FLYING OBJECT ARMOUR CONCEPT ANALYSIS BASED ON HELICOPTER

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ABSTRACT

Medium helicopter armour concept is discussed. Basic analysis of armour configuration on helicopter fuselage is described. Important zones and requirements for their protection are analyzed as well. Aerodynamic characteristics of medium helicopter are obtained using numerical simulation and wind tunnel tests.

1. INTRODUCTION

Helicopter armour needs some compromises. Armour must provide proper protection level for crew and helicopter components and has to be as light and as dense as possible due to mass requirements. In Cobra, Apache or Mi-24 helicopters, armour is made as integral part of helicopter fuselage (Mi-24, fig 1 and 2)

Figure 1. Mi-24 helicopter – example of armour integrated with fuselage of the helicopter (photo: Wikipedia)

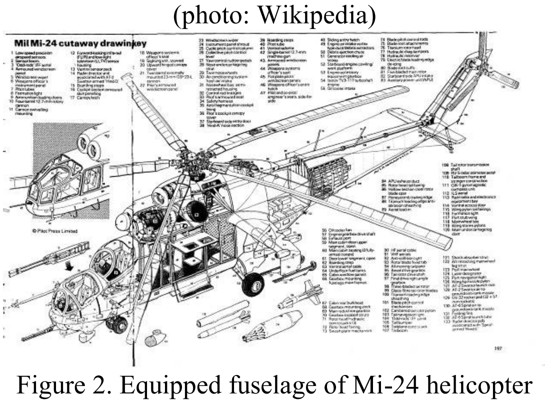

Figure 2. Equipped fuselage of Mi-24 helicopter (photo: Wikipedia)

In case of multipurpose helicopters used both in transport, medical and combat missions, external armours (built around helicopter fuselage) or internal armours (built as protective screens for transported cargo) are used. These armours are generally protecting against fire from small or medium calibre machine guns (Mi-17, fig. 3)

Figure 3. Mi-17 helicopter with Dyneema RQ-4 armour plates (photo: Wikipedia)

2. HELICOPTER ARMOR REQUIREMENT.

For multipurpose helicopter armour protection concept phase, design team based on experience and test methodology recommended by ,,Standardization Agreement - 4569" (STANAG) for light armoured vehicles.

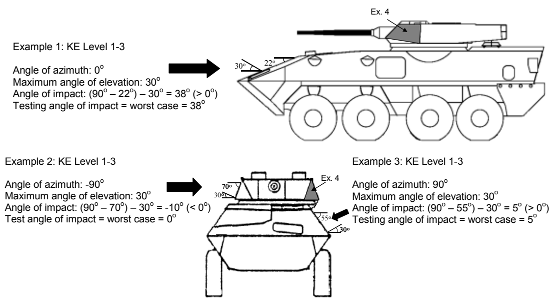

Figure 4. Demonstration of the determination of angles of impact for sloping plates on actual vehicles. The impact angle of the artillery threat may be established using the same methodology but applying 360° of azimuth and the elevation specified for each Protection Level defined in Appendix 1 STANAG 4569 .

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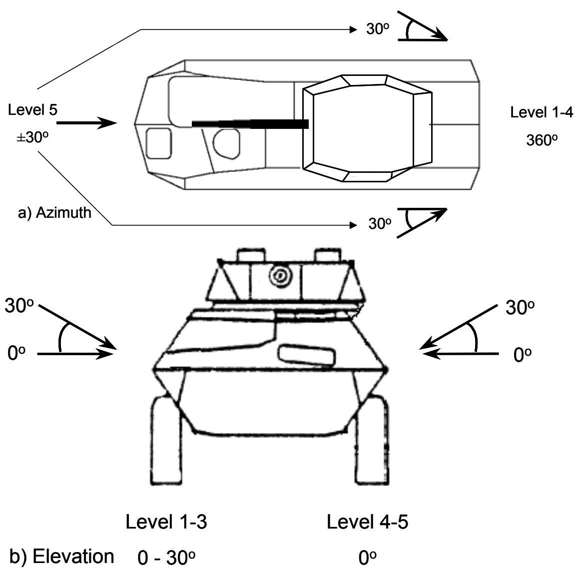

