Education Examples for Constitutive Material Behavior

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1 Chapter Summary and Highlights

2 Elastic Solid Constitutive Examples

2.1 Linear Elastic Constitutive Examples

Pure Shear, Monotonic Loading

Material Parameters:

```
model name "test";

add material # 1 type linear_elastic_isotropic_3d
   mass_density = 2E3 * kg/m^3
   elastic_modulus = 2E7 * Pa
   poisson_ratio= 0.25 ;

simulate constitutive testing strain control pure shear use material # 1
   confinement_strain = 0.001
   strain_increment_size = 0.0001
   maximum_strain = 0.01
   number_of_increment = 100;

bye;
```

Material Response:

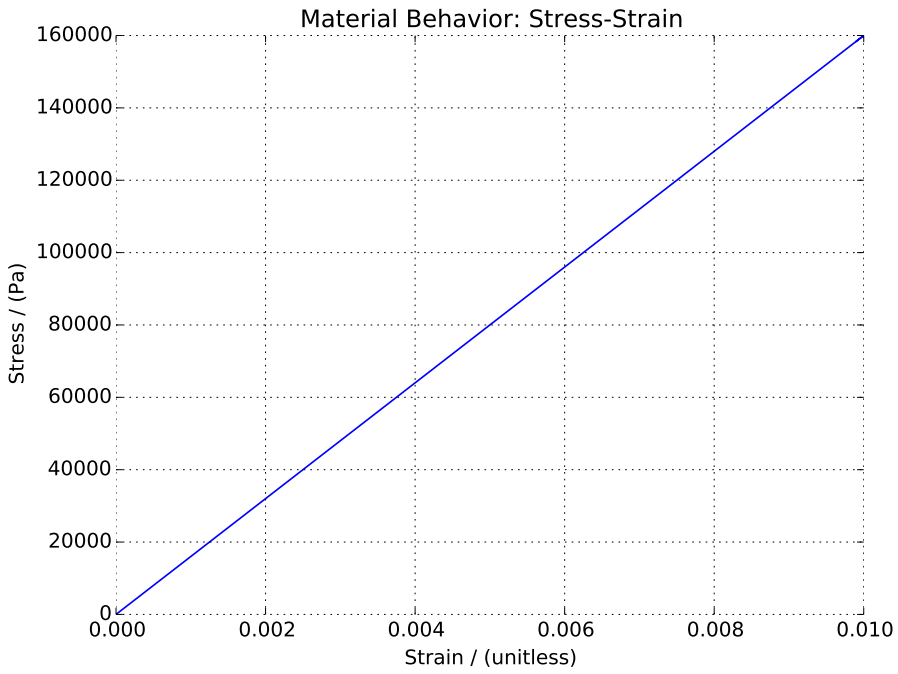

Figure 1: Linear Elastic Pure Shear Monotomic Loading

Pure Shear, Cyclic Loading

Material Parameters:

```
model name "test";

add material # 1 type linear_elastic_isotropic_3d
   mass_density = 2E3 * kg/m^3
   elastic_modulus = 2E7 * Pa
   poisson_ratio= 0.25 ;

simulate constitutive testing strain control pure shear use material # 1
   confinement_strain = 0.001
   strain_increment_size = 0.0001
   maximum_strain = 0.01
   number_of_increment = 500;

bye;
```

Material Response:

