SSNP502 - Crushing of a polyurethane ring between two indeformable plates with Summarized

friction:

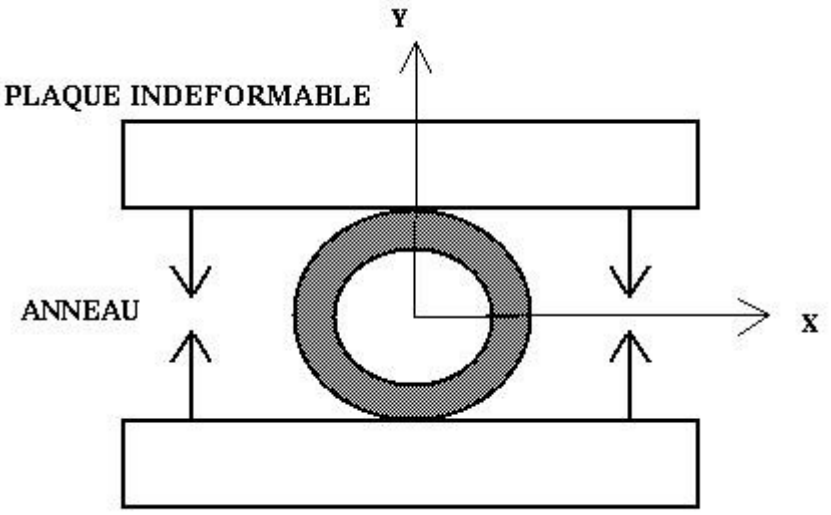
The test consists in simulating crushing in plane stresses of an elastic circular polyurethane ring by two indeformable symmetric plates. The purpose is to test the features related to the contact. This test comprises a resticking on a contact zone important length with the presence of elastic large deformations.
A symmetric imposed displacement is applied to the two plates; the resultant force as well as the contact pressure for various points in contact are compared with the results got in the standard commodity.

In the three modelizations suggested, the ring is modelled with meshes QUAD4 in plane stresses:

- **modelization A**, a contact **with friction** treated with the Lagrangian method was defined between the plate and the ring,
- **modelization B**, a contact **with friction** treated with the method of penalization was defined between the plate and the ring,
- **modelization C**, a contact **with friction** treated with the continuous method was defined between the plate and the ring.

1 Problem of reference

1.1 Geometry



radius external of the ring	$6,35\,cm$
interior radius of the ring	$4,15\,cm$
displacement imposed	$4,45\,cm$

1.2 Properties of the material

Ring: polyurethane, elastic constitutive law.

Young modulus:	$E=407\,N/cm^2$
Poisson's ratio:	$\nu=0,48$
Coefficient of friction:	$\mu=0,4$

1.3 Boundary conditions and loadings

the stresses are plane.

An incremental displacement imposed of 0 on $4,45\,cm$ is applied to the nodes of the indeformable plates.

Notice on the units:

Dimensions and displacements are in centimetres thus, to remain homogeneous, the pressures must be entered in N/cm^2 .

1.4 Initial conditions

None.

2 Reference solution

2.1 Method of calculating used for the reference solution

the solution is resulting from a computer code and an experimental test.

For the reference solution valid for a modelization of the whole plate, it is necessary to divide the normal resultant by two to obtain a reference valid for a half-plate.

2.2 Results of reference

the normal force of reaction is the following one:

Displacement imposed (cm)	Reaction force (N)
1,1125	8,0083
2,2250	16,0166
3,3375	24,0250
4,4500	32,0333

the normal pressure of contact is bench-mark datum. But, the meshes used are different. This pressure will be used to define tests of NON-regression.

2.3 Uncertainties on the solution

These results relatively approximate because are raised directly on curved paper.

