

# Advanced Training in Fracture Mechanics

## Objectives:

- 1) How to design the optimal mesh at singularities (crack tips & re-entrant corners).
- 2) How to extract stress intensity factors (SIF's) for thru cracks & corner cracks.
- 3) How to use solid modeling tools to embed 3D crack surfaces.
- 4) How to utilize auto meshing features for 3D crack problems.
- 5) How to perform a 2D Crack Path analysis (optional).
- 6) Hands-on training:
  - Constructing 2D and 3D models for fracture mechanics problems.
  - Extracting SIF's for 2D and 3D models using "Fracture" and "Points" tabs.

## Session I (4 hrs)

### 2D Stress Intensity Factors

- ❑ **Lecture:** "Fracture Mechanics".
- ❑ **Exercise:** Build and solve 2D problem #1 "Linkage Arm" (pg 3-9).
- ❑ **Exercise:** Build and solve 2D problem #2 "2D Cracked Lug" (pg 9-16). Save project as *2DCrackedLug.scp*. Perform Exercises 1, 2 and 3. (pg 15-16).
- ❑ **Exercise (optional):** Retrieve *2DCrackedLug.scp* and create a second solution (SOL2) that replaces the sinusoidal bearing load with a normal spring constraint (CONST2). Assign to the spring a normal/radial stiffness ( $k_s = 1.0e+8$  lbf/in/in<sup>2</sup>). Assign a traction equivalent to the bearing load to the end of the lug. Run a General nonlinear analysis (releases normal springs in tension) using linear run for p=6 and compute SIF's. Compare to the open hole SIF's.

## Session II (4 hrs)

### 3D Stress Intensity Factors

- ❑ **Exercise:** Retrieve *2DCrackedLug.scp* model, convert mapping to geometric and extrude (RBC's!). Solve & compute SIF's thru-the-thickness using the "Points" extraction tab.
- ❑ **Lecture:** "Hints and Tips for Fracture Mechanics".
- ❑ **Exercise:** Solve & compute SIF's for 3D problem #1 "Cracked Panel" (pg 26-30). Discuss 3D meshing strategy. Demonstrate how to use geometric boundaries for SIF's.
- ❑ **Exercise:** Build, solve & compute SIF's for 3D problem #2 "Cracked Longeron" (pg 31-36). Save project as *CrackedLongeron.scp*. Perform Exercises.
- ❑ **Exercise:** Build, solve & compute SIF's for 3D problem #3 "Cracked Lug" (pg 36-41). Save project as *CrackedLug3D.scp*. Perform Exercises 1 and 2.

## Extended Exercises

### Crack Path Analysis

- ❑ **Discussion:** "General Overview of Crack Path Analysis" (ref. pages 17-19).
- ❑ **Exercise:** Build and solve CP problem #1 "Plate with Edge Crack" (pg 20-24).