EPICU01 - Summarized validation of the command

POST_K_BETA:

This test of the command validates the operation POST_K_BETA which calculates the stress intensity factors with the two points of defaults, using the nodal stresses resulting from the mechanical resolution.

This test breaks up into two types of modelization:

- EPICU01a: axisymmetric modelization,
- EPICU01b: modelization 3D .

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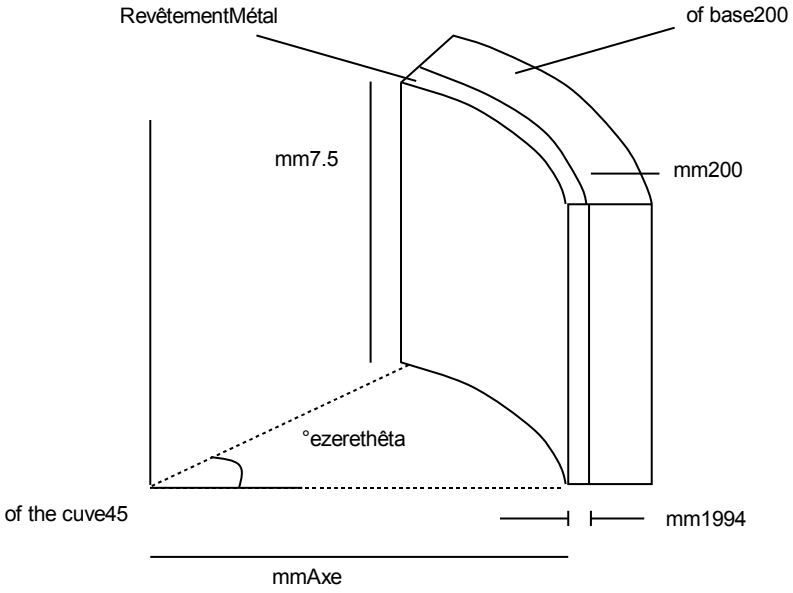
1 Problem of reference

1.1 Geometry

the studied geometry is that of a slice of tank bimetal, restricted with 45 degrees in azimuth.



1.1.1 Default considered

In the method $K\beta$, the default is not modelled in the mesh. The mesh allows to calculate the nodal stresses. A postprocessing is then applied to compute: the factor of intensity of the stresses by the method β starting from the nodal stresses (the method is detailed in [R7.02.10]).
For this test, the default considered is elliptic and of longitudinal directional sense. Its dimensions are the following ones (see figure which follows):

- depth: $prof_{\text{def}} = 6\text{mm}$
- width: $2\text{b} = 60\text{mm}$
- shift in the coating: $deca = -0{,}2\,mm$

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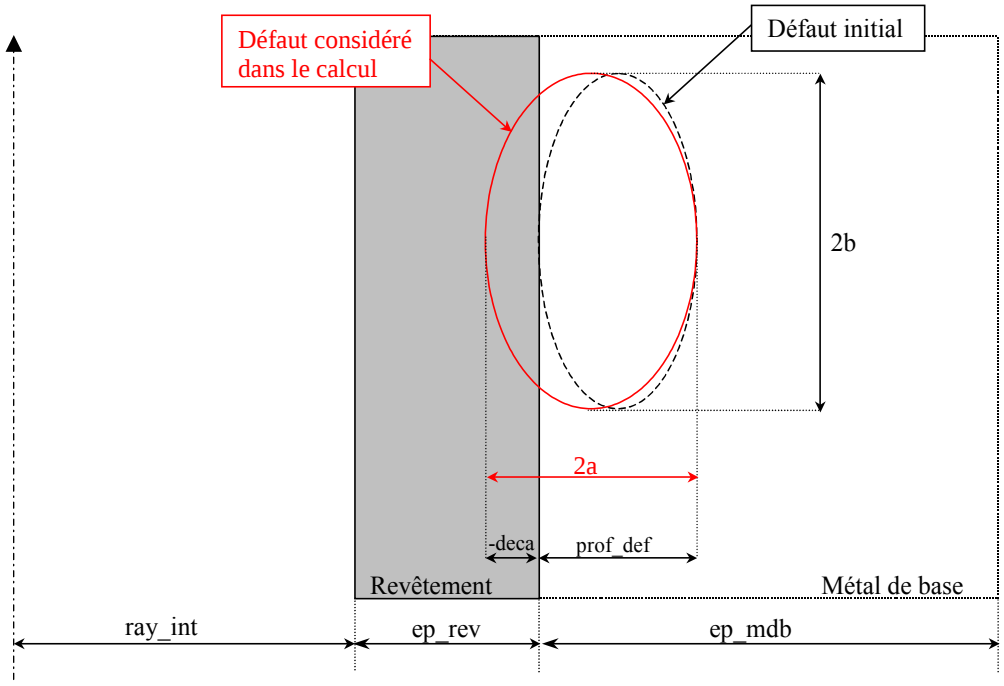

Axe de la cuve

1.2 Material properties

For computation in thermal:

Two properties are indicated, it acts of:

- LAMBDA : thermal conductivity isotropic function of the temperature, expressed in $W.m^{-1}.K^{-1}$,
- BETA: voluminal enthalpy according to the temperature, expressed in $J.m^{-3}$.

