ES 128: Computer Assignment #2

Due in class on Monday, 08 Mar 2010

Problem 1.

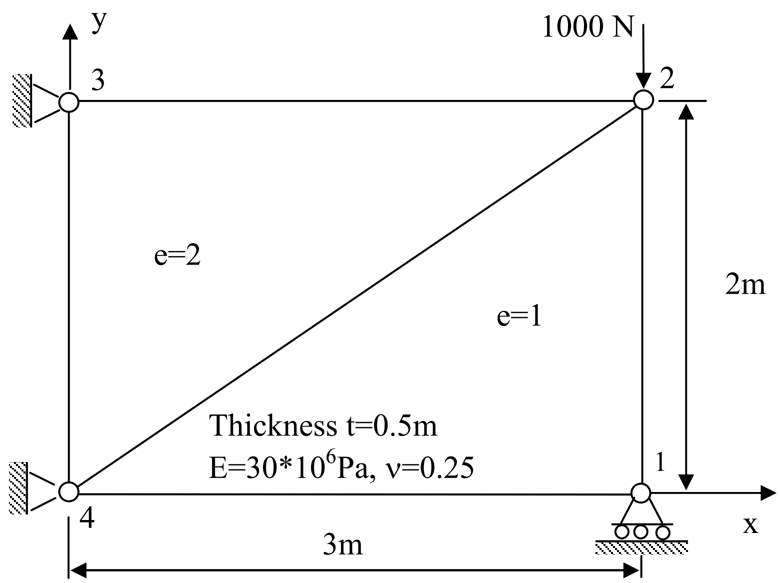

Fig.1a

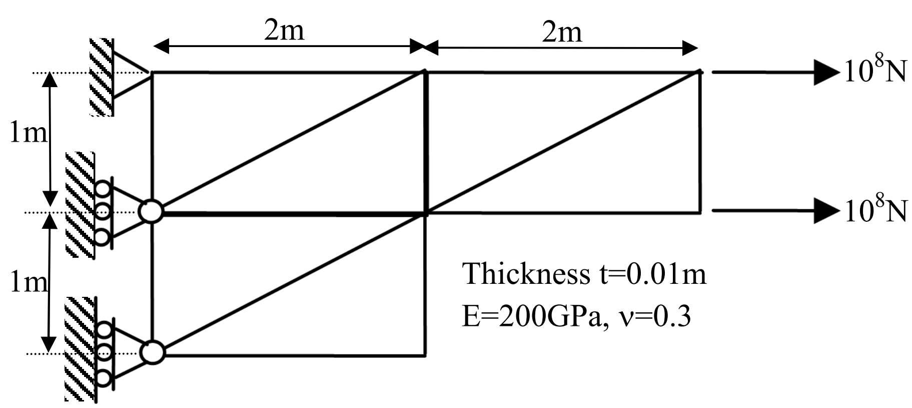

Fig.1b

You can download the ABAQUS input file for a plate problem (Fig.1a) from the course website. You can see that the structures of ABAQUS input files for truss problems and plane problems are similar. Modify the input file to solve the plate problem in Fig.1b. There are 6 elements (Notice elements are explicitly drawn for you). Suppose the material has a modulus 200GPa, and Poisson's ratio 0.3. The structure is loaded on the right side by two horizontal forces (F= 10^8N). Print the input file, all nodal displacements, all element stresses and strains.

Problem 2.

