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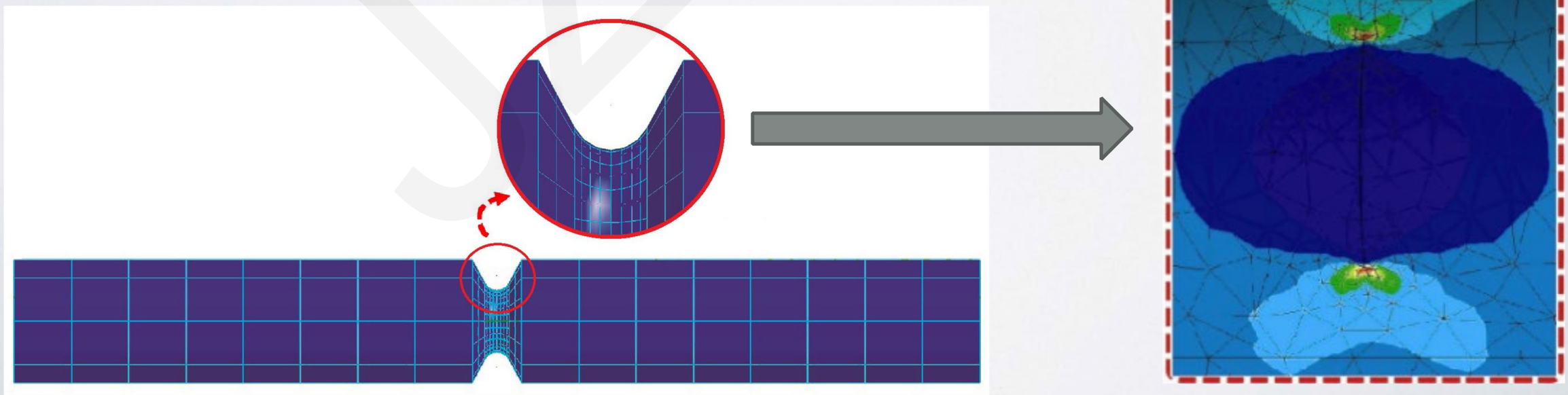
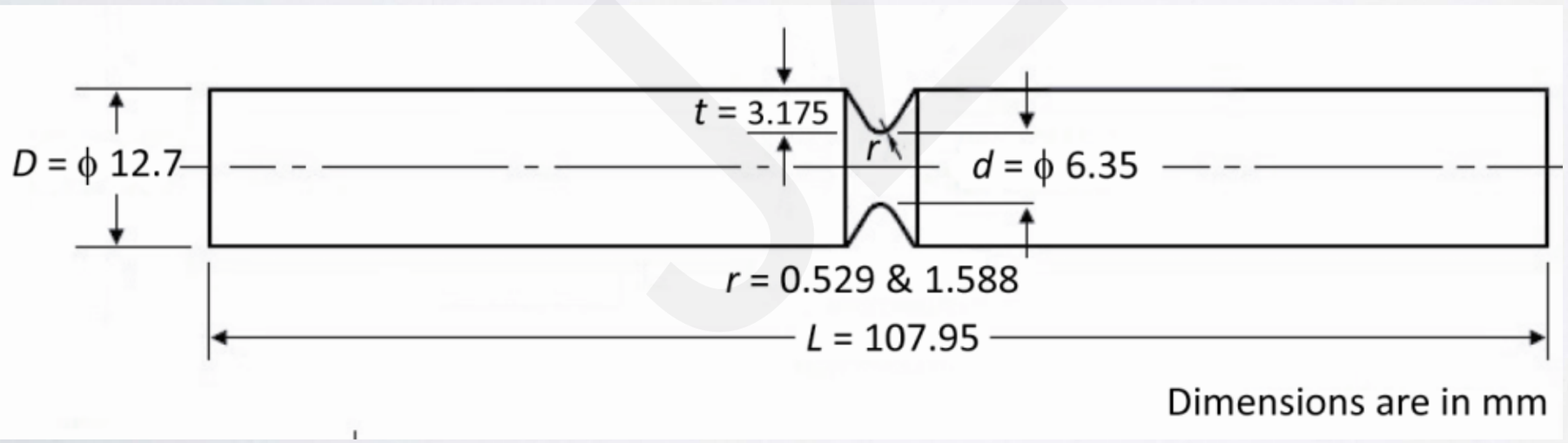
Fatigue growth of a surface crack in a V-shaped notched round bar under cyclic tension

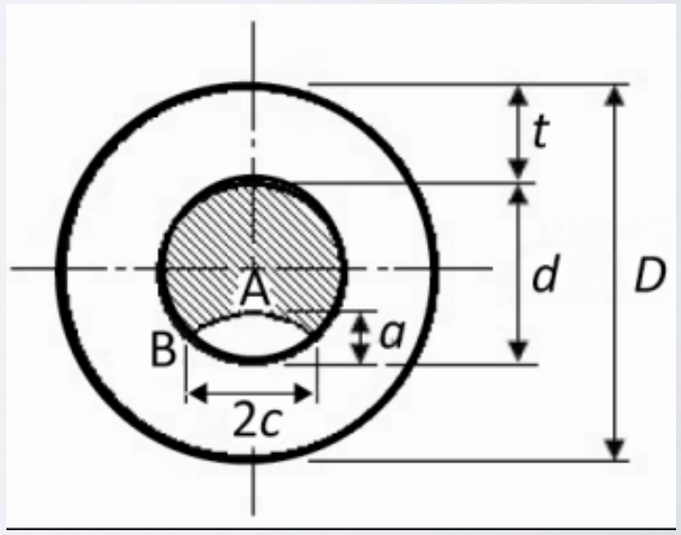
Key words: Fatigue crack growth, Crack aspect ratio, Boundary element method, Stress intensity factor (SIF)



