Design and Analysis of Industrial Safety Helmet using Polyamide 4 6

C.Maiyuran[1], R.Karthick[2], S.Aravind[3]

[1] Student, Mechanical Engineering, KRCE, Tamilnadu, India
[2] Student, Mechanical Engineering, KRCE, Tamilnadu, India
[3] Asst. Professor, Mechanical Engineering, KRCE, Tamilnadu, India

ABSTRACT

All helmets attempt to protect the user's head by absorbing mechanical energy and protecting against penetration. Their structure and protective capacity are altered in high-energy impacts. Beside their energy-absorption capability, their volume and weight are also important issues, since higher volume and weight increase the injury risk for the user's head and neck. Every year many workers are killed or seriously injured in the construction industry as a result of head injuries. Wearing an appropriate safety helmet significantly reduces the risk of injury or even death. Protective headwear could save your life. At present strength of the helmet using industry is less due to improper filling of material, uneven pressure distribution and blow holes. The aim of the project is to increase the strength of industrial helmet by modifying the existing material. Here, we are using Polyamide 4 6 for the manufacturing of helmet. The helmet is designed and analyzed using SolidWorks and the variations between the two materials is studied and results are noted.

Keyword: - *Polyamide 4 6, Nylon 4 6, Acrylonitrile Butadiene Styrene, Industrial Safety Helmet*

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1. INTRODUCTION

All helmets attempt to protect the user's head by absorbing mechanical energy and protecting against penetration. Their structure and protective capacity are altered in high-energy impacts. Beside their energy-absorption capability, their volume and weight are also important issues, since higher volume and weight increase the injury risk for the user's head and neck. According to these design suggestions, a new design prototype was developed, tested, and further modeled. At this product development stage, attention was also paid to structural safety, appearance, manufacturability of the helmet shell, and other practical issues. Finally, we developed our helmet shell design as shown in Fig. Some of the important features of this design are listed below:

1. There are ventilation holes on the front and back, as well as both sides of the helmet shell.
2. Together with the ventilation holes, wind channels were designed on the top of the shell and on both sides of the shell, to provide clearance between the shell and the head.
3. The wind channels also provide local reinforcement against impact on the top of the shell, and increase the lateral rigidity of the helmet shell.
4. The beak of the helmet has an arched front tip and a wind channel that integrated smoothly into the front end of the helmet shell.
5. There are arched angels on both sides and the back end of the helmet shell, to allow more arrow between the helmet shell and the head from deferent directions.
6. There are angels around the ventilation holes to prevent water from leaking into the helmet on a rainy day.

2. LITERATURE REVIEW

The literature towards the design methodologies, analysis techniques proposed by different authors is collected and presented in the subsequent paragraphs.

Franklin, Glen A.

The purpose of this study was to identify the impact of motorcycle helmet use on patient outcomes and cost of hospitalization, in a state with a mandatory helmet law. Patients admitted after motorcycle crashes from July 1996 to October 2000 were reviewed, including Demographics, Injury Severity Score, length of stay, injuries, outcome, helmet use, hospital cost data, and insurance information Helmet use decreased mean cost of hospitalization by more than $6, 000 per patient. Failure to wear a helmet adds to the financial burden created by motorcycle-related injuries. Therefore, individuals who do not wear helmets should pay higher insurance premiums.

G M Ginsberg and D S Silverberg

Legislation requiring bicyclists to wear helmets in Israel will, over a helmet's 5-year duration (assuming 85% compliancy, 83.2% helmet efficiency for morbidity, and 70% helmet efficiency for mortality), save approximately 57 lives and result in approximately 2544 fewer hospitalizations; 13, 355 and 26, 634 fewer emergency room and ambulatory visits, respectively; and 832 and 115 fewer short-term and long-term rehabilitation cases, respectively.

Syrotuik, Daniel G. Reid, David C.

