Trellis material library
Ottmar Klaas

Nonlinear Elasticity

Neo Hooke II

The Neo Hooke material law is fully nonlinear in the displacements and the strains. It can therefore be used for large displacement/large strain calculations.

The free energy function we consider is given as

$$W = \qquad \text{(EQ 1)}$$

with the right Cauchy Green strain tensors $\boldsymbol{C}$, and the material constants κ (bulk modulus) and μ (shear modulus). J represents the determinant of the deformation gradient $J = |\boldsymbol{F}| = |1 + \nabla \boldsymbol{u}|$. The Kirchhoff stress τ tensor can now be derived as

$$\tau = (\kappa J(J-1) - \mu)\boldsymbol{1} + \mu \boldsymbol{b} \qquad \text{(EQ 2)}$$

where $\boldsymbol{1}$ is the second order unit tensor. The elasticity tensor is given as

$$\mathbb{C} = (2\kappa J^2 - \kappa J)\boldsymbol{1} \otimes \boldsymbol{1} - 2(\kappa J(J-1) - \mu)\mathbb{I} \qquad \text{(EQ 3)}$$

with the fourth order unity tensor $[\mathbb{I}]^{ijkl} = [\delta]^{ik}[\delta]^{jl}$.

To choose this material for the calculation within the SCOREC analysis framework the imageClass of the group “deformable material” has to be set to “Neo Hooke material II”.

Example:

```
AttCase *case1 = mngr.newCase(“uniaxial tension”,”problem specification”);
ModelAssociation *ModelAss = c1->newModelAssoc();
{
   AttGroup *d = mngr.newGroup(“”,”deformable material”);
   d->imageClass(“Neo Hooke  materia II”);
   AttInfoDouble *kappa = mngr.newDouble(“kappa”,”kappa”);
   AttInfoDouble *mu = mngr.newDouble(“mu”,”mu”);
   *kappa = 7999.47;
```

```
  *mu = 0.8;
  d->add(kappa);
  d->add(mu);

  ModelAss->add(d);
  case1->add(d);
 }
```

Literature

[1] U. Brink, E. Stein [1996]: On some mixed finite element methods for incompressible and nearly incompressible finite elasticity. Comp. Mech. 19, 105 - 119.