



Post-buckling Due to The Eigenstrain

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12/9/2008

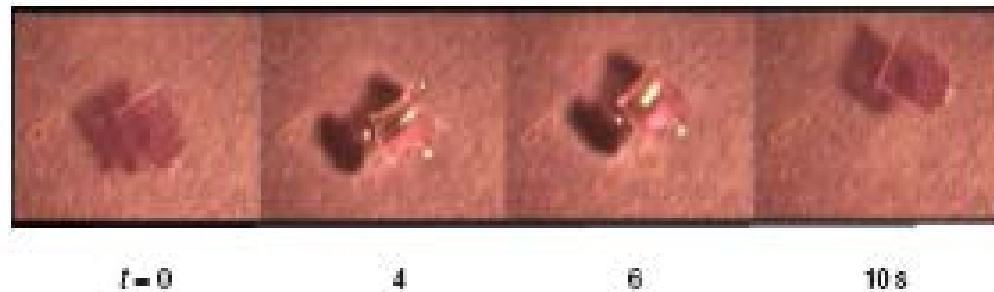
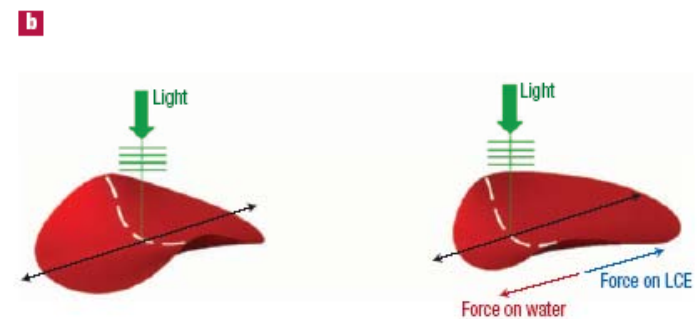
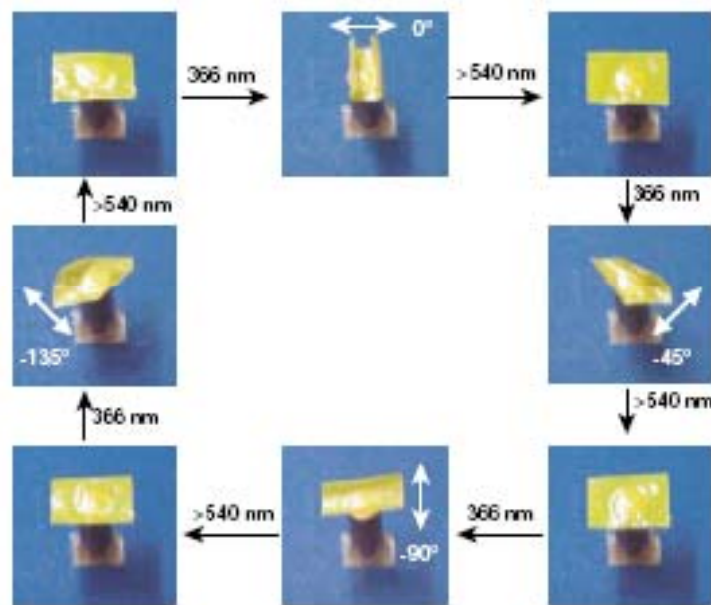


Background

- **Eigenstrain**
thermal expansion, phase transformation,
plastic strains, misfit strains, photo strains
- **Eigenstress**
residual stresses after fabrication or plastic
deformation, thermal stresses