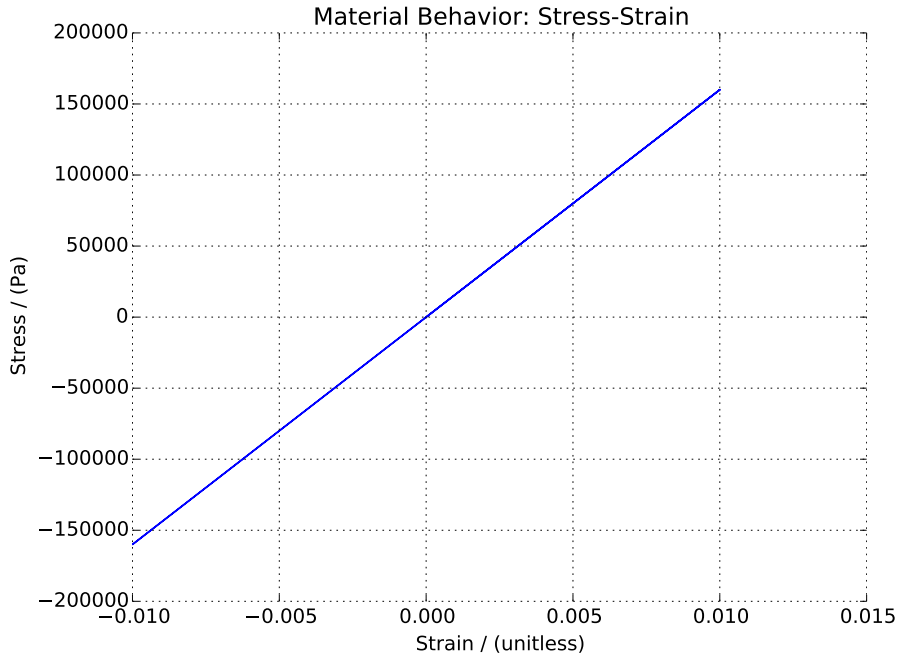

Figure 2: Linear Elastic Pure Shear Cyclic Loading

Uniaxial Strain, Monotonic Loading

Material Parameters:

```
model name "test";

add material # 1 type linear_elastic_isotropic_3d
   mass_density = 2E3 * kg/m^3
   elastic_modulus = 2E7 * Pa
   poisson_ratio= 0.0 ;

simulate constitutive testing strain control uniaxial loading use material # 1
   confinement_strain = 0.001
   strain_increment_size = 0.0001
   maximum_strain = 0.01
   number_of_increment = 100;

bye;
```

Material Response:

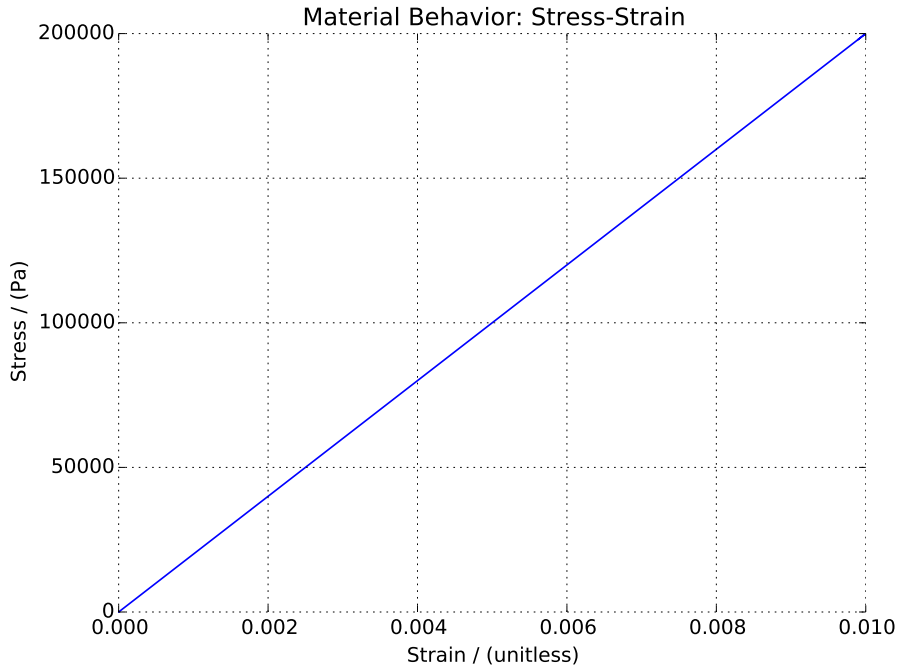

Figure 3: Linear Elastic Pure Shear Cyclic Loading

Uniaxial Strain, Cyclic Loading

Material Parameters:

```
model name "test";

add material # 1 type linear_elastic_isotropic_3d
   mass_density = 2E3 * kg/m^3
   elastic_modulus = 2E7 * Pa
   poisson_ratio= 0.25 ;

simulate constitutive testing strain control pure shear use material # 1
   confinement_strain = 0.001
   strain_increment_size = 0.0001
   maximum_strain = 0.01
   number_of_increment = 500;

bye;
```