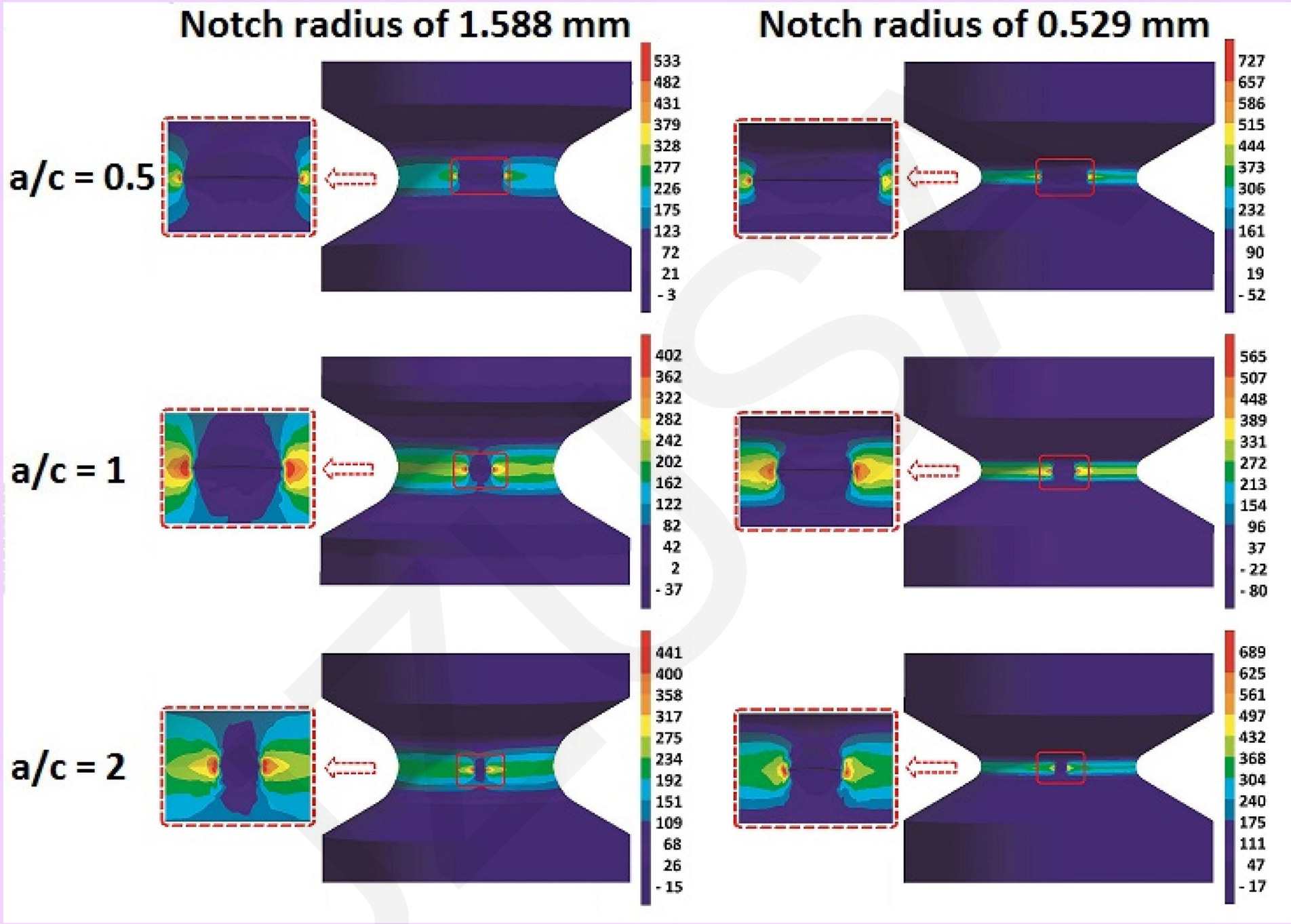
Backgrounds

A quarter- or half-cracked model was used in most of the previous studies by the FEM. However, not many findings on fatigue growth of a surface crack in a solid cylinder have been reported. Most of the researches that have been reported were using the Paris's crack growth law for their simulations. In the present study, the fatigue crack growths, the SIFs, and the crack shape evolutions of a semi-elliptical surface crack in a full model of a V-shaped notched round bar under cyclic tension are evaluated using the boundary element method software package of BEASY. The mechanical and fracture properties of AZ-6A-T5 magnesium alloy are used in the simulations. The *J*-integral is used to evaluate the SIFs, and the NASGRO crack growth rate law is chosen to simulate the fatigue crack growths. The influences of notch size and aspect ratios of cracks on the SIFs and fatigue life are studied.

