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Research Article

Design and Analysis of a Car Bonnet

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Abstract

Bonnet is main component of a car at the front portion. It is used to decorate the car and add luxurious look. The shape of the bonnet is made aerodynamic in order to minimize the air effect. Bonnet is generally used to access the parts easily such as radiator, engine and many other parts. In automotive world the weight optimization plays an important role. In this paper material changes is applied to the bonnet for the same design and finally showing the stiffest bonnet and less weight component. For designing the hood 3D model CATIA V5 R19 is used, then import the cad model in to hypermesh and pre-processing is done using Hypermesh, solver is Optistruct Fea which helps to do the analysis for hood. For results visualization Hyperview and HyperGraph is chosen

Keywords: *Hood, steel AISI 1045, Aluminium 6061, Inner panel, outer panel, Hypermesh*

1. Introduction

In recent years, the work has been done on the bumper and hood design of the vehicle front end to reduce the injuries to the pedestrians in the event of a pedestrian vehicle collision. The front portion of the vehicle gets damaged including bonnet when met with an accident. So there is need to change the existing design of bonnet or by changing the material. The bonnet is the hinged cover over the engine of motor vehicles that allows access to the engine compartment for maintenance and repair. Bonnet usually do not directly open onto the passenger cell which greatly reduces the importance (weighting) of certain of the functional requirements normally associated with closures such as air tightness, passenger safety, low cycle fatigue strength etc. The objective of these measures is to reduce the number of road accident fatalities and the severity of injuries sustained by pedestrians involved in a collision with a vehicle in urban traffic. Impact frequency and seriousness of injury has been studied for many years, resulting in rating systems and improved design.

The bonnet system is an access panel to the engine compartment to enable maintenance of power train, drive belts, battery, fluid levels and lamp units. It is fundamentally a reinforced skin panel with many safety and quality requirements.

2. Literature Survey

Masoumi studied comparison of steel, aluminium and composite bonnet in terms of pedestrian head impact. In this paper a new finite element model has been developed which is capable to simulate head impact phenomenon between head form impactors and composite bonnet. Then the behaviour of three identical bonnets made of steel, aluminium and composite have been investigated by the developed model. It is shown that the energy absorption of aluminium bonnet is smaller than steel and composite ones and for keeping the aluminium bonnet at the same level of stiffness, it is necessary to increase the thickness.

3. Modeling

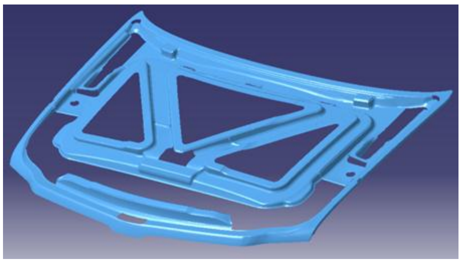


Fig.1: Inner panel

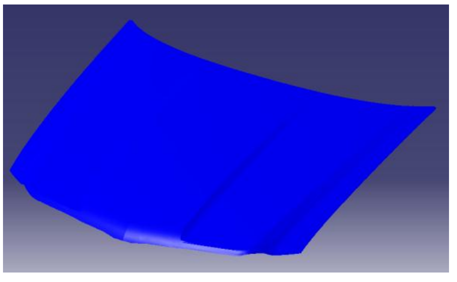


Fig.2: Outer panel

*Corresponding author **N. Bhaskar** is a PG student **and P. Rayudu** is working as Associate Professor

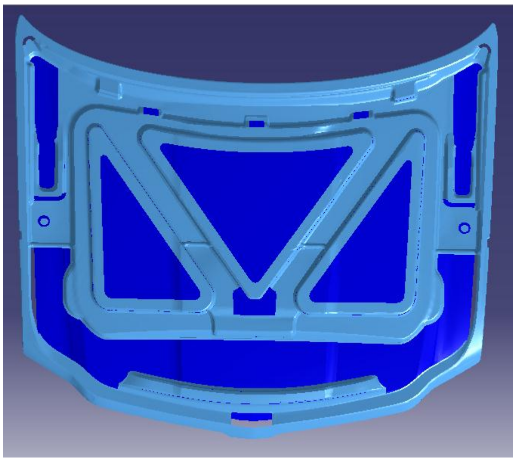


Fig.3: Assemble of inner and outer panels

4. Material selection

The material selection is based on the properties and strength of material.

