

Optimisation Of Engine Mounting Bracket Under Static Loading Conditions By Using Ansys

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Abstract- It is very important to reduce the development times from the initial concept development stage to the mass production stage in automotive engineering. Much trial and error occur from the initial design to mass production to verify the performance and durability and other design criteria. Computational simulations for reducing such trials and errors are generally utilized and have proven to be useful tools in many areas. The ability of using CAD/CAE has become one of the core technologies nowadays because of shortened development periods. The compressor mounting bracket was studied in this paper.

This study is mainly concentrated on the optimization of Material of the model automobile engine mounting bracket, optimization will help in reducing the unwanted material investment, simplifying the design and reduce the production time, in this work 4 different materials are used for optimization, all the observations are discussed below, the optimized models have irregular shapes, and are not ready for manufacturing, these models are to be redesigned excluding the portions that are removed during optimization.

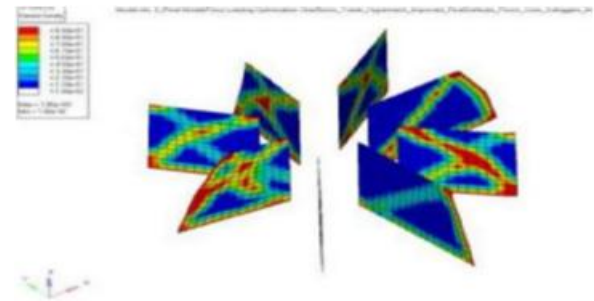
I. INTRODUCTION

Structural optimizations are concerned with enhancing the utility of a fixed quantity of resources to fulfill the given objective. Three categories of structural optimization exist; topology, size and shape.

Structural topology optimization is the most general of the three categories yielding information on the number, location, size and shape of "openings" within a continuum. The first solutions to a topology optimization problem were presented by Michell. Modern topology optimization techniques can be applied to generalized problems through the use of the Finite Element (FE) method, as a relatively recent innovation. Aerospace, automotive and mechanical engineers have successfully utilized topology optimization in order to achieve weight savings in structures.

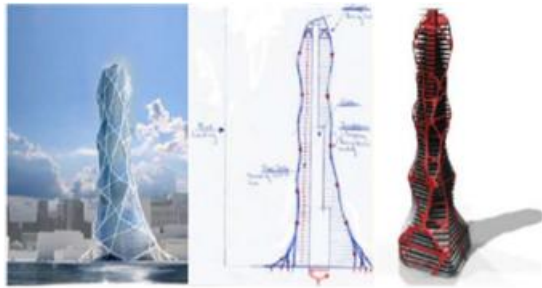
This paper briefly details the two most popular topology optimization techniques currently available; presents

the theoretical background and practical implementation of the most commonly used Solid Isotropic Material with Penalization (SIMP) technique; and reveals previous applications of topology optimization in both structural engineering and architecture. Moreover, the implementation of topology optimization within the field of structural engineering, and potential opportunities beyond the present frontiers, are examined through various examples. A description of studies conducted by the authors using the topology optimization technique for: (a) the design of a high-rise structure, and(ii) the development of a novel steel I-section with atypical web openings configurations, is also presented.



The term "topology" is derived from the Greek word "tops" meaning position/place. The application of topology optimization extends to the number of holes, their location, their shape and the connectivity of the structural domain. Shape and sizing optimization are more limited than topology optimization in the respect that the designer must specify the topology of the proposed structure which is then fixed throughout the optimization process.





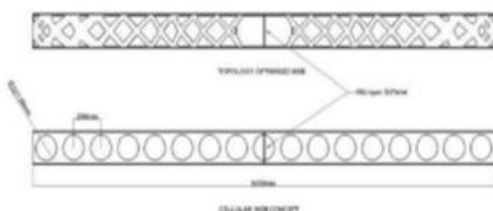
Rational truss structures suggested for the outriggers in the results of the topology optimization study

The judicious placement of holes in the webs of steel beams has been employed to design lighter and stiffer beams for over 100 years. The original concept of creating a beam with web openings can be attributed to Geoffrey Murray Boyd [30], who patented what is now known as the castellated beam.

