CRACK01 - Validation of *Wizard Analysis Ace* of the modulus Aster of Salome-Meca

Summarized

This test makes it possible to validate the command file obtained thanks to Wizard (assistant) *Analysis Ace* of the modulus Aster of Salome-meca. One recalls that this Wizard allows a computation of the rate of refund and stress intensity factors in 2D, in axi-symmetry and 3D, from a sane mesh of a structure, by means of the method X-FEM and the level-sets as well as automatic refinement of mesh.

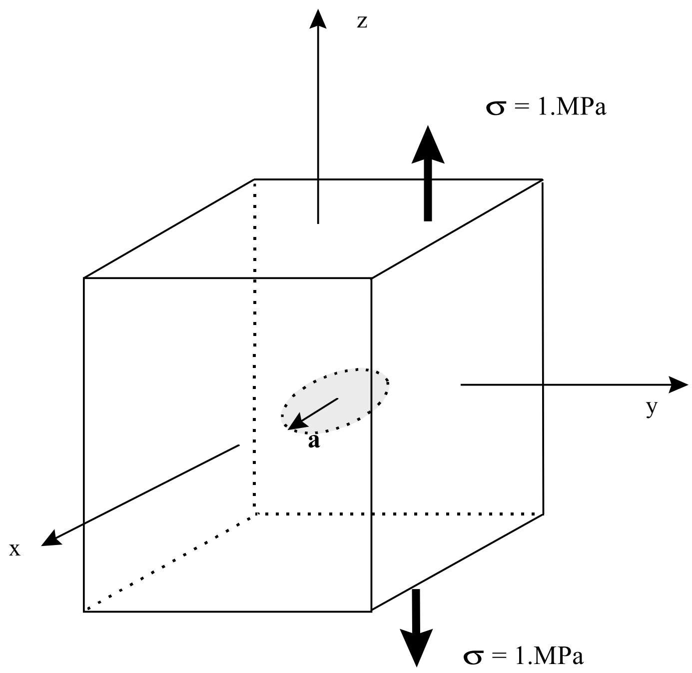
The case treated here is a circular crack plunged in a presumedly infinite medium, resulting from the sslv134 benchmark.

- The modelization A milked the problem in 3D (similar to the case test sslv134h),
- The modelization B milked the problem in 2D axisymmetric (similar to the case test sslv134i).

A each time, the value of the factor of intensity of the stresses in mode I is compared with the theoretical value resulting from an analytical solution.

1 Problem of reference

1.1 Geometry



the crack is circular (*penny shaped ace*) of radius a, in the plane Oxy. So that the medium is regarded as infinite, the quantities characteristic of the solid mass are about 5 times higher than the radius a.

1.2 Material properties

Modulus Young: $E=2.10^5\,MPa$

Poisson's ratio: $\nu=0.3$

Density: $\rho=7850\,kg/m^3$

1.3 Boundary conditions and loadings

lower Face	: uniform stress of tension $\sigma_z=1.\,MPa$
Upper face	: uniform stress of tension $\sigma_z=1.\,MPa$

2 Reference solution

2.1 Method of calculating used for the reference solution

For a circular crack of radius a in an infinite medium, subjected to a uniform tension σ according to the norm with the plane of the lips, local rate of energy restitution $G(s)$ is independent of the curvilinear abscisse s and is worth [bib1]:

$$G(s)=\frac{(1-\nu^2)}{\pi E}4\sigma^2 a$$

then the stress intensity coefficient K_I is given by the formula of Irwin:

$$G(s)=\frac{(1-\nu^2)}{E}K_1^2 \text{ that is to say } K_I=\frac{2\sigma\sqrt{a}}{\sqrt{\pi}}$$

2.2 Results of reference

For the loading considered and $a=2m$, one obtains:
$G(s)=11.586 J/m^2$
$K_I=1,5958 MPa$.

