Micro reinforcement of cement composites
Short introduction to the theme of the symposium

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The field of new cement-bonded composite materials is in full development. Developments include the addition of reinforcing elements (fibres, wires) of various kinds and of widely varying geometry.
Despite this large variety, micro-reinforcement has some common features which will be briefly described in this paper.

The improvements – in the mechanical sense – which can be achieved with fibres and wires in cement-based materials include: higher strength, greater deformation capacity, better toughness and improved overall cohesion of the material.

Qualitatively speaking, these improvements are common to all microreinforced cementitious materials. So, whether we discuss steel fibre reinforced concrete, or glass fibre reinforced cement, or mortars reinforced with a net of steel wires (ferrocement) or with a textile type of reinforcement using nylon, polypropylene or another polymeric material, or with "high tech" fibres such as aramide, the composites will offer – to a certain extent – the above-mentioned improved characteristics.

What these materials have in common is a cementitious matrix with a low tensile strength and with a very low tensile deformation capacity (less than 0.1%). Since the strain in the reinforcing elements can hardly be larger than the strain of the surrounding matrix, and since the stiffness ratio (fibre/matrix) is not really high (indeed quite low for most organic reinforcements), it follows that in the *uncracked* state of the matrix the reinforcement is not very effective. The fibres are "just lying there, doing nothing". It is only after reaching the ultimate strain, i.e., when matrix cracks are developing or have developed, that the reinforcing elements will act as a substantial – sometimes the major – load carrying component. In its more elementary form, fibre reinforcement of cementitious materials means that once the matrix has cracked, the material is still held together by the reinforcement (overall cohesion).

In a more advanced form, it means: influencing the initiation and the further development of cracks, bridging of cracks by fibres and corresponding load transfer across cracks through fibres, controlled slipping of fibres along the fibre/matrix interface resulting in pseudo-plasticity and greatly increased macro-deformation capacity of the composite.

The latter features are manifested particularly in the case of bending (of plate-type materials for instance).

Actual performance will depend largely upon the product of the fibre volume fraction (V_f) and the fibre ratio (l/d). In the case of oriented continuous reinforcing material (l in finite), the entire load may well be resisted by the reinforcement (at the end of the matrix cracking process), leading to ultimate tensile strength values that are quite unusual for rock-type materials.

In situations with short, statistically dispersed fibres (steel fibre reinforced concrete) the improvement in (tensile) strength will not be substantial. There is, however, still a tremendous gain in deformation capacity and energy absorption capacity.