There is lack of consensus among pre-hospital personnel (athletic therapists, paramedics, sport physiotherapists) concerning specific aspects of initial care and assessment of injured athletes presenting signs and symptoms of a cervical spine injury (CSI). In instances of serious injury involving the head and/or spine, complicated by altered levels of consciousness, protective equipment such as helmets and shoulder pads may provide a hindrance to prompt, safe, and efficient management. Specifically, there is disagreement concerning the need or advisability of removing protective head gear, as in the case of football and hockey athletes.

Mohan J. Edirisinghe, Heidi M. Shaw and Katherine L. Tomkins

The yield stress of seven A16.SG alumina suspensions was estimated using shear stress-shear rate data measured at the processing temperature. Five of these were processed using a high molecular weight polypropylene binder system but each have a different %vol. of ceramic. The two other formulations contain a low molecular weight alcohol as the major binder. The relative viscosities of three other alumina powders processed using the same polypropylene binder system were also investigated using the same equation in order to assess the effect of particle characteristics on Vmax.

3. PLASTICS

A material consisting of very large molecules characterized by light weight, high corrosion resistance, high strength-to-weight ratios, and low melting points. Most plastics are easily shaped or formed.

3.1 Thermoplastic

A thermoplastic, or thermo softening plastic, is a polymer that becomes pliable or moldable above a specific temperature, and returns to a solid state upon cooling. Most thermoplastics have a high molecular weight. The polymer chains associate through intermolecular, which permit thermoplastics to be remolded because the intermolecular interactions increase upon cooling and restore the bulk properties. In this way, thermoplastics differ from thermosetting polymers, which form irreversible bonds during the curing process. Thermo sets often do not melt, but break down and do not reform upon cooling

3.2 Types of Thermoplastic

- Acetal
- Acrylics
- Acrylonitrile-Butadiene-Styrene
- Nylon
- Polyamide etc

3.3 Nylon 4-6 (polyamide 4 6)

The name "nylons" refers to the group of plastics known as polyamides. Nylons are typified by amide groups (CONH) and encompass a range of material types (e.g. Nylon 6,6; Nylon 6,12; Nylon 4,6; Nylon 6; Nylon 12 etc.), providing an extremely broad range of available properties. Nylon is used in the production of film and fiber, but is also available as a molding compound.

Nylon is formed by two methods. Dual numbers arise from the first, a condensation reaction between diamines and dibasic acids produces a nylon salt. The first number of the nylon type refers to the number of carbon atoms in the diamine, the second number is the quantity in the acid (e.g. nylon 6, 12)

The second process involves opening up a monomer containing both amine and acid groups known as a lactam ring. The nylon identity is based on the number of atoms in the lactam monomer (e.g. nylon 4-6 or nylon 12 etc).

4. DESIGN OF INDUSTRIAL SAFETY HELMET

Dimensions of the Helmet according to BS EN 397:1995:-

1. External vertical distance not more than 130 mm.
2. Internal vertical distance not more than 110 mm
3. Horizontal distance not less than 5 mm.
4. Wearing height 80 mm for helmets mounted on head form
5. Cradle width shall be not less than 15 mm
6. Chin strap not less than 10 mm

5. ANALYSIS OF INDUSTRIAL SAFETY HELMET

Table -1: Material properties

Model Reference	NYLON 4 6
	Name: nylon 4 6 Model type: Linear Elastic Isotropic Yield strength: 2.5e+008 N/m^2 Tensile strength: 3e+007 N/m^2 Elastic modulus: 1.6e+010 N/m^2 Poisson's ratio: 0.394 Mass density: 1400 kg/m^3 Shear modulus: 3.189e+008 N/m^2

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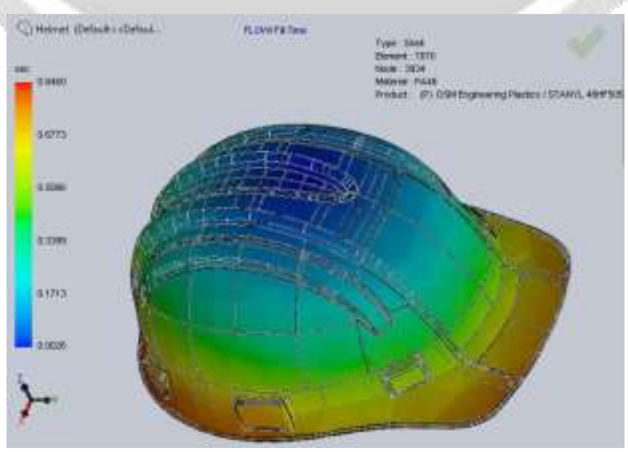
5.1 Plastic flow analysis

