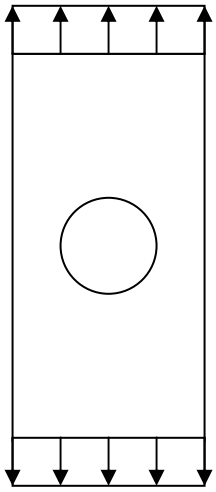
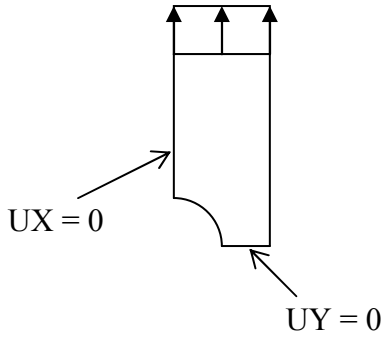
ABAQUS Tutorial – Plane Stress Analysis

Consider the problem of a 4" x 2" x 0.1" aluminum plate (E=10e6 psi, ν=0.3) with a 1" diameter circular hole subjected to an axial stress of 100 psi.

Full Model



Use of Symmetry



Determine the maximum axial stress associated with the stress concentration at the edge of the circular hole. Compare this solution with the design chart (ref. Mechanical Engineering Design, 5th edition, Shigley and Mischke, 1989) value σ_{max}= 2.18 (200 psi) = 436 psi.

Charts of Theoretical Stress-Concentration Factors K_t*

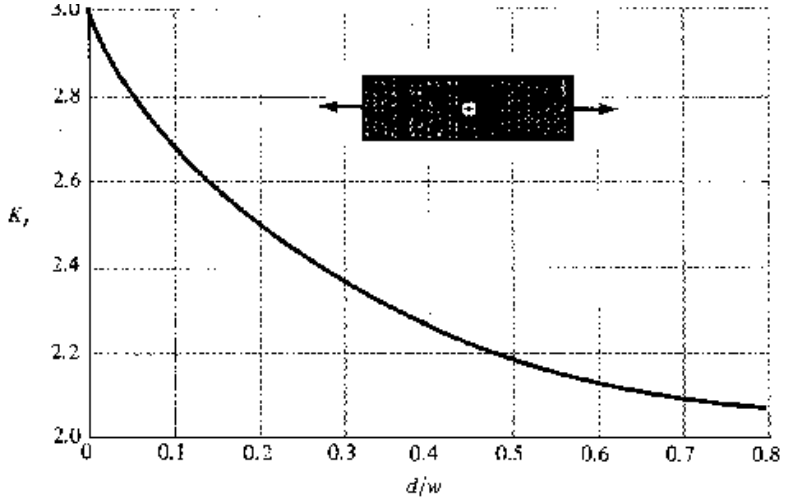


FIGURE A-15-1

Bar in tension or simple compression with a transverse hole. $\sigma_0 = F/A$, where $A = (w - d)t$ and t is the thickness.

Finite Element solution

Start => Programs => ABAQUS 6.7-1 => ABAQUS CAE
File => Set Work Directory => select folder for Abaqus generated files
Select 'Create Model Database'
File => Save As => save .cae file in Work Directory

Module: Sketch
Sketch => Create => Approx size - 5
Add=> Point => enter coordinates (.5,0), (1,0), (1,2), (0,2), (0,.5) => select 'red X'
View => Auto-Fit
Add => Line => Connected Line => select point at (.5,0) with mouse, then (1,0), (1,2), (0,2), (0,.5) => right click => Cancel Procedure => Done
Add => Arc => Center/Endpoint => select point at (0,0), then (.5,0), then (0,.5) => Cancel Procedure => Done

Module: Part
Part => Create => select 2D Planar, Deformable, Shell, Approx size - 5=> Continue
Add => Sketch => select 'Sketch-1' => Done => Done

Module: Property
Material => Create => Name: Material-1, Mechanical, Elasticity, Elastic => set Young's modulus = 10e6, Poisson's ratio = 0.3 => OK
Section => Create => Name: Section-1, Solid, Homogeneous => Continue => Material - Material-1, plane stress/strain thickness - 0.1 => OK
Assign Section => select entire part by dragging mouse => Done => Section-1 => OK

Module: Assembly
Instance => Create => Instance Type – Independent (mesh on instance) => Part-1 => OK

Module: Step

Step => Create => Name: Step-1, Initial, Static, General => Continue => nlgeom off => OK

Module: Load
Load => Create => Name: Step-1, Step: Step 1, Mechanical, Pressure => Continue => select top edge => Done => set Magnitude = -100 => OK
BC => Create => Name: BC-1, Step: Step-1, Mechanical, Symmetry/Antisymmetry/Encastre => Continue => select bottom edge => Done => YSYM (U2=UR1=UR2=0)
BC => Create => Name: BC-2, Step: Step-1, Mechanical, Symmetry/Antisymmetry/Encastre => Continue => select left edge => Done => XSYM (U1=UR2=UR3=0)

Module: Mesh

Seed => Edge by Size => select full model by dragging mouse => Done => Element Size=0.1 => press Enter => Done
Mesh => Controls => Element Shape => Tri (for triangles), Quad (for quadrilaterals), or Quad dominated (for mixed triagles and quads - mostly quads)
Mesh => Element Type => Plane Stress => Linear/Tri (for CST), Quadratic/Tri (for LST), Linear/Quad (for 4 node quad), or Quadratic/Quad (for 8-node quad) => OK => Done
Mesh => Instance => OK to mesh the part Instance: Yes => Done
Tools => Query => Region Mesh => Apply (*displays number of nodes and elements at bottom of screen*)

Module: Job
Job => Create => Name: Job-1, Model: Model-1 => Continue => Job Type: Full analysis, Run Mode: Background, Submit Time: Immediately => OK
Job => Manager => Submit => Job-1
Results

Module: Visualization
Plot => Deformed Shape
Deformed Shape Options => Basic => Show superimposed undeformed plot => OK
View => Graphics Options => Background Color => White
Ctrl-C to copy viewport to clipboard => Open MS Word Document => Ctrl-V to paste image

Plot=> Contours => Result => Option => Set Nodal Averaging Threshold to 0% => Apply
Result => Field Output => Name - S => Component = S22 => OK
Contour Options => Limits => Specify Max = 450, Min = 0 => OK
Ctrl-C to copy viewport to clipboard => Open MS Word Document => Ctrl-V to paste image

Tools => Query => Probe Values => Apply => select desired Field Output (S11, S22, etc.) => Probe Nodes => move cursor to desired location to view nodal results

Tools => Path => Create => Node List => Continue => Add Before => select nodes along bottom edge => Done => OK
Tools => XY Data => Create Path => Continue => X Distance => Plot
Ctrl-C to copy viewport to clipboard => Open MS Word Document => Ctrl-V to paste image

Report => Field Output => Setup => Number of Significant Digits => 6
Report => Field Output => Position - Centroid => Variable - S => Apply
Examine tabulated results in 'abaqus.rpt' file.