Table 1 Material properties

Property	Steel AISI 1045	Al 6061
Density(Kg/m^3)	7850	2700
Poisson's ratio	0.3	0.33
Young's modulus (MPa)	21000	70000
Yield strength (MPa)	505	275
UTS (MPa)	585	310

5. Meshing

The CAD model imported into Hyper Mesh V13 for Pre-processing. 2D shell mesh used for meshing of the component. Hypermesh Optistruct is used to create mid surface of the component and shell mesh is done the mid surface. 2D shell mesh is used if the component has less than 10mm thickness.

Mesh: 2D Mesh
Mesh type: Shell mesh
Mesh element: mixed (Quad and trias)
Element size: 10

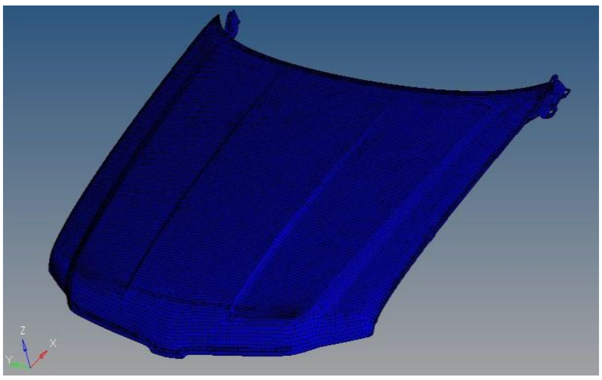


Fig.4. Meshed model of hood

6. Loads and boundary conditions

6.1 oil canning analysis

Oil canning analysis is used to find local stiffness of hood at the position where the load is applied. Hood hinges, front corners and latch points are the boundary conditions for this analysis. Hood hinges is fixed in five degrees of freedom leaving rotational motion in x-direction. Latch point and front corners are fixed in all degrees of freedom. The load applied for this analysis is 2370 N in z-direction downward.

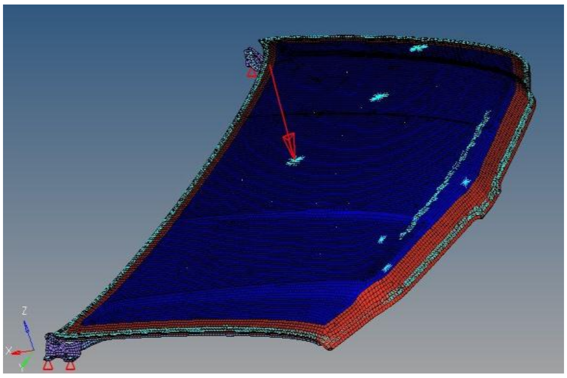


Fig.5. Oil canning analysis

6.2 Torsional stiffness analysis

Torsional analysis is done on the hood to find out the torsional stiffness of the hood. The boundary conditions are hinge points, front corners and latch points. At hinge positions and front corner opposite to load applied are all degrees of freedom fixed. At latch point three translation motions are fixed and three rotational motions are free. The load for this analysis is 2370 N in z-direction downward.

