

RamSeries - Validation Case 40

Plastic loading of a thick cylinder



RamSeries

Version
15.1.0

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1 Validation Test 40 - Plastic loading of a thick walled cylinder

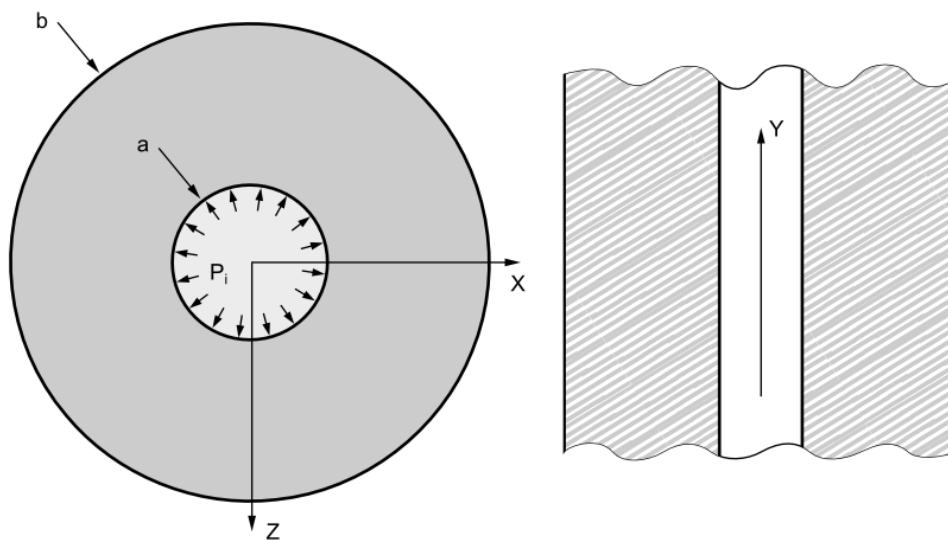
Model description

The aim of this test case is to check the accuracy of non-linear static analysis with plastic materials.

A long thick-walled cylinder is subjected to an internal pressure. Two different pressure values in two load cases are considered. In the first load case, the stress is just below the yield strength of the material, so it is an elastic case. But in the second load case, the entire cylinder wall is brought into a state of plastic flow.

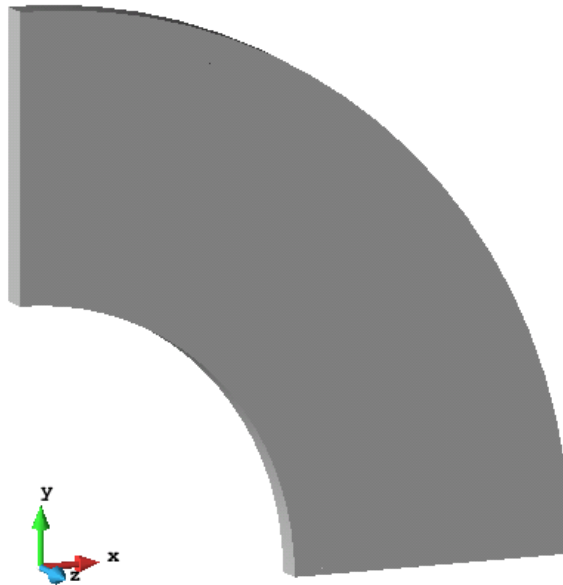
In the first load, case radial and tangential stress at locations near the inner and outer surfaces are compared with results shown in reference [1]. In the second load case, Von Mises stress at the same locations is compared.

