

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

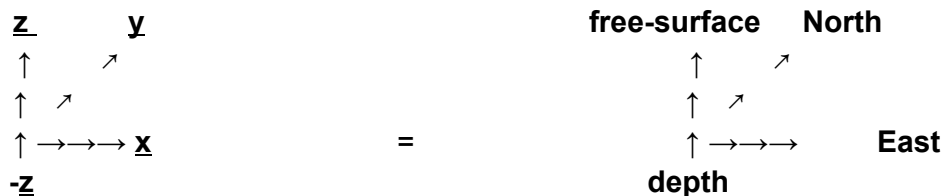
From SeisSol 3D revision number 806 (Dec 4 2012) the following definitions regarding fault and stress orientation are convention. Matlab scripts 'stressrotation2D' and 'stressrotation3D' are available for a correct rotation of initial stress values on arbitrary orientated faults. **Attention: Be aware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

## Definitions

- **Traction** = normal vector  $\underline{n}$  \* stress tensor  $s_{xyz}$
- **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  $\underline{n}$  pointing towards the fault, at **+y**

## Fault geometry

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



- Arbitrary fault orientation possible, **except** a fault in the xy-plane, i.e. parallel to the free surface
- Output in fault coordinate system  
 $\underline{n}$  = normal vector, from + y  $\rightarrow$  - y  
 $\underline{s}$  = along-strike vector  
 $\underline{d}$  = along-dip vector, pointing in -z direction (downwards)

$$\underline{n} = \begin{pmatrix} n_x \\ n_y \\ n_z \end{pmatrix} \quad \underline{s} = \begin{pmatrix} n_y \\ -n_x \\ 0 \end{pmatrix} * \text{sqrt} ( n_x^2 + n_y^2 ) \quad \underline{d} = \begin{pmatrix} -s_y * n_z \\ s_x * n_z \\ s_y * n_x - n_y * s_x \end{pmatrix} / || \underline{d} ||$$

## Examples

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

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

3D, right-lateral main fault in xz-plane (TPV14)

normal stress $s_{yy}$	= -120 MPa
shear stress $s_{xy}$	= +70 MPa
nucleation patch shear stress	= +81.6 MPa

branch in -y direction (transformation by Theta= 330 degree )

normal stress $s_{xx}$	= + 30.62.. MPa
normal stress $s_{yy}$	= - 150.62.. MPa
shear stress $s_{xy}$	= - 16.96.. MPa

3D, left-lateral main fault in xz-plane (TPV15)

normal stress $s_{yy}$	= - 120 MPa
normal stress $s_{xy}$	= - 78 MPa
nucleation patch shear stress	= - 81.6 MPa

branch in -y direction (transformation by Theta= 330 degree )

normal stress $s_{xx}$	= - 97.55.. MPa
normal stress $s_{yy}$	= - 22.45.. MPa
shear stress $s_{xy}$	= - 90.96.. MPa

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

3D, normal fault in xz-plane dipping 60 degree in -y-direction

Depth  $|z|$  dependent initial stresses ( $s_{yy}$ = - 7378 Pa and  $s_{yz}$  = 4058 Pa at  $z=-1$  m),  
rotation by  $\theta=-30$  degree

normal stress $s_{yy}$	= - 2019.26.. Pa * $ z $
normal stress $s_{zz}$	= - 5358.74.. Pa * $ z $
shear stress $s_{yz}$	= + 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 coefficient + 0.0057)\* initial normal stress

normal stress $s_{yy}$	= - 641.03.. Pa *   -z
normal stress $s_{zz}$	= - 6736.97.. Pa *   -z
shear stress $s_{yz}$	= + 6019.43.. Pa *   -z

cohesion $c_{yy}$	= - 173205 Pa
cohesion $c_{zz}$	= +173205 Pa
cohesion $c_{yz}$	= - 100000 Pa