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Optimization of Front Suspension Shackle Support using Finite Element Analysis

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Abstract - Design of suspension systems for Heavy Trucks is always challenging due to the heavy loads the system is exposed to and the long life requirements for the total system. Topology optimization is used at the concept level of the design process to arrive at a conceptual design proposal that is then fine-tuned for performance and manufacturability. Due to this avoids costly design iterations and time consuming. Hence it reduces design development time and overall cost of improved design performance. A mathematical approach that optimizes material layout within a given design space, and for a given set of loads and boundary conditions such that the resulting structure meets a prescribed set of performance targets. Engineers can find the best design concept that meets the design requirements by using topology optimization. Application of topology optimization has been done with finite elements methods

INTRODUCTION

Optimization carried out by considering space design is the allowable volume within which the design can exist. Assembly and packaging requirements, human and tool accessibility are some of the factors that need to be considered in identifying this space, with the definition of the design space. Regions or components in the model that cannot be modified during the course of the optimization are considered as non-design regions. It will be shown that the optimum topology obtained #rom an example topology optimization process is independent of the material used and the dimension size of the structure. Without considering any cad model Topology optimization is carry out by considering box model.

In this paper describe the how to achieved the optimization of support for more strength, stiffness and less weight. From optimization we got solution near the mass production, design is improve in the weak areas of the part.

THE SETUP PARAMETERS for TOPOLOGY OPTIMIZATION

The side cast support bracket is neatly meshed as in case of the topology optimization the person can assign to the part different densities but cannot move the grid points in to the model.

1. Design variable Geometry
2. Constraints Geometry: Mass of design space <30
3. Objective function (Design function) - Introduced stress below Manufacturing constraint
5. Member Size Control –Maximum or Minimum size
6. Draw Direction Constraints –Drawing parts Direction
7. Design Space –Removal of material.

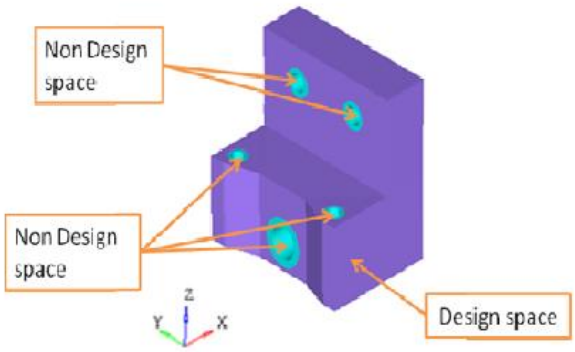

Figure1.Design and non-design space

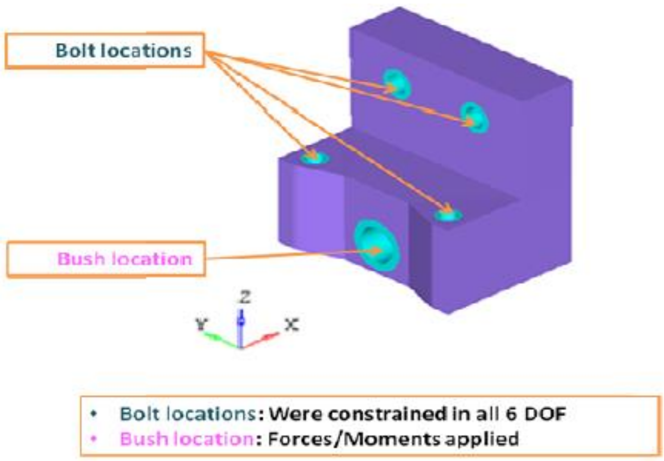

Figure 2.Bolt location and Bush location

Table -1: Summary of Forces/Moments applied for model to be optimized

Magnitude	Vertical	Longitudinal	Lateral	Cross twist	Bogie twist	Slow turning Event
Fx (N)	4882.9	4342.3	8427.2	7510.1	-866.5	-5931.4
Fy (N)	18976.3	21901.5	1731.2	2785.8	-5368.4	-411.2
Fz (N)	-37715.7	-43543.9	-3446.7	-5546.3	10688.2	818.7
Mx (N-mm)	-7	-7.9	-0.5	-0.9	2	0.1
My (N-mm)	-280072	-264441	-649054	-492882	-257676	502312
Mz (N-mm)	335367.6	-309294	-595629	-674952	375537.4	426390