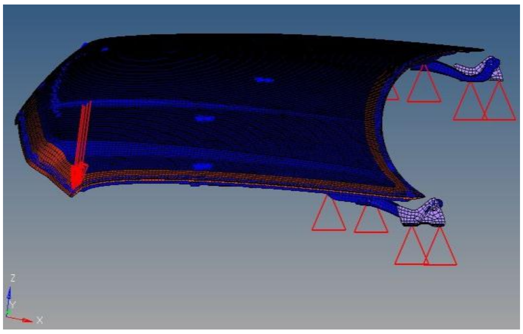


Fig.6. Torsional stiffness analysis

6.3 Lateral stiffness analysis

Lateral stiffness analysis is done on hood assembly to find lateral stiffness of hood. The boundary conditions are hinge positions and front corners. The hood hinges are fixed in all degrees of freedom and one corner of front side is also fixed and load is applied on the other side. The load for this analysis is 2370 N in X-direction.

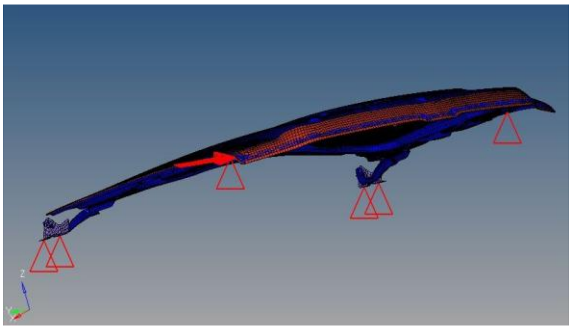


Fig.7. Lateral stiffness analysis

7. Results

Oil canning results

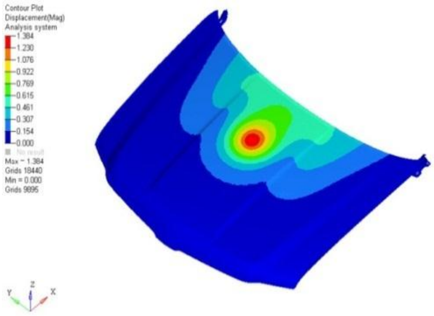


Fig.8. Displacement of base design

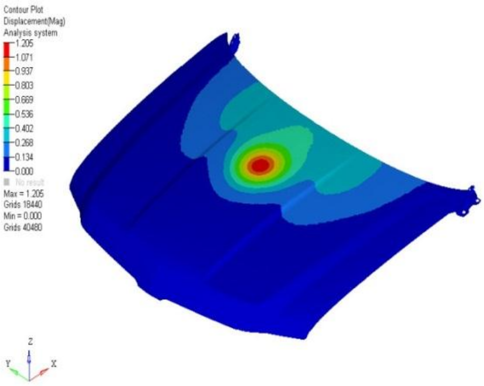


Fig.9. Displacement of design 1

