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WEIGHT OPTIMIZATION OF COMPRESSOR MOUNTING BRACKET IN AUTOMOBILES BY USING TOPOLOGY ANALYSIS

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ABSTRACT

As we know competitive pressure among the manufacturing organization is increasing day by day that is why the factors which attract mostly customers are comfort & cost.

This work is consists of Finite Element Analysis (FEA) of steel bracket & a bracket made of material i.e. steel. The CAE tools used for this work are Solid work for modeling & ANSYS 19.2 for FE Analysis. The FE analysis of bracket is performed for the deflection, stresses and weight optimization . In ANSYS, the general process of FEA is divided into three main phases i.e., preprocessor, solution, and postprocessor. This model Of bracket of material i.e. (steel) is also prepared and analyzed by FEA which is then compare with the previous bracket with optimized bracket. The use of topology optimization technique then finds out weight reduction.

KEYWORDS: FEA, ANSYS, Solidwork, topology optimization , CAE, Steel.

1. INTRODUCTION

1.1 Introduction

While designing the vehicle structure it is very tough job to obtain the higher stiffness and strength and also minimize the weight of the component. Compressor mounting bracket is the bracket used to mount the air conditioner compressor in the car. Mounting bracket goes under certain problems like design space issue, material used , weight of the bracket affecting the performance etc. The compressor mounting bracket is used to safely support the car AC compressor. Mounting locations and types of support are very difficult to change after the compressor is built. The compressor is connected to the engine body. If the stiffness of the mounting bracket is not appropriate, it can create vibration and noise. Due to these factors, it is necessary that compressor mounting brackets have enough stiffness and strength. To verify bracket properties early in the design stage, the strength analysis needs to be performed. It measures the magnitude of load from the mass of the compressor, including safety and applies this load to the compressor mounting bracket. The stress analysis is performed with these boundary conditions and the analyst verifies the results. Parameters like cost of the vehicle and fuel efficiency are mostly influenced by the weight of the vehicle in automotive industries. As per the safety standards, it is very important to design light weight components.

A. Types of brackets

1. Engine Mounting Bracket of Car

Engine mounting bracket of the car is the bracket used to mount the engine from the back side. It is made of steel. The large face of the bracket is connected to the engine while the small end of the bracket is connected to the vehicle structure for taking load and vibrations. Due to less vibration rate and knocking rate of the engine its operational life is more. But if the engine is old or there are some other problems related with the vehicle structure, then there are large chances of failure of the engine mounting bracket.

Crack in the bracket is the main failure due to high stresses generated in the bracket.

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Fig.1.1: Engine mounting bracket of a car

2. Aero plane engine's continental engine mounting Bracket

Fig 1.2: Aero plane engine's continental

A mounting bracket is used as a base member having a flat upper surface and an elongated shoulder extending upward from the base surface. The mounting bracket consists of bracket member having an upper surface adapted to support a component and a flat lower bracket surface. The base is connected to the plane structure and the other part connected to the engine which takes most of the load. It is made up of aluminum casting.

3. AC compressor mounting bracket

The compressor plays a very important role in the automotive air conditioning system. The unbalanced forces produced from the engine and compressor causes the structure vibrations. The compressor is supported by the engine mounting to reduce the vibratory forces is called compressor mounting bracket.

1.2 Topology Optimization

At the design stage the concept of the topology optimization is very important. It is common habit to design, depending on the designer's experience at the early stage of product development. Reliable and satisfactory results with the verified structural model is obtained by topology optimization. Topology optimization is a method which distributes the density of an initially homogenous volume to achieve a certain objective function while observing the defined constraints. The main objective function is minimizing volume and the displacement acts as a constraint and with manufacturing constraint such as casting of the bracket. Initially we have to collect the information regarding different loads acting on the bracket. The base bracket results from testing and finite element analysis (FEA) point of view for evaluating final optimized design. A structural domain consists of many rectangular perforate materials in the structural optimization topology and these microstructures within design domain material are reproduced to maximize structural stiffness.

