International Conference on Extended Finite Element Methods - XFEM 2013
September 11 – 13, 2013, Lyon, France
A. Gravouil, Y. Renard and A. Combescure

Ultra fast simulations for 3D fatigue crack propagation by model reduction techniques

Cédric POZZOLINI
INSA-Lyon, LaMCoS UMR5259, F-69621 Villeurbanne, France, *cedric.pozzolini@insa-lyon.fr,*

Florent GALLAND
florent.galland@ansys.com,

Anthony GRAVOUIL
INSA-Lyon, CNRS, LaMCoS UMR5259, F-69621 Villeurbanne, France,
anthony.gravouil@insa-lyon.fr

Key Words: *crack, fatigue, model reduction.*

ABSTRACT

The so called Crack Tip Condensed Plasticity (CTCP) model, developed by S. Pommier [1], for an efficient simulation of confined plasticity fatigue crack propagation has been implemented in the ANSYS software. The numerical method combine finite element discretization and updating mesh (by morphing, for instance) to be consistent with the evolving crack front as predicted by the propagation law. This process is repeated iteratively on the whole considered time domain [2]. For this purpose, we propose a global model reduction strategy [3] in order to drastically decrease the computational cost of these types of problems. After an initialization phase, a nominal stress intensity factor (SIF) is computed. For that first step, a linear elastic finite element problem corresponding to the current crack configuration is set up. Then by using the SIF, the plastic behavior of the cracked structure is obtained, thanks to the CTCP model. After that, an additional *a priori* model reduction technique is used to accelerate the CPU time of the whole simulation. This technique consists in building incrementally and without any previous calculations a reduced basis specific to the considered test-case, by extracting information from the evolving displacement field of the structure. Finally, the displacement solutions of the updated crack geometries are sought as linear combinations of those few basis vectors. This allows to reach accurate simulations of 3D fatigue crack propagation with large numbers of cycles in a reasonable CPU time.

REFERENCES

[1] Pommier S., Risbet M., *Time-derivative equations for fatigue crack growth in metals*. International Journal of Fracture, vol. 131, no 1, (2005), p. 79106.

[2] Pommier S., Hamam R., *Incremental model for fatigue crack growth based on a displacement partitioning hypothesis of mode I elastic-plastic displacement fields.* Fatigue and Fracture of Engineering Materials and Structures, vol. 30, no 7, (2007), p. 582598.

[3] Galland F., Gravouil A., Malvesin E., Rochette M,*A global model reduction approach for 3D fatigue crack growth with confined plasticity*, Comput Methods Appl Mech Eng 200(5-8):18 (2011)