EXPERIMENTAL AND FEA ANALYSIS TO ENHANCE THE STRENGTH OF ENGINE MOUNTING BRACKET USING CARBON FIBER EPOXY REINFORCEMENT

SAHIL SHAUKATALI SAYYAD
ME Student, Department of Mechanical Engineering (Design)
TSSM's Padmabhooshan Vasantdada Patil Institute of Technology, Bavdhan, Pune

P. K. PARASE
Professor, Department of Mechanical Engineering (Design)
TSSM's Padmabhooshan Vasantdada Patil Institute of Technology, Bavdhan, Pune.

Abstract: ***today automotive part designing is completely supported strength & light-weight as per as quality worries for performance improvement. So, for saving of price in production strategies of elements of automobile and considerately of weight of elements within which a part is targeted having less stresses are cut inside pure mathematics of elements. The main purpose of an engine mounting bracket is to support the power –train system in an Automobile in all conditions of road surfaces including even, uneven road surfaces. It is very difficult to change the supporting locations and the types of support after the engine is built, the mounting brackets must be verified in the design stage. This project contains the study of vibration and Optimization of an engine mounting bracket and comparison between existing and optimized engine mounting bracket. Optimize model will be manufacturing using aluminium material with reinforcement of carbon fibre layer. CAD model has been generated through reverse engineering. The bracket of Mahindra Alturas G4 Engine is to be taken for study. After analyzing the engine mounting bracket of Mahindra Alturas , Optimization is done. Experimental testing will be performed with help of FFT analyzer and impact hammer test***.

Keywords—Engine mounting bracket, Composite material, FEA

I. INTRODUCTION

In this automotive era the necessity for lightweight weight structural materials is increasing as there's a a lot of specialize in fuel consumption reduction and improvement in decreasing the emission. The magnitude of production volumes has historically placed severe needs on the strength of method employed in the producing. The makers have sturdy importance on price|the value|the price} has the demand for the element to enhance the fabric performance and to deliver these materials at low cost is that the demand. In automobile sector the extraordinarily competitive automotive business wants manufactures to pay heaps of attention to traveling comfort. Resonant vibration is from unbalanced lots exist among the engine body, this is often inflicting the designers to direct their attention to the event of high quality engine mounting brackets therefore on ensure that there's improvement in riding comfort. The demand for higher play acting engine mount brackets shouldn't be offset by arise among the assembly costs and/or development cycle time. In diesel, the engine mounting bracket is that the major downside as there's unthrottled condition and better compression quantitative relation and even there square measure a lot of speed irregularities at low speed and low load compared to hydrocarbon engines. therefore because of this there square measure a lot of vibration excitation. By this vibration engine mount bracket might fail, therefore by optimizing the form and thickness of engine mount bracket we are able to improve the performance at initial style stages. By some studies it's discovered that brackets saved thirty eighth of mass. Structural improvement is a very important tool for Associate in Nursing optimum design; comparison in terms of weight and element performance structural improvement techniques is effective tool to provide higher quality merchandise at lower price.

Fig. 1 bracket

II. LITERATURE REVIEW

Sreekanth Dondapatibet al. [1]In the current work, trial examination on the disappointment of a suppressor mounting section joined to business vehicle is finished. Splits are distinguished at the welded area of suppressor mount which shows that weld joint has preferred quality over the suppressor/section body. To comprehend the conceivable main drivers of the disappointment, fishbone outline was utilized, which helped in deciding the significant reasons for the disappointment by a graphical portrayal. Further, the three boundary Weibull dispersion was additionally evolved to decide the Mean Time to Failure (MTTF) life which was seen as 15,172 km. Furthermore, pliable testing of sheet metal was performed on the sheets which was utilized in the assembling of Muffler. Moreover, a Thermo-Mechanical coupled examination was done utilizing business code, ANSYS 16.0, which adjusts Finite Element Analysis (FEA) plan. The warm loads on suppressor were imported to basic investigation alongside a static heap of 4 g increasing speed were forced on the suppressor body to reenact the impacts of high effect loads.

Joong Jae Kim et al. [2]In request to get a consequently planned state of motor mount, an ideal shape configuration procedure of motor mounting elastic utilizing a parametric methodology is presented. The advancement code is created to decide the shape to meet the solidness prerequisites of motor mounts, combined with a business nonlinear limited component program. A shrubbery type motor mount being utilized in a traveler vehicle is picked for an application model. The shape from the aftereffect of the boundary improvement is resolved as a last model with certain alterations. The shape and firmness of every streamlining stage are appeared and the solidness of the improved model along the primary heading is contrasted and the plan determination of the current model. At last, a diagram of the current status and future works for the motor mount configuration are talked about.

Liu Qiangaet al. [3]Because of the dispatch vibration and stun, attractively suspended flywheels (MSFWs) are outfitted with an extra dispatch locking defensive gadget (LLPD), and the LLPD execution has extraordinary effect on the disposition control exactness of the flywheel framework. In this paper, a LLPD that takes the carbon fiber section as the key clipped and releasable component was introduced. What's more, the arrangement, working rule and practical execution prerequisites were presented. The locking/opening power, most extreme pressure and contact power of the carbon fiber section were broke down. The dynamic investigation of the single carbon fiber section proportional to the cantilever pillar model was done. In this manner, the affectability of the imperative factors versus the auxiliary boundaries was determined. The lower and upper pieces of the carbon fiber section were independently streamlined. The outcome shows that the mass of the carbon fiber section can reach to the base of 60.5 g when the quantity of the upper carbon fiber section cuts is 12. At last, the LLPD model was made and its locking security for the flywheel framework was checked by the cleared sine vibration and the irregular vibration.

