EUROMECH Colloquium 582

"Short fibre reinfoced cementitious composites and ceramics"

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Chairperson: Heiko Herrmann
Co-Chairperson: Jürgen Schnell

Composites containing short fibres are important in many technological fields, the used composites range from fibre plastics to fibre concretes. Fiber composites are gaining importance, especially in the building industry, as they may increase the building speed and improve material properties. Fibres already in use include steel, basalt, carbon and polymer fibres, of many different shapes and aspect ratios. The aim of including fibres also varies, including improving tensile strength, post-cracking behaviour (ductility) and temperature resistance. In all cases, the microstructure and spatial and orientational distribution of the fibres is important. At this colloquium different methods and results for the analysis of microstructure and fibre orientation analysis in cementitious building materials containing fibres, among them concretes and refractory composites, have been presented.

The goal of EUROMECH Colloquium 582 was to present a platform for the exchange of ideas between different fields with similar problems. While having different chemical compositions and length scales, cementitious composites and ceramics reinforced with short fibres share similar mechanical properties and theoretical problems. The addition of short fibres leads to a composite that has stochastically anisotropic and inhomogeneous properties, since several macro- and meso-scale properties depend on the spatial and orientational distribution of fibres. An important aspect is the micro-structure around the fibres and the adhesion of the matrix to the fibres, which has large influence on mechanical properties.

There were altogether 19 participants and 14 presentations at Colloquium 582, among these 3 keynote talks, given by: Daniele Casucci, Kaiserslautern; Johan L. Silfwerbrand, Stockholm; and Akke Suiker Eindhoven. Most importantly, the length of the presentation slots was larger than at typical conferences and offered more time for discussions and presentation of the topic in detail. Furthermore, informal discussions took part during coffee and lunch breaks as well as during the social programme.

Topics that recurred throughout were:

- **Fiber orientation analysis**

As mentioned before, the orientation distribution of the short fibres causes anisotropic material behaviour. As a consequence, the fibre orientation needs to be assessed and monitored during and after the production of parts made of short fibre reinforced materials. Different methods to extract information about the positions and especially orientations by means of X-ray computed tomography were discussed. Important aspects were the possibility to minimize user interaction and user mistakes, as well as the reliable separation of touching fibres to obtain information about individual fibres.

- **Interface between fibre and matrix**

Another important topic was the interface between the fibres and the matrix material, notably the interfacial transition zone (ITZ). The structure of the transition zone has great influence on the bond between fibres and matrix (stiction), and on failure mechanisms, such as delamination of fibre and matrix, pull-out of fibres, friction during pull-out or rupture of the fibre in case of very strong bond/anchorage. influence of fibre orientations on cracking behaviour. The orientations of fibres have a strong influence on

the cracking and post-cracking behaviour of the composite material. After an initial micro-crack has formed, it could be bridged by fibres and these fibres could arrest the crack growth if fibre orientations are favourable. It is also possible that fibres can be well aligned with each other, but have a “bad” orientation with respect to the acting forces.

- **Formation of shear bands**

The influence of short fibres on the tensile and compressive strength of concrete has been investigated for some time already, but the interest in high temperature properties and fire safety is a more recent development. The addition of short polymer or carbon fibres has an influence on the fire resistance at temperatures much higher than the melting temperature of the polymer fibres or even after the carbon fibres have been burned away in refractory composites. The polymer fibres help to avoid explosive spalling caused by high vapour pressure in the material as they influence the migration of the vapour.

In refractory composites the addition of fibres can have a beneficial influence of the compressive strength even after the material has been heated to temperatures at which the fibres themselves have been burned out.

Many participants have expressed their wish to obtain the slides of other presentations and also to have full papers. This demonstrates both the topical interest and the quality of the presentations. Also the wish to have future colloquia on this and related subjects has been expressed. The organisers and participants thank Euromech for making the meeting possible and for the financial support.