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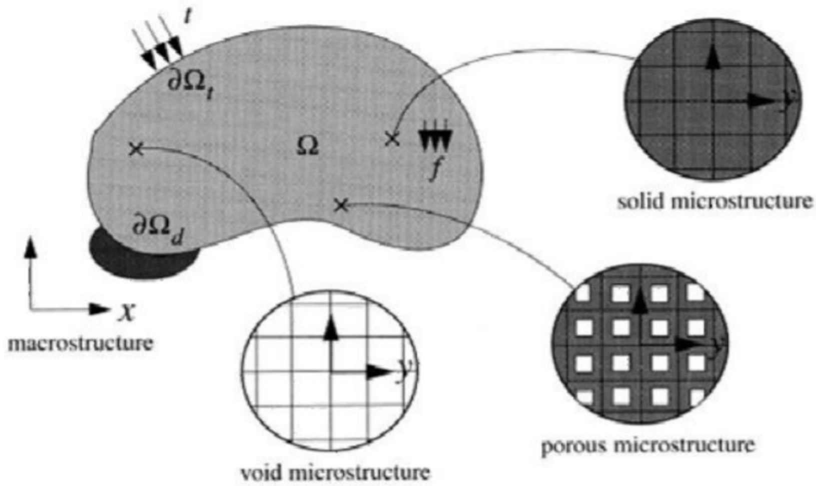

