Structure and FE Examination of Hybrid Composite Motor Protective Helmet

D.Sreenivasulu Reddy, Ram Mohan B.

Abstract : ***The helmet is defensive thing, used to shield head from foremost injuries. The head protector fundamentally ensures the skull and mind amid lethal mishaps. So the fundamental subject of the protective helmet is to safe watch the rider (or) the talented operator amid mishaps. It is essential for the rider to wear head protector, amid the riding of the vehicle as its exceptionally basic nowadays, that the little to significant mishaps occurring, not on account of the riders speed, might be a result of the environment, current streets, busy works of the general public and a few exposures on street. So the mishaps are unavoidable however we must be progressively watchful. Yet at the same time we ought to have clear knowledge of the injuries those might cause deadly passing of the rider. Thus the head protector is must for rider security. From that point onward, the comfort of the rider all through the journey is additionally critical worry for the helmet business to increase best market for their own item. So to meet the fundamental worries of the rider, it's most vital to build up the best comfort with a light weight, high quality, and high effect safe and better feel for the rider.***

The present work manages the geometrical improvement of the current head protector utilizing CAD programming apparatus and after that the basic investigation of the current model utilizing ANSYS workbench, straight examination, the outcomes, distortion, stress, and strain plots was been contrasted and entrenched outcomes. At that point the elective model with different mixes had been produced and broke down for the basic investigation and the outcomes had been contrasted and the current head protector. Toward the finish of the protective helmet with predominant quality, attributes with low material cost will be accomplished through the exploration.

Index Term: ***helmet, deformation, stress, strain, structural analysis.***

I. INTRODUCTION

The helmets square measure principally accustomed safe guard the top from injury thus the planning construct of the helmet is incredibly helpful topic to debate at this time. Helmets realize its use in numerous fields. Supported the applications the helmets square measure primarily designed to guard the top from numerous environmental conditions. Hence the planning of the helmet starts with the thought of the helmet material, size, comfort and therefore the ability to resist the required load with minimum deformation while not damaging the top. So the application fields additionally impact the look strength, weight, form and size of the helmet.

A. Area of applications of helmet

1. Industrial safety
2. Construction safety
3. Road safety
4. Sports safety
5. Racing helmets
6. Snow helmets
7. Police helmets
8. Military helmets etc.

B. Construction of the helmet

Modern rider helmets are constructed with outer shell made of polycarbonates and visor with fiber glass and inner cushion lining with polystyrene to protect the rider from the impacts and injuries.

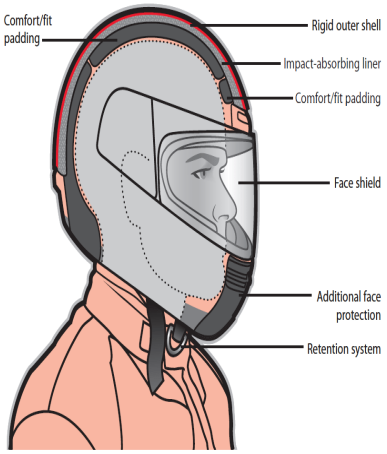

Fig 1: The basic constructions of helmet

II. OBJECTIVES AND METHODOLOGY

1. To achieve the composite helmet over existing helmet having superior strength.
2. To optimize the helmet for max strength and reduction of the material.
3. To plan cross breed composite helmet with better comfort, wellbeing and style.

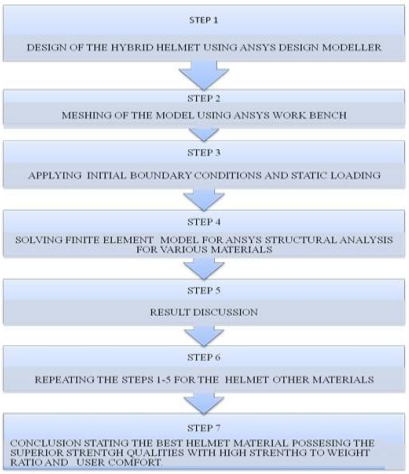

Fig 2: Square chart

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Dr.D.Sreenivasulu Reddy M.Tech.,Ph.D,HOD& Associate Professor, Dept. of Mechanical Engg, MTIET,Palamaner, CHITTOR (dist.), Andhra Pradesh, India.

Ram Mohan B, Assistant Professor, Dept. of Mechanical Engg, MTIET,Palamaner, CHITTOR (dist.), Andhra Pradesh, India.