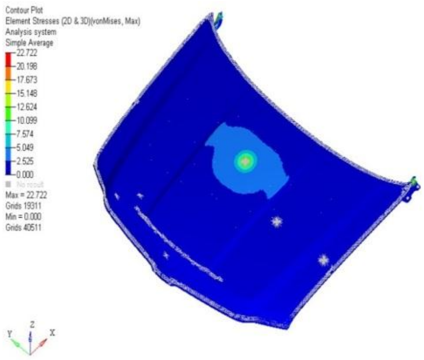


Fig.10. Von mises stress of base design

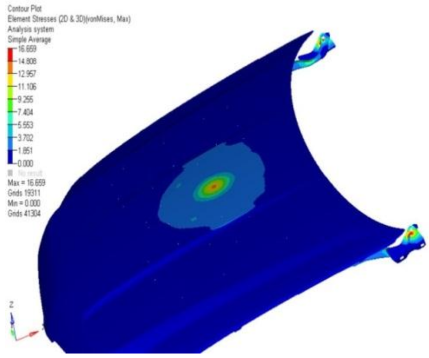


Fig.11. Von mises stress of design 1

Torsional stiffness results

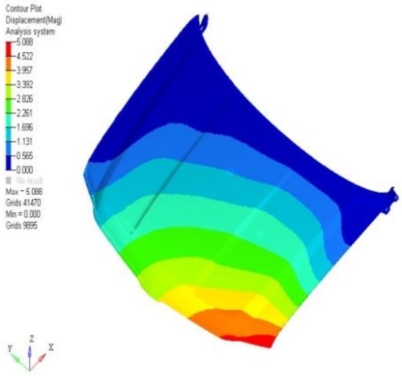


Fig.12. Displacement of base design

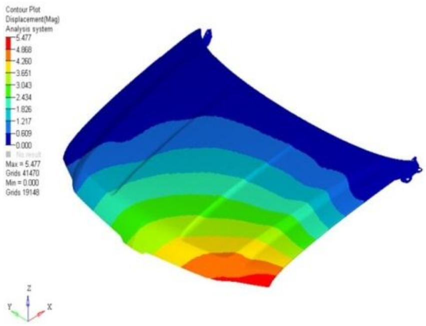


Fig.13. Displacement of design 1

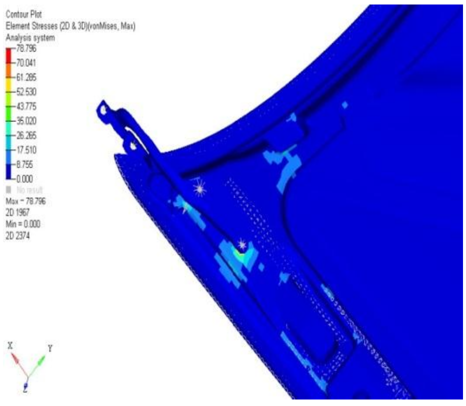


Fig.14. Von mises stress of base design

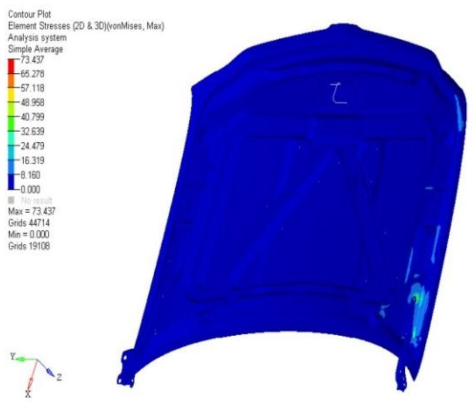


Fig.15. Von mises stress of design 1

Lateral stiffness results

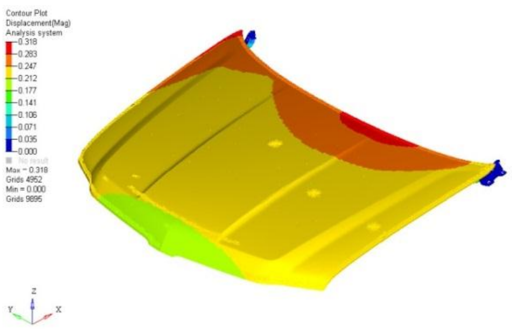


Fig.16. Displacement of base design

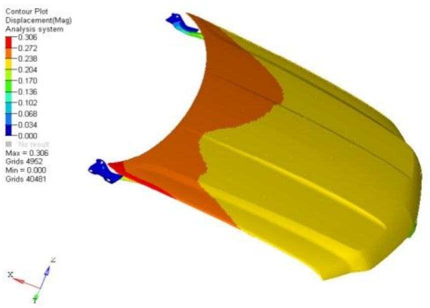


Fig.17. Displacement of design 1

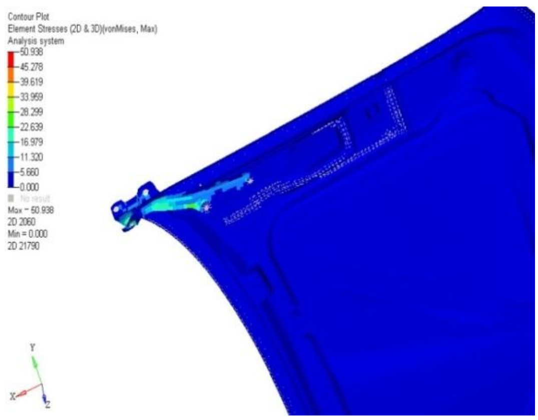


