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Structural Investigation and Topological Optimization of Connecting Bracket Based on Optimality Creation

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Abstract – *Topological optimization is a form of FEA method to reduce the compliances in structure based on the creation of a mathematical model. In this technique the material layout is optimized within sets of design constraints limit based on the feature of either Mass constraint Algorithms or Volume constraints Algorithm where the aim is to eliminate the stiff part of material which is assigned by pseudo density factor.*

Key Words: Topology Optimization, FEA, Compliance, Mass constraints, Volume Constraints, Optimilaty Creation(OC).

1.INTRODUCTION

Topological optimization is a method to optimize the material layout within the design space where the aim and goal is to increase the sustainability and adaptable efficiency of the product by reducing its overall weight of the structure. During the initialization of the Topological optimization set of a mathematical model based on the Numerical method of optimization, the theory works with the material to assign the pseudo density factor with a scale of 0-1.

In the present paper operation of Topological optimization for the connecting bracket is performed with the help of Commercial used Ansys software.

2. OPTIMIZATION TECHNIQUES

The type of Optimization technique include -a)Shape and Size optimization b) Topology optimization c) Layout optimization and Structural and Material optimization.

As compared with other mode of creations the main Aim of Topological optimization is to figure out the most prominent space of design working limit.

The development of topological optimization was first pioneered by **Bendsøe and Kikuchi [1988], [1].** They have proposed the method of Homogenization of anisotropic material. In **1991 Suzuki and Kikuchi,** they have presented strength-based planer structure theory which is the modification of carryforward research based on the Homogenization method **[2]**. In **[1992] Thomsen** has presented sets of validated numerical results based on maximization stiffness in an isotropic material **[3]. In 2008** Hui Zhang & Xiong Zhang & Shutian LiuIn presented a practical validation that says nodes in element figured the similar corresponding knowledge of the previous attach nodes **[4].**

3. MATERIALS AND METHODS

The Topology optimization is performed using the optimality creation method through commercial based workbench of Ansys software. The layout of different types of optimization techniques shown in the below layout **[5]**.

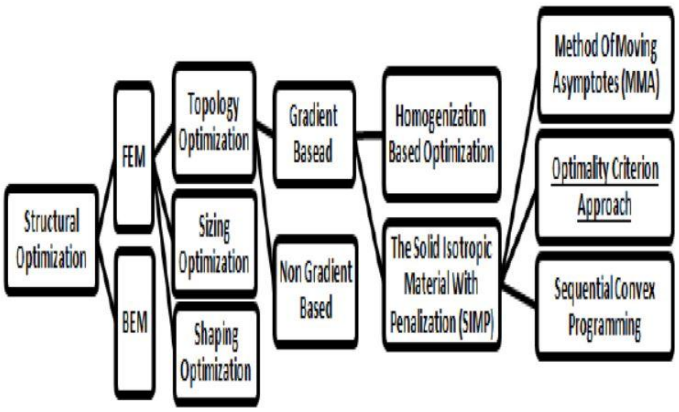

Fig 1: Layout of Optimization techniques.

 Numerical Scheme.
General formulation: Set of function to find the design
variable, X
Minimize F(X) (1)

Subject to:

Gj (X) <0 ; j=1, m (2)

iXL < Xi < Xi U ; i=1, n (3)

[K]u = p (4)

Equation 4 states the Finite element method to solve the
displacement of vectors and minimum weight structure in
constrained limits.

4. ALGHORITH SCHEME AND TO INTITILIZATION.

Fig 2. The Alghorith of optimization procedure and convergence criteria

Pre-Processing.

a) Geometry creation and Meshing – The geometry has been created with with Design Modelar feature of Ansys workbench. The structural mesh with 4 mm of uniformity length has been devloped for the structrue.

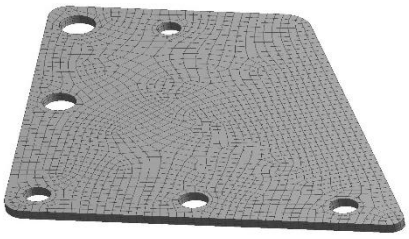

Fig 3. Meshing and Geometry creation of the bracket.

b) Boundary Condition and FEA preparation – The Designed bracket is further gets sets loading as per the practical boundary conditions. As shown in fig 4 notation A consist of fixed cylindrical support and Notation B consist of Bearing Load assigned to the structure.

