

FIGURE 1 Cruciform sample for biaxial loading

(a) Sample size (b) Welded sample



FIGURE 2 Xstress Robot

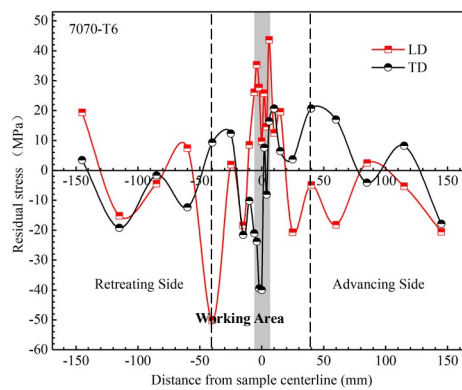


FIGURE 3 Residual stresses profile in FSW cruciform sample (LD and TD means

longitudinal residual stress and transverse residual stress respectively)

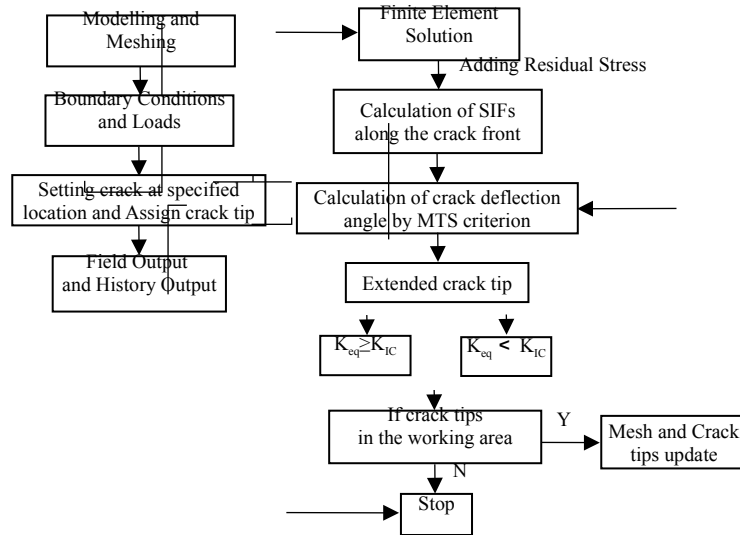


FIGURE 4 Flowchart of fatigue crack propagation analysis

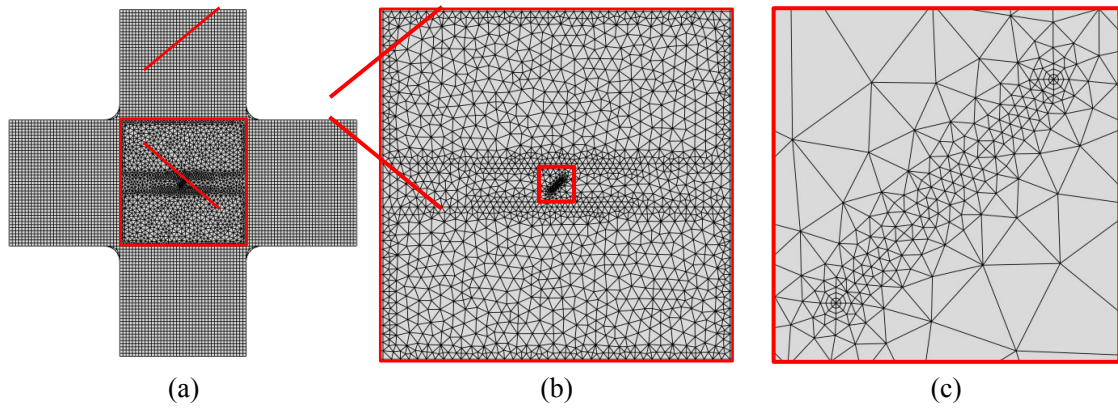


FIGURE 5 Finite element meshes used for the numerical simulation of cruciform sample

