SIMULATING CRACK CLOSURE WITH COHESIVE ZONE ELEMENTS DURING CRACK GROWTH

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Abstract
Closure and the cohesive effect at crack fronts/surfaces play key roles in simulating crack growth. In this paper, fracture analysis method has been coupled with finite element remeshing techniques to automatically insert cohesive zone element on crack surfaces when cracks propagate, and then multiple cohesive zone models are compared and discussed. This feature has been implemented in Ansys Mechanical MAPDL so that customers are capable of accurately analysing crack growth in a more general background.

1. Introduction

Finite element is a powerful tool for fracture analysis. It often, however, suffers from meshing updating caused by geometry/configuration changes during crack growth. To resolve this problem, Ansys Mechanical MAPDL releases crack growth analysis tool, a.k.a. SMART, which automatically updates finite element mesh to track the crack fronts/surfaces evolution. In this remeshing process, physical quantities are mapped from old mesh to the new one, e.g. loadings, boundary conditions, solution variables etc. Cohesive zone element is one of the adjustments enhanced to crack surface during remeshing, which simulates interface tractions introduced by cohesive damage, friction, crack closure etc.

Fig. 1 shows the code architecture and data exchange among software modules. MAPDL Module first collects and backups geometry and mechanical data around cracks, and send required data to Mesh Module to get new mesh back, then build necessary information for the new mesh/element and continue regular structure analysis with the updated mesh. The above steps are repeated every time when crack growth criteria are satisfied in the model.

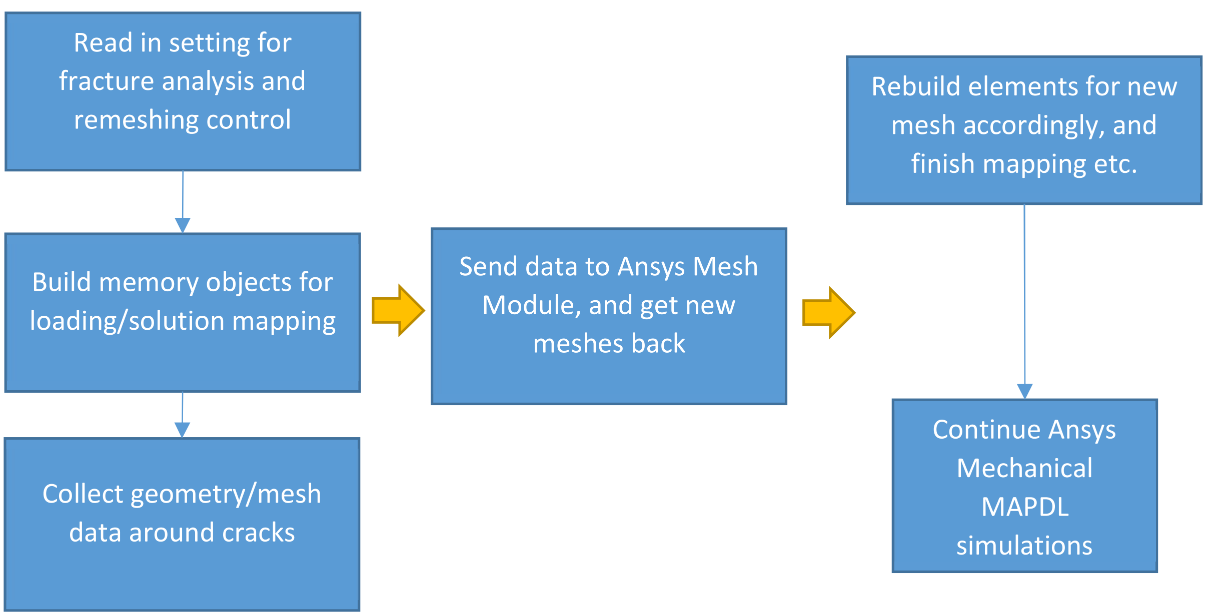

Fig.1 – Flow chart of crack growth remeshing

2. Results

A four-point-bending-beam model is used to illustrate how cohesive zone elements on crack surfaces help simulating crack growth under complicated loading conditions. Fig. 2 shows the sketch of the model, where line support locates at **A** and **B** of bottom face and line pressure locates at **C** and **D** of the top face, and an edge-crack is imbeded at the middle. The loading and constraints cause crack opening on one side and mixed with closure on another side, and unsymmetrical growth. Details of model information including models size and material properties etc. will be presented in conference.

