CHOOSING METHOD OF COMPOSITE MATERIAL FOR THE PRODUCTION OF VEHICLES HOOD

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ABSTRACT:The evolution of materials for component parts of motor vehicles has reached a very high level, with the aim of achieving the lowest and the most resistant mass. The development trend in the sports automobile area and beyond is to achieve the highest possible performance and the lowest possible cost. The method presented in the paper allows the analysis of 3 composite materials chosen for a component part of a car. The paper presents the principles and method of modelling the car bonnet 3D with the help of the Catia software.The presented method is used to design prototypes of cars regardless of brand. The materials proposed for the hood are composite materials, especially those with carbon fiber. For the 3D modelling of a hood, the model from 2001-2005, 3er Touring (E46), is taken as a reference model, because in this model the grille is part of the bonnet assembly.

KEY WORDS: composite materials, hood, road vehicle,modelling 3D, hood, vehicles

1. INTRODUCTION (HEADING 1)

Two of the most important functions of a hood, be it on a regular or sports automobile, are to cover the engine and to provide aerodynamic performance.

If the incline of the hood plane is high with respect to the horizontal plane, the aerodynamic coefficient is reduced and the sliding curve between the hood and the windshield is better.

In case the hood is placed centrally or towards the back, airflow on the car roof can create a low-pressure vortex area behind the vehicle.

In order to create a 3-dimensional model of a hood, the 2001 – 2005, 3er Touring (E46) is chosen as a reference, given that on this particular model, the grill is part of the hood assembly and further analysis to determine the optimal materials to use in the construction of the hood is less complex.

2. MODELLING METHOD

In order to build the hood model, its profile is drawn using the "sketch" command, and then the profile is extruded in the "YZ" direction, using the "extrude" command, Figure 1.

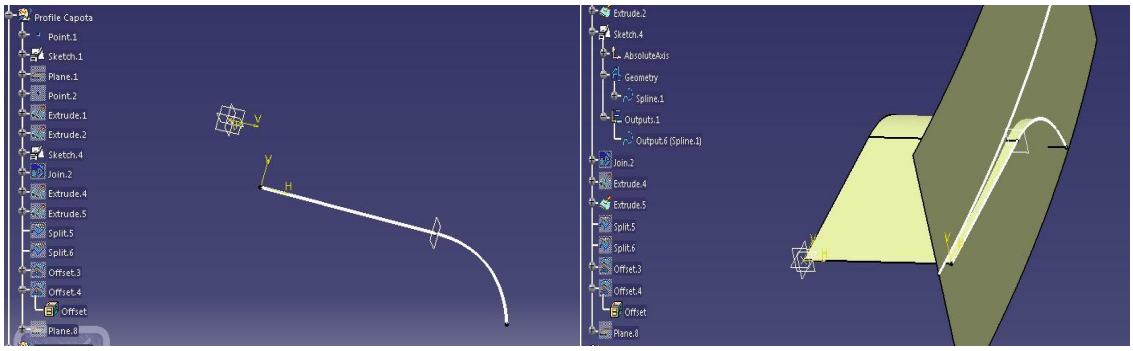

Figure 1. "Extrude" command

After the hood profile is obtained, its shape is created by creating parallel planes, at different angles with respect to the "YZ" planes, in order to obtain intersection with the hood profile. After the intersections are obtained, the "split" command is used in order to create the curved surface of the hood, Figure 2.

