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Responsable : Jean-Luc FLÉJOU

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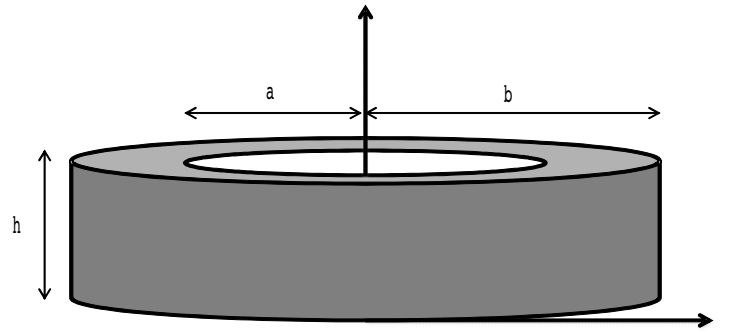
SSNV178 – Cylinder with reinforcement under pressure

Summarized:

One considers a cylinder with reinforcements under pressure. More exactly, a hollow roll 3D, is supplemented on its external face by a circumferential reinforcement. This structure is charged by an internal pressure. The computation is elastic linear.

Simulation is compared with an analytical solution in order to validate the modelizations of reinforcements of the grille_membrane TYPE on a structure.

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1   Problem of reference

1.1   Geometry

the cylinder has an interior radius $a=10\,m$, an external radius $b=20\,m$, a height of $h=0.02$m the circumferential reinforcement, positioned on surface external of the cylinder, has a section per unit of length of $s=0.1\,m^2/ml$. The principal direction of reinforcements is vertical.

Only one portion of the cylinder, corresponding to an angular section $\theta=0.1°$, is modelled.
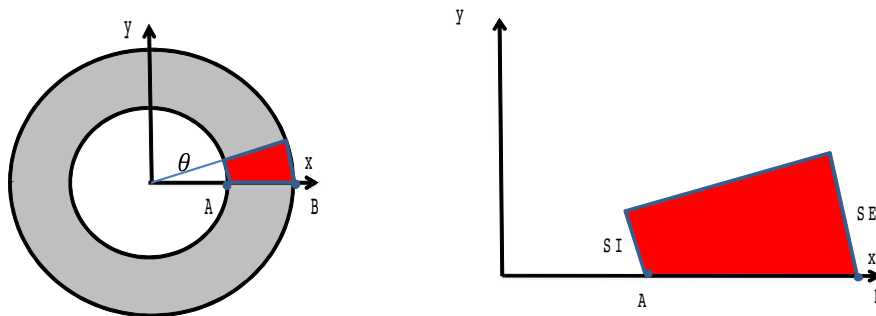
1.2   Properties of the material

the characteristic materials of the concrete forming the hollow roll are:
* $E=20\,000\,MPa$, $\nu=0.2$

The characteristic materials of reinforcements are:
* $E=200\,000\,MPa$ $\nu=0.0$ $\sigma_y=200000\,MPa$, $E_{cr}=20000\,MPa$

to model the grids of reinforcements, one uses `RELATION=' GRILLE_ISOT_LINE'` in the command `STAT_NON_LINE` . For that the affected behavior with the grids of reinforcements must define the plastic characteristics. In all the modelizations the steel reaction of must remain in the elastic domain, σ_y is given sufficiently large to observe this condition .

1.3   Boundary conditions and loadings

the following boundary conditions are imposed on the modelled angular section:
*   a null displacement on the lower surface of the cylinder
*   a normal displacement no one on the side sides of the section of the cylinder

the loading consists of a pressure imposed $10^6\,Pa$ on the internal surface SI of the section of the cylinder.

1.4   Initial conditions

At the beginning displacements and the forced are worth zero everywhere.

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2 Reference solution

2.1 Method of calculating

the analytical solution of the problem is presented in the documentation of the case test SSNS107 [V6.05.107].
All the behaviors of the materials remain in the elastic domain.

2.2 Quantities and results of reference

the evaluated quantities are displacements along the axis X of the points A and B the mesh (cf Appears).
The point A is on the internal surface of the cylinder and the point B on external surface.