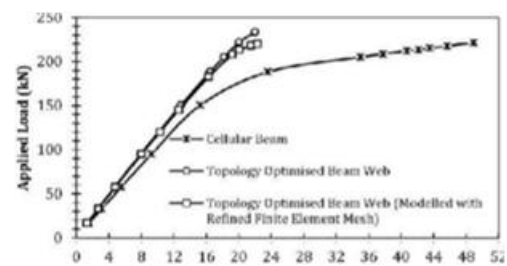
Castellated beams are formed by the expansion of a parent I-section to form a deeper stiffer section with web openings (fig.6a). Cellular beams, which contain circular openings, are currently the most widely used perforated beams due to their beneficial weight-to-stiffness ratio, and the ability to pass services (e.g. hydraulic pipes, electric wires, etc.) through large holes, while the stresses are distributed evenly in the vicinity of the circular holes. An alternative to the castellation process of fabrication is the plate assembly

The examination was led on a standard 305x165x40 General Shaft (UB). The area was chosen on the premise that it has been broadly utilized in before both trial and numerical examinations and speaks to an average 5m range segment in building development. The bar was exposed to consistently conveyed stacking along the top pressure steel rib to mimic the heap from a steel-solid composite (SCC) or fortified solid deck with the incomplete shear quality (for example parallel strength was not given).

The evenness compelled study brought about a comparable structure with rhomboid openings. However, it was better parity along the length of the pillar design with rhomboidal openings; unit was better balanced along the length of the beam.

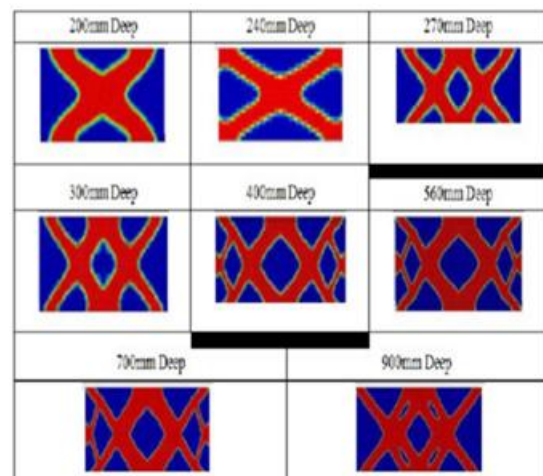


The results of the topology optimization study were post-processed in order to generate the finalized geometry of the optimized beam web (fig.8a). In order to further investigate the structural performance of the beam web in comparison to a typical beam with circular web openings, a nonlinear FE analysis was employed. The size of the circular web openings was determined based on the maximum size generally used widely in industry, equal to 0.75 times the depth of the web. A total of 17 web openings were placed along the length of the beam, in order to make the weight of the cellular beam as similar as possible to the optimized one, whilst retaining the same flange dimensions. It was desirable to compare a cellular beam of a similar mass in order to be able to draw valuable conclusions regarding the structural efficiency of the topology optimized design.



Vertical Displacement at Mid-span (mm)

Novel web opening architecture: In light of the results detailed above and Kingman et al., it is concluded that the topology optimization is a useful tool identifying alternative improved beam configurations and improving the in depth understanding of their structural behavior.





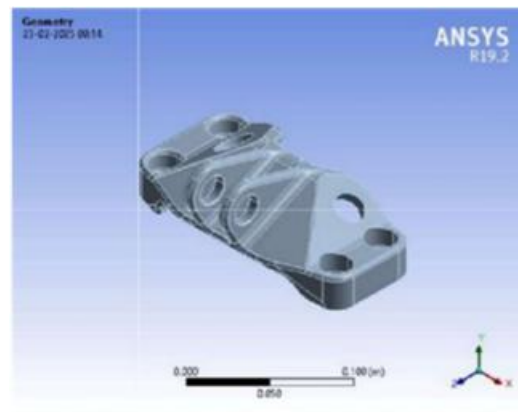
A local approach was implemented in order to identify a more generalized opening type. Based on the results of this study a novel opening architecture has been suggested (fig.11). It is anticipated that this new configuration is possible to be fabricated using the plate assembly technique, while no cost implies, compared to any other opening shapes. Further study is, however, required to examine various failure mechanisms that might have been introduced due to the complexity of these web openings as well as derive an analytical and/or empirical method to determine the load carrying capacities.

