EXPERIMENTAL INVESTIGATION ON PILOT-GLIDER SYSTEM CRASHWORTHINESS AND SAFETY

[1]Łukasz Lindstedt, [1]Cezary Rzymkowski, [1]Krzysztof Kędzior

[1]Warsaw University of Technology, Institute of Aeronautics and Applied Mechanics, Warsaw, Poland,

email: czarek@meil.pw.edu.pl, web: www.pw.edu.pl

INTRODUCTION

Nowadays the lack of experimental data, necessary for designing modern and more safe gliders, has became a very important problem. According to the rules for gliders covered by the JAR-22 [1] the glider design should prove the safety of pilot during correct landing procedure (with the defined level of vertical speed) and/or during a „hard landing", when levels of acceleration and forces affecting the pilot do not exceed "acceptable" values. However, a small number of accidents involving casualties as well as relatively weak interest in the crashworthiness issues caused that crash tests of gliders are not obligatory and, as a consequence, no procedures associated with crash accidents were established.

The presented problems allows one to formulate the following research aims:

- Collecting data on the loads acting upon the human body (accelerations and forces) and upon a glider cockpit structure during the "hard landing" process, including such dynamical issues as load history, strain and damage propagation;
- Providing the data that allow for validation of a numerical model of the pilot-glider system during the impact;
- Formulating suggestions for aviation authorities that could be useful in the process of issuing regulations on crashworthiness of the glider.

METHODS

The test was performed in the Automotive Industry Institute in Warsaw. The original glider PW-5 cockpit with a dummy (Hybrid-II) inside was crashed at the speed of 54.7 km/h onto a ground at the angle of 45 degrees (Figure 1). Such a configuration was selected as a result of preliminary studies and analyses [2].

The ground barrier was represented by a special cage, full of congested soil and covered with grass. The glider was represented by the original PW-5 cockpit with elements of the fuselage, while the wings and tail cone were modeled by elements of proper weights fixed onto the cockpit.

In the course of experiment signals from 34 channels of measurement gauges were recorded; additionally, the whole process was filmed using three high-speed cameras.

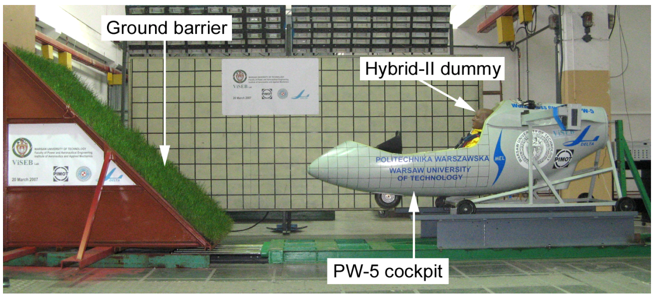

Figure 1: Experimental stand.

RESULTS AND DISCUSSION

In the course of test the loads acting upon the pilot as well as the structure of cockpit occurred to be relatively low. However, cinematographic analysis shows, that there are some other potential hazards, e.g.: serious risk of pilot being injured after hitting his head and arms on the canopy.

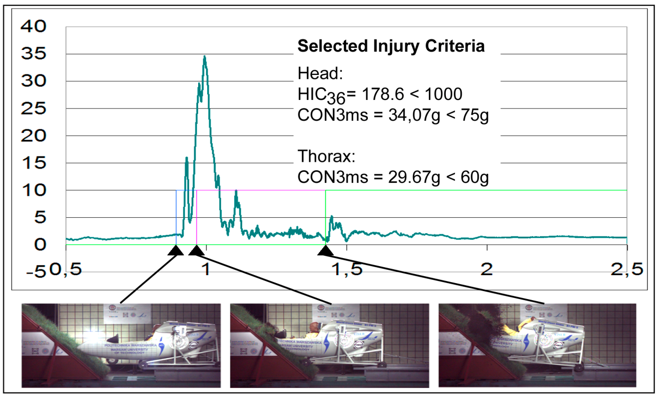

Figure 2: Time history of the resultant head mass center acceleration [g] with corresponded test phases.

Generally, obtained values were far below the tolerance limits of human body. However, one of the loads is worth to be taken into consideration. The force in lumbar section of spine exceeds 3.2 kN. It is a "safe" value for the pilot up to an age of 60, but for older person it could be potentially dangerous [3]. Moreover, the measurement results allowed for the determination of some injury criteria and evaluation of risk of serious injuries. The longitudinal force in the femur bone reaches the value of 1.31 kN for the left leg and 1.71 kN for the right one. Basing on the Femur Force Criterion [4] one can arrive at the conclusion, that the legs are part of pilot's body subject to a relatively lowest load. For evaluating the risk of head injuries, the Head Injury (HIC36) and the Continuous_3ms (CON3ms) criteria [4] were applied. The later criterion was applied also to the thorax.

The calculated value of the HIC36 was very low (Figure 2). Also the CON3ms determined for the head and thorax were significantly lower than their tolerance limits (the values were about a half of the limits).

CONCLUSIONS

The results obtained show that the simulated[2] glider accident can be considered as a minor one, in view of both the pilot and the glider. One of the aims of experimental investigations was collecting the data necessary for validation of numerical model of crash phenomena, which could be applied to further research into pilot's safety and glider crashworthiness.

REFERENCES

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[2] In case of impact onto real hard airfield an outcome could be worse.