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Description of Modification of Armor Protection for Helicopters

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Abstract: In case of some danger realization in helicopter usage area for passive protection of the crew, passengers or troops on board, as same for protecting of some electronic units and engines , a set of ballistic protection is likely should be used. In this study lightweight armoring equipment based on the modern technologies and suitable for military helicopters is tackled.

Index terms: Armor, Armor Materials, Armor Protection, Helicopter Armor, Armor Plate.

I. INTRODUCTION

Over recent years the governments of many advanced countries (mainly among the armies of NATO member states) pay a great attention to humanitarian missions and to peace keeping operations in fight against terrorism. The results of the research and development of advanced materials with enhanced ballistic protection as well as armor protection systems are immediately applied on protection of soldiers and newly developed military equipment. Because of the strict requirements on the tactical mobility and airlift of military vehicles, the further increase in the armor weight is unacceptable. However, the weight reduction is the program priority in spite of continuous increase of the antiarmor weapon penetration capability. The change of conditions of military equipment usage is connected with the change in priorities in the area of its protection. In accordance with experience achieved from last humanitarian missions the main emphasis is placed on protection against sudden impact of blast waves at explosions of mines together with assurance of protection against small arms and splinters at least. Combat vehicles, fighter aeroplanes and helicopters have to be designed in such a way as to provide an optimised ballistic protection, armament and mobility according to the rational needs outgoing from analysis expected activities [6].

Figure 1: McDonnel Douglas AH-64D Longbow Apache demonstrator is seen carrying a full weapons load of 16 Hellfire missiles during a pres demonstration in the mid 1990s. By 1997 this helicopter was wearing Boeing titling [2]

Utility helicopters like Mi-17 or UH-1 are not armored comparison with attack/fighter ones like Ka-52 or AH-64. Forinstance, The Apache is heavily armored on all sides (Figure 1). Some areas are also surrounded by Kevlar soft armor for extra protection. The cockpit is protected by layers of reinforced armor and bulletproof glass. According to Boeing, every part of the helicopter can survive 12.7-mm rounds, and vital engine and rotor components can withstand 23-mm fire.

Table 1. Ballistic protection levels and materials [3]

Item	Quantity	Ballistic resistance according US NIJ standard	Shot gun, ammunition, velocity, range	Material
Armored steel plates (floor protection)	2 pcs	III+	308 Winch 7.62x51 nato ball 15m AK-47 7.62x39 MSC 715m/s 20m M-16 5,56x45 SS109 1000m/s 20m AK-74 5,56x39SSC 870m/s 20m	Armox 500Carbon steel
Bullet proof glass (front protection)	1 pcs	III	308 Winch 7.62x51 nato ball 15m AK-47 7.62x39 MSC 715m/s 20m AK-74 5,56x39SSC 870m/s 20m	Multilayer armored glass
Ceramic composite panels (side protection)	6 pcs	III+	308 Winch 7.62x51 nato ball 15m AK-47 7.62x39 MSC 715m/s 20m M-16 5,56x45 SS109 1000m/s 20m AK-74 5,56x39SSC 870m/s 20m	SIC aramid
Dyneema panels (floor protection)	12 pcs	III+	308 Winch 7.62x51 nato ball 15m AK-47 7.62x39 MSC 715m/s 20m M-16 5,56x45 SS109 1000m/s 20m AK-74 5,56x39SSC 870m/s 20m	Dyneema HB26/HB80
Dyneema panels (overhead protection)	2 pcs	III+	308 Winch 7.62x51 nato ball 15m AK-47 7.62x39 MSC 715m/s 20m M-16 5,56x45 SS109 1000m/s 20m AK-74 5,56x39SSC 870m/s 20m	Dyneema HB26/HB80
Ceramic composite (overhead protection) panels	4 pcs	III+	308 Winch 7.62x51 nato ball 15m AK-47 7.62x39 MSC 715m/s 20m M-16 5,56x45 SS109 1000m/s 20m AK-74 5,56x39SSC 870m/s 20m	SIC aramid

The area surrounding the cockpit is designed to deform during collision, but the cockpit canopy is extremely rigid. In a crash, the deformation areas work like the crumple zones in a car they absorb a lot of the impact force, so the collision isn't as hard on the crew. The pilot and gunner seats are outfitted with heavy Kevlar armor, which also absorbs the force of impact. With these advanced systems, the crew has an excellent chance of surviving a crash [1].

