

Curved Grid

Introduction

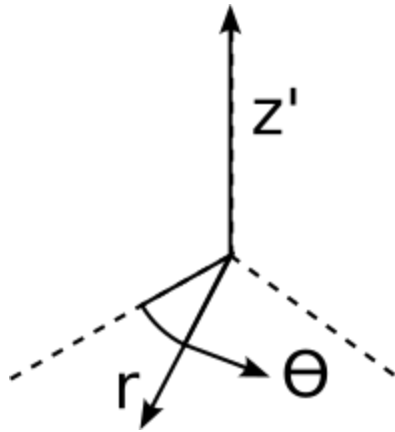
Some problems are better tackled when working on a structured grid constructed on a curvilinear basis. This is particularly so for models with curved structure.

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Controls

- The bend for cylindrical axis has the axis of rotation as the local z axis of the coordinate system defined by the axis command
- The vector connecting the neutral point to the origin of the local coordinate system controls the radius of curvature of the bend command
- If the vector is not perpendicular to the axis of rotation, the radius of curvature will depend on location along axis of rotation. If it is perpendicular to the axis of rotation, the radius of curvature is constant. If it is parallel the radius of rotation presents a full cone
- Both of the axes in the plane perpendicular to axis of rotation can be the neutral axes. The res

Cylindrical Axes



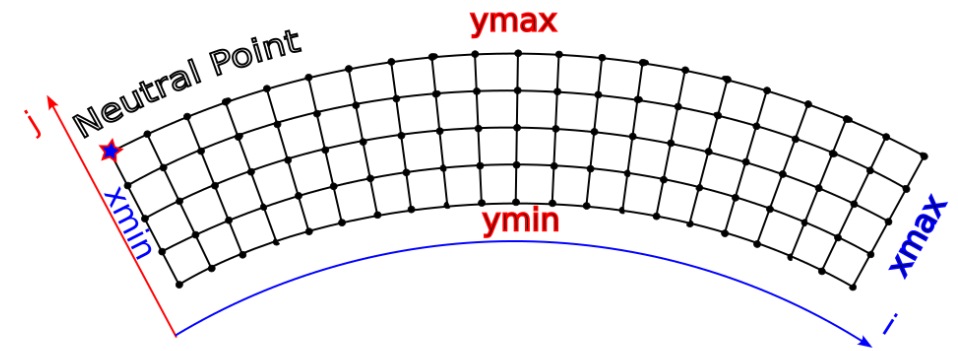
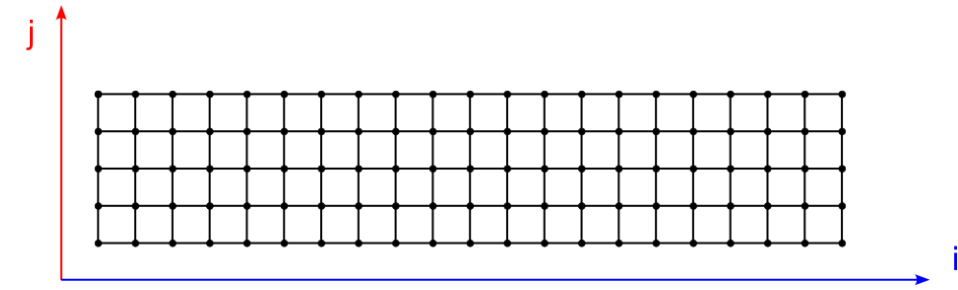
Neutral Point