Maryam Hajizadehet al. [4], The holding quality of section cement tooth framework ought to be sufficiently high to withstand various burdens applied either for treatment reason or by understanding. Various boundaries influence the bond quality of section cement tooth framework; be that as it may, just a couple of studies have assessed the impact of orthodontic section base on bond quality of section cement tooth framework. In this examination, enhancement of the section base geometry for teeth with planar finish surface was explored so as to expand the shear, elastic and torsional bond quality of section glue tooth framework. Materials and strategies: Rectangular section was fundamentally reinforced on maxilla focal tooth to gauge pressure dissemination of section cement tooth framework with applying shear and malleable powers and torsional second. Trapezoidal, hexagonal and curved sections were then displayed for this planar finish surface tooth. These sections were attached to tooth independently and comparative stacking conditions were applied on the section of every framework. Stress disseminations of section glue tooth frameworks were determined and contrasted with one another. Results: It was seen that for hexagonal section glue tooth framework, cement layer and finish, and for circular section the section and veneer layer were of more symmetric and fitting example of stress circulation and lower greatest pressure. Consequently, these states of section are more legitimate than the other two shapes for a planar finish surface tooth. End: Bracket base geometry was affirmed to vitally influence the bond quality of section cement tooth framework through limited component examination approach.

B. Vijaya Ramnathaet. al[5] An all around structured sprinter and gating framework is critical to deliver great quality pass on castings by giving a homogenous shape filling design. Stream investigation of the part is done so as to noticeably dissect the hole filling process. In this examination, a Commutator End (CE) section, a virus chamber kick the bucket threw item was picked. At first when the segment was given various imperfections such a role as Cold closes, Misrun, Shrinkage porosity and Gas porosity were found. This thus prompted dismissal of number of parts. So as to improve the nature of the castings created, the gating framework was transformed from the current level door to adjusted coddled entryway. The segment was structured utilizing Pro-Engineer and stream examination was completed utilizing Rotork Flow 3D Software.

PROBLEM STATEMENT

Automotive parts like mount brackets are having weight which leads to increase in total weight of automobile with less performance for mobility, as it is directly affects the mileage & cost. To overcome this problem modelling of bracket will be done in CAD & analyzing in CAE for induced stresses & deformation. Excess material will be search by region having less stresses & that region will be cut & again optimized model is analyzed for comparison with experimental test results.

III. OBJECTIVES

- Modelling Starter motor housing bracket in CATIA V5 software.
- Analyzing for stresses and deformation in engine mounting bracket of vehicle
- Topological optimization for the model.
- Optimize model will be manufacturing using aluminum material with reinforcement of carbon fiber layer.
- To perform Model analysis of both engine mounting bracket with help of ANSYS 19 software
- To perform experimental testing ofnew, optimize engine mounting bracket on FFT analyzer and impact hammer test Experimental testing and correlating results

IV. METHODOLOGY

Step1: - Initially research paper is studied to find out research gap for project then necessary parameters are studied in detail. After going through these papers, we learnt about excavator arm and reinforcement material for existing structure.

Step2: - Research gap is studied to understand new objectives for project.

Step 3: - After deciding the components, the 3 D Model and drafting will be done with the help of software and analysis with ANSYS software.

Step 4: - The components will be manufactured and testing will be performed according to defined objectives.
Step 5: -The testing will be carried out and then the result and conclusion will be drawn.

CATIA MODEL

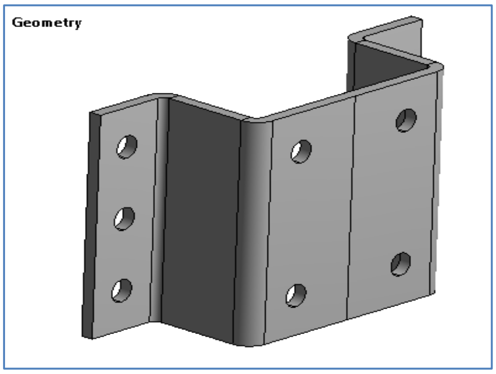


Fig.2 CATIAof excavator arm

Table. Material Properties

Properties of Outline Row 3: Structural Steel

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	7850	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
6	Isotropic Elasticity		
7	Derive from	Young's Modulus and Pois...	
8	Young's Modulus	2E+11	Pa
9	Poisson's Ratio	0.3	
10	Bulk Modulus	1.6667E+11	Pa
11	Shear Modulus	7.6923E+10	Pa

