Rubber Cylinder Pressed Between Two Plates

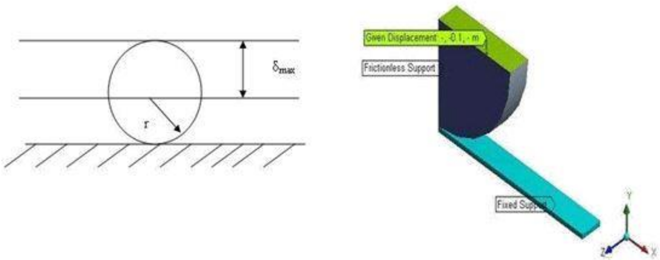
Overview

Reference:	T. Tussman, K.J. Bathe, "A Finite Element Formulation for Nonlinear Incompressible Elastic and Inelastic Analysis", *Computers and Structures*, Vol. 26 Nos 1/2, 1987, pp. 357-409
Solver(s):	ANSYS Mechanical
Analysis Type(s):	Nonlinear Static Structural Analysis (Large Deformation ON)
Element Type(s):	Solid

Test Case

A rubber cylinder is pressed between two rigid plates using a maximum imposed displacement of δ_{max}. Determine the total deformation.

Figure 54: Schematic



Material Properties	Geometric Properties	Loading
Solid1: E = 2 x 10^{11} Pa ν = 0.3 ρ = 7850 kg/m^3	**Solid1:** 0.05 m x 0.01 m x 0.4 m	Displacement in Y direction = -0.1 m
Solid2: Mooney-Rivlin Constants C10 = 2.93 x 10^5 Pa C01 = 1.77 x 10^5 Pa Incompressibility Parameter D1 1/Pa = 0	**Solid2:** Quarter Circular Cylinder Radius = 0.2 m Length = 0.05 m	

Analysis

Due to geometric and loading symmetry, the analysis can be performed using one quarter of the cross section.

- Frictionless supports are applied on 3 faces (X = 0, Z = 0 and Z = 0.05 m).
- Given displacement of 0.1 m is applied on the top surface.
- The bottom surface of Solid1 is completely fixed.
- Frictionless Contact with Contact stiffness factor of 100 is used to simulate the rigid target.
- Augmented Lagrange is used for Contact formulation.

Results Comparison

Results	Target	Mechanical	Error (%)
Total Deformation (m)	0.165285	0.16527	-0.009075

4.6.5. Mooney-Rivlin Hyperelasticity

The Mooney-Rivlin model applies to current-technology shell, beam, solid, and plane elements.

The TB,HYPER,,,,MOONEY option allows you to define 2, 3, 5, or 9 parameter Mooney-Rivlin models using *NPTS* = 2, 3, 5, or 9, respectively.

For *NPTS* = 2 (2 parameter Mooney-Rivlin option, which is also the default), the form of the strain energy potential is:

$$W=c_{10}(\overline{I}_1-3)+c_{01}(\overline{I}_2-3)+\frac{1}{d}(J-1)^2$$

where:

W = strain energy potential
$\overline{I}_1$ = first deviatoric strain invariant
$\overline{I}_2$ =second deviatoric strain invariant
c_{10}, c_{01} = material constants characterizing the deviatoric deformation of the material
d = material incompressibility parameter

The initial shear modulus is defined as:

$$\mu=2(c_{10}+c_{01})$$

and the initial bulk modulus is defined as:

$$K=\frac{2}{d}$$

where:

d = (1 - 2*v) / (C_{10} + C_{01})

The constants c_{10}, c_{01}, and d are defined by C1, C2, and C3 using the TBDATA command.