Comparative Tests with a modified "PK17dynA" for an Integrated Assessment of Ballistic Backface Deflections on Combat Helmets

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Abstract

The present study continues a scientific project dealing with experimental investigations on dynamic back face deflections caused by ballistic impact on combat helmets and the effect to the human skull. The preceding work, published at Personal Armour Systems Symposium 2016, showed the new measurement setup "PK17dynA" for ballistic impact tests on combat helmets. The test setup consists of a polyamide headform and an integrated measurement field with 17 piezoelectric force transducers. In the publication some first force-time-sequences of 9mm bullets fired on the left lateral side of two different types of helmets were presented.
Following the presented results, functional and comparative test series with the measurement system "Pk17dynA" were conducted. The present paper provides total force values determined by firing 9 mm Luger on aramid and polyethylene helmets as well as 1.1 g FSP on aramid helmets on 4 different impact locations. To compare measurement values with the commercially available "Ballistic Load Sensing Headform" (BLSH), an additional test series using a modified version of the Pk17dynA, including PU-cover, is presented. The modified system delivered suitable measurement results and a good approximation of the two test setups could be shown. Differences of curve progressions are pointed out by using an improved version of the analysis software. The interpretation of the results presented in this paper reconfirmed theories regarding the differences of the material behaviour. The detected variabilities are mainly depending on the helmet type, the chosen type of ammunition and the alignment of the whole test setup. A disadvantage was the lack of precise alignment possibilities of the headform to the line of fire, which lead to additional deviations. The results of the comparative tests with Pk17dynA and BLSH show the suitability of the presented modified headform for potential investigations on different defined boundary layers between helmet and head.

Time histories of the force measurements obtained with the sensors are subsequently used as loading conditions on a state-of-the-art Finite-Element Model of the human head (SUFEHM).

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Further Simulations and the prediction of injury risks need to be considered in future analyses.

Keywords: Ballistic Experiments, Combat Helmets, Backface Deflection, Measurement Headform, Force Transmission, Finite Element Simulation, Biomechanics