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*Research topic: Characterising the shear behaviour of steel fibre-reinforced cement-based composites*

*Status: Completion March 2016*

*Research scope, objectives and strategy:*

The building material to be investigated can be categorised as follows:

* Advanced/high-performance cement-based composites
  + Strain-softening cement based composites
    - Fibre-reinforced cement-based composites
      * Steel macro fibre-reinforced mortar and concrete
        + *Steel macro fibre-reinforced self-consolidating mortar and concrete (Material to be investigated in this research)*

The properties of the material to be investigated include:

* Mechanical/hardened state properties of the material subject to shear dominant fracture
* Material-level investigation, characterising the fundamental material properties:
  + Mode II fracture (i.e. ‘pure shear’ conditions)
  + Mode I fracture (uniaxial tension)
  + Mode II fracture in combination with Mode I conditions (initial crack width and confinement across the shear plane)
* Evaluate the governing intrinsic (inherent properties of the composite) and extrinsic (external conditions) parameters

Experimental and modelling strategy employed to characterise material behaviour:

* Characterisation of the governing mechanisms which determine composite behaviour
* Identification, definition, isolation/discretisation and characterisation of the principal/governing mechanisms and the controlling parameters (intrinsic and extrinsic parameters influencing shear displacement and dilation/crack width opening) at different levels of observation via a multi-scale modelling and experimental approach
* Multi-scale modelling and experimental approach:
  + Micro-level: behaviour of an individual fibre including axial pull-out, dowel action and transverse pull-out out of a cement-based matrix.
    - Research parameters include: fibre orientation, fibre embedded length, fibre and matrix properties
    - Model individual pull-out response of a single fibre
    - Link pull-out behaviour of a single fibre to composite behaviour (Meso-level)
  + Meso-level: behaviour of the composite in the vicinity of a single, well-defined/localised crack (Crack localisation enforced via specimen geometry, load configuration and notching)
    - Research parameters include: volume of fibre reinforcement, initial crack width, aggregate particle size distribution (aggregate interlock or shear interface roughness mechanism) and confinement across the shear plane.
  + Macro-level: material can be considered homogenous, where redistribution of stresses and multiple cracking is permitted
* This research will adopt and evaluate experimental methods commonly observed in the literature, including the shear push-off, shear push-through and the Ohno-beam/Iosipescu shear test methods
  + An optical analysis system utilising digital image correlation will be used to capture complete specimen response.
* Constitutive relations derived on the basis of the component behaviour of individual mechanisms and parameters at different levels of observation: Utilising detailed characteristic testing, adopting from the existing literature and drawing appropriate analogies where necessary
* Assemble and verify experimentally, multi-scale models and determine material/composite behaviour

Proposed research outcomes:

* Constitutive model/analytical formulation of the primary shear transfer mechanisms and composite behaviour
* Verification and assessment of modelling strategies and design methods as well as reinforcement types (conventional vs. fibre-reinforcement) via a case study of an appropriate structural design problem
* Assessment of different experimental techniques employed to characterise material behaviour at different levels of observation

*Publications:*

Zeranka, S. & van Zijl G.P.A.G, 2013. A review of the shear behaviour of reinforced steel fibre concrete, *Proceedings of the 5th international conference on structural engineering, mechanics and computation* (ed. A. Zingoni), Cape Town, South Africa, 2-4 September 2013, pp.567-568.

*Prizes:*

Wilhelm Frank Bursary 2012 - 2013