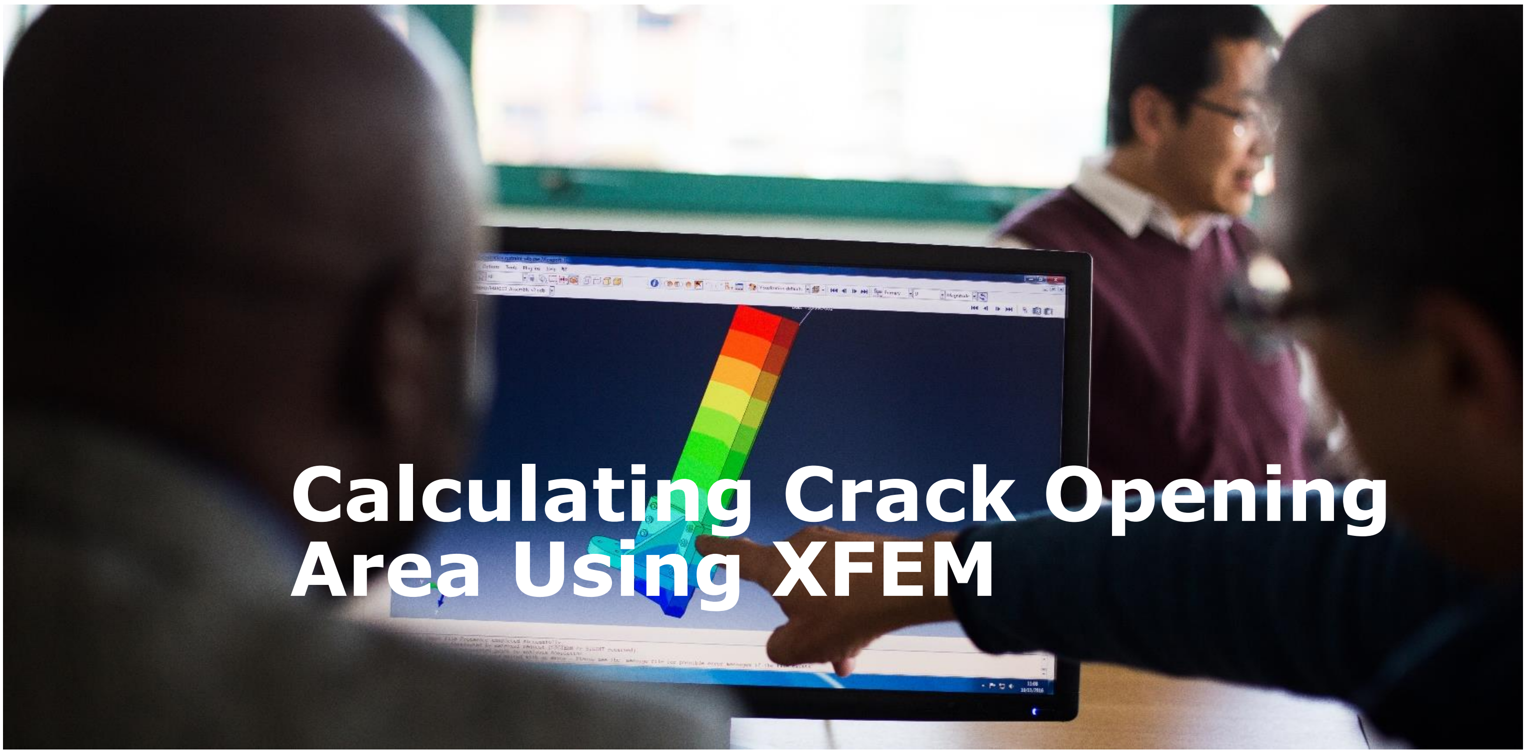


Calculating Crack Opening Area Using XFEM

Case study

Given EASL's specialised expertise and historic relationship with many nuclear power stations throughout the UK, we are often approached for consultation and analysis on safety case reviews. With both onsite and offsite skill, we were selected to undertake this review due to our competency in specific analysis software and our superior understanding of integrity assessment.

Above other competition

The client required the adoption a new module of the ABAQUS Finite Element Analysis software known as XFEM (extended finite element method) to be used in calculating the effects of a postulated transverse defect on a steam header.