III. STRUCTURE OF HYBRID HELMET

Design is the very essential part of any product and hence the work focuses on the first objective. Here the helmet has been planned with easy to use ideas. The new structure of the helmet is altered version of the ¾th cap and half cap. The helmet covers the full head from the back head base and it extraordinarily covers the ears, eyes from the dust, wind stream and daylight. Gives more comfort than the full-confront helmet and ensures more than the half cap. Uncommonly the head protector is easy to understand to deal with and simple to wear.

The geometry of the protective helmet has been planned utilizing ANSYS Design Modular apparatus according to the illustrations utilizing the surface directions in the tool kit and the surface has been given the thickness of 3.5mm. The beneath figure demonstrates the isometric perspective of the helmet.

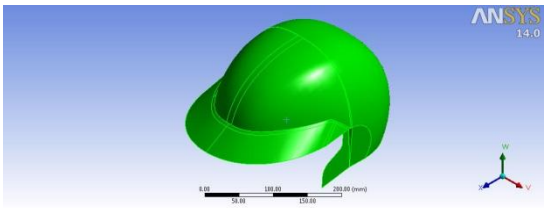

Fig 3: Depicts the isometric perspective of the CAD model of Hybrid helmet

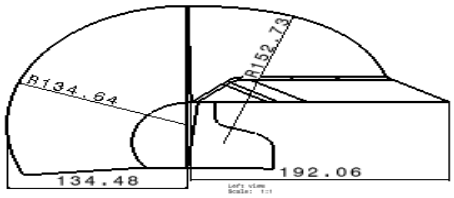

Fig 4: Depicts the front perspective of hybrid helmet as according to the illustration

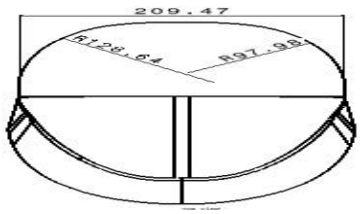

Fig 5: Depicts the top view of hybrid helmet asaccording to the illustration

IV. FE EVALUATION OF HYBRID COMPOSITE MOTOR CYCLE HELMET

FEA is the numerical solution tool for the engineers, scientist and researchers to solve any engineering problem through simulation to predict the product strength and durability etc, before launching the product to the market to save the cost.

Today's engineering and scientist groups depends on this method of solution before launching actual product into the market and this saves lot of money, time and human resources to them.

So the geometry model of the hybrid helmet has been imported to ANSYS Work Bench to generate FE model. Since the geometry has involved with many surfaces and curvatures. The discretization of the helmet has been done using the quadrilateral and triangular elements.

A. Mesh generation of hybrid helmet geometry

The CAD geometry has been imported to ANSYS art work bench then the floor of the geometry has been assigned with 3.5mm thickness essentially to provide real helmet ver sion.

Then from the engineering fabric directory, the preferred fabric homes had been decided on and assigned to the discredited model.

The geometry has been meshed with fine default element size capturing the smooth growth of elements in the curves with the quadrilateral and triangular elements.The records of the mesh generations have been tabulated in the below table. The mesh quality mayabeavery essential which virtually giv es theproper consequences asthe range offactors advanced, s o mesh density increases the accuracy of the consequences however will growths the computation time. So the analyst has to exchange the various factors and computational time.

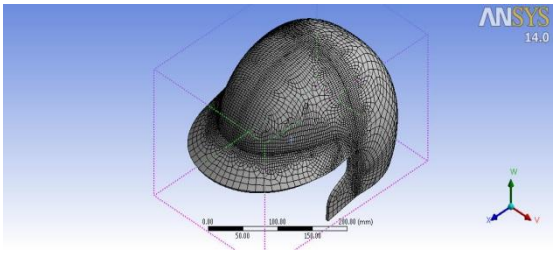

Fig 6: Shows the meshed Version of Hybrid helmet in Isometric View

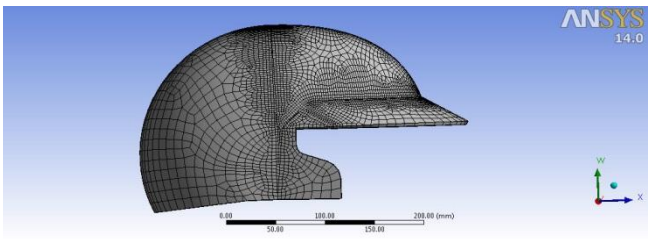

Fig 7: Shows the meshed Model of Hybrid helmet in sideview

Table 1: Indicates the mesh information of the hybrid helmet geometry

Hybrid helmet geometry- Mesh details		
S.No	**Type**	**Details**
1	Mesh type	Course default
2	Element size	Default
3	Hexahedron and tetrahedron	3D mesh
4	Total number of elements	9981
5	Total number of nodes	10035

