Current Trends in Material- and Ressource-Efficient, Sensor-Integrated Textile Reinforcements for Concrete and Asphalt-based Infrastructure

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Abstract

Growing housing demand and deteriorating transport infrastructure (road pavements and buildings) require construction solutions that minimize material consumption, carbon emissions, and maintenance while extending service life. Fiber-reinforced polymer (FRP) textile respectively non-metallic reinforcements offer high tensile strength, corrosion resistance, and lightweight design, but their broader application is constrained by insufficient bond performance, anchorage efficiency, flexibility, and robustness during installation.
This poster presents current developments in profiled and braided carbon rods for resource-efficient reinforcement of concrete and asphalt infrastructure as well as novel CFRP rope structures for prestressing of concrete components. Tetrahedral profiling of impregnated carbon rovings increases bond stress in concrete by up to 400 % compared with unprofiled rovings by nearly maintaining their tensile strength.

Novel CFRP rope structures based on profiled carbon rovings combined with thermoplastic and elastomeric impregnation systems feature a spiral configuration of multiple profiled strands to enhance bond behavior in combination with compact and reusable anchor systems. By means of prestressed CFRP ropes the fully potential of tensile strength performance of high-performance carbon fibers can be exploited for concrete composites, especially bridges and structures with large span widths.

Innovative methods for manufacturing textile reinforcement structures with integrated sensor networks are intended to retrofit concrete structures with smart reinforcements and create more durable transportation routes, while simultaneously enabling real-time structural monitoring e.g. strain maps, crack-openings in addition to environmental influences such as pH, temperature, moisture and chloride ingress. In road construction, these multifunctional textile reinforcement structures are used for traffic monitoring, such as detecting the speed or axle loads of moving individual and freight transport traffic for exact dimension approaches as well as perspective smart city management.
These textile reinforcement concepts with sensor-integration improve fiber utilization, bond performance, structural adaptability, demountability, and recyclability and enable the permanent as well as real-time structure-integrated monitoring of structural health and extending of building and infrastructure service life.

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