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Modelling, Design and Analysis of Car Bonnet Assembly – Mechanical Design Process

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Abstract : Bonnet is one of the main important components of a car at the front portion used to decorate the car and to add luxurious look. The shape of the bonnet is to be made aerodynamic in order to minimize the drag. Bonnet is used as a shield/cover to access the parts such as radiator, engine and many other components, hence the design is made in such away so that it can be easily accessible. In this project work, different materials were used for the same bonnet design and ultimately arrived at a conclusion for the stiffest bonnet. The static structural analysis is carried out on engine hood to evaluate the stresses and displacements induced in the car bonnet assembly for two different materials and the obtained results were interpreted. For designing the hood, geometric model was created using CATIA V5 R20, 3D modeler and then CAD model was imported into Hypermesh for meshing. The static and modal analysis was carried out for bonnet assembly using NASTRAN. The obtained results were viewed using Hyperview.

IndexTerms **- Car Bonnet, structural analysis, CATIA V5 R20, Hypermesh, Msc NASTRAN.**

I. Introduction

Car bonnet is the important component which is utilized for several purposes at the front. It gives access to the engine compartment which enable the repair and maintenance of many parts namely car engine, radiator etc. Therefore bonnet must be designed in suitable manner and it should minimize the hindrances from the disturbance caused by the external environment on the hood and its components below it. When the car is in running condition, the resisting forces from the air acting on the hood therefore the design of the bonnet should be made aerodynamic to reduce the air resistance. Hood assembly includes inner panel, outer panel, hinges, latch and reinforcements. The upper and stiffener panels are joined through the process of hemming or both panels are joined by using the adhesive namely mastic. Spot weld can be made where it will be necessary. Sandwich construction of the hood structure that will increases the capability of the hood’s ability to absorb the energy impacted by the external forces which are acting on the bonnet. The bonnets of the most vehicles are basically fabricated using the sheet metal structure, a good energy absorbing structure so it causes substantially a small threat. Outer and inner stiffener panels are made or fabricated by using the of sheet metal structures therefore environment used is surface modeling. Since the hood assembly is a sheet metal component, hood structure is vulnerable to the vibrations. The source of the vibrations could be the engine generated vibrations, the vibrations due to the un-evenness in the road surface, and aerodynamic interactions of the hood surface when the vehicle is in motion. Excessive vibrations will put an impact on the passenger's ride comfort, and also make the structure susceptible to fatigue failure. Too many vibrations also affect the functioning of the locking mechanism of the bonnet, considerably risking the unlocking function and bonnet will be open up while the vehicle is in motion. Because of the many ongoing efforts are to reduce the weight of the vehicle, the thickness of the bonnet is being reduced to its possible values. This could considerably increase the severity of the vibrations that the structure is subjected to. Hence, determining the fundamental frequencies of the bonnet structure and its behavior at those frequencies is necessary.

II LITERATURE SURVEY

‘Mahesha J, Prashanth A S’, studied on Design Verification Procedure (DVP) Load Case Analysis of Car Bonnet. The hood assembly is analysed for the strength assessment with various DVP load cases. The nonlinear static structural analysis is conducted on the bonnet design to obtain results of stresses, displacement and plastic strain induced in the hood components. They applied material non linearity and contact non linearity. The base line model is analysed, and from the the results obtained, the various methodology for optimization like shape topology and thickness operation carried out on the hood inner to in order to minimize the overall weight of the bonnet assembly.

‘D. Costi, E. Torricelli, L. Splendi and M. Pettazzoni’ the present work carried is, They adopted the optimization methodology for the 3D hood structure. They represented a methodology which minimize the weight of the inner stiffener panel i.e. weight optimization. various optimization namely topography, topology, size and topometry which are combined, at the meantime redesigning of the existing hood inner panel is done without compromising the performance and efficiency. The weight is reduced with respect to the manufacturing constrains. The target is designing the internal frame parts made of aluminium of the assembled engine bonnet keeping the same performance of the car model and reducing the car weight at the same time.

