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DESIGNING AND MANUFACTURING A GOALIE MASK

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At the present time the composite materials are used in many areas of industry. The main utilizations are in the aircraft industry and the sports equipment manufacturing. The first part of the work offers on overwiew of composite materials, their properties and utilize. The next part introduces the evolution of goalie masks. In the main part, we used the knowledge from the previous chapters, and designed a new shape of the mask and produced a prototype model. The backplate was designed by 3D CAD software and the form was produced on NC milling machine. For the production of the mask I used technology of laminating and remark two possible solutions as production forms and prototype models.

Keywords: Composite materials, hockey goalie mask, CNC milling, laminating

Introduction

It´s very hard to find any group from the section of polymeric materials which offers such a wide range of possibilities as fiber reinforced plastics materials. These materials meet the requirements of technical applications from the simplest solutions to extremely complicated structures. The composite materials price became available in the last few years. They offer such a usage, which can not any other material.

The use of composite materials has increased dramatically in the last few years. Currently they are mostly used in aircraft and automotive industry and in manufacturing of sports equipments.

Review of composite materials

The main advantage of composite materials is their extreme strength at relatively low weight.

As a composite can be understood such a material that meets following conditions:

- Were made artificially.
- The materials consist of at least two chemically different components.
- The components have homogenous distribution throughout the volume.
- Consequential properties of composite are different from the properties of the individual components. [1]

The most common fabric is shown on following figures:

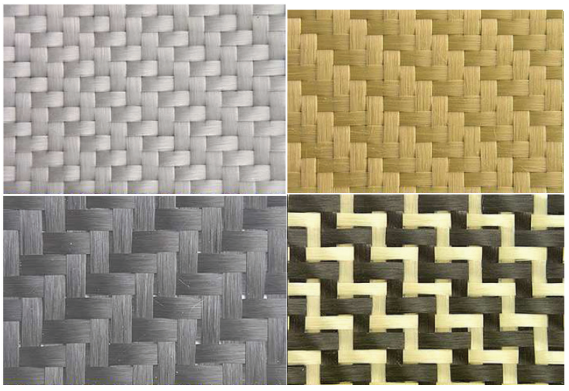


Figure 1: Glass fiber, kevlar, carbon fiber, carbon-kevlar

Evolution of goalie mask

It is hard to believe that ice hockey goalies haven't used a head protector for many decades. Last year goalie mask celebrated its 50th birthday. Officially the first goalkeeper, who used some kind of face protector (the first goalie mask) was Jacques Plante, the goalie of Montreal Canadiens. His mask was made from fiberglass (GFRP).

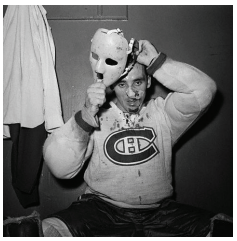


Figure 2: The first goalie mask

Nowadays, only the specialized technologies and materials are used for the production of goalie masks. Composite materials are used for their very good properties. Currently all high-quality goalie masks are made of them. Of course every producer keep in a secret the "know-how", how to made a high quality goalie mask which is solid but also very light.

The modern hockey goalie mask is composed of two parts. The first is the front part of the mask and the second is the backplate, which is the backside of the goalie mask. The backplate is attached to the mask by rubber bands, which are regulable so we can set the mask to the required size. The backplate was designed in a 3D CAM software.

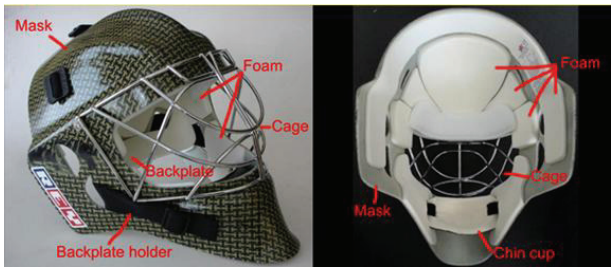


Figure 3: The modern goalie mask and its parts

Designing the new shapes

We were inspired by goalies masks used in NHL. A material called plasticine was fixed to the original mask. There are many reasons why plasticine was chosen as a suitable material. It is easily formable relatively cheap and popular material which can be simply removed after the lamination.