2.3 Bibliographical references

1) Solution of Sneddon (1946) in G.C. SIH: Handbook of stress-intensity factors Institute of Fracture and Solid Mechanics - Lehigh University Bethlehem, Pennsylvania

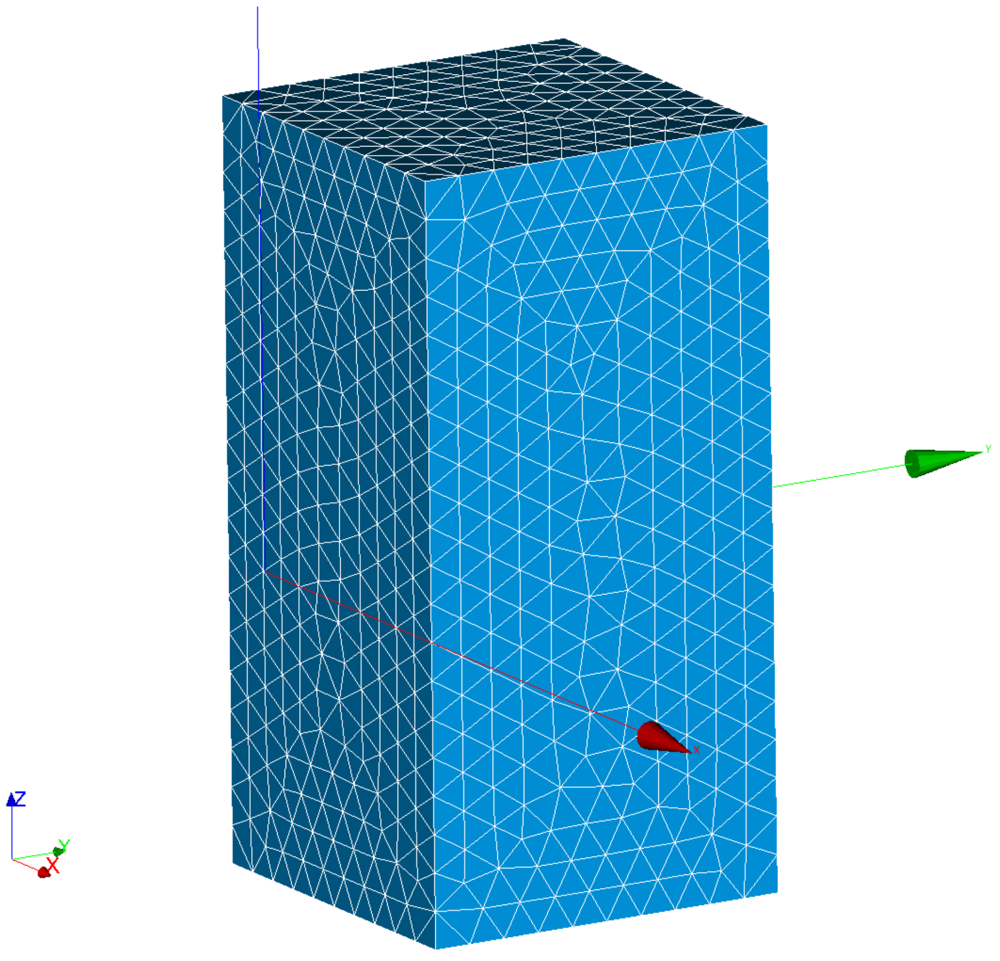
3 Modelization a: modelization in 3D

3.1 Characteristics of the modelization

the crack is not with a grid.
A quarter of structure is modelled.
Conditions of symmetry on the side sides will be applied.

3.2 Characteristics of the mesh

The mesh initial is healthy and relatively coarse. The initial size of meshes is of approximately $h_0=1{,}25$ (unit of the mesh).