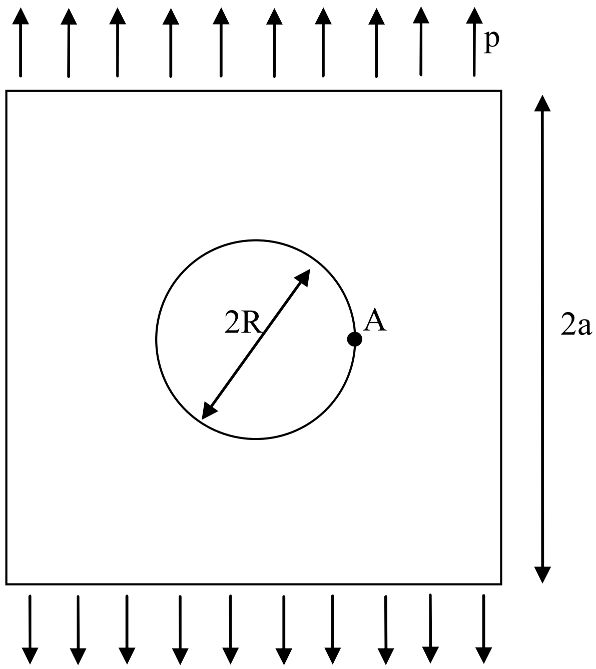

Fig. 2

Use 3-node triangular elements to solve the classic stress concentration problem in ABAQUS/CAE. A small circular hole with radius R is in the middle of a square sheet (with width 2a). A uniform tension p is applied on the top and bottom surfaces of the sheet. The problem can be taken as plane stress. You may only mesh 1/4 of the model by using the 2-fold symmetry conditions.

Use any specific values for the dimensions (a and R) as you like, and choose any Young's modulus and load levels you like. The dimensions and units you choose will not affect the final result. The only thing you need to pay attention to is the sign of the applied pressure, since you want the structure to be loaded in tension.

1) Choose any a and R such that a/R=2. By fixing a and R, refine your mesh locally around the circular hole. Obtain the stress component in the y direction, σyy, at point A, by probing the values from your contour plot and/or from the dat file. Refine your mesh until the dimensionless variable kc=σyy /p is approaching a certain limit (an accuracy of 5% will be good enough) at point A. This limit is the <u>stress concentrator factor</u> (at point A) for this particular geometry a/R=2. It is independent of the Young's modulus you chose, and it is independent of the specific dimension of R (or a). Show how did your results converge by printing the relevant meshes and the corresponding values of kc.

2) Now you should have an idea about the local mesh density that can lead to an accurate result. Keep that mesh density locally, fix R and increase a. It can be shown from dimensional analysis that the stress concentration factor is only a function of a/R. The classic elasticity solution indicates that when a/R is infinite, the stress concentration factor is exactly 3 at point A.

You may choose a/R to be 2, 4, 6, 8, and 10. Plot your stress concentration factor kc (at point A) as a function of a/R. How large should a/R be such that the stress concentration factor at point A is about 3?

Problem 3.

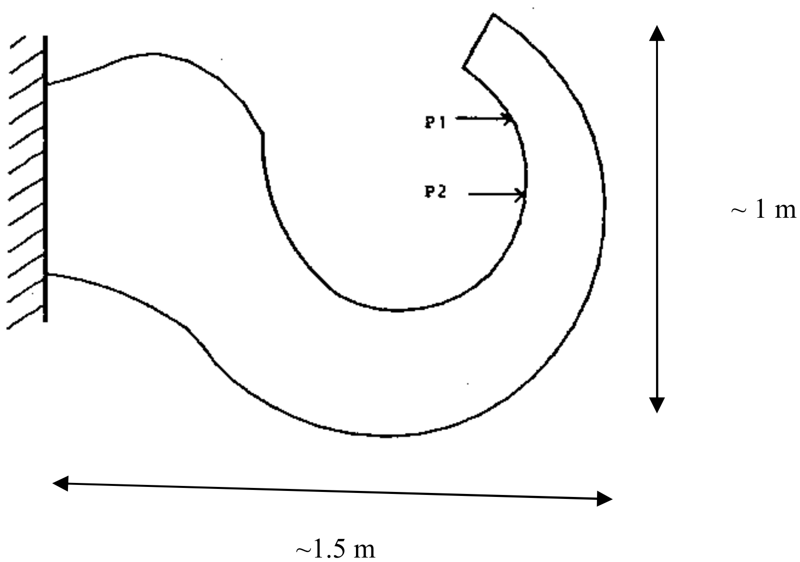

Fig.3

Analyze the metal hook shown in Fig. 3 in which the geometry, loads and boundary conditions are also indicated. The problem can be taken as plane stress. The hook is loaded by two concentrated forces, P1 and P2, each of a magnitude of 25 kN. The material is assumed to be elastic and isotropic with an elasticity modulus E=210GPa and Poisson's ratio *v*=0.3.

1) How does the metal hook deform?
2) Where does the metal hook experience the max von Mises stress?