An Optimum Selection of Bike Chassis Material by Factorial Design. A case study

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Abstract- *The present study focuses on the selection of the bike chassis material based on the design of experiments, in order to know the which material is best for the high strength and less weight and has the ability to restrain the shocks and the weight of the rider a multiple material is parametrically tested and their deformation at the rear end is taken for the study. The main factors that are taken inti study are the density, young's modulus and the passion ration and the main response of the deformation is consider, upon study the main effects the main interaction between the density and the young's modulus and has the maximum effect, the optimal set of the factors and the response is given to minimize the maximum deformation.*

Keywords-bike chassis, DoE

I. INTRODUCTION

Materials which are capable of the restraining the large impacts, more researches and the automobile designers are incorporating those materials, this material include steel, aluminums, magnesium alloys, and recently the carbon fiber reinforcement. The idea of all this material is they do offer lightweight and the good structural rigidity, though the design of the bike frame is also a main factor which can be optimized based on the topological optimization, but the fabrication of such structures is a bit cumbersome, and even the cost of the manufacturing is also higher, so the material altering has been a good alternative,

The design of experiments is a methodology of attaining or having the optimal solution based on the factors and the responses of the trails, the factorial design test the given data with the mathematical and statistical interface alongside with testing the fits, this method helps in the estimation of the optimal solution along with the relating the main objective (response)with the main effective parameters, the main effective factors are decided by the probability valve less than the 0.05. the true optimum response of the design is given in the contour plots as the function of the main output response. Here the main input factors are density and the young's modulus and the Poisson ration and the main response is of directional deformation.

II. LITERATURE REVIEW

Different types of the analyzing techniques for analyzing the automobile chassis has been made by reviewing the past research(Bhunte en Deshmukh 2015). The stress analysis of the vehicular chassis has been made in order to study the dynamic conditions based on the test data (Dubey en Dwivedi n.d.). The structural analysis of the vehicular chassis has been studied numerically by considering the Chevy model has been addressed (Ghodvinde en Wankhade 2014)

III. METHODOLOGY

The problem statement is that under the sturdy maximum load acting on the rear end of the bike frame where the suspension is made to fitted to the frame. The sudden maximum jerk is excreted onto the rear which the frame offers the restrain to the jerk by making the small displacement agnist it by decaying through the damper. The 3D standard bike frame is taken into consideration to study and give the optimal solution.

the model is finely meshed with the Maximum element size of 10 mm with the tetragonal element method this have generated a very fine

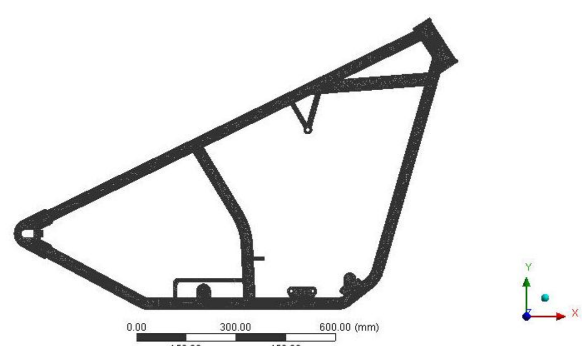

Figure 1 the 3D model of the standard bike frame

mesh by catching the curves and the structural deformities, this have generated a total of 85 thousand nodes. The element type of solid185 is taken to solve in plane strain condition.

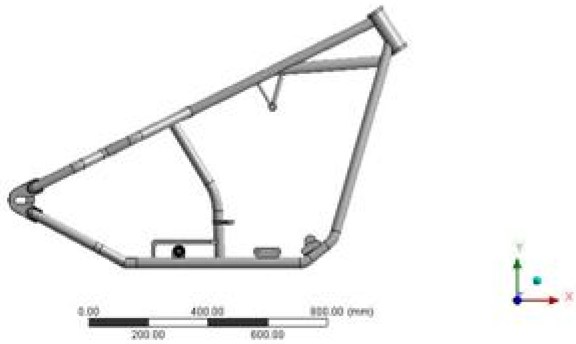

Figure 2 the overall mesh model of the model

know how the mesh have capture the curves and the structure deformities the following figure helps to visualize the mesh in a close-up.