Background

- Application



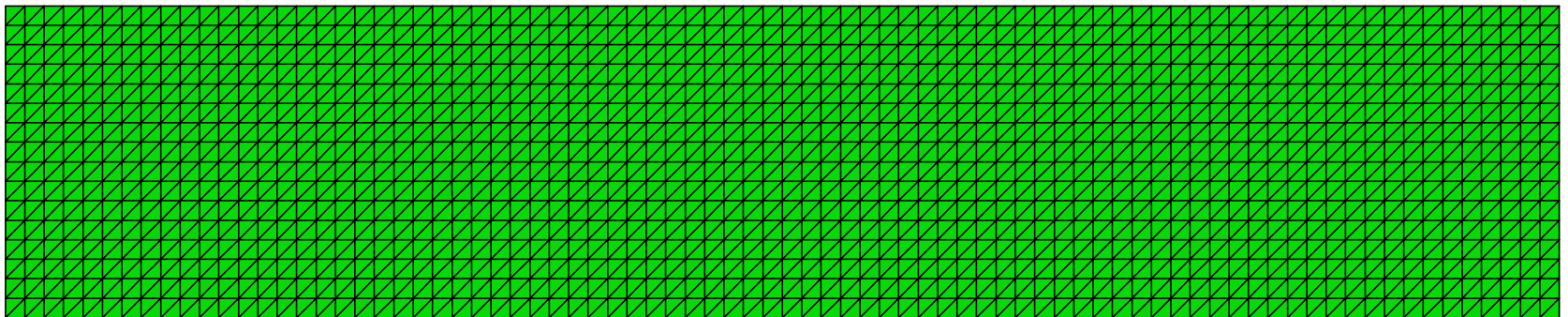
Background

- Application



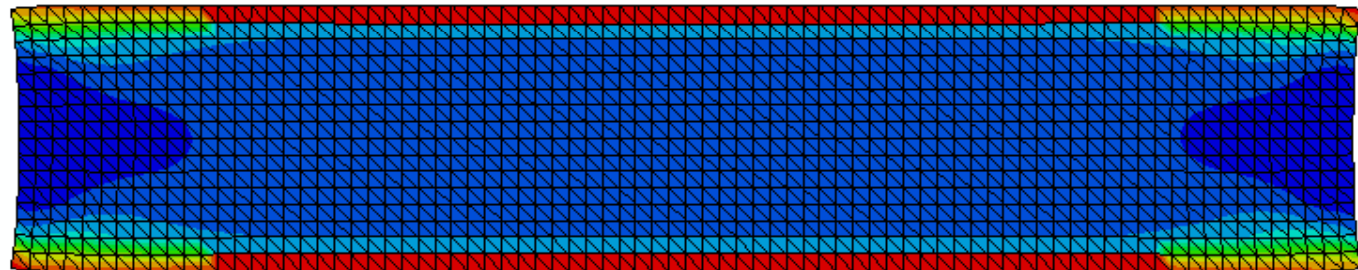
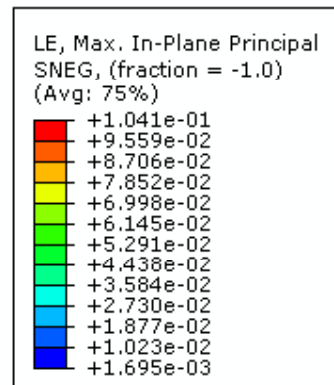
Model

- Solid $\rightarrow$ Shell $\rightarrow$ Linear triangular elements
- Size: $1000 \times 200 \times 2$
- Boundary condition: fixed in the center
- Temperature field: $T = \alpha (y / 200)^\beta$



Model

- In-plane deformation



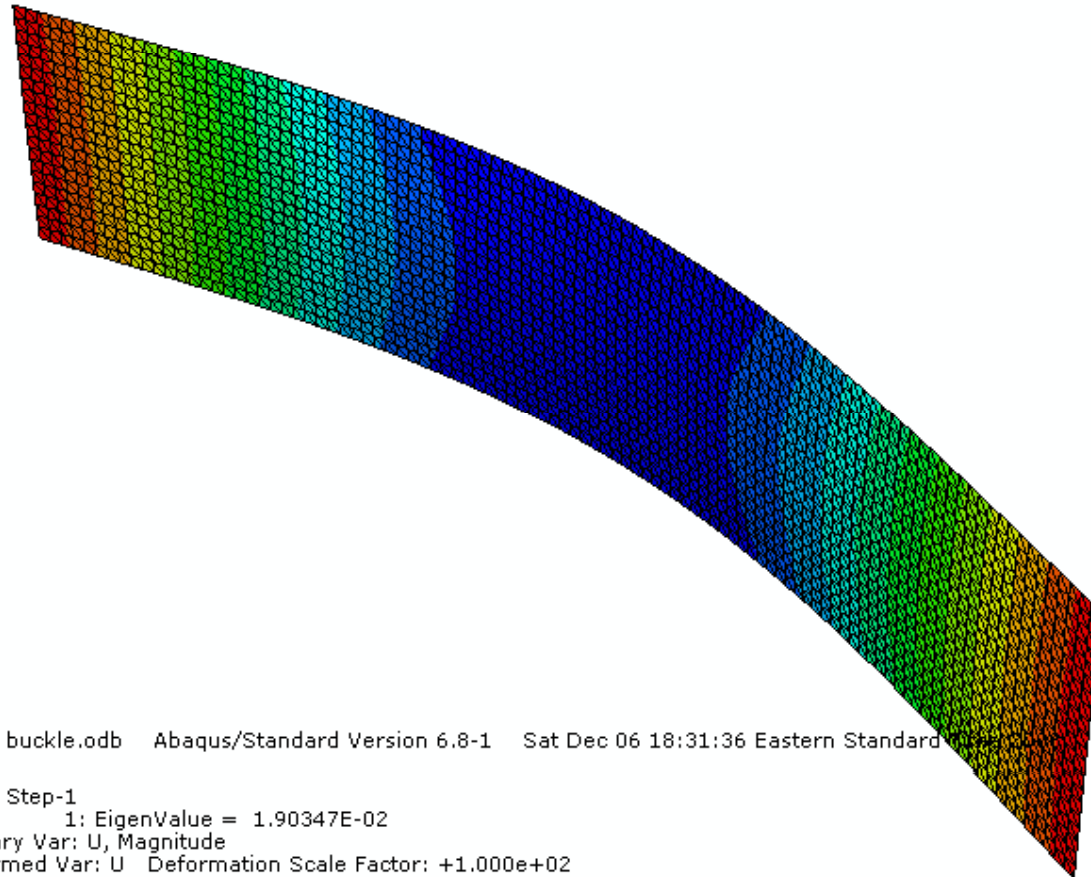
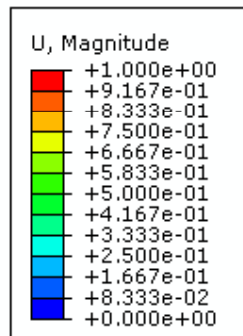
ODB: Job-1.odb Abaqus/Standard Version 6.8-1 Mon Dec 08 20:16:05 Eastern Standard Time 2008



Step: Step-1
Increment 23: Arc Length = 1.496
Primary Var: LE, Max. In-Plane Principal
Deformed Var: U Deformation Scale Factor: +1.000e+00