Fig 1.3: Design domain and microstructure

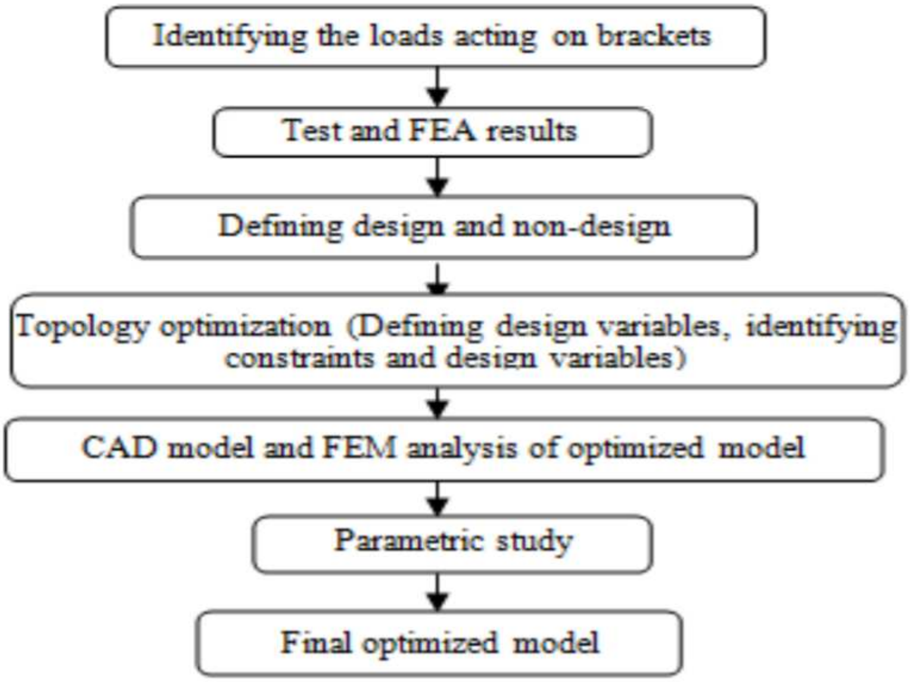

Fig1.4: Flow chart for optimization

2. MODELING

2.1 2D Sketching

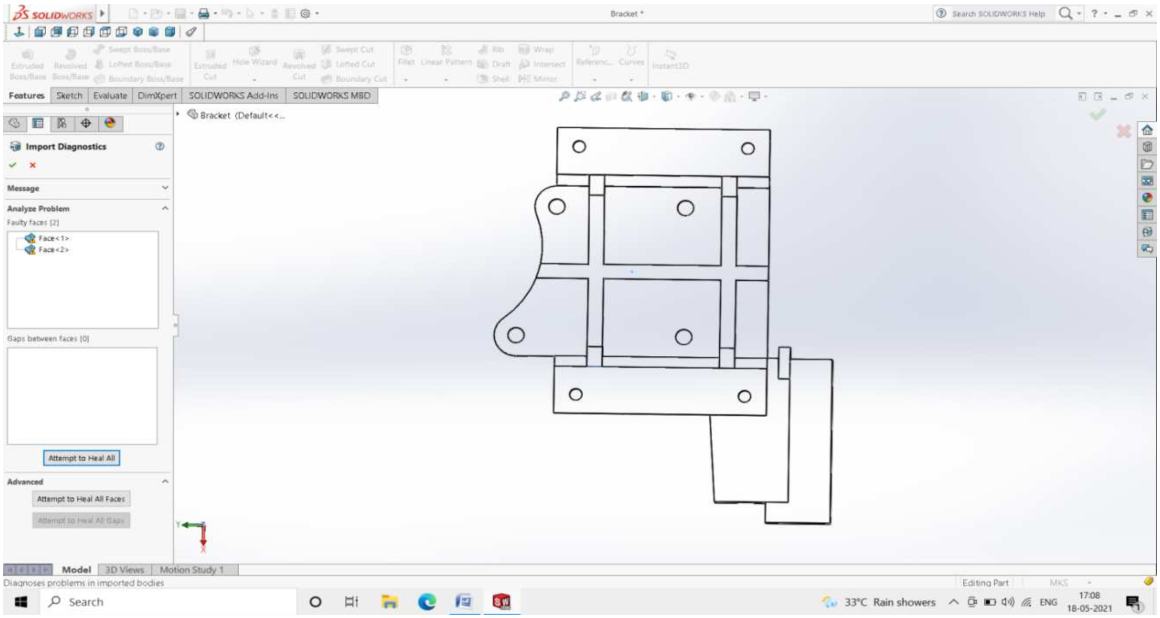

Fig.2.1 Exiting Bracket 3D wire frame layout on solidwork

2.2 Structural Steel

Material Field Variable	Value	Units
Density	7850	Kg/m^3
Young's modulus	2E+05	Mpa
Poisson Ratio	0.30	
Shear modulus	76923	Mpa
Bulk Modulus	1.6667E+05	Mpa
Tensile Yield Strength	250	Mpa
Compressive Yield Strength	250	Mpa
Tensile Ultimate Strength	460	Mpa

According to these calculations different materials are selected and DOE is performed to select the best alternative for the design for the compressor support system links.

2.3 Boundary Condition

Three dimensional models are analyzed in ANSYS is the neutral preprocessor where we can open IGES, STEP, SOLIDWORKS Mounting bracket is saved as STEP format and opened in ANSYS for doing meshing (tetrahedral mesh). A rigid element is created for the portion of the engine mounting bracket which fits into the slot of the vehicle chassis and the independent node for this rigid is determined. A load of 45 N is applied on this node along the Z-axis. The three holes on the engine mounting bracket which are connected to the engine are constrained in all degrees of freedom.

A remote force of 45 N, that is, mass 9 acceleration, was assumed to be acting at the centre of mass of the compressor. This centre of mass was calculated using the option available in Solid Works package. The software package calculates the centre of mass using the material properties and the outer shape of the compressor.

Analysis . It shows that total of 0.00728 MPa pressure is applied on the surface to simulate 512 N load due to 3 gram acceleration of the compressor assembly towards the base. Also All four bolt holes are applied with fixed boundary conditions to simulate its bolting connection with the chassis. Total mass of the bracket is around 4.5 kg.