For the coating:

Temperature ($°C$)	LAMBDA0
	14.7
20	14.7
50	15.2
100	15.8
150	16.7
200	17.2
250	18.300
	18.6
350	19.3

Temperature ($°C$)	BETA
0	0.000000.E+00
50	1.102100.E+08
100	3.013300.E+08
150	5.014300.E+08
200	7.081300.E+08
250	9.188800.E+08

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300	1.132910.E+09
350	1.348980.E+09

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For the base metal:

Temperature ($°C$)	LAMBDA0
	37.7
20	37.7
50	38.6
100	39.9
150	40.5
200	40.5
250	40.2
300	39.5
350	38.7

Temperature ($°C$)	BETA
0	0.000000.E+00
50	1.061900.E+08
100	2.903300.E+08
150	4.829100.E+08
200	6.832800.E+08
250	8.921600.E+08
300	1.109440.E+09
350	1.335060.E+09

For computation in mechanics:

Four parameters are indicated, it acts of:

- E : modulus Young, expressed in Pa ,
- $nu=0.3$ Poisson's ratio,
- ALPHA: isotropic thermal coefficient of thermal expansion, expressed in $°C$,
- TEMP_DEF_ALPHA = 20: value of the temperature to which the values of thermal coefficient of thermal expansion ALPHA were determined, expressed in $°C$.

For the coating:

Temperature ($°C$)	E
0	1.985E+11
20	1.97E+11
50	1.95E+11
100	1.915E+11
150	1.875E+11
200	1.84E+11
	250.1.8E+11
300	1.765E+11
350	1.72E+11

Modelization has		Modelization B	
Temperature ($°C$)	ALPHA	Temperature ($°C$)	ALPHA
0	1.756E-05		
20	1.764E-05	20	1.64E-05
50	1.7787E-05	50	1.654E-05
100	1.8019E-05	100	1.68E-05
150	1.8225E-05	150	1.704E-05
200	1.8575E-05	200	1.72E-05

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250	1.8568E-05	250	1.75E-05
300	1.8768E-05	300	1.777E-05

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For the base metal:

Temperature ($°C$)	E
0	2.05E+11
20	2.04E+11
50	2.03E+11
100	2E+11
150	1.97E+11
200	1.93E+11
250	1.89E+11
300	1.85E+11
	350.1.8E+11

Modelization A

Temperature ($°C$)	ALPHA
0	1.2878E-05
20	1.3002E-05
50	1.3198E-05
100	1.3521E-05
150	1.382E-05
200	1.4102E-05
250	1.4382E-05
300	1.4682E-05

Modelization B

Temperature ($°C$)	ALPHA
20	1.122E-05
50	1.145E-05
100	1.179E-05
150	1.214E-05
200	1.247E-05
250	1.278E-05
300	1.308E-05

1.3 Boundary conditions and loadings

the imposed boundary conditions are those of an axisymmetric system.

Two types of loadings are applied:

- heat exchange in intern skin,
- fluid pressure in intern skin.

2 Reference solution

2.1 Results of reference

the results of reference are those resulting from a similar computation carried out starting from code CUVE1D. 3D case treated here is identical to the simulation 1D similar obtained with version 2.1 of CUVE1D, which is used as reference.

These computations carried out with CUVE1D are detailed in the note of validation of this software: "CUVE1D Version 2 - Note of validation" H-T26-2007-00833-FR.

2.2 Uncertainty on the solution

uncertainties on the reference solution are estimated at 2% .