B. Materials selected for the analysis

i. Polypropylene
ii. Polycarbonate
iii. Kevlar composite

Table 2: The below table suggests the houses of the hybrid helmet substances

S.N	Materials	Density in Kg/m^3	Tensile strength in Mpa	Poisons ratio
1	Polypropylene	1140	55-83	0.4
2	Polycarbonate	1190	55-75	0.37
3	Kevlar composite	1440	1430	0.23

C. Case 1-FE analysis of Hybrid helmet made of polypropylene shell material

The analysis starts with the well known material polypropylene as the outer shell of the hybrid helmet. The properties of the propylene are well published and the same material properties are used in the analysis and in this analysis polypropylene is used as the first material for the analysis because the material as the helmet already in use hence the results which comes base line results to compare alternative materials.

The structural assessment has been carried for the polypropylene material for the burden cases starting from 0N to 2000N in step of 1000N and the deformation, Von Mises stress and strains are acquired from the analysis and plotted as demonstrated within the below figures.The below figures shows the deformation plots of the polypropylene helmet shell material over the load range of 1000N and 2000N and deformation is found to 12.57mm, and 25.142mm, hence the deformations for the for the most load of 2000N is 25.142mm is observed to be the maximum for the load and may affect the rider.

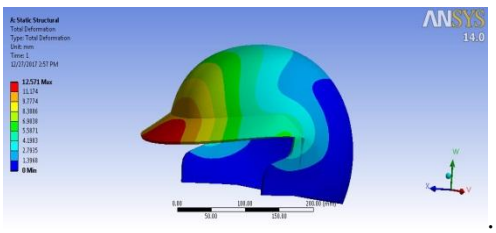

Fig 8: Shows the deformation of Polypropylene helmet forthe load of 1000N

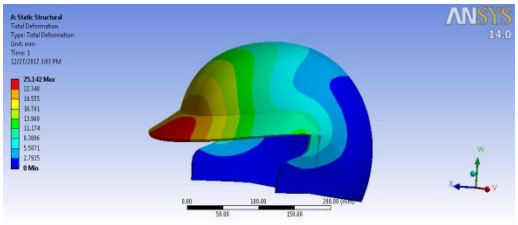

Fig 9: Shows the deformation of Polypropylene helmet forthe load of 2000N

The structural analysis over the polypropylene hybrid helmet shows that the Von mises stresses on the helmet shell for the load of 1000N and 2000N. The Von mises stress is found be 22.8Mpa and 45.75Mpa respectively.

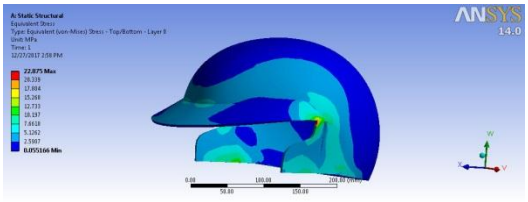

Fig 10: Shows the Von Mises stress of Polypropylene helmet for the load of 1000N

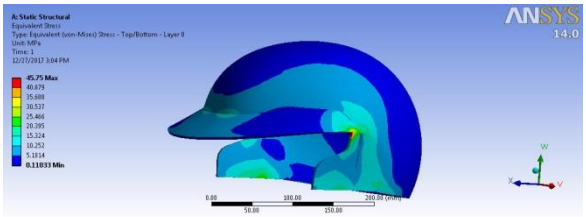

Fig 11: Shows the Von Mises stress of Polypropylene helmet for the load of 2000N

The below picture depicts the strain variation plots over the polypropylene hybrid helmet for the loads 1000N and 2000N, the strain over the helmet seems to be very less. And the maximum strain is depicted near the joint of ear protection. So even the stress is found maximum over that location of the helmet and it could be reduced by cornering the joint. The strain variation for the load cases is found to be 0.0199mm and 0.0398mm respectively