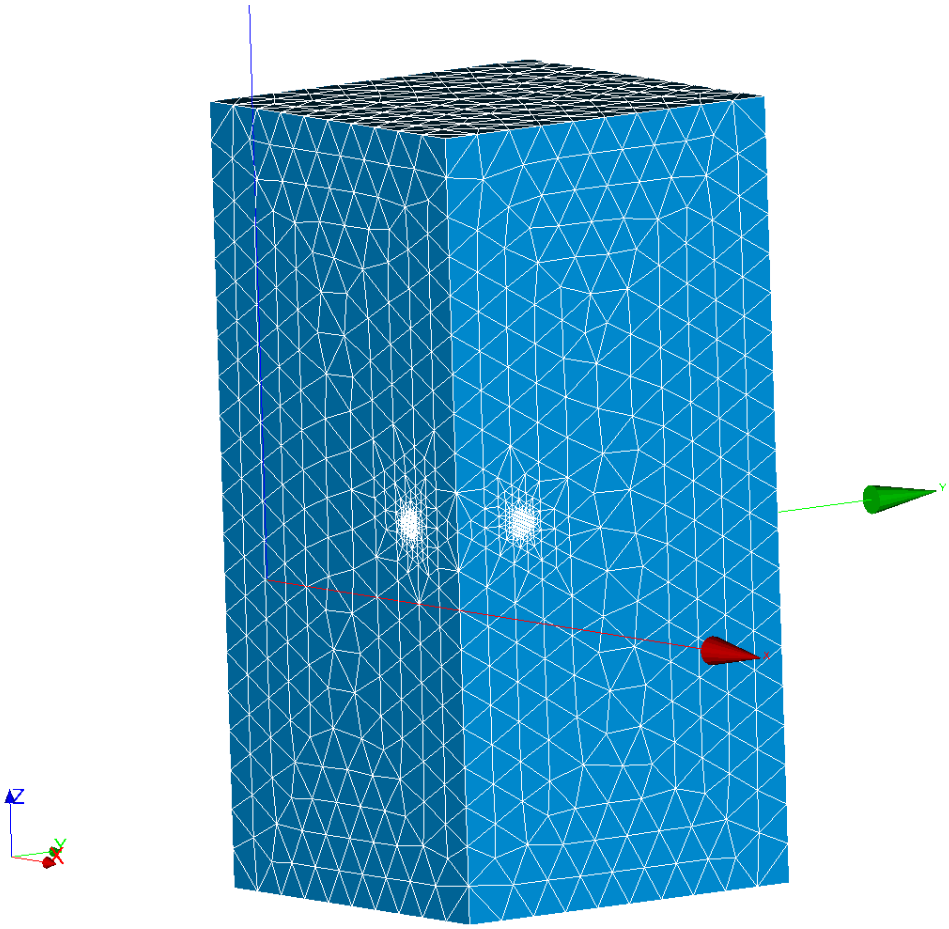
Appear 3.2-a: mesh initial 3D

Many nodes: 2927
Number of meshes and type: 14086 TETRA4

This mesh will be refined in an automatic way before the mechanical resolution thanks to the software Homard in a zone around the crack tip. The target size of meshes of the refined mesh is $h_c=0{,}15$. That implies 4 calls to Homard. After refinement, the size of meshes is of approximately $h=0{,}078$ and the mesh comprises:

Many nodes: 14228
Number of meshes and type: 79573 TETRA4

the radius of the refined zone east $R_{raff}=6\mathrm{h}$.



Appear 3.2-b: mesh 3D after refinement automatic

3.3 Quantities tested and results

One tests the value of K_I calculated by the command CALC_G along the crack tip. Theoretically, K_I is constant along the crack tip. It is thus checked that the max and the min of the values of K_I along the crack tip are close to the value of reference.

Integration contour is: $2\mathrm{h}-5\mathrm{h}$.
The lissage by default is used.

Standard	identification	*Reference of reference*	$\%$ tolerance
$max(K_I)$	1,595 106	ANALYTIQUE	3.0
$min(K_I)$	formulates 1,595	106	3.0

4 3,0 Modelization b: modelization in axi-symmetry

4.1 Characteristics of the modelization

the crack is not with a grid.
Only one section of structure is modelled.

4.2 Characteristics of the mesh

The mesh initial is healthy and relatively coarse. The initial size of meshes is of approximately $h_0=1{,}25$ (unit of the mesh).