Buckling Modes

- Mode 1



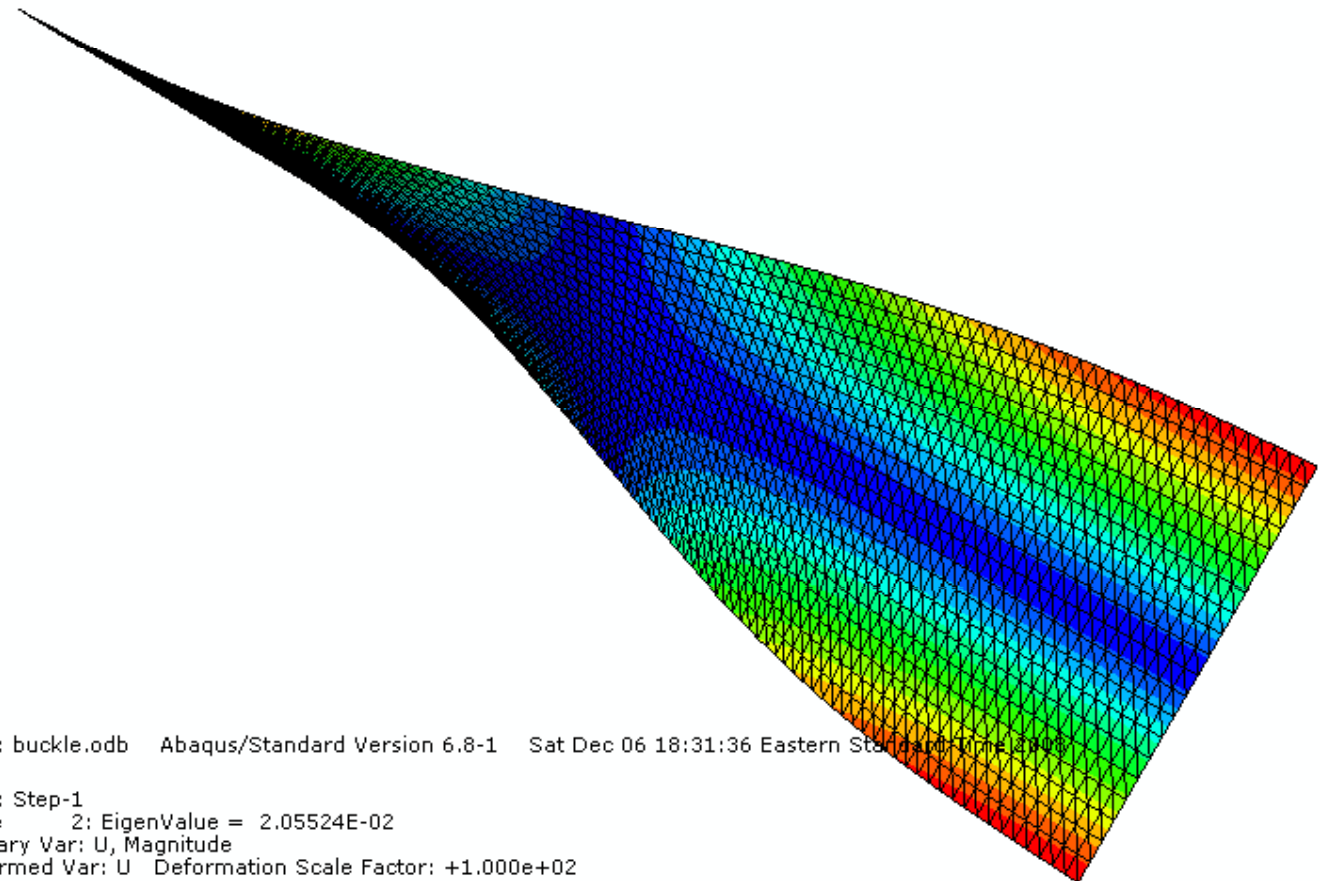
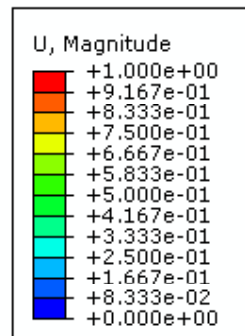
ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time 2008



Step: Step-1
Mode 1: EigenValue = 1.90347E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02

Buckling Modes

- Mode 2



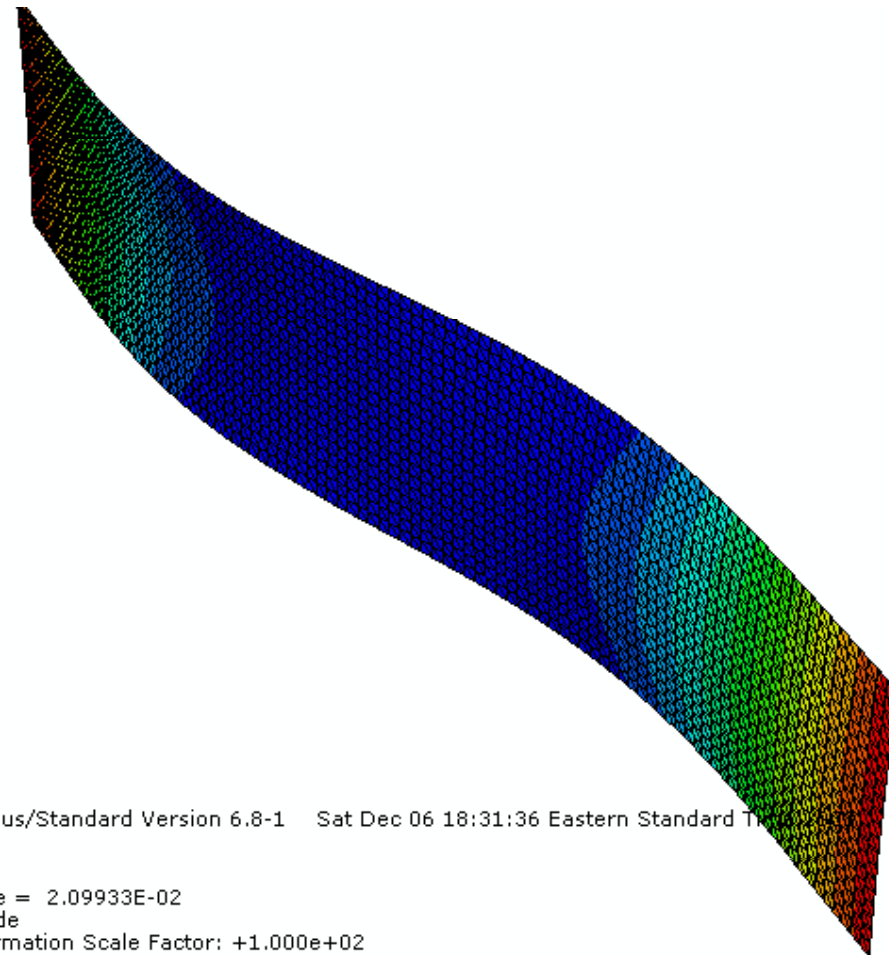
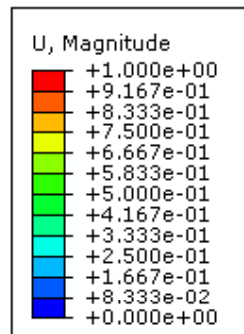
ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time 2008