Control of the bend operation achieved with neutral point vector

Relative distance determines the radius of curvature

For cylindrical bend, neutral point position vector is in radial plane

Neutral point vector is parallel to nodal axis



Arc Basis

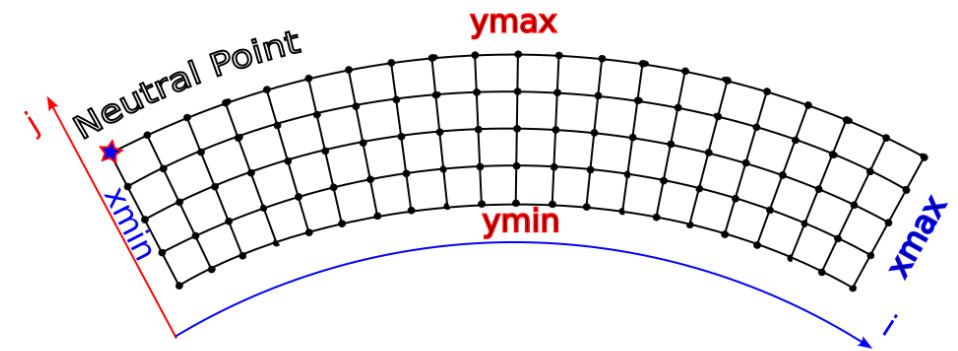
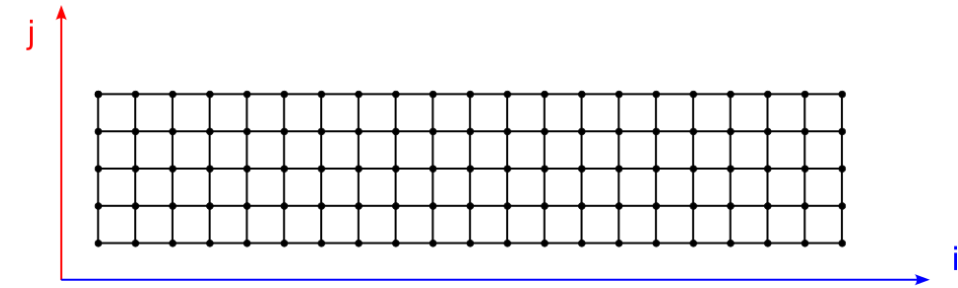
Cylindrical coordinate system has a basis vector that describes an arc.

Perpendicular to neutral point vector

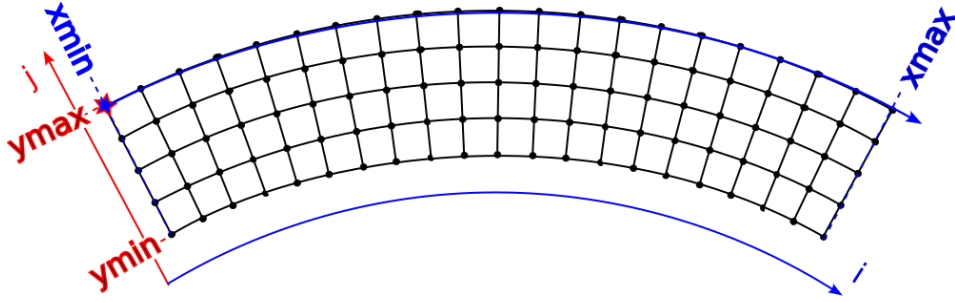
Arc axis coordinates assigned to outer arc.

Radius of curvature refers to outer arc.

