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Helicopter research: Major EU measurement programme with tilt rotors successfully concluded

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The Bell XV-15 tilt rotor aeroplane

Noordoostpolder/Braunschweig - Two key EU programmes run by international consortia in the field of helicopter research, in which the German Aerospace Center (DLR) played a crucial role, were recently brought to a successful conclusion in the large low-speed wind tunnel operated by German-Dutch Wind Tunnels (DNW). This was the first occasion on which a 'half-wing model' (at 1:2.5 scale) of the european tilt rotor concept had been used in wind tunnel measurements.

The tilt rotor concept involves a tilt rotor with a large diameter, combining the advantages of a helicopter, with its vertical take-off and landing capability, and the characteristics of a fast, high-altitude turbo-prop winged aircraft.

During take-off and landing, the plane of rotation of the tilt rotor is horizontal, as with a conventional helicopter. During flight, however, the engine and propeller are swivelled forwards, creating a vertical plane of rotation just like a fixed-wing aircraft.

As part of the recent EU programme TILTAERO, scientists studied the aerodynamic interaction between the rotor and engine nacelle and the independently adjustable inner and outer blades. The measurement programme covered all operating conditions, from hovering and tilting to flying in a horizontal line with propellers pointed forwards.

Four scales were used (for the rotor, the inner and outer blades and the whole model) to measure the aerodynamic forces of both the individual components and the model as a whole. Hundreds of pressure sensors were fitted on the rotor blades, the engine nacelle and the wings to record the often very unsteady distribution of lift on the components. Strain gauges on the rotor blades, together with the specially built rotor head, also allowed the researchers to calculate elastic deformation.

The main task of DLR's Institute of Flight Systems was to control the model and record the data from the scales, while DLR's Institute of Aeroelasticity was involved in the pressure measurements. DLR's many years of experience in controlling rotors in the wind tunnel came into its own in critical situations where a sensor malfunction meant that the test run had to be terminated by 'flying blind': the model was brought back to a secure operating status and safely shut off every time, without sustaining any damage.

This programme was immediately followed by a second EU programme called ADYN, which was concerned with the acoustics of the tilt rotor, particularly when the aircraft is diving, because the heavily loaded rotors are very sound-intensive. It was here that DLR employed a rotor optimised in collaboration with French partner organisation ONERA, which promised greater efficiency when the aircraft is hovering and cruising and also lower noise emissions when it is diving. This rotor is a spin-off of the DLR/ONERA partnership, which has already given rise to the development of the patented quiet ERATO rotor for helicopters. The operating conditions in these flight situations are on the very edge of what is technologically possible, and represent a considerable challenge to the materials used and the pilots of the model.

The international consortiums of the two EU programmes TILTAERO and ADYN are made up of the industrial partners AGUSTA, Eurocopter, Eurocopter Deutschland, IDS (Ingegneria dei Sistemi, Italy), the aeronautical research establishments CIRA (Italy), DLR (Germany), NLR (Netherlands), ONERA (France) and the Technical Universities of Athens and Milan.

Related Contacts

Prof. Dr.-Ing., M.S. Berend Gerdes van der Wall
German Aerospace Center
Institute of Flight Systems, Rotorcraft
Tel: +49 531 295-2849
Fax: +49 531 295-2641
E-Mail: Berend.VanDerWall@dlr.de

Hans-Leo Richter
Deutsches Zentrum für Luft- und Raumfahrt (DLR) - German Aerospace Center
Corporate Communications, Editor, Aeronautics Research
Tel: +49 2203 601-2425
Fax: +49 2203 601-3249
E-Mail: hans-leo.richter@dlr.de