Geometric model



Inner radius (a) = 101.6 mm Outer radius (b) = 203.2 mm

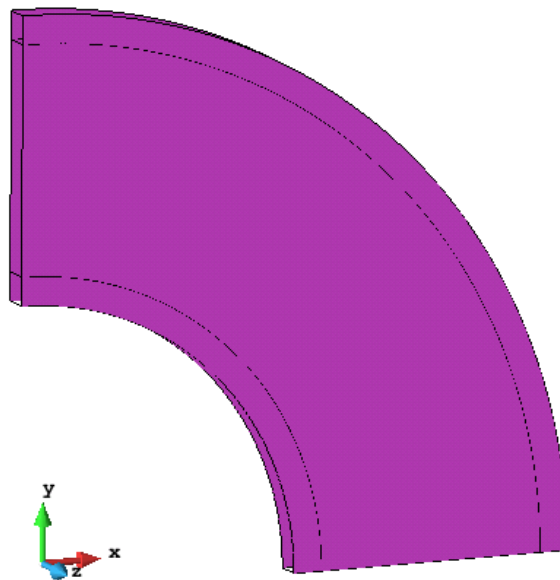
Because of the symmetry in loading conditions and in the geometry, this problem is solved as an axisymmetric problem. Moreover, the axial length is arbitrary and it is taken a value of 10 mm because model is a long cylinder.



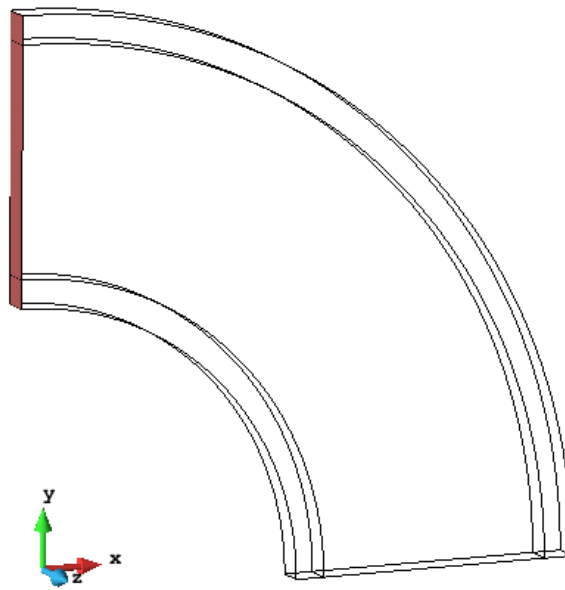
Geometric model used to perform the analysis with Ramseries.

Restrictions

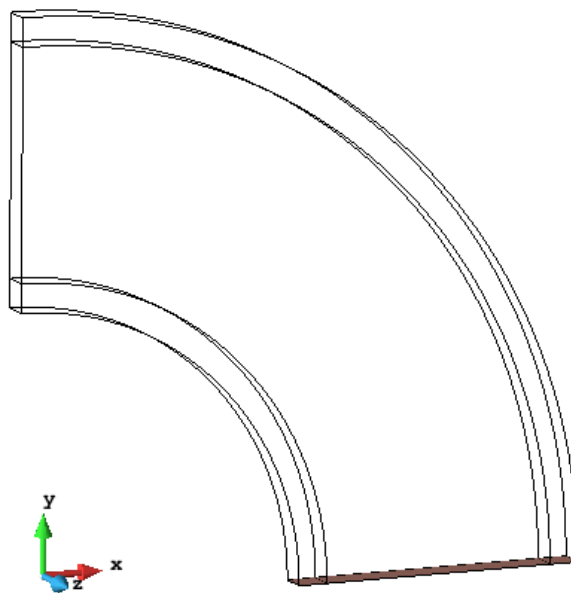
To apply symmetry conditions, the following restrictions must be created.



