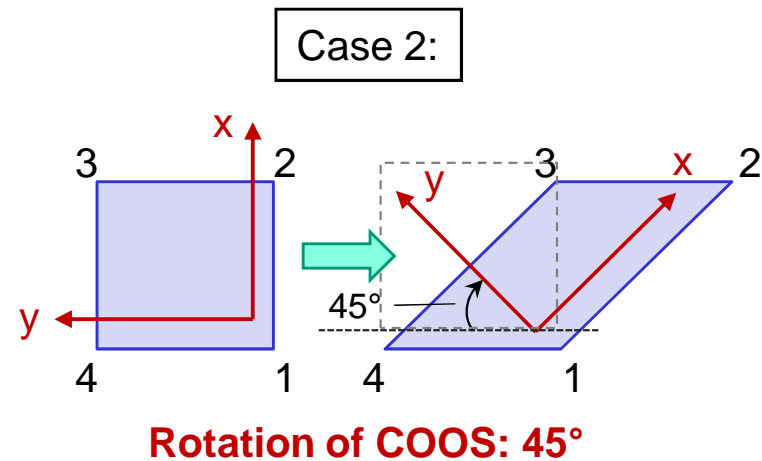
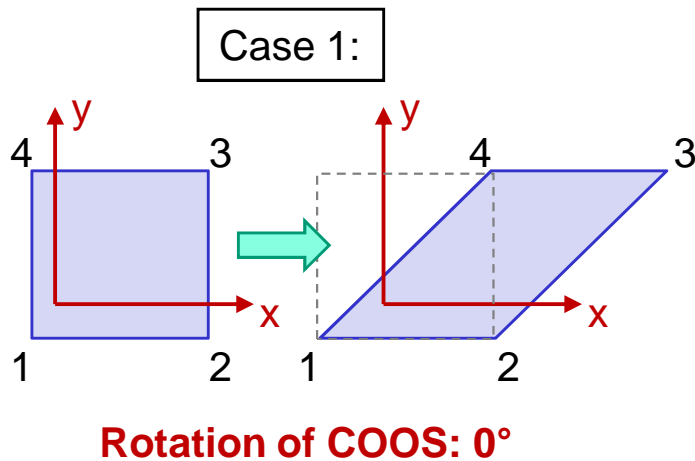


Why should we use „Invariant Node Numbering“?

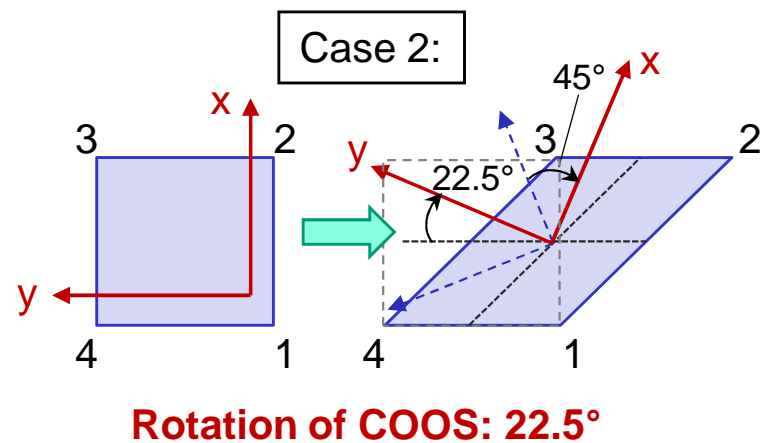
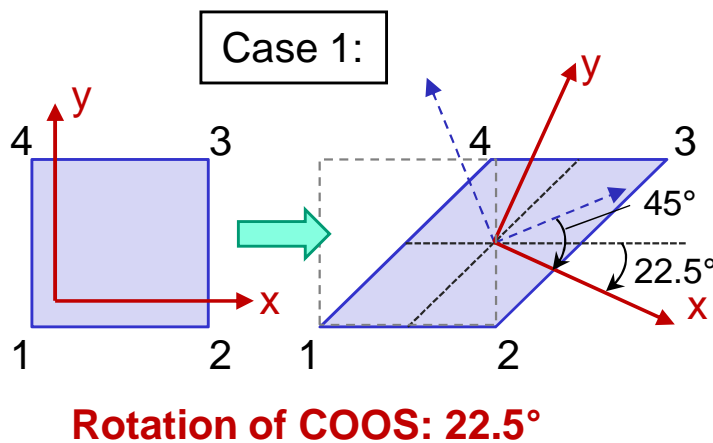
→ *CONTROL_ACCURACY (INN=2/3/4)

Change of element coordinate system during deformation (Example – Shells)

- Without Invariant Node Numbering (Default)



- With Invariant Node Numbering (based on element bisection)



Steps to define local (element) coordinate system for shells with invariant node numbering:

- Create vectors \mathbf{a}_1 and \mathbf{a}_2 through midpoints of element sides
- Create shell normal vector \mathbf{n} with:

$$\mathbf{n} = \mathbf{a}_1 \times \mathbf{a}_2$$

- Define vector \mathbf{b}_1 as middle between \mathbf{a}_1 and \mathbf{a}_2 :

$$\mathbf{b}_1 = \frac{\mathbf{a}_1}{\|\mathbf{a}_1\|} + \frac{\mathbf{a}_2}{\|\mathbf{a}_2\|}$$

- Create vector \mathbf{b}_2 orthogonal with:

$$\mathbf{b}_2 = \mathbf{n} \times \mathbf{b}_1$$

- Rotate back (45°) \mathbf{b}_1 and \mathbf{b}_2 to get \mathbf{x} and \mathbf{y} :

$$\mathbf{x} = \frac{\sqrt{2}}{2} \left(\frac{\mathbf{b}_1}{\|\mathbf{b}_1\|} - \frac{\mathbf{b}_2}{\|\mathbf{b}_2\|} \right)$$

$$\mathbf{y} = \frac{\sqrt{2}}{2} \left(\frac{\mathbf{b}_1}{\|\mathbf{b}_1\|} + \frac{\mathbf{b}_2}{\|\mathbf{b}_2\|} \right)$$

