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A Comparative Review of Performance of an Army Helmet Design & Material

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Abstract

In this paper, the continuous development of an army helmet and modifications in its design adapted in last decay by various researchers were studied and trying to suggest the best material and the design for the army helmet. This study is basically a comparative review of different research works according to some parameters i.e. comfort, fitting, weight, maintainability, ballistic limit, material etc.

Keywords: *Advanced combat helmet, Personal armor system for ground troops, Kevlar ®, AUTODYN-3D®, Fragment simulating projectile, Ultrahigh molecular weight polyethylene, Carbon nanotubes, Ballistic impact,*

INTRODUCTION

In this era of advancement, many designs and materials have to be adopted by various persons for army helmet. Each of them suggest a best design as well as most suitable material accordingly. In this paper some of previous research work has studied and trying to found the most suitable design as well as material for army helmet. Also try to find the demerits/drawbacks in the design and material of army helmet and how to improve that one.

According to Brain J. Ivins [1], ACH (advanced combat helmet) is more satisfactory design than PASGT (personal armor system for ground troops) helmet but it has frequently experienced problems related to malfunctioning parts. PASGT is not more comfortable as compare to ACH.

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On the other hand, if we consider the material aspect, Kevlar®[2] is the most suitable material for the replacement of all lighter fibre materials of 21stcentury which is capable to defeat a 9 mm FMJ (full metal jacket) striking at the top of helmet as well as side impact. In the ballistic impact test, a stainless steel spherical projectile of different masses struck on the back and top of the helmet at different velocities. The AUTODYN-3D® simulation indicated that the Kevlar® helmet can provide the protection against a FSP (fragment simulating projectile) travelling up to a maximum velocity 610 m/s.

New researchers continuously studied and modified the design of helmet regarding various parameters i.e. mechanisms for ballistic energy absorption, effect of curvature of helmet, helmet sizing and fittings etc. S. G.Kulkarni [3] found that the curvature of helmet has a significant effect on the ballistic limit. Also ballistic performance measures of conventional helmet materials (such as Kevlar®K29,K129fibre and thermoset polymers) and new materials like UHMWPE(ultrahigh molecular weight polyethylene), thermoplastic polymers, Nano-composites and CNT's(Carbon nanotubes) are elaborated in view of weight, tensile properties, energy absorption capabilities, manufacturing ease, cost effectiveness, and environmental concerns. It has become known that UHMWPE/ carbon fibre composites can provide higher ballistic protection at a reduced weight than the composites used in the current helmet. Polymer matrix Nano composites, especially those reinforced by carbon nanotubes can potentially offer the highest ballistic protection. However, their viability in terms of manufacturing, feasibility and cost effectiveness needs to be further explored.

Methodology:

A no. of researcher's working in the field of modification and modernization of an army helmet. Since last two decays some of the most efficient design as well as materials have been found by researchers. In this research paper different research papers were studied and compare them according to various parameters and try to found the best material and design to for army helmet.

According to Brain J. Ivins [1]. two different helmets ACH&PASGT were compared on the basis of some parameters i.e. comfort, fitting, weight, maintainability etc. and results are shown as in figure 1.

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According to this survey number of problems identified in ACH & PASGT that was frequently reported by the soldiers. Both type of helmet problem is enlisted below:

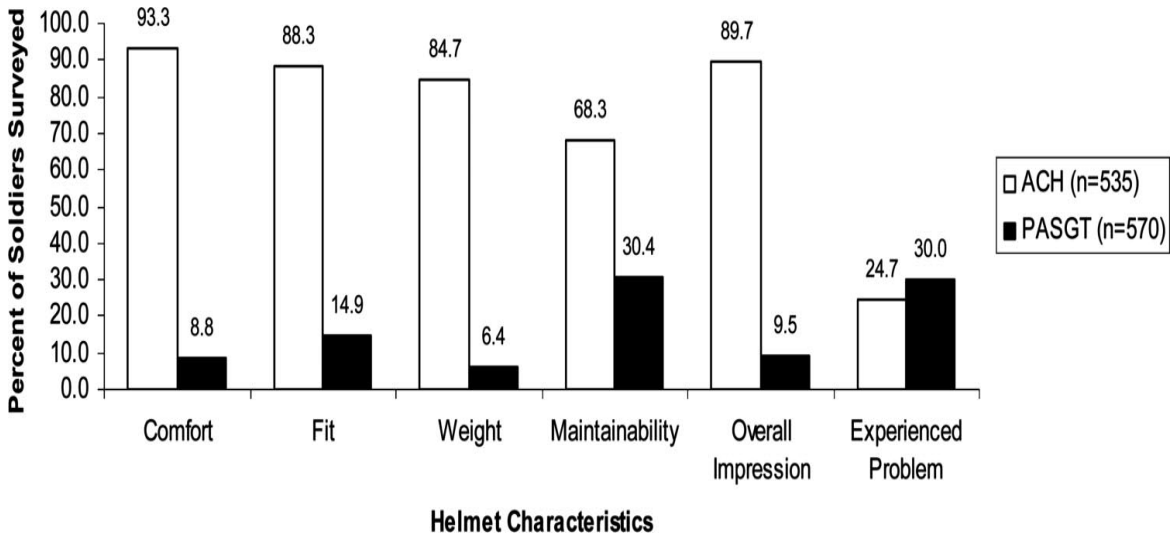


Fig 1 Percentages of ACH and PASGT users who were satisfied with their helmets, according to helmet characteristics All differences between the ACH and PASGT were statistically significant. (p<0.001)