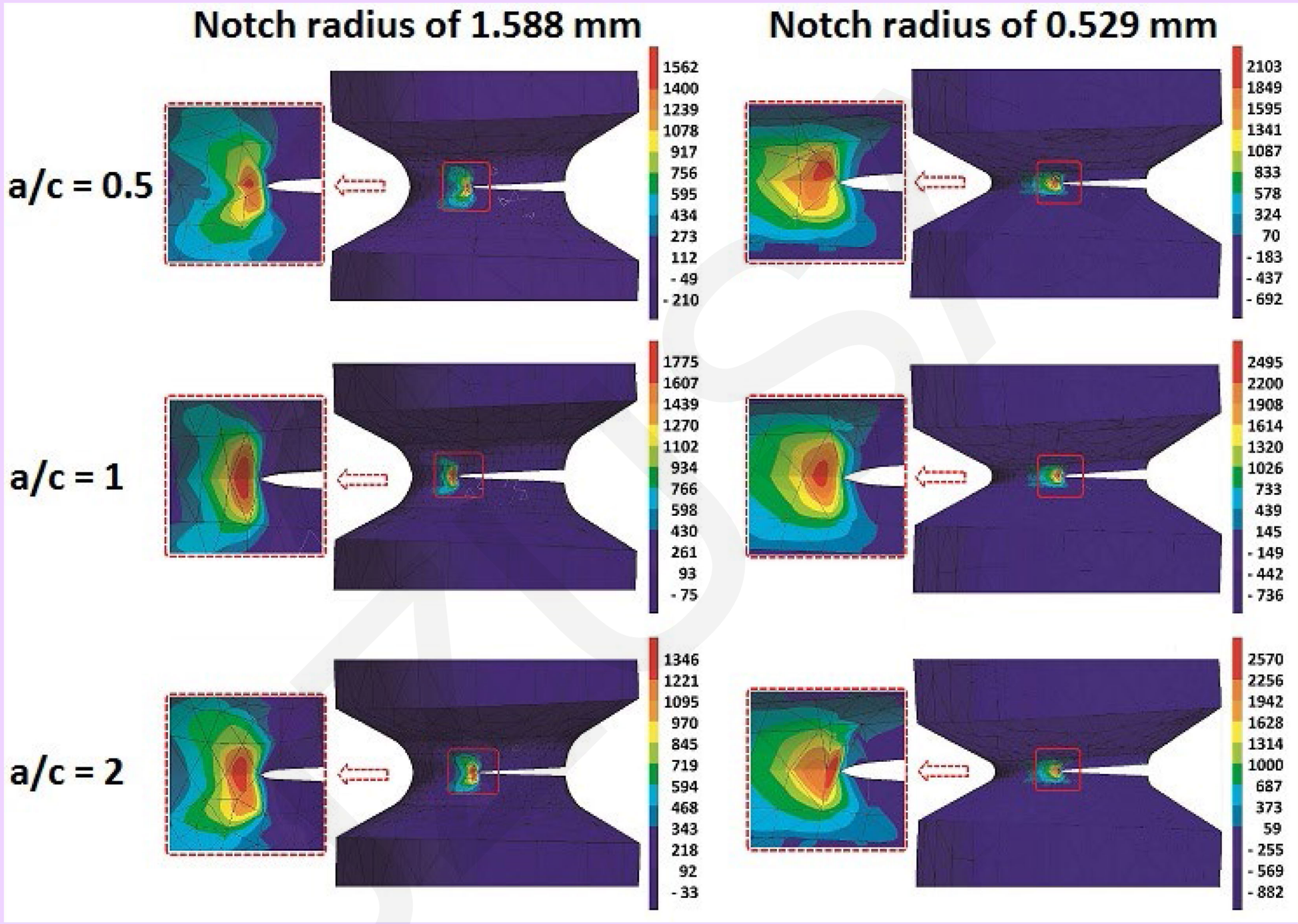




Axial stress contours at around the surface crack at the initial increment

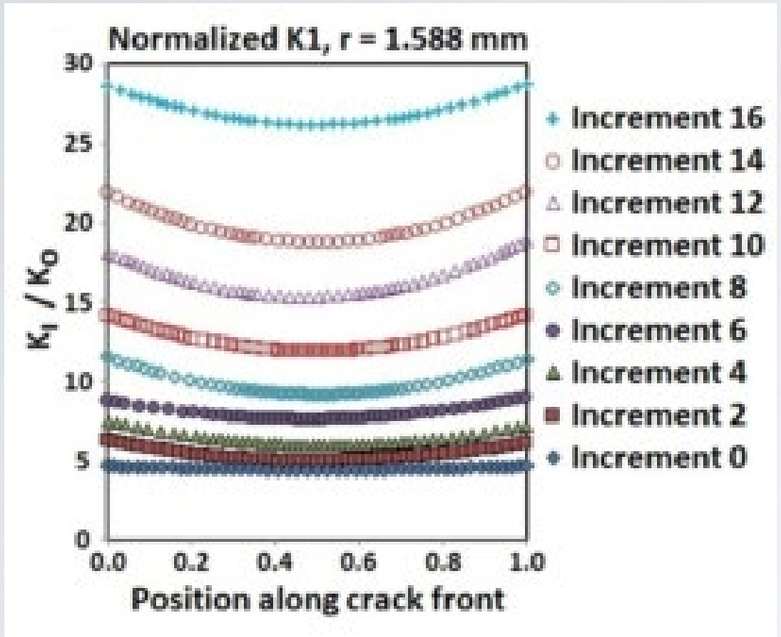


Axial stress contours at around the surface crack at the final increment

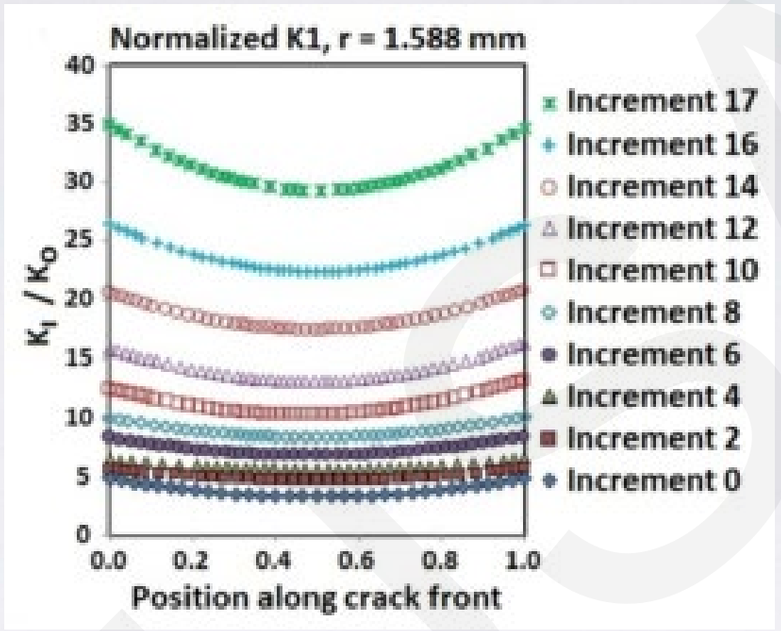