3. SIMULATION

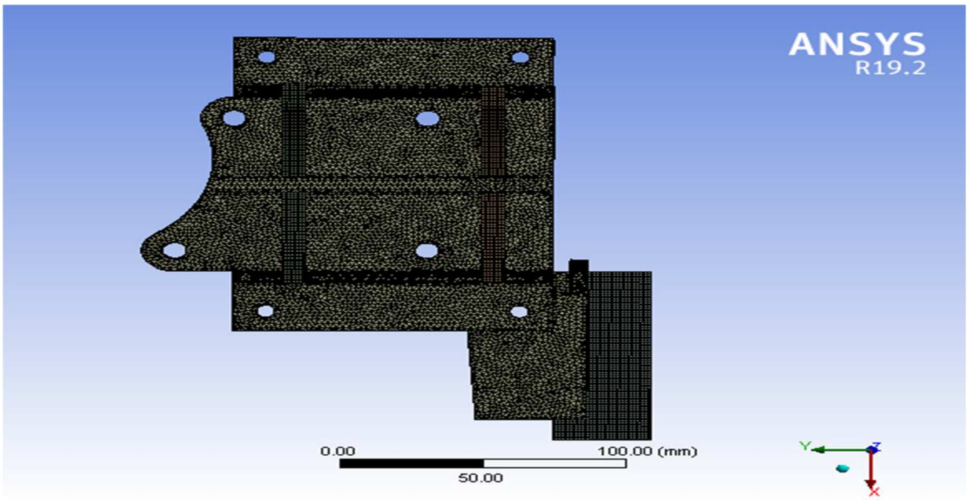

Fig.3.1 Exiting bracket meshing

Exiting model of engine mounting bracket import to ANSYS workbench and then model has meshed with number of nodes is 769429 and number of elements is 273049 with tetrahedral meshing and size of meshing is fine .

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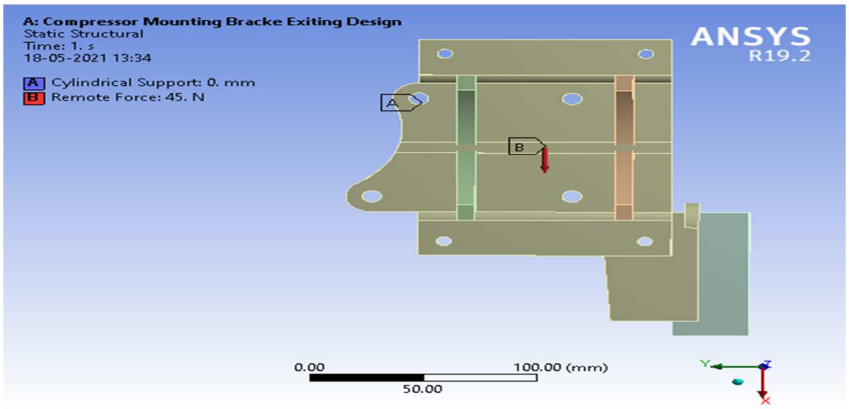

Fig.3.2 Bracket cylindrical support and force applied

In this figure Bracket middle 04 hole cylindrical support applied. Which is shown in figure blue sign and after applied cylindrical support on Bracket at middle 04 hole and then then applied force all 04 outer holes. Which is shown in figure red arrow sign .

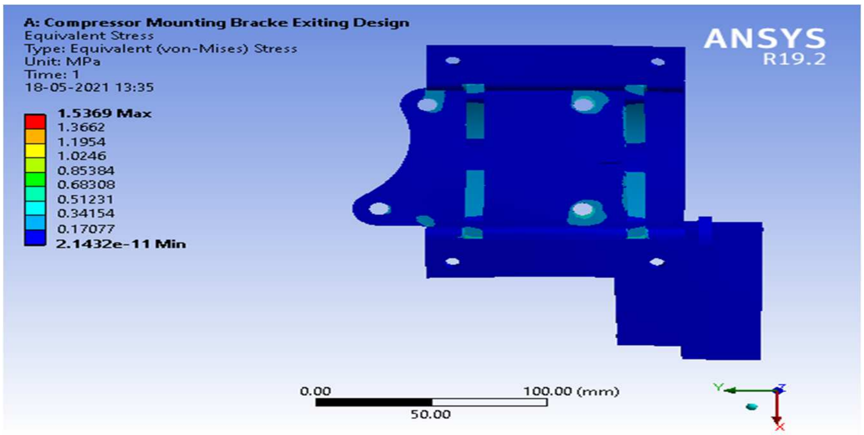

Fig.3.3 Exiting bracket stress concentration results

Now here postprocessing phase has come so here find out Exiting bracket stress (MPa) concentration results. Which is shown figure as a color coding scale.

