International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 07
March 2018

Finite element analysis of internal door panel of a car by considering natural composites

B.Durga[1], G. Samba Siva Rao[2], K .Venkateswara Rao[3]& K.V.Kalyani[4]
[1] M .Tech - Machine Design student, Sir CRR College of Engineering, ELURU, India.
[2] Principal, Sir CRR College of Engineering, ELURU 534007, Andhra Pradesh, India.
[3]Professor, Department of Mechanical Engineering, Sir CRR College of Engineering.
[4]Asst.Professor, Department of Mechanical Engineering, Sir CRR College of Engineering.

Abstract:

In this paper work the dynamic structural Finite Element Analysis of internal door panel of a vehicle by considering Delonix Regia Seed Shell (DRSS) powder, coconut shell powder, orange peel powder and kneaf fiber composite materials was conducted. The objective of the paper is to develop a suitable model of internal door panel for Toyota DX car, to conduct a transient dynamic structural analysis (stress and deformation analysis) of internal door panel by finite element method, to compare the performance of DRSS powder, coconut shell powder, orange peel powder and kneaf fiber composite materials of internal door panel. The door panel of Toyota Corolla DX model vehicle was used to develop the geometric model of the internal door panel by CATIA V5 R20 modeling software.
This 3-D geometric model was imported to using ANSYS Workbench 14.5. The transient dynamic structural FEA was done after assigning loading and boundary conditions. The applied load considered for this analysis is the self-inertial weight of the panel due to the acceleration field produced while the door is closing. The equivalent stress and the deformation are noted and investigated to compare with the literatures revised. The result shows that, DRSS powder reinforced polyester composite panel has the smallest equivalent stress and deformation values, as compared with the other. Based on these outcomes, it is recommended that DRSS powder reinforced with polyester composite materials are suitable for internal structural automotive panel applications.

Keywords

DRSS powder, Coconut shell powder, Orange peel powder, Kneaf fiber, Polyester, Composite, Door panel, Transient structural analysis, Equivalent stress, Deformation, Finite element analysis.

1. Introduction:

In order to conserve natural resources and economize energy, weight reduction has been the main focus of automobile designers and manufacturers in the present scenario. Weight reduction can be achieved primarily by the research of better material, design optimization and better manufacturing processes. Due to rise in demand of lightweight and more efficient vehicles and better mechanical performance of materials in automotive applications, different material combinations such as composites, plastic and light weight metals are implemented on different structural parts of vehicles. Applications of composite materials in automotive industries already include some structural parts, such as dashboard, roof, floor, front and back bumper, passenger safety cell and door panels [1].
The internal door panel of an automobile is typically made of different materials. Unlike the materials used on the exterior side of the vehicle door, the material on the interior side serves a greater purpose other than just aesthetic appeal. The internal door panel of an automobile contributes to the overall functionality and ergonomics of the ride, such as: armrests, various switches, lights, electronic systems like the window controls and locking mechanism; etc. [2].
Composite materials made of natural fibers and polymer matrix provides synergistic properties, improving their strength and durability. These materials are suitable for achieving automotive interior components, where in addition to their low weight have also high rigidity and good thermal and sound insulation. The most important internal vehicle elements include car internal door panels.

2. Materials and Methods:

In this analysis, the DRSS powder/polyester composite, coconut shell powder, orange peel powder and kneaf fiber composite materials with a considerable composition are used as the materials of internal door panel of an automotive.

During selecting the material, the characteristics of the composite, the ways of fiber extraction, the ease of the manufacturing process, the types of the matrix used for the composite and some other criteria are taken into consideration. In addition to this, the selection of the material for this specific research work is basically focusing on the DRSS powder, coconut shell powder, orange peel powder and kneaf fiber composites and the researches which have previously done on it. [1-5]

Figure1. The internal door panel of Toyota Corolla DX model vehicle

3. Modeling and Analysis:

The following steps are used in the solution procedure using
ANSYS Workbench software for transient structural Finite Element Analysis:

1. Imported the geometry of the panel from modeling software to the ANSYS workbench.
2. The material type and its properties are specified.
3. Meshing the imported panel model.
4. The boundary conditions and external loads are applied.
5. The solution is generated based on these input parameters.
6. Finally, the solution can be displayed.