Normalized stress intensity factors

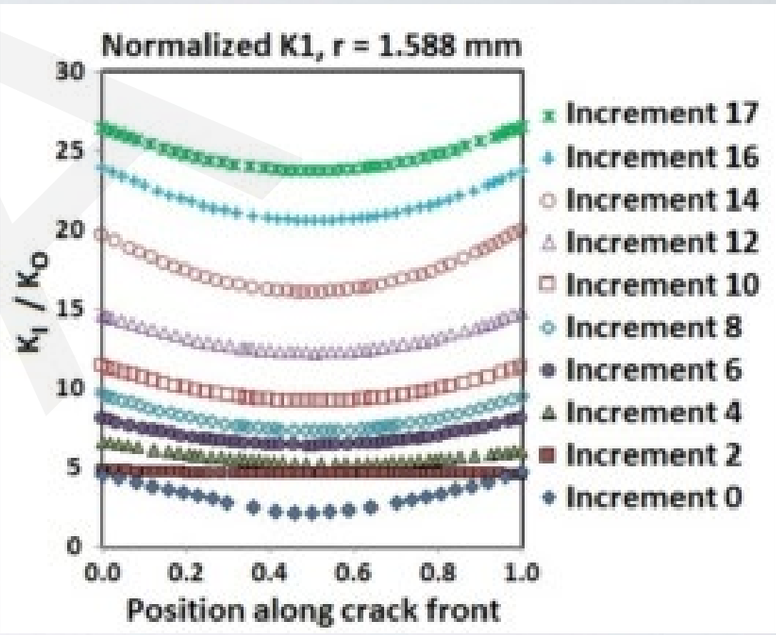
a = 0.5 mm; c = 1 mm

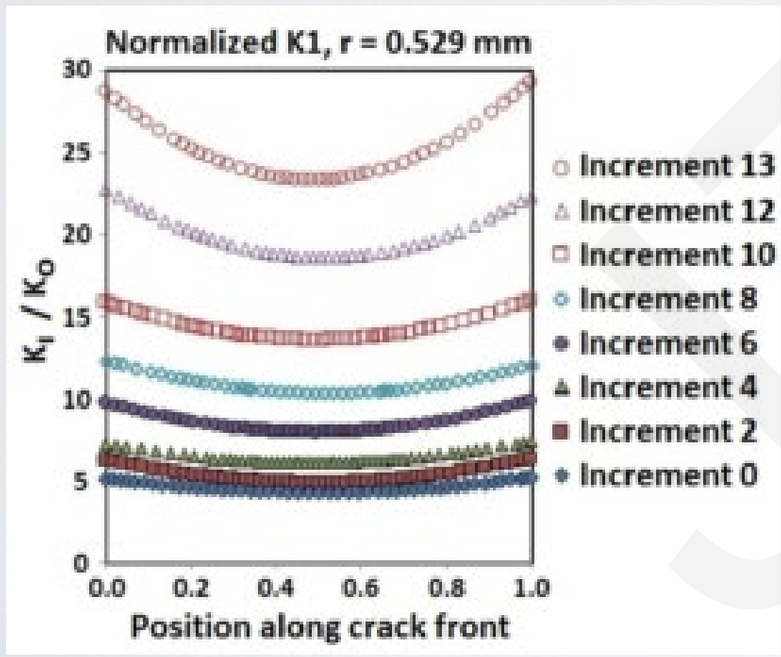


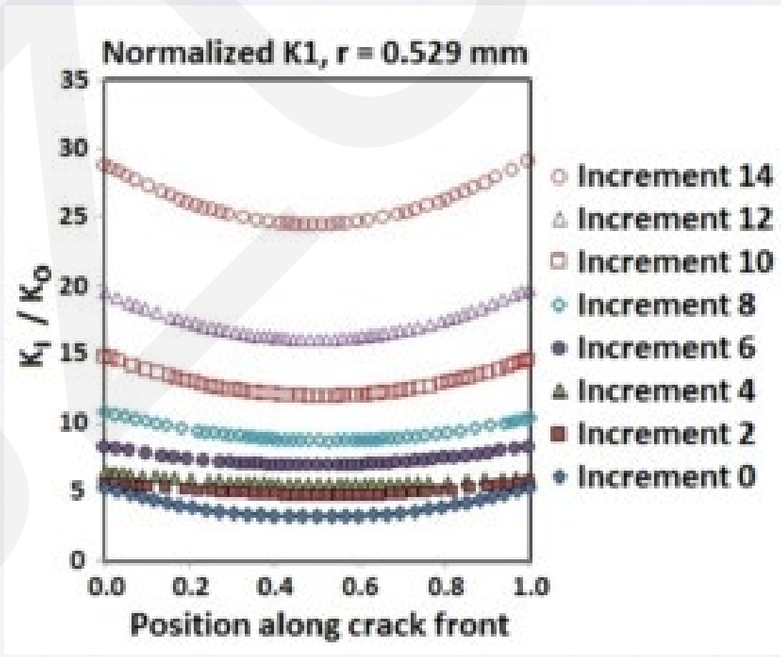
a = 0.5 mm; c = 0.5 mm

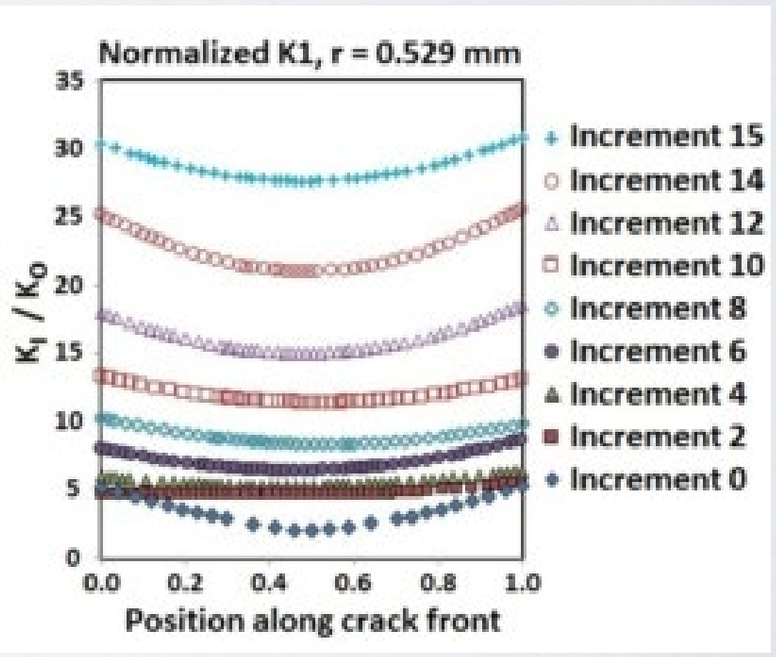


a = 0.5 mm; c = 0.25 mm



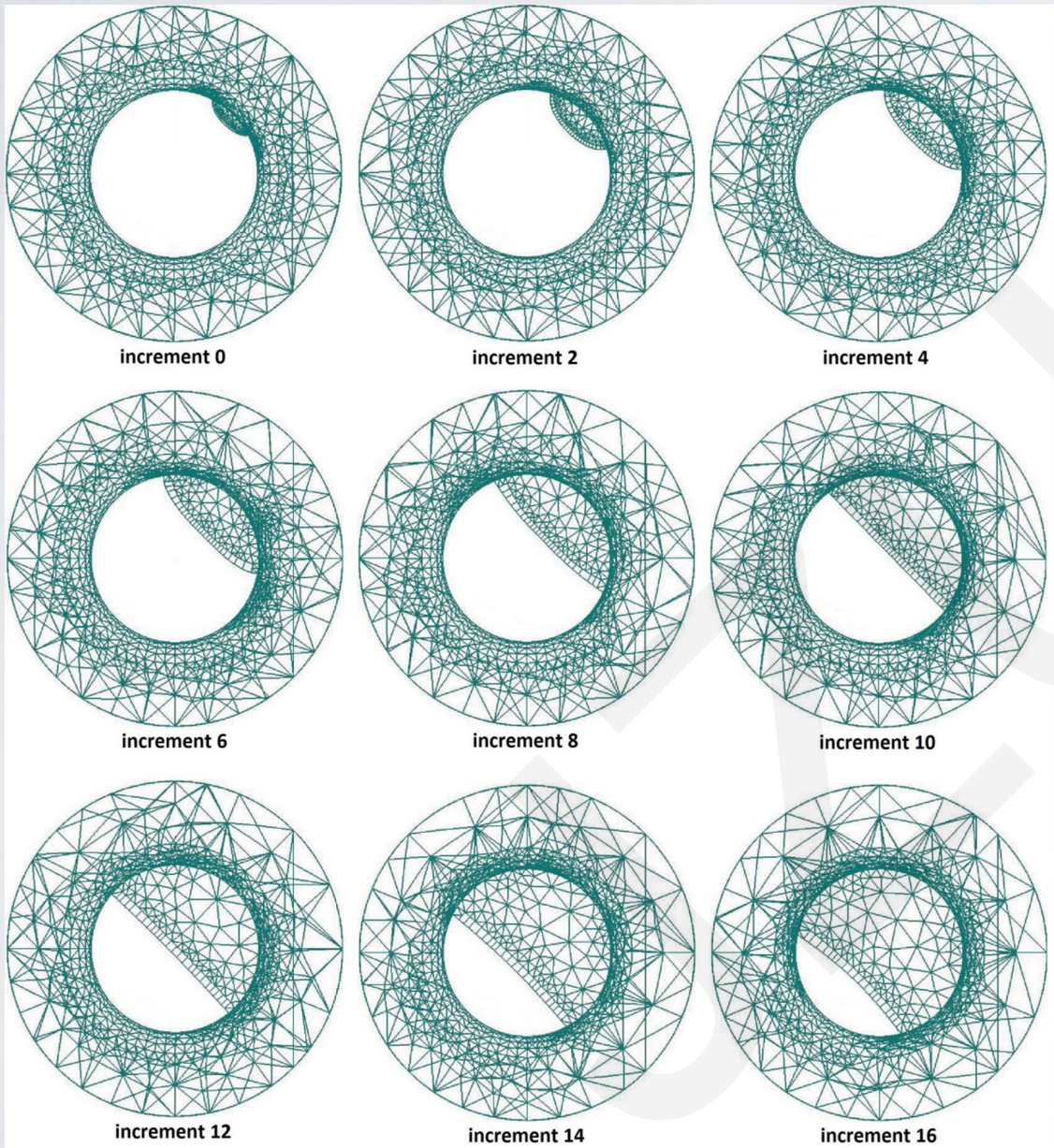