Mesh detail (a) in finite element model (b) in working area (c) around the crack tip

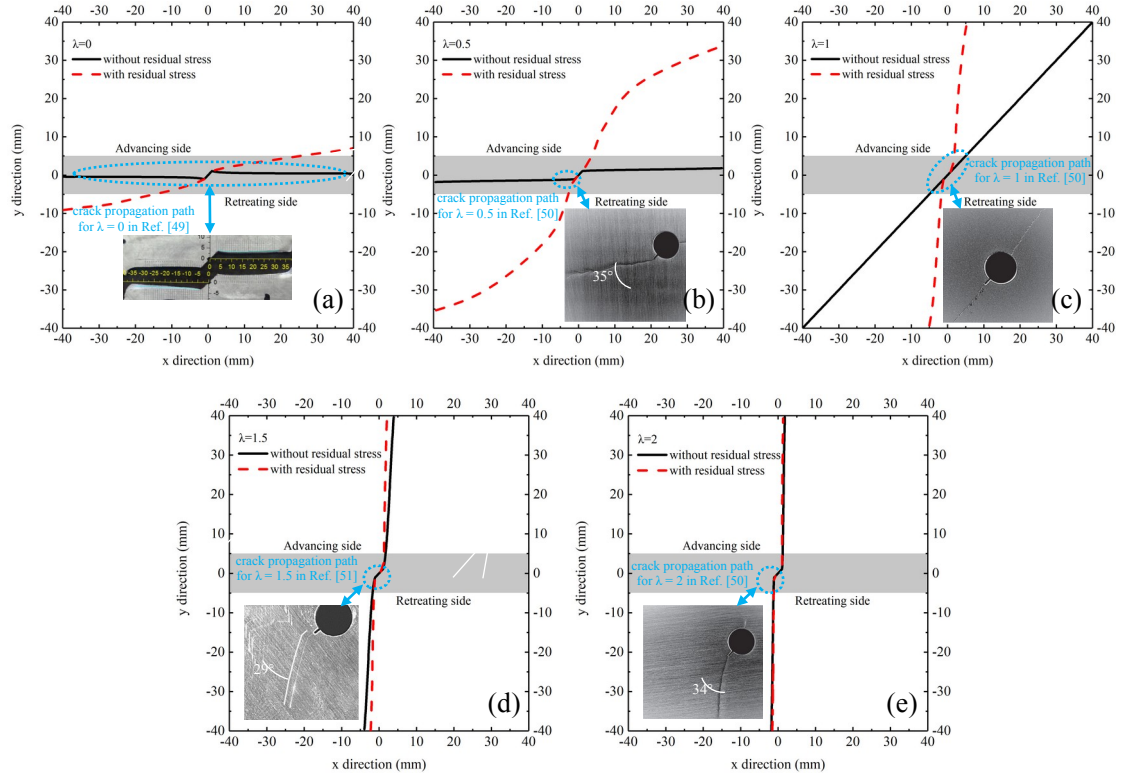
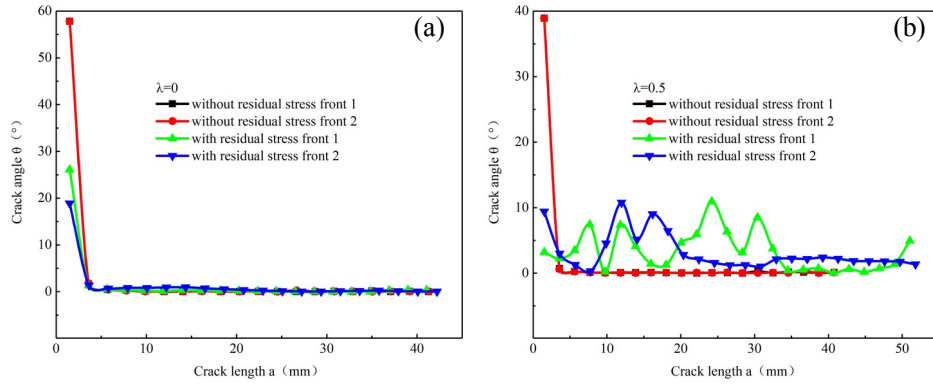