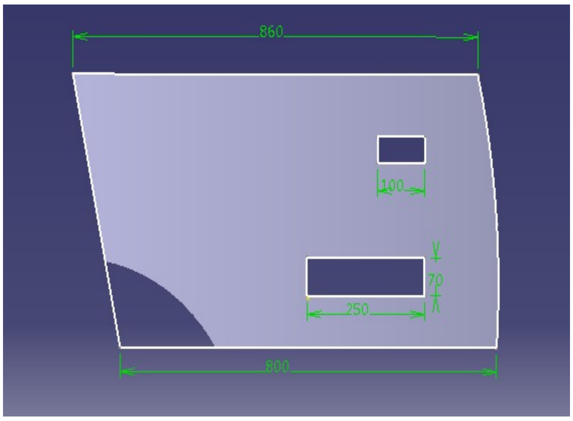


Figure2. The 2D drawing of the internal door panel

(All dimensions are in mm)

Table1. Material Type and Input Properties

Materials	**Density [g/cm3]**	**Tensile strength [MPa]**	**Elastic Modulus [GPa]**	**Poison's ratio**
Kneaf fiber composite	1.4	14.87	0.971	0.192
Coconut shell powder composite	1.23	28.4	0.856	0.157
Orange peel powder composite	1.26	27.87	0.840	0.136
DRSS powder composite	1.22	29.85	0.845	0.169

The internal door panel has several areas where constraints are applied as follows:

- Upper part rests on a metal door structure, thus blocking shifting on the y direction (U2).
- In screw mounting areas shifting are blocked on all three directions (U1, U2 and U3).
- On clips systems panel mounting metal structure areas, shifting are blocked on all the three directions (U1, U2 and U3).

Where, U1, U2 and U3 are the displacements in x, y and z directions, respectively.

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 07
March 2018

These boundary conditions and constraints can be applied on the imported model in ANSYS Workbench.

4. Results and Discussion:
The transient structural dynamic analysis determines characteristics of the stress and deformation of the structures (the panel) caused by the applied loading systems and boundary conditions (Figures 3-13).

5. Discussion:
This transient structural dynamic analysis of the internal door panel of a vehicle using natural composites was performed for self-weight inertial load intensity of the shock produced while closing the door. Comparing the results obtained by FEA of the all natural composite panels. The comparison is carried out by making everything the same, except the material properties; i.e. at the same acceleration field (150 mm/s2) in the same model and the same method of FEM analysis (Figure 5).

6. Equivalent (Von-Mises) stress:
The results of this analysis show that the equivalent (Von-Mises) stress of the DRSS powder composite panel is the smallest one as compared to that of other natural composites. This implies that DRSS powder material is less stressed and thus, has a better performance.

7. Deformation:
This analysis shows that, the maximum displacements of the DRSS powder reinforced polyester composite panel have the lowest value. This values displacements decrease is due to the greater rigidity of DRSS powder reinforced polyester composite material.
The smaller mass of the DRSS powder reinforced polyester composite panel helps to make the vehicle lightweight, so that the efficiency and fuel economy of the vehicle is improved by reducing its dead weights.

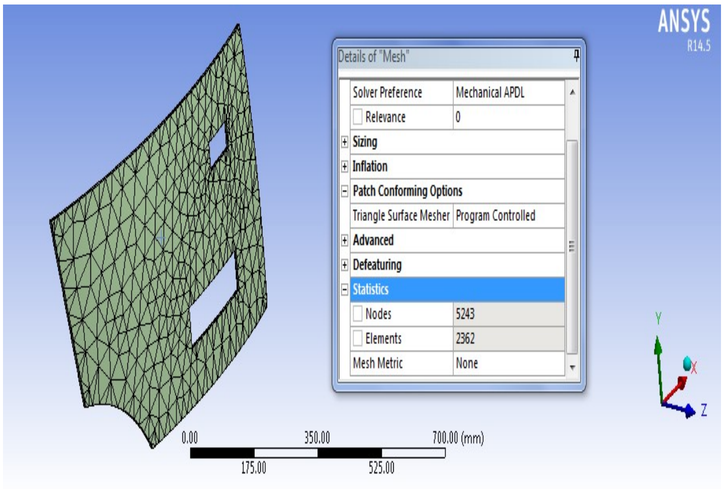


Figure3. Geometric Meshing of the left rear internal door panel model on ANSYS Workbench