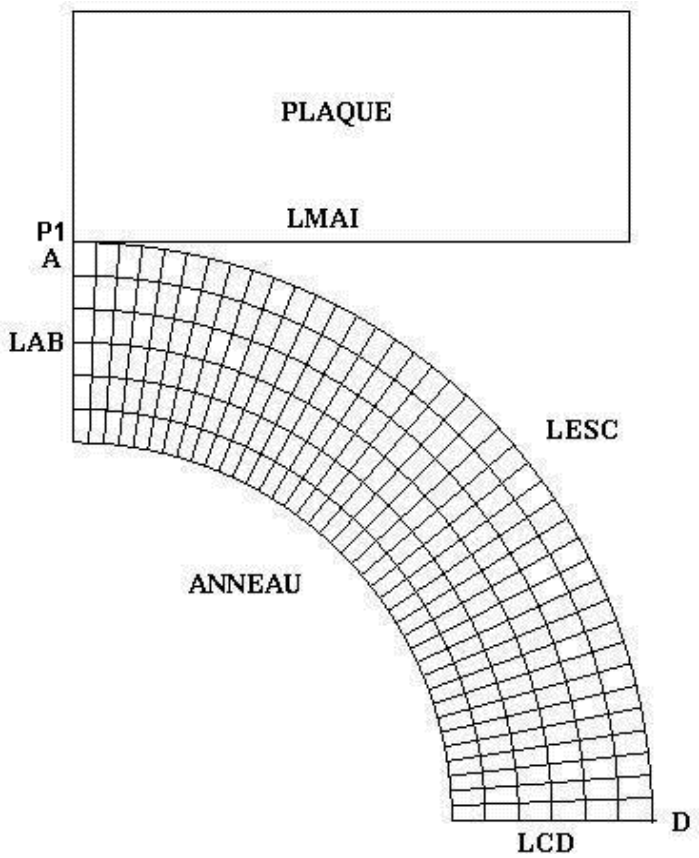
2.4 Bibliographical references

•A.F. SALEEB, K. CHEN, and T.Y.P. CHANG: “Year effective two dimensional frictional contact model for arbitrary curved geometry” - Int. *J. Num. Meth. Eng. 37 (* 1994) p. 1297 - 1321. Modelization

3 A Characteristic

3.1 of the modelization

a modelization testing the functionalities of contact with friction treated with the Lagrangian method was implemented. Taking into account the symmetry of the problem, it understands a quarter of the ring as well as the mesh of an indeformable plate. Boundary condition



: Conditions
of symmetry:

the nodes of the group located LAB in the plane $X=0$ are blocked according to the direction (), X $DX=0$
the nodes of the group located LCD in the plane $Y=0$ are blocked according to the direction (), Y all $DY=0$
the nodes of the group of mesh $«Plaque»$ are blocked according to the direction () X $DX=0$

to avoid motions of rigid bodies, the nodes and A have $P1$ even vertical displacement. Loadings

: Imposed
displacement following on all the Y nodes of the plate: vary DY from with 0 . ($2,225\,cm$
the value of is $4,45\,cm$ the vertical bringing together of the two symmetric plates.) Note:

The mesh

| *was realized in. Characteristics* cm

3.2 of the mesh Many

nodes: 291 Number of meshes
and type: 241 QUAD4 and 51 SEG2 Quantities

3.3 tested and results Identification

Standard	Reference	Displacement	of reference Tolerance	Reaction force
() – N 8,01	$1{,}1125\,cm$	“SOURCE_EXTERNE	″ 15,000%	Reaction force
() – N 16,02	$2{,}2250\,cm$	“SOURCE_EXTERNE	″ 15,000%	Reaction force
() – N 24,02	$3{,}3375\,cm$	“SOURCE_EXTERNE	″ 15,000%	Reaction force
() – N 32,03	$4{,}4500\,cm$	“SOURCE_EXTERNE	″ 15,000%	Displacement
in () 7,382 D cm	$2{,}2250\,cm$	E-01 “NON_REGRESSION	″ 0,001%	0.001%
in () 1,302 D cm	$4{,}4500\,cm$	E+00 “NON_REGRESSION	″ 0,001%	Contact pressure
in A () -1,532 $N.cm^{-2}$	$2{,}2250\,cm$	E+01 “NON_REGRESSION	″ 0,001%	Contact pressure
in A () -1,20 $N.cm^{-2}$	$4{,}4500\,cm$	E+01 “NON_REGRESSION	″ 0,001%	Remarks

