Element 10

Arbitrary Quadrilateral Axisymmetric Ring

Element type 10 is a four-node, isoparametric, arbitrary quadrilateral written for axisymmetric applications. As this element uses bilinear interpolation functions, the strains tend to be constant throughout the element. This results in a poor representation of shear behavior.

In general, you need more of these lower-order elements than the higher-order elements such as types 28 or 55. Hence, use a fine mesh.

This element is preferred over higher-order elements when used in a contact analysis.

The stiffness of this element is formed using four-point Gaussian integration.

For nearly incompressible behavior, including plasticity or creep, it is advantageous to use an alternative integration procedure. This constant dilatation method which eliminates potential element locking is flagged through the GEOMETRY option.

This element can be used for all constitutive relations. When using incompressible rubber materials (for example, Mooney and Ogden), the element must be used within the Updated Lagrange framework.

For rubber materials with total Lagrange procedure, element type 82 can be used. This is slightly more expensive because of the extra pressure degrees of freedom associated with element type 82.

Quick Reference

Type 10

Axisymmetric, arbitrary ring with a quadrilateral cross section.

Connectivity

Four nodes per element. Node numbering must be counterclockwise (see Figure 3-12).

Geometry

If a nonzero value is entered in the second data field (`EGEOM2`), the volume strain is constant throughout the element. This is particularly useful for analysis of approximately incompressible materials, and for analysis of structures in the fully plastic range. It is also recommended for creep problems in which it is attempted to obtain the steady-state solution.

Coordinates

Two coordinates in the global z- and r-direction.

Degrees of Freedom

1 = u (displacement in the global z-direction)
2 = v (displacement in the global r-direction).

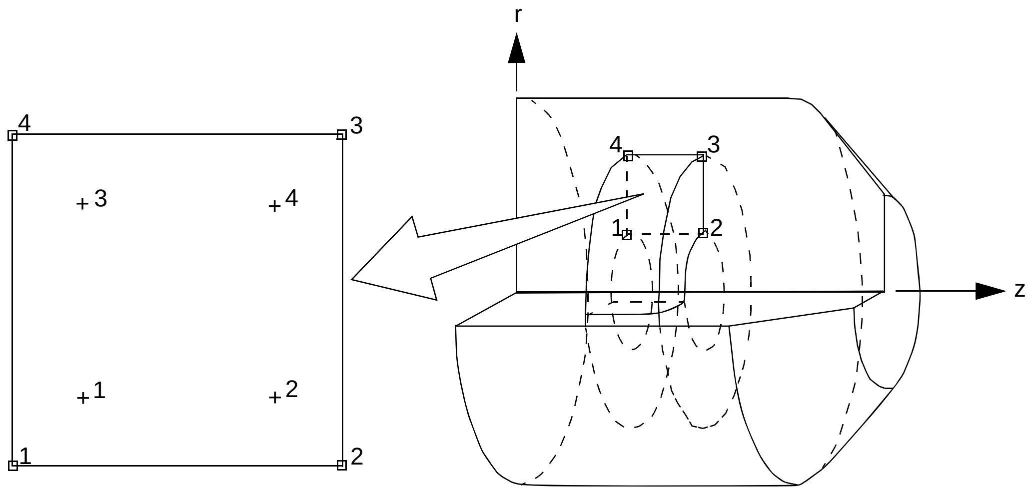

Figure 3-12 Integration Points for Element 10

Distributed Loads

Load types for distributed loads are as follows:

Load Type	Description
0	Uniform pressure distributed on 1-2 face of the element.
1	Uniform body force per unit volume in first coordinate direction.
2	Uniform body force by unit volume in second coordinate direction.
3	Nonuniform pressure on 1-2 face of the element; magnitude supplied through the FORCEM user subroutine.
4	Nonuniform body force per unit volume in first coordinate direction; magnitude supplied through the FORCEM user subroutine.
5	Nonuniform body force per unit volume in second coordinate direction; magnitude supplied through the FORCEM user subroutine.
6	Uniform pressure on 2-3 face of the element.
7	Nonuniform pressure on 2-3 face of the element; magnitude supplied through the FORCEM user subroutine.
8	Uniform pressure on 3-4 face of the element.
9	Nonuniform pressure on 3-4 face of the element; magnitude supplied through the FORCEM user subroutine.
10	Uniform pressure on 4-1 face of the element.
11	Nonuniform pressure on 4-1 face of the element; magnitude supplied through the FORCEM user subroutine.

Load Type	Description
20	Uniform shear force on side 1-2 (positive from 1 to 2).
21	Nonuniform shear force on side 1-2; magnitude supplied through the FORCEM. user subroutine
22	Uniform shear force on side 2-3 (positive from 2 to 3).
23	Nonuniform shear force on side 2-3; magnitude supplied through the FORCEM user subroutine.
24	Uniform shear force on side 3-4 (positive from 3 to 4).
25	Nonuniform shear force on side 3-4; magnitude supplied through the FORCEM user subroutine.
26	Uniform shear force on side 4-1 (positive from 4 to 1).
27	Nonuniform shear force on side 4-1; magnitude supplied through the FORCEM user subroutine.
100	Centrifugal load; magnitude represents square angular velocity [rad/time]. Rotation axis is specified in the ROTATION A option.
102	Gravity loading in global direction. Enter three magnitudes of gravity acceleration in the x-, y-, and z-direction.
103	Coriolis and centrifugal load; magnitude represents square of angular velocity [rad/time]. Rotation axis is specified in the ROTATION A option.

All pressures are positive when directed into the element. In addition, point loads can be applied at the nodes. The magnitude of point loads must correspond to the load integrated around the circumference.

For other types of distributed loads that are normally applicable for all types of elements, please refer to Distributed Loads in Chapter 1 of this manual.

Output of Strains

Output of strains at the centroid of the element in global coordinates is:

$1 = \varepsilon_{zz}$
$2 = \varepsilon_{rr}$
$3 = \varepsilon_{\theta\theta}$
$4 = \gamma_{rz}$

Output of Stresses

Same as for **Output of Strains**.

Transformation

Two global degrees of freedom can be transformed into local coordinates.

Tying

Can be tied to axisymmetric shell type 1 using standard tying type 23.