Topology Optimization: For the past three decades tremendous improvement is noticed in the application of topology optimization in generating efficient design concepts. Current structural optimization software applications have built-in topology optimization modules in addition to shape optimization capabilities. Altair Opti-Struct is one such efficient tool appeared in the last decade.

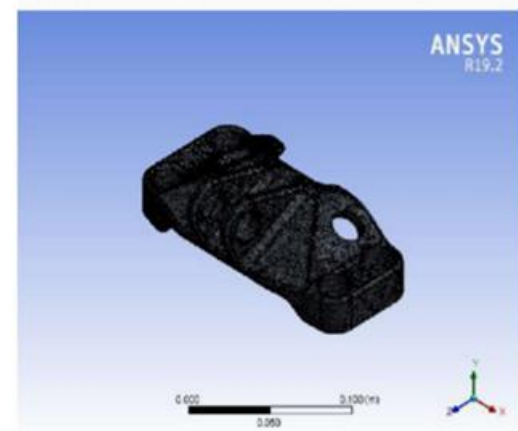
However, special optimization modules equipped with fewer analysis capabilities than general FEM codes offer higher efficiency for optimization. The reasons for this are highly specialized codes are typically smaller and therefore more flexible for incorporating the latest developments than general codes, and for specialized codes, highest priority is devoted to its core technology of optimization. Now-a- days topology optimization has been performed separately while thickness and shape optimization can be combined into a single process.

MODELING: There are various types of drawings required in the different fields of engineering and science. In earlier days, various drawing instruments like drafting machine, T-square, scale etc., are used to prepare drawings easily and accurately. But to obtain better ease in modifying the design and making calculations, the process of preparing a drawing is made in the computer using certain software's. This use of computer systems is termed as computer aided design. It replaces manual drawing with an automated process.

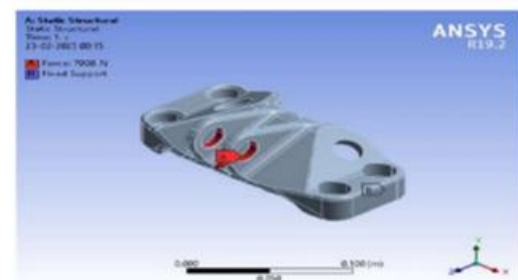
Topology optimization



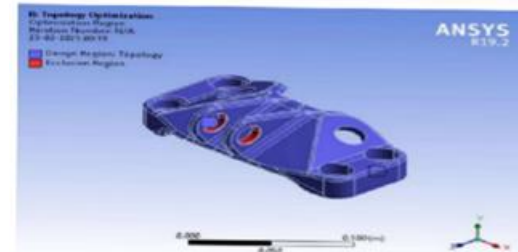
Mesh model



Boundary conditions



OptimisationRegion



MATERIAL PROPERTIES

Grey Cast Iron

Properties of Outflow Rate to Steel Cast Iron					
	A	B	C	D	E
	Property	Value	Unit		
2	Material Field Variables	Table			
3	Density	7200	kg m ⁻³		
4	Isotropic Secant Coefficient of Thermal Expansion				
5	Coefficient of Thermal Expansion	1.1E-05	C ⁻¹		
6	Isotropic Elasticity				
7	Derive from	Young's Mod...			
8	Young's Modulus	1.1E+11	Pa		
9	Poisson's Ratio	0.28			
10	Bulk Modulus	8.3333E+10	Pa		
11	Shear Modulus	4.2969E+10	Pa		
12	Tensile Yield Strength	0	Pa		
13	Compressive Yield Strength	0	Pa		
14	Tensile Ultimate Strength	2.4E+08	Pa		
15	Compressive Ultimate Strength	8.2E+08	Pa		

