Boeing to fly composite-airframe helicopter

PHILADELPHIA

Boeing Vertol’s private-venture Model 360 advanced-technology helicopter is to fly in November 1984, reports Graham Warwick.

The tandem-rotor helicopter brings together Boeing developments in rotor and airframe aerodynamics and composite structures, offering a 200kt cruise speed and a 25 per cent increase in payload over the CH-46.

There are no plans to put the 360 into production, but the aerodynamic and structural technology incorporated could be applied to the CH-47 Chinook and to the Bell-Boeing Model 901-X tilt-rotor, now in preliminary design to meet the JVX joint-service vertical-lift requirement.

Boeing has developed a new transonic rotor aerfoil section optimised for a 180kt cruise speed. Relative to the Chinook’s VR7/8 aerfoil, the new VR12/15 offers 6 per cent more hover efficiency and 23 per cent better cruise performance by delaying drag rise. Blade planform, twist, and mass and stiffness distributions are optimised for minimum vibration at high speed. The tapered tip produces less vibration than a swept tip, says Boeing.

The Model 360 uses a four-blade rotor, essential for low vibration at speeds up to 200kt, says Kenneth Grina, Boeing Vertol engineering vice-president. Flight tests in 1972 of a four-blade Chinook, the Model 347, demonstrated acceptable vibration levels at speeds up to 170kt. For the Model 360 rotor Boeing conducted 3,200hr of isolated-rotor windtunnel tests at speeds up to 230kt, followed by 1,400hr of tandem-rotor testing, demonstrating vibration reduction similar to that experienced in flight-test.

A significant reduction in airframe and rotor hub drag was required to achieve the 200kt cruise speed. The Model 360 has retractable tricycle landing gear and all the fuel is carried internally under the cabin floor. This eliminates the need for external sponsons, a major source of drag and hover download.

A major drag-reduction effort focused on the upswept rear fuselage required by the loading ramp. Airflow separation at the base of the ramp results in a download on the rear of the aircraft. Some 400hr of windtunnel testing at Boeing Vertol’s own on-site facility has resulted in after-body lines producing a 58 per cent reduction in drag relative to the CH-46.

The move from three to four blades should have increased hub parasite drag significantly, but the compact, all-composite rotor head, with designed-in automatic blade fold, results in a 20 per cent drag reduction compared with a conventional four-blade rotor, and therefore only a slight increase in drag relative to the CH-46’s three-blade hub.

The result of Boeing’s efforts is a drag reduction of almost a half, from 44·4ft² equivalent flat-plate area for the CH-46 to 24ft² for the Model 360.

The all-composite airframe is dramatically simpler than that of the CH-47. Carbon fibre is used for longerons, frames, and the attachments for landing gear, cargo nooks, and other loads. Frames are located only where major loads are applied. The resulting large skin panels are of Kevlar backed by Nomex honeycomb, and reinforced around cut-outs with carbon-fibre. Rear-fuselage panels exposed to the engine exhaust use a high-temperature resin. Frame flanges and panel