Constitutive models for materials

Teams of the IFSTTAR research institute, former LCPC, developed and validated numerous constitutive models for various materials used in Civil Engineering. In order to encompass these research works, a numerical toolbox of constitutive models has been designed and integrated in the software CESAR-LCPC, proposing elastic laws, plasticity and hardening criteria. Thus adapted to the project context and geomaterials types, they show value added to geotechnical engineers for a better analysis of earthworks behaviour.

A rich integrated database

**Elasticity**
- Homogeneous isotropic linear elasticity
- Homogeneous orthotropic linear elasticity
- Isotropic linear elasticity with E and ν varying linearly with depth
- Isotropic linear elasticity with E = f(z)
- Non-linear elasticity of the Hardening Soil Model
- Non-linear elasticity of Cam-Clay
- Non-linear elasticity of Duncan
- Non-linear elasticity of Fahey-Carter

**Plasticity criteria for soils & rocks**
- Mohr-Coulomb
- Mohr-Coulomb criterion with c et φ varying linearly with depth (c = f(z) ; φ= f(z))
- Hardening Soil Model
- Cam-Clay (modified)
- Drucker-Prager
- Prévost–Høeg
- Hoek-Brown (1997)
- Tresca
- Oriented criterion
- HiSS (Shao & Desa)
- S-Clay 1
- Vermeer
- Nova
- Mélanie.

**Plasticity criteria for other materials**
- Von Mises
- Parabolic criterion
- Hill-Lourengo
- William Warnke
- Early-age concrete

**Synoptic of possible combinations**

- Elastic law
- Plasticity mechanism
- Plasticity criterion
- Plasticity potential
- Hardening law
- Drained-or-undrained behaviour
A toolbox for user-defined constitutive laws

Examples of dialog toolboxes in CESAR-LCPC (version 6) for input of parameters of the constitutive laws

Example #1: Association of anisotropic elasticity with a plasticity criterion

Sketch of the problem

Results as scalar plots of plastic strains on the deformed mesh.

Example #2: Use of the Hardening Soil Model for a non-supported excavation

Sketch of the problem

Comparison of vertical displacements computed at the surface of the earth behind excavation.