Default Stress Orientation and Fault Geometry conventions in SeisSol 3D (friction.f90)

From SeisSol 3D revision number 806 (Dec 4 2012) the following definitions regarding fault and stress orientation are convention. Matlab scripts ‘stressrotation2D’ and ‘stressrotation3D’ are available for a correct rotation of initial stress values on arbitrary orientated faults. **Attention: Be aware that the 2D Version of SeisSol requires exactly opposed sign conventions.**

Definitions

- **Traction** = normal vector n * stress tensor sxyz
- **Normal stress** = **negative** in compression
- **Cohesion** = negative, must be manually added to stress drop output
  (acts on shear stress components, encapsulates the effect of pore pressurization)
- **Reference point** = defines dip direction, starting point of the normal vector n pointing towards the fault, at **+y**

Fault geometry

- Right-handed coordinate system required
  Please, make sure to follow this convention during model/mesh generation!

z ↑ ↑ ↑ **-z**	**y** ↗ ↗ →→→ **x**	=	**free-surface** ↑ ↑ ↑ **depth** — **North** ↗ ↗ →→→ **East**

- Arbitrary fault orientation possible, **except** a fault in the xy-plane, i.e. parallel to the free surface

- Output in fault coordinate system
  n = normal vector, from + y → - y
  s = along-strike vector
  d = along-dip vector, pointing in -z direction (downwards)

$$\underline{n} = \begin{pmatrix} nx \\ ny \\ nz \end{pmatrix} \qquad \underline{s} = \begin{pmatrix} ny \\ -nx \\ 0 \end{pmatrix} * \mathrm{sqrt}\,(nx^2 + ny^2) \qquad \underline{d} = \begin{pmatrix} -sy*nz \\ sx*nz \\ sy*nx - ny*sx \end{pmatrix} / \| \underline{d} \|$$

Examples

Attention: SCEC defines normal stress as positive in compression, opposite to SeisSol 3D convention.

- **SCEC TPV14 und TPV15 (branching fault geometry)**

  <u>3D, right-lateral main fault in xz-plane (TPV14)</u>
  normal stress syy = -120 MPa
  shear stress sxy = +70 MPa
  nucleation patch shear stress = +81.6 MPa

  <u>branch in -y direction (transformation by Theta= 330 degree)</u>
  normal stress sxx = + 30.62.. MPa
  normal stress syy = - 150.62.. MPa
  shear stress sxy = - 16.96.. MPa

  <u>3D, left-lateral main fault in xz-plane (TPV15)</u>
  normal stress syy = - 120 MPa
  normal stress sxy = - 78 MPa
  nucleation patch shear stress = - 81.6 MPa

  <u>branch in -y direction (transformation by Theta= 330 degree)</u>
  normal stress sxx = - 97.55.. MPa
  normal stress syy = - 22.45.. MPa
  shear stress sxy = - 90.96.. MPa

- **SCEC TPV10 (dipping fault geometry)**

  <u>3D, normal fault in xz-plane dipping 60 degree in -y-direction</u>
  Depth |-z| dependent initial stresses (syy= - 7378 Pa and syz = 4058 Pa at z=-1 m), rotation by theta=-30 degree

  normal stress syy = - 2019.26.. Pa * | -z |
  normal stress szz = - 5358.74.. Pa * | -z |
  shear stress syz = + 5223.72.. Pa * | -z |
  cohesion = - 0.2 MPa

Nucleation patch: add rotated cohesion of -0.2 MPa to increased initial stress values
shear stress=cohesion+(static friction cofficient + 0.0057)* initial normal stress

normal stress syy	= - 641.03.. Pa * | -z |
normal stress szz	= - 6736.97.. Pa * | -z |
shear stress syz	= + 6019.43.. Pa * | -z |

cohesion cyy	= - 173205 Pa
cohesion czz	= +173205 Pa
cohesion cyz	= - 100000 Pa