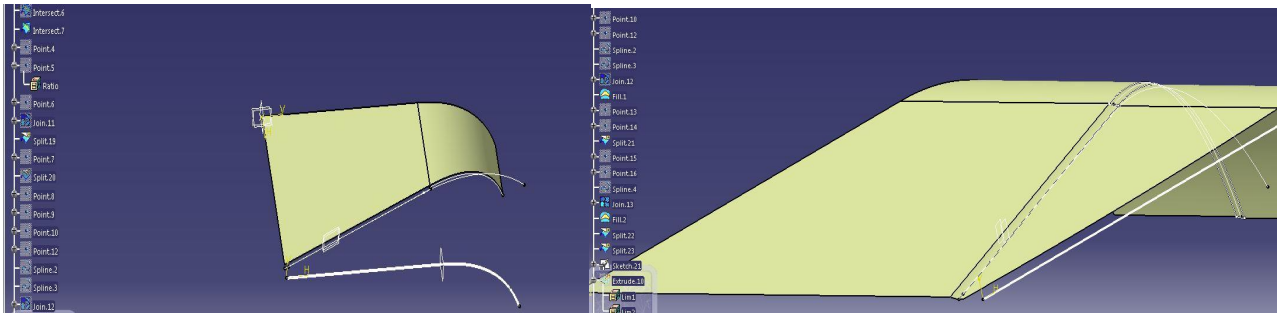

Figure 2. Create the curved surface of the hood

A new profile is created (using "sketch" command) which will be extruded and this new profile will intersect ("split" command) the previously created surface, this "cut" representing the space for the headlight assemblies, Figure 3.

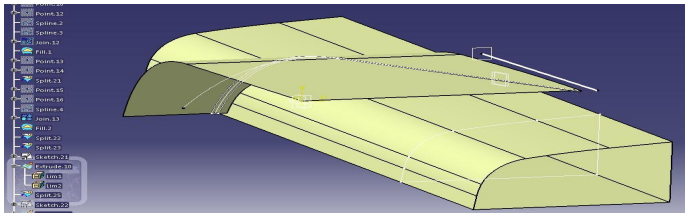

Figure 3. Created surface

After the space for the headlight assemblies is created, the space for the radiator grill is designed in the same way, first using "sketch", to trace the profile of the grill opening, followed by "extrude" to intersect the hood, and "split" to extract the profile from the surface of the hood.

Using the "symmetry" command with respect to the "YZ" plane the hood surface is obtained, Figure 4.

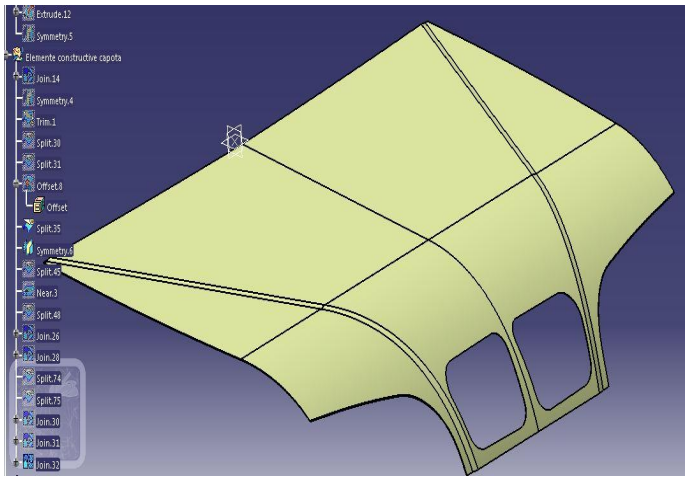

Figure 4. Plane the hood surface

The next step is to define the thickness of the hood, and in order to do this, the "offset" command is used.

In order to close the profile of the hood, the edge surfaces must be obtained. For this, the hood profile is extracted using the "extract" command followed by its extrusion.

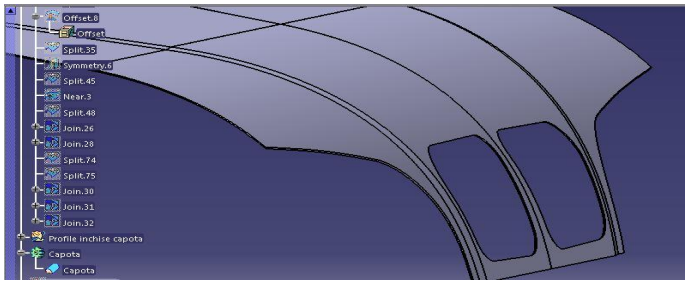

Figure 5. The "extract" command

The final step is done using the "close surface definition" command which can only be done once the surfaces intersect correctly and create a continuous surface, Figure 5.