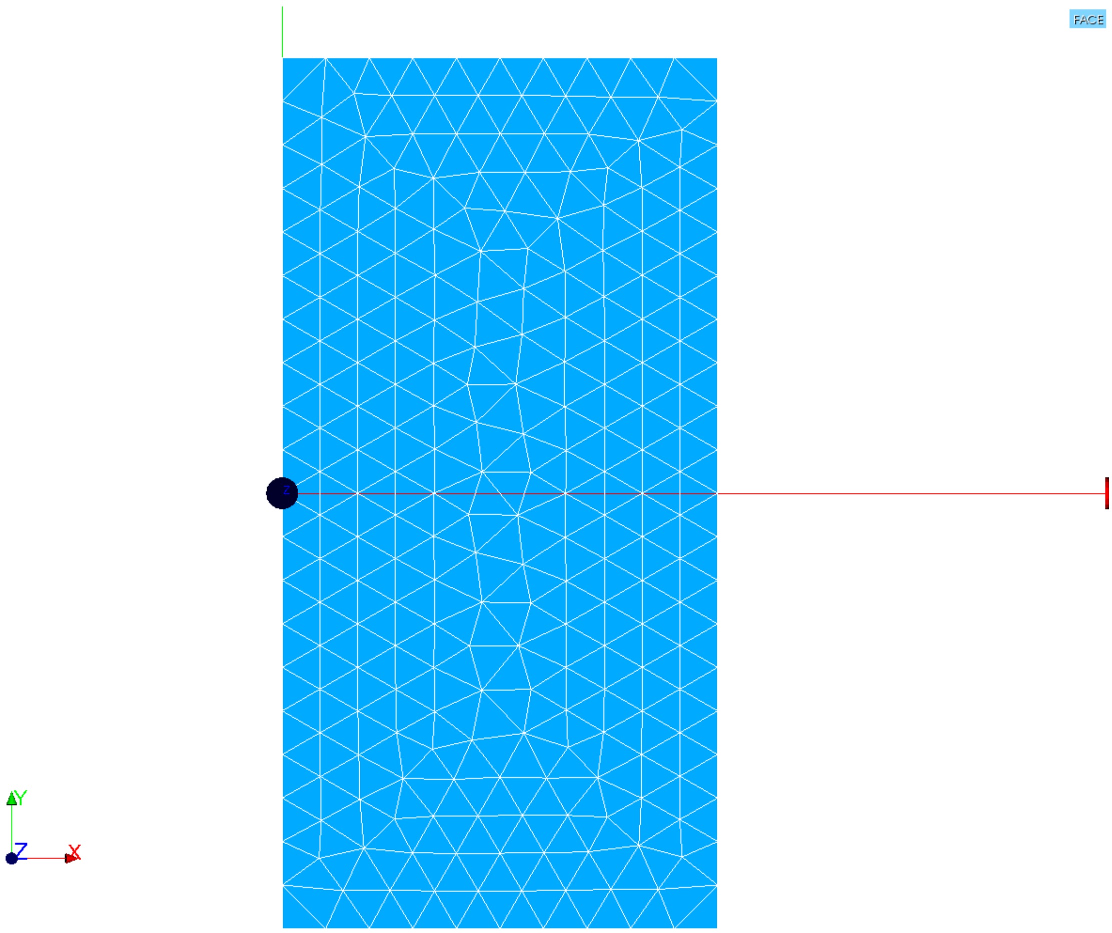
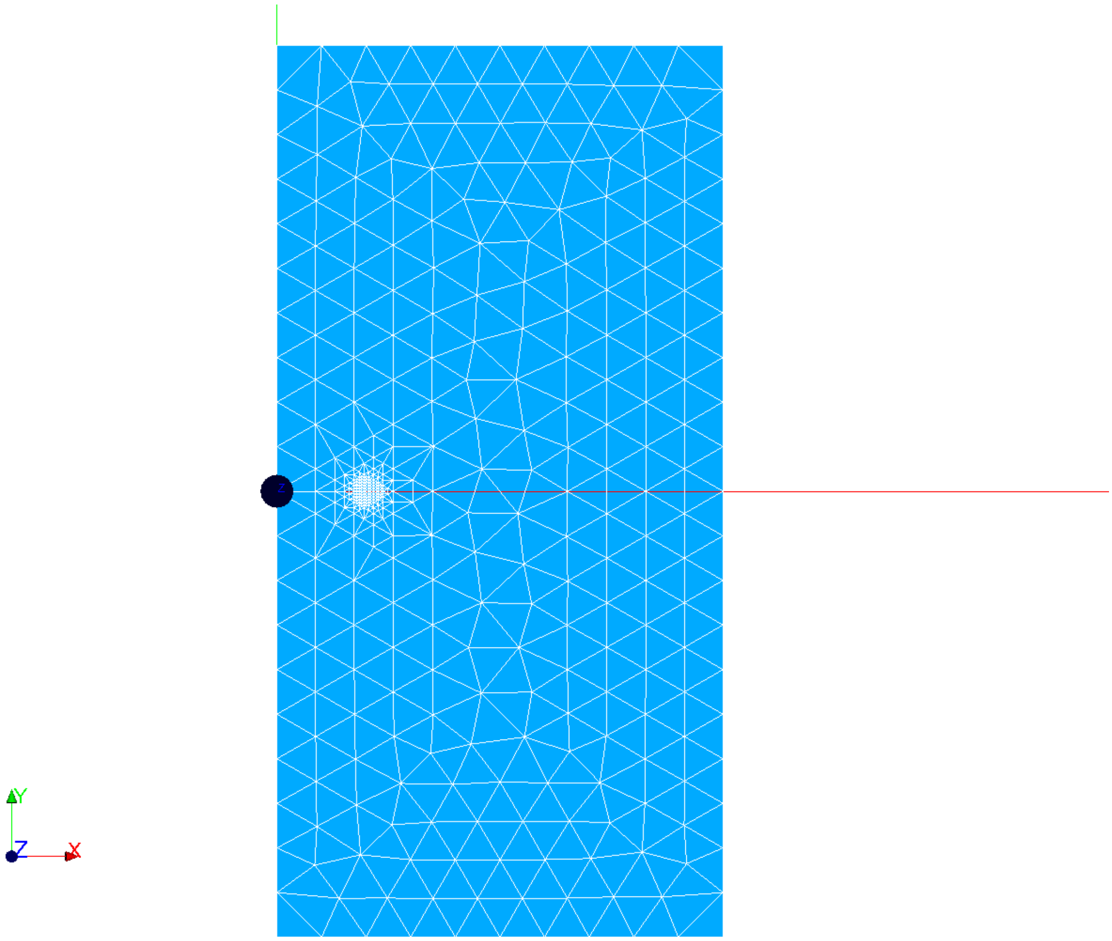


