New mixed mode integral for three-dimensional fracture mechanics applied to cracked bodies: analytical and numerical approach

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The mixed mode loading configuration occurs in many civil engineering and mechanical applications. Consequently, a mixed mode crack path process occurs. In three-dimensional crack approaches, take into account this problem is very important. In fact, this complex scientific key point requires more understanding (i) the corner point effect; (ii) the local effect due to the torsion mode (mode III) and (iii) the necessity to consider the thickness effect. In order to study the mixed mode loading for three-dimensional crack problem, a new three-dimensional contour integral entitled M3D integral is modeled using global approach. Combining real and virtual mechanical displacement fields, this new integral is used to separate numerically mode I, mode II and mode III. In earlier research works, Moutou Pitti et al [1] have proposed a new specimen called Mixed Mode Crack Growth (MMCG), and El kabir et al [2] have studied numerically the stability of this specimen for various geometries in two-dimensional case. This work deals with numerical and analytical modeling to study the crack path stability in real three-dimensional case for mixed mode crack problem. Using MMCG specimen, the non-dependence of integration domain is presented, and the stability of the calculation of M3D Integral with respect to various geometries and thicknesses is shown for the opening mode (Mode I), the shear mode (Mode II), the out-of-plan shear mode (Mode III) and also for the mixed mode ratio by computing the energy release rate versus the crack length.

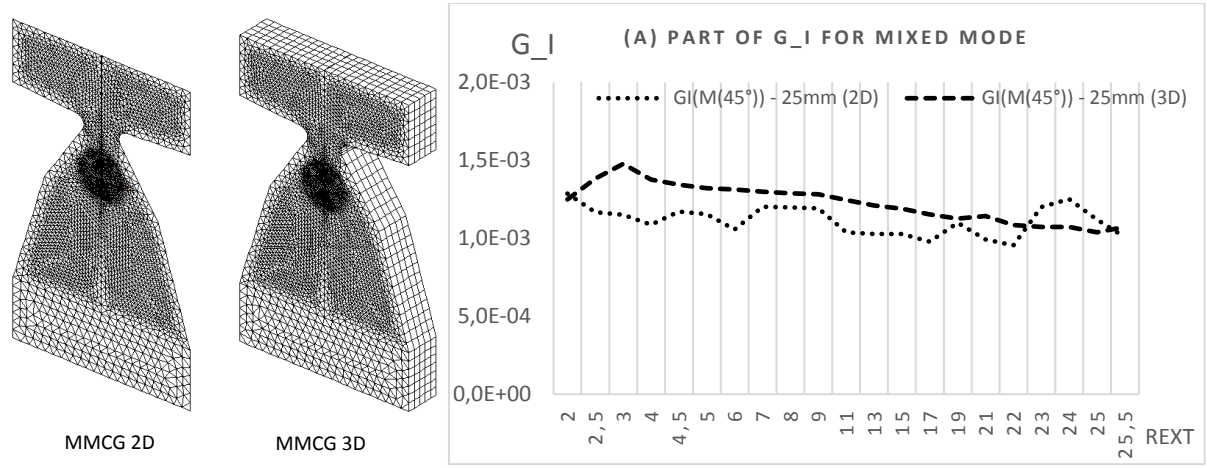

Fig. 1: 3D versus 2D comparison of a fracture mechanics problem

Key words: Energy release rate, MMCG specimen, Finite element, Fracture mechanics, Invariant integral, Numerical computation, Three-dimensional problem.

References

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Acknowledgments

The authors would like to acknowledge the PEPS “RUMO” CNRS projects “Green engineering” for the financial support to attend this conference.