Table 1 Types of problems identified for the ACH

Problem Types	**Percentage of *ACH* users with helmet problems (n=132)**	**Percentage of all *ACH* users (n=535)**
Loose screws	44.7	11.0
Loose/broken straps	23.5	5.8
Hard/loose pads	16.7	4.1
Spare parts unavailability	14.4	3.6
Heat retention	6.1	1.5

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Poor fit	2.3	0.6
Falls of head	2.3	0.6
Other	4.5	1.1

Table 2. Types of problems identified for the PASGT

Problem Types	**Percentage of *PASGT* users with helmet problems (n=169)**	**Percentage of all *PASGT* users (n=570)**
Causes Headaches	20.7	6.1
Too heavy	18.9	5.6
Uncomfortable	16.0	4.7
Poor fit	13.6	4.0
Uncomfortable straps	12.4	3.7
Causes cuts and skin irritation on head	11.2	3.3
Loose screws	5.9	1.8
Causes neck/back problem	5.9	1.8
Difficulty shooting from prone position	5.3	1.6
Problem with webbing	4.7	1.4
Problem with night vision equipment	3.0	0.9
Heat retention	3.0	0.9
Interferes with body armor	2.4	0.7
No padding	2.4	0.7
Restricts hearing	2.4	0.7
Fall of head	2.4	0.7
Other	6.0	1.8

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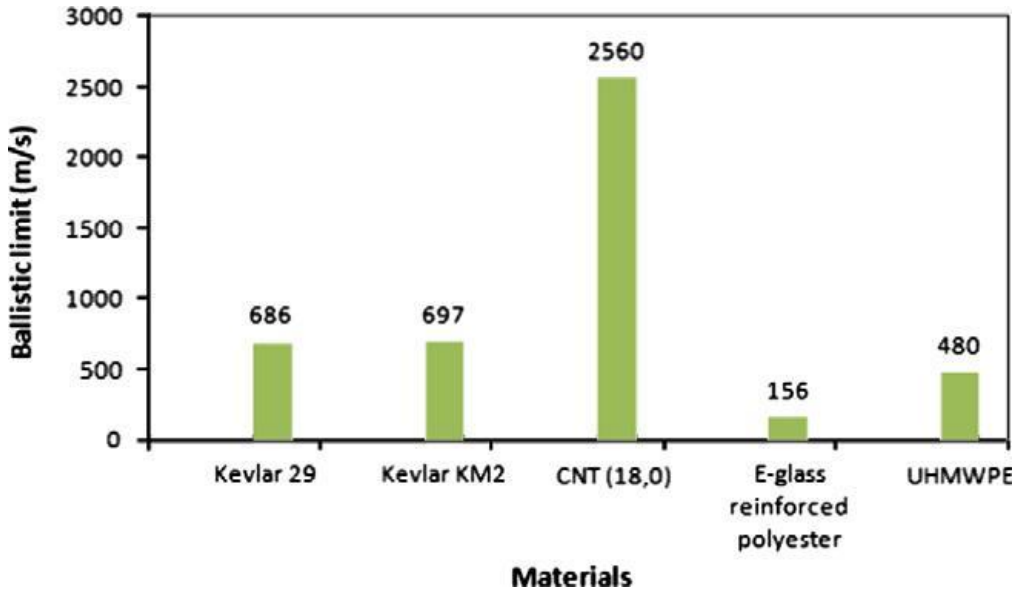


Fig. 2 Ballistic limits for various materials (e.g., [5,6]). The value for the CNT was based on molecular dynamics simulations [4]

After this research C. Y.Tham [2]& his team suggest a new material Kevlar® for the army helmet which is sufficient to capable to defeat a 9 mm FMJ striking on the helmet at the velocity 610 m/s. the ballistic resistance of the Kevlar® helmet is assessed using hydro-code simulations. The simulation is carried out using AUTODYN-3D®.

Further new research in the year 2013 by Kulkarni was done on various materials and found the ballistic limit for them. The value for CNT was based on the molecular dynamic simulation [4].

CONCLUSION

This study shows that the best army helmet material is CNT which provide highest ballistic limit of 2560 m/s and ACH is the most suitable helmet for army according to various parameters. Hence the ACH made by CNT's is the best combination which is highly satisfy the need of soldiers and greatly reducing the risk of sustaining a brain injury.

FUTURE WORK

The design and material of army helmet are well studied up to date. But this research is not so clear about the force distribution on

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the brain of soldiers while bullet is strike on the helmet at very high velocity. Also the force/load carrying capacity of various army material combinations with different layers can be analyzed with the help of various cad software.

REFERENCES:

1. Ivins BJ, Schwab KA, Crowley JS, McEntire J, Trumble CC, Brown FH, et al. How satisfied are soldiers with their ballistic helmets? A comparison of soldiers' opinions about the advanced combat helmet and the personal armor system for ground troop's helmet. Mil Med 2007; 172(6):586–91.

2. Tham CY, Tan VBC, Lee HP. Ballistic impact of a KEVLAR helmet: experiment and simulations.Int J Impact Eng2007; 35:304–18.

3. Kulkarni SG, Gao XL, HornerSE, ZhengJQ, David NV. Ballistic helmet-their design, materials and performance against traumatic brain injury. Composite structure 2013;101:313-31.

4. Mylvaganam K, Zhang LC. Ballistic resistance capacity of carbon nanotubes. Nanotechnology 2007;18(47):5701–4.

5. David NV, Gao X-L, Zheng JQ. Ballistic resistant body armor: contemporary and prospective materials and related protection mechanisms.ApplMech Rev 2009;62(5). 050802-1 20.

6. Song, JW. Thermoplastic composite for ballistic application. Ph.D. dissertation. University of Massachusetts at Lowell; 1986. 118 p.

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