III METHODOLOGY

First the Geometric model of car bonnet is created by using CATIA V5 R20 and then the model is imported to the Hypermesh for Meshing, Boundary and Loading conditions are incorporated simultaneously and material properties are assigned and then static structural and modal analysis is performed with the help of NASTRAN software. Post processed results were plotted using the Hyperview.

IV GEOMETRY MODELING

The car hood assembly consists of outer and inner panel, hinge and it's reinforcements, latch and it's reinforcements. The CAD models of all the components were created by using the CATIA V5 R20.

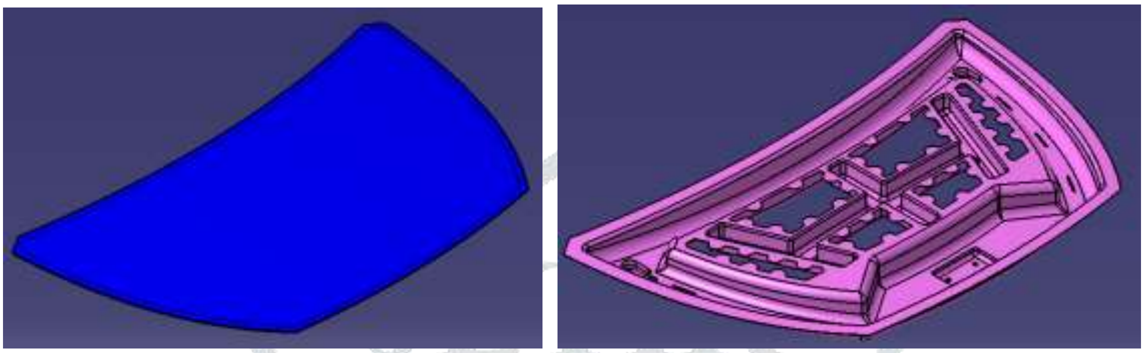

Fig. 1 : Outer & Inner Panel

V FE MODELING

Finite element modeling is done with the help of meshing software Hypermesh V13.0. The Quad and triangle elements are used to mesh FE modelling of all hood components. The total no. of elements in the hood assembly is found to be 24317 and the total no. of nodes is found to be 24352 and the Element size is 10mm.

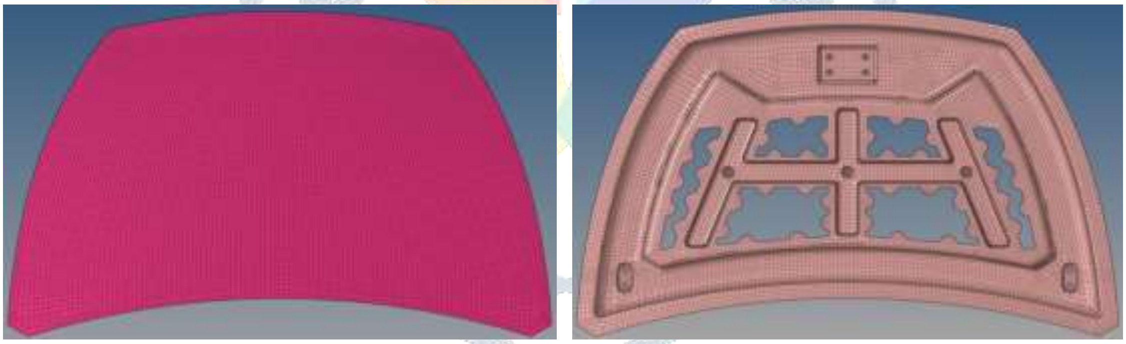

Fig. 2 : Outer & inner panel FE model

VI. STATIC STRUCTURAL ANALYSIS

Static structural analysis on the hood, oil canning, torsion analysis is done in order to get local, torsional stiffness of the 3D hood assembly respectively.