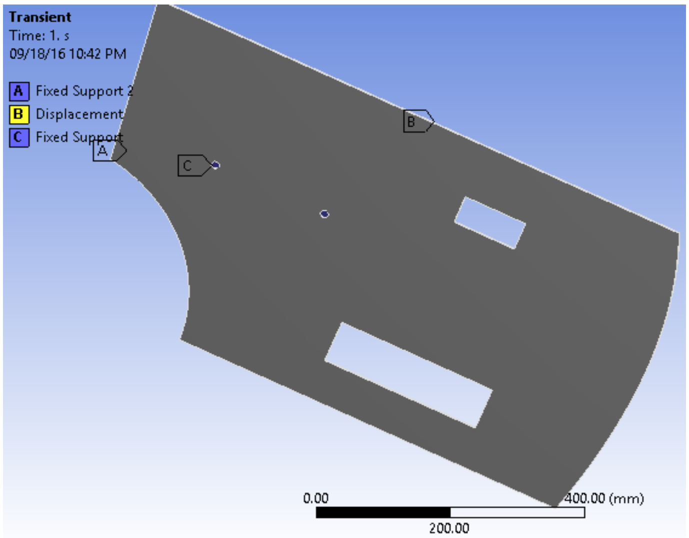


Figure4. Applying boundary conditions on ANSYS Workbench

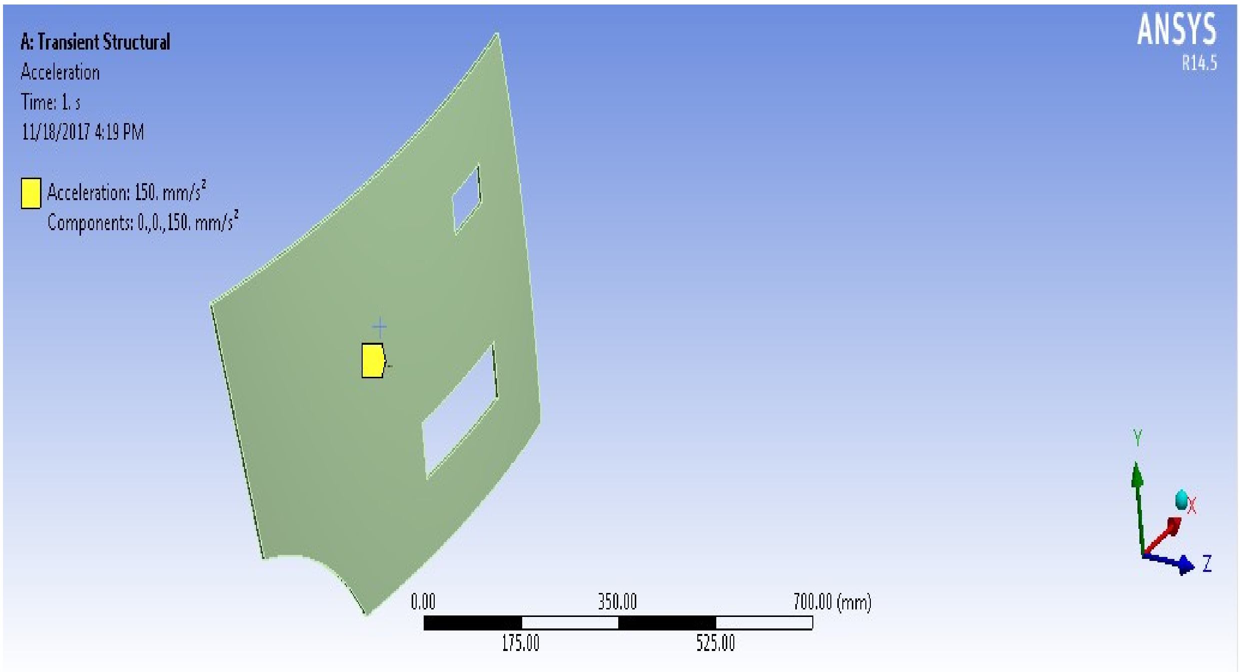


Figure5. Application of acceleration field due to inertial load on ANSYS Workbench

Equivalent (Von-Mises) stress and Deformation

The equivalent (Von Mises) stress and deformation values of rear left internal door panels of all composites FEA are shown in the following figures.