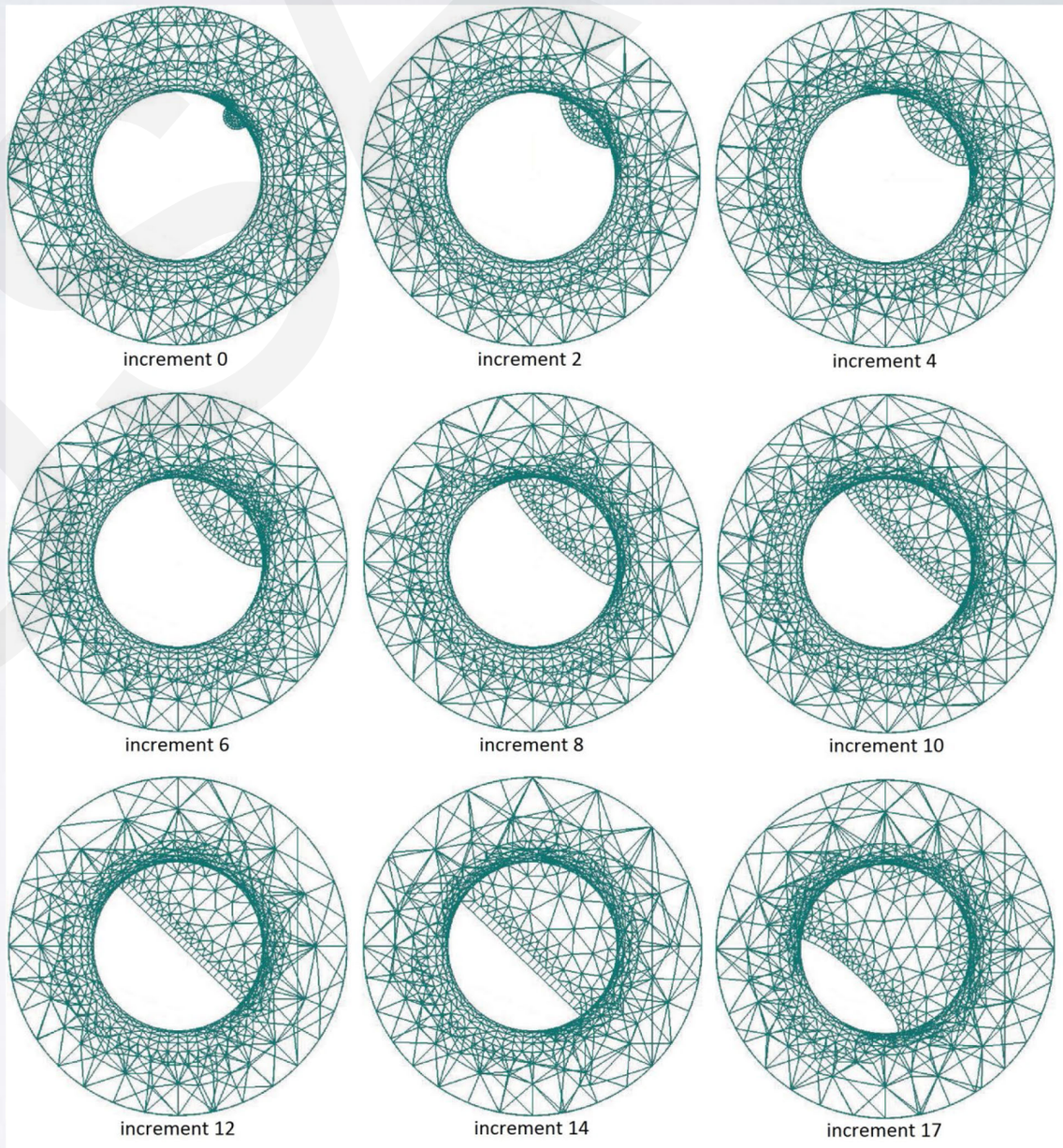


Crack shape evolutions

a/*c* = 0.5 and *r* = 1.558 mm

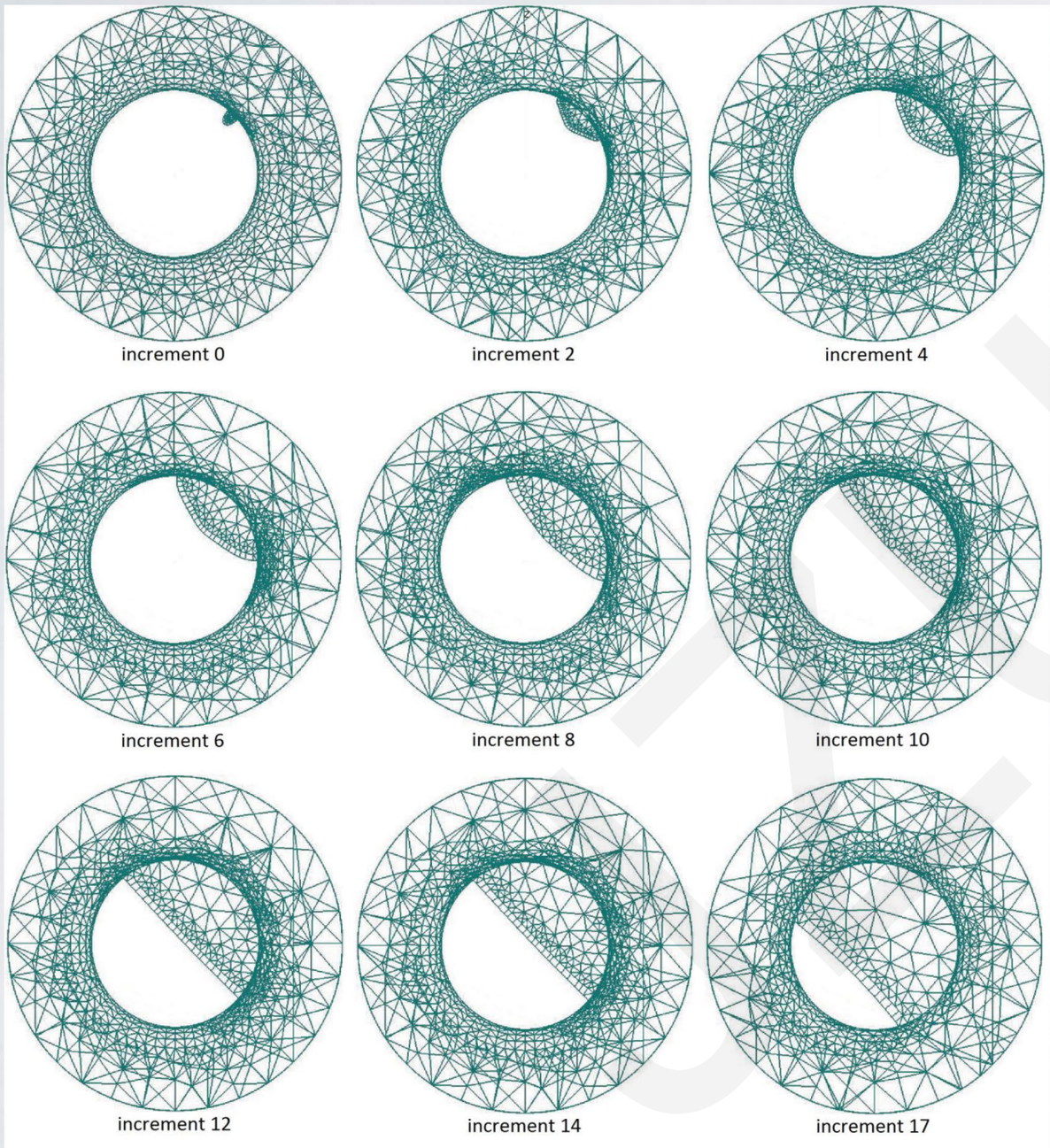


a/*c* = 1 and *r* = 1.558 mm

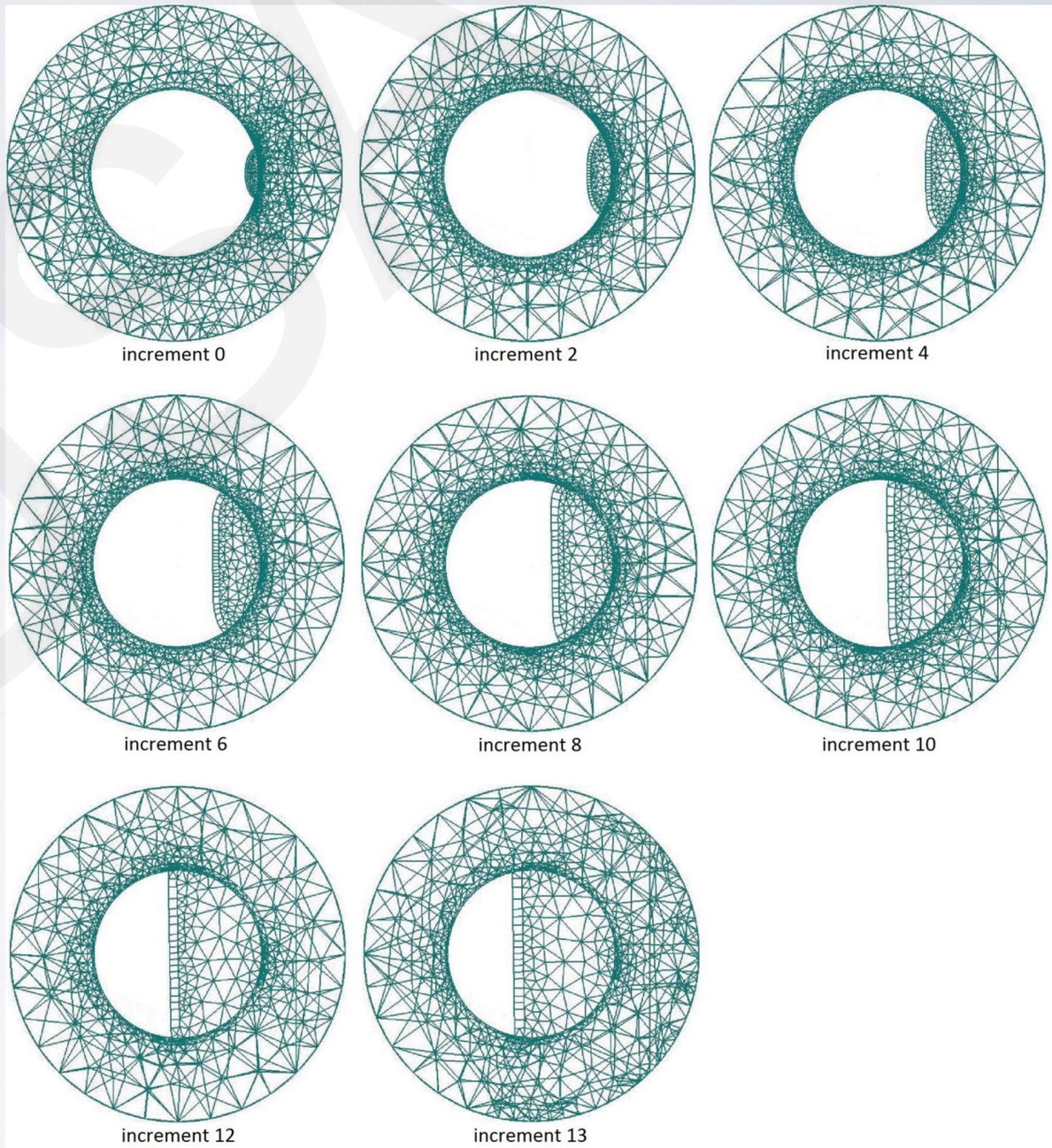


Crack shape evolutions

a/*c* = 2 and *r* = 1.558 mm