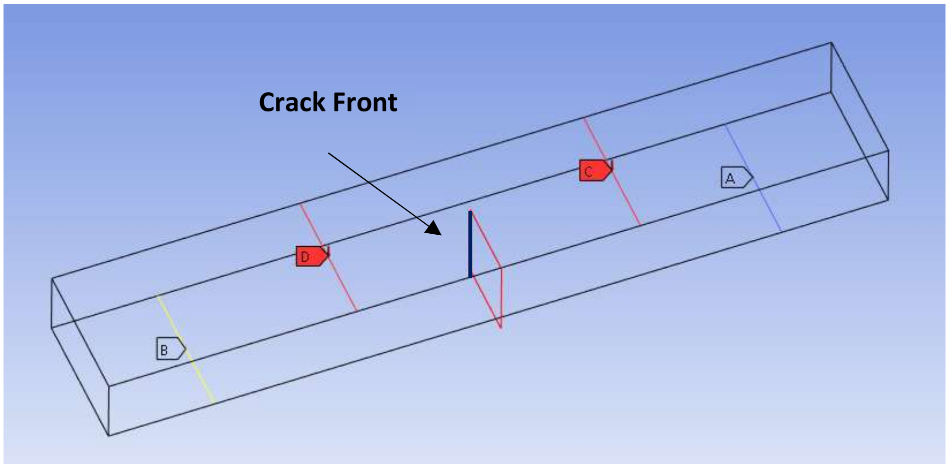

Fig.2 – A four-point-bending beam under Flow chart of crack growth remeshing

The interface traction in the normal direction is shown in Fig. 3. Cohesive zone elements provide anti-penetration traction on the compression side due to crack closures, and crack growth mainly happens at the tension side, while the crack front maintains no change at the compression side.

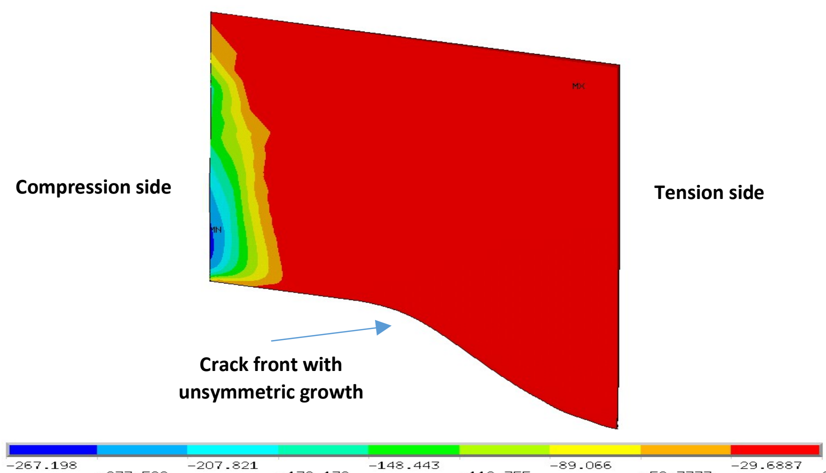

Fig. 3 – Interface traction along normal direction on crack surfaces

3. Conclusions

The design by integrating remeshing models to Ansys Mechanical MAPDL is capable to insert cohesive zone element on crack surfaces during remeshing and simulate interface behavior accurately.