Step: Step-1
Mode 2: EigenValue = 2.05524E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02

Buckling Modes

- Mode 3



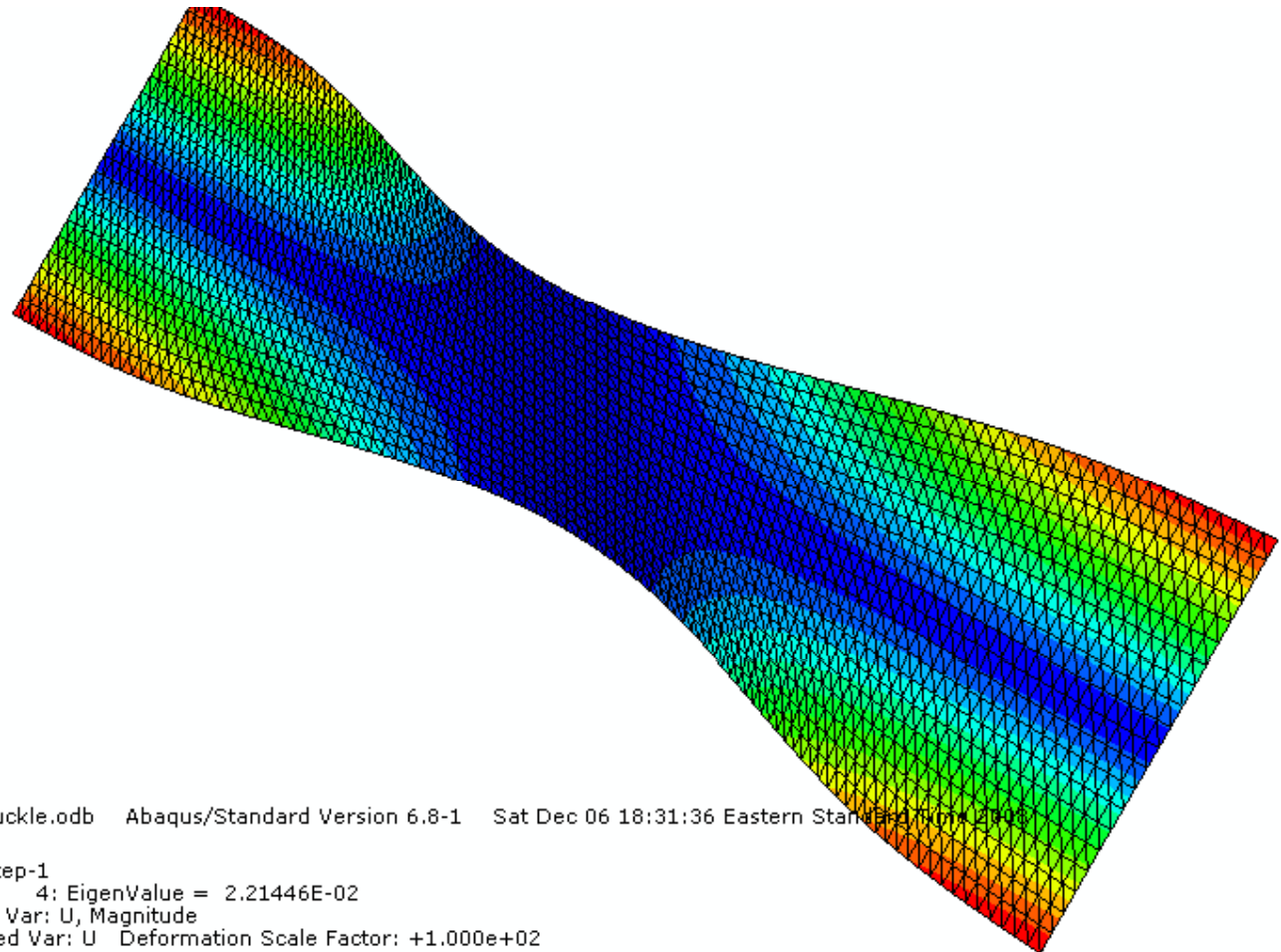
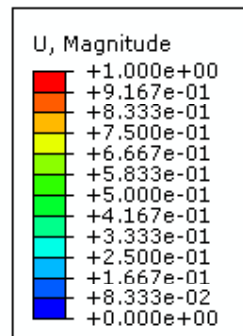
ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time 2008



Step: Step-1
Mode 3: EigenValue = 2.09933E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02