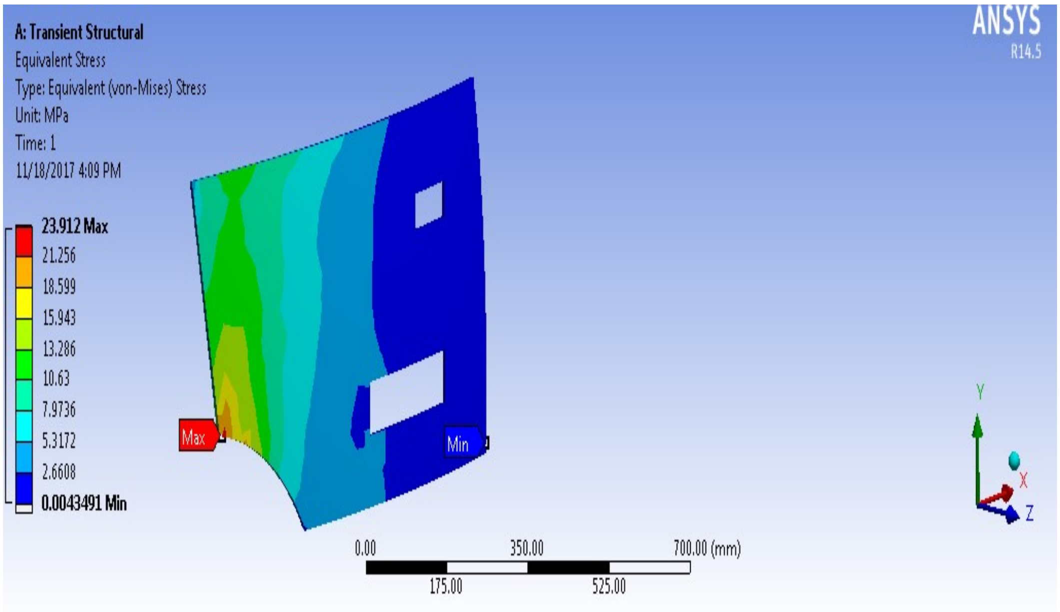


Figure6. DRSS powder composite Von-Mises stress

International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 07
March 2018

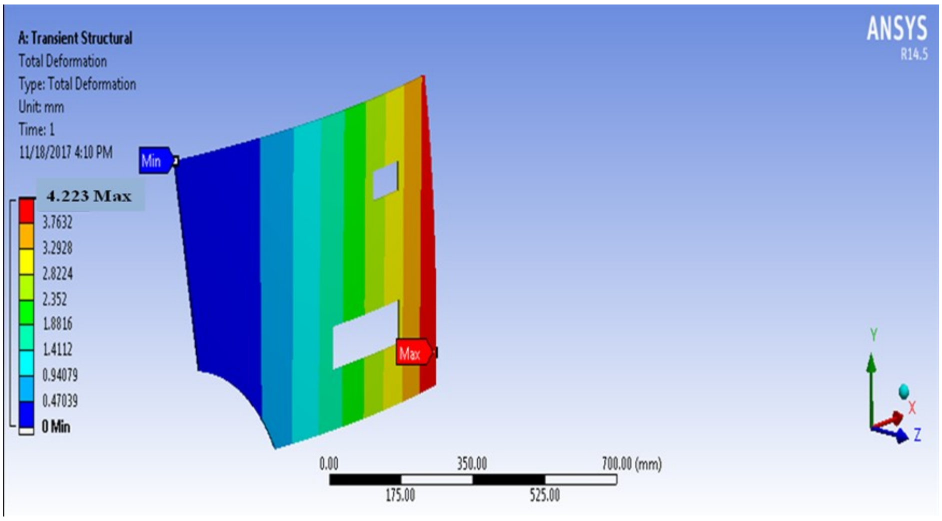


