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COMPARATIVE DYNAMIC ANALYSIS FOR A DOOR CAR USING DIFFERENT TYPES OF MATERIAL BASED ON VIRTUAL SIMULATION

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Abstract: *In this paper, we attempt to evaluate the structural behavior of the door car (stress and displacement magnitude values) based on dynamic stress simulation, for two material types (composite and steel materia)l.*
Keywords: *finite elements, stress, strain, optimization, rigidity, and composite material.*

1. INTRODUCTION

The actual tendency of the engineers and researchers people from worldwide are focused both on the research-developed-optimization activities for some components or parts of system assemblies or sub-assemblies and on the increasingly quality, reliability and durability of products in order to remain competitive and profitable or to obtain the marketplace.
The manufacturers are pressed to refresh their product models much faster than before. Shortening time to market and reducing costs are simply not good enough anymore. They have to penetrate new markets with innovative new products that support and cultivate strong brand values. This calls for a high performance development process – with high throughput and high precision. A process that delivers the right products – designed right first time. Engineering departments now more than ever are challenged to tune the functional performance characteristics of their new designs.
Creating innovative and attractive products is not just about producing visually attractive designs. Some manufacturers consider safety and reliability not just to be constraints but critical to their image.
Today, the industry evolution towards more virtual prototyping results in fewer prototypes that must be tested in greater detail.
Virtual prototyping method won it an important role in the different high industry domains, such as: automotive, aircraft, biomechanical industry. The truth virtual prototyping is created by means of FEA software, seeing obtained some products which accomplish the request imposes by market. Therefore, by means of FEA software, it can be obtained a faithful modeling, both for system components and functional conditions of the system. In this way, it can be eliminated a long stage from experimental testing which represent an expensive process.
FE analyses provide a very efficient way to represent structural flexibility for even the most complicated geometry. The method uses an advanced numerical algorithm based on displacement calculus method. The flexible behavior for any number of parts in the simulation can be represented and visualized by graphing and animating results.
This functionality allows visualizing the stress field of a part undergoing dynamic or static loading. When using the dynamic solver, the resulting stresses are the dynamic stresses that take all transients into account. In this paper, we attempt to evaluate the structural behavior of a door car under a shock loading resulting from close door. The dynamical loading that acts on the door is an inertial acceleration.

2. TECHNICAL REQUIREMENTS

The processes and phenomena that develop in mechanical system are quite complex and difficult to represent faithful in virtual models, which represent in fact an approximation of the real systems.
Theoretical interpretation of the phenomena and processes from mechanical systems gets useful in order to make a final decision with regard to adoption some optimal functional parameters.
The analyzed model was made for a 3 point bending composite cantilever, and block diagram of the debate study is presented in the figure 1.
The input values known are mass, material & geometrical properties for cantilever. The other components: supports and nose that acts on the cantilever in the middle zone of it, will be considered as rigid body parts. The external loading is applied as velocity on the nose. The supports have all DOF restraints.

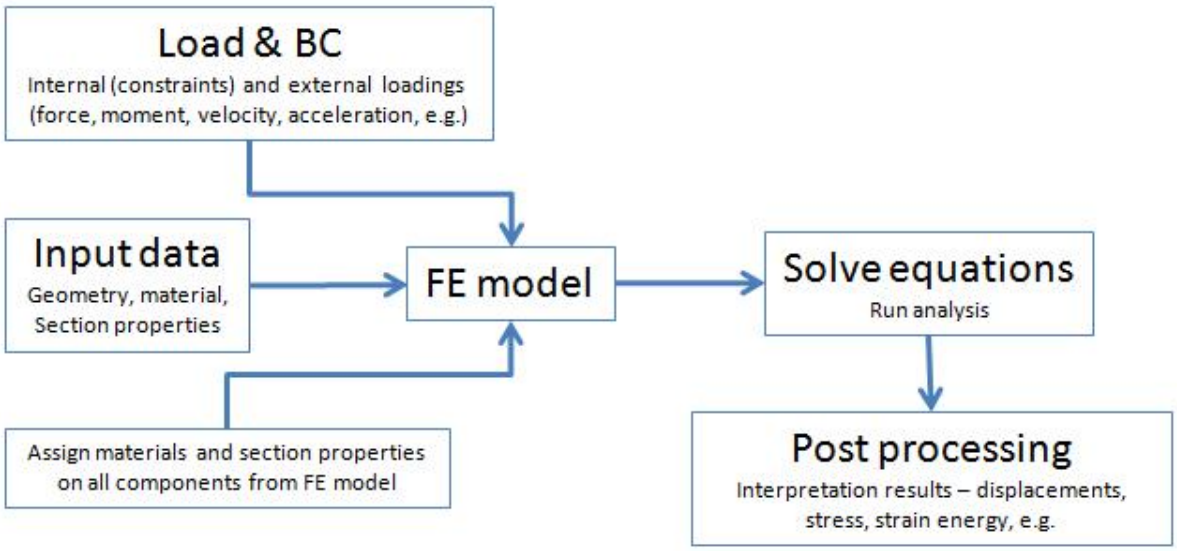

Figure 1 - Bloc schema for analysis

Based on input parameters adopted and the restraints, it can be obtained the equation solutions of the mechanical system, resulting the reactions force in the nodes that have restraints all DOF and based on them the force loading that charge the composite cantilever. The motion equations obtained from dynamic behavior of the mechanical system along with external and internal loading applied on the study model leads on to obtained the dynamic FE model.

