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TIME-ACCURATE SIMULATION OF FLOW PAST PZL W-3A "SOKÓŁ" (FALCON) HELICOPTER MAIN ROTOR IN FORWARD FLIGHT

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A numerical simulation of the flow past a complete helicopter poses many challenges for the Computational Fluid Dynamics. The rotor blades not only rotate and move forward with a flight speed, but also undergo a complicated motion due to the strong asymmetry of the inflow conditions between the retreating and advancing sides. This articulation consists of the pitch, flap and lead-lag motions designed to maintain the stability of the helicopter in flight. Usually, the first approximation is to abandon the influence of the fuselage and tail rotor and isolate the main rotor blades. The elastic deformation due to airloads is neglected in the overall picture as well. Still, the remaining task is computationally very demanding.

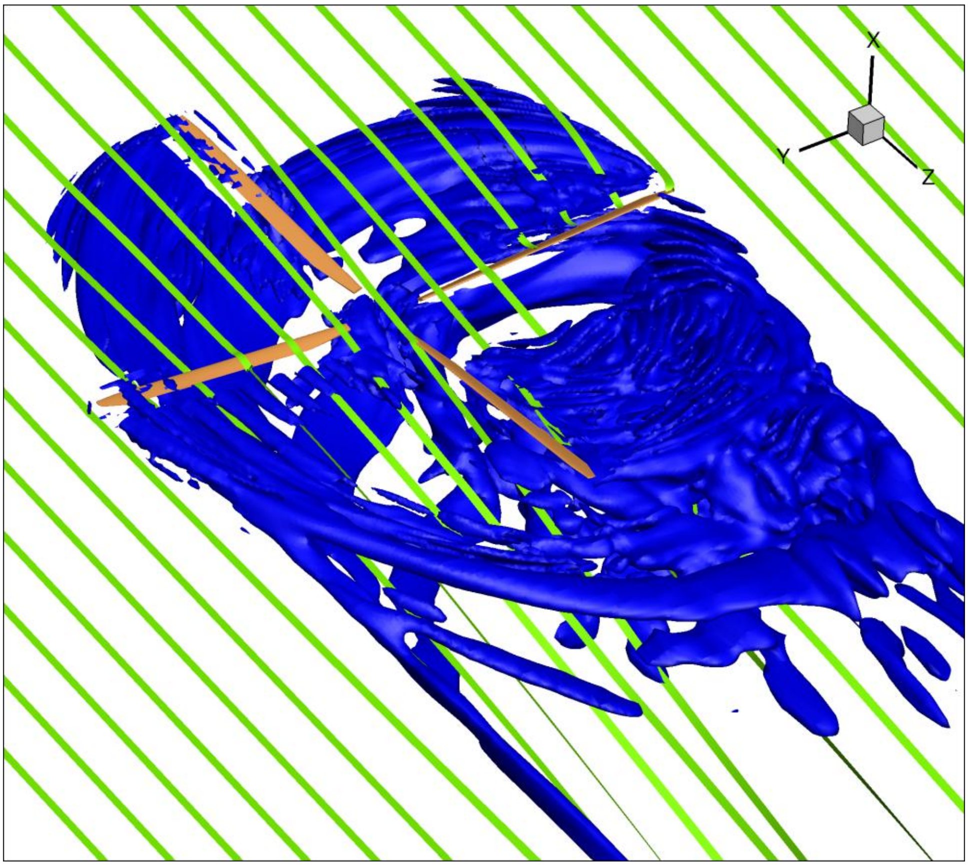

Fig. Aerodynamic wake of the PZL W-3A "Sokół" (Falcon) helicopter rotor in high-speed forward flight

The paper presents results of the numerical simulations based on the URANS approach and chimera overlapping grids technique of the main PZL W-3A “Sokół” (Falcon) helicopter rotor in forward flight conditions. The low-speed flight case models helicopter rotor as parallel to the ground keeping forward speed of approximately 100 km/h. This case could well model part of the manoeuvre when helicopter slows down from forward flight to hover. Strong Blade-Vortex Interaction (BVI) due to the tip vortices colliding with the blades is responsible for high level of vibration and noise. The high-speed (265 km/h) case reveals two main problems of modern helicopters: compressibility effects due to strong shock-wave boundary interaction on the advancing side and separation leading to dynamic stall on the retreating side of the rotor. The attempt is undertaken to correlate the results of the simulations with limited flight test data.