SSNP139 – Cracking of an elastoplastic beam DCB with a Summarized cohesive

model:

This test makes it possible to model the propagation of a plane crack in a beam DCB (Double Beam Cantilever) two-dimensional elastoplastic with the finite elements of interface (modelization PLAN_INTERFACE).

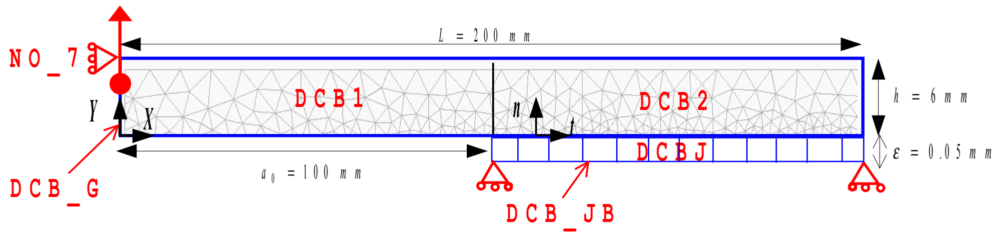
Modelization a: cohesive Model CZM_OUV_MIX , propagation by brittle fracture in the presence of plasticity
Modelization b: cohesive Model CZM_FAT_MIX , propagation by fatigue in the presence of ad hoc

plasticity The classification *local* of the cohesive elements is assured by the command MODI_MAILLAGE and key word ORIE_FISSURE.

1 Problem of reference

1.1 Geometry and loading

Is a beam DCB having an initial crack length a_0, subjected to a displacement imposed U at an end.



Appear 1.1-a : Diagram of the beam DCB, boundary conditions and loading.

The cohesive finite elements of interface are laid out along the axis of symmetry of the beam in the prolongation of initial crack. The beam DCB is with a grid with quadratic triangular elements, it has an elastoplastic behavior with isotropic linear hardening. The symmetry of the problem makes it possible to carry out computations on half of the beam, the crack is requested in pure I mode, to see figure 1.1-a.

The boundary conditions are the following ones:
- Imposed displacement U : DY imposed on face DCB_G
- Condition of symmetry: $DY=0$ on DCB_JB
- Blocking of rigid body motions: $DX=0$ on NO_7

For the modelization A the loading is monotonous, it grows of $DY=0$ at $DY=3.5\,mm$ time 0 at time 10.

For the modelization B the loading is cyclic in teeth of saw (tops at odd times: 1,3 and 5 and hollow at even times: 2 and 4). The amplitude of the loading is of $0.4\,mm$ and the ratio of load is null.

2 Reference solution

It does not have there a reference solution for this problem, one carries out tests of non regression.

3 Material parameters

the values of the Young modulus, the Poisson's ratio, the stress threshold of elasticity, the plastic modulus, the critical stress and the tenacity of the material are in the following way selected:

$E=200000\ MPa$	$\nu=0.3$
$S_y=30\ MPa$	$E_{plas}=3577\ MPa$
$\sigma_c=35\ MPa$	$G_c=0.259\ Mpa.mm$

They are values "tests" which do not correspond to any material in particular.

Note:

- The mechanical problem is symmetrized: one models only half of a crack (only one lip). The latter dissipates an energy twice less important than a complete crack. To model a material of tenacity given G_c, it is thus necessary to carry out simulation with a value of $G_c/2$.
- The numerical parameters of the model of interface are those proposed by default with the user.

4 Modelization A

4.1 Characteristic of the modelization

the simulation of the crack propagation by brittle fracture in the presence of plasticity is carried out with the modelization PLAN_INTERFACE and constitutive law CZM_OUV_MIX for the meshes cohesive ones. The voluminal elements, in plane strains D_PLAN, are elastoplastic with isotropic linear hardening: model VMIS_ISOT_LINE.

4.2 Characteristics of the mesh

One carries out a quadratic mesh not structured of the half-beam and potential crack.
Voluminal elements (DCB): 8060 TRIA6
Elements of interface (crack way): 500 QUAD8

4.3 Quantities tested and results

One carries out tests of non regression. One tests F^R the resultant of the force corresponding to the displacement imposed U, as well as the jump of normal displacement on the first mesh of interface to be opened ($V7$ on the mesh $M9788$).

Quantity tested	***Code_Aster***
F^R at time 3	3.7160114004283D+00
F^R at time 5	4.0367141086100D+00
F^R at time 10	4.5900151235115D+00
$V7$ on $M9788$ at time 10	3.87055D-03

5 Modelization B

5.1 Characteristic of the modelization

the simulation of the crack propagation by fatigue is carried out with the modelization PLAN_INTERFACE and constitutive law CZM_FAT_MIX for the meshes cohesive ones. The voluminal elements, in plane strains D_PLAN, are elastoplastic with isotropic linear hardening, model VMIS_ISOT_LINE.

5.2 Characteristics of the mesh

The mesh is identical to that of modelization A.

5.3 Grandeurs tested and results

One carries out tests of non regression. One tests F^R the resultant of the force corresponding to the displacement imposed U, displacement at a top of the loading, as well as the jump of normal displacement on the first mesh of interface to be opened ($V7$ on the mesh $M9788$).

Quantity tested	*Code_Aster*
F^R at time 3	3.1612780004784D+00
F^R at time 5	3.1586454525417D+00
U at time 5	4.0000000000000D-01
$V7$ on $M9788$ at time 5	6.20331E-05

6 Summary of the results

The model cohesive of interface makes it possible qualitatively to simulate the crack propagation in brittle fracture or fatigue in the presence of plasticity. The introduction of nona linearity material disturbs the convergence of computations slightly. The time necessary is a little longer than for a linear material.

It is necessary however simultaneously to take some care during the use of the two types of nonlinearity (CZM and plasticity). One advises to refer to the documentation of use of the cohesive models U2.05.07.