As experts in ABAQUS, EASL regularly run internal and external training sessions, and could therefore provide a more cost effective and efficient work output than the client's available internal resources.

The work required consultation on a hypothetical issue with steam headers found in power stations. Should the findings result in significant issues, the client would be provided with clear, independent advice for whether preventative action could be taken to avoid higher remedial costs and loss of operations.

A postulated transverse defect on a steam header was assessed to ensure that no excessive steam leakage occurs during an over-pressurisation event. The crack opening area of the postulated defect was then analysed.

A finite element model of a section of the steam header was created and a crack seam representing a through-wall transverse crack placed at the required location using XFEM.

Our solution

Traditional cracked body assessments are generally carried out using finite element software, which requires a significant amount of effort to model the crack and its associated mesh.

The sometimes iterative mesh refinement process required in fracture assessments to determine the stress intensity factors may be impossible for complex crack geometries. However, using XFEM, complex crack geometries can be modelled efficiently and can account for a high degree of stress concentration around the crack without the need for iterative mesh refinement

Apart from determining the crack opening area, XFEM allows the extraction of stress intensity factors through the depth of the postulated crack. As with new technology, validation studies have been carried out by EASL to provide a level of confidence in the results. The studies undertaken compared stress intensification factors for various geometries against theoretical solutions.

The results

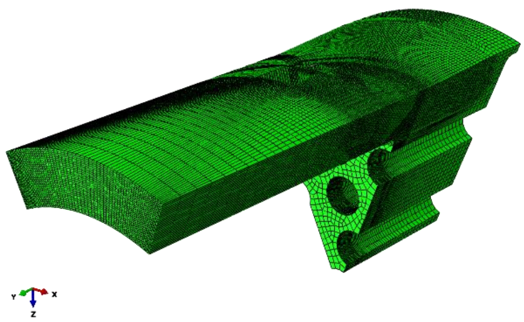
EASL is currently developing the methodology to apply XFEM in crack propagation assessments.

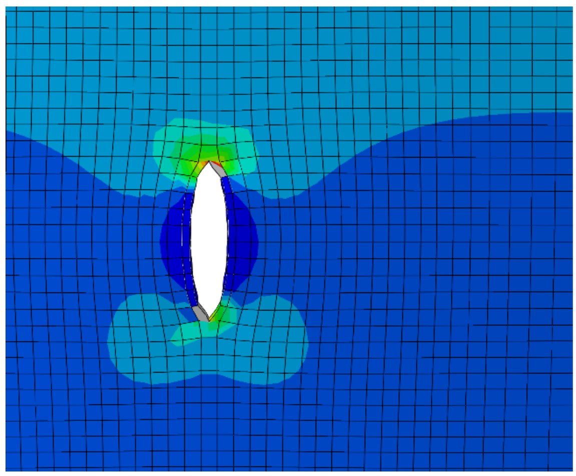
Using this software, an initial crack seam is not required and crack path definitions do not need to conform to the structural mesh as the crack path is solution-dependent.

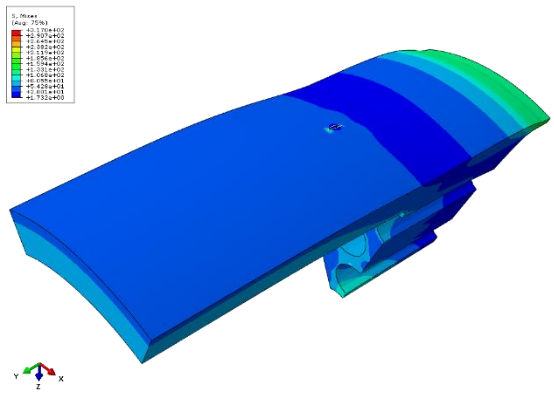
In addition, cracks are allowed to propagate through elements allowing for modelling of fracture of bulk material.

From the results of the study, EASL could provide information to the client that the crack wouldn't result in a collapse, allowing the current safety case to retain.

The work by EASL prevented the client from unnecessary remedial or replacement should such a scenario occur giving peace of mind of the future safety for such an event.







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