FIGURE 6 Crack propagation path in working area

(a) $\lambda = 0$ (b) $\lambda = 0.5$ (c) $\lambda = 1$ (d) $\lambda = 1.5$ (e) $\lambda = 2$



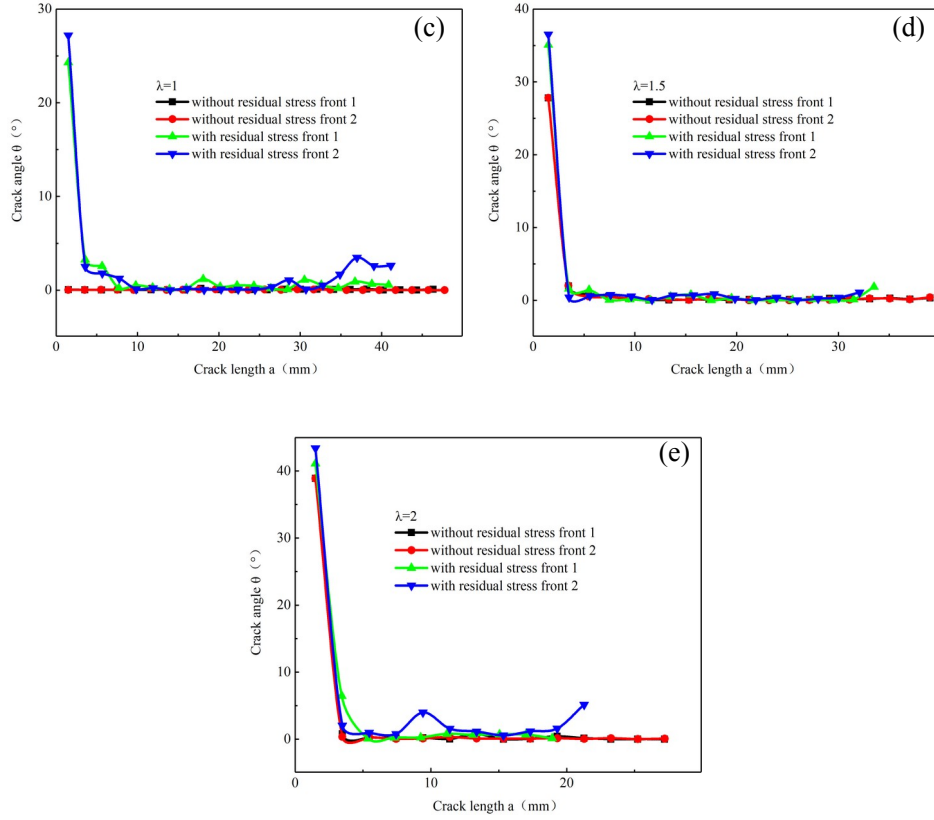
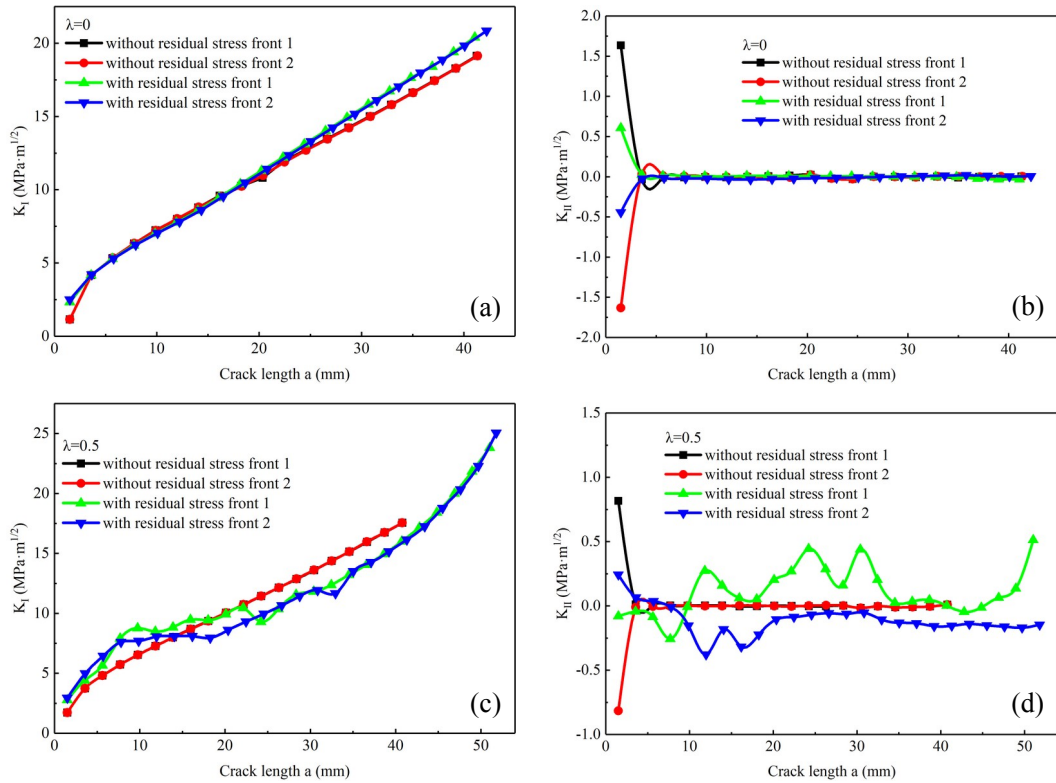