Material Response:

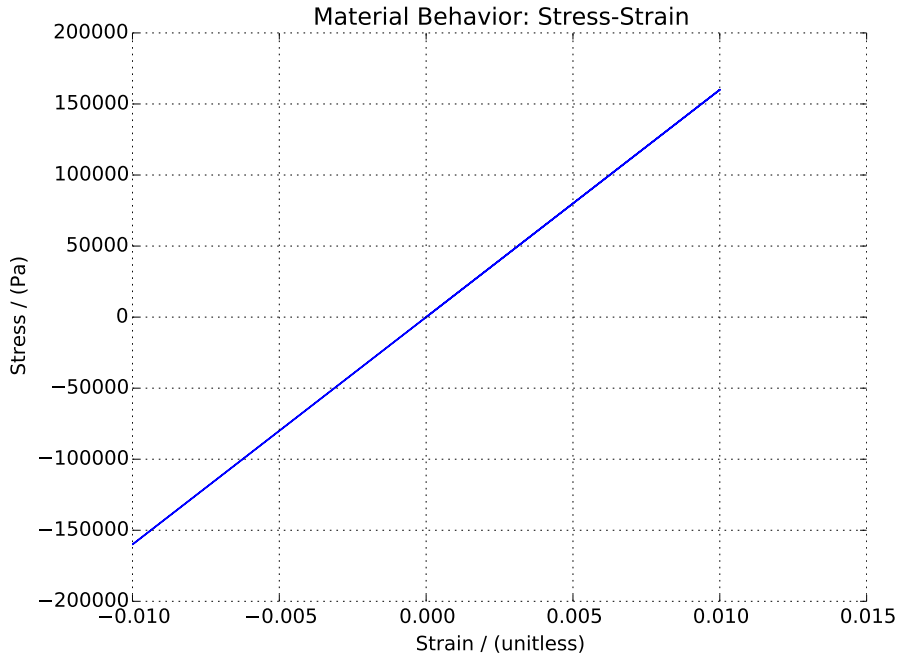

Figure 4: Linear Elastic Pure Shear Cyclic Loading

2.2 Nonlinear Elastic Constitutive Examples

Pure Shear, Monotonic Loading

Pure Shear, Cyclic Loading

Uniaxial Strain, Monotonic Loading

Uniaxial Strain, Cyclic Loading

3 Elastic Plastic Solid Constitutive Examples

3.1 Elastic Perfectly Plastic Constitutive Examples

Pure Shear

Material Parameters:

```
model name "test";
add material # 1 type VonMises
   mass_density = 2E3*kg/m^3
   elastic_modulus = 2E7 * Pa
   poisson_ratio=0.25
   von_mises_radius = 1E5*Pa
   kinematic_hardening_rate = 0.0 *Pa
   isotropic_hardening_rate = 0.0*Pa ;
define NDMaterial constitutive integration algorithm Backward_Euler
   yield_function_relative_tolerance = 1E-2
   stress_relative_tolerance = 1E-3
   maximum_iterations = 30;
simulate constitutive testing strain control uniaxial loading use material # 1
   confinement_strain = 0.001
   strain_increment_size = 0.0001
   maximum_strain = 0.01
   number_of_increment = 500;
bye;
```

Material Response:

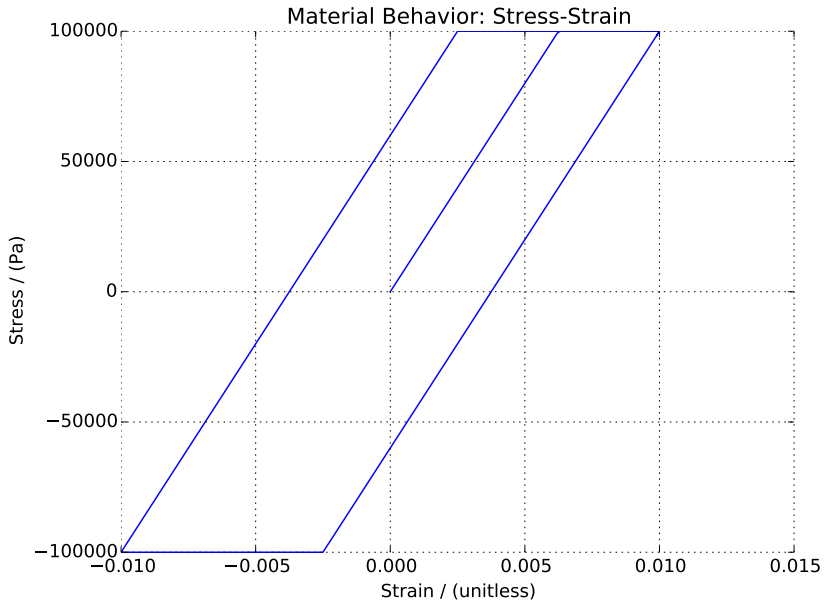

Figure 5: Linear Elastic Pure Shear Cyclic Loading

Uniaxial Strain

Material Parameters:

```
model name "test";
add material # 1 type VonMises
   mass_density = 2E3*kg/m^3
   elastic_modulus = 2E7 * Pa
   poisson_ratio=0.25
   von_mises_radius = 1E5*Pa
   kinematic_hardening_rate = 0.0 *Pa
   isotropic_hardening_rate = 0.0*Pa ;
define NDMaterial constitutive integration algorithm Backward_Euler
   yield_function_relative_tolerance = 1E-2
   stress_relative_tolerance = 1E-3
   maximum_iterations = 30;
simulate constitutive testing strain control uniaxial loading use material # 1
   confinement_strain = 0.001
   strain_increment_size = 0.0001
   maximum_strain = 0.01
   number_of_increment = 500;
bye;
```

Material Response:

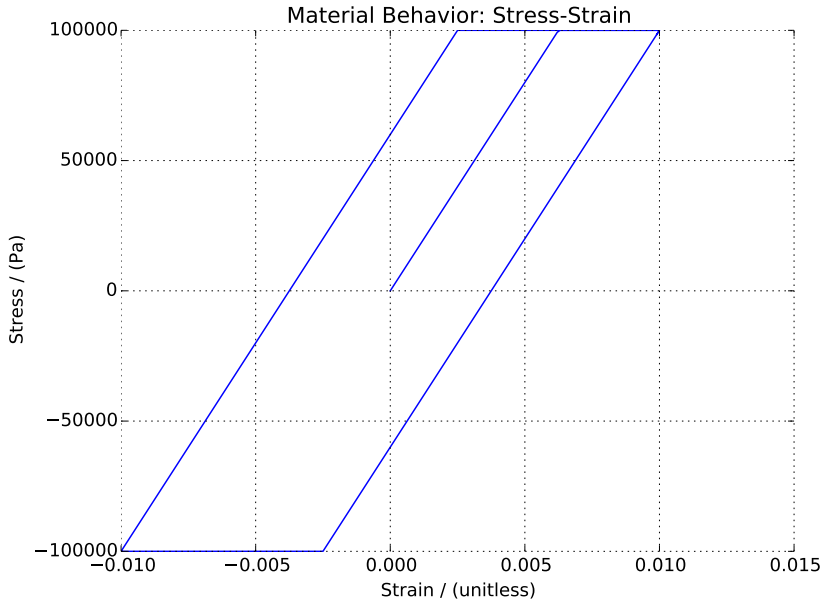

Figure 6: Linear Elastic Pure Shear Cyclic Loading

3.2 Elastic Plastic, Isotropic Hardening, Constitutive Examples

Pure Shear, Monotonic Loading

Pure Shear, Cyclic Loading