The first step to obtain the grill profile is extracting it from the surface of the hood with the help of the "extract" option and extruding it.

Planes parallel to "YZ" are created at the lower end of the hood, followed by their intersection with the grill surface, using the "intersect" command, in order to create the surfaces that make up the outer part of the grill.

Using the „fill" command, the contour of the element which allows air to flow towards the radiator is obtained.

The elements that make up the air flow guide to the radiator are obtained by creating multiple planes parallel to "YZ" and the "symmetry" option with respect to those planes. All of these elements are connected using the „join" command.

To finalize the grill, the "split" command is used to create all the surfaces necessary to close its profile. All surfaces used have already been created, with the hood surfaces, at these only aesthetic tweaks being required for finishing.

For the hood reinforcement, the profile is created using "sketch", Figure 6.

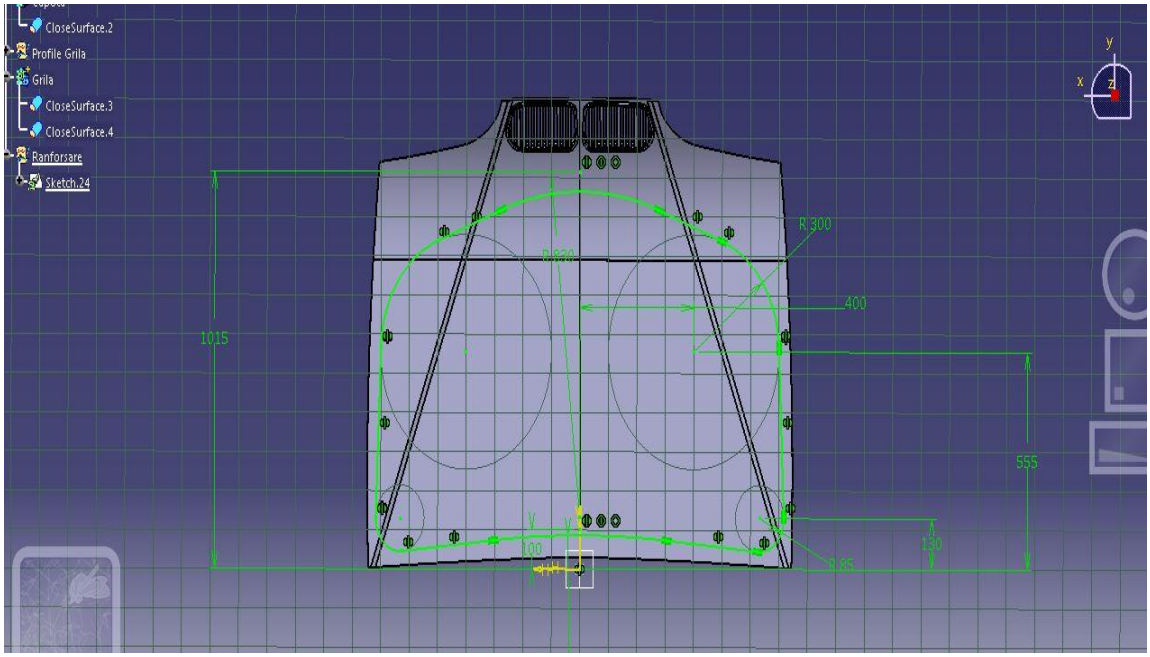

Figure 6. Create all the surfaces necessary to close its profile

The previously created profile is extruded and the "offset" command is used in order to obtain a surface to represent the thickness of the reinforcement profile.

"Close surface definition" is used to finish the reinforcement design, Figure 7.