Figure 4.2-a : 4.2-a axisymmetric mesh 2d initial

Number of nodes: 251
Number of meshes and type: 440 TRIA3

This mesh will be refined in an automatic way before the mechanical resolution thanks to the software Homard in a zone around the crack tip. The target size of meshes of the refined mesh is $h_c=0{,}15$. That implies 4 calls to Homard. After refinement, the size of meshes is of approximately $h=0{,}078$ and the mesh comprises:
Many nodes: 425
Number of meshes and type: 788 TRIA3
the radius of the refined zone east $R_{raff}=6\mathrm{h}$.



Appear 4.2-b: axisymmetric mesh 2d after automatic refinement

4.3 Quantities tested and results

One tests the values of G and K_I calculated CALC_G `by the command`.

Integration contour is: $2\text{h}-5\text{h}$.

Standard	identification	*Reference of reference*	% tolerance
G	11,58	ANALYTIQUE	3.0
K_I	1,595 106	ANALYTIQUE	3.0

5 Summaries of the results

This test shows that the file of Aster commands obtained thanks to Wizard (assistant) *Ace-Analysis* of the modulus Aster of Salome-meca makes it possible to conclude a computation of crack harmfulness in 3D and 2D axisymmetric because the got results (rate of energy restitution and stress intensity factor) are in accordance with the analytical solution.