Figure7. DRSS powder composite Total Deformation

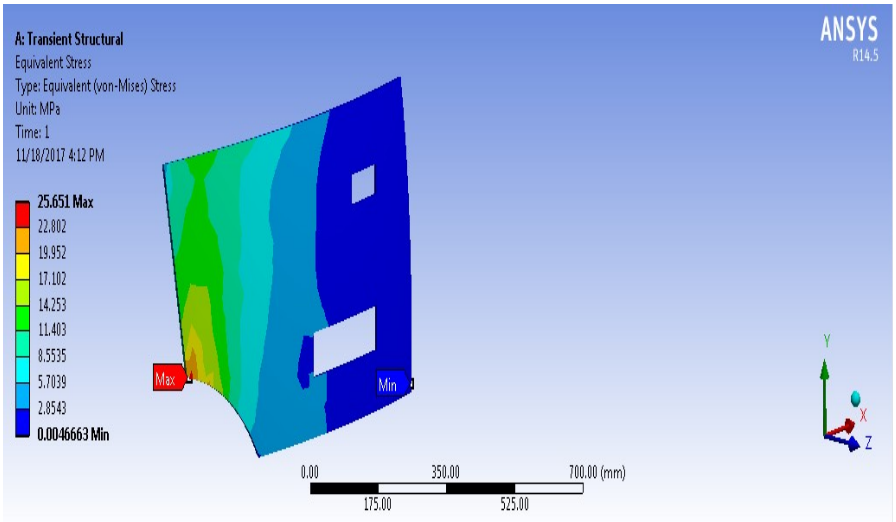


Figure8. Orange peel powder composite Von-Mises stress

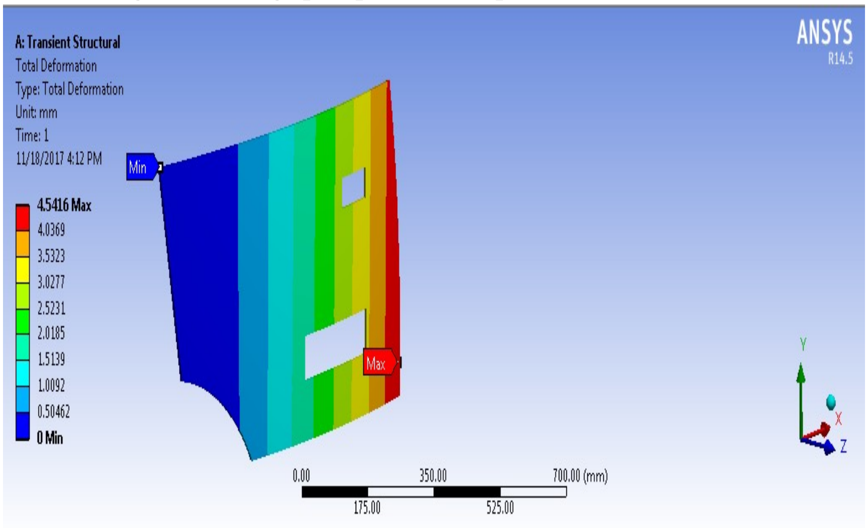


Figure9. Orange peel powder composite Total Deformation