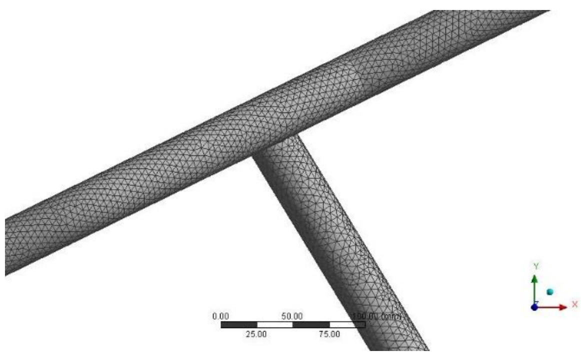

Figure 2 the tetragonal mesh with the element size of 10 mm

The boundary conditions applied to the model is according to test the rear deformation. The standard test load of 2857 N is applied according to the Indian road terrain.

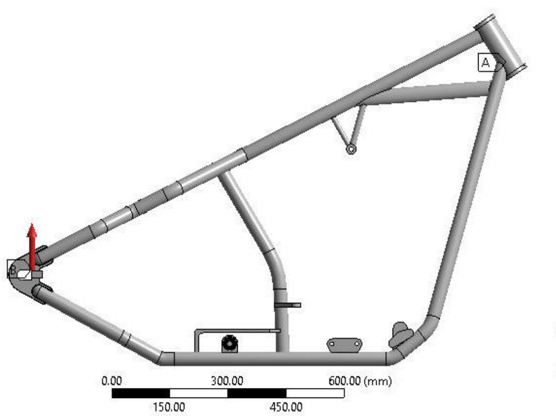

Figure 3 The boundary conditions applied for testing the rear deformation

The materials which are applied to test the rear deformation and for selecting the right combination is given in table 1. This data is mostly tested on the steel alloys and the aluminum alloys since they have the same Poisson ration ad the young's modulus does vary from the 190-210 GPa the data do have some broached runs.

Table 1The material models applied for the study

STEEL ALLOYS			
Designation	Density (Kg/m^3)	Young's Modulus (Pa)	Poisson ratio
304	8000	7.93e+11	0.33
4130	7850	2.1e+11	0.3
5160	7850	2.1e+11	0.3
410	7800	2e+11	0.33
316	7870	1.9e+11	0.265
ALUMINUM ALLOY			
7050	2800	8e+10	0.33
5020	2680	7e+10	0.33
3003	2700	8e+10	0.33
5083	2660	8e+10	0.3
5251	2690	7e+10	0.3
6061	2700	7e+10	0.33
6063	2700	69.5e+10	0.33
7020	2780	7e+10	0.33

The finite element analysis is conducted for the all the above properties and the maximum deformation is calculated.

Table 2 the maximum solution calculated form the FEA simulation

Density (Kg/m^3)	Young's modulus (Pa)	Poisson ration	Maximum deformation (mm)
8000	7.93e+11	0.33	10.9292
7850	2.1e+11	0.3	10.9239
7850	2.1e+11	0.3	10.0466
7800	2e+11	0.33	10.0445
7870	1.9e+11	0.265	10.5467
2800	8e+10	0.33	10.9375
2680	7e+10	0.33	26.3539
2700	8e+10	0.33	30.1187
2660	8e+10	0.3	26.3539
2690	7e+10	0.3	26.3723
2700	7e+10	0.33	30.1187
2700	69.5e+10	0.33	26.3539
2780	7e+10	0.33	26.3723

