DESIGN OF DYNAMICALLY LOADED FIBRE-REINFORCED STRUCTURES CONSIDERING THEIR VIBRO-ACOUSTIC BEHAVIOUR

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Dynamically loaded structures generally require a high material damping combined with a low constructive weight and adequate stiffness. Advanced lightweight structures will have to meet not only these high dynamic demands but also very high acoustic (low noise) standards. High-performance materials like magnesium, aluminium or titanium, which are mainly used in today's lightweight applications, have reached their limits with respect to these dynamic and especially vibroacoustic requirements. They offer high stiffness and strength, but a relatively low damping, which leads to high acoustic radiation. Therefore, composites or compound materials with a dynamically and vibroacoustically optimized property profile are needed.

Especially long-fibre reinforced polymers belong to this group of high-technology lightweight composites. They are successfully used in the aircraft and spacecraft industry. With these materials, damping values can be reached that significantly exceed those of light metals.

The vibration behaviour of such composites can show a complicated coupling of bending and torsion depending on the fibre orientation and the matrix composition. In addition, a pronounced anisotropy of the material damping, caused by the anisotropic material behaviour, by the dissipation of energy in the elastic-viscous matrix and by the microstructural interaction of fibre and matrix, is observed.

The acoustic radiation is a complex function of the particular material, degree of damping, eigenforms, frequency and boundary conditions. With the example of two different boundary conditions and force-excitations, it was found that a reduction in the radiated sound pressure by up to 30 dB could be achieved due to the effect of material damping.

The structural-dynamic and vibroacoustic behaviour of these types of lightweight structures cannot be described by the classical models. Here, advanced methods were developed which take into account the specific mechanical properties of fibre-matrix compounds. Also, sophisticated numerical simulation techniques such as the Boundary Element Method were successfully applied.