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 07
March 2018

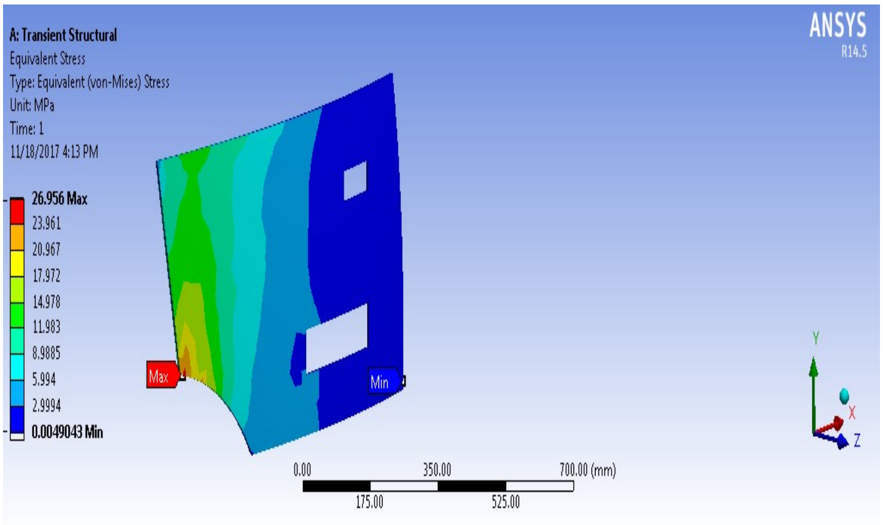


Figure10. Kneaf fiber composite Von-Mises stress

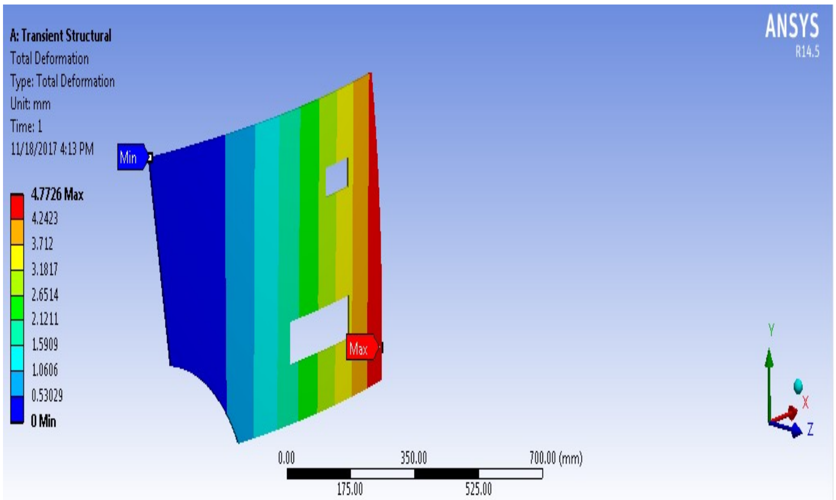