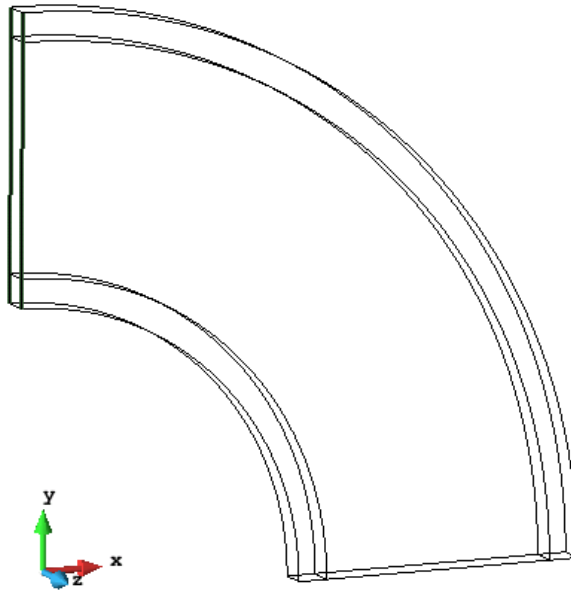
Restriction: Z direction



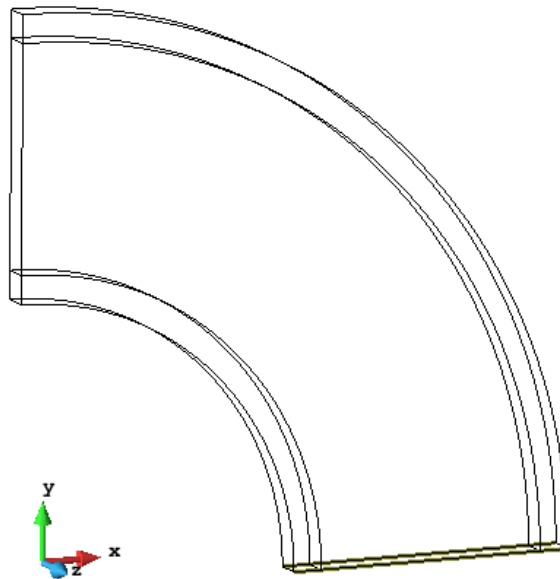
Restriction: X direction



Restriction: Y direction



Restriccion: directions X and Z



Restriction: Y and Z

Analysis parameters

- Analysis type: Incremental Loads Analysis
- Material constitutive model: Plasticity on materials
- Number of increments: 10

Material properties

E (Young's modulus) = 206820 MPa

G (Shear modulus) = 79546 MPa

ν (Poisson's modulus) = 0.3

Specific weight = 42112 N/m^3

Plasticity constitutive model: J2

Tensile Yield Stress = 206.82 MPa

Isotropic hardening = None

Kinematic hardening = None

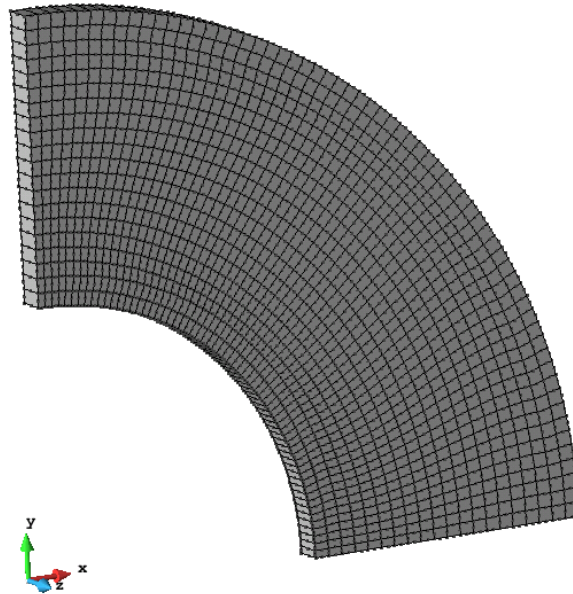
Load conditions

	Internal pressure (Pi) [MPa]
First load case	89.55
Second load case	165.53

Results

Mesh

A structured mesh of quadratic hexahedra is used in this validation test. The volumetric size of elements is 5.08 mm.