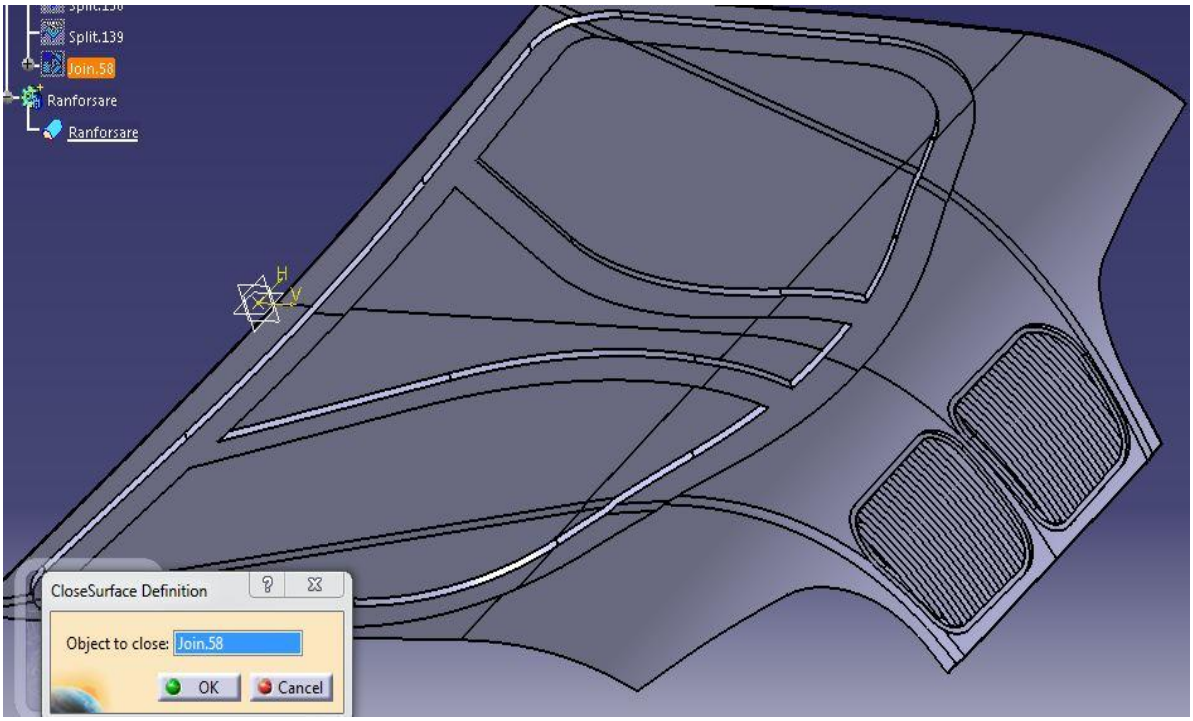

Figure 7. Close surface definition

Choosing a material is a very important stage in finalizing a 3-dimensional model of a car hood. A comparative study of three material combinations is conducted in order to determine the optimal choice for the considered car hood. The comparison has the hood mass as the crucial criterion, considering this has a significant impact on the performance of the vehicle, and due to its sporting characteristics of the car, this requires increased attention due to influences on aerodynamic performance and fuel consumption.

For this hood, the following three material combinations are proposed:

- Carbon fiber radiator grill and hood
- Plastic radiator grill and aluminum hood
- Plastic radiator grill and carbon fiber hood

Two aspects need to be considered when designing an in telling material or structure. The first one is

related to creating a composite material that can have any structure, and the second, the characteristics of the "intelligent" component need to be obtained such that it corresponds to the requirements of the usage of the part. In the present paper, we highlight the problem of creating a material having an epoxy resin as a base, with fiber glass reinforcement. Usually, epoxy or fenol based resin composites have a wide range of uses in the automobile and aerospace industries. The study could extend to other types of composites, the main problems being solved and the specific differences of each material being the only items in need of consideration. Firstly, in order to configure the materials in the CAD software, the technical specifications of the materials being used is required. For general materials, such as aluminium, bronze, copper etc., there is a pre-configured library.

However, in order to configure other materials which do not exist in the softare's library, the desired material needs to be defined in a new material library. This configuration is done by accessing the Start->Infrastructure->Material Library->New Material menu. Once this is accessed, a window is opened in which the physical and mechanical characteristics of the desired material are introduced, Figure 8.