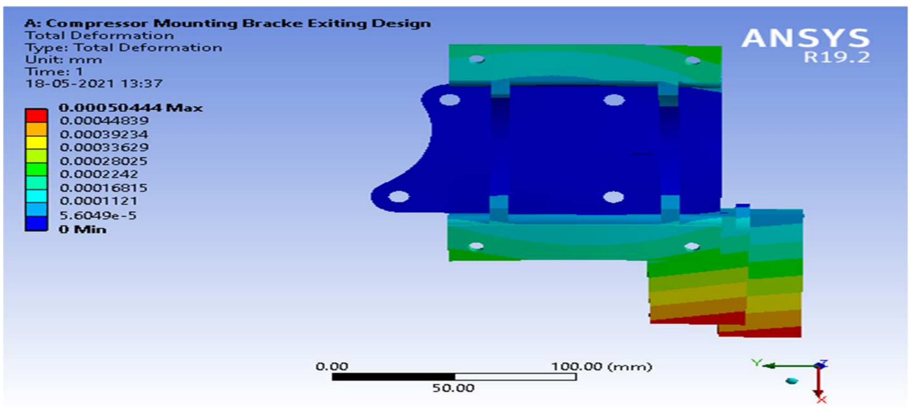

Fig. 3.4 Exiting bracket deformation results

Now here postprocessing phase has come so here find out Exiting bracket deformation (mm) results. Which is shown figure as a color coding scale.

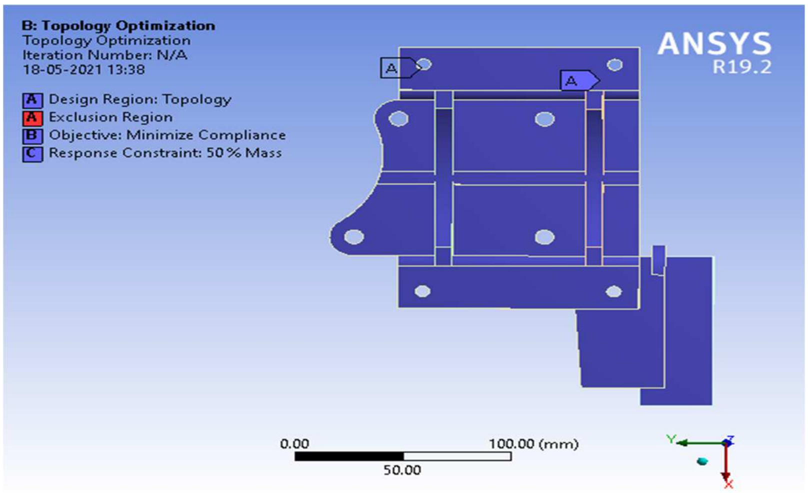

Fig. 3.5 Exiting bracket import to Topology otimization

After finishing post processing phase then this simulation is imported on Topology platform of ANSYS. Thend applied constraint.