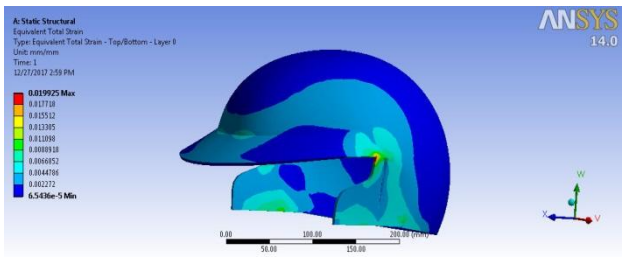

Fig 12: Shows the strain on Polypropylene helmet for the load of 1000N

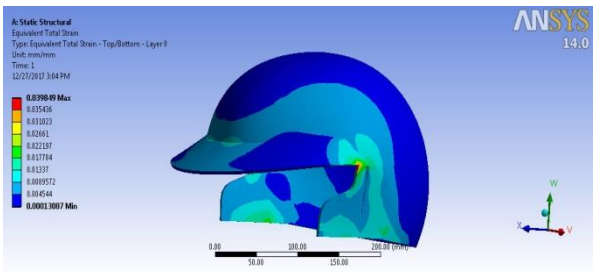

Fig 13: Shows the strain on Polypropylene helmet for the load of 2000N

D. Case 2-FE analysis of Hybrid helmet made of polycarbonate shell material

The structural evaluation has been carried for the polycarbonate material fabric for the burden cases starting from 0N to 2000N in step of 1000N, the deformation, Von mises strain and lines are obtained from the evaluation and plotted as shown inside the beneath figures. The below

figures shows the deformations plots of the polycarbonate helmet shell material over the load range of 0N to 2000N and deformation is found to 8.55mm and 12.67mm. Hence the deformation for the highest weight of 2000N is 12.67mm.

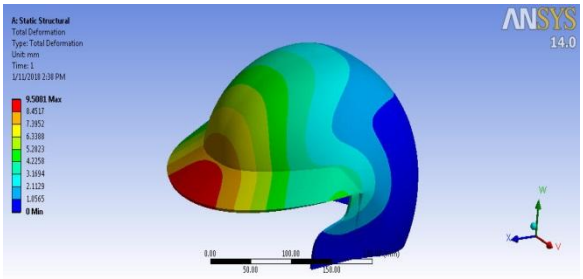

Fig 14: Shows the deformation of polycarbonate helmet forthe load of 1000N

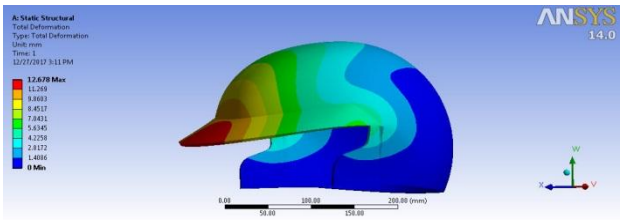

Fig 15: Shows the deformation of polycarbonate helmet forthe load of 2000N

The structural analysis over the polycarbonate hybrid helmet shows that the Von mises stresses on the helmet shell for the load of 1000N and 2000N is found to be 22.1Mpa & 45.83Mpa respectively.

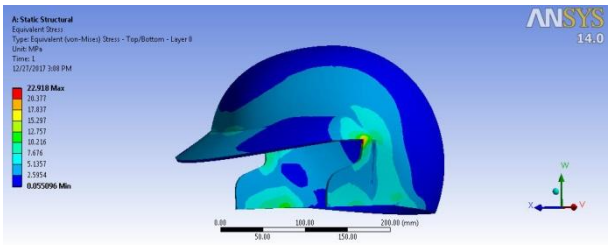

Fig 16: Shows the Von Mises stress of polycarbonate helmet for the load of 1000N

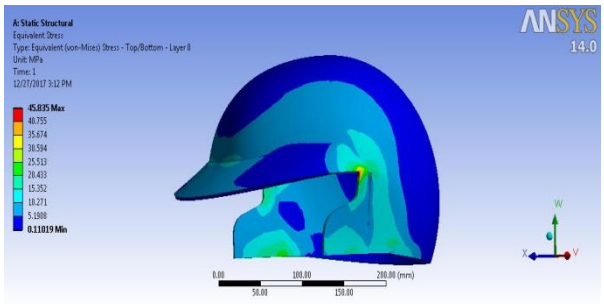

Fig 17: Shows the Von Mises stress of polycarbonate helmetfor the load of 2000N

The stress variation for the burden instances is located to be 0.01mm and 0.02mm respectively for the loads 1000N and 2000N