Buckling Modes

- Mode 4



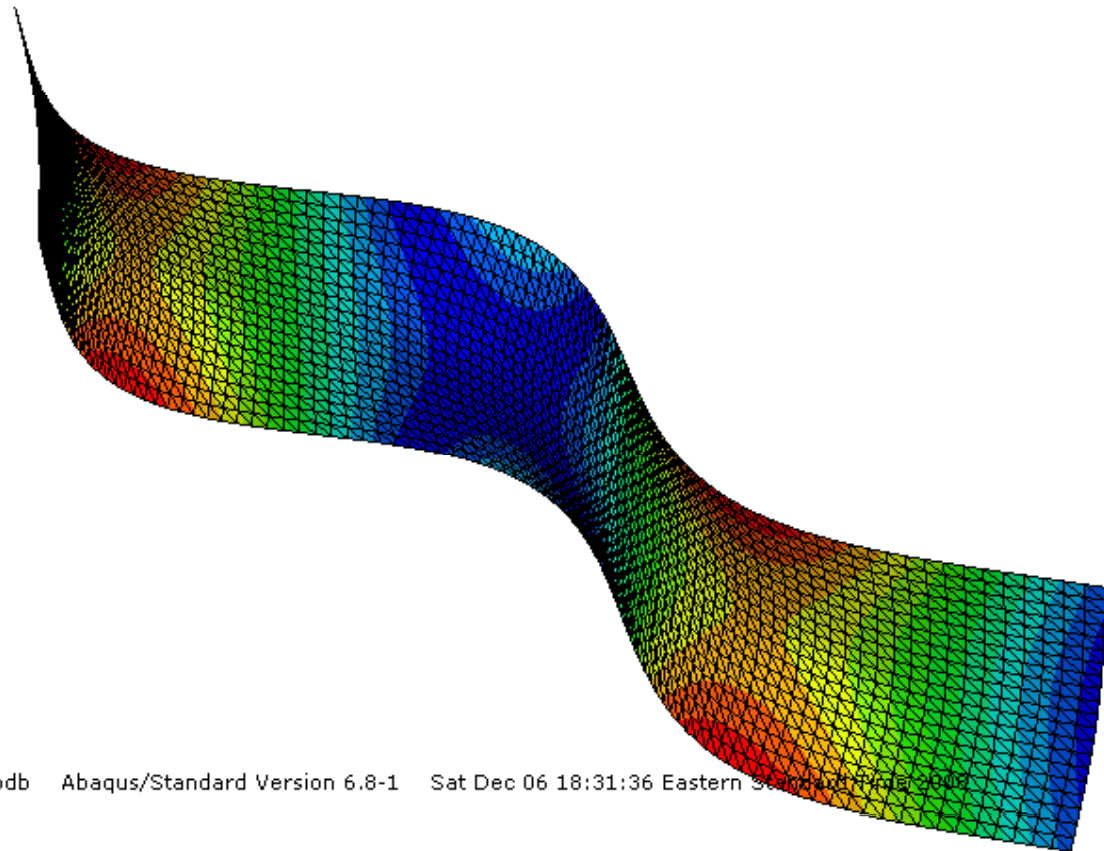
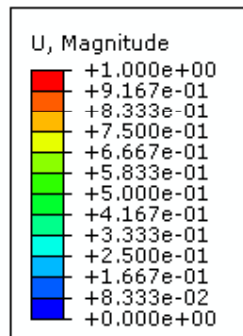
ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time 2008



Step: Step-1
Mode 4: EigenValue = 2.21446E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02

Buckling Modes

- Mode 5



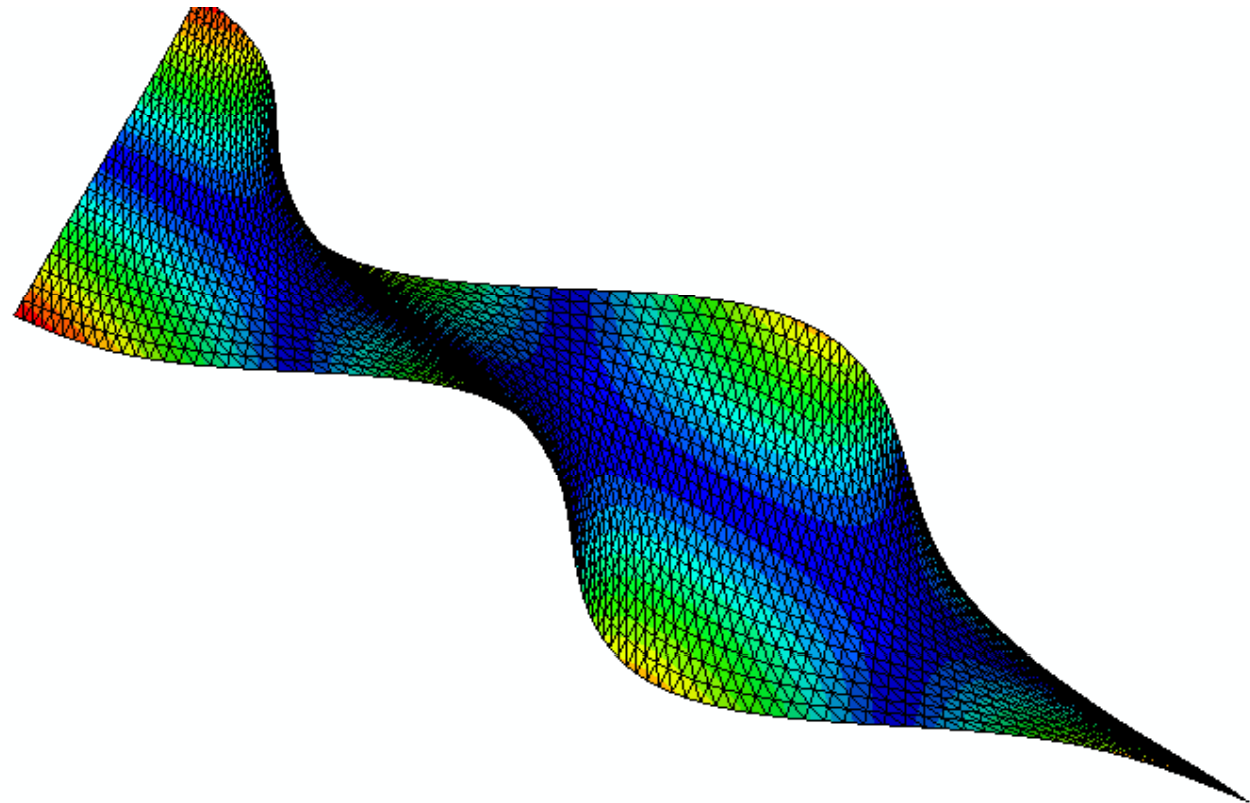
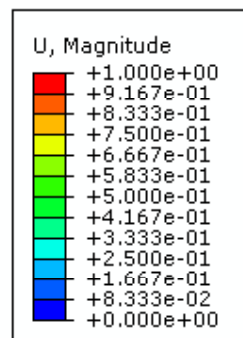
ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time 2008