Figure 5. Attack angles defined in Appendix 1 STANAG 4569 for the Kinetic Energy Protection Levels

3. HELICOPTER ARMOUR CONCEPT.

Proposed armour concept concentrates on bullet protection of cockpit (pilot + special instrumentation operator) as well as on protection of main systems of the helicopter such as radio-electronic devices compartments/bays, main gear reducer and engines. It will be possible by using flat plates made of multilayer Ultra-High Molecular Weight Polyethylene (UHMWPE) Dyneema SB 21 with energy absorption coefficient Eabs" > 245 J/(kg/m2) for cockpit protection and radio-electronic devices compartment. Total area of external armour will be equal to 12,48[m^2]

Cargo bay will be protected by soft screen made out of kevlar fabric reinforced with ceramic inserts, which protect from 7,62[mm] and 12,7[mm] calibre machine gun bullets. Total area of soft armour will be equal to 11,12[m^2]

Armour of areas exposed to high temperature engine exhaust gases from turbine engines will be made out of Titanium plates (1,66[m^2] total area).

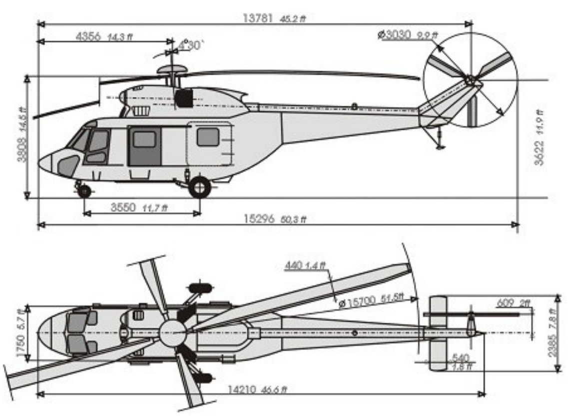

Figure 6. General geometry of Helicopter

In helicopter mass balance, statistically speaking, armour is around 20÷30% of payload. This size of additional mass possibly slightly decrees performance properties such as climb speed and range, which are important parameters in terms of tactical applications.

Transparent surfaces of the helicopter has been reduced to smallest dimensions as possible, reducing the area of hitting inside of the helicopter and these areas will be secured by polycarbonate plates.

The front part of the helicopter, due to the small angular velocity relative to earth movement, when frontal gunfire emerges, requires particularly careful protecting, both for technical and psychological reasons, what gives reason for placing large percentage of the armour in front section of the helicopter (above 90%).

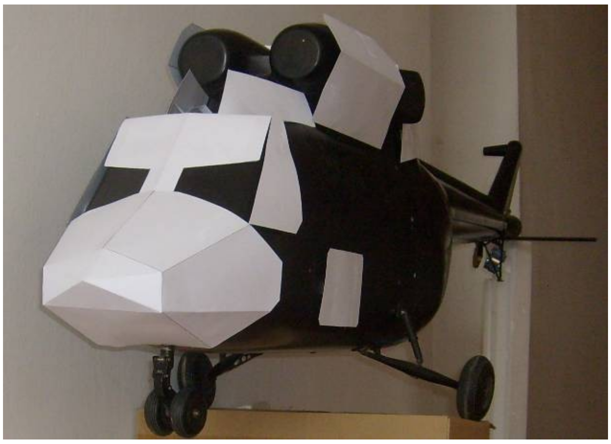

Figure 7. Concept of 6 tons take off mass helicopter armour (model)

Figure 8. Front view of armour installed on helicopter model (model used in wind tunnel tests)

4. ARMOUR INFLUENCE ON AERODYNAMIC CHARACTERISTICS OF HELICOPTER

The additional armour mounted on a helicopter fuselage changes its external geometry. This fact leads to change of object's aerodynamic characteristic.

To obtain aerodynamic characteristics of the tested object the commercial code FLUENT has been used. Simulations were done for Mach number M=0.1 and selected angles of attack. Two configurations are tested. The first one is the clean helicopter geometry - basic configuration. The second one is the armoured helicopter configuration.

In the Figure 9 the numerical meshes for both tested configuration are presented.

