11th World Congress on Computational Mechanics (WCCM XI)
5th European Conference on Computational Mechanics (ECCM V)
6th European Conference on Computational Fluid Dynamics (ECFD VI)
July 20 - 25, 2014, Barcelona, Spain

Modeling crack propagation in shells by X-FEM with CB shell elements

QL Zeng[1]*, ZL Liu[1], DD Xu[1] and Z Zhuang[1]

[1] School of Aerospace, Tsinghua University, Beijing 100084, China
zengqinglei2008@126.com

Key Words: *CB shell element, XFEM, level set method, crack propagation.*

Abstract:

There are two approaches to develop shell element, developing the formulation by using classical strain-displacement and momentum equations for shells or developing shell elements directly from a continuum element, which is called the continuum-based (CB) shell element. Zhuang and Cheng[1] introduced X-FEM into CB shell element to model arbitrary crack propagation in shells in 2011. The 8-node quadratic CB shell element was adopted to avoid locking and they used the "equivalent domain integral" for 3D non-planar crack to calculate SIFs. Compared to X-FEM implemented in classical shells[2], cracks in CB shells are not necessarily perpendicular to the mid-surface, which is a great advantage over the previous methods.

Based on the essential idea of CB shell element with X-FEM, we improve the method to model arbitrary crack propagation in shells. Firstly, the level set method (LSM) is introduced to represent the crack. The governing equations of CB shell element are derived from 3D solid element and so the level set values are defined on the continuum element, which are calculated for every slave node. In addition, because cracks are not necessarily perpendicular to the mid-surfacein, crack surfaces in neighboring elements may not be continuous when the crack propagates. LSM can conveniently control the continuity of crack surfaces. A new integration scheme is proposed in this paper for the elements crossed by the crack surface. We adopt the maximum strain as the fracture criterion and thus the crack will propagate when the maximum eigenvalue of the strain reaches a failure value.

REFERENCES

[1] Zhuang Z, Cheng BB. A novel enriched CB shell element method for simulating arbitrary crack growth in pipes. Science China Physics, Mechanics and Astronomy, 2011, 54(8): 1520-1531
[2] Areias PMA, Belytschko T. Non-linear analysis of shells with arbitrary evolving cracks using XFEM. International Journal for Numerical Methods in Engineering, 2005, 62(3): 384-415