FIGURE 7 Crack deviation angle

(a) $\lambda = 0$ (b) $\lambda = 0.5$ (c) $\lambda = 1$ (d) $\lambda = 1.5$ (e) $\lambda = 2$



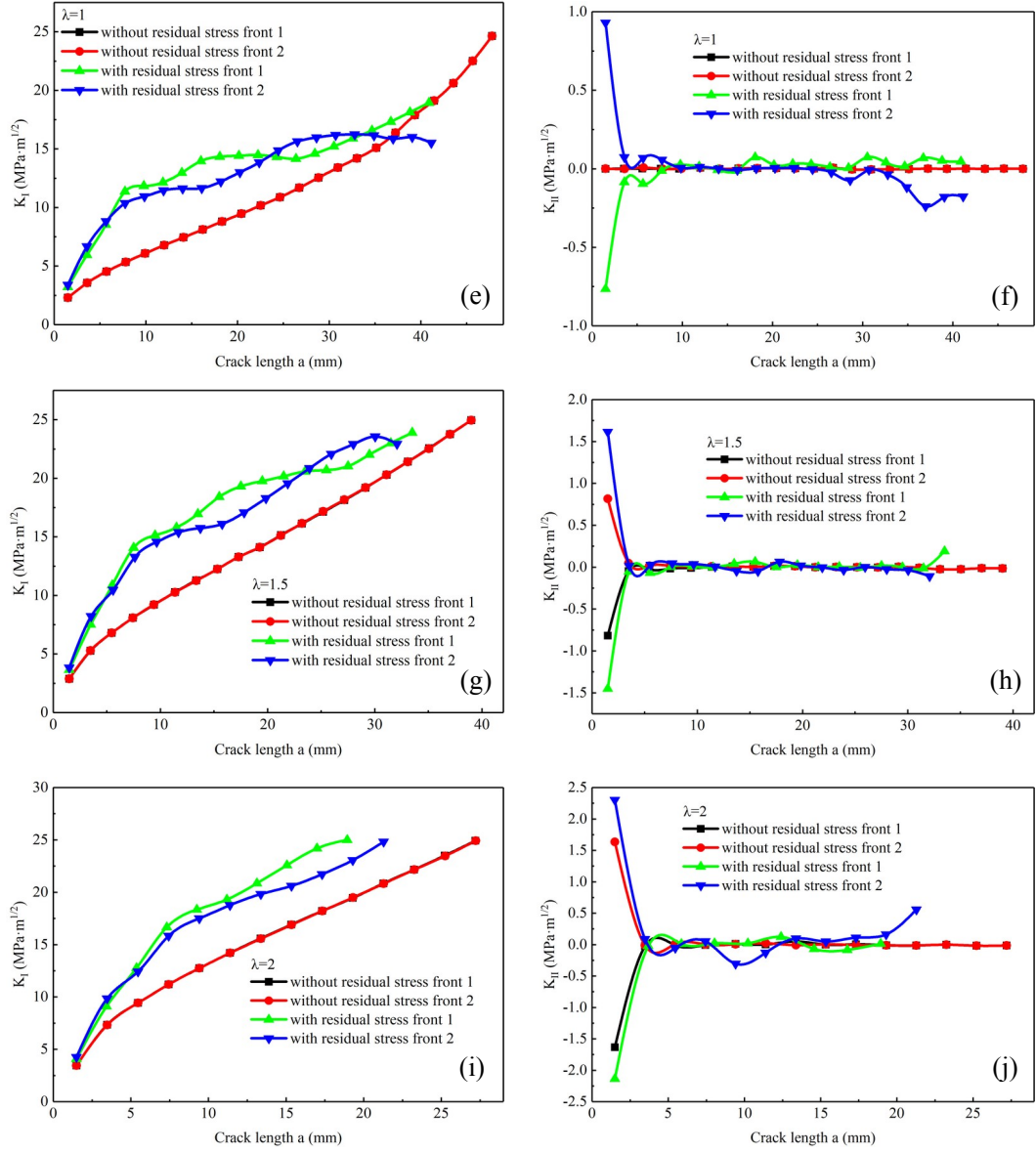