VII. OIL CANNING ANALYSIS

The oil canning is done on outer panel of 3D hood design to find the local stiffness of the hood. The stiffness detected is at the location the point load is acting. The boundary condition for oil canning are hood hinge and latch points. Hinges are constrained in 5 DOF without constraining rotational motion in x-direction. Hood Latch points are constrained in all DOF. At Hinges all 5 DOF i.e. rotation RY, RZ and translation UX, UY, UZ are arrested without fixing the rotation RX direction. At Latch in the hood all the six degrees of freedom including RX is arrested. The loading for the analysis work applied at weak locations of the bonnet design and weak location in the design is determined by the modal analysis. Oil canning analysis is done for region which is having maximum deformation in the modal analysis results. A load value of 50N, 100N is applied in the weak spot along the Z-direction. Table 1 gives the Load and boundary conditions.

VIII. MATERIAL PROPERTIES

Property	'Steel AISI 1045'	'Aluminium 6061'
Youngs modulus (MPa)	21000	70000
Yield strength (MPa)	505	275
Density (Kg/m^3)	7850	2700
Poisson's ratio	0.30	0.33
Ultimate tensile strength (MPa)	585	310

Table 1. Load and bounadary conditions

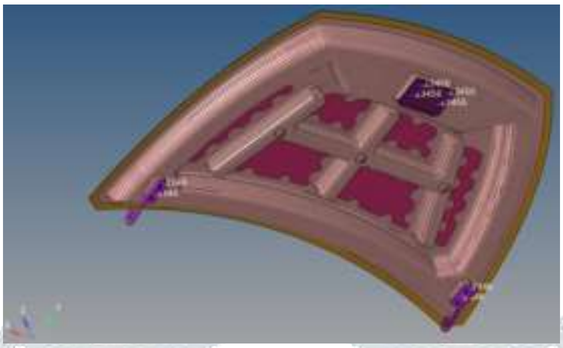

Fig. 3. Oil canning boundary condition

IX. TORSIONAL STIFFNESS ANALYSIS

This analysis is conducted on the 3D hood design in order to determine the torsional stiffness. Boundary conditions for the following analysis are front corners, hinge and latch points. At the hinges all the DOF i.e. translation and rotation about three directions X, Y, Z are constrained. At the latches 3 translation i.e. UX, UY and UZ were fixed and three rotation RX, RY and RZ are free. At front corners, one corner is constrained in all DOF, and at the other corner, load values of 100N and 250N were applied in the Z-direction.

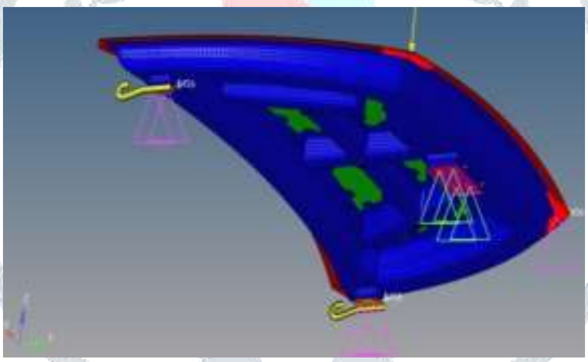

Fig. 4. Torsional stiffness analysis Boundary condition

X. MODAL ANALYSIS

To perform modal analysis boundary conditions are Hinges and latch. At Hinges all the 5 DOF namely rotation RY, RZ and translation UX, UY, UZ are fixed without arresting the rotational motion RX. At Latch in the hood all the 6 DOF including RX is constrained.

XI. CONCLUSIONS

In this paper, we have presented the car design assembly detailed processes. Bonnet is one of the main important components of a car at the front portion used to decorate the car and to add luxurious look. The shape of the bonnet is to be made aerodynamic in order to minimize the drag. Bonnet is used as a shield/cover to access the parts such as radiator, engine and many other components, hence the design is made in such away so that it can be easily accessible. In this project work, different materials were used for the same bonnet design and ultimately arrived at a conclusion for the stiffest bonnet. The static structural analysis is carried out on engine hood to evaluate the stresses and displacements induced in the car bonnet assembly for two different materials and the obtained results were interpreted. For designing the hood, geometric model was created using CATIA V5 R20, 3D modeler and then CAD model was imported into Hypermesh for meshing. The static and modal analysis was carried out for bonnet assembly using NASTRAN. The obtained results were viewed using Hyperview. To conclude, the car design assembly detailed processes was presented in this paper.

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