Figure 2. Outside ceramic composite panels [3]

Figure 3. transport version with modified self – defence equipment [4]

On the other hand, if it is aimed to change protection features utility helicopters, offered protection kit provides reliable ballistic protection against most widely used light infantry carried guns and munitions. Usage of latest synthetic composites and high-performance polymer (ultra high molecular weight polyethylene) fibers made possible to create modern lightweight armor for use in aviation. Offered panels are corrosion and abrasive resistant. Excellent strength-to-weight ratios of these materials (in a range from 10 times higher than for steel) makes it very important feature in helicopter use due to influence to flight and fuel consumption characteristics. Protection panel mounting system improves simple remove of panels and it does not interrupt maintenance procedure.

I. AERODYNAMIC SHAPE

Unique thermoplastic technology provides capability to manufacture aerodynamically shaped ceramic panels. Unless usual steel armor, shaped exterior armor provides better ballistic coverage, less drag and better fuel economy performance.

Figure 4. Outside ceramic composite panels installed [3]

Ballistic protection panels are made of lightweight ceramics SiC/aramid and Dyneema polyethylene fiber (Table 1) [3]. A lot of ceramic composite panels provide side protection of the helicopter like Mi-17

or AH-64 crew and are placed on special mounts outside the cockpit, fixed by screwed fixers (Figure 2; 3; 4).

Bulletproof glass is installed on special frame inside the cockpit between the front windows and instrument panels (Figure 5). That gives pilots front protection and good visibility.

Figure 5. Front panel with bulletproof glass [3]

II INTERIOR PLATES OF AIRBORNE SYSTEM

Armor plates used in following areas in a helicopter.

- Pilot seat protection
- Floor protection. (Figure 6)
- Side protection
- Chin bubble protection
- Gunner port protection
- Other areas

These light weight armor applications are of a specified weight, thickness and project certain chemical and mechanical properties that are important for the specific applications and in-field requirements for which they are made. These panels supplement the basic hull of the airborne system in order to achieve the specified ballistic performance or to meet a given specification.

Figure 6. Front panel with bulletproof glass [5]

So it would be protected against the danger of small handguns, assault rifles, armor piercing ammunitions, fragments, Heavy Machine Guns and the other threat standards to helicopter.

III DESIGN OF LIGHTWEIGHT ARMOR

The architecture of the component for blast protection has to be optimally designed with respect on required properties and expected effect. A typical lightweight component for ballistic protection should consist of (as shown in Figure 7):

- Surface layer capturing the pieces of fragmented ceramics
- layer of ceramic plates
- both absorption and adhesive layer of metallic foam reinforced with expanded stainless steel sheet
- layer of primer armor
- Pilot seat protection

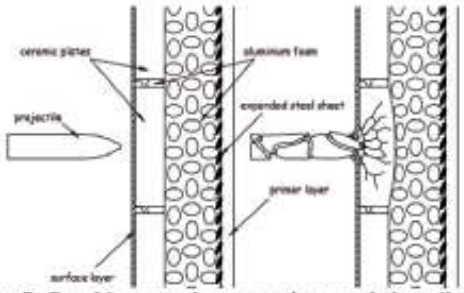

Figure 7. Outside ceramic composite panels installed [6]

The adhesive layer of aluminium foam reinforced with expanded stainless steel sheet is suitable for this purpose because of its enhanced ability to absorb blast energy. This layer provides damping of impact on the ceramics without transmission of stress peaks onto the neighbouring plates. The reinforced aluminium foam creates not only a tight bed for the ceramic plates but enables also the diffusive bonding of Al-foam with surface metal sheet. This multilayer armor can be therefore prepared during foaming in one technological step, which makes the production cost-effective. Moreover, the absence of adhesives between ceramic and foam make the armor fireproof, heat resistant and non inflammable. The sheets can be prepared as flat panels or shaped shields. The layer

of primer armor should be the steel sheet or composite material with polymer matrix, eventually combination of both. The advantages of multilayer armor can be summarized as follows:

- considerably larger area of foam is deformed by using ceramic plates from impact side
- ceramics reduces penetration effect of projectile by blunting of its sharp spike
- undesirable tensile stresses can be minimized by reinforcing of foam with expanded steel sheet from backward side
- ceramic plates are tightly embedded in the aluminium foam - drop out of fragmented ceramics is avoided
- foam provides damping of impact on the ceramics without transmission of stress peaks onto the neighbouring plates
- aluminium foam enables diffusive bonding of absorption layer with surface metal sheet
- multilayer armor can be prepared during foaming in one technological step
- absence of adhesive increases temperature resistance of the armor [6].

IV. CONCLUSION

With the development of lightweight armors, they have been able to use in helicopters like UH-1, Mi-17, UH-60, Cougar etc. These armor sets can be mounted on a helicopter in only 20 minutes. plates are done by screwing the corresponding region. So a helicopter to go to the conflict zone, can be easily secured.

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