Step: Step-1
Mode 5: EigenValue = 2.39418E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02

Buckling Modes

- Mode 6



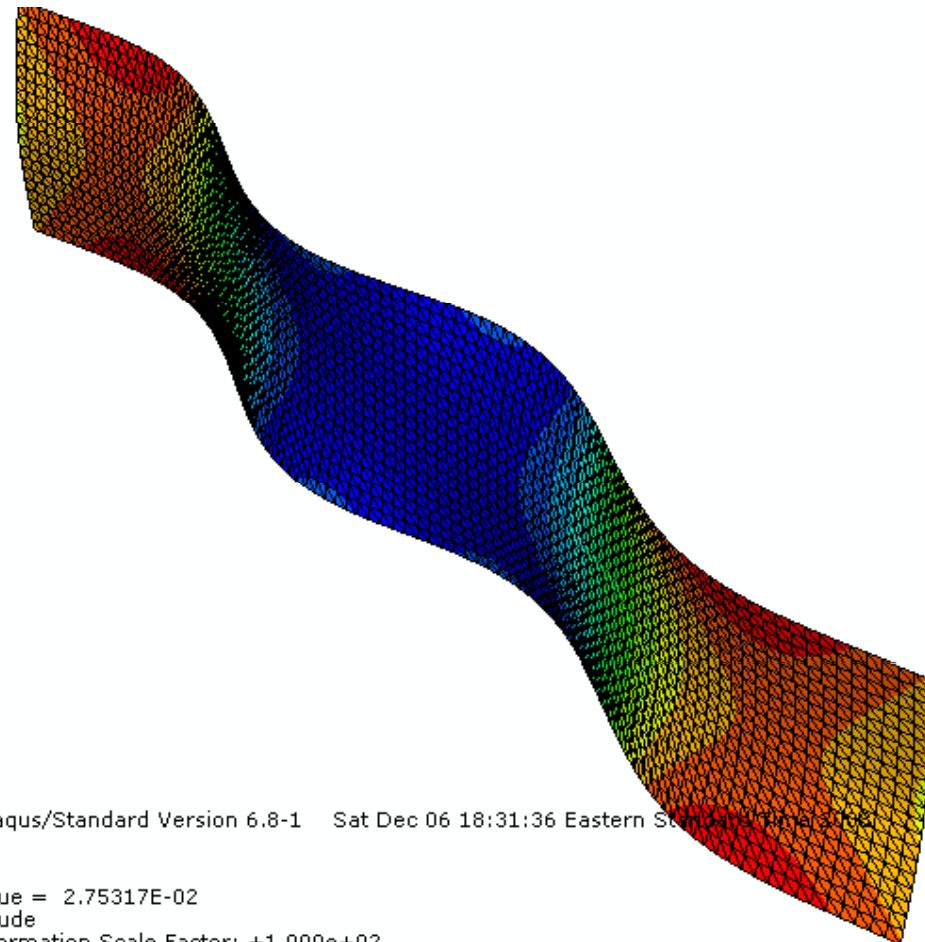
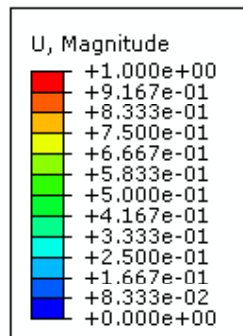
ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time 2008



Step: Step-1
Mode 6: EigenValue = 2.46915E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02