The first configuration of the hood materials is:

- Hood: Aluminum Magnesium Alloy (Al Mg 5052)
- Reinforcement: Aluminum Magnesium Alloy (Al Mg 5052)
- Radiator Grill: Polipropilene (PP)

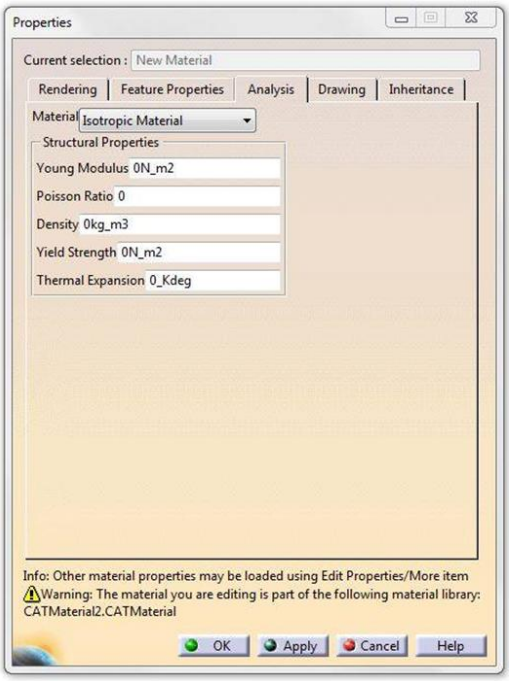

Figure 8. Defining a new material in Catia

After choosing these materials, the method described above can be used in conjunction with the technical specifications of the materials, after applying the desired material to each component of the hood with the help of the „Apply Material" command, Figure 9.

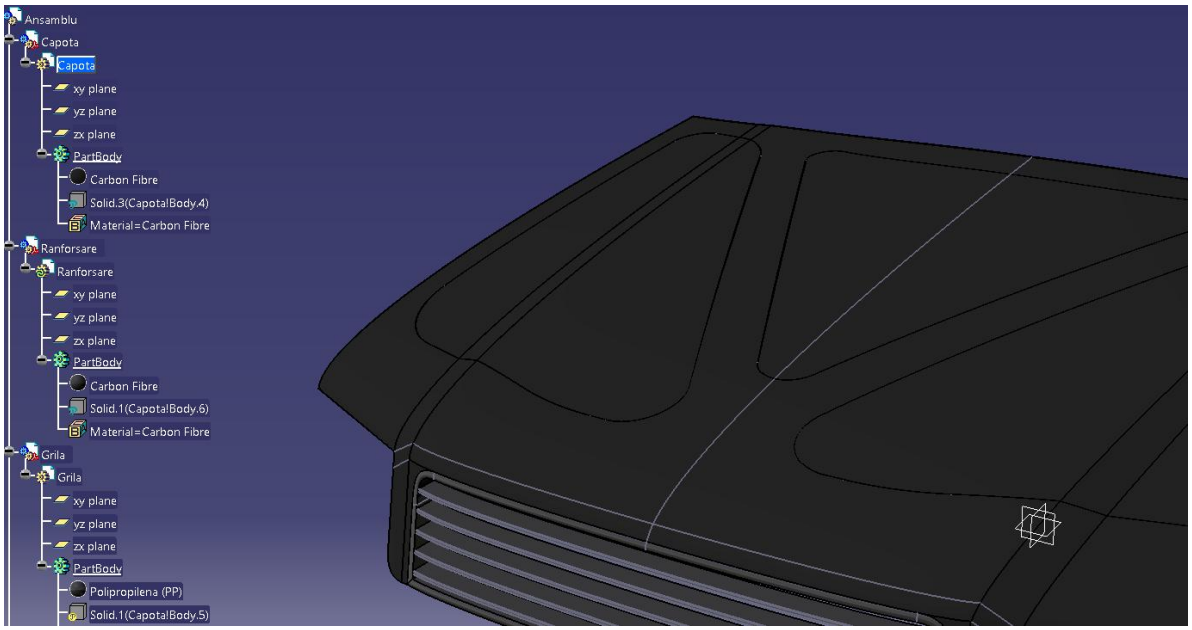

Figure 9. Engine hood with applied material

Once the material is applied, the „Measure Inertia" command is used in order to obtain the physical measurements of the hood, for example volume, mass, centre of mass etc. With the help of these, results can be obtained which can be compared to other choices of materials in order to select the optimal combination.