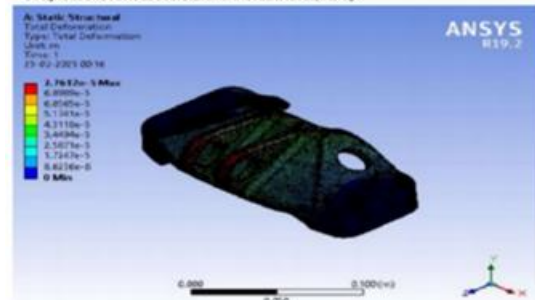
StructuralSteel

Parameters of Concrete Used for Structural Design				
	A	B	C	D
1	Concrete	Value	Unit	
2	Concrete Compressive Strength	25	N/mm ²	
3	Concrete Tensile Strength	1.65	N/mm ²	
4	Concrete Modulus of Elasticity	20000	N/mm ²	
5	Concrete Poisson's Ratio	0.2		
6	Concrete Density	2400	N/m ³	
7	Concrete Unit Weight	24	kN/m ³	
8	Concrete Thermal Expansion Coefficient	10	1/°C	
9	Concrete Shrinkage Coefficient	0.0001		
10	Concrete Creep Coefficient	2.0		
11	Concrete Durability Coefficient	1.0		
12	Concrete Permeability Coefficient	1.0		
13	Concrete Carbonation Coefficient	1.0		
14	Concrete Chloride Ion Penetration Coefficient	1.0		
15	Concrete Sulfate Resistance Coefficient	1.0		
16	Concrete Acid Resistance Coefficient	1.0		
17	Concrete Fire Resistance Coefficient	1.0		
18	Concrete Seismic Resistance Coefficient	1.0		
19	Concrete Durability Coefficient	1.0		
20	Concrete Permeability Coefficient	1.0		
21	Concrete Carbonation Coefficient	1.0		
22	Concrete Chloride Ion Penetration Coefficient	1.0		
23	Concrete Sulfate Resistance Coefficient	1.0		
24	Concrete Acid Resistance Coefficient	1.0		
25	Concrete Fire Resistance Coefficient	1.0		
26	Concrete Seismic Resistance Coefficient	1.0		
27	Concrete Durability Coefficient	1.0		
28	Concrete Permeability Coefficient	1.0		
29	Concrete Carbonation Coefficient	1.0		
30	Concrete Chloride Ion Penetration Coefficient	1.0		
31	Concrete Sulfate Resistance Coefficient	1.0		
32	Concrete Acid Resistance Coefficient	1.0		
33	Concrete Fire Resistance Coefficient	1.0		
34	Concrete Seismic Resistance Coefficient	1.0		
35	Concrete Durability Coefficient	1.0		
36	Concrete Permeability Coefficient	1.0		
37	Concrete Carbonation Coefficient	1.0		
38	Concrete Chloride Ion Penetration Coefficient	1.0		
39	Concrete Sulfate Resistance Coefficient	1.0		
40	Concrete Acid Resistance Coefficient	1.0		
41	Concrete Fire Resistance Coefficient	1.0		
42	Concrete Seismic Resistance Coefficient	1.0		
43	Concrete Durability Coefficient	1.0		
44	Concrete Permeability Coefficient	1.0		
45	Concrete Carbonation Coefficient	1.0		
46	Concrete Chloride Ion Penetration Coefficient	1.0		
47	Concrete Sulfate Resistance Coefficient	1.0		
48	Concrete Acid Resistance Coefficient	1.0		
49	Concrete Fire Resistance Coefficient	1.0		
50	Concrete Seismic Resistance Coefficient	1.0		
51	Concrete Durability Coefficient	1.0		
52	Concrete Permeability Coefficient	1.0		
53	Concrete Carbonation Coefficient	1.0		
54	Concrete Chloride Ion Penetration Coefficient	1.0		
55	Concrete Sulfate Resistance Coefficient	1.0		
56	Concrete Acid Resistance Coefficient	1.0		
57	Concrete Fire Resistance Coefficient	1.0		
58	Concrete Seismic Resistance Coefficient	1.0		
59	Concrete Durability Coefficient	1.0		
60	Concrete Permeability Coefficient	1.0		
61	Concrete Carbonation Coefficient	1.0		
62	Concrete Chloride Ion Penetration Coefficient	1.0		
63	Concrete Sulfate Resistance Coefficient	1.0		
64	Concrete Acid Resistance Coefficient	1.0		
65	Concrete Fire Resistance Coefficient	1.0		
66	Concrete Seismic Resistance Coefficient	1.0		
67	Concrete Durability Coefficient	1.0		
68	Concrete Permeability Coefficient	1.0		
69	Concrete Carbonation Coefficient	1.0		
70	Concrete Chloride Ion Penetration Coefficient	1.0		
71	Concrete Sulfate Resistance Coefficient	1.0		
72	Concrete Acid Resistance Coefficient	1.0		
73	Concrete Fire Resistance Coefficient	1.0		
74	Concrete Seismic Resistance Coefficient	1.0		
75	Concrete Durability Coefficient	1.0		
76	Concrete Permeability Coefficient	1.0		
77	Concrete Carbonation Coefficient	1.0		
78	Concrete Chloride Ion Penetration Coefficient	1.0		
79	Concrete Sulfate Resistance Coefficient	1.0		
80	Concrete Acid Resistance Coefficient	1.0		
81	Concrete Fire Resistance Coefficient	1.0		
82	Concrete Seismic Resistance Coefficient	1.0		
83	Concrete Durability Coefficient	1.0		
84	Concrete Permeability Coefficient	1.0		
85	Concrete Carbonation Coefficient	1.0		
86	Concrete Chloride Ion Penetration Coefficient	1.0		
87	Concrete Sulfate Resistance Coefficient	1.0		
88	Concrete Acid Resistance Coefficient	1.0		
89	Concrete Fire Resistance Coefficient	1.0		
90	Concrete Seismic Resistance Coefficient	1.0		
91	Concrete Durability Coefficient	1.0		
92	Concrete Permeability Coefficient	1.0		
93	Concrete Carbonation Coefficient	1.0		
94	Concrete Chloride Ion Penetration Coefficient	1.0		
95	Concrete Sulfate Resistance Coefficient	1.0		
96	Concrete Acid Resistance Coefficient	1.0		
97	Concrete Fire Resistance Coefficient	1.0		
98	Concrete Seismic Resistance Coefficient	1.0		
99	Concrete Durability Coefficient	1.0		
100	Concrete Permeability Coefficient	1.0		