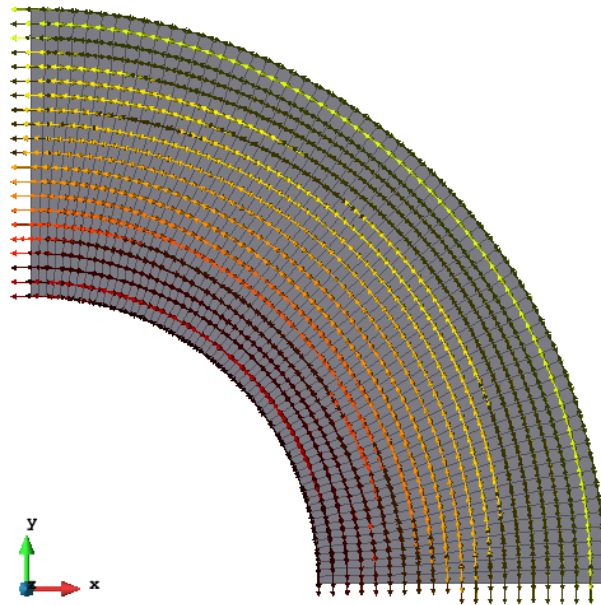


The mesh used in this test. Number of nodes: 9238.
Number of elements: 1260

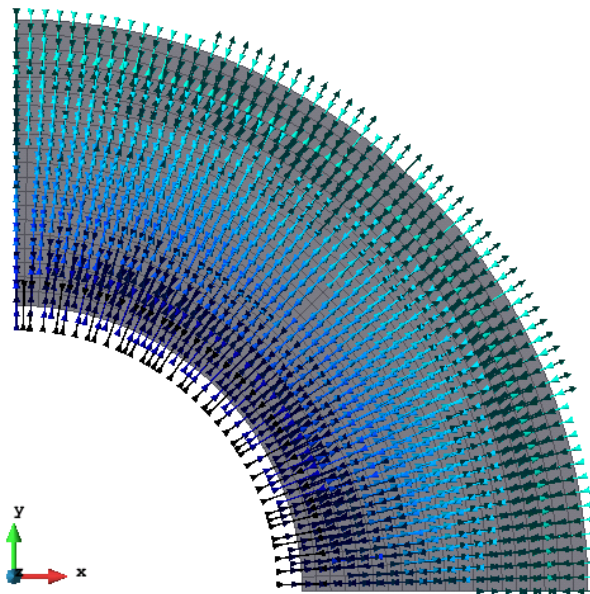
Results

- First load case:

In this case, radial and tangential stress are compared with reference [1]. As the following pictures show, the tangential stress is equivalent to the first principal stress (σ_1) and the radial stress is equivalent to the third principal stress (σ_3).

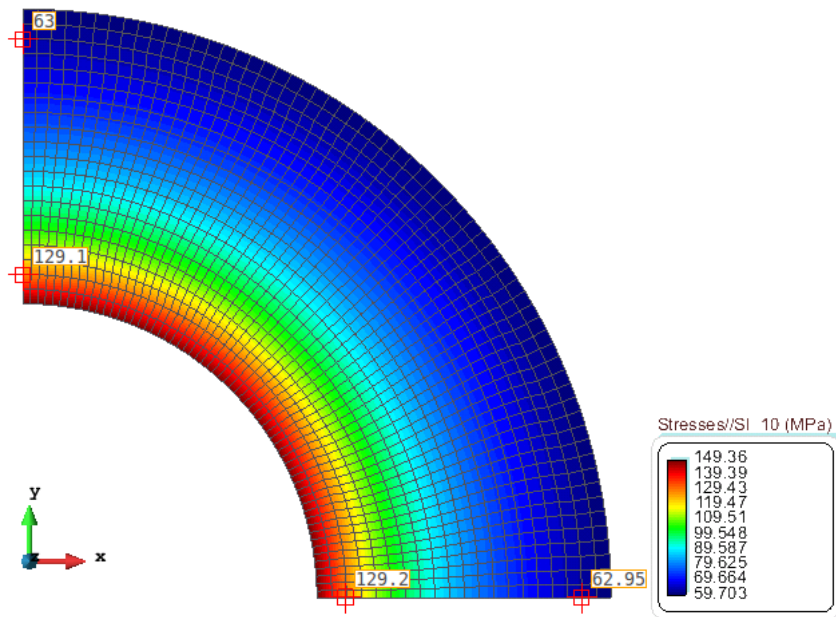


The first principal stress (S_i) is equivalent to tangential stress.