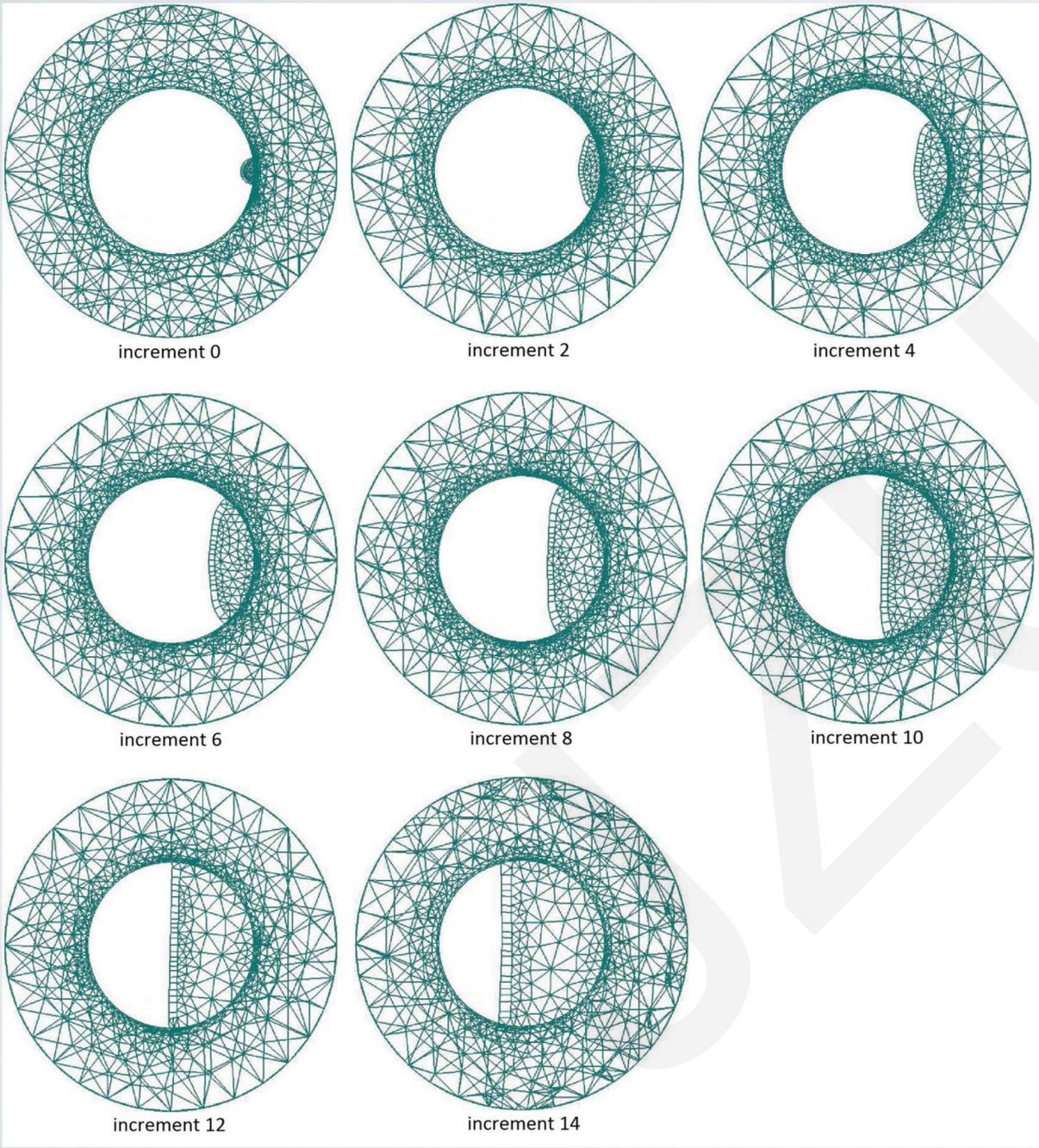


a/*c* = 0.5 and *r* = 0.529 mm

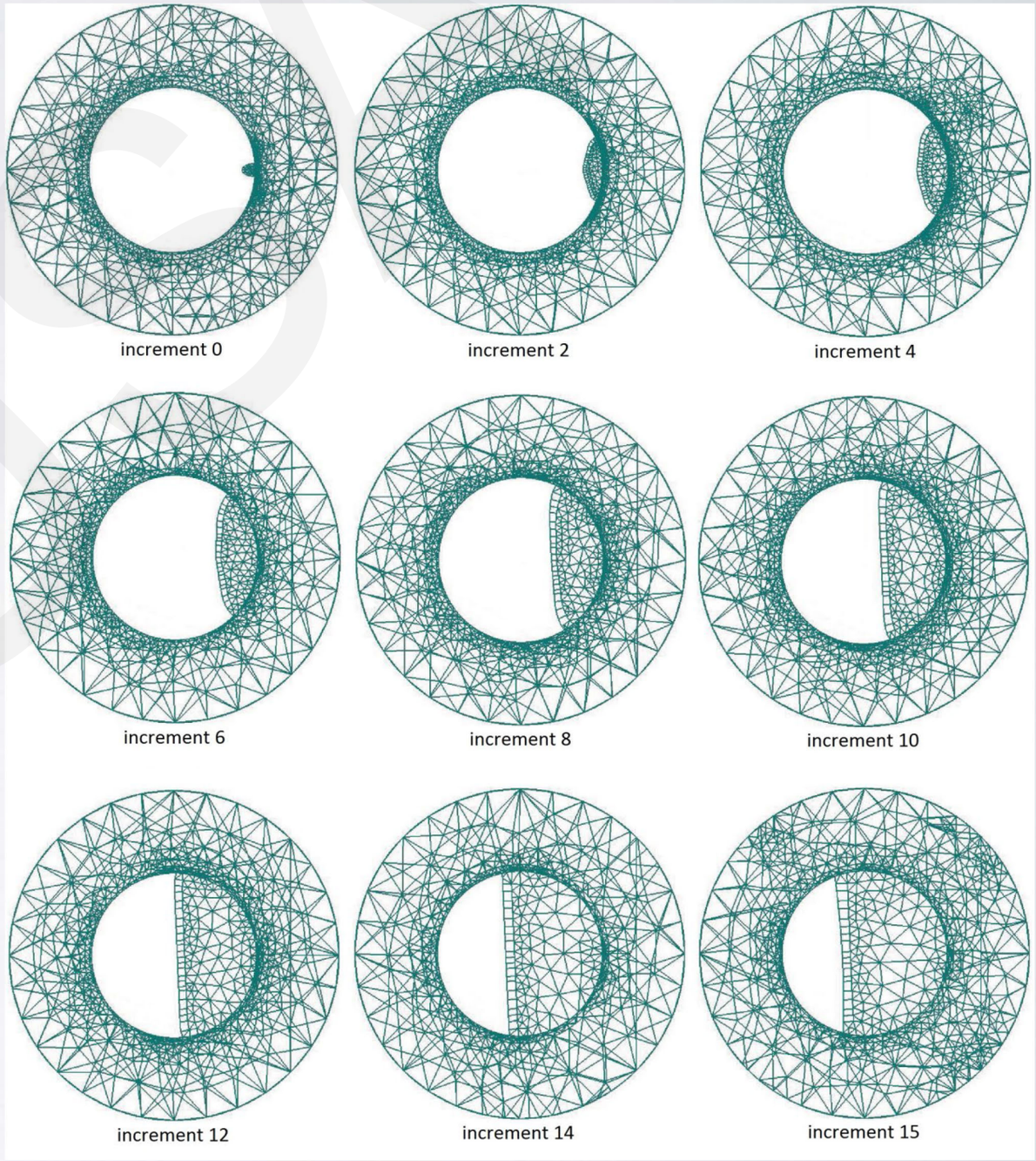


Crack shape evolutions

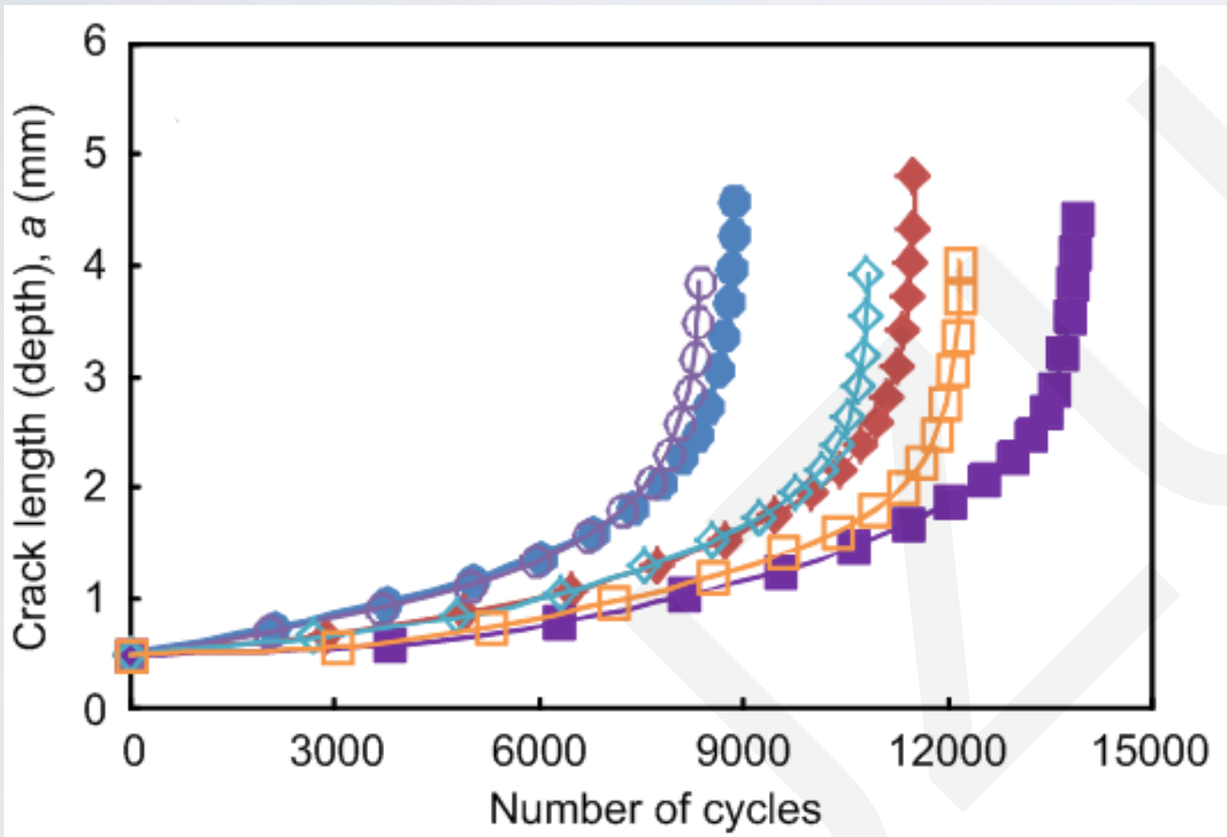
a/*c* = 1 and *r* = 0.529 mm

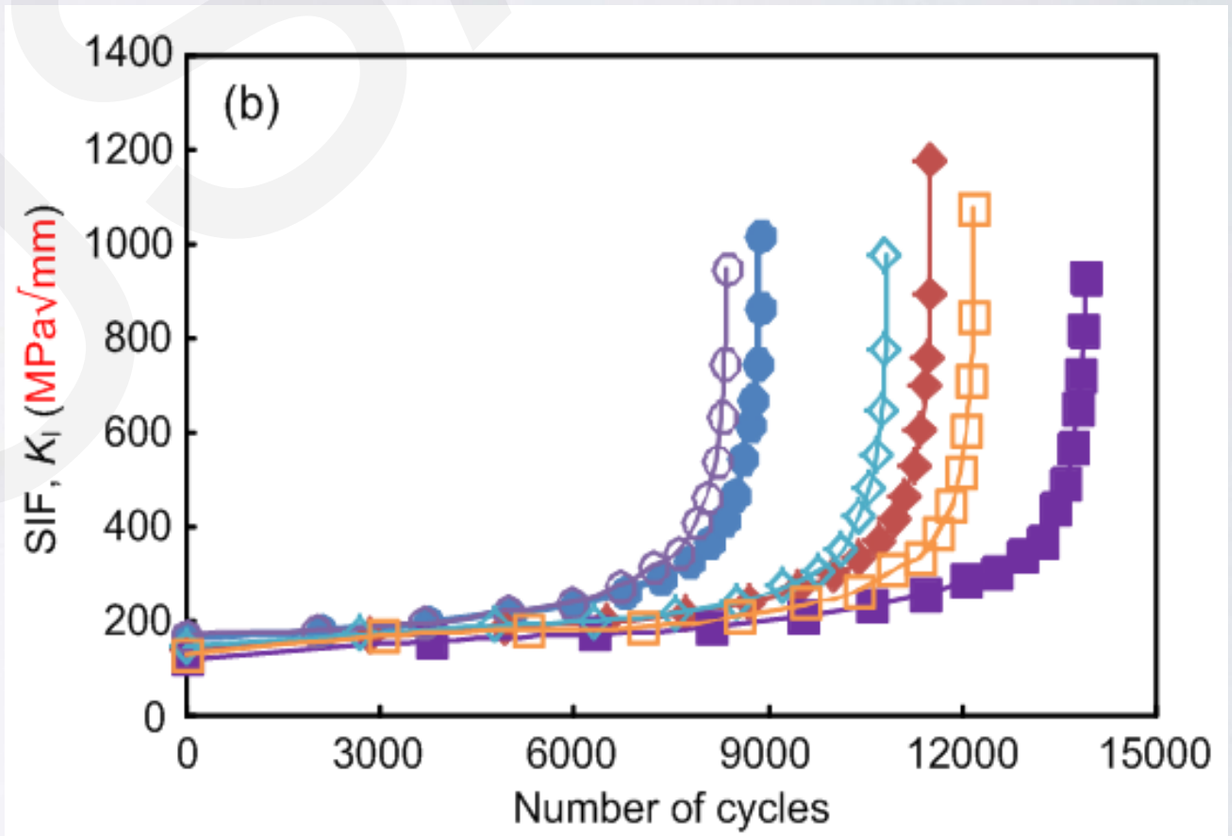


a/*c* = 2 and *r* = 0.529 mm



Estimated fatigue life





Concluding remarks

❖ The size of the initial crack aspect ratio has significant influence on the crack shape evolution during crack growth.

❖The effect of the crack aspect ratio on fatigue life is more significant than the notch radius.

❖Unstable crack growth was observed when the crack front had evolved to form a straight shape.

❖For a given crack depth, smaller crack aspect ratios lead to shorter fatigue lives.

❖The unstable crack extension during the crack growth was observed when the crack aspect ratio *a*/*c* evolved to be between 0.6 and 0.7.