

Advanced Training in Fracture Mechanics

Session I LEFM Overview/2D SIF's/3D Modeling Considerations DAY DATE (TIME)

- Welcome and introductions
- Presentation/Exercise: “Linear Elastic Fracture Mechanics (LEFM) with StressCheck”
 - Overview of linear elastic fracture mechanics (LEFM) theory and background
 - Computation of stress intensity factors (SIFs) in 2D and 3D
 - Computation of separated energy release rates via J-integral
 - Why use StressCheck for LEFM analysis?
 - Sample LEFM applications via StressCheck
 - Global-local analysis
 - Multi-body contact analysis
- Presentation/Exercise: “2D Trim Out Radius: Stress and LEFM Analysis”
 - Planar analysis of a parametric plate with trim out radius (notch)
 - File: Notch.par
 - Imprint a line in a 2D plate to represent a thru-crack
 - Automesh the plate/thru-crack and apply materials/boundary conditions
 - Crack Edge method → free edges along imprinted line
 - Note: crack will initially be inactive for the stress analysis
 - Solve a linear p-extension and extract maximum 1st principal stress at notch root
 - Activate the crack, re-solve and extract the Mode I SIF at the crack tip
- Presentation: “Best Practices and Guidelines for 3D LEFM Analysis”
 - Embedding surfaces for part-thru and thru crack representation in 3D
 - Guidelines and best practices for crack front automeshing
 - Crack Face method → free edges/faces at crack surface
 - Boundary layer method → geometrically graded layers around crack front
 - Crack Front method → combines Crack Face and Boundary layer methods
 - Guidelines and best practices for 3D SIF computations
 - Selection of an appropriate integration radius
 - Points tab → extraction of SIF distributions along crack front
 - Fracture tab → point & click extraction of SIF's at any location along crack
- Presentation/Exercise: “3D Cracked Longeron”
 - Import a 3D longeron section and embed a parametric elliptical crack in a hole
 - Files: CrackParameters.par and L-Cap Holes.x_t
 - Automesh the longeron/part-thru crack via Global/Crack Front methods, respectively
 - Apply materials/boundary conditions and solve a linear p-extension
 - Plot deformed shape to ensure crack face is “opening”
 - Assess SIF convergence via the Fracture tab
 - Extract SIF distribution along crack front via the Points tab
 - Compare AUTO vs manual integration radius

Session II 3D Fracture Mechanics Applications/COM Automation DAY DATE (TIME)

- Presentation/Exercise: “3D Parametric Cracked Shoulder Bushing”
 - Build a fully parametric shoulder bushing with an embedded 180-degree elliptical flaw.
 - File: ShoulderBushingCrack.par
 - Automesh the bushing/elliptical flaw via Global/Crack Front methods, respectively
 - Apply materials/boundary conditions and solve a linear p-extension
 - Plot deformed shape/stress fringes and extract SIF distribution along crack front
 - Update parameters for a new configuration, re-solve/re-extract SIFs
- Presentation/Exercise: “3D Cracked Rib with TLAP Loads: Stress and LEFM Analysis”
 - Perform a global-local analysis for imported 3D rib section and global point loads
 - Files: Rib.x_t, CrackedRib.par and RibTLAPs.csv
 - Embed parametric elliptical crack in a cutout using a temporary clocking angle
 - The clocking angle will be updated after the stress analysis once the crack initiation location is computed
 - Automesh the rib/crack via Global/Crack Front methods, respectively
 - Note: crack will initially be inactive for the stress analysis
 - Apply materials/boundary conditions and solve a linear p-extension
 - TLAP Traction Cross Section method → apply global loads as linear stresses
 - Plot 1st principal stresses in cutout and compute crack initiation location
 - Update clocking angle, activate crack, re-solve and extract SIF distribution along crack
- Presentation/Demo: “3D Cracked Shoulder Bushing COM Driver”
 - How StressCheck may be automated via scripting (e.g. VBA/Python)
 - Demo: Analyzing the 3D cracked shoulder bushing model via Excel VBA script
 - Files: 3DCrackedShoulderBushingDriver.xlsm, 3DCrackedShoulderBushing.scw
- Presentation: “Wrap Up & Next Steps”
 - What we learned in this training course
 - Next steps & online e-Learning resources
 - Q&A