Natural fibre-reinforced composites for structural applications based on novel low twisted bast fibre yarns

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As part of a research project (NF-CompPlus), novel yarn structures made of staple fibres from the European disordered line are being developed for use in highly stressed composite materials. Currently, long flax fibres of a high quality, which are suitable for structural and higher loaded components, are very expensive. The high price of these high-quality fibres is often the limiting factor for the use in many potential applications yet. The lower-cost flax and hemp staple fibres selected in the project are processed into yarns with nearly unidirectional oriented fibres by an alternative spinning process. The high orientation of the fibres in the composite material leads to good mechanical properties. Compared to yarns with a high twist, the mechanical properties of the fibres can be transferred more effectively to the polymer matrix in the composite. A fibre length of around 5 mm is already sufficient to allow sufficient fibre/matrix adhesion for a good stress transfer from the fibre to the polymer matrix. The produced unidirectional staple fibre yarns with a fineness of about 200 tex were further processed into fabrics, and subsequently transformed in combination with thermosetting matrices to composite plates for material analysis. To test the reinforcing effect of the yarns, unidirectionally reinforced specimens were additionally produced by a winding and a pultrusion process. It could already been shown for flax that the alternative unidirectional flax yarn leads to comparable composite properties compared with a commercial long-flax roving. For unidirectional fibre-reinforced composites a bending modulus of around 23 GPa, a tensile modulus of around 21 GPa, a bending strength of around 280 MPa and a tensile strength of around 190 MPa were reached. These values are multiple higher as compared, e.g., with injection moulded bast fibre-reinforced thermoplastics. The developed bast fibre fabrics shall be finally used to produce composite prototypes for vehicle construction. For this purpose, a hybrid composite material made of bast and glass fabrics will be developed for a leaf spring element for a bogie of a narrow-gauge railway with optimised damping properties. Hence, the novel yarn structures are intended to give bio-based composites new price segments that are not achievable with previously available bast fibre yarns, and may thus expand the area of application.