Buckling Modes

- Mode 7



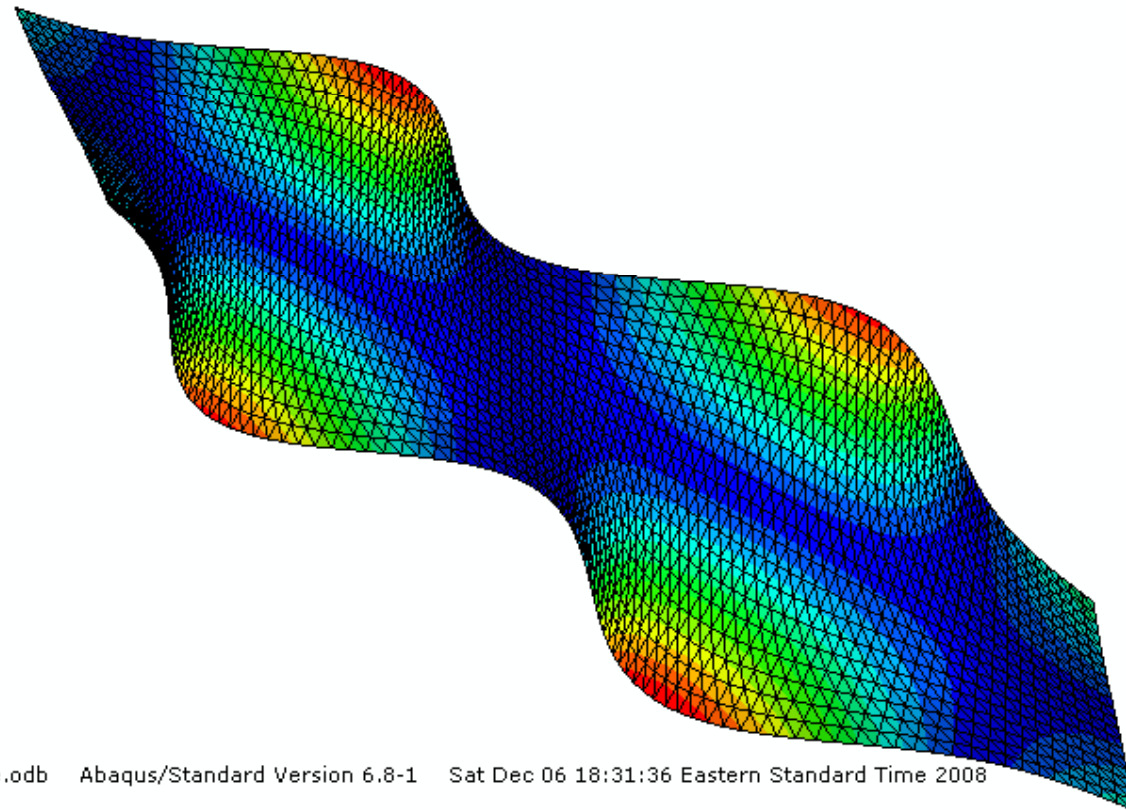
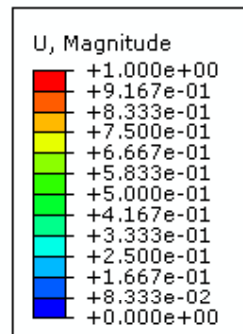
ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time 2008



Step: Step-1
Mode 7: EigenValue = 2.75317E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02

Buckling Modes

- Mode 8



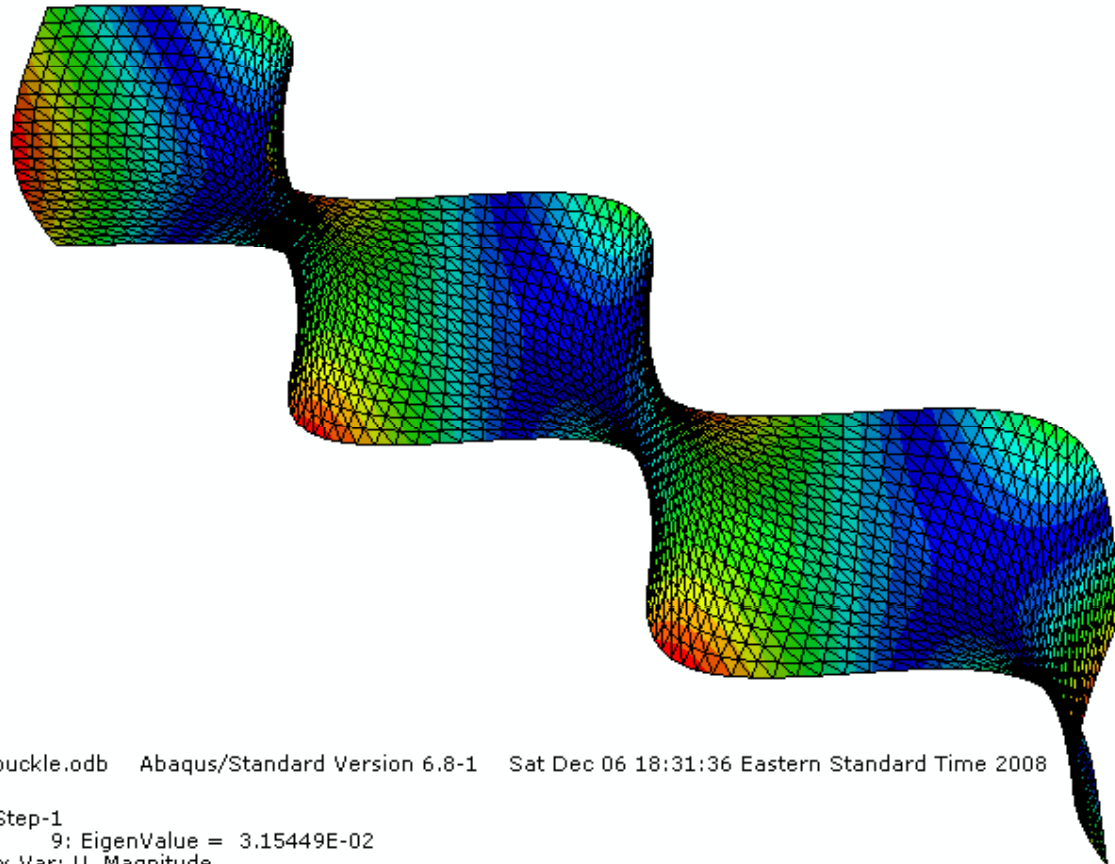
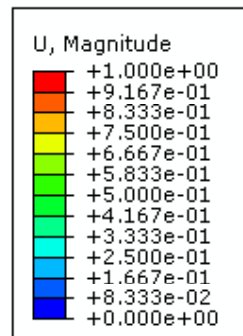
ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time 2008



