MiG-29 and Su-22 aircraft as air-launch platforms for space rockets[1]

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Abstract:

On the basis of the project's research area, the two-stage micro-satellite launch system was selected. The system, a space-kit is based on an adopted combat aircraft carrying a satellite-laden rocket that is fired at the maximum altitude. As a potential transport platform, two withdrawn supersonic aircraft were selected: the MiG-29 and the Su-22. A dedicated mission-laden rocket is to be carried under the fuselage. In terms of safety concerns, the configuration of the aircraft and the ventrally mounted rocket is an acceptable solution, whereas further development involving payloads mounted dorsally on the MiG-29 aircraft was abandoned. In the considered configuration, the MiG-29 and Su-22 are expected to successfully complete the task of delivering a rocket of 930 kg with useful payload of 10 kg, which is the equivalent of a nano-satellite at the least, carried dorsally on the fuselage or under the wing.

Preliminary analyses have shown that the aircraft indicated with the proposed mission profile will successfully carry out the task of launching a hypothetical rocket with a payload of at least 10 kg into low earth orbit. This confirmed the merits of the basic thesis of the research project. For the analysis of the aeromechanical properties of the kit, both 3D digital models for computer simulations and physical models scaled for tunnel tests were developed. Laser scanners were used to map aircraft geometry, and measurements were made on Su-22 and MiG-29 aircraft. Using three-dimensional scaled models generated in a CAD environment, physical solid models were printed for wind tunnel investigations.

The experience gained and the purchased laser scanner with software, allowed the structure of planes and the construction of air-launch-to-orbit system calculation models to be rendered. The same can be said about 3D printers in the context of scaled models for wind tunnel tests.

The results of initial computer simulations of air-launch-to-orbit models indicate that by using computational fluid dynamics, it is possible to effectively determine the aerodynamic properties of highly manoeuvrable combat aircraft with unconventional "space-bound" cargo. The analysis of the results indicates that the rocket influences the aerodynamic characteristics only slightly and that the presence of the carried rocket does not significantly affect the flow area of the airframe. Further detailed results of analyses of aeromechanical properties will be conducted in subsequent stages of the study project.

Aircraft surface models created for computer simulations are to be used to develop models for experimental research. That way, the numerical analyses and simulations will be verified through experimental testing of the systems in a wind tunnel of the Air Force Institute of Technology at the Faculty of Mechatronics, Armament and Aerospace of the MUT.

[1] The work presents the current state of progress on the project: MoD Research Grant project no. 13-989/2018/WAT titled: Air-Launch System for delivery space payload for LEO – feasibility study, funded by the Ministry of National Defence and conducted at the Military University of Technology since 2018.

Furthermore, analyses will be conducted on reducing the net mass of the aircraft, development of a station for carrying the rocket and the space rocket itself as well as different mission scenario variants (e.g. selection of an air base, carrier rocket drop zone, etc.).