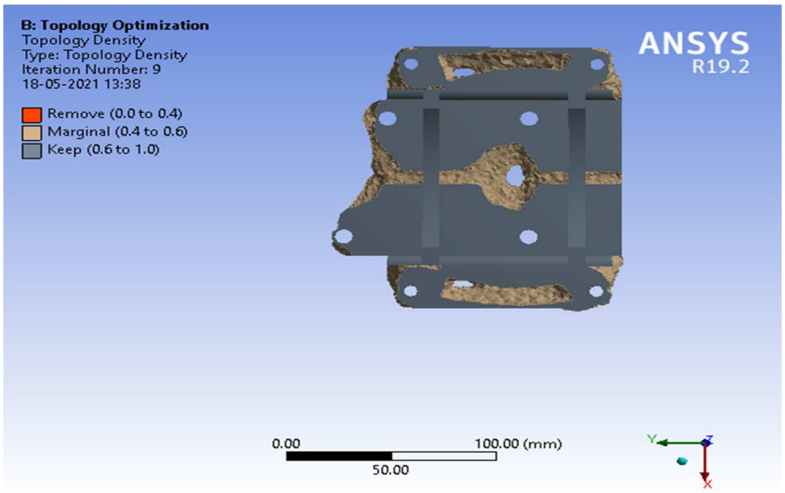

Fig. 3.6 Exiting bracket Topology otimization results

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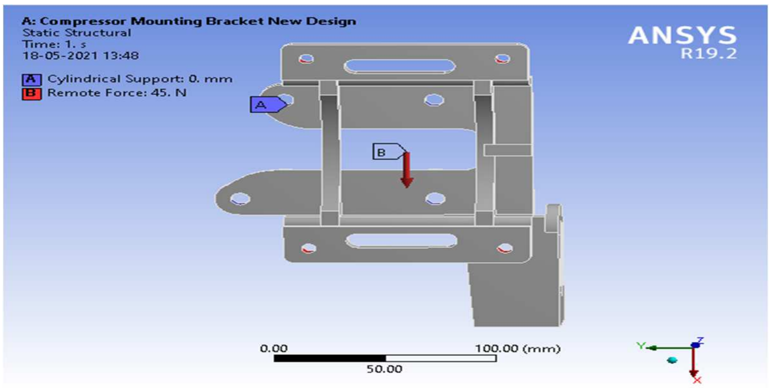

Fig.3.7 Modify Bracket cylindrical support and force applied

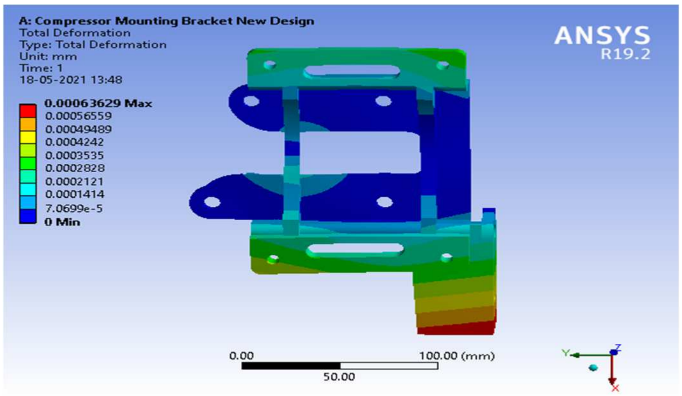

Fig. 3.8 Modify bracket stress concentration results

Now here postprocessing phase has come so here find out Modify bracket stress (MPa) concentration results. Which is shown figure as a color coding scale.

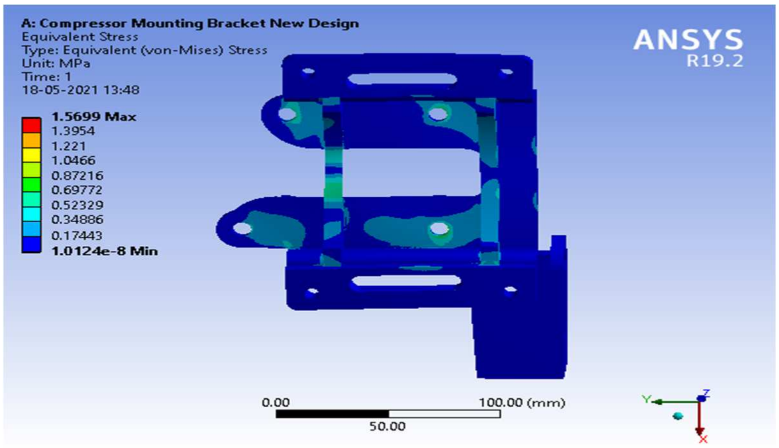

Fig.3.9 Modify bracket deformation results

Now here postprocessing phase has come so here find out Modify bracket deformation (mm)