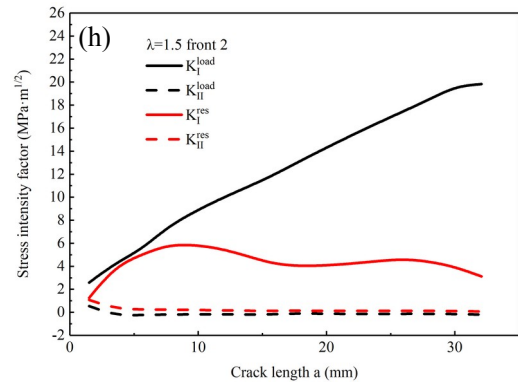
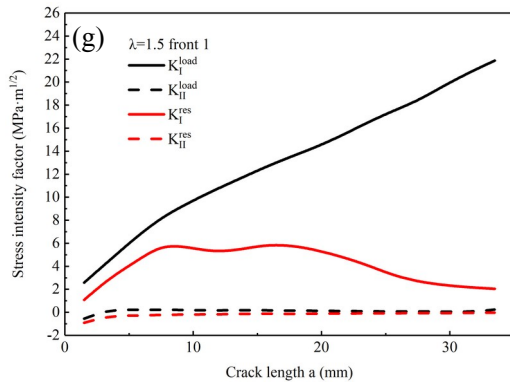
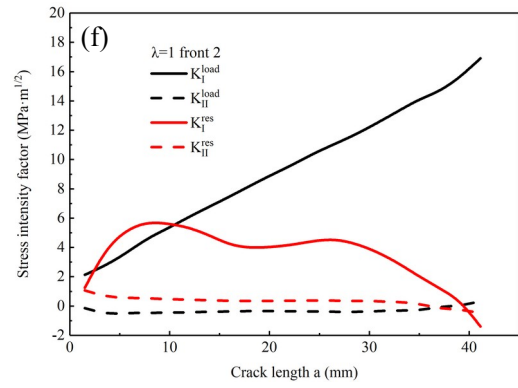
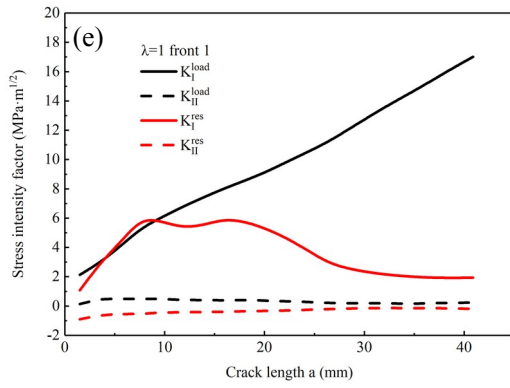