2. Finite Element Analysis:

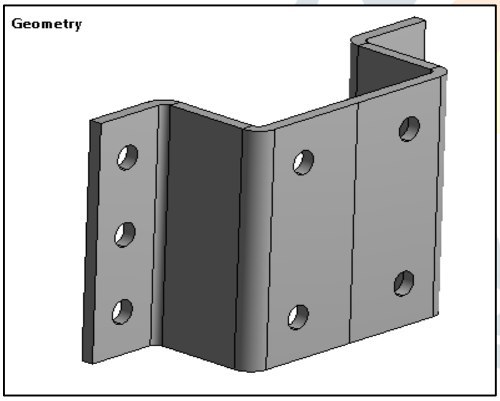
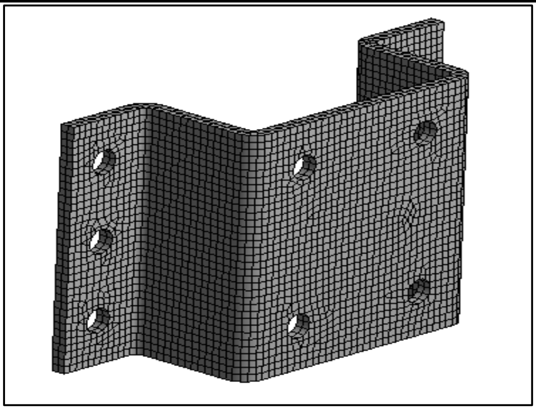


Fig.3CATIA model imported in ANSYS

Mesh

In ANSYS meshing is performed as similar to discretization process in FEA procedure in which it breaks whole components in small elements and nodes. So, in analysis boundary condition equation are solved at this elements and nodes. ANSYS Meshing is a general-purpose, intelligent, automated high-performance product. A mesh well suited for a specific analysis can be generated with a single mouse click for all parts in a model. The power of parallel processing is automatically used to reduce the time you have to wait for mesh generation.



Details of "Body Sizing" - Sizing

Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Type	Element Size
Element Size	3.0 mm

Statistics	
Nodes	5565
Elements	5348

Details of "Part1"

Graphics Properties	
Definition	
Suppressed	No
Stiffness Behavior	Flexible
Coordinate System	Default Coordinate System
Reference Temperature	By Environment
Thickness	7. mm

Fig.4 Details of meshing of mounting bracket

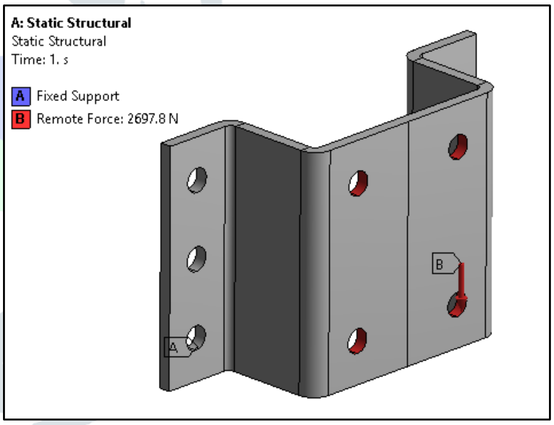


Fig.5 Boundary condition

Boundary condition are applied as per research paper to determine stress and deformation with and without reinforced composite material.

