

#1334: OptiStruct – Plasticity Results

Product: OptiStruct

Product Version: OptiStruct 2017.0 or above

Topic Objective

Plasticity results in OptiStruct.

Topic Detail

Element strain results are computed as follows:

- Total strain computed from displacement gradients at the integration points and averaged over the element volume.
- Total strain (small-strain plasticity) is the sum of elastic and plastic strain components.

$$\varepsilon_{ij} = \varepsilon_{ij}^{pl} + \varepsilon_{ij}^{el}$$

where:

- ε_{ij} is the total strain,
- ε_{ij}^{el} is the elastic strain,
- ε_{ij}^{pl} is the plastic strain, and
- $0 < i \text{ and } j \leq 3$

Total strain for large-strain plasticity is calculated through the following:

$$\mathbf{E}_{log} \stackrel{\text{def}}{=} \ln \mathbf{U} = \sum_{i=1}^3 \ln \lambda_i \mathbf{N}_i \otimes \mathbf{N}_i$$

Where: \mathbf{N}_i are the eigenvectors of $\mathbf{C} = \mathbf{F}^T \mathbf{F}$, and λ_i^2 , its eigenvalues
 $\mathbf{F} := \delta \mathbf{x} / \delta \mathbf{X}$ – deformation gradient
 $\mathbf{F} = \mathbf{R} \mathbf{U}$ – polar decomposition of \mathbf{F}

Equivalent plastic strain is the trajectory length in the plastic strain space (mod sqrt(2/3))

- Equivalent plastic strain is the scalar measure of the accumulated plastic strain. For loading with reversals, equivalent plastic strain will continue to increase if the plastic strain rate is non-zero.
- Calculated at the integration points first, and then averaged over the element volume.

$$\varepsilon_{ps} = \sqrt{\frac{2}{3}} \int_0^t \sqrt{\dot{\varepsilon}_{ij}^{pl} \dot{\varepsilon}_{ij}^{pl}} dt$$

where ε_{ij}^{pl} is the plastic strain deviator and $\dot{\varepsilon}_{ij}^{pl}$ is its rate.

Equivalent plastic stress is the stress intensity according to the yield criterion

- OS currently supports von Mises yield criterion
- For von Mises, the equivalent plastic stress is the same as regular von Mises stress
- This value is used to compare against the initial yield stress to determine occurrence of plastic flow

Plastic strain options are available for viewing tensor information

- Component values/directions are available as an OptiStruct output
- Specified in the control cards through STRAIN (PLASTIC)=YES