SSNP148 - Computation of the stress intensity factor by the regularization of the stresses with ENDO_HETEROGENE

Summarized:

This test calculates the threshold of propagation of a central crack in a plate infinite length requested by a stress with the infinite one. In this case an analytical solution exists since one can calculate the stress intensity factor. This test gives a comparison between this analytical solution and the value of the factor of intensity of the stresses calculated starting from the regularized stresses (modelization D_PLAN_GRAD_SIGM). The purpose of this approach is to validate the méthode de calcul (modelization D_PLAN_GRAD_SIGM and model ENDO_HETEROGENE.) for cases where the characteristic length is low in front of the size of crack and structure.

1 Problem of reference

1.1 Geometry

One represents a field length $l=6000\text{mm}$, height $h=1000\text{mm}$ containing a vertical initial crack length $2a$. By condition of symmetry, one models only half of the field (Illustration 1).

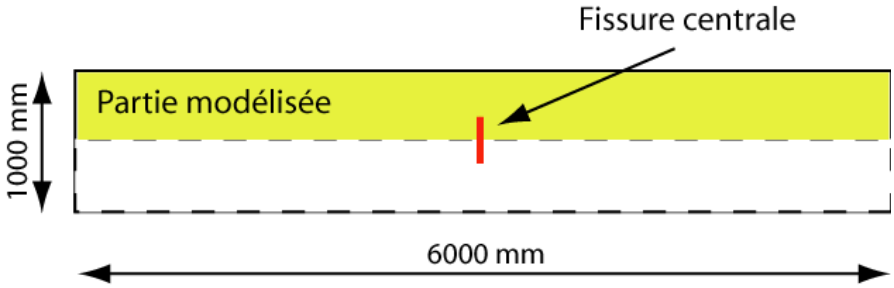


Illustration 1: Geometry of the case test

1.2 Properties of the materials

Parameters of elasticity:
Young modulus $E_1=20.10^9 MPa$, Poisson's ratio $\nu_1=0,25$

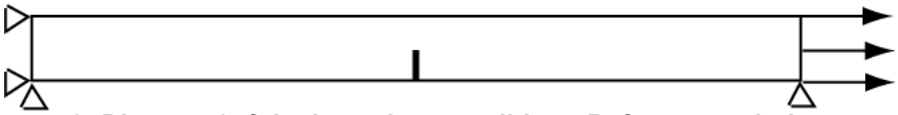
Parameters of model ENDO_HETEROGENE :
Yield stress $\sigma_y=10^{18} Pa$
Modulates of Weibull $m=2$
Tenacity $K_c=1000\,MPa.m^{1/2}$
Thickness of the sample $ep=1\text{m}$
Granulates $GR=121$

Parameter of the nonlocal model:
Characteristic length $l_c=0,02\,m$

1.3 Boundary conditions and loading

One blocks vertical displacements on lower edge of the model as well as horizontal displacements on left edge and one imposes on flat rim a horizontal stress. The central crack is represented by a vertical tape of broken finite elements (*i.e.,*). $d=1$

The pressure applied to the edge right varies from 0 with during $10\,MPa$ the computing time, i.e. Illustration $1\,s$



2: Diagram 2of the boundary conditions Reference solution

2 For

a central crack length in $2a$ a bar of thickness and $2b$ infinite length requested by a stress to σ_∞ infinite, one can express the factor of intensity of the analytical stresses by the following equation: Since

$$K_{Ia} \approx \sqrt{\frac{\pi a}{\cos(\frac{\pi a}{2b})}}$$

in the case treated crack is solicited in mode one can I introduce for a length characteristic given an equivalent to the factor of intensity of the stresses [1]: with

$$K_{IIc} = \frac{5\pi}{6\Gamma\frac{3}{4}} . \bar{\sigma}_{Ip} \sqrt{\pi l_c}$$

the maximum $\bar{\sigma}_{Ip}$ principal stress regularized at a peak of crack. In order to compare the numerical results with the analytical solution the parameter is introduced. $RKI = K_{Il_c} / K_{la}$ The 2

equations above were introduced into the command file of the case test by the means of handling of arrays. One extracts the value from the stress regularized to the forefront of crack. The values of the factor of intensity of the stresses analytical and numerical are calculated in the command file. One calculates then the relationship between the two values (). This RKI ratio was tested via command TEST_ COUNTS. Bibliographical

3 references Granet

[1] , Seyedi (2010) probabilistic Modelization of damage of the geological barriers of major storage of nuclear waste. Final report of the BRGM in the frame of collaboration ENDOSTON. Note HT64-2010-01265 Guy,

[2] N., Seyedi, D.M. and Hild, F., (2010). Hydro-mechanical modeling of geological possible CO2 storage and the study of caprock fracture mechanisms. Georisk. Modelization