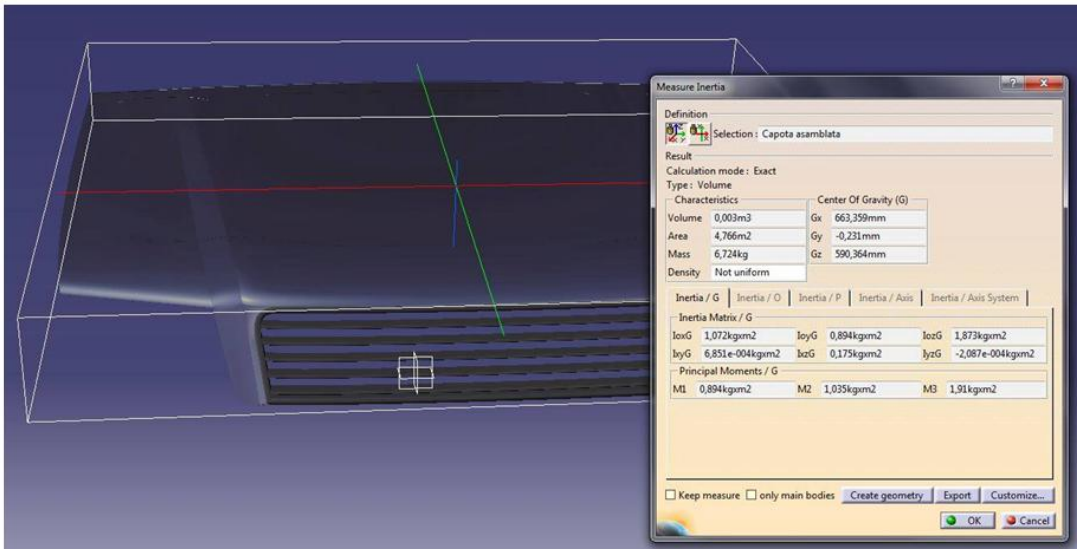

Figure 10. Obtained results

Results show that producing the hood out of Al-Mg alloy and the radiator grill out of polypropilene will yield a mass of 6.724 kg, a volume of 0.003 $m^3$and a total surface area of 4,766 m^2. Out of these, the mass is the most important characteristic, given that it has the most significant influence on automobile performance, Figure 10.

Visualising the influence of the masses of the hood components on its total mass is done by individually measuring each component.

Figure 11 shows that the second choice of materials, composite hood and plastic radiator grill is the choice with the lowest mass, followed by the case in which the hood is realized completely out of compositematerials.