Dynamic stress analysis of the door car under inertial loading
In the figure 2, it is shown the FE (virtual) model of door car. According with virtual schema, the inertial loading is applied on the door and body car..
The inertial loading represents in fact the acceleration that can appear from a shock loading after a close door stage. The inertia loading imposed is 10g = 98100 [mm/s^2].
The connection between both components (door and body car) was made using rigid elements applied in the pin connection and latch zones.
The constraints assembly was applied on the external contour of the body car included in FE model (see figure 3). .
The door car was analyzed in two scenarios:
1. With door made from composite material,
2. With door made from steel material

The both analysis scenarios were made in order to appreciate the behavior of the door made from composite materials with respect of door made from steel material.
The principal output parameters that will be used for interpretation results are magnitude displacements and von Mises stress.
The material properties used for both scenarios are shown in the Table 1.
The weights of door using both materials have the next values:
- Door car from composite material = 7 [kg],
- Door car from steel material = 19 [kg]

Table 1: Material properties

	Steel mat	Composite mat
Young modulus [MPa]	202500	15000
Poison ratio	0.3	0.38
Density [tone/mm^3]	7.8e-9	2.72e-9

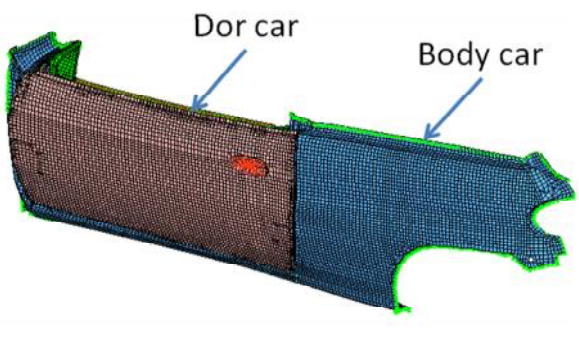

Figure 2 - FE model of composite cantilever

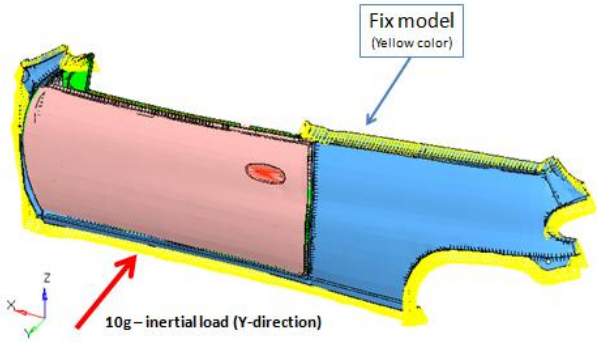

Figure 3 – Load & Boundary conditions

In the figure 4 is shown the displacement magnitude field obtained on the door under 10g inertial loading applied.