Fig.18. Von mises stress of base design

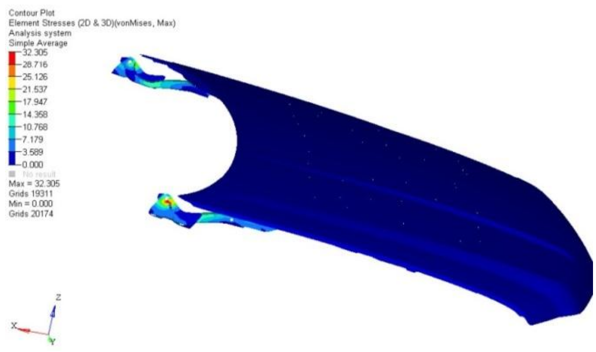
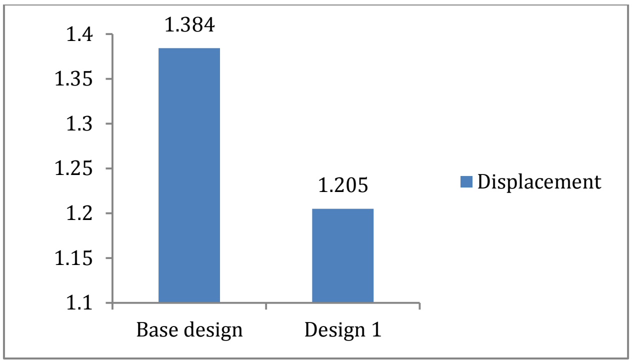


Fig.19. Von mises stress of design 1

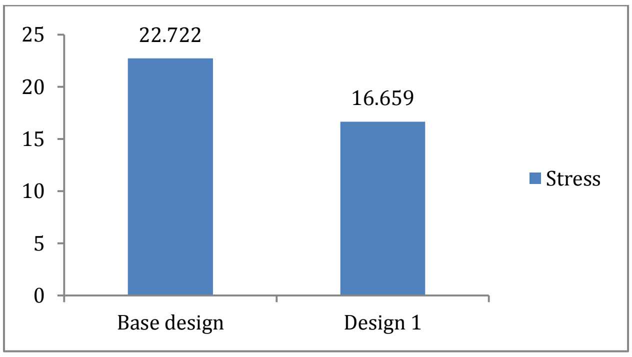
Table 2 Tabular results for analyses

Analysis		Designs	
		Base design	Design 1
Oil can analysis	Displacement (mm)	1.384	1.205
	Stress (MPa)	22.722	16.659
Torsional stiffness analysis	Displacement (mm)	5.088	5.477
	Stress (MPa)	78.796	73.437
Lateral stability analysis	Displacement (mm)	0.318	0.306
	Stress (MPa)	50.938	32.305

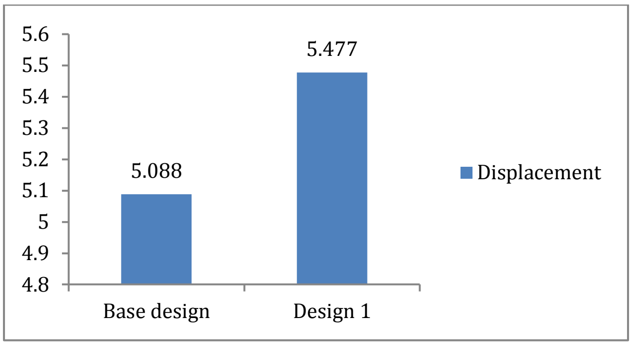
The comparisons are made between base design and design 1 with designs, displacements, weight reduction and stress reduction