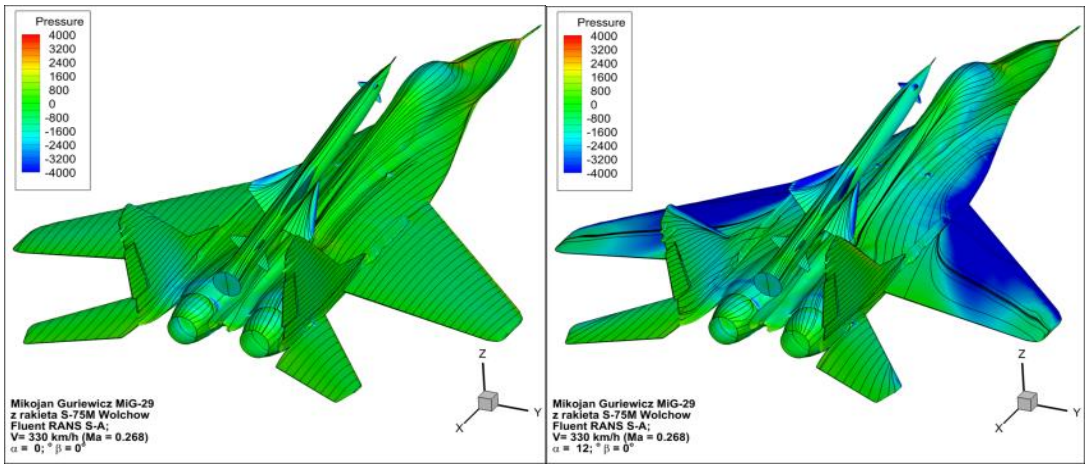

Fig. 1. Distributions of static pressure on the surface of the MiG-29 aircraft's airframe in configuration with a dorsally mounted S-75 rocket for different angles of attack.

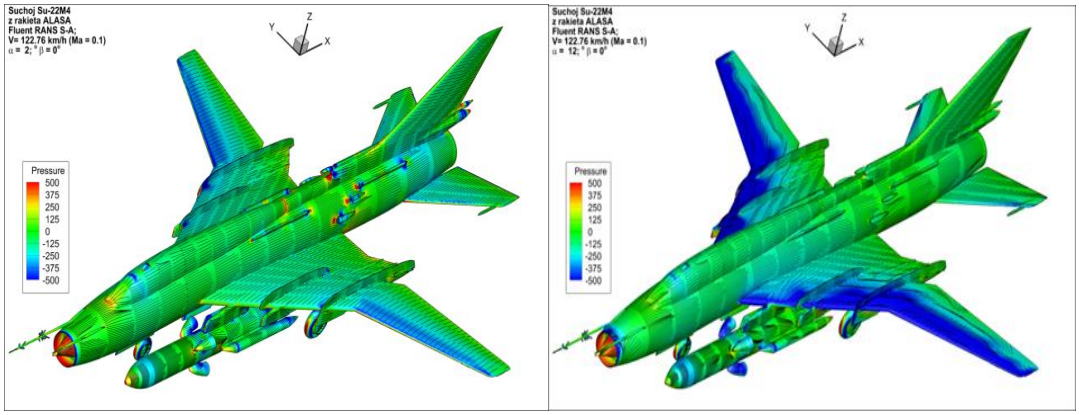

Fig. 2. Comparison of the changes in the distribution of pressure and the streamline on the surface of the Su-22 aircraft in the configuration with an ventrally mounted ALASA rocket .

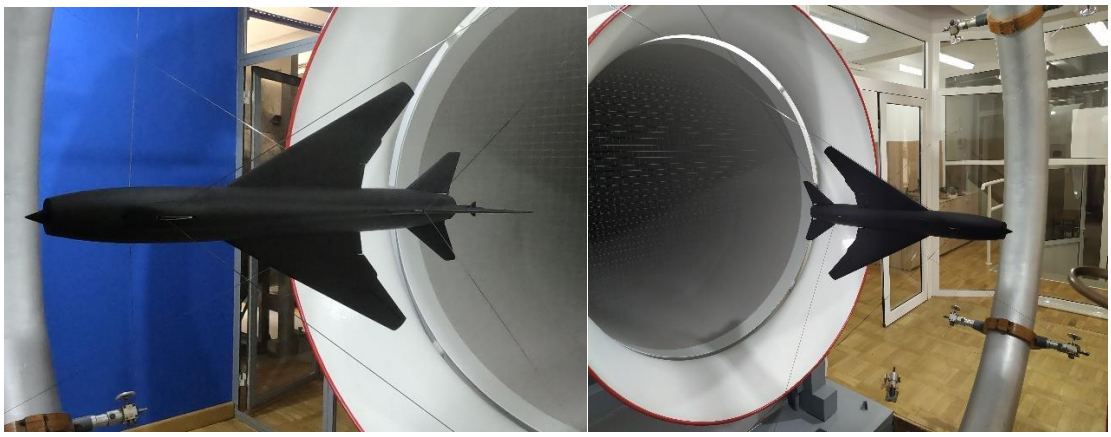

Fig. 3. Model of the Su-22 (clean configuration) under wind tunnel investigations.