The Flow Analysis summary page gives an overview of the model's analysis, including information about actual injection time and pressure and whether weld lines and air traps are present. In addition, the dialog uses the Confidence of Fill result to assess the mould ability of the part.

Fig -1: Fill time



5.2 Load analysis

VON-MISSES Stress Analysis and Displacement analysis for the Industrial Safety Helmet made of nylon 4 6:- The properties of the nylon 4 6 are given as input to Analyze the designed model of the helmet. The output of the model is obtained. Von-misses stress and displacement of the designed model is obtained.

Table -1: NYLON 4 6 VS ABS

S. No	Description	NYLON 4 6		ABS	
		Maximum	Minimum	Maximum	Minimum
1	Shear stress	1.21244e+8 N/m^2	79436.7 N/m^2	1.60755e+007 N/m^2	11301.8 N/m^2
2	Displacement	1.1169 mm	0.00208716 mm	1.1480 mm	0.00161728 mm
3	Shear strain	0.00515385	0.62889e-006	0.00547961	2.94323e-006

Fig -2: Von Misses Stress

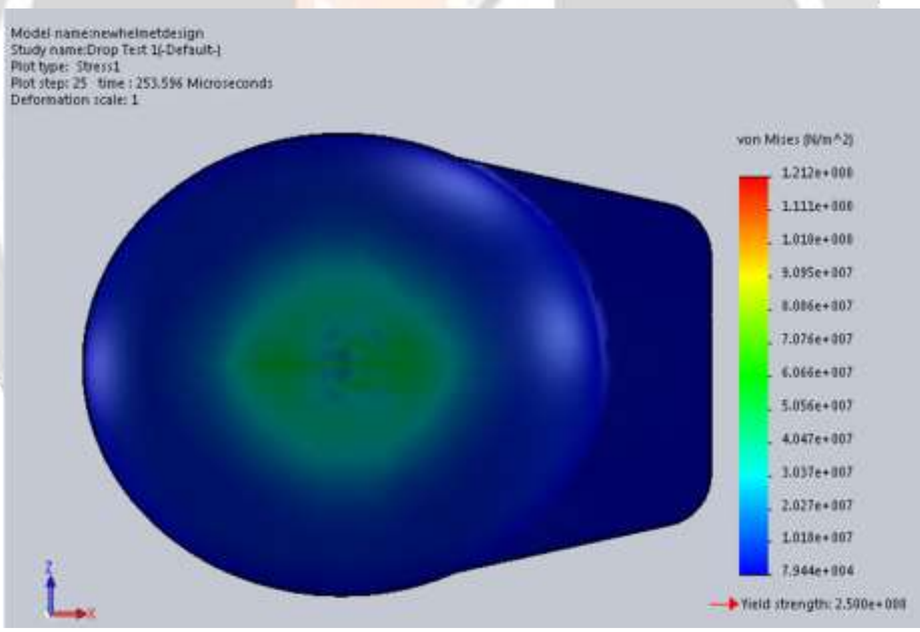


Fig -1: Displacement