Standard	identification of reference	Value of reference
Not formula A Displacement formulates DX	"ANALYTIQUE"	8.91925E-04
Not formula B Displacement formulates DX	"ANALYTIQUE"	6.21118E-04

the strains and stresses are evaluated in the concrete and the reinforcements on surfaces internal and external of the cylinder. The strains and stresses radial and tangential are respectively EPXX, EPYY, SIXX and SIYY by neglecting the curvature of the elements.

Standard	identification of reference	Value of reference			
		EPXX	EPYY	SIXX	SIYY
Concrete IF	"ANALYTIQUE"	-6.58E-05	8.92E-05	-1.00E+06	1.58E+06
Concrete SE	"ANALYTIQUE"	-7.70E-06	3.11E-05	-3.11E+04	6.15E+05
Steel	"ANALYTIQUE"			6.21E+06	

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3 Modelization A

3.1 Characteristic of the modelization

One 3D uses a voluminal `modelization` for the concrete and a model `GRILLE_MEMBRANE` for reinforcements whose meshes supports are quadrangles.

3.2 Characteristics of the mesh

The mesh contains:
- 100 meshes `HEXA20` for the concrete
- 1 mesh `QUAD8` for steel Remarks reinforcement

3.3

- All the behaviors of the materials remain in the elastic domain.
- Displacements are evaluated at the points A and B describes previously.
- The strains and stresses are evaluated in the adjacent mesh of the concrete on the internal surface and in the adjacent mesh of the concrete on the external surface.

Field	Quantity	Place	Reference	Tolerance
DEPL	DX	A	8.92E-04	0.10%
EPSI_ELNO	EPXX	nets: M100, point: 0	-6.58E-05	0.10%
EPSI_ELNO	EPYY	nets: M100, point: 0	8.92E-05	0.10%
SIGM_ELNO	SIXX	nets: M100, point: 0	-1.00E+06	0.10%
SIGM_ELNO	SIYY	nets: M100, point: 0	1.58E+06	0.10%

Field	Quantity	Place	Reference	Tolerance
DEPL	DX	B	6.21E-04	0.10%
EPSI_ELNO	EPXX	nets: M1, point: 0	-7.70E-06	0.10%
EPSI_ELNO	EPYY	nets: M1, point: 0	3.11E-05	0.10%
SIGM_ELNO	SIXX	nets: M1, point: 0	-3.11E+04	0.70%
SIGM_ELNO	SIYY	nets: M1, point: 0	6.15E+05	0.10%
SIGM_ELNO	SIXX	nets: M502, point: 0	6.21E+06	0.10%

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4   Modelization B

4.1   Characteristic of the modelization

One 3D uses a voluminal `modelization` for the concrete and a model `GRILLE_MEMBRANE` for reinforcements whose meshes supports are triangle.

4.2   Characteristics of the mesh

The mesh contains:
*   660 meshes `TETRA10` for the concrete
*   2 meshes `TRIA6` for steel Remarks reinforcement

4.3

*   All the behaviors of the materials remain in the elastic domain.
*   Displacements are evaluated at the points A and B describes previously.
*   The strains and stresses are evaluated on the nodes of the mesh concrete adjacent on the internal surface and of the mesh of the concrete adjacent on the external surface.

Field	Quantity	Place	Reference	Tolerance
DEPL	DX	A	8.92E-04	0.10%
EPSI_NOEU	EPXX	A	-6.58E-05	0.10%
EPSI_NOEU	EPYY	A	8.92E-05	0.10%
SIGM_NOEU	SIXX	A	-1.00E+06	0.10%
SIGM_NOEU	SIYY	A	1.58E+06	0.10%

Field	Quantity	Place	Reference	Tolerance
DEPL	DX	B	6.21E-04	0.10%
EPSI_NOEU	EPXX	B	-7.70E-06	1.00%
EPSI_NOEU	EPYY	B	3.11E-05	0.10%
SIGM_NOEU	SIXX	B	-3.11E+04	5.50%
SIGM_NOEU	SIYY	B	6.15E+05	0.20%
SIGM_ELNO	SIXX	nets: M1403, point: 0	6.21E+06	0.10%

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5 Summary of the results

the various modelizations of this case test validate behavior `GRILLE_MEMBRANE` for a complete structure (cylinder with reinforcement). The results are compared with an analytical solution.