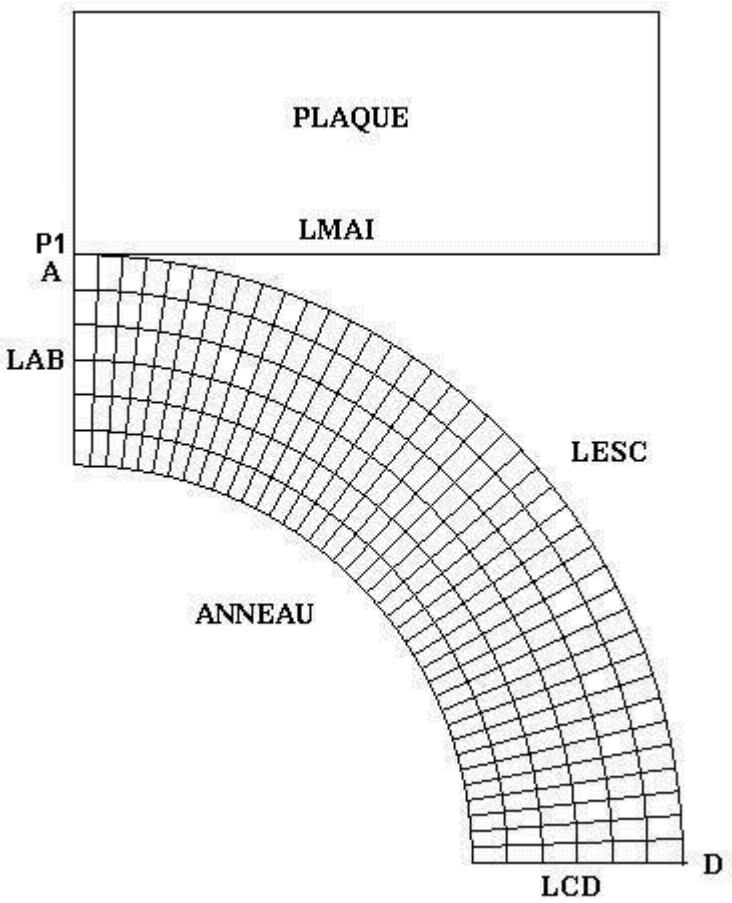
3.4 One can

visualize the influence friction by looking at the shearing stress with the nodes in contact. The difference should be made enters with $SIXY$ friction and without $SIXY$ friction to eliminate the problems of averages on the nodes of edge. Modelization

4 B Characteristic

4.1 of the modelization

a modelization testing the functionalities of contact with friction treated with the method of penalization was implemented. Taking into account the symmetry of the problem, it understands a quarter of the ring as well as the mesh of an indeformable plate. Boundary condition



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the nodes of the group of mesh $«\ Plaque\ »$ are blocked according to the direction () X $DX=0$
to avoid motions of rigid bodies, the nodes and A have $P1$ even vertical displacement. Loadings

: Imposed
displacement following on all the Y nodes of the plate: vary DY from with 0 . ($2{,}225\,cm$
the value of is $4{,}45\,cm$ the vertical bringing together of the two symmetric plates.) Note:

The mesh

| *was realized in. Characteristics* cm

4.2 of the mesh The mesh

is in any point identical to the mesh used for modelization A. Grandeurs

4.3 tested and results Identification

Standard	Reference	Displacement	of reference Tolerance	Reaction force
() – N 8,01	$1{,}1125\,cm$	“SOURCE_EX TERNE	″ 15,000%	Reaction force
() – N 16,02	$2{,}2250\,cm$	“SOURCE_EX TERNE	″ 15,000%	Reaction force
() – N 24,02	$3{,}3375\,cm$	“SOURCE_EX TERNE	″ 15,000%	Reaction force
() – N 32,03	$4{,}4500\,cm$	“SOURCE_EX TERNE	″ 15,000%	Displaceme nt
in () 7,382 D cm	$2{,}2250\,cm$	E-01 “NON_REGRE SSION	″ 0,001%	0.001%
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in A () -1,532 $N.cm^{-2}$	$2{,}2250\,cm$	E+01 “NON_REGRE SSION	″ 0,001%	Contact pressure
in A () -1,20 $N.cm^{-2}$	$4{,}4500\,cm$	E+01 “NON_REGRE SSION	″ 0,001%	Notices