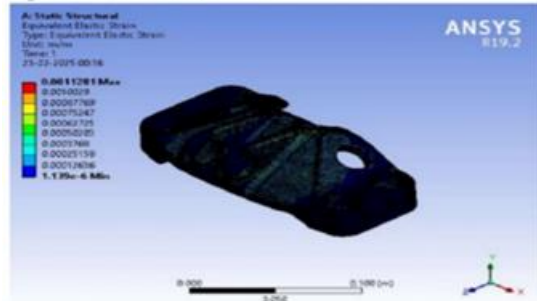
Aluminium Alloy

Properties of Concrete from 3. Materials Library		B	C	D	E
	Property	Value	Unit		
2	Material Fict. variables	Table			
3	Density	2750	kg m ⁻³		
4	Isotropic Secant Coefficient of Thermal Expansion	2.3E-05	C ⁻¹		
5	Isotropic Elasticity				
6	Concrete flow	Young's Modu...			
7	Young's Modulus	7.1E+10	Pa		
8	Poisson's Ratio	0.33			
9	Bulk Modulus	6.9608E+10	Pa		
10	Shear Modulus	2.4092E+10	Pa		
11	Stress-Strain Curve	Tabular			
12	Interpolation	Secant-Slope			
13	Scale	1			
14	Offset	0	Pa		
15	Tensile Yield Strength	2.8E+10	Pa		
16	Compressive Yield Strength	2.8E+10	Pa		
17	Tensile Ultimate Strength	3.3E+10	Pa		
18	Compressive Ultimate Strength	0	Pa		

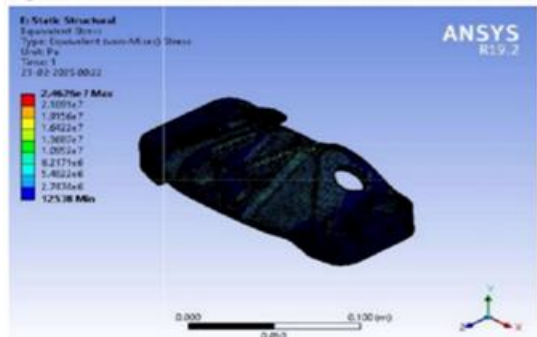
Grey Cast Iron Directional Deformation(MM)