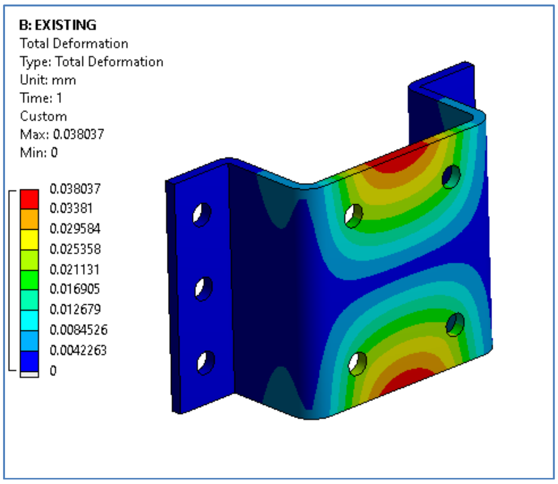


Fig.6 Deformation results

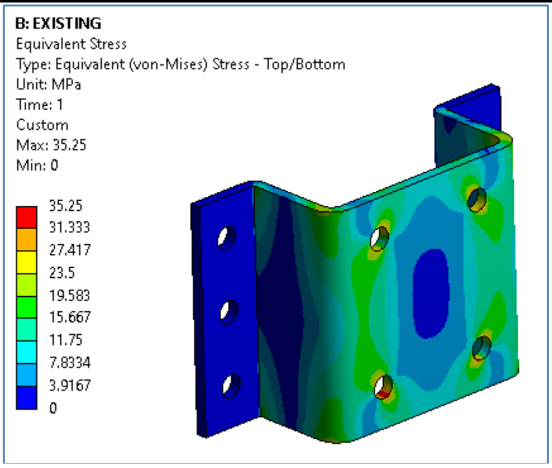


Fig.7 Equivalent stress results

Modal analysis

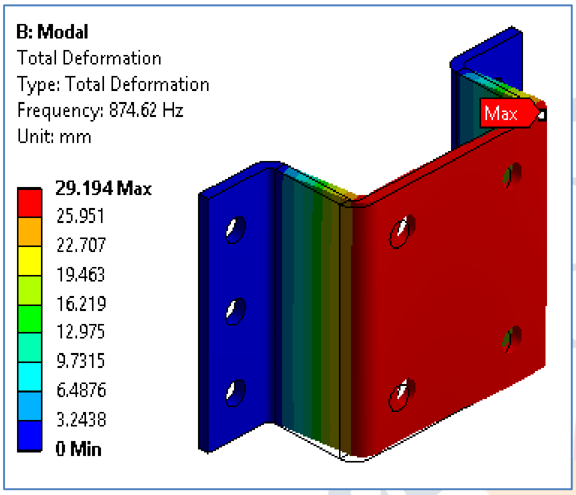


Fig.8 Mode shape 1

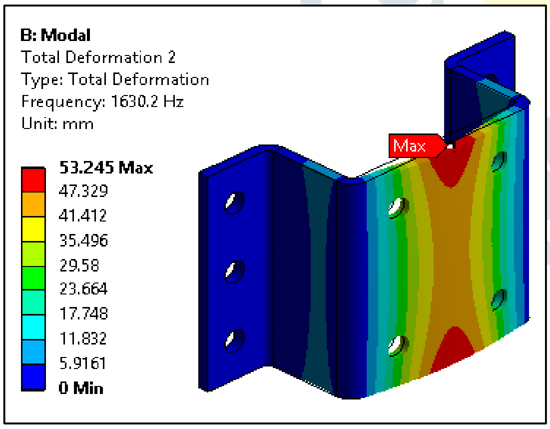


Fig.9 Mode shape 2

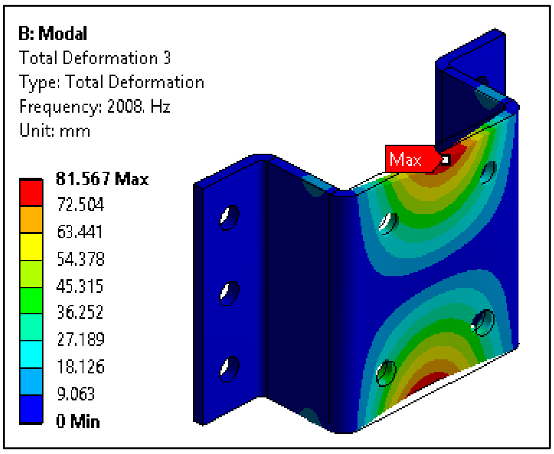


Fig.10 Mode shape 3

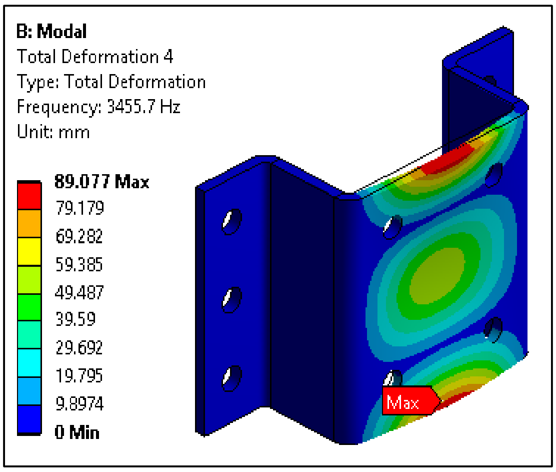


Fig.11 Mode shape 3

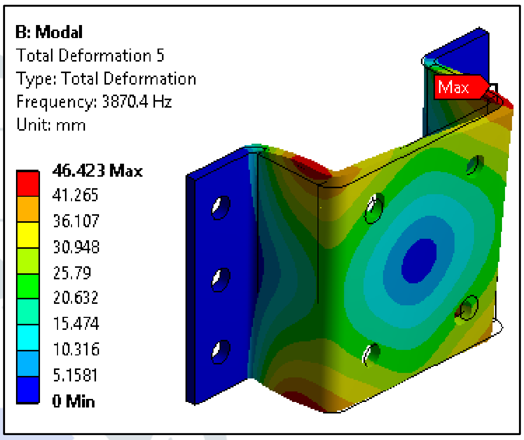


Fig.12 Mode shape 5

FEA OF ALUMINUM ENGINE MOUNTING BRACKET

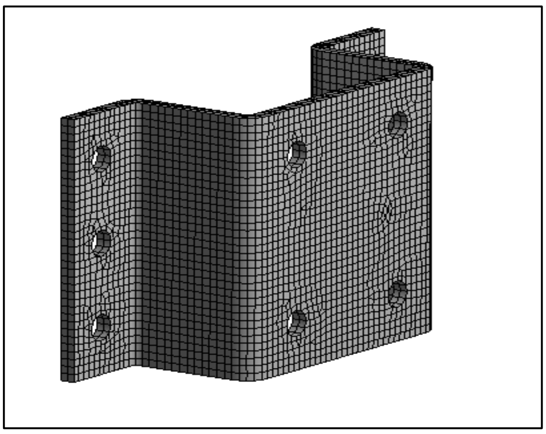
Material properties

Properties of Outline Row 3: Aluminum Alloy