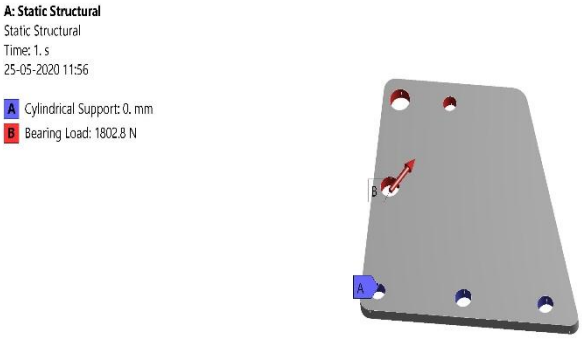

Fig. 4 The boundary condition for FEA modelling.

c) FEA Results – The FEA results shows that induces amount of von mises stress in the structure. Since the induce stress is less than yield strength the design structure is safe.

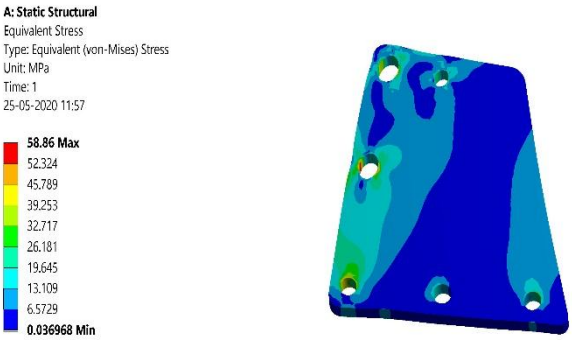

Fig.5. FEA results before TO.

- **Solution Preparation for Topology Optimization.**

The FEA validated structure for Von-Misses Stress is further discretize in 0-1 Pseudo Density variable factor where Orange section shows the removal Mass of the bracket as shown in fig 6.

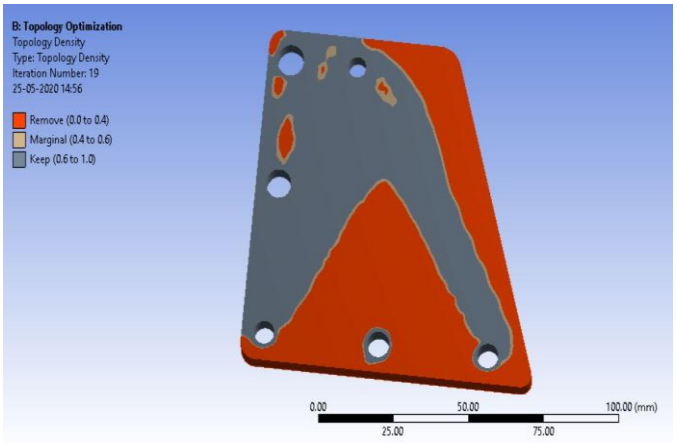

Fig. 6. Pseudo Density discretization.

- **Post-Processing and Design Validation.**

In the view of sustainable and sensible design approach it is necessary to post-process obtained optimize product as looking up the sensible design approach by vatiling out the sharp corner edges and lungus. It is necessary to revalidate our Optimized design bracket to check wether its induscess equivalent stress remains safe within the working design limits. Fig 7 and Fig 8 shows the post process design validation result and Final post process ready to manufacturing Geometry.

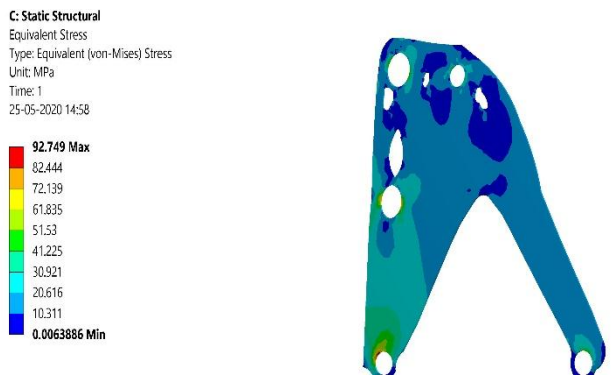

Fig 7. Shows the induce von-mises result in optimize geometry.

Fig. 8. Final post process ready to manufacture optimize design.

5. CONCLUSIONS

In present paper, the detail workflow of topological optimization is explained. The connecting bracket which is made up of structural steel is optimized for its total volume of mass constraint with optimality creation mode of commercial Ansys software. The total mass reduction 60% is obtained through this operation where it has been post process and validated for Additive manufacturing constraints.

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