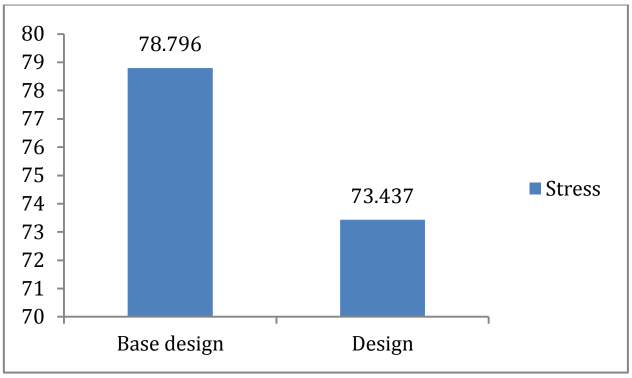
Graph 1: Displacement comparisons of oil can analysis.



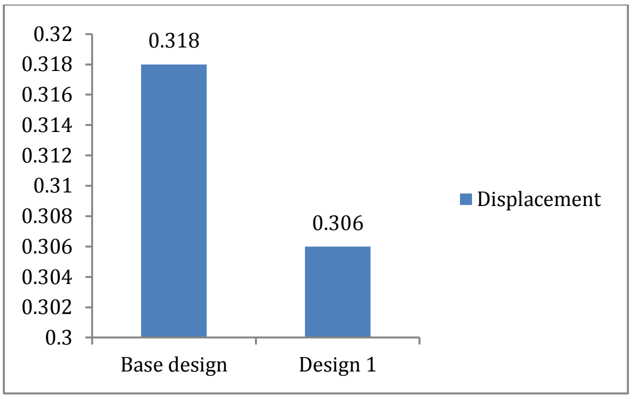
Graph 2: Stress comparisons of oil can analysis.



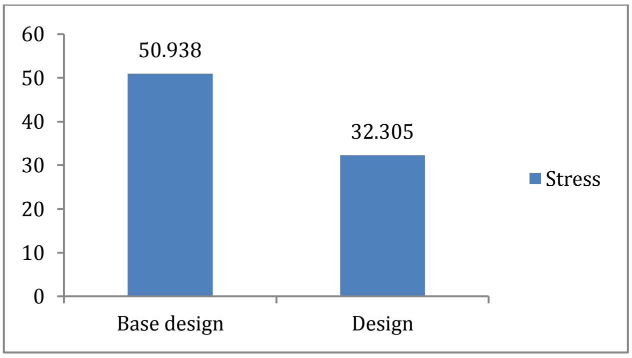
Graph 3: Displacement comparisons of torsional stiffness analysis



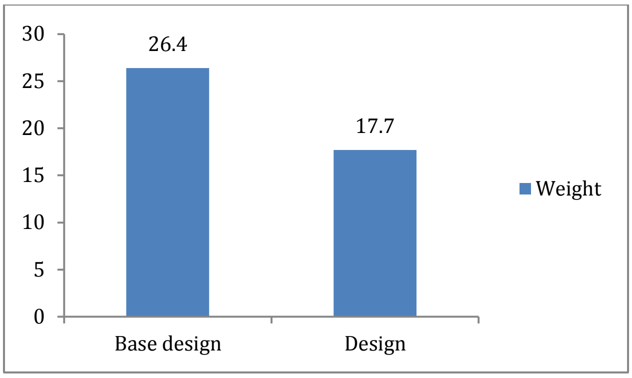
Graph 4: Stress comparisons of torsional stiffness analysis



Graph 5: Displacement comparisons of lateral stiffness analysis



Graph 6: Stress comparisons of lateral stiffness analysis



Graph 7: weight comparisons of designs

Conclusions

Comparing the both the designs, design 1 has

1) Highest weight reduction **36.95%**

2) Highest stress reduction **36.57%**

3) Negligible displacement increment in lateral stability analysis.

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