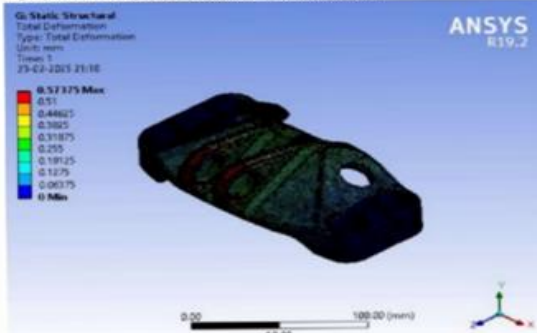
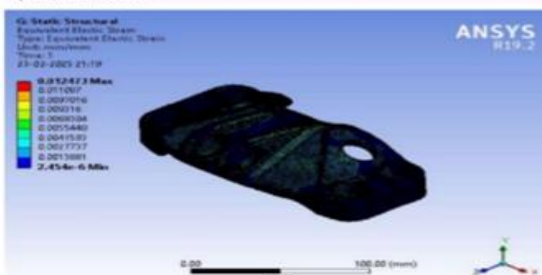
Equivalent Elastic Strain(MM/MM)



Equivalent Stress(MPa)

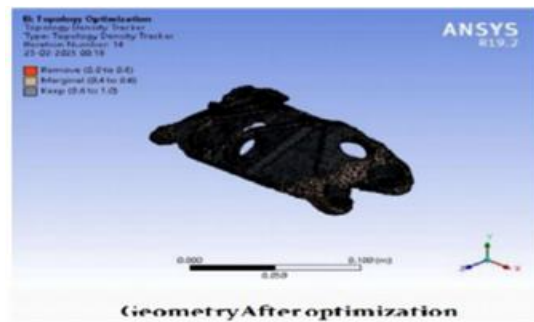


Epoxy Carbon Composite Directional Deformation (MM)

Equivalent Elastic Modulus, E_{eq} , MPa

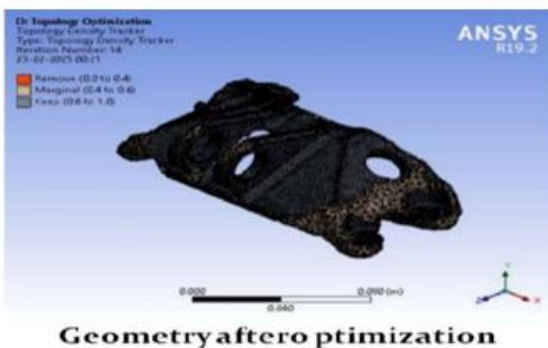
Grey Cast Iron

Model (A, B, C)	Topology Optimization (R ₁)	Solution (R ₂)	Results
Object Name	Topology	Density	Surface
Source			
Scoping Method		Optimization Region	
Optimization Region		Optimization Region	
Definition			
Type	Topology Density		
By	Iterations		
Iteration	1 out		
Returned Threshold	0.5		
Execution Participation	Yes		
Calculate Time History	Yes		
Suppression	No		
Results			
Iterations	1 to 4000		
Non-linear	1		
Average	0.50083		
Original Volume	1.64456e+005 mm ³		
Final Volume	94.141 mm ³		
Reduced Volume	94.141 mm ³		
Original Mass	1.3312 kg		
Final Mass	0.67765 kg		
Reduced Mass	50.907		
Availability			
Shown Optimization Region	Optimized Region		
Results			
Iteration Surface	1st		



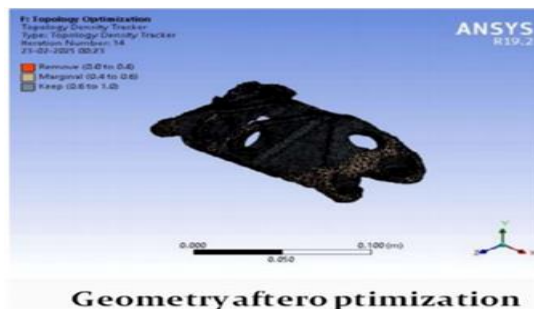
Structural Steel
Model: C4_8q7-Topology Optimization(T3)-Solution(T6)-Results