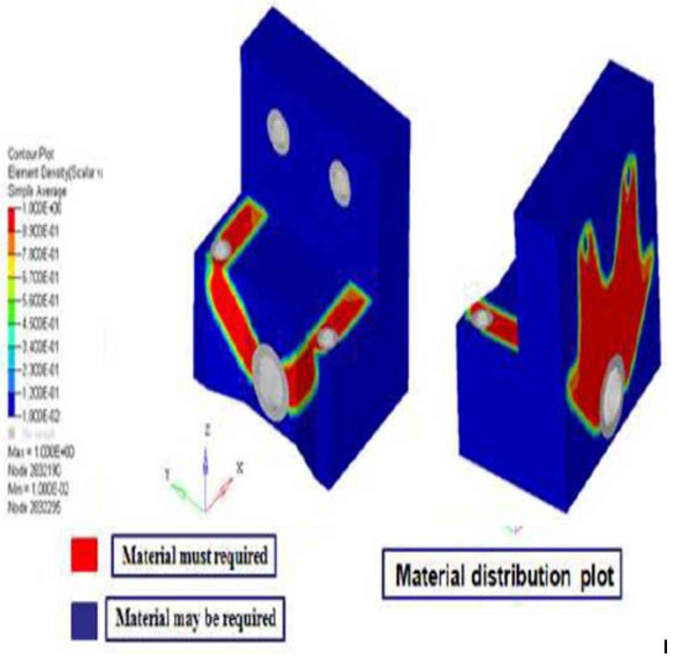

Figure 3. Element density plot

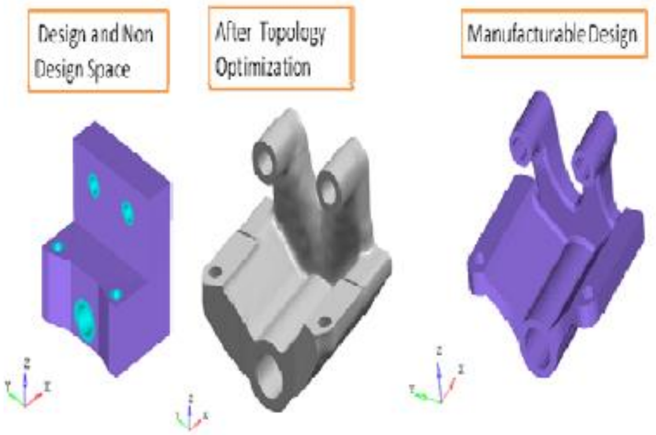

Figure 4. Optimization Results

LINEAR STATIC ANALYSIS OF MANUFACTURABLE DESIGN

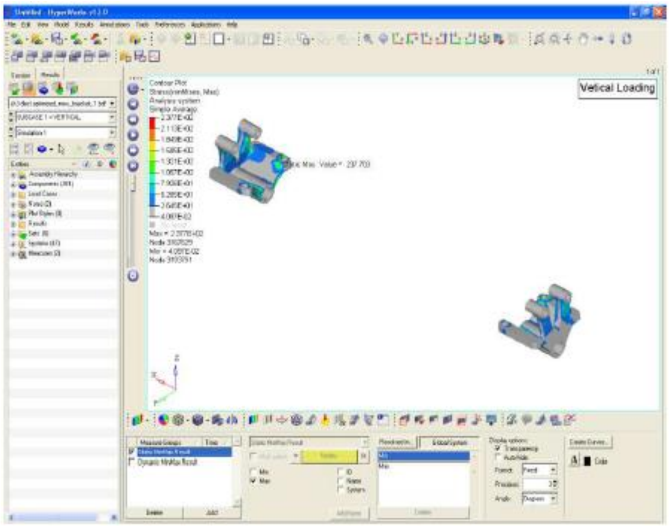

Figure 5.von Misses Stress plot: Vertical Load case

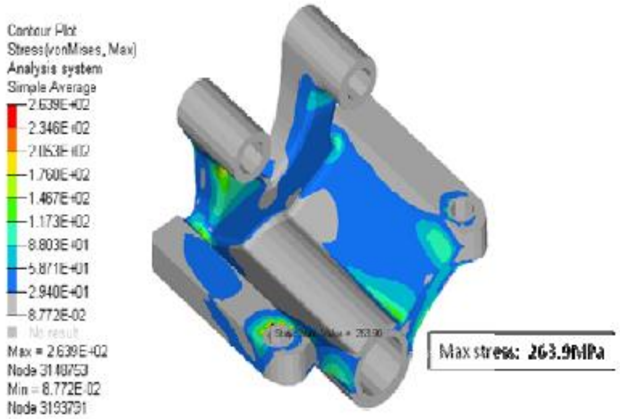

Figure 6.von Misses Stress plot: Longitudinal Load case

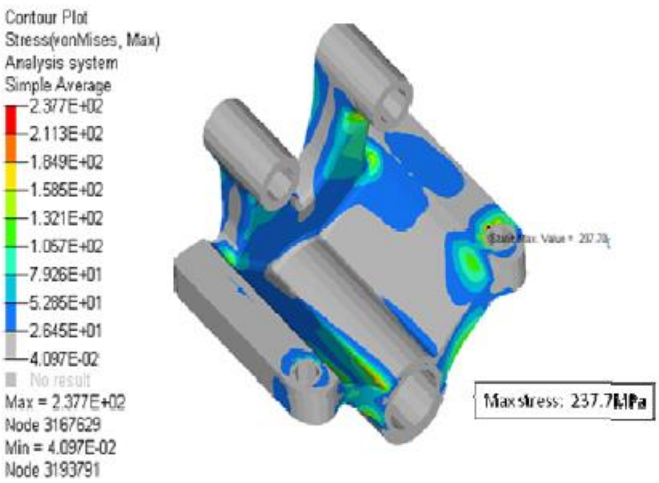

Figure 7.von Misses Stress plot: Vertical Load case

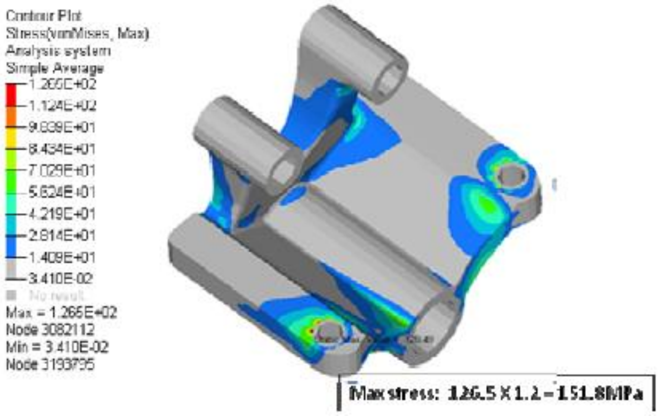

Figure 8.von Misses Stress plot: Lateral Load case

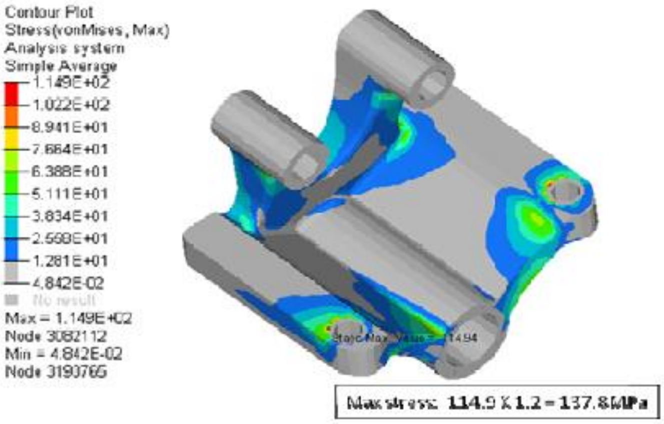

Figure 9.von Misses Stress plot: Cross Twist

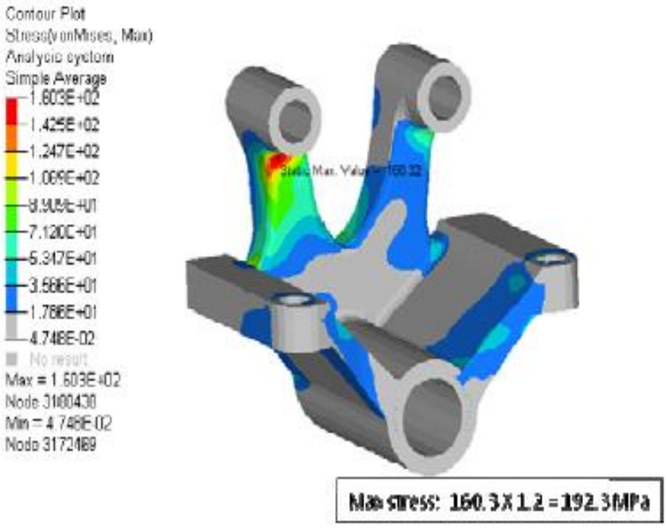

Figure 10. von Misses Stress plot: Bogie Twist

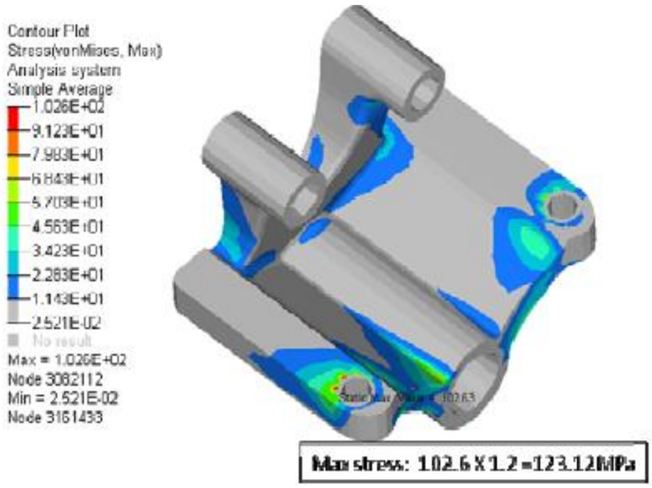

