Design of Textile Reinforced Concrete: a consistent approach towards reliable design methods and a suitable safety format

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Nowadays, reinforced concrete (RC) can be considered as one of the most widely used construction materials. To ensure the performance and durability of RC, actual code of practice prescribe a minimal concrete cover (typically between 20-60 mm depending on the exposure class). Such cover requirement, together with the spacing between reinforcement layers necessary for compacting and vibrating needs yield eventually to relatively thick members (typically between 20-30 cm) and in many cases has associated concrete construction to a massive and heavy building technique. In the last decades, Textile Reinforced Concrete (TRC) has emerged as an interesting alternative to RC, allowing to reduce concrete cover needs (as fabric reinforcement consisting of non-corrosive materials such as carbon, glass or basalt fibres is used). The non-metallic reinforcement is insensitive to corrosion and the cover requirements of the reinforcement can be reduced to minimum static values, allowing to decrease the overall thickness of the TRC elements to 10-30 mm. Since no passivation of the reinforcement is required, a low clinker content cement can also be used so reducing the environmental footprint of the material related to the CO_2 emissions of cement production. This opens the possibility to build using a more sustainable cement, developing light structures and promoting the use of concrete for a number of construction elements where currently it is difficult to apply.

Currently several analytical and numerical models are available to describe the response of TRC members. These approaches refer normally to the average material properties and allow determining the average resistance of TRC structural elements. Yet, structural verifications are performed by comparing design actions with design resistances, accounting the latter for the variability of the material properties as well as uncertainties related to the calculation model and construction tolerances. Differently to RC, TRC is characterised by a brittle response once its tensile strength is reached. These aspects point to the fact that there is a need to define a suitable safety format and to propose tailored values of the partial safety factors accounting for the peculiarities of the material.

Within this research, the issue of design approaches is addressed in a scientific manner. First, a comparison of models characterizing the response of TRC will be performed. The results will be used to determine the accuracy of the models (by means of the associated coefficients of variation). Based upon material tests performed in literature and by the authors the variability of the material properties will also be calculated. This information, in addition to some potential specific tests, will be used to perform a reliability analysis, allowing to determine the values of the partial safety factors for design. Eventually this will allow engineers to design TRC confidently, with a comparable level of safety than RC.