

ZZZZ257 - Estimator of error in quantity of interest for the breaking process

Summary:

This test makes it possible to validate the estimate of error in quantity of interest for the breaking process. One thus tests the 3 methods available in *Code_Aster* (residues, smoothing *ZZ1* and smoothing *ZZ2*). Moreover command files give a groundwork for the implementation of the estimate of error in quantity of interest and more particularly the definition of the loading for the dual problem.

There are 3 modelings which decline 3 different problems:

- Modeling a: fissured plate subjected to a uniform tractive effort;
- Modeling b: beam cantilever subjected to a shearing force;
- Modeling C: plate with an inclined crack, subjected to a tractive effort.

1 Problem of reference

1.1 Geometry

In this test, one considers three configurations of fissured plate. The first problem is a fissured plate subjected to a uniform tractive effort (request in mode I). The second problem is a beam cantilever subjected to a shearing force (request in mode I and in mode II). Finally the third problem is a plate with an inclined crack, subjected to a tractive effort (request in mode I and in mode II).

The geometrical parameters are the following:

- $L/b=16/7$;
- $h=L/2$;
- $a/b=1/2$;
- $L=16$;
- $\theta=60^\circ$.

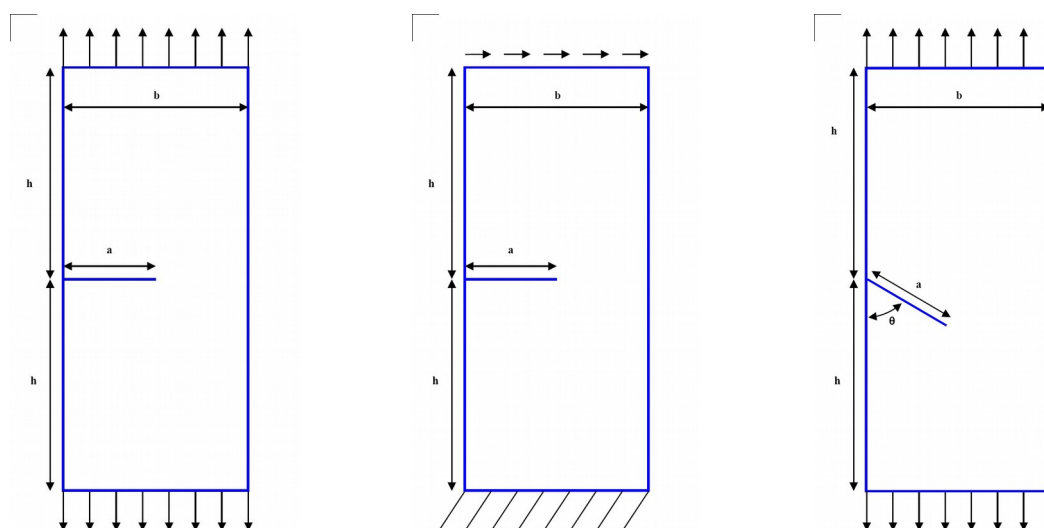


Table 1.1-1: Problem 1 (left), problem 2 (center) and problem 3 (right-hand side)

One definite:

- the group of meshes *HAUT* like the higher edge;
- the group of mesh *BAS* like the lower edge;
- the group of node *FONDFISS* (only one node) like the bottom of crack;
- the group of node *BLOCAGE* (only one node) like the intersection of the prolongation of the crack and the flat rim.

In addition, for the error analysis in quantity of interest, it is necessary to define another problem (the dual problem) which differs from the initial problem only by the conditions of Neuman (the matrix of rigidity and the conditions of Dirichlet are the same ones). The specific loading of the dual problem within the framework of the estimate of error on the factors of intensity of the constraints must be defined by the means of functions to impose on the lips of the crack. To know how to define this loading and how to impose it, one will be able to refer on the one hand to the command files and on the other hand in the reference material on the estimate of error in quantity of interest [R4.10.06].

1.2 Properties of material

- Young modulus: $E = 200000$ MPa
- Poisson's ratio: $\nu = 0.3$

1.3 Boundary conditions and loadings

Problem 1:

- Group of mesh *HAUT* : $FY = 1$
- Group of mesh *BAS* : $FY = -1$
- Node *FONDFISS* : $DY = 0$
- Node *BLOCAGE* : $DX = DY = 0$

Problem 2:

- Group of mesh *HAUT* : $FX = 1$
- Group of mesh *BAS* : $DX = DY = 0$

Problem 3:

- Group of mesh *HAUT* : $FY = 1$
- Group of mesh *BAS* : $FY = -1$
- Node *FONDFISS* : $DY = 0$
- Node *BLOCAGE* : $DX = DY = 0$

2 Reference solution

2.1 Method of calculating

The reference solutions for the factors of intensity of the constraints result from the "Stress Intensity Factors Handbook" of Murakami [bib1]. The reference solutions for the estimate of error are solution of not-regression. The estimators of error were validated in the thesis of J. Delmas [bib2].

2.2 Sizes and results of reference

The results of references for the factors of intensity of the constraints are:

	K_I	K_{II}
Problem 1	9.37	-
Problem 2	33.93	4.53
Problem 3	6.33	1.86

Table 2.2-1 : Sizes and results of reference

2.3 Bibliographical references

- [1] Y. Murakami, "Stress Intensity Factors Handbook", Pergamon Close Oxford, 1987.
- [2] J. Delmas, "Strategies of controls of miscalculation of industrial structures. Implementation of estimate of error in quantity of interest and adaptation of grid", Doctorate, University of Picardy Jules Verne, 2008.