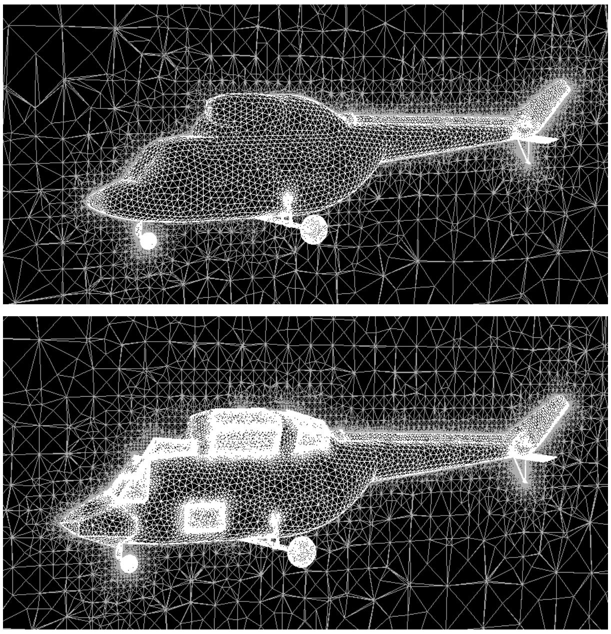

Figure 9. Numerical mesh for basic configuration (upper) and armoured configuration (lower)

The size of numerical meshes are: 0.8 mln cells for baseline and 1.5 mln cells for armoured geometry respectively.

During the simulation basic flow parameters of flowfield over the objects are analyzed. In the Figure 9 the static pressure on the helicopter surface are presented. In the Figure 10 the Mach number distribution in symmetric plane is shown. It can be seen that on the upper surface of fuselage by the front armour there are flow separation region.

For each tested case the basic aerodynamic forces were calculated. The influence of helicopter armour on aerodynamic characteristics is analyzed for selected cases (conditions). For example for angle of attack α=0, the lift coefficient is near for both configurations but drag coefficient for armour configuration is 25% higher than for basic configuration.

In next step of the analysis the wind tunnel test both configurations will be done.

