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COMPUTATIONAL MECHANICS OF COMPOSITE MATERIALS

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PREFACE

The idea of using different materials to build composite structures with favourable properties with respect to strength and stiffness is not quite new. Probably, the principle has been used intuitively since mankind started building structures. The first use of composite *materials* is somewhat more recent, but the abundant use of concrete - plain, reinforced or prestressed - in civil engineering applications and the use of polymer and metal-matrix composites in the automotive and aerospace industries is a silent testimony of the great potential of these kind of materials.

Nevertheless, the understanding of the failure processes that occur in composite materials has not kept equal pace with their use. Issues like delamination, debonding and matrix cracking could till recently only be investigated experimentally, since the tools were lacking to solve the equations that can be set up to describe these processes. The development of the finite element method and the advent of modern powerful workstations have changed this situation.

One can describe failure in composite materials on three different levels. At the macro-level there is the smeared representation where a homogenisation procedure is applied with respect to the different constituents. The first article of this issue takes such an approach. Fibre-reinforced concrete is described using a homogenisation procedure and the resulting model is applied in a non-linear finite element analysis of a beam loaded by impact.

The next level of refinement is the meso-level. At such a scale damage mechanics is commonly used as a vehicle for modelling the degradation processes that take place in the solid. The second article of this issue outlines a model that is rather typical for these approaches. In this case the numerical application will be for a polymer-based composite, but the ideas underlying the approach may be used for any composite material.

The latter statement also holds true for the last article, where a micromechanics analysis is carried out of a carbon fibre-reinforced siliciumcarbide matrix and in which delamination in a chip is simulated. Here also the interface elements used to describe the debonding and delamination processes, respectively, are applicable to a far wider range of composite materials, and can equally well be used to analyse masonry structures and steel-concrete interaction problems.

R. de Borst