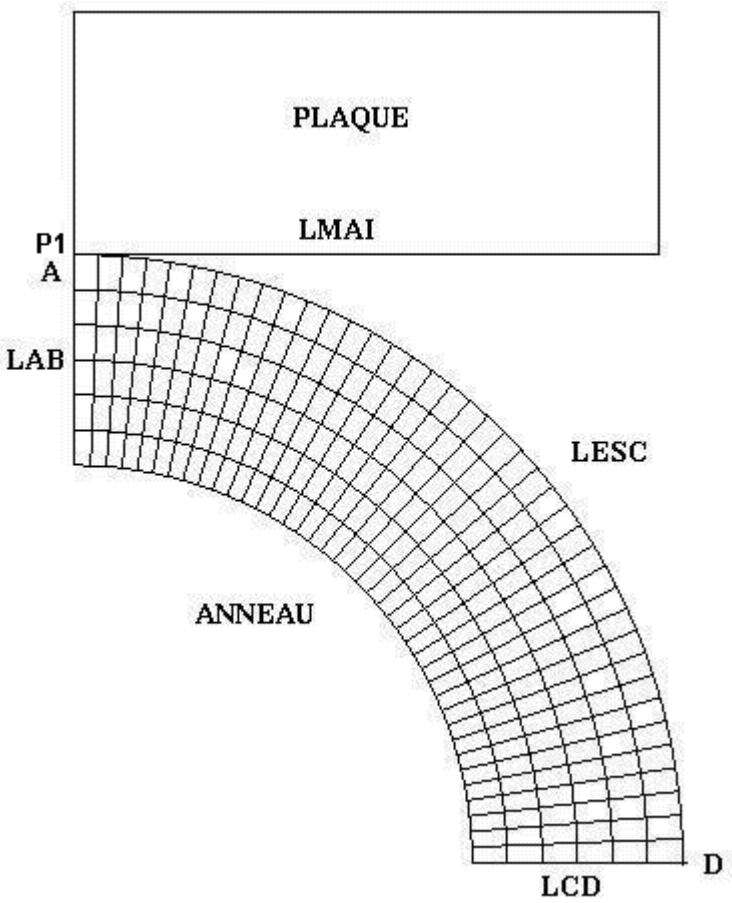
4.4

the results are very close to those of modelization A. Modélisation

5 C Characteristic

5.1 of the modelization

a modelization testing the functionalities of contact with friction treated with the continuous method was implemented. Taking into account the symmetry of the problem, it understands a quarter of the ring as well as the mesh of an indeformable plate. Boundary condition



: Conditions
of symmetry:
the nodes of the group located LAB in the plane $X=0$ are blocked according to the direction (), X $DX=0$
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the nodes of the group of mesh $«\ Plaque\ »$ are blocked according to the direction () X $DX=0$
to avoid motions of rigid bodies, the nodes and A have $P1$ same vertical displacement. Loadings

: Imposed
displacement following on all the Y nodes of the plate: vary DY from with 0 . ($2{,}225\,cm$
the value of is $4{,}45\,cm$ the bringing together vertical of the two symmetric plates). Note:

The mesh

| *was realized in. Characteristics* cm

5.2 of the mesh The mesh

is in any point identical to the mesh used for modelization A. Grandeurs

5.3 tested and results Identification

Standard	Reference	Displacement	of reference Tolerance	Reaction force
() – N 8,01	$1{,}1125\,cm$	“SOURCE_EX TERNE	″ 15,000%	Reaction force
() – N 16,02	$2{,}2250\,cm$	“SOURCE_EX TERNE	″ 15,000%	Reaction force
() – N 24,02	$3{,}3375\,cm$	“SOURCE_EX TERNE	″ 15,000%	Reaction force
() – N 32,03	$4{,}4500\,cm$	“SOURCE_EX TERNE	″ 15,000%	Displaceme nt
in () 7,382 D cm	$2{,}2250\,cm$	E-01 “NON_REGRE SSION	″ 0,001%	0.001%
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in A () -1,532 $N.cm^{-2}$	$2{,}2250\,cm$	E+01 “NON_REGRE SSION	″ 0,001%	Contact pressure
in A () -1,20 $N.cm^{-2}$	$4{,}4500\,cm$	E+01 “NON_REGRE SSION	″ 0,001%	Notices

5.4

the results are very close to those of the modelizations A and B. Summary

6 of the results Whatever the

type of modelization of the contact zone, the got results are satisfactory. The variations observed on the reaction force are weak. But the values of reference are very approximate because they are extracted from a curved paper. The mesh

code computer taken in reference and that used by Aster are different. Moreover, he is not explained in the reference how is extracted the normal pressure from contact. Thus, it was not carried out tests of reference on this pressure. However tests of NON-regression are carried out on the contact pressure (with the node $SIYY$ in contact). The pace of this pressure and the contact zone are identical between the two computer codes.