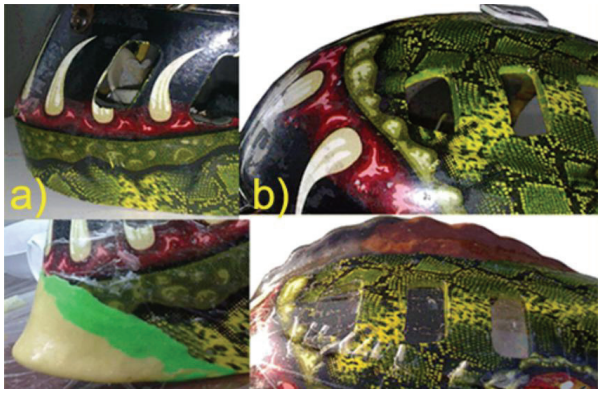


Figure 4: The new design of: a) chin b) forehead

The chin was formed in symmetrical way. It is important to have a flat surface, because it makes the work easier after the lamination.

After applying the necessary amount of separator on the surface of the mask the lamination started. Firstly, a bigger glass fabric was used for the inner surface of the prototype form. Then smaller pieces of glass fabric were applied because it´s easier to work with. The basic form is composed of three or four layers of fabric. The thickness of the mask depends on the usage because some parts of the mask have to absorb more power than others.

After lamination the prototype form was left outside on the open air for a few hours for better solidification. After that process the base mask was taken out from the form.

Figure 5: The base mask and the prototype form

The lamination was followed by sanding the inner surface of the mask. This treatment was repeated twice to get a relatively smooth surface.

Producting the prototype model

Before lamination the form had to be separated. A liquid separator called FREWAX was used for that purpose.

FREWAX – liquid separator, mainly used at form making. [2]

For the lamination was used MGS-Scheufler L 285 epoxy resin with epoxy hardener no. 285.

Epoxy resin L 285 – is a liquid resembling honey with its colour and fluidity. [2]

Ordinary plastic filler was used for that purpose. Two different types of fillers were applied, one for the rougher and one for the smoother filling. The filling was always followed by surface grinding.

Figure 6: Separating the prototype form and filling the prototype model

The prototype form was separated by Frewax. Firstly, a thin layer of Frewax was brushed on the surface of the prototype model and after the dry up the layer was polished by a dry towel. Altogether six layers of separator were brushed on the surface of the prototype form. The effectiveness was verified by using a tape. Prototype model became ready by this complicated way. This process was followed by making the final form of the goalie mask for the serial production. This process was very similar to making the prototype model.

Making the production form

The next part of goalie mask producing was the preparation of the surface of the prototype model. A liquid substance called GELCOAT was brushed on the internal surface in black colour.

Figure 7: Brushing the gelcoat and laminating the production form

GELCOAT – is a liquid and thick meld used as an inner layer in the form manufacturing. The Gelcoats main advantage is that it could be polished to "mirror" and create a completely smooth surface of the form. [32]

The lamination of the form began by brushing the resin on the surface. After that was completed the glass cloth was continuously treated on the surface of the prototype model. After applying about 8-10 layers of glass fabric on the surface of prototype model the form of the goalie mask was ready. The prototype model was taken out from the production form.

Making the mask

The form was cut around the roughness's were filled up and polished. The edges and vents of the mask were drawn on the form too. For the outer layer of masks were used a carbon cloth because of possible to adjust the surface. If we use Kevlar eventually. carbon-Kevlar, we couldn´t sand the surface.

The forehead and the chin are the most critical parts of the goalie masks and have to maintain the biggest potential impacts of the head.

After two layers of carbon cloth there was a need of three more reinforcement layers of hybrid fabric (carbon-kevlar) on forehead and on chin. Carbon fiber reinforced with aluminium wires was used for the next few layers and to add more strength to the mask. Three more layers of that material were used and the final layer was a carbon fabric again.

The vents and holes which attach the cage and the backplate holders were drilled to the mask. After the drilling the mask was prepared for painting. Of course the surface of the mask has not been perfectly smooth, so it was necessary to brush the surface again and spread it with resin.