Subtended angle $\text{arclength} / \text{radius}$ radians



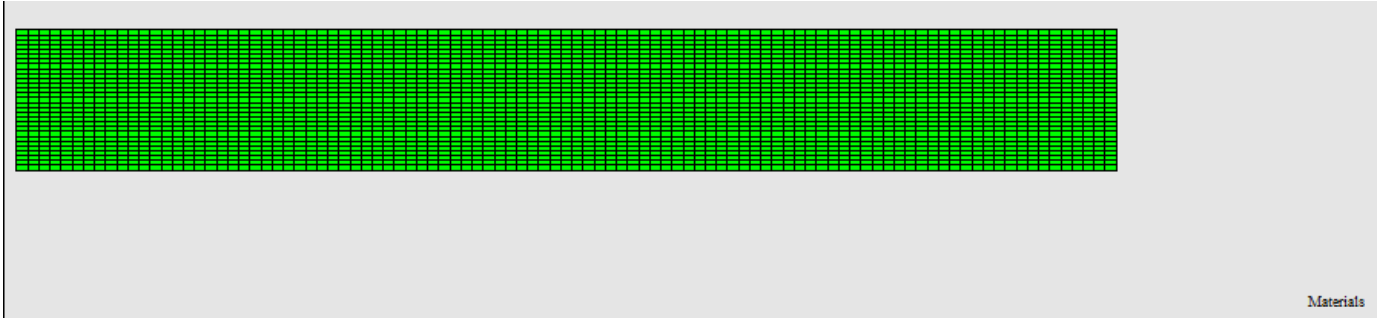
Example 1



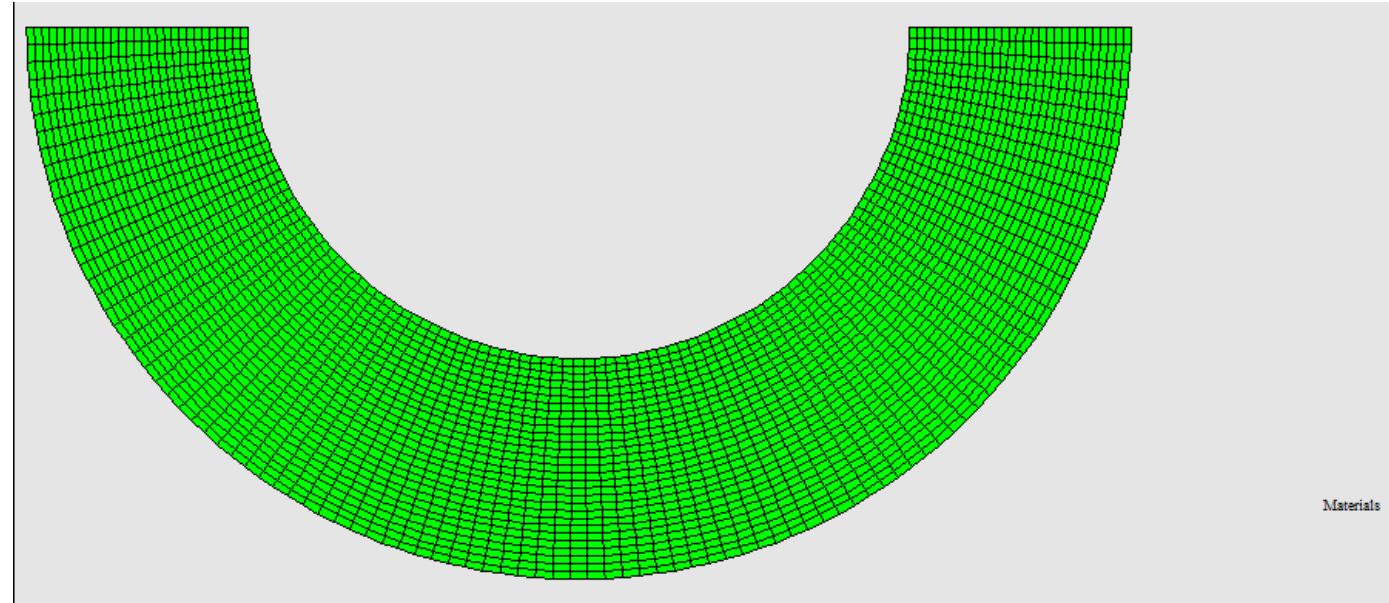
```

3 symb pi = atan ( 1 ) * 4
4 symb pi2deg = $pi / 180
5 symb rad = 50e-3
6
7 symb x1 = 0
8 symb x2 = $rad * $pi          /* Arc length calculation for semicircle
9
10 symb y1 = 30e-3
11 symb y2 = 50e-3
12
13 symb i1 = 1
14 symb i2 = 100
15
16 symb j1 = 1
17 symb j2 = 30
18
19 axis
20   form angl
21   defn bax cyln 0. 0. 0.      0. 0. 0.
22   end
23
24 grid $i2 $j2
25
26 geom
27   keypnt 2 2
28   skew stnd
29   bend bax 0. $y2
30   end