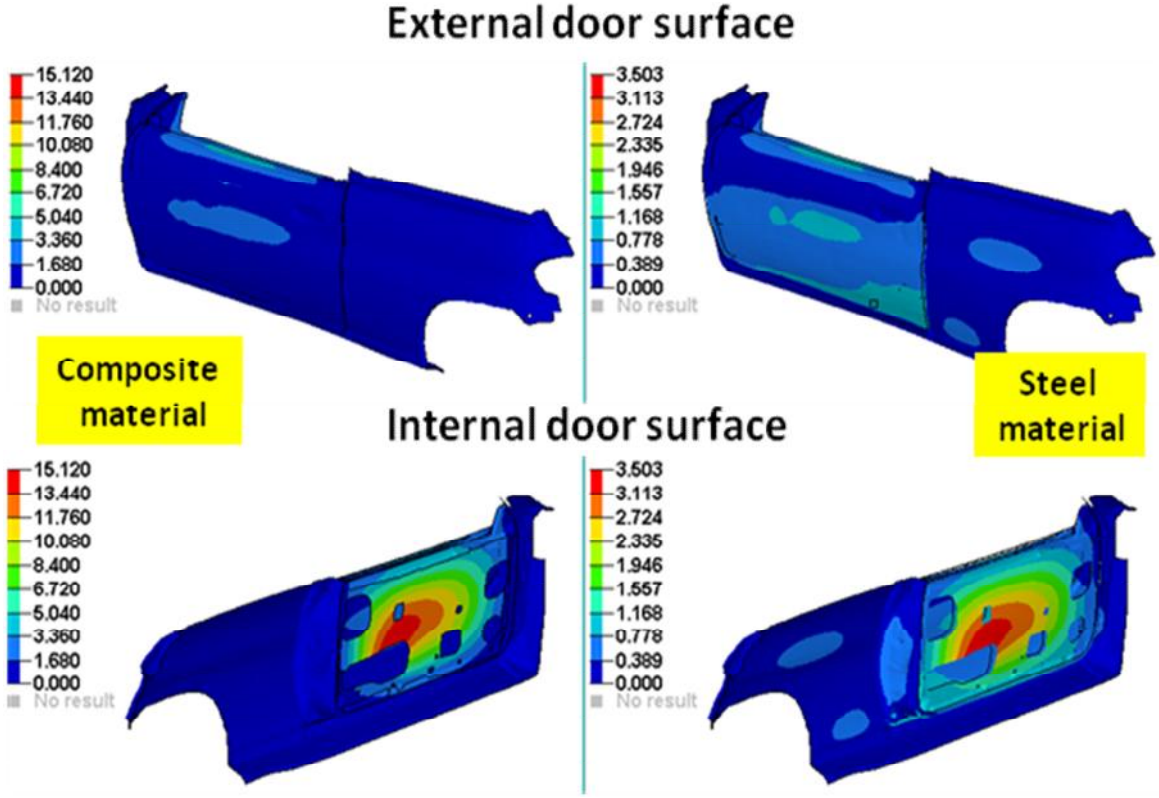

Figure 4 – Plot displacement magnitude obtained on the door

In the figure 5 is shown the von Mises stress field obtained on the door under 10g inertial loading applied.

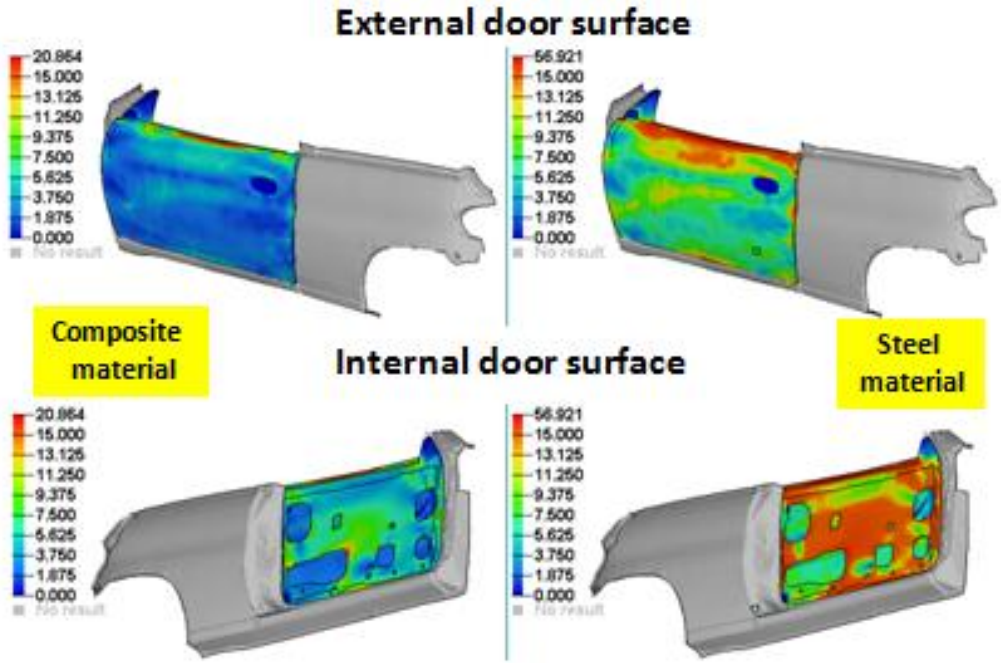

Figure 5 – Plot von Mises stress field obtained on the door

Table 2: Comparison analysis Results obtained on the door car

	Composite mat	Steel mat
Maximum displacement magnitude [mm]	15.12	3.5
Maximum von mises stress [MPa]	20.86	56.92

4. CONCLUSION

In the figure 4 & 5, it can be observed the comparison results obtain from the FEA analysis for the door car analyzed.

Based on the results obtained, it can be concluded that the composite material offers a little advantage with respect to steel material for case studied. These advantages consist in: light weight and stress values lower than values obtained on steel door car.

The output parameters (displacement and stress) evaluation method based on virtual simulation offer a quickly and better information about state stress for a part under a dynamic loading comparison by evaluation method based on static analysis because the dynamical analyses with inertial loading taking into account to dynamical motion equation.

Also, the dynamical stress evaluation method of the state stress is very advantageous for research-developed-optimization activities of the product and is applicable for any complex mechanical system.

Based on dynamic FEA analysis, it can make appreciation with regards to factor of safety for a component desired on a complete duty cycle, known material properties of the part studied.

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