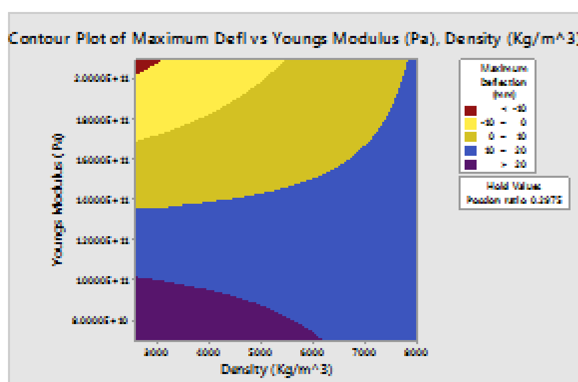

Figure 4 the response contour of the maximum interaction plot

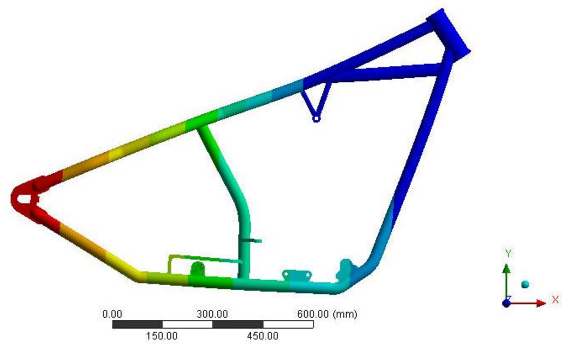

Figure 5 The characteristic deformation for the applied load

IV. RESULTS

The application of factorial design to the table 1 is defined as the design point in order to analyses the points, the standard level of the design is of 2 k type and it is observed that the density and the young's modulus has the maximum effect. The effect of the interaction is notated is of 18.67 and the probability value0.00 hence have shown the significant factor.

The optimum maximum deflection which is affected by the young's modulus and the density has the higher quality value greater than 20 is at the maximum area in-between the 6000 (Kg/m^3) to the young's modulus of range of 1.93E+11 is observed with the Poisson ratio of close value of 0.3

The optimum solution set of the factors is given as follows. This has been based on the regression model made by the designs as follows.

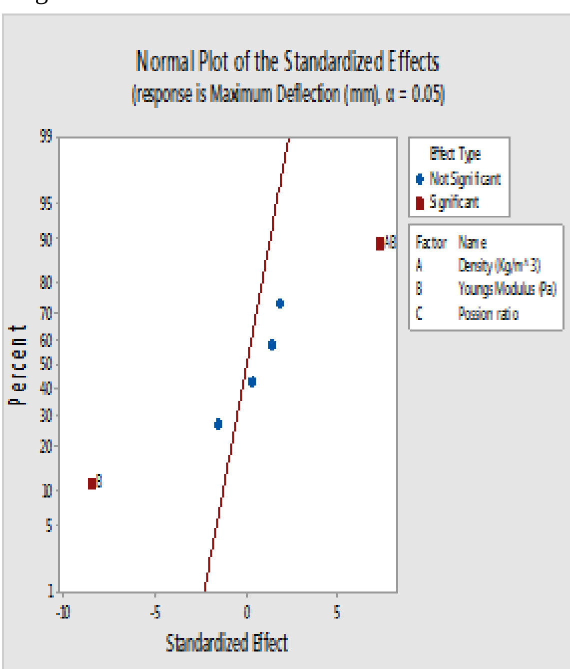

Figure 7 The normal plot of the factors showing the significant effect of density and young's modulus of the design system

$$\delta_{\max} = 49.3 - 0.01486 \cdot \rho + 55.8 \cdot \nu + 0.0296 \cdot \rho \cdot \nu$$

where $\delta_{\max}$ is maximum deformation , ρ is known as density and the ν is known as Poisson ration.

Table 3 the solution set from the predicted model

Density (Kg/m^3)	Yong's modulus (Pa) range	Poisson ratio	Predicted maximum deflection (mm)
5300	(1.46 to 1.9)E+11	0.26 to 0.3	10.0445
2641.84	(1.46 to 1.9)E+11	0.26 to 0.3	10.0445

V. CONCLUSION

It is observed form the above study that the optimal minimizing the maximum deflection is observed from the table 3 shows the most optimal factor combination and there also exist a singular effect that is the young's modulus which also define the strength of the structure.

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