```

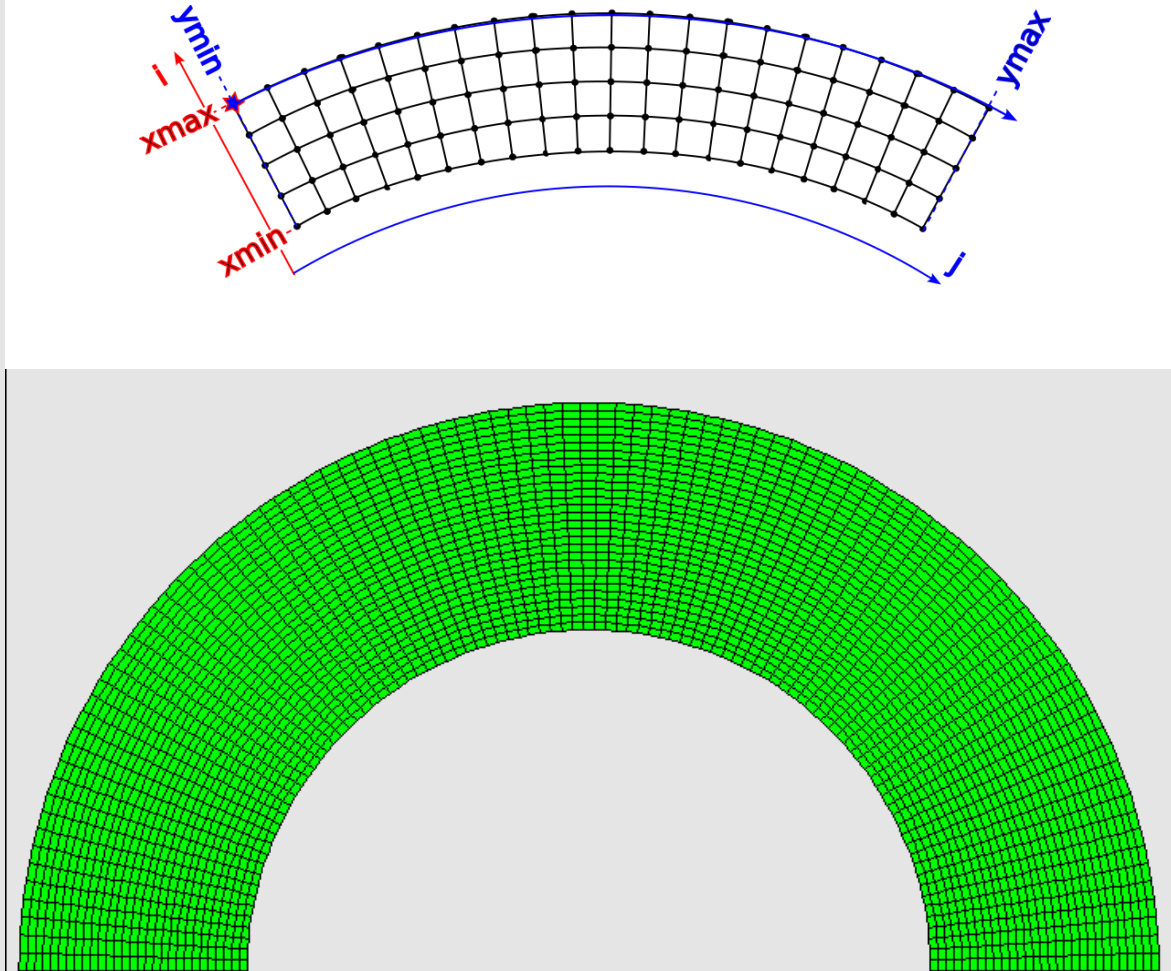
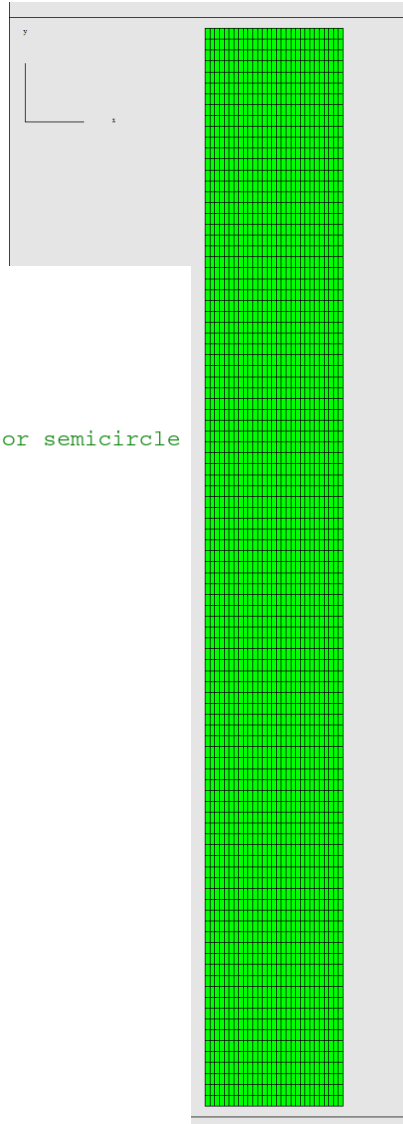