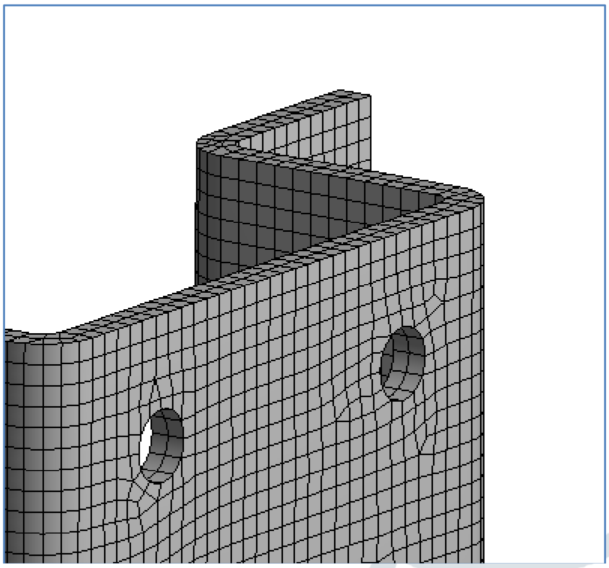
	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	2770	kg m^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
5	Coefficient of Thermal Expansion	2.3E-05	C^-1
6	Isotropic Elasticity		
7	Derive from	Young's Modulus a...	
8	Young's Modulus	7.1E+10	Pa
9	Poisson's Ratio	0.33	
10	Bulk Modulus	6.9608E+10	Pa
11	Shear Modulus	2.6692E+10	Pa

Fig.13material properties in ANSYS

Mesh



Statistics	
Nodes	39794
Elements	8539



Details of "Body Sizing" - Sizing	
Scope	
Scoping Method	Geometry Selection
Geometry	5 Bodies
Definition	
Suppressed	No
Type	Element Size
Element Size	4.0 mm