Figure11. Kneaf fiber composite Total Deformation

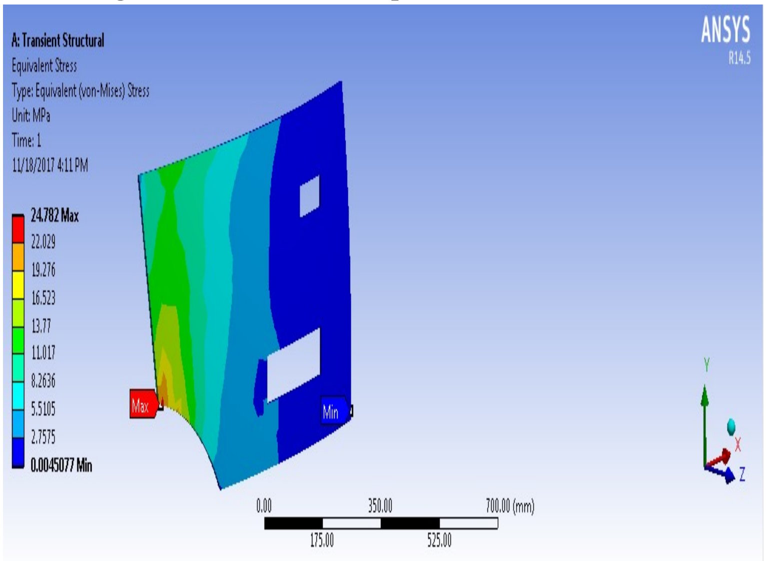


Figure12. Coconut shell powder composite Von-Mises stress

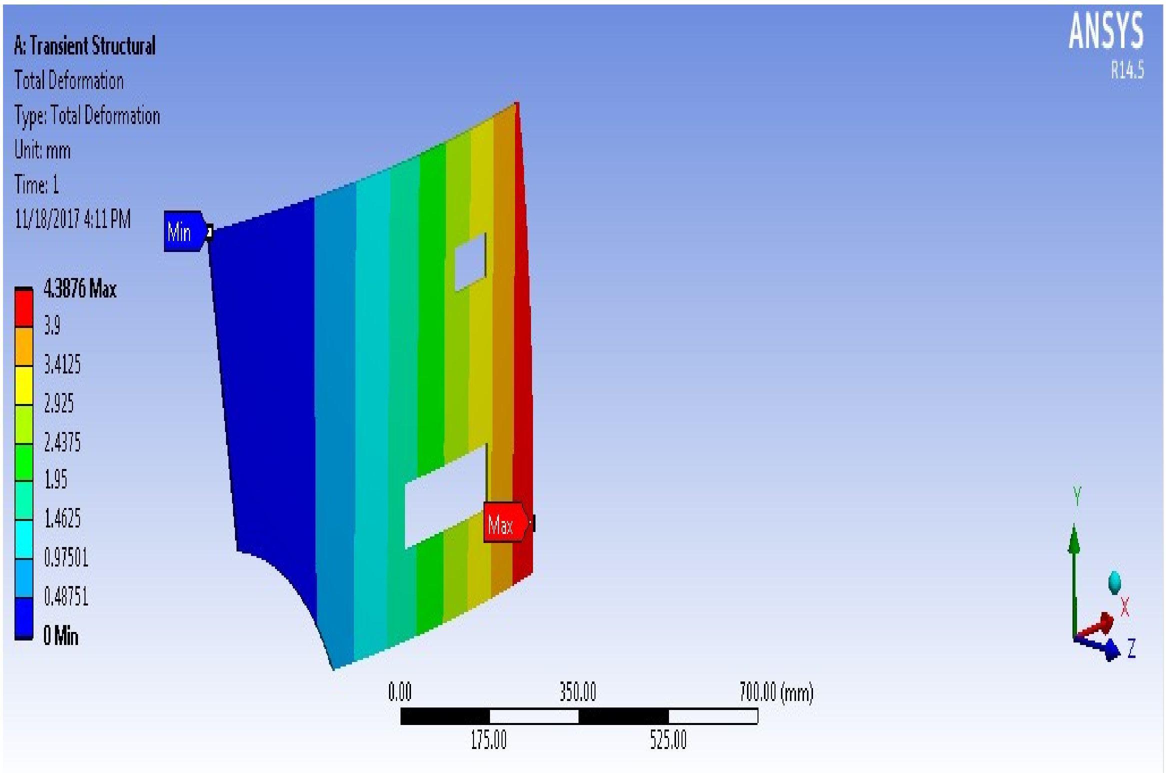
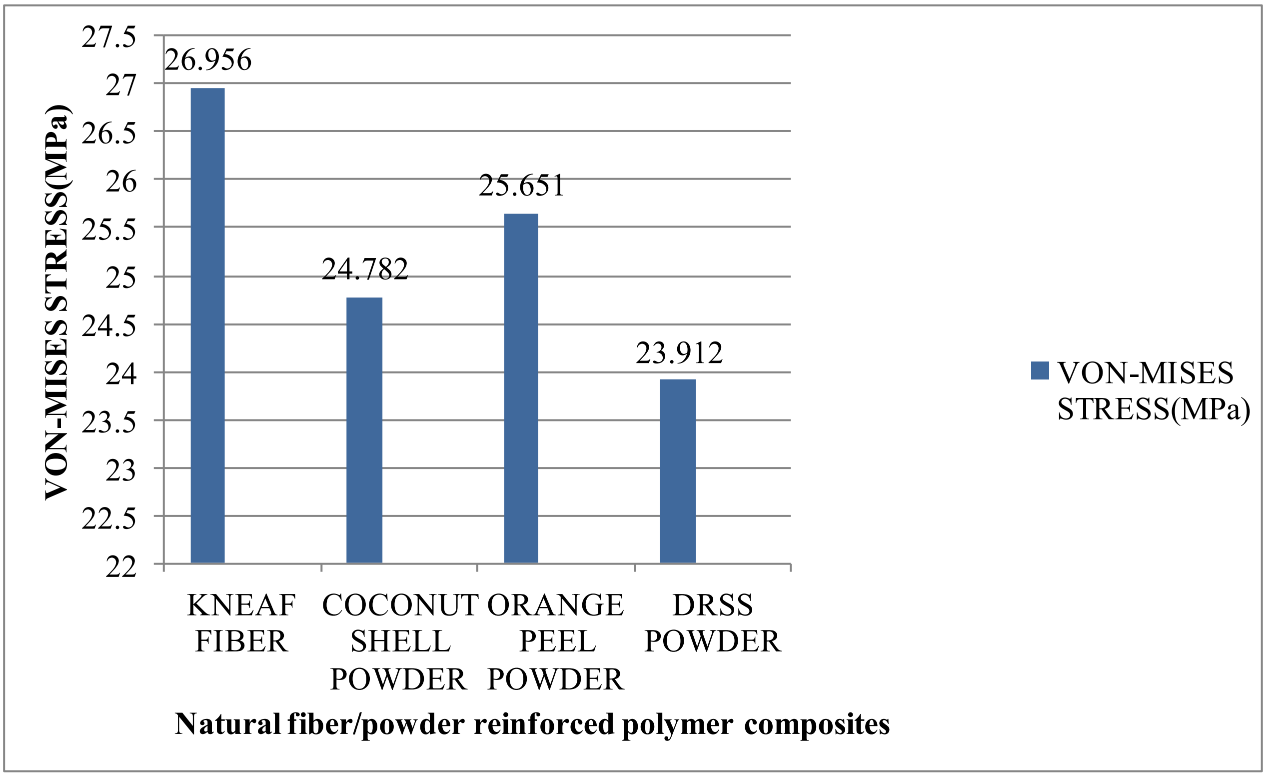