Figure 8: Reinforced chin and forehead with carbon-kevlar and the last layer of resin

Making the backplate model

Ice hockey goalie mask consists of two parts. After the first part was ready a solution was proposed for the second part in 3D software.

This solution is a 3D model of the backplate. Milling of this form was produce on VMC Eagle 1000 milling machine. Polyurethane (PUR) in green colour was chosen for a base product. Consequently, the boundaries of the cutting tool were defined. For the roughing was used a monolith milling cutter of diameter 16 mm.

The designing was started by defining the main points and drawing the line that intersected the curve of the backplate. The basic form was illustrated in three planes. The three planes were defined by an existing model and by our measurements. After it both curves of the masks were drawn. They were immediately connected together and the surface was ready.

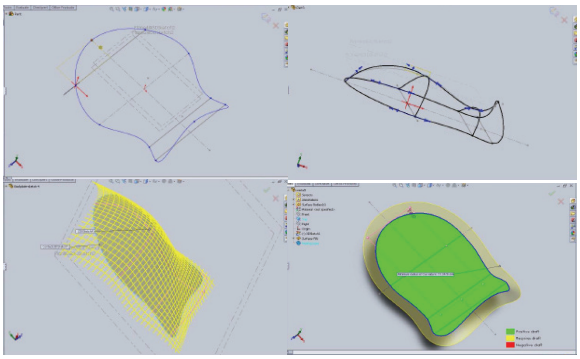
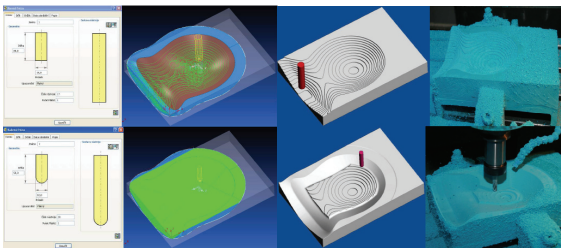


Figure 9: Designing the backplate in 3D

For the making of the backplate we milled a production form. As a base we used the previously prepared 3D model. Boundary line width was defined previously. The line makes easier the removal of the finished product from the form.

The next point we had to select a strategy for milling. For the purpose was chosen roughing by offset. For finishing was used a Ø10 mm monolith milling cutter with marking 95102 MEGA. For completing our work we have select strategy of the optimized constant Z.



a) b) c)

Figure 10: Milling of backplate form (roughing/finishing): a) tool selection b) way of the tool c) the milling process simulation/real

This form will serve us for the further production of the backplate from glass, carbon, Kevlar and hybrid fabrics.

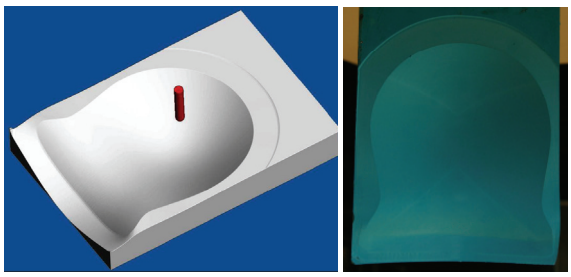


Figure 11: The finished backplate form simulated and real

Conclusion

The Main aim of the work was to produce a goalie mask that will be suitable for playing ice hockey.

Of course, it was necessary to read thoroughly the available literature before the production. The starting point for the work was a goalie mask designed for street hockey. A new design was proposed based on this street hockey mask from composite materials. As a first step we made a prototype form then a prototype model and finally the form for the manufacturing of the mask. By assistance of that form a goalkeeper mask with carbon fabrics was produced. This mask is suitable for playing ice hockey. From the available resources and experiences we found that the most stressed parts of the mask (chin and forehead) need more reinforcement, so on these sites were used more flexible fabric, carbon – kevlar.

The blackplate of the mask was designed in the 3D CAD software, then that part was milled by PowerMill software to the polyurethane. The polyurethane milled form of the backplate will be used to produce the back of goalie masks from composite materials.

Our goal has been achieved because the carbon-Kevlar mask stands for a better quality than the street hockey mask. Our work helped us to uncover the characteristics, applications, manufacturing technologies and processes for the production from composite materials.

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