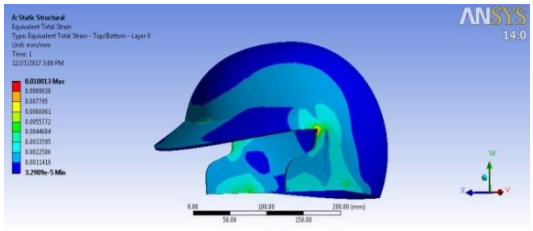

Fig 18: Shows the strain on Polycarbonate helmet for the load of 1000N

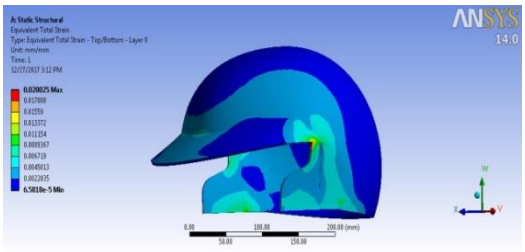

Fig 19: Shows the strain on Polycarbonate helmet for the load of 2000N

E. Case 3-FE analysis of Hybrid helmet made of Kevlar composites material

The below figures shows the deformations plots of the Kevlar composites helmet shell material for the load 1000N & 2000N, the deformation is found to 0.138mm and 0.2776mm. Hence the deformation for the maximum load of 2000N is 0.2776 mm.

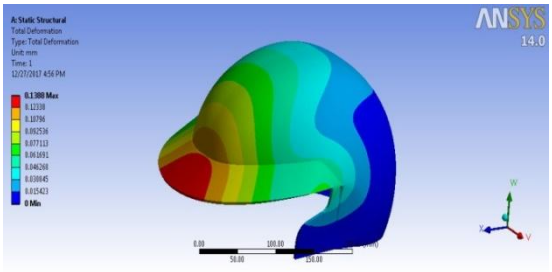

Fig 20: Shows the deformation of Kevlar composite helmet for the load of 1000N

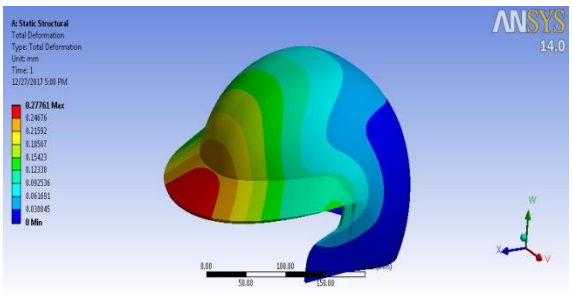

Fig 21: Shows the deformation of Kevlar composite helmet for the load of 2000N

The structural analysis over the Kevlar composite hybrid helmet shows that the Von mises stresses on the helmet shell for the load of 1000N and 2000N is found to be 22.92Mpa and 45.85Mpa respectively.

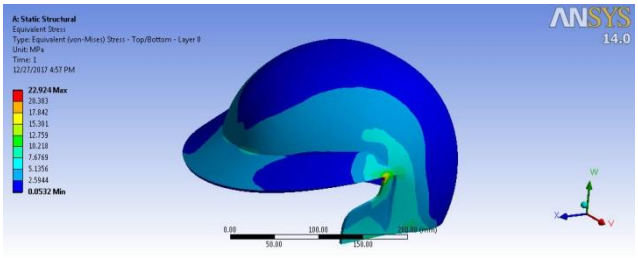

Fig 22: Von Mises stress of Kevlar composite helmet forthe load of 1000N

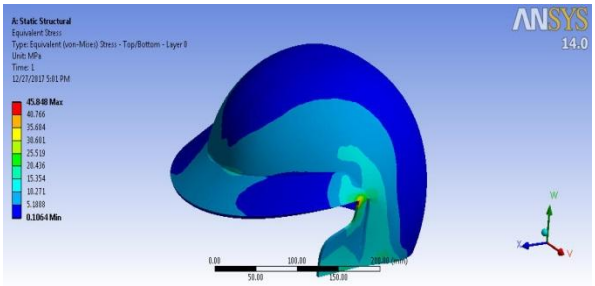

Fig 23: Shows the Von Mises stress of Kevlar compositehelmet for the load of 2000N

The below picture depicts the strain variation plots over the Kevlar composite hybrid helmet for the loads of 1000N and 2000N. The strain variation for the load cases is found to be 0.0002mm and 0.0004mm respectively for the loads 1000N and 2000N.