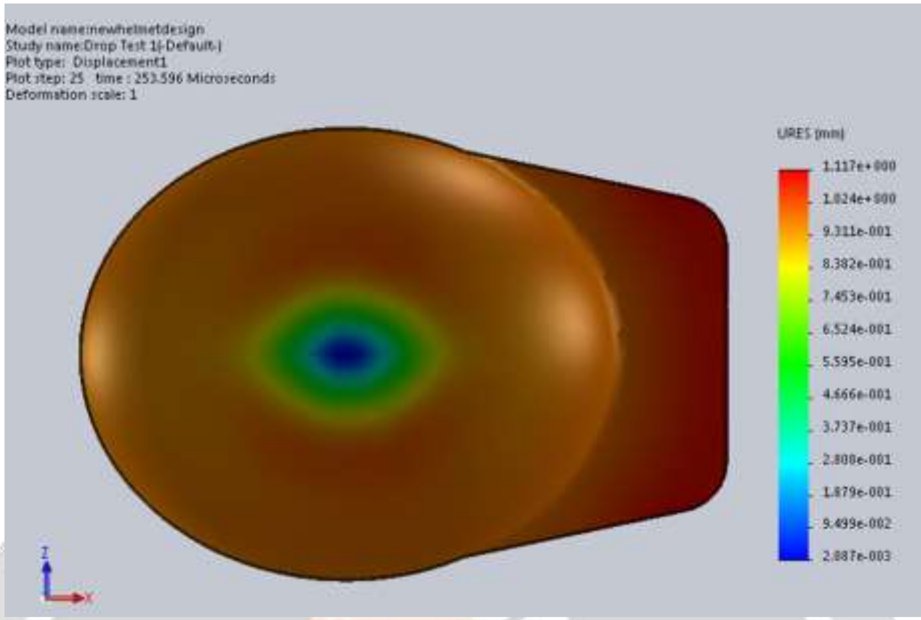
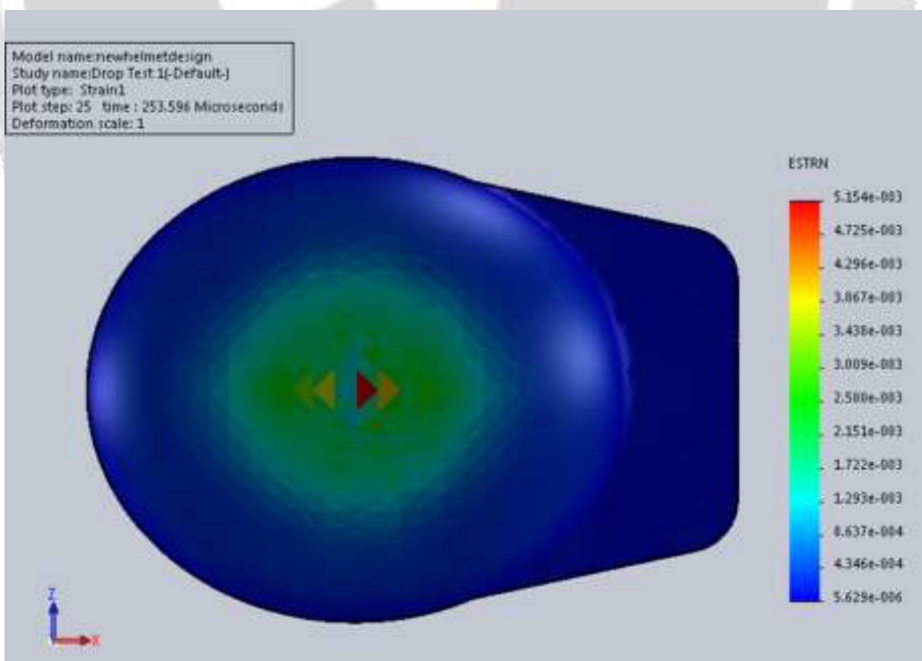


Fig -1: Strain



6. CONCLUSION

Stress produced in Nylon 4-6 plastic helmet is more than stresses produced in ABS plastic helmet for different heights. It indicates that the resistance against the load per unit area, factor of safety is more, and with standing capacity of Nylon 4-6 plastic is more.

From the results it is proved that displacement produced in Nylon 4-6 plastic helmet is less than displacement produced in ABS plastic helmet for different heights. It shows that the displacement of helmet cannot be altered to high and the impact of load on helmet is less.

Volumetric Strain produced in Nylon 4-6 plastic helmet is less than strain produced in ABS plastic helmet for different heights, which gives more rigidity to the human neck from impact loads.

In this chapter, it is found that the Nylon 4-6 plastic is good instead of ABS plastic helmet by using based on the above results.

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