6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

An adaptive algorithm to accelerate the critical plane identification for multiaxial fatigue criteria

M. Wentingmann*, **P. Noever-Castelos**, **C. Balzani**

Leibniz Universität Hannover, Institute for Wind Energy Systems, Appelstraße 9 A, Hannover 30167, Germany, www.iwes.uni-hannover.de, research@iwes.uni-hannover.de

Keywords: *adaptive algorithm, critical plane, multiaxial fatigue, non-proportionality*

To analyse the fatigue damage of multiaxial, non-proportional stress histories the critical plane approach offers the opportunity to design components in a physically meaningful way. In contrast to proportional stress histories the failure criteria have to be evaluated on every material plane due to varying principal stress directions. Therefore the computational effort is very high, which often leads to a limitation of the fatigue assessment to several deterministically chosen material planes. The most damaged plane within the analysis is declared as the critical plane and used for fatigue verification. [1, 2, 3, 4]

In order to make full use of the critical plane approach an adaptive algorithm for the identification of the critical plane is presented in this work. The algorithm is based on the segmentation of a half sphere in segments of equal surface area proposed by Weber et al. [5]. Starting with a coarse mesh the algorithm refines only those segments, which could include the critical plane. This simple yet very effective approach refers only to the accumulated damages of the segments and is hence suitable for every critical plane failure criterion. Depending on the discretisation level and used failure criterion reductions of 35 % to 82 % in computational time can be expected, which is demonstrated by a fatigue analysis of the trailing edge adhesive joint of a wind turbine rotor blade.

REFERENCES

[1] D. F. Socie and G. B. Talyor, *Multiaxial Fatigue*. Society of Automotive Engineers Inc., 2000.

[2] J. T. P. de Castro and M. A. Meggiolaro , *Fatigue Design Techniques Under Real Service Loads. Volume II - Low Cycle and Multiaxial Fatigue*. 1st Edition, CreateSpace Indepentent Publishing Platform, 2016.

[3] S. Suresh, *Fatigue of Materials*. Cambridge University Press, 2004.

[4] E. Haibach, *Betriebsfestigkeit- Verfahren und Daten zur Bauteilberechnung*. 3rd Edition, Springer-Verlag, 2006.

[5] B. Weber, B. Kenmeugne, J. Clement and J. Robert, Improvements of multiaxial fatigue criteria computation for a strong reduction of calculation duration, *Computational Material Science*, Vol. **15**, pp. 381–399, 1999.