PROPERTIES

EuCIA
European Composites Industry Association

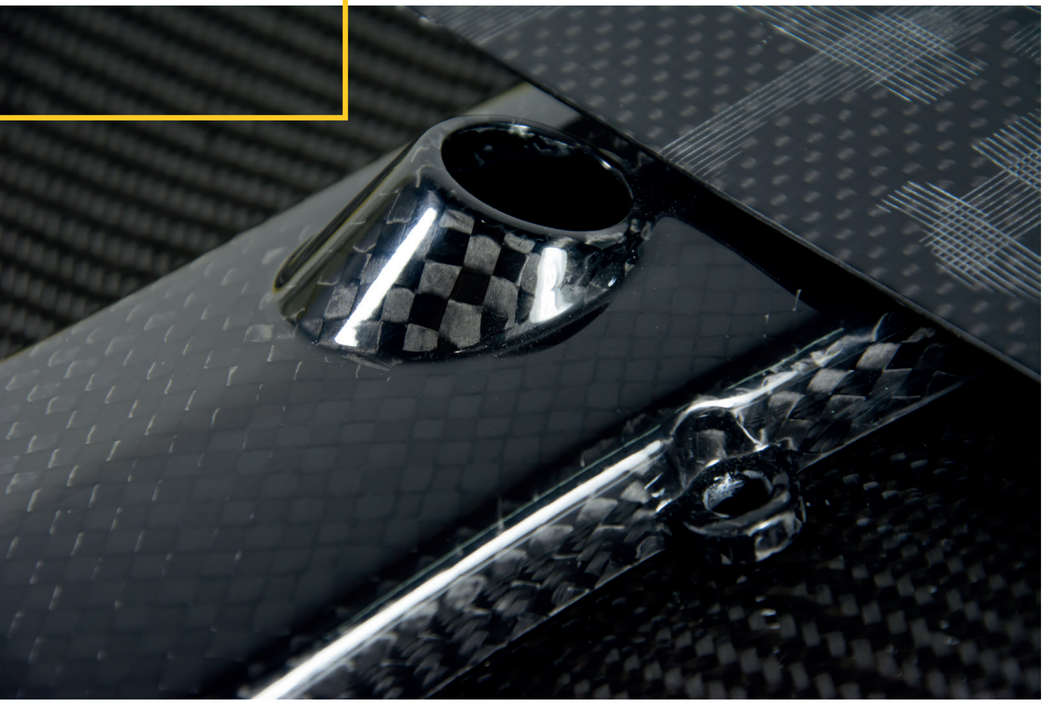
The simplest type of laminate is the so-called "cross-ply", in which the fibres are layered perpendicular to each other. By adding extra layers at ± 45° a quasi-isotropic behaviour is obtained. The stiffness of a quasi-isotropic laminate is approximately 40% of the stiffness of a UD laminate.

In general, the mechanical behaviour of a composite is non-symmetrical in tension and compression, the latter being weaker in general. This is due to the fact that fibres are very thin with respect to their length, since it is common knowledge that ropes cannot be used to push things. Aramid fibres have the lower compressive strength among all fibres.

Also other properties are affected by the choice of the fibres, the resin and the measuring direction. For example, the thermal expansion coefficient of the fibres can be negative, which means that along the fibre direction the composite will shrink when heated. With the proper choice of the amount and quality of fibres, as well as their orientation, it is possible to manufacture composites with zero thermal expansion coefficient. Such materials can be utilised in measurement instruments and satellites, for example.

The fact that composites are built by overlapping layers of fibres on top of each other makes it easy to produce sandwich structures, in which two relatively thin layers of composite (skins) are separated by a core made of a lightweight and less strong material. These structures possess an extraordinary combination of lightness, stiffness and strength: it can be demonstrated that the flexural stiffness of a sandwich beam is proportional to the elastic modulus of the skins – made of composites – times the thickness of the core squared. This means that keeping the same skin type and increasing the core thickness produces stiffer – or lighter – structures. The effect on strength is the same, although less pronounced. The core material is usually made of stiff plastic foams or honeycomb structures made of phenol Nomex® paper, plastic or aluminium. The core material can also be designed so that it will give the structure other properties, such as thermal insulation.

Composite materials can also easily be used to produce "smart" structures by directly integrating sensors - such as antennae, RFID tags, electronics and optical fibres, mainly used to check for structural integrity during service - actuators or both. "Self-repairing" composites have also been developed based on hollow microspheres or hollow fibres, which contains uncured liquid resin. If they break, the resin come into contact with catalytic particles contained in the solid matrix and quickly cures, so immediately repairing the damage.



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