3 Modeling A

3.1 Characteristics of modeling

Modeling used is a modeling C_PLAN.

3.2 Characteristics of the grid

The grid is composed of 240 linear triangles. The grid is transformed into quadratic grid in the command file. Moreover elements in bottom of crack are transformed into elements of Barsoum.

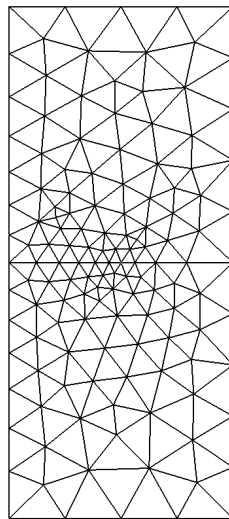


Figure 3.2-a: Grid for problem 1

3.3 Sizes tested and results

One tests the values of the factors of intensity of the constraints given by the order POST_K1_K2_K3 (analytical comparison and not-regression) and the value of the estimators of error for the 3 methods implemented in Code_Aster (parameters ERREUR_ERRE, ERREUR_ERZ1, ERREUR_ERZ2, ERREUR_QIRE, ERREUR_QIZ1, ERREUR_QIZ2) for the primal problem and the dual problem (comparison not-regression).

Size tested	Value of reference	Tolerance (relative)
K1 (analytical)	9.37	0,005
ERREUR_ERRE	2.6654055228458E-03	1.E-8
ERREUR_ERZ1	3.0877585644437E-03	1.E-8
ERREUR_ERZ2	7.4767989844696E-03	1.E-8
ERREUR_ERRE	5.2145715958031E+01	1.E-8
ERREUR_ERZ1	6.2002976336900E+01	1.E-8
ERREUR_ERZ2	1.4362442647950E+02	1.E-8
ERREUR_QIRE	9.3257156697600E+01	1.E-8
ERREUR_QIZ1	3.0877585644437E-03	1.E-8
ERREUR_QIZ2	7.4767989844696E-03	1.E-8

Table 3.3-1 : Results for the sizes tested

4 Modeling B

4.1 Characteristics of modeling

Modeling used is a modeling C_PLAN.

4.2 Characteristics of the grid

The grid is the same one as for modeling A

4.3 Sizes tested and results

One tests the values of the factors of intensity of the constraints given by the order POST_K1_K2_K3 (analytical comparison and not-regression) and the value of the estimators of error for the 3 methods implemented in *Code_Aster* (parameters ERREUR_ERRE, ERREUR_ERZ1, ERREUR_ERZ2, ERREUR_QIRE, ERREUR_QIZ1, ERREUR_QIZ2) for the primal problem and the dual problem (comparison not-regression).

Size tested	Value of reference	Tolerance (relative)
K2 (analytical)	4.53	0,03
K2 (not regression)	4,65	1.5E-6
ERREUR_ERRE	1.0037405543237E-02	1.E-8
ERREUR_ERZ1	1.1598992325170E-02	1.E-8
ERREUR_ERZ2	4.3649921113998E-02	1.E-8
ERREUR_ERRE	3.1841311747473E+01	1.E-8
ERREUR_ERZ1	5.6752165388391E+01	1.E-8
ERREUR_ERZ2	9.1883438831033E+01	1.E-8
ERREUR_QIRE	4.7392126029165E+01	1.E-8
ERREUR_QIZ1	1.1598992325170E-02	1.E-8
ERREUR_QIZ2	4.3649921113998E-02	1.E-8

Table 4.3-1 : Results for the sizes tested

5 Modeling C

5.1 Characteristics of modeling

Modeling used is a modeling C_PLAN.

5.2 Characteristics of the grid

The grid is composed of 222 linear triangles. The grid is transformed into quadratic grid in the command file. Moreover elements in bottom of crack are transformed into elements of Barsoum.

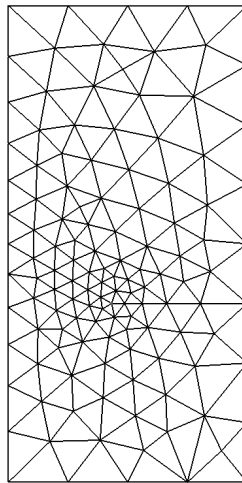


Figure 5.2-a: Grid for problem 3

5.3 Sizes tested and results

One tests the values of the factors of intensity of the constraints given by the order POST_K1_K2_K3 (analytical comparison and not-regression) and the value of the estimators of error for the 3 methods implemented in Code_Aster (parameters ERREUR_ERRE, ERREUR_ERZ1, ERREUR_QIRE, ERREUR_QIZ1) for the primal problem and the dual problem (comparison not-regression).

Size tested	Value of reference	Tolerance (relative)
K1 (analytical)	6.33	0,099
K1 (not regression)	6.95029	1.E-6
ERREUR_ERRE	2.2009669815803E-03	1.E-8
ERREUR_ERZ1	2.2766563775709E-03	1.E-8
ERREUR_ERRE	5.2902256540711E+01	1.E-8
ERREUR_ERZ1	5.5578633368626E+01	1.E-8
ERREUR_QIRE	7.6783302550272E+01	1.E-8
ERREUR_QIZ1	2.2766563775709E-03	1.E-8

Table 5.3-1 : Results for the sizes tested

6 Summary of the results

The got results are satisfactory. The estimate of error in quantity makes it possible well to adapt the grid.