4 A Characteristic

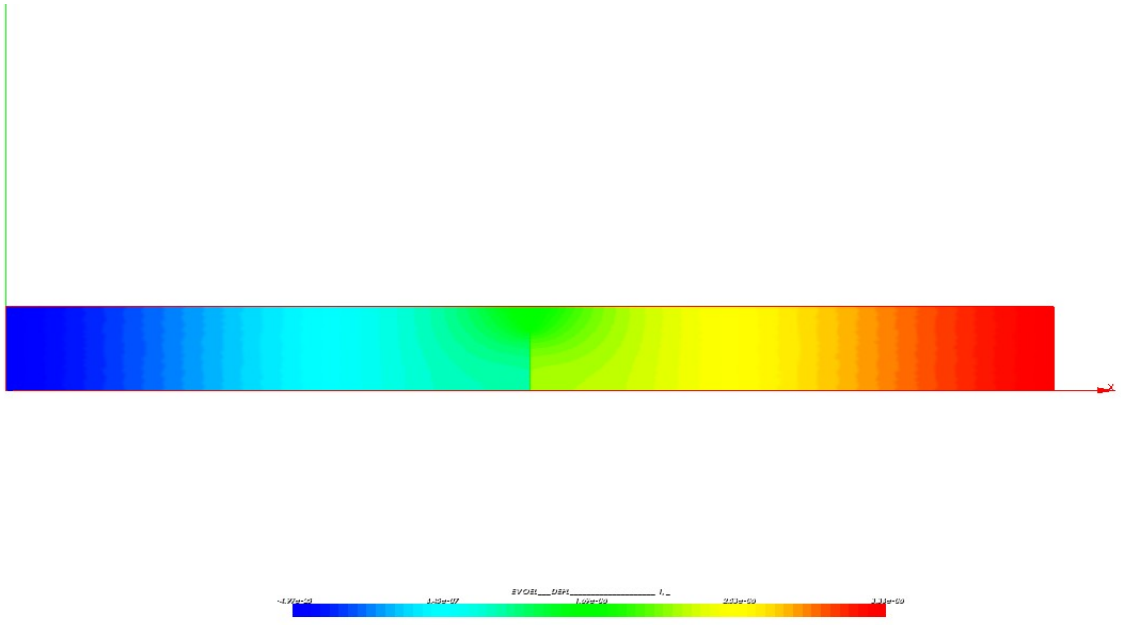
4.1 of the modelization the higher

half of the field is with a grid in triangular elements with 6 nodes. The mesh comprises 16602 triangles TRIA6 and 223 SEG2. The size

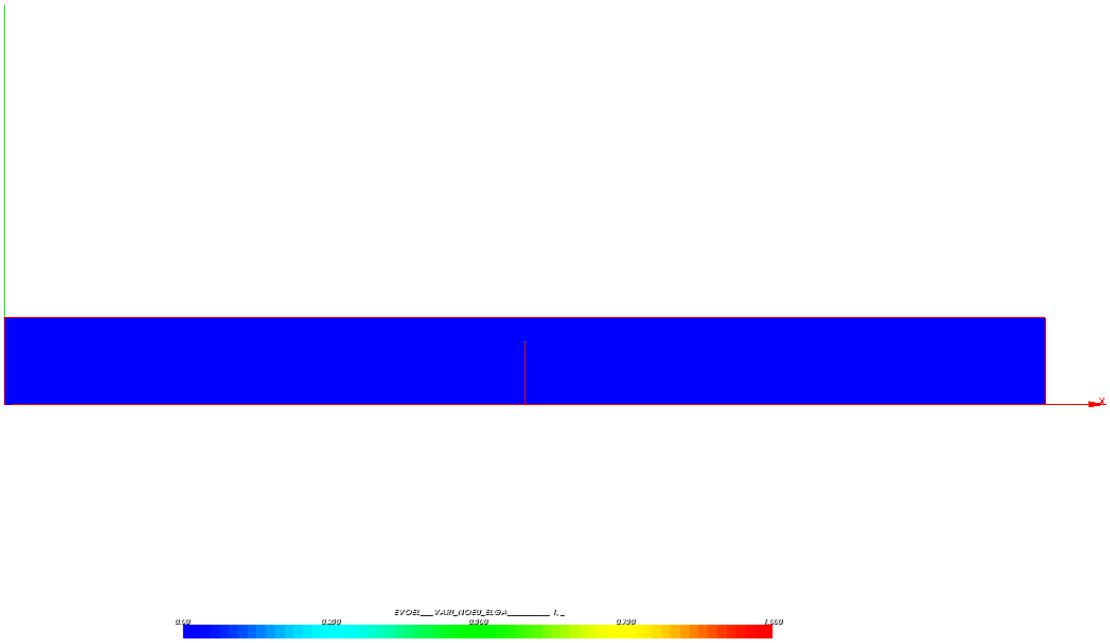
of central crack, has, is equal. 1 time $0,3571\,m$ of is modelled $1\,s$. Results

4.2 One traces

on horizontal figures 3 3 4 4 respectively displacements DX and the criterion of damage (local variable V1) at the end of . Illustration $1\mathrm{s}$



3: Horizontal 3displacements, Illustration $DX \quad t=1\mathrm{s}$



4: Variable 4of damage (), Values $V1 \quad t=1\mathrm{s}$

4.3 tested One tests

the value of intensity of stress via TEST_ FONCTION. Function

Time	Value of reference	Tolerance	(%) 1 1 1
$RKI=K_{II_c}/K_{la}$	1	1	Summary

5 of the results This test

makes it possible to calculate the threshold of propagation of a central crack in a plate infinite length requested by a stress with the infinite one. We can compare the results got with an analytical solution: the results correspond. This test thus makes it possible to validate the model D_PLAN_GRAD_SIGM and model ENDO_HETEROGENE .