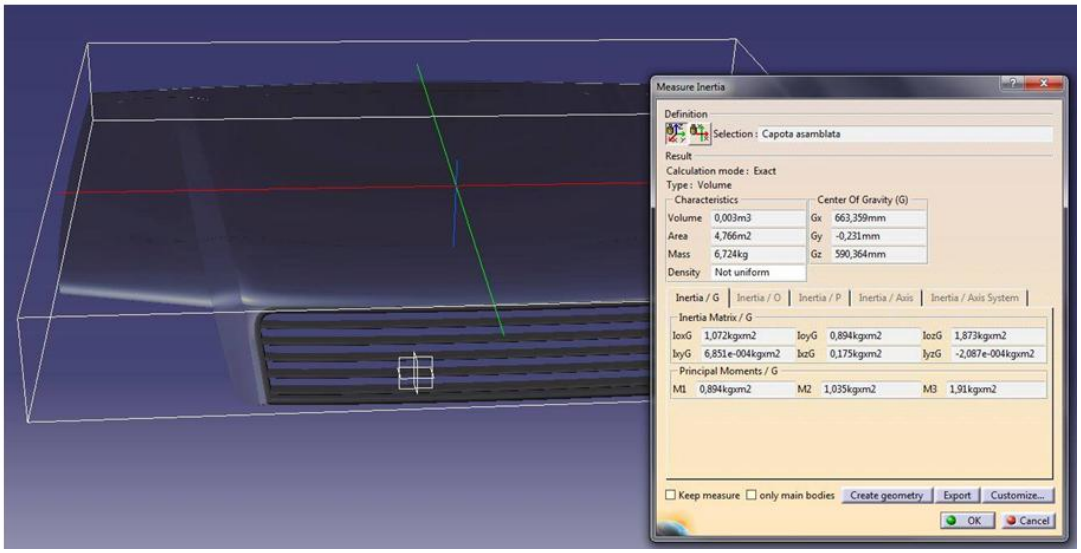

Figure 11. The second choice of materials, composite hood and plastic radiator grill

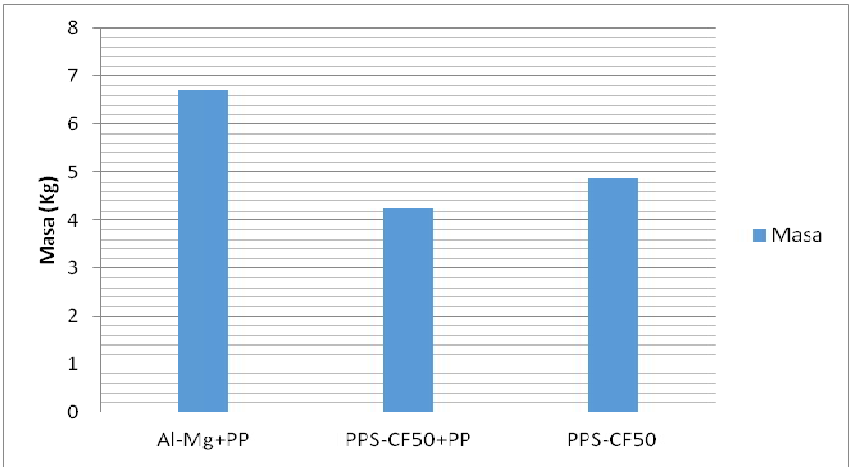

Figure 12. Total mass of the hood for each material combination

Out of these two choices, the materials for the hood will be selected, Figure 12.

Considering that the hood is designed for a sports vehicle, the choice with composite and plastic will be selected. Even though plastic has a slightly lower stiffness than the composite, it is more feasible since the grill does not need to fulfil any special functions, only to allow air currents to reach the cooling radiator.

3. CONCLUSIONS

The paper presents the incipient phase of creating a part or assembly for a sports automobile. The hood design was presented, using specialized software, Catia V5. In order to design the hood, the dimensions were required.

All the steps for creating the 3-dimensional model are presented from placing points using specified dimensions to creating the profiles, creating the surfaces following the lines of the vehicle, and finally creating the solid model of the hood. The design of the hood was done by designing its components. The first component was the outer surface of the hood, the second was the reinforcement and the last was the radiator grill.

The 3-dimensional modelling phase is one of the most important phases of design, since during this stage ideas take shape and it is the first phase in which the design engineer contacts the shape of his creation. Even if at first the part exists in a virtual world and the designer cannot touch it and feel its mass, this is no longer a problem. Due to development of techniques and design software, fast prototyping of parts is achievable, for example 3D printing, even if these parts are not identical to the original part with respect to mechanical properties.

The choice of material for the hood of a sports automobile was obtained following a comparison of three different material combinations, and selecting the optimal one, in order to obtain the lowest mass, and an increased stiffness of the body. The structural elements are composites, characterized by high stiffness and a relatively reduced mass by comparison to aluminium or steel, while for the ornamental and airflow guidance parts plastic was chosen in order to obtain a lightweight part. For the assembly, polyurethane foam is used, after treating the parts with a cleaning solution and an activating solution for the bonding surfaces of the assembly parts.

4. REFERENCES (HEADING 1)

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