# Determination of stress intensity factors in a thick-walled cylinder with multiple axial cracks using the energy based_nite element method

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ABSTRACT

The stress intensity factors at the crack tip in an internally pressurized pressure vessel with multiple axial cracks were determined using the energy based modi_ed vir-tual crack closure technique. This technique was selected because it had been shownto give accurate results in determining stress intensity factors in at plates despitethe fact that only one _nite element analysis is required unlike in the virtual crackclosure technique which requires two _nite element analyses. Furthermore, the liter-ature sources that were consulted did not show evidence of the use of this method indetermining stress intensity factors in cylinders with multiple cracks. The Ansys10 Finite Element Analysis software was used to obtain the nodal forces at the crack tip and the nodal displacements in the vicinity of the crack tip. The _nite element hoop, radial and axial stresses along the crack face were found to be very close to those obtained using the Lame's equations for an un-cracked cylinder except at the crack tip where a region of stress concentration exist. The stress intensity factors obtained using the modi_ed virtual crack closure technique for cylinders with a single crack were found to be very close to those in literature. However this was after assuming that the crack extends by 37.5% of the length of the _nite element behind the crack tip. The same assumption was also found to be valid for cylinders with multiple cracks.

The cylinders that were considered in this analysis were those with 1_ n_100, 0.1_ a/t_0.7 and 1.5_ Y_2.5. Most of the stress intensity factor values obtained for both single crack and multiple crack cases were in good agreement with those found in literature with the error being less than 5% in most cases. It is anticipated that this work will form a useful reference material for owners of such cylinders, manufacturers, designers and developers of design codes. A lot of light has

also been shed on how e_ectively this technique can be applied to obtain stress intensity factor values in both single and multiply cracked cylinders.