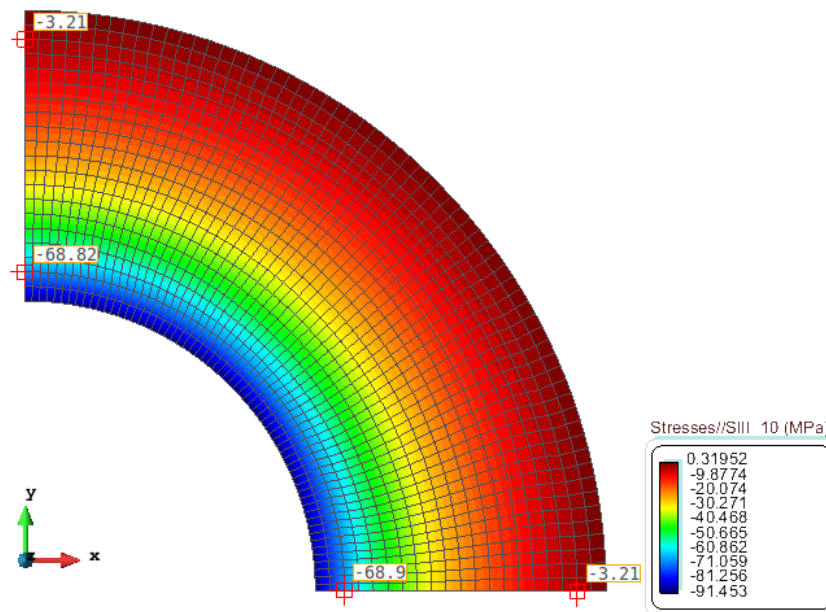
The third principal stress (S_{iii}) is equivalent to radial stress.

The tangential stress is shown in the following picture:



Tangential stress (Si).

Similarly, the radial stress is shown in the picture below:



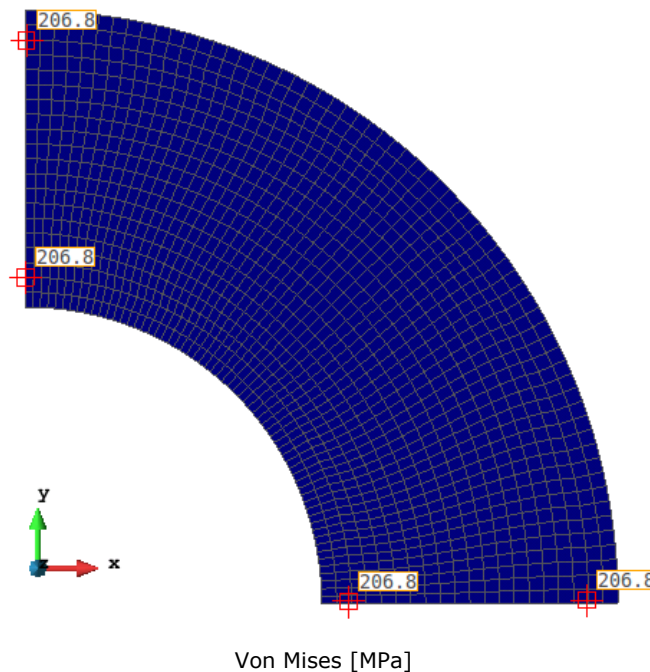
Radial stress (Siii)

The next table compares the results obtained by Ramseries analysis with reference [1].

	Target [MPa]	Ramseries Results [MPa]	Error [%]
Tangential stress (r = 111.76 mm)	128.5	129.2	0.5
Tangential stress (r = 193.04 mm)	62.9	63	0.1
Radial stress (r = 111.76 mm)	-68.8	-68.9	0.1
Radial stress (r = 193.04 mm)	-3.23	-3.21	0.5

- Second load case:

In this case, Von Mises equivalent tensile stress is compared with reference [1].



	Target [MPa]	Ramseries Results [MPa]	Error [%]
Von Mises (r = 111.76 mm)	206.8	206.8	0.0
Von Mises (r = 193.04 mm)	206.8	206.8	0.0

References

[1] ANSYS. Verification Manual for Workbench, pag 153-154. April 2009. Release 12.0.

Validation Summary

CompassFEM version	15.1.0
Tdyn solver version	15.1.0
RamSeries solver version	15.1.0
Benchmark status	Successfull
Last validation date	27/11/2018