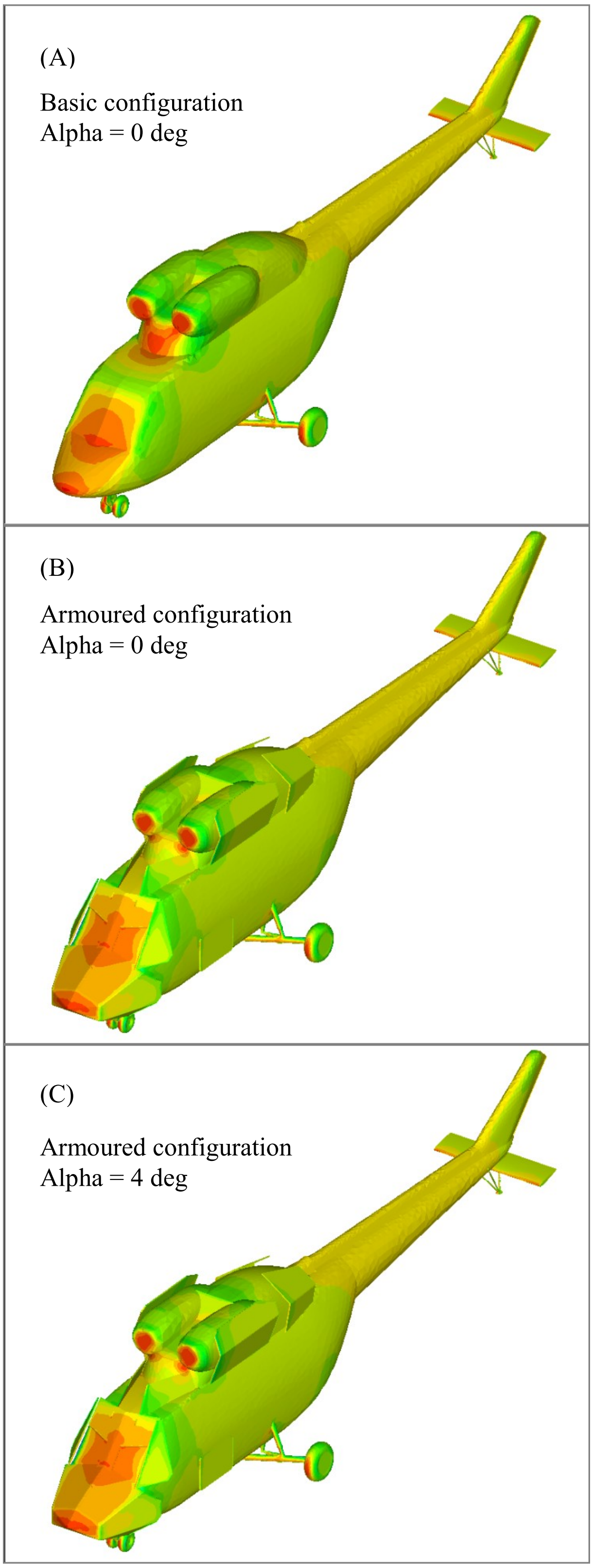

Figure 10. Static pressure distribution on helicopter surface for basic configuration (A) and armoured configuration (B) and (C)

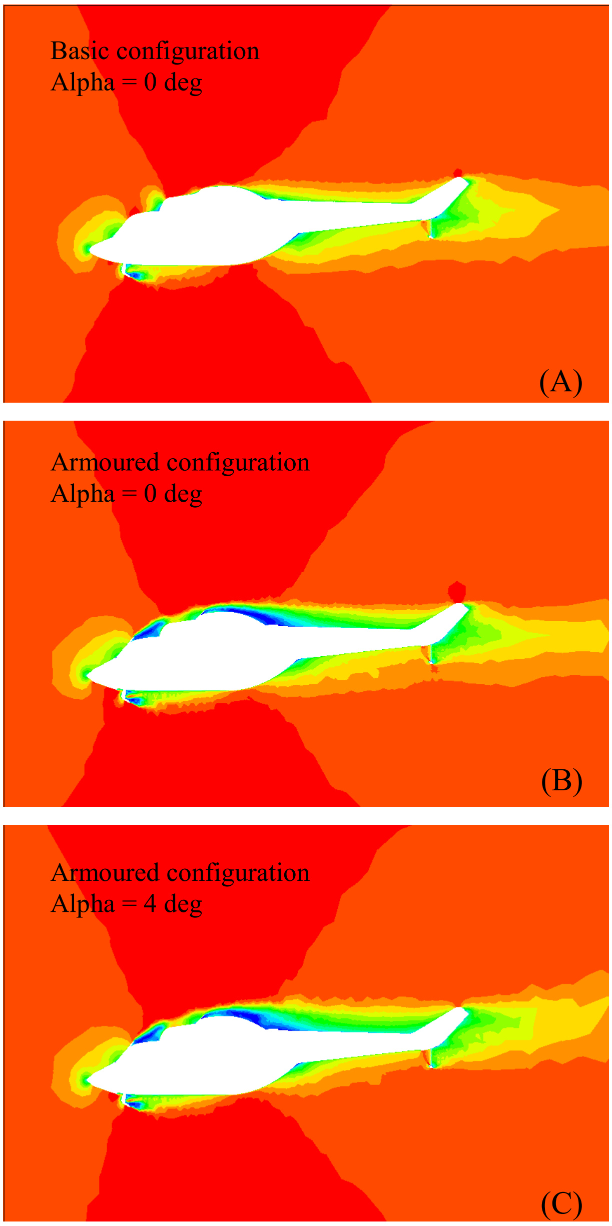

Figure 11. Mach number distribution in symmetric plane for basic configuration (A) and armoured configuration (B) and (C)

5. SUMMARY

Protection of flying objects is very difficult. Due to rigorous mass requirement and specific external shape (profile highly optimized during designing), any even small modification of the mass, redistribution of CG or external shape can lead to dramatic decreasing functionality, safety or performance. From the other side operation condition quite often required additional protection of the flying object to provide acceptable safety level for the crew and important subsystems. Article presents initial stage of armour developing for 6T helicopter. Three faze are described: literature study, armour concept build on model, CFD analysis and initial preparation to model based wind tunnel tests. All these steps was done to provide preliminary answers concerning sensitivity and stability of the flying object under modifications caused by eventual armour installation.

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