Step: Step-1
Mode 8: EigenValue = 2.79760E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02

Buckling Modes

- Mode 9



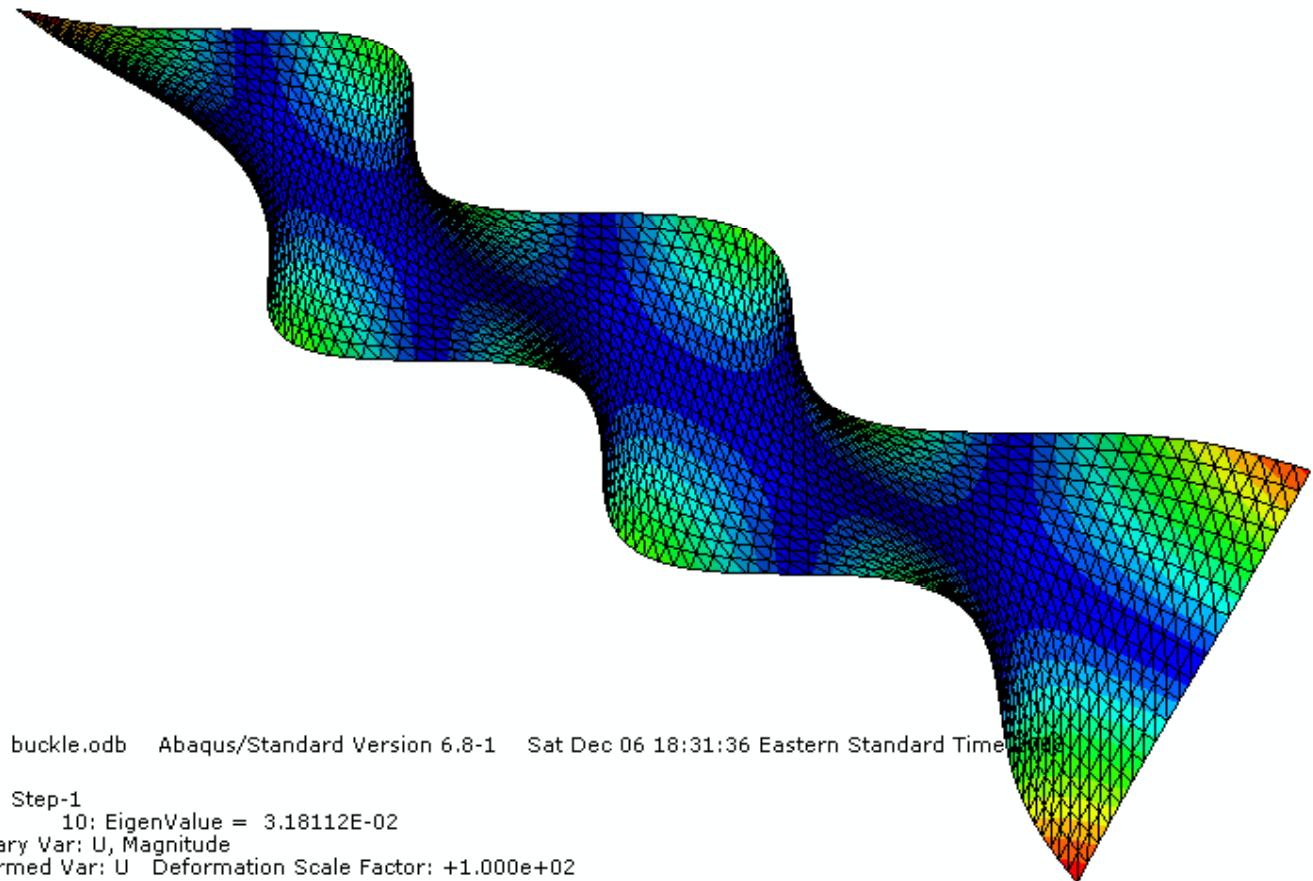
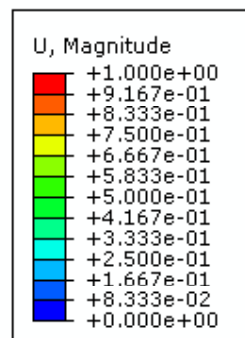
ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time 2008



Step: Step-1
Mode 9: EigenValue = 3.15449E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02

Buckling Modes

- Mode 10



ODB: buckle.odb Abaqus/Standard Version 6.8-1 Sat Dec 06 18:31:36 Eastern Standard Time



Step: Step-1
Mode 10: EigenValue = 3.18112E-02
Primary Var: U, Magnitude
Deformed Var: U Deformation Scale Factor: +1.000e+02



Post Buckling Analysis

- Eigenvalues closely spaced
Sensitive to perturbation
- Static Riks Method
- Perturbation
 1. linearly add up the displacements of different modes using different weights
 2. Gaussian distribution
- Vary α β

Post Buckling Analysis

- Arch

$$\beta = 10, \quad \alpha = 0.01$$

$$\beta = 10, \quad \alpha = 0.02$$

$$\beta = 10, \quad \alpha = 0.05$$

$$\beta = 2, \quad \alpha = 0.05$$

$$\beta = 10, \quad \alpha = 0.08$$

$$\beta = 10, \quad \alpha = 0.10$$



Post Buckling Analysis

- Edge buckling
need further attempt
- Phase diagram
How does the length, width, and thickness affect buckling?



 **THANK YOU!**