Materials



Materials

Example 2

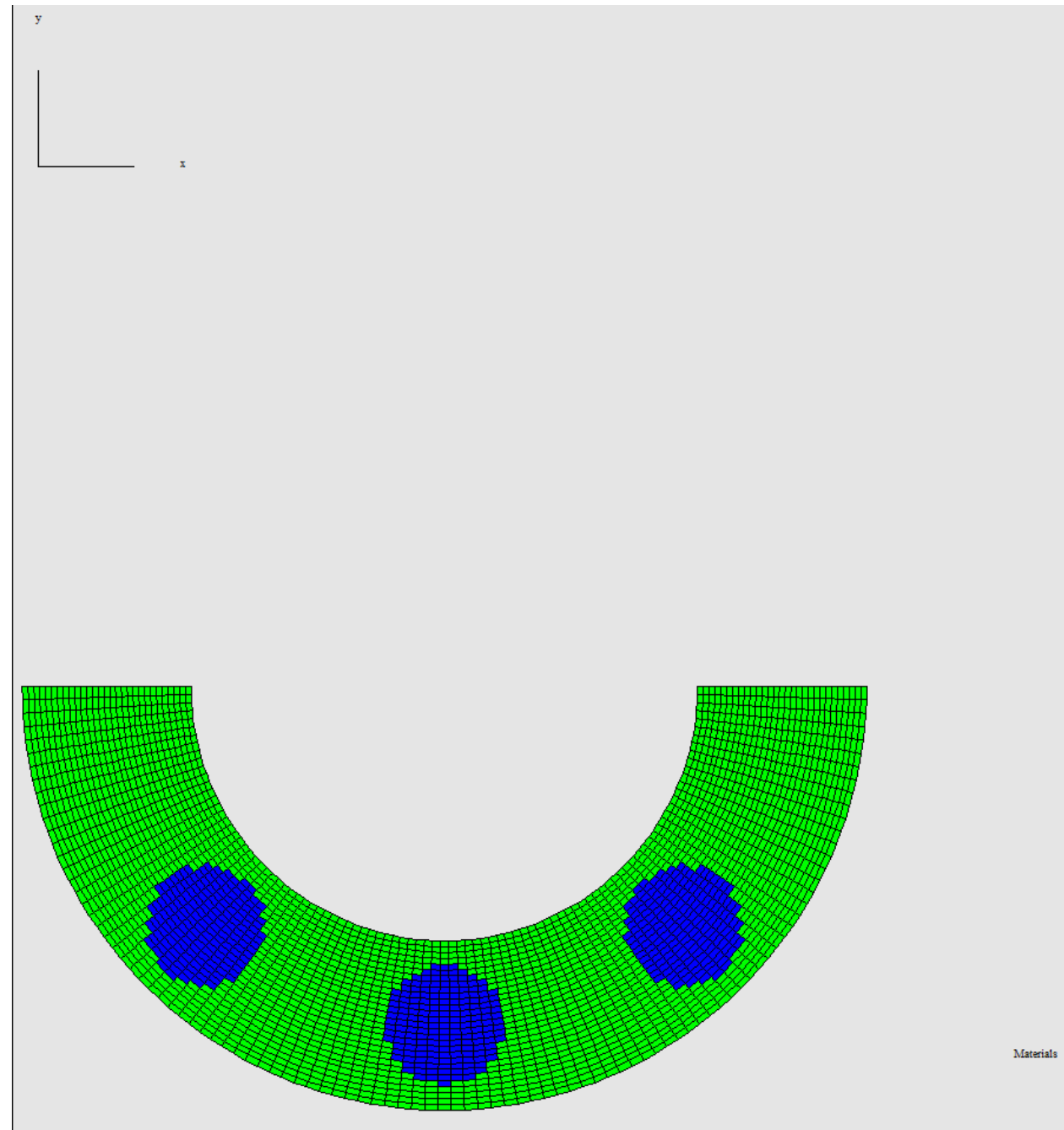


```
3 symb pi = atan ( 1 ) * 4
4 symb pi2deg = $pi / 180
5 symb rad = 50e-3
6
7 symb y1 = 0
8 symb y2 = $rad * $pi      /* Arc length calculation for semicircle
9
10 symb x1 = 30e-3
11 symb x2 = 50e-3
12
13 symb j1 = 1
14 symb j2 = 100
15
16 symb i1 = 1
17 symb i2 = 30
18
19 axis
20   form angl
21   defn bax cyln 0. 0. 0.      0. 0. 0.
22   end
23
24 grid $i2 $j2
25
26 geom
27   keypnt 2 2
28   skew std
29   bend bax $x2 0.
30   end
```