Topology Density	
State	Solved
Scenario	Optimization Region
Optimization Method	Optimization Region
Definition	Optimization Region
Type	Topology Density
Iteration	1
Retained Threshold	0.5
Excitation Participation	Yes
Calculate Time History	No
Suppressed	No
Results	
Minimum	1.e-003
Maximum	1
Average	0.50863
Original Volume	1.8488e+003 mm ³
Final Volume	941.08 mm ³
Percent Volume of Original	50.901
Original Mass	1.4513 kg
Final Mass	0.72565 kg
Percent Mass of Original	50.001
Stability	
Show Optimized Region	Retained Region
Iteration Number	14



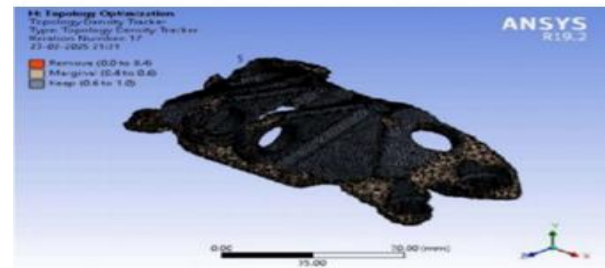
Aluminum Alloy
Model: E4_T3-Topology Optimization(T3)-Solution(T6)-Results

Topology Density	
State	Solved
Scenario	Optimization Region
Optimization Method	Optimization Region
Definition	Optimization Region
Type	Topology Density
Iteration	1
Retained Threshold	0.5
Excitation Participation	Yes
Calculate Time History	No
Suppressed	No
Results	
Minimum	1.e-003
Maximum	1
Average	0.5085
Original Volume	1.8488e+003 mm ³
Final Volume	941.08 mm ³
Percent Volume of Original	50.942
Original Mass	0.81213 kg
Final Mass	0.26080 kg
Percent Mass of Original	30.942
Stability	
Show Optimized Region	Retained Region
Iteration Number	14



Epoxy carbon composite
Model: G4_H3-Topology Optimization(T3)-Solution(T6)-Results

Topology Density	
State	Solved
Scenario	Optimization Region
Optimization Method	Optimization Region
Definition	Optimization Region
Type	Topology Density
Iteration	1
Retained Threshold	0.5
Excitation Participation	Yes
Calculate Time History	No
Suppressed	No
Results	
Minimum	1.e-003
Maximum	1
Average	0.50863
Original Volume	1.8488e+003 mm ³
Final Volume	941.08 mm ³
Percent Volume of Original	50.901
Original Mass	1.4513 kg
Final Mass	0.72565 kg
Percent Mass of Original	50.001
Stability	
Show Optimized Region	Retained Region
Iteration Number	14



Experimentation Results

Topology Optimization	Directional Deformation(Mm)		Equivalent Elastic Strain(Mm/Mm)		Equivalent Stress (Map)	
	Max	Min	Max	Min	Max	Min
Grey Cast Iron	7.76e-02	0	0.001128	1.14e-06	1.24e+02	7.73e-02
Structural Steel	4.29e-02	0	0.000618	6.40e-07	1.24e+02	5.91e-02
Aluminum Alloy	2.44e-02	0	0.000347	3.69e-07	2.46e+01	1.25e-02
Epoxy Carbon Composite	5.74e-01	0	0.012473	2.45e-06	2.68e+02	3.80e-02

II. CONCLUSIONS

This study is mainly concentrated on the optimization of Material of the model automobile engine mounting bracket, optimization will help in reducing the unwanted material investment simplifying the design and reduce the production time, in this work 4 different Materials are used for optimization, all the observations are discussed below, the Optimized models have irregular shapes are not ready for manufacturing, these. models are to be redesigned excluding the portions that are removed during optimization.

1. Aluminium model has the lowest stress of all models
2. As these optimizations are targeted for material optimization the dead mass is optimized.
3. 50% present of the original mass is optimized and hence the dead mass is more than 50 percent
4. All the models are to be redesigned excluding the volumes removed during optimization.
5. By optimizing these models, we can reduce the material cost by 50% present and additionally material

- handling cost, machining cost etc. are also reduced significantly
6. The only problem will be redesign of both model and dies for casting the component as these components are dying cast

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