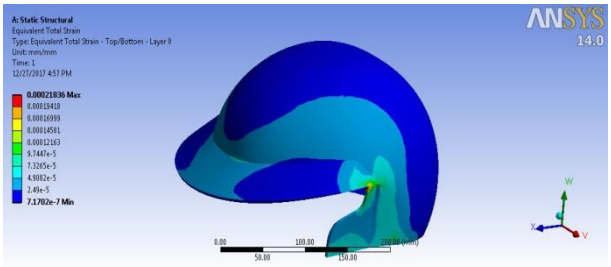

Fig 24: Shows the strain on Kevlar composite helmet for the load of 1000N

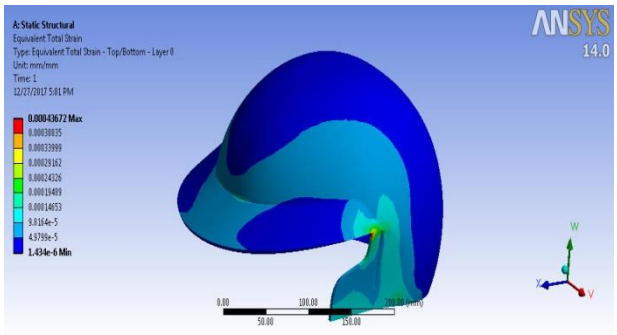

Fig 25: Shows the strain on Kevlar composite helmet for theload of 2000N

V. RESULTS AND DISCUSION OF STRUCTURAL ANALYSIS ON HYBRID HELMET

The linear structural analysis has been carried on the 3 helmet substances as it's mentioned in the above section. Now it's the time to discuss the finding of the intended work to the extent where one can make decisions on the selection of the alternate material for the helmet. Hence the results so obtained from the previous section are tabulated and plotted graphs to interpret appropriately the proper material for the hybrid helmet. From the structural analysis the following outcomes have been acquired and are tabulated within the beneath tables.

a. Deformations
b. Stresses
c. Strains

Table 3: Shows the load versus deformation values forall the materials of the work and deformations are measured in mm

S.No	Loads in N	Polypropylene	Polycarbonate	Kevlar composites
1	0	0	0	0
2	1000	12.57	8.55	0.138
3	2000	25.142	12.678	0.2776

From the analysis it is seen that, the above all helmet materials, out of that the Kevlar composites shows the least deformation for the load ranging from 0N to 2000N in steps of 1000N. And it's also quite visible that for the composite, the contortion being less and this shows the helmet with the material Kevlar composites, shows much extraordinary and have influence insurance from the associated load, and this also shows that the essentialness fascinating breaking point of the composite material is more than those of the conventional helmet materials.

Table 4: shows the load versus Von Mises stress values forall the materials of the work and stress are represented in Mpa

S.No	Loads in N	Polypropylene	Polycarbonate	Kevlar composites
1	0	0	0	0
2	1000	22.875	22.91	22.92
3	2000	45.75	45.83	48.848

As the above table shows us, the Von Mises stress values for the load instances of the work and its seem that the stress levels being roughly identical, but the Kevlar composite exhibits more yield stresses at higher loads. This makes experience that composites might be used due to the fact the possibility substances over the conventional materials.

Table 5: shows the load versus strain values for all thematerials of the work

S.No	Loads in N	Polypropylene	Polycarbonate	Kevlar composites
1	0	0	0	0
2	1000	0.01998	0.01	0.000218
3	2000	0.0398	0.02	0.000436

So the next results are the load versus strain diagrams. The values of the strain suggests that the for the Kevlar composites the lines are very much less for the weight cases, this suggests their stiffness and durability houses of the composite material and hence as its well known fact that the composites also exhibits the highest tensile strength and impact toughness. Because of its strength to weight ratio, high impact strength, easiness of handling and manufacturing.

VI. CONCLUSION

For the duration of the thesis the principle goal was to locate the alternative material for the user friendly rider helmet. Hence the evaluation has been achieved to keenly notice the structural strength of the diverse present helmet material. So the studies started with the materials like polypropylene and polycarbonate.

But the structural evaluation shows that the deformation to the weight is greater and therefore the durability and effect resistance appears to be much less. Then the stress levels being same inside the traditional substances gives chance for the alternate materials.

Then in search of better alternative helmet material, the other material is Kelvar composite, also analysed for the various load cases. Since the Kevlar composite very low weight and have high impact resistance compared with already existing materials. The same is seen through the FE simulation von Mises stresses almost same in the previous materials as well as in Kevlar composite. The deformation and strain is less in Kevlar composite helmet material compared with the existing materials. So we can select Kelvar composite material as another alternate helmet material.

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