Final - Contact mechanics

In this problem, we would like to study the contact problem when an elastic body comes into contact with a rigid, immobile foundation. An elastic body Ω is deformed due to volume and surface forces, but the body should not penetrate a given, rigid obstacle (figure 1) : this is the classical Signorini's problem. This leads to unilateral boundary conditions, called contact conditions. This problem is nonlinear and non differentiable at the contact interface.

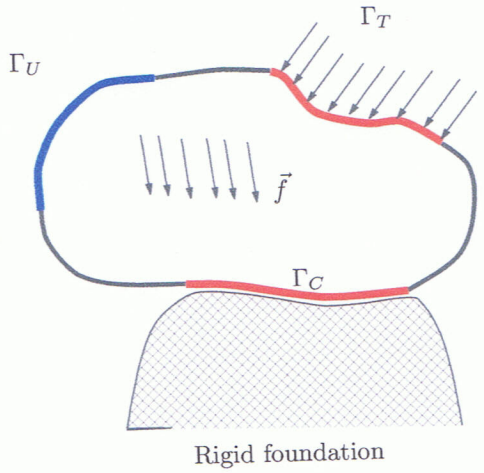


FIGURE 1 – Contact with a rigid foundation

1. Remind the main hypothesis and the framework of the Signorini's problem.
2. Here, we will only work with the normal component of the traction vector defined by p_n and the normal distance g_n. We suppose the normal initial gap g_0 equal to zero.
   (a) Describe and explain the main steps to write the contact boundary conditions.
   (b) Write the contact boundary conditions.
   (c) What do you remark compared to classical boundary conditions ?
3. Weak form (Variationnal formulation)
   (a) Describe and explain the main steps to write the weak form of this contact problem.
   (b) What is the main "originality" ?
   (c) What would the difference be with a contact problems between two deformable bodies ? Could you imagine the form of this weak formulation ?

Evaluation for the MQ52 course

(Fracture Mechanics, Non Linear Mechanics)

A) For the cantilever beam shown in the Figure, determine the potential energy release rate G (Joules/m^2), by the derivative of the elastic energy of the beam U_e, in regard of the fracture surface $A = B \cdot {}_a$.

Where:

B: is the constant thickness of the beam, perpendicular to the plane X-Y ($B = 0.1$ m),

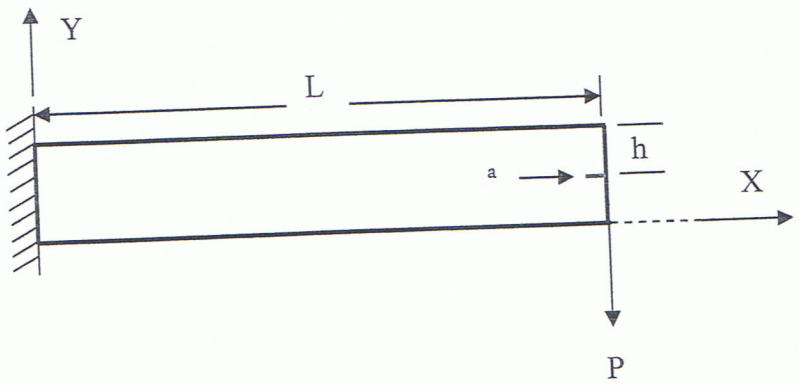
${}_a$: is the crack length (${}_a = 0.05$ m),

L: is the beam length ($L = 0.8$ m)

E: is the Young Modulus of the beam aluminum alloy ($E = 70E9$ N/m^2)

P: is the applying load ($P = 500$ N)

h: is the semi-height of the beam ($h = 0.05$ m)



MQ52_A2012_M.DOMASZEWSKI - SUJET à 5 points – QUESTIONS

Sujet X (5pts) – Choisir une bonne réponse

1. In the geometrically nonlinear analysis, for a bar element, the axial strain contains
   A. only the linear terms of the displacement gradients
   B. the linear and quadratic terms of the displacement gradients
   C. the linear and cubic terms of the displacement gradients

2. The approximation of the displacements for a nonlinear bar element, in function of four degrees of freedom, is
   A. linear
   B. quadratic
   C. cubic

3. In the local coordinate system, a nonlinear bar element has
   A. two degrees of freedom
   B. six degrees of freedom
   C. four degrees of freedom

4. In general, for geometrically nonlinear analysis, the total tangential stiffness matrix is composed of
   A. one matrix
   B. two matrices
   C. three matrices

5. For the initial stability problem or buckling problem, what matrix can be neglected?
   A. initial displacement or large displacement matrix
   B. elastic constant matrix
   C. initial stress or geometric matrix

MQ52 – « Abradables coatings – effective properties of composite materials »

1. Define in a few words the functionalities of abradable materials in aeronautic engines

2. Indicate in a few words the expected properties for abradable materials

3. Abradable materials applied in the different parts of an engine (i.e. low pressure compressor, HP turbine, etc.) are different. According to your knowledge, please explain why.

4. Under ANSYS APDL, what is the role of the following list of commands:

```
nsel,S,loc,y,0
d,all,uy,0
nsel,S,loc,y,height
d,all,uy,height/1000
```

5. In a **stationary thermal simulation**, are the following commands useful? Please justify…

```
MP,ALPX,1,33.0e-6
```

```
MP,DENS,1,2700.0
```