Defining Geometry

- Grid is already defined
- None nodal site commands can be used to generate geometry to be mapped onto grid

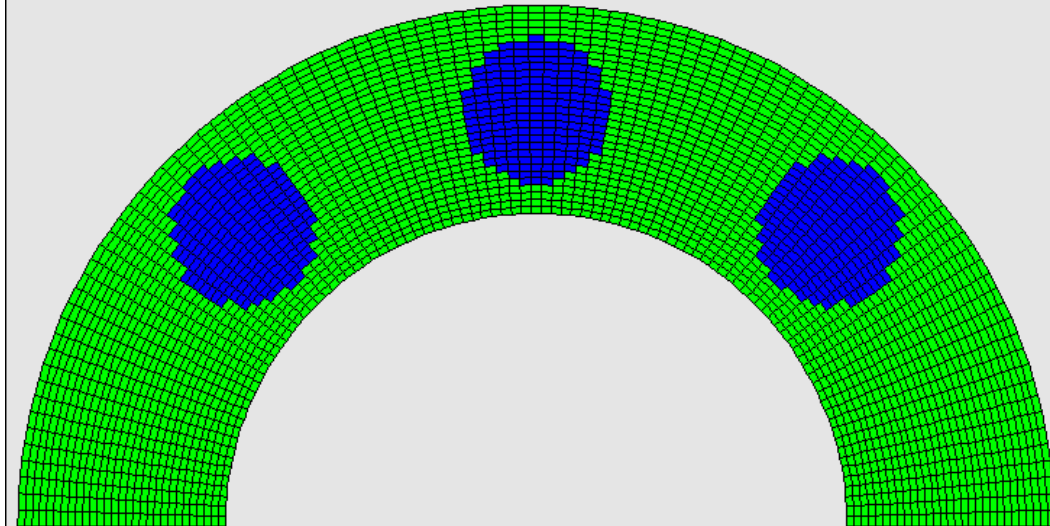
```
138 symb cx1 = 40e-3 * cos ( 225 * $pi2deg )
139 symb cy1 = 40e-3 * sin ( 225 * $pi2deg )
140
141 symb cx2 = 40e-3 * cos ( 270 * $pi2deg )
142 symb cy2 = 40e-3 * sin ( 270 * $pi2deg )
143
144 symb cx3 = 40e-3 * cos ( 315 * $pi2deg )
145 symb cy3 = 40e-3 * sin ( 315 * $pi2deg )
146
147 site
148     regn void
149     regn watr $i1 $i2 $j1 $j2
150     cyln stst 0. 1. $cx1 $cy1 7e-3 7e-3
151     cyln stst 0. 1. $cx2 $cy2 7e-3 7e-3
152     cyln stst 0. 1. $cx3 $cy3 7e-3 7e-3
153 end
```



Material Mapping Commands

- Commands like `cyln` will still operate as they normally do
- Take care that the coordinates are correctly defined

```
138 symb cx1 = 40e-3 * cos ( 45 * $pi2deg )
139 symb cy1 = 40e-3 * sin ( 45 * $pi2deg )
140
141 symb cx2 = 40e-3 * cos ( 90 * $pi2deg )
142 symb cy2 = 40e-3 * sin ( 90 * $pi2deg )
143
144 symb cx3 = 40e-3 * cos ( 135 * $pi2deg )
145 symb cy3 = 40e-3 * sin ( 135 * $pi2deg )
146
147 site
148   regn void
149   regn watr $i1 $i2 $j1 $j2
150   cyln stst 0. 1. $cx1 $cy1 7e-3 7e-3
151   cyln stst 0. 1. $cx2 $cy2 7e-3 7e-3
152   cyln stst 0. 1. $cx3 $cy3 7e-3 7e-3
153 end
```



Things to watch out for

- Avoid including the region near the centre of rotation. Nodes are very close to each other. This will crash the time step
- There is a circumferential axis. Coordinate interpretation will be different.
- Be careful with boundary conditions. These operate at the extremes of the axes, which are distinct from the usual interpretation of x , y , z being r , θ and z' instead even though the command uses x_{\max} , y_{\max} etc
- Boundary condition errors will present with an error message about excess element angle

Meshing

Mixed Grid