DISCUSSION

A. For Bajaj Maxima "C" Chassis Longer Member:

The modeling and meshing of 3D CAD model has been described in previous sections. The analysis was done on a single member without considering other strengthening structures.

The stress on the member according to the theoretical calculation was found to be 10 MPa, and the deflection of the chassis with given load condition was 0.55 mm. The result analysis with ANSYS 16 are shown in fig 8a and 8b

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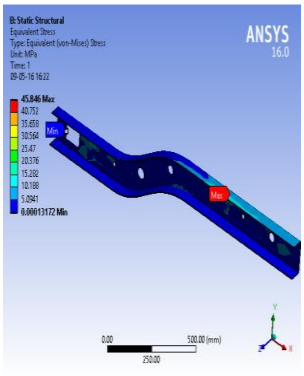

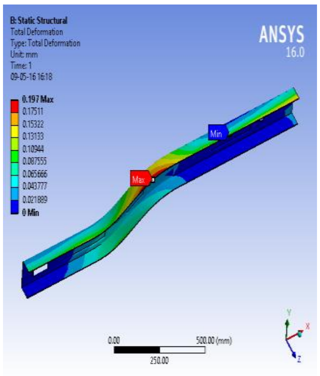

Figure 8a.Maximum Stress   Figure8b. Max. Deformation

The stress distribution model is shown in fig 8a and the deformation is shown in fig 8b.The analysis using ANSYS revealed that the stress value for C section channel chassis member lies between nearly 0 to 45.85 MPa. For analytical calculation the member was consider to be under uniformly distributed load at simple parallel beam. The calculation was carried out using the equation 1 & 2, the result for the stress was found tobe 45.84 MPa andmaximum deflection was 0.197 mm

The results obtain from analytical calculations and FEA analysis, the difference of values was encountered. The discrepancy occurred in analytical and FEA result can be due to the following conditions.

1. In numerical calculation the beam consider to be plane/parallel with uniform distribution of load. On the other hand, the FEA analysis done directly on 3D model which has complex geometry.
2. The stress in FEA is considered in all directions and represents its sum up.
3. In numerical calculation only single stress condition i.e. in vertical direction is considered.

The reasons for discrepancy in numerical and FEA result have been discussed. Though there are some differences in values which are not to a great extend gives results in the same sense that the chassis member with a given load condition lies in safe zone. The yield strength of the material E34/SS4012 is 333 MPa.Which is sufficiently higher than though obtain results, this is shows that the given C section and material of single member takes the load with the ease.

Now even the load on the chassis member is consider to be increased with higher factor of safety, the member will still in a safe zone, it means that the same member can be used for higher load or the material weight or the member can be designed with modified cross-section so as to withstand the given load condition to the optimum level. The big differences in calculated stress value and yield strength of the material shows that the chassis member can be manufacture with minimize cross section, hence reducing the weight.

B. For Modified chassis longer member:

We made stress and deflection calculations for Bajaj Maxima "C" chassis member and decide to do shape optimization to achieve our goal which is weight optimization. In modification of cross-section, height parameter takes in consideration. Two different models were made in solidedge ST5, one with 133 mm in height (Case I) and another with 132 mm (Case II). These two models were analyzed in ANSYS WORKBENCH 16.0.

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Following result was obtained. The stress on the member according to the theoretical calculation was found to be 65.169(case I) MPa and 110.15 (Case II) MPa, and the deflection of the chassis with given load condition was 0.619 (case I) mm and 0.5769 (Case II) mm. The result analysis with ANSYS 16 are shown in fig. 9a. and fig. 9b.

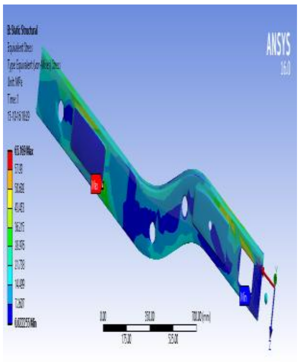

Figure 9a. Maximum Stress for Case-I

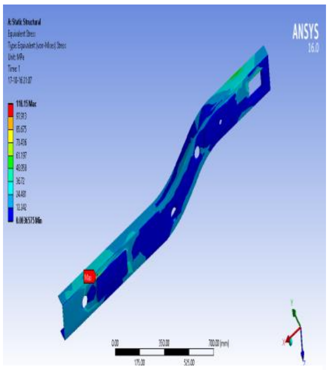

Figure 9b. Maximum Stress for Case-II

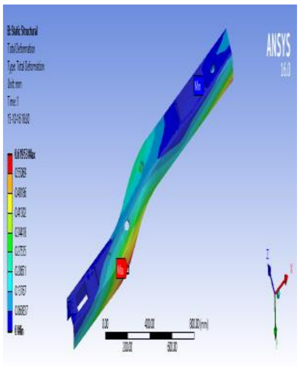

Figure 10a.Maximum Deflection for Case-I

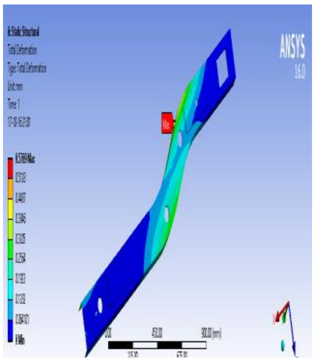

Figure 10b. Maximum Deflection for Case-II

Above fig.10a & fig.10b.shows the max. deflection of chassis for Case I and Case II section. The minimum and maximum deflection for Case I section is 0 mm and 0.619 mm respectively, for Case II section 0 mm is minimum and 0.5769 mm is maximum deflection, which was very small deformation in given boundary condition. So the chassis long member model is safe in total deformation (displacement) in both cases.

V CONCLUSION

Table 2. Different Load and Stress Conditions with Bajaj Maxima C chassis member Cross Section

FOS	Load in N	Deflection in mm	Stress in MPa
1	2452.5	0.178	10.05
1.5	3678.75	0.356	15.25

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2	4905	0.385	20.09
2.5	6131.25	0.445	25.12
3	7357.5	0.554	30.14
Analysis Result		**0.197**	**45.84**

Analysis for Bajaj Maxima "C" chassis member and modified chassis has been done and results obtain from it.

Table 3.Different Load and Stress Conditions with Modified Cross Section

Sr. No	Load kN	Stress MPa	Deflect^n mm	Stress MPa	Deflect^n mm	Modified cross-section
		Numerical	Analytical	Numerical	Analytical	
1	7.357	30.97	65.169	0.5613	0.619	Case I
2	7.357	31.32	110.15	0.5722	0.5769	Case II

Above table 3.clearly shows that both of the sections are in safe zone by considering stress and deflection. Chassis material (E34/SS 4012) having Yield strength is 333 MPa and Ultimate Tensile strength is 373 MPa.

Table 4. Weight Calculation for Case I

Bajaj Chassis Member C/S Weight(kg)	Modified C/S Weight(kg)	Difference in Weight(kg)	Weight Reduction %
10.45	10.33	0.12	1.1483

Table 5. Weight Calculation for Case II

Bajaj Chassis Member C/S Weight(kg)	Modified C/S Weight(kg)	Difference in Weight(kg)	Weight Reduction %
10.45	10.29	0.16	1.5311

Weight calculation tables shows that 1.14 % and 1.53 % weight reduction has achieved for a chassis longer member. Hence our goal is achieve.

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Future scope:

The present work was indeed to optimize the weight of Bajaj Maxima C Chassis longer member only. Optimization of longer member would obviously decrease the weight to some extent. To optimize the weight of overall chassis, the same method can be used by analysing different component of chassis. This can be considering as the future scope of the work.

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