Figure13. Coconut shell powder composite Total Deformation

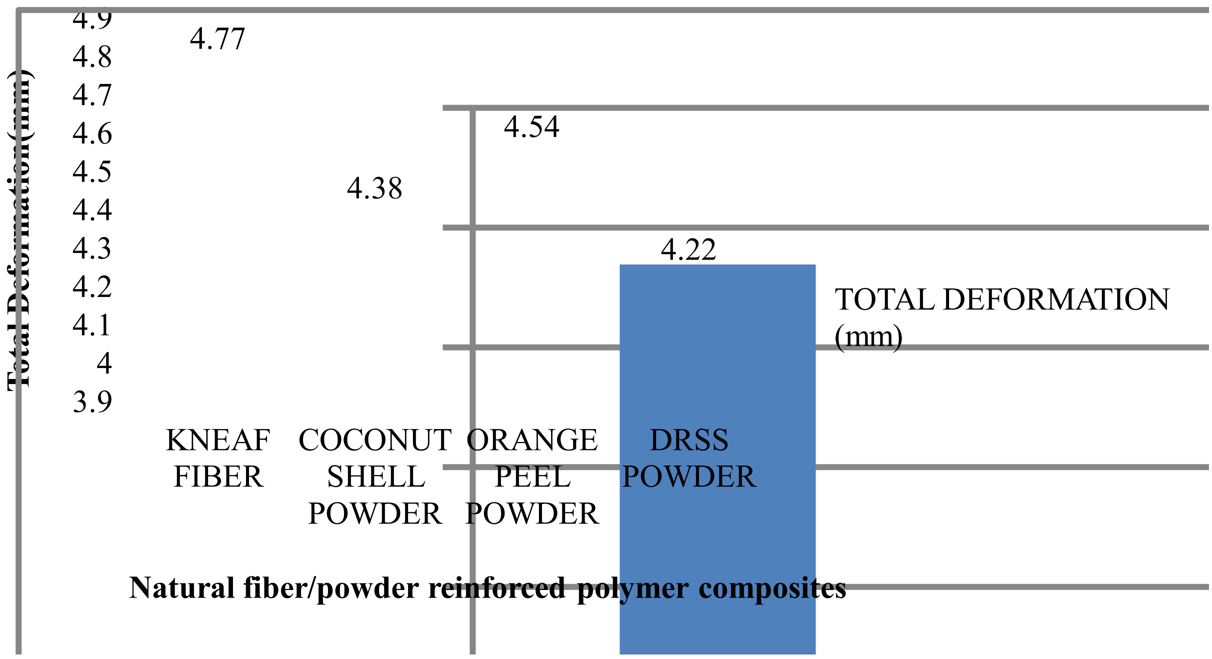
Table2.Comparing the FEA results of the panel of different materials at an acceleration of 150 mm/s^2

S.No.	Internal Door Panel (Rear left)	Equivalent Stress (MPa)	Maximum Deformation (mm)
1.	Kneaf fiber composite	29.956	4.77
2.	Coconut shell powder composite	24.782	4.38
3.	Orange peel powder composite	25.651	4.54
4.	DRSS powder composite	23.912	4.22

The charts plotted below will show the comparisons of these values clearly for rear left door panel. The results are the values obtained at an acceleration field of 150 mm/s^2 applied on the panel [2].



Graph1. Comparison of equivalent or von-mises stress of a panel of different materials



Graph2. Comparison of deformations of a panel of different materials

Conclusions:

- The finite element analysis (FEA) is a powerful computational tool for analyzing complicated structures like doors. It can reduce prototype parts producing and the number of physical tests to shorten the development cycle and reduce the development investment; i.e., it saves much time, effort and cost.
- The result of this analysis shows that, the equivalent stress and deformation of DRSS powder reinforced polyester composite panel has the smaller value, as compared with the kneaf fiber, coconut shell powder and orange peel powder composites.
- Based on these outcomes, it is recommended that DRSS powder reinforced with polyester composite materials are suitable for internal structural automotive panel applications.
- Compared to fiber reinforced composite fabrication, powder reinforced fabrication is easier.

References:

[1]Myrtha Karina, Holia Onggo and Anung Syampurwadi, 2007, "Physical and Mechanical Properties of Natural Fibers Filled Polypropylene Composites". Recycle. Journal of Biological Sciences, 7: 393-396.

[2]O.M. Terciu, I. Curtu, and C. Cerbu, "FEM modeling of an automotive door trim panel made of lignocelluloses composites in order to determine the stresses and displacements in case of a door slam simulation"; The 4th International Conference of Advanced Composite Materials Engineering, COMAT 2012.

[3]Johnson Olumuyiwa Agunsoye, Sefiu Adekunle Bello, and Lordson Olasubomi Adetola, "Experimental investigation and theoretical prediction of tensile properties of Delonix regia seed particle reinforced polymeric composites". Journal of King Saud University- Engineering Sciences.

[4]B.Venkatesh, "Fabrication and Testing of Coconut Shell Powder Reinforced Epoxy Composites. International Journal of Advance Engineering and Research Development Volume 2, Issue 2, February -2015. e- ISSN (O): 2348-4470; p-ISSN (P): 2348-6406.

[5]Anoopisan, I.Barath, and S.Nagakalyan, "Interfacial Behavior of Composites of Polymer and Orange Peel Particulates". ISSN (Print): 2319-3182, Volume -4, Issue-4, 2015.