ROHACELL® in Helicopter Rotor Blades for a Reliable Lift-Off

How a High-Performance Rigid Foam from Evonik Can Save Lives

The Bavarian Red Cross reports that a 27-year-old woman and her four-year-old son from Bad Reichenhall were rescued after dark on a Sunday evening in the Latten Mountains, thanks to a masterly display of flying skills by the helicopter pilot and the professionalism of the mountain patrol.

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It's all about technology you can trust.
The pilot can devote his attention to stabilizing the helicopter and doesn't have to think twice about the rotor blades, the most important component of this aircraft, thanks to their stable sandwich construction—made possible by ROHACELL® rigid foam cores.

Flying an EC 135 rescue helicopter in high mountainous terrain is generally a tricky undertaking for the pilot, particularly when a line has to be used to rescue a climber from a rock face in stormy weather. "In such a situation, the pilot often has to fly to within a couple of meters of the rock face and hover there until a second rescuer retrieves the person in distress," says Dr. Martin Schlottermüller, project manager for production technologies at Eurocopter Deutschland GmbH, describing the fraught scenario. The company, a wholly owned subsidiary of EADS, is world market leader in civilian helicopters and also has an approximately 25 percent share of the military helicopter market. Civilian applications cover a wide range, from rescue operations to maintenance of offshore equipment.

Pilots must be able to rely on the technology

Schlottermüller emphasizes that while the pilot concentrates entirely on keeping the helicopter stable, he also has to place complete trust in the technology that went into it. This applies particularly to the most important components of the helicopter: the rotor blades. They must enable the aircraft to lift off dynamically, quickly, and safely in the air streaming toward it and ensure a very high degree of stability. Advanced high-performance rotor blades based on sandwich constructions with a ROHACELL® rigid foam core satisfy these demanding requirements.

Debut 100 years ago

The pioneer of free helicopter flight was Frenchman Paul Cornu, who lifted off with a two-rotor 24 HP engine near Le Havre in 1907. This first manned vertical take-off to a "height" of 30 centimeters lasted all but 20 seconds. In those pioneering days of the helicopter, the rotor blades consisted entirely of wood, canvas, and metal. Today's helicopters have little in common with these early designs. In the 1960s, the idea of producing rotor blades from flexible materials began gaining momentum; soon afterward the first carbon fiber composite materials captured the rotor market.

Rotor tips must hold up under enormous forces

The rotor blades of helicopters are subjected to enormous stresses. The rotor of a helicopter the size of the EC 135 traveling at 250 kilometers per hour, for example, makes about 400 revolutions per minute, with the tips moving at speeds of about 220 meters per second (ca. 800 km/h). The resulting centrifugal forces at the blade tips can reach about 1,000 times the force of gravity. The sandwich construction counters these forces because the shearing forces are absorbed by the rigid foam, which stabilizes the rotor blade.

It's up and away from Darmstadt! ROHACELL® is a material that can be perfectly shaped into the cores of sandwich components—as are used in helicopter rotor blades, for example—by using high-precision CNC technology.

Eurocopter has been relying on sandwich technology since 1996. "ROHACELL® simplifies manufacturing because the material can be pressed cleanly," explains Ulrich Denecke, head of Eurocopter's rotor blade construction division.

Because ROHACELL®, unlike other materials, tolerates the temperatures that the company needs for the materials and the heating systems it uses, applications for this foam have tripled over the last ten years. Each rotor blade requires between 1.0 and 1.5 kilograms of foam. Eurocopter produces about 500 blades a year. In post-production quality control, the finished blades are checked by computer tomography for possible material or manufacturing defects.

High performance rigid foam doesn't "get tired"

A further reason for the growing demand is the outstanding stability of the material. ROHACELL® structures, for example, are clearly superior to those of most metals. "The useful life is four to five times longer than for aluminum-titanium metal structures because there is no material fatigue," says Denecke. So with sandwich technology, operating periods of 15,000 hours, or 40 years, can be reached, which corresponds to the maximum useful life of a helicopter. This is why Eurocopter is committed to this technology and will continue to use it in the future.

ROHACELL®—a synonym for reliability

The most technically advanced rotor blades are built like a sandwich: They consist of a core of ROHACELL® foam covered by layers of fiber composite material. This construction method yields a unique combination of low weight and maximum mechanical stability. In technical terms, ROHACELL® is a copolymer of methacrylonitrile and methacrylic acid, with a few key additives, including a foaming agent. "The foaming process is carried out in large drying ovens. As soon as the foam block is ready, it is separated into panels in the thermoforming stage," says Dr. Alexander Roth, head of New Technologies at Evonik Röhm GmbH's Performance Polymers Business Unit.

Saving fuel and reducing CO_2 emissions

Because of its outstanding material properties—primarily its excellent pressure resistance and shear stability, even under prolonged dynamic stress—ROHACELL® has proven to be an excellent material for structural foam in fiber composite components for the aviation industry. The applications range from winglets on airplane wings, through loading doors, landing gear doors, pressure bulkhead reinforcement, and reinforcement ribs in the engine cowling, all the way to the folding tables in the passenger cabin. The reduced weight saves fuel and also reduces CO_2 emissions.