Figure 11.von Misses Stress plot: Slow turning event

RESULT

Table 2. Optimization Result

Load Cases	Permissible stress (Mpa)	Baseline Design(Mpa)	Optimized Design (Mpa)
Vertical	320	478	238
Longitudinal	320	357	264
Lateral	200	342	152
Cross Twist	300	176	138
Bogie Twist	300	355	192
Slow turning event	250	338	123

CONCLUSIONS

To Perform Optimization of a Suspension Shackle support under load cases as per industry standard using topology optimization methodology.

These includes literature review that is to judge to be significant for this analysis, complete modeling of Shackle support.

Following are the conclusions drawn from above analysis report.

1. All the steps of the optimization methodology are described briefly. This method can be used to optimize any kind of structure. The suspension shackle support is optimized to show application of methodology.
2. The topology optimization is advanced function of many analysis software this is the functionality to empower analysis/design specialist with these currently available in the market useful tools to optimize any complicated model.
3. Using this methodology we have saved the material 30%.
4. The optimized Suspension Shackle support is manufacturable and the shape does not interfere with the working of other nearby components.
5. Further, these loads are used in Finite element analysis of suspension shackle support and stresses are found out for every load i.e. longitudinal, vertical, lateral, racking, cross twist and bogie twist results shows maximum stresses are found near holes and corners but are within specified limits.

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