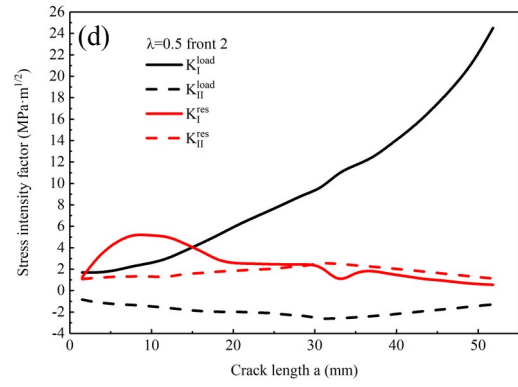
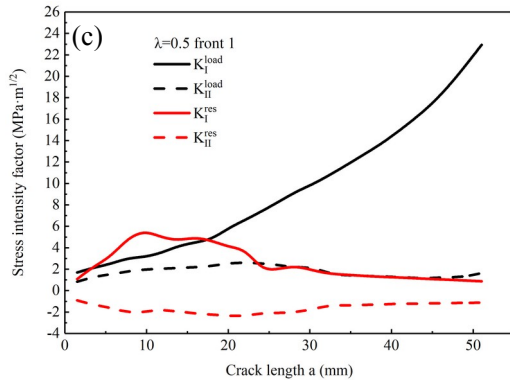
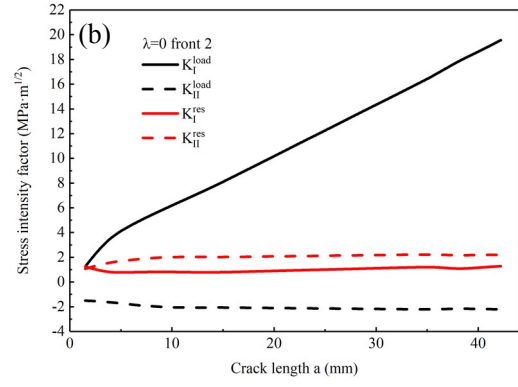
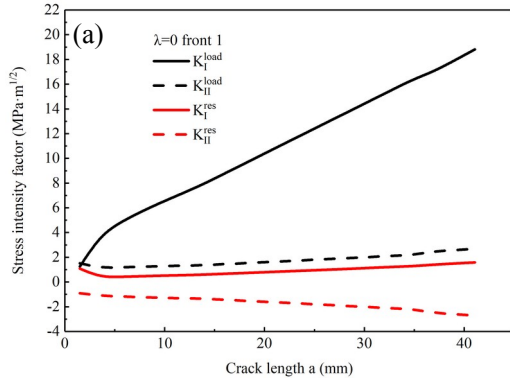


