

Name:

## Homework 4 Solutions

### Due 17 October 2019

Use a finite element software package of your choosing to model a center-crack, ensure that your model is sufficiently wide to match the infinite solution. Assume that  $E = 70$  GPa and  $\nu = 0.3$ . Use an analytic solution to calculate  $K_I$  for an infinitely wide panel.

Compare various methods we have discussed in class to the analytic solution

- Direct method (both stress field and displacement field)
- Virtual crack closure
- J-integral

#### Solution:

For an infinitely wide, center-cracked panel, we have  $K_I = \sigma\sqrt{\pi a}$ , if  $\sigma = 50$  MPa and  $a = 0.05$  m, that gives  $K_I = 19.8 \text{ MPa} \cdot \sqrt{\text{m}}$ . Using a quarter-symmetric model in COMSOL (von mises stress shown in Figure 1)

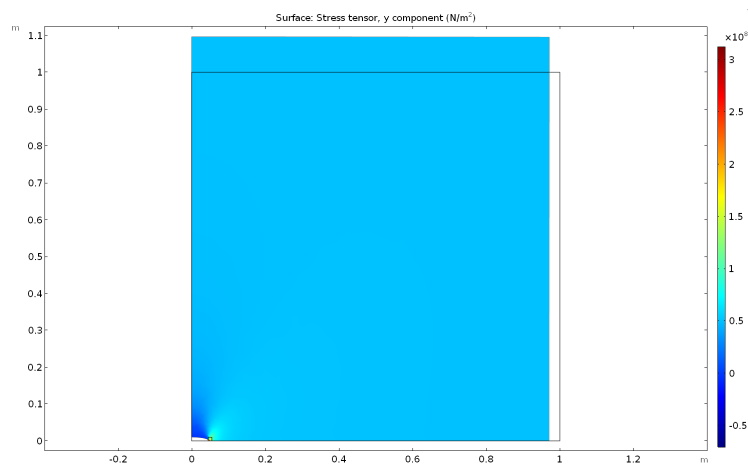


Figure 1: Von Mises stress in COMSOL model

A comparison of the various stress intensity factor methods can be seen in Figure 2. It is difficult to see in the figure, but the J-integral almost exactly matches the analytic prediction, while VCCT is also very close (both of these methods are not dependent on position, but are plotted that way to compare with the direct method, which is).

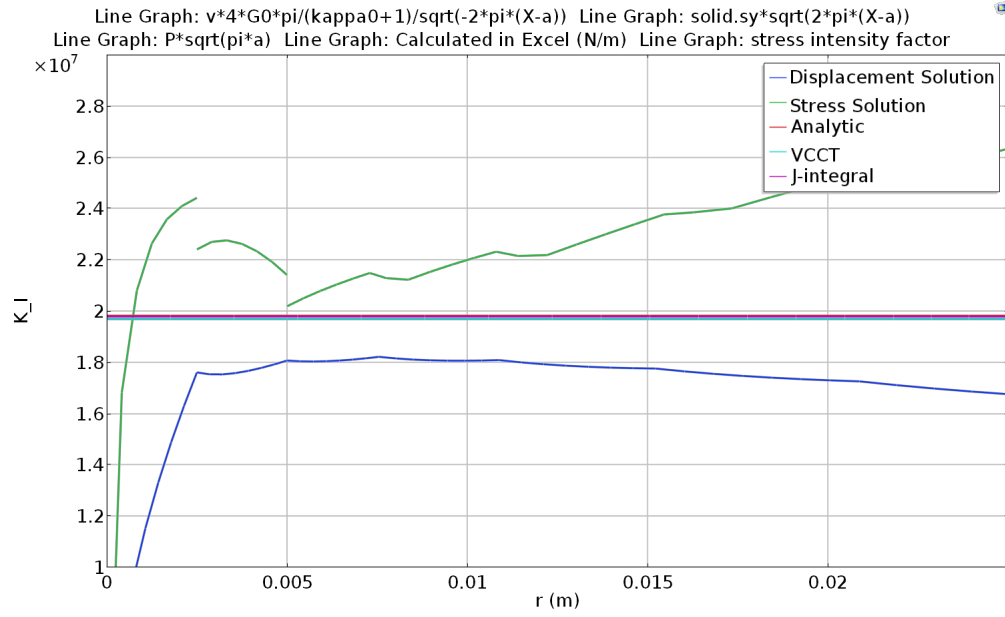


Figure 2: Stress Intensity Factor calculations from COMSOL