Fig.14 mesh of Aluminum Engine Mounting Bracket

Boundary condition

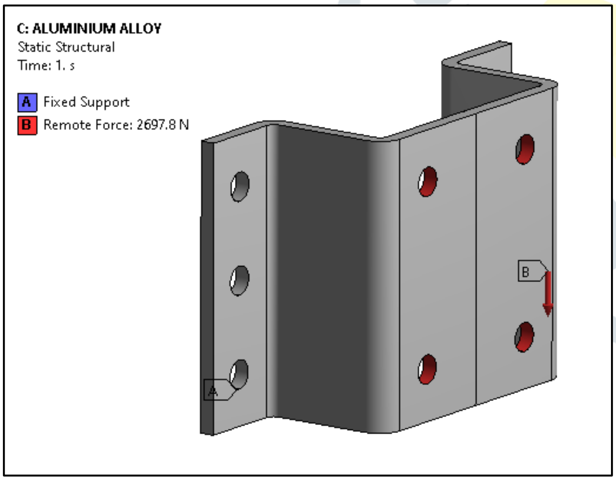


Fig.15 boundary condition of Aluminum Engine Mounting Bracket

Total deformation

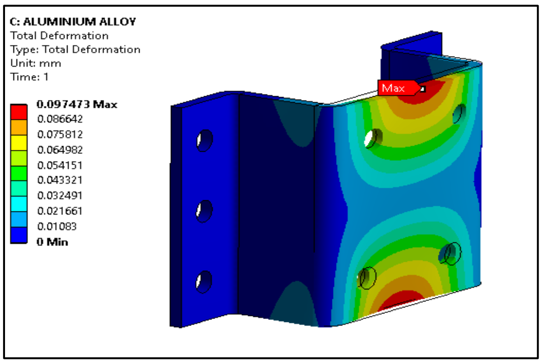


Fig.16 Total deformation of Aluminum Engine Mounting Bracket

Equivalent stress

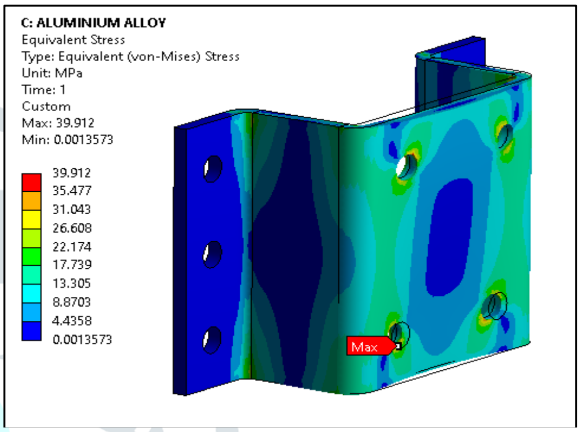


Fig.17 Equivalent stressof Aluminum Engine Mounting Bracket

Principal stress

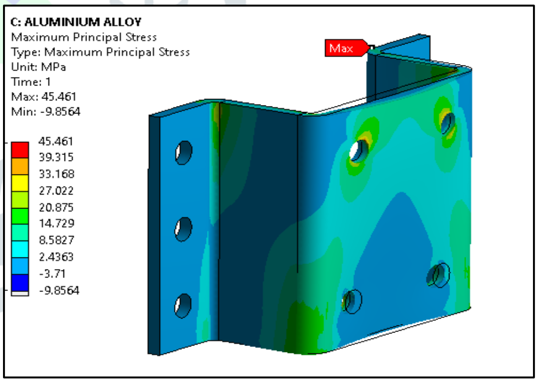


Fig.18 Principle stressof Aluminum Engine Mounting Bracket

FEA of Aluminum Engine Mounting Bracket with carbon fiber

Material properties of carbon fiber

Properties of Outline Row 4: Epoxy Carbon UD (230 GPa) Prepreg

	A	B	C
1	Property	Value	Unit
2	Density	1.49E-09	mm^-3 t
3	Orthotropic Secant Coefficient of Thermal Expansion		
8	Orthotropic Elasticity		
9	Young's Modulus X direction	1.21E+05	MPa
10	Young's Modulus Y direction	8600	MPa
11	Young's Modulus Z direction	8600	MPa
12	Poisson's Ratio XY	0.27	
13	Poisson's Ratio YZ	0.4	
14	Poisson's Ratio XZ	0.27	
15	Shear Modulus XY	4700	MPa
16	Shear Modulus YZ	3100	MPa
17	Shear Modulus XZ	4700	MPa
18	Orthotropic Stress Limits		
19	Tensile X direction	2231	MPa
20	Tensile Y direction	29	MPa
21	Tensile Z direction	29	MPa
22	Compressive X direction	-1082	MPa
23	Compressive Y direction	-100	MPa
24	Compressive Z direction	-100	MPa
25	Shear XY	60	MPa
26	Shear YZ	32	MPa
27	Shear XZ	60	MPa

Table. Material Properties of composite material

Layer information

Layer	Material	Thickness (mm)	Angle (°)
(+Z)			
4	Epoxy Carbon UD (230 GPa) Prepreg	1	90
3	Epoxy Carbon UD (230 GPa) Prepreg	1	45
2	Epoxy Carbon UD (230 GPa) Prepreg	1	0
1	Aluminum Alloy	4	0
(-Z)			

Fig.19 Details of composite layer

composite of each layer with aluminum alloy of 4 mm thickness and composite layer of each 1 mm is provided