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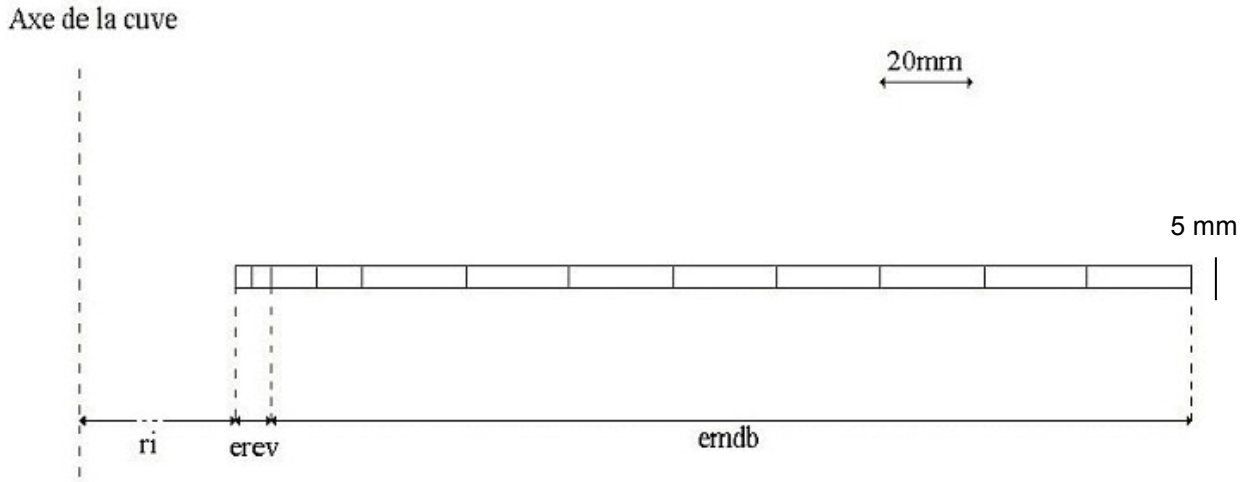
3 Modelization A

3.1 Characteristic of the modelization

Modelization 2D **, axisymetic (SEG3, QUAD8)**



3.2 Characteristic of the mesh

Many nodes: 63
Many elements: 26 SEG3, 12 QUAD8.

3.3 Quantities tested and results

Below and in complementary test of NON-regression, the comparison of the Aster *results* compared to the results of reference resulting from the computer code CUVE1D in version 2.1:

Urgent type of	value	Reference	% Tolerance
K1_REV	0	1.5187E+07	1.0
KCP_REV	0	1.818E+07	1.0
TEMPPF_REV	0.287.1.0		
K1_MDB	0	1.5223E+07	1.0
KCP_MDB	0	2.0223E+07	1.0
TEMPFF_MDB	0.287.1.0		
K1_REV	3871	9.462E+06	1.0
KCP_REV	3871	2.6737E+07	1.0
TEMPPF_REV	3871	84.88	1.0
K1_MDB	3871	4.29E+06	1.0
KCP_MDB	3871	2.9246E+07	1.0
TEMPFF_MDB	3871	86.05	1.0

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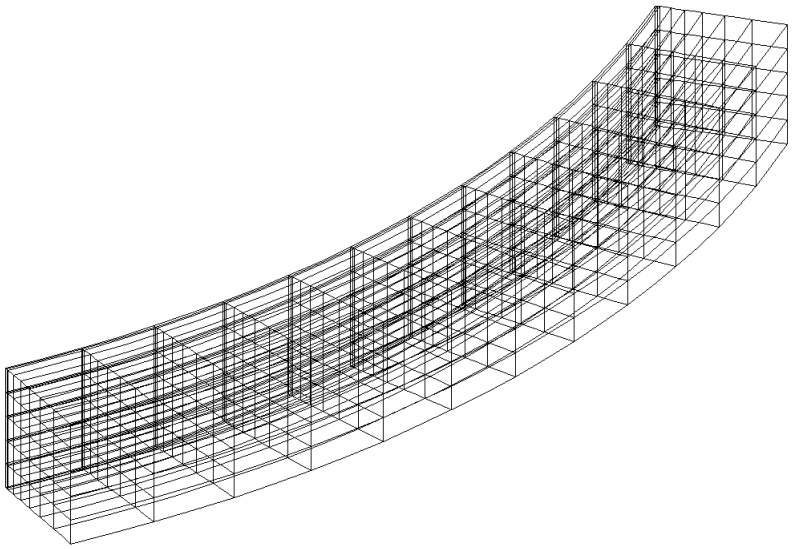
4 Modelization B

4.1 Characteristic of the modelization

Modelization 3D **(SEG3, QUAD8, HEXA20)**



4.2 Characteristic of the mesh

Many nodes: 1667
Many elements: 40 SEG3, 312 QUAD8, 288 HEXA20

4.3 Quantities tested and results

Below and in complementary test of NON-regression, the comparison of the Aster *results* compared to the results of reference resulting from the computer code CUVE1D in version 2.1:

Urgent type of	value	Reference	% Tolerance
K1_REV	3871	9.407E+06	1,5
KCP_REV	3871	25.167E+06	1,5
TEMPPF_REV	3871	84.88	1,5
K1_MDB	3871	3.585E+06	1,5
KCP_MDB	3871	25.894E+06	1,5
TEMPFF_MDB	3871	86.04	1,5

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5 Summary of the results

This case test validates command POST_K_BETA for the first type of modelization.

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