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Guest editorial

Cohesive models are comparatively old models for describing fracture events. The foundation of these models goes back to the early 1960s when Dugdale [1] and Barenblatt [2] published their theories. In recent years, substantially improved computing capabilities have boosted fundamental and application oriented research work in this area. In order to obtain an overview on the progress achieved the international workshop on *Fundamentals and Applications of Cohesive Models* was organised by the GKSS Research Centre on 10–11 June 2002. Nineteen invited lectures presented a wide range of aspects.

On a micro-scale, fracture phenomena in micro-structures, such as fracture of hard second phase particles, decohesion in lamellar structures, and fibre bridging in composites were discussed.

On a macro-scale, the global behaviour of specimens and components as well as the performance of adhesive joints was described in terms of cohesive models. The materials and material systems treated comprised bulk materials such as metals, concrete, polymers, ferroelectric materials as well as fibre reinforced polymers and functionally graded materials.

Fracture and damage phenomena covered ductile tearing, quasi-brittle fracture, interface decohesion, dynamic versus quasi-static fracture, rate dependent damage, and electromechanical coupling.

An important prerequisite for the application of cohesive models (like any other model!) to engineering problems is the determination of the model parameters. Some progress in this respect has been demonstrated.

Open issues have also been identified:

- *Mixed mode*—Crack path deviation comes along with transition between separation modes. A classical example is given by the transition from normal (mode I) fracture to slant fracture, the latter representing a mode I/mode III mixture. Therefore, reliable models coupling normal and tangential separation are needed.
- *Elastic stiffness*—For physical reasons, elastic stiffness should be as high as possible, numerical requirements call for finite values. This is not an issue if the crack path is predefined and, hence, the number of cohesive elements is much smaller than that of continuum elements. If for arbitrary crack path cohesive elements have to be introduced between all continuum elements, then the finite stiffness of the former may cause trouble.
- *Cohesive properties*—Cohesive models characterise material separation by very few parameters, mostly only two, namely cohesive strength and separation energy or critical opening. Whether or not these parameters are actually material parameters over a wide range of stress states remains to be investigated for different fracture mechanisms. In addition, the effect of the shape of the traction–separation curve is still controversial.
- *Prediction of crack path*—As material separation occurs only at the interfaces between continuum elements, crack paths are restricted to the orientation of the mesh. The *strong discontinuity approach*, where continuum elements are generated which include a displacement jump in the shape functions, allow for arbitrary crack paths. This approach, however, cannot be realised with commercial FE codes.

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The workshop has provided an excellent state-of-the-art review of the modelling of damage and fracture using cohesive models. Moreover, this type of models has been demonstrated to be a versatile tool for solving engineering problems, even some kind of standardisation seems to be within sight. The advantage of cohesive models compared to continuum damage models is the intrinsic lengthscale due to the formulation that stresses depend on displacements instead of strains, which avoids mesh size effects. The present *Special Issue of Engineering Fracture Mechanics* contains 13 papers given at the workshop.

We wish to thank the 53 participants from 10 countries for coming and taking part in the discussions, the lecturers for their excellent presentations and their willingness for submitting written versions of their papers and last but not least Ines Boysen for taking care of a smoothly running meeting. It may be worth mentioning that the meeting site—the Hotel Residenz Hafen Hamburg located above the port of Hamburg—contributed to a very positive workshop atmosphere.

References

[1] Dugdale DS. Yielding of steels containing slits. J Mech Phys Solids 1960;8:100–4.
[2] Barenblatt GI. The mathematical theory of equilibrium cracks in brittle fracture. Adv Appl Mech 1962;7:55–129.

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