Boundary condition

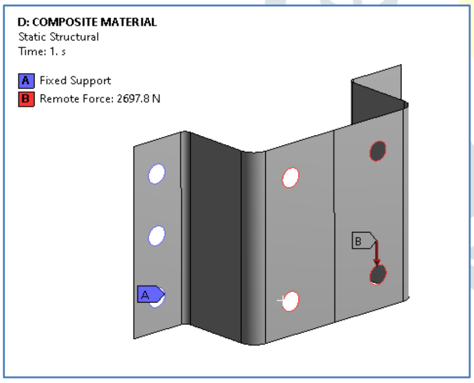


Fig.20 Boundary conditionof Aluminum Engine Mounting Bracket with carbon fiber

Total deformation

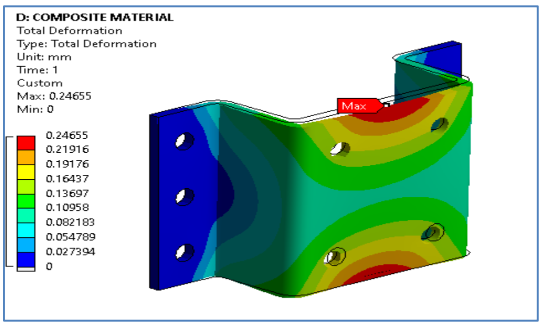


Fig.21 Total deformation of Aluminum Engine Mounting Bracket with carbon fiber

Equivalent stress

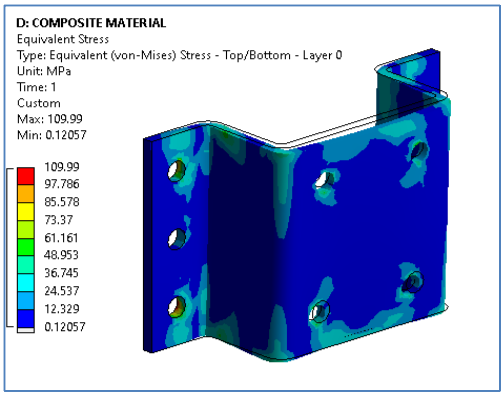


Fig.22 Equivalent stress of Aluminum Engine Mounting Bracket with carbon fiber

Principal stress

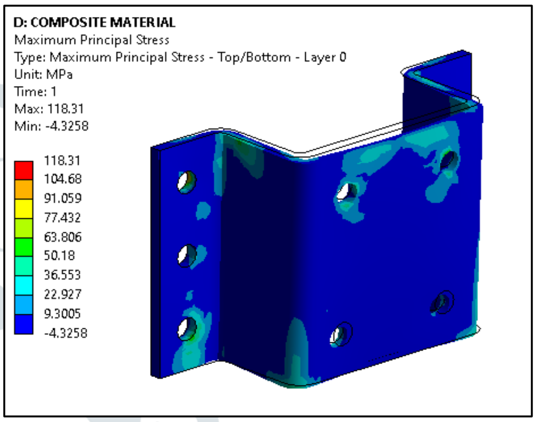


Fig.23 Principle stress of Aluminum Engine Mounting Bracket with carbon fiber

LAYER WISE EQUIVALENT STRESS ON CARBON FIBRE

At 0 ply orientation

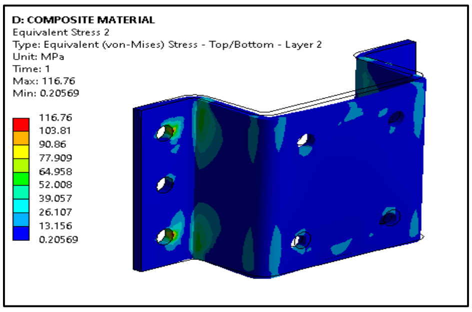


Fig.24 Equivalent stressof Aluminum Engine Mounting Bracket with carbon fiber

At 45 ply orientation

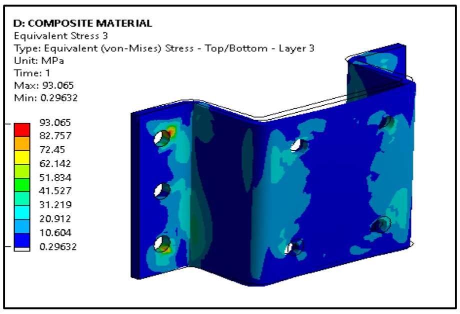


Fig.25 Equivalent stressof Aluminum Engine Mounting Bracket with carbon fiber

At 90 ply orientation

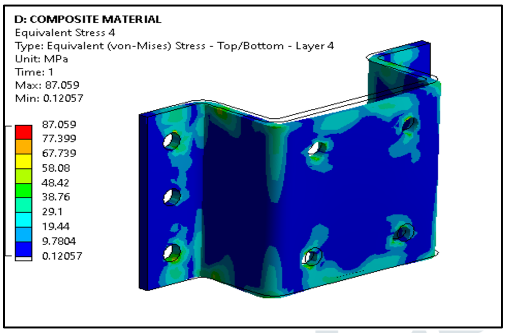


Fig.26 Equivalent stressof Aluminum Engine Mounting Bracket with carbon fiber

EXPERIMENTAL SETUP

A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials. An earlier name for a tensile testing machine is a tensometer. The "universal" part of the name reflects that it can perform many standard tensile and compression tests on materials, components, and structures (in other words, that it is versatile). The set-up and usage are detailed in a test method, often published by a standards organization. This specifies the sample preparation, fixturing, gauge length (the length which is under study or observation), analysis, etc. The specimen is placed in the machine between the grips and an extensometer if required can automatically record the change in gauge length during the test. If an extensometer is not fitted, the machine itself can record the displacement between its cross heads on which the specimen is held. However, this method not only records the change in length of the specimen but also all other extending / elastic components of the testing machine and its drive systems including any slipping of the specimen in the grips. Once the machine is started it begins to apply an increasing load on specimen. Throughout the tests the control system and its associated software record the load and extension or compression of the specimen.

Specification of UTM

1	Max Capacity	400KN
2	Measuring range	0-400KN
3	Least Count	0.04KN
4	Clearance for Tensile Test	50-700 mm
5	Clearance for Compression Test	0- 700 mm
6	Clearance Between column	500 mm
7	Ram stroke	200 mm
8	Power supply	3 Phase , 440Volts , 50 cycle. A.C
9	Overall dimension of machine (L*W*H)	2100*800*2060
10	Weight	2300Kg

EXPERIMENTAL TESTING FEA

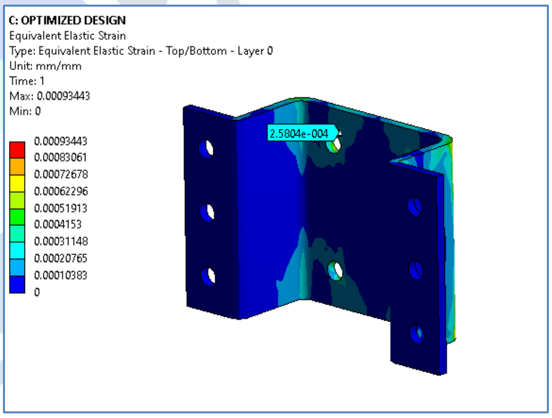


Fig.27 experimental testing

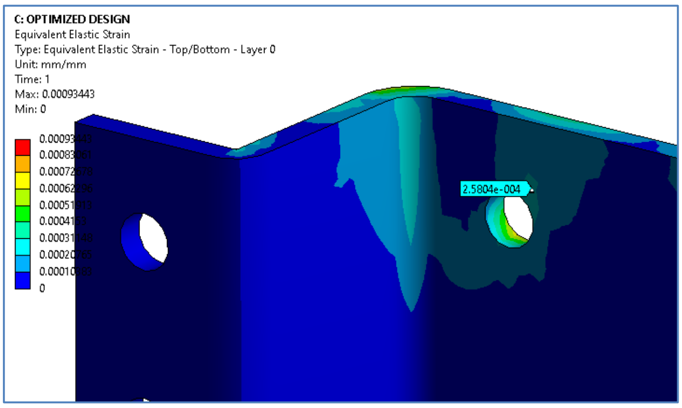


Fig.28 experimental testing

Strain is observed around 258 microns using FEA.