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4. RESULTS

4.1 Results

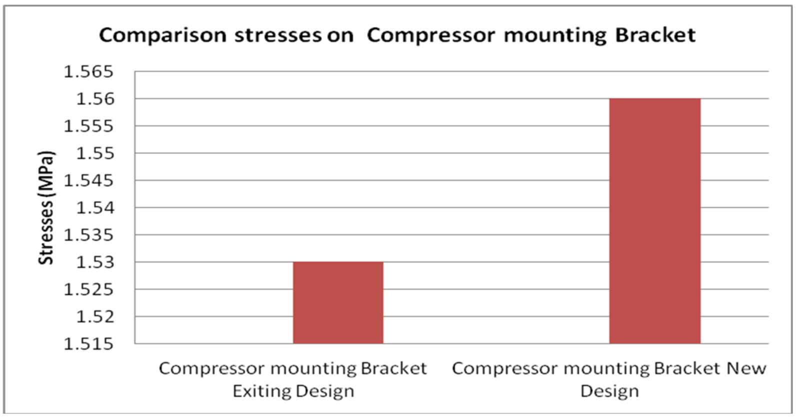

Fig. 4.1 Comparison stresses on compressor mounting bracket

Here exiting bracket and new bracket results has taken after finished simulation so here stress results find out which is underconsiderable range very less range of stresses results find out when applid 4.5 kg load on engine mounting brakects on both cases.

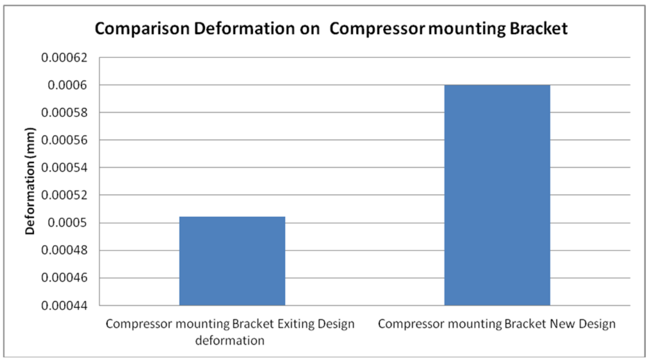

Fig. 4.2 Comparison deformation on compressor mounting bracket

Here exiting bracket and new bracket results has taken after finished simulation so here deformation results find out which is underconsiderable range very less range of deformation find out when applid 4.5 kg load on engine mounting brakects on both cases.

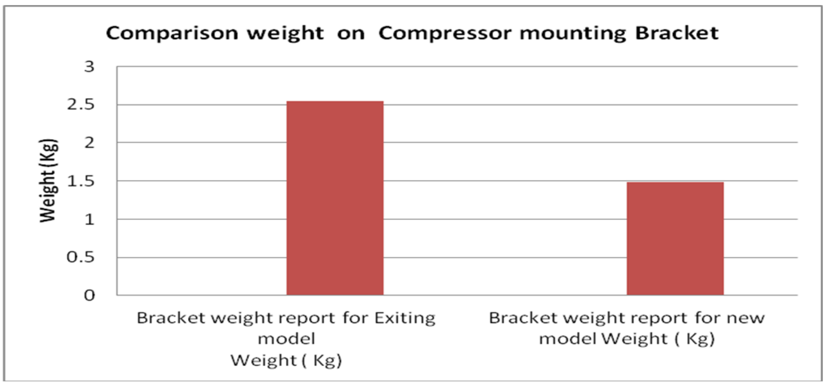

Fig. 4.3 Comparison weight on compressor mounting bracket

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Here exiting bracket and new bracket results has taken after finished simulation so here weight results find out which is very less of weight when used modified brakect compared to exiting bracket.

5. CONCLUSION

5.1 Conclusion

From the results obtained from FE Analysis, some discussions have been made and it will be concluded that,

1. When Exiting steel bracket is replaced by new steel bracket. Then deformation results of new steel bracket. Its under considerable condition.
2. The bending stress in case of steel exiting bracket and new bracket is nearest. Its under considerable condition.
3. At the same time when comparing steel exiting and new bracket , there is a material saving of 58.6 % by weight.

5.2 Future Scope

In further research work can be extended as a form of vibration analysis and used composite material for bracket making process.

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