FIGURE 8 SIFs versus crack length

K_I : (a) $\lambda = 0$ (c) $\lambda = 0.5$ (e) $\lambda = 1$ (g) $\lambda = 1.5$ (i) $\lambda = 2$

K_{II} : (b) $\lambda = 0$ (d) $\lambda = 0.5$ (f) $\lambda = 1$ (h) $\lambda = 1.5$ (j) $\lambda = 2$



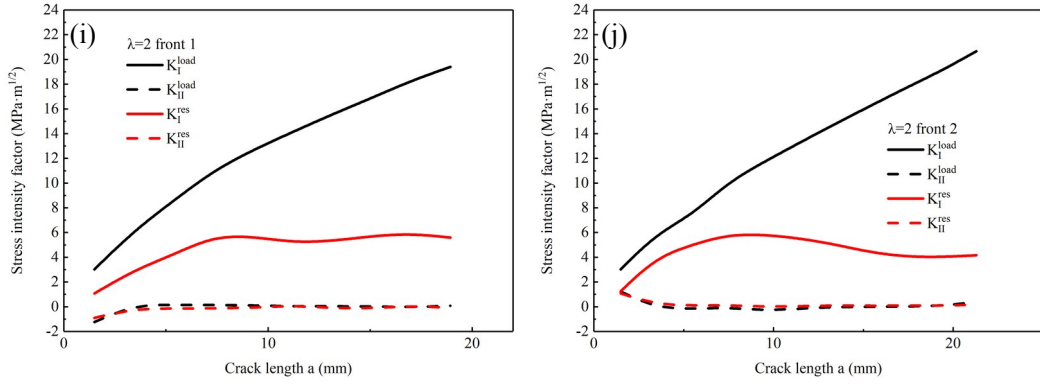


FIGURE 9 SIF components caused by the applied load and residual stress
front 1 (Advancing side): (a) $\lambda = 0$ (c) $\lambda = 0.5$ (e) $\lambda = 1$ (g) $\lambda = 1.5$ (i) $\lambda = 2$
front 2 (Retreating side): (b) $\lambda = 0$ (d) $\lambda = 0.5$ (f) $\lambda = 1$ (h) $\lambda = 1.5$ (j) $\lambda = 2$

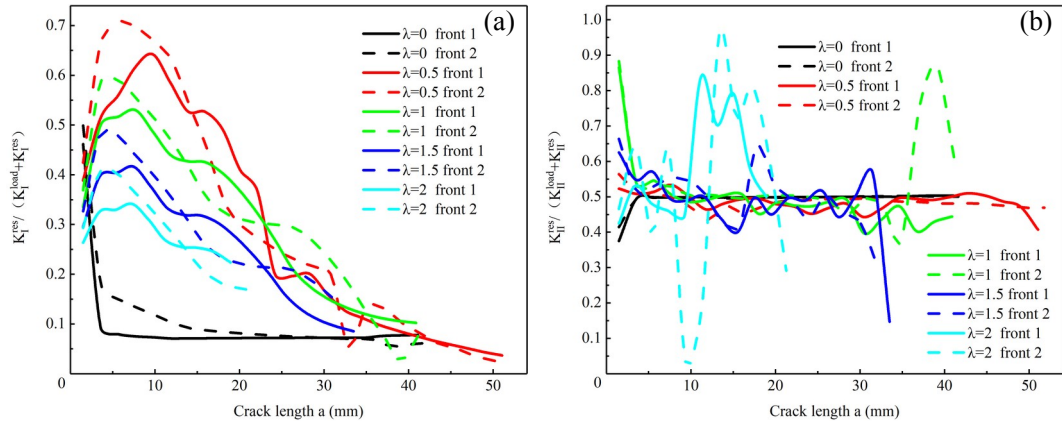


FIGURE 10 Nondimensional (a) $K_I^{res} / (K_I^{load} + K_I^{res})$ and

(b) $K_{II}^{res} / (K_{II}^{load} + K_{II}^{res})$ versus crack length for $\lambda = 0 \sim 2$