EXPERIMENTAL PROCEDURE

- Fixture is manufactured according to component designed.
- Single force is applied as per FEA analysis and reanalysis is performed to determine strain by numerical and experimental testing.
- Strain guage is applied as per FEA results to maximum strained region and during experimental testing force is applied as per numerical analysis to check the strain obtained by numerical and experimental results.
- During strain gage experiment two wires connected to strain gage is connected to micro controller through the data acquisition system and DAQ is connected to laptop. Strain gage value are displayed on laptop using DEWESOFT software.

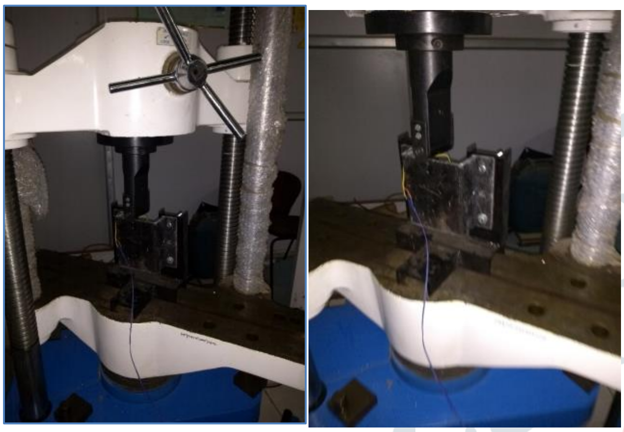


Fig.29 experimental testing

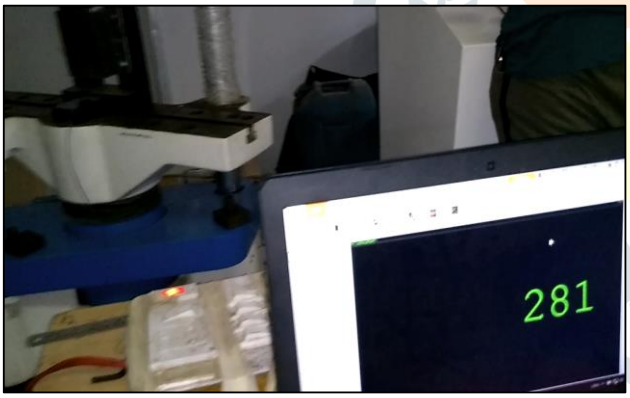


Fig.30 experimental result

CONCLUSION

- From FEA result conclude that After applying 2697.8 N force on single engine mounting bracket, Equivalent stress on Engine Bracket was 39.414MPa
- Modal analysis of engine mounting bracket is performed to obtain different mode shapes and natural frequency of existing engine mounting bracket and also it is observed that maximum frequency is around 3870.4 Hz.
- Strain measurement of 258 microns and 281 microns by numerical and experimental testing respectively.

REFERENCES:

1. Umesh.S.Ghorpade, d.s.chavan, vinaypatil&mahendragaikwad, "Finite Element Analysis and Natural Frequency Optimization of Engine Bracket" (IJMIE) ISSN No. 2231 –6477, Vol-2, Iss-3, 2012.
2. Mr.PramodWalunje, Prof.V.K.Kurkute, "Engineering Optimization of Engine Mounting Bracket Using FEA" Indian Journal of Research ISSN-2250-1991 volume:2, Issue:12, Dec 2013.
3. Dr.Yadavalli Basavaraj, Manjunatha.T.H, Design Optimization of Automotive Engine Mount System, International Journal of Engineering Science Invention Issn (Online): 2319 – 6734, Issn (Print): 2319 – 6726, Volume 2 Issue 3, March. 2013
4. P.D. Jadhav , Ramakrishna , Finite Element Analysis of Engine Mount Bracket, Internation Journal of Advancement In Engineering Technology, Managament And Applied Science, Volume 1, Issue 4, Issue no. 2349-3224,Setember 14
5. Sandeep Maski, Yadavalli Basavaraj, Finite Element Analysis of Engine Mounting Bracket by Considering Pretension Effect and Service Load, IJRET: International Journal of Research in Engineering and Technology, e-ISSN: 2319-1163, p-ISSN: 2321-7308, Volume: 04 Issue: 08, August-2015.
6. B. Sreedhar,U. Naga Sasidhar, Optimization of Mounting Bracket, htc2012
7. Investigation on the mechanical stresses in a muffler mounting bracket using Root Cause Failure Analysis (RCFA), finite element analysis and experimental validation Sreekanth Dondapatib, Mudit Trivedib, Raja Sekhar Dondapatia,∗, Divya Chandra
8. SHAPE DESIGN OF AN ENGINE MOUNT BY A METHOD OF PARAMETER OPTIMIZATION Joong Jae Kim? and Heon Young Kim
9. Analysis and Optimization of Gating System for Commutator End Bracket B. Vijaya Ramnatha*, C.Elanchezhiana, Vishal Chandrasekharb, A. Arun Kumarb, S. Mohamed Asifb, G. Riyaz Mohamedb, D. VinodhRajb ,C .Suresh Kumar
10. Optimization design of launch locking protective device (LLPD) based on carbon fiber bracket for magnetically suspended flywheel (MSFW) Liu Qianga, Wang Kunb,∗, Ren Yuanc, Chen Xiaocenc, Ma Limeia, Zhao Yon