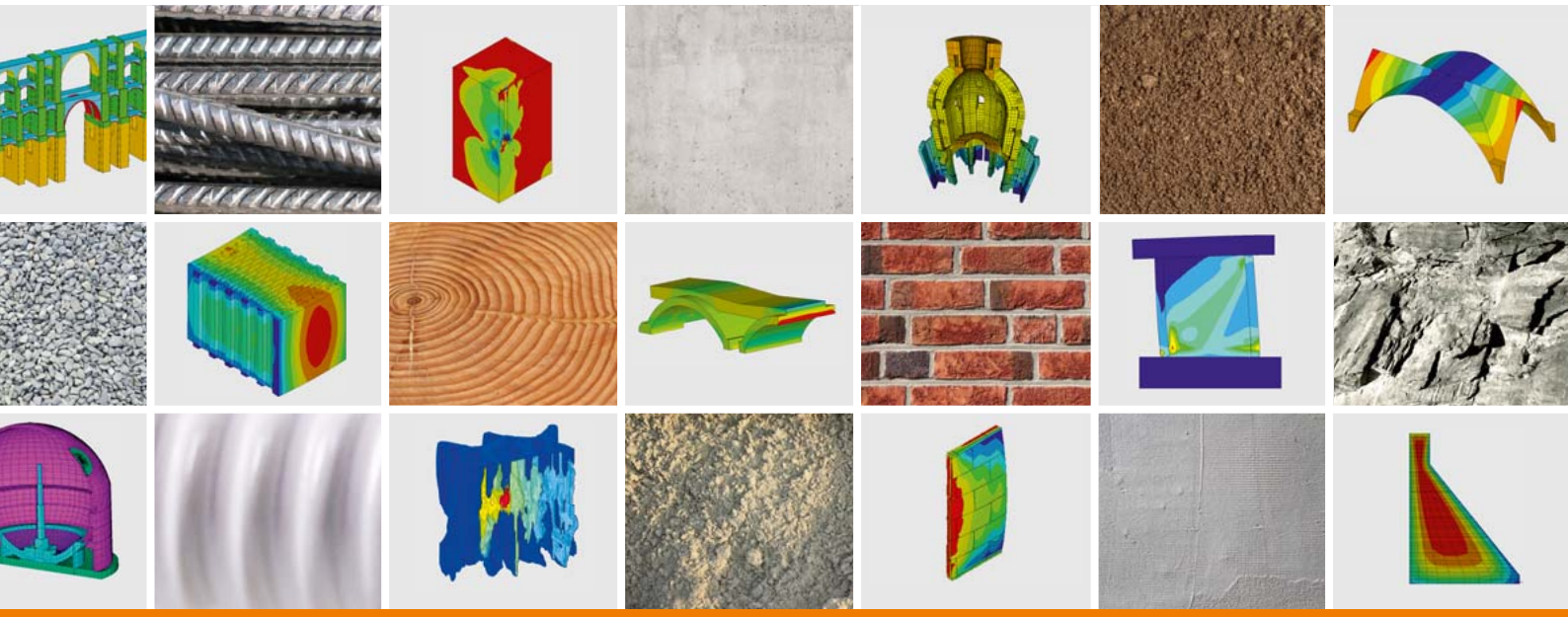
dynardo
dynamic software & engineering



# MULTIPLAS FOR ANSYS MECHANICAL

**Dynardo has developed a material model collection for ANSYS mechanical, called multiPlas, which has been frequently applied in consulting services. In civil engineering and geotechnical applications, multiPlas enables the modeling of complex behavior by using powerful material models.**

**Geomechanics and civil engineering address unique challenges to engineers. Dealing with heavy loads, enormous costs in the case of misconstruction as well as highly complex material behavior, there is just a small margin for errors. For example, the understanding of geomaterials and their interactions with artificial structures is a key requirement for companies working in industries like oil and gas, civil engineering or mining.**

## Concept

multiPlas material models allow analyzing the stability and serviceability of constructions in the fields of structural and civil engineering as well as for undersea applications. Further, the conduction of a load limit analysis can often explore additional load bearing capacities. multiPlas supports material modeling for e.g. concrete, reinforced concrete, UHPC, ceramics, masonry, rock, soil, timber, mortar or stone. The constitutive equations of the material models are based on isotropic and anisotropic elasto-plastic flow functions. The associated and non-associated flow rules can be optionally defined with hardening or softening criteria. The FE-programming is characterized by an efficient and high-performance algorithm using single and multi-surface plasticity and resulting in the best possible convergence. Internal adaptive algorithms ensure the consistent integration of multi-surface flow and failure conditions and guarantee convergence. A special feature of the material models is the easy combination of several flow conditions and failure modes along with hardening or softening criteria.

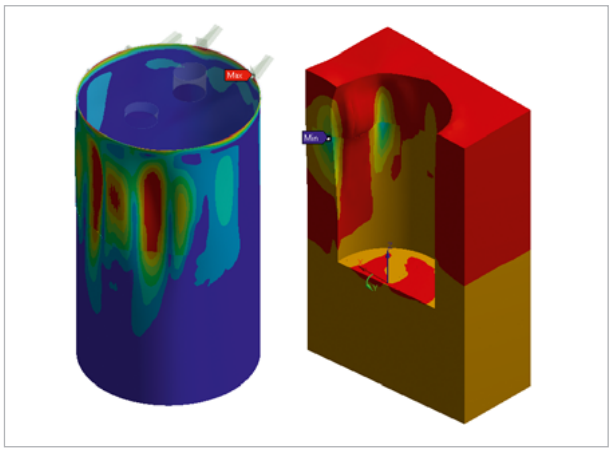


Fig. 1: Simulation plots of a suction pile (left) and soil (right)

## Application

The range of applications reaches from non-linear masonry over concrete calculations to limit load calculations of structures grounded in soil or rock.

**For example, the following challenges can be adressed:**

- Ground stability for anchor or suction piles in the sea bed is important for the oil and gas industry (see Fig. 1 front page)

- The construction and maintenance of underground structures in more and more challenging environments and dimensions, like waste disposals or tunnels, means a tough pressure for engineers to fulfill projects in time and quality (see Fig. 2).

Fig. 2: Nonlinear stability analysis of a sheet metal tunnel construction

- In simulations of construction foundations and in slope stability analysis, the behavior of surrounding materials has to be considered requiring a profound understanding of the complex behavior of rock formations and soils (see Fig. 3).

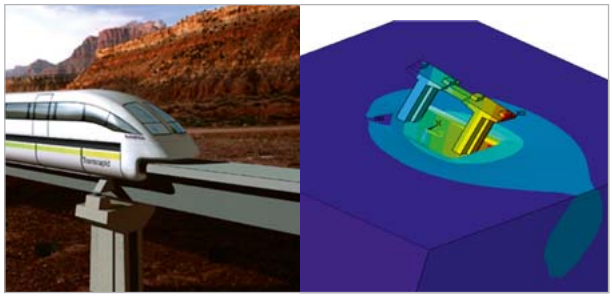


Fig. 3: Hydro-mechanical analysis of a Transrapid train loading on the foundation structure

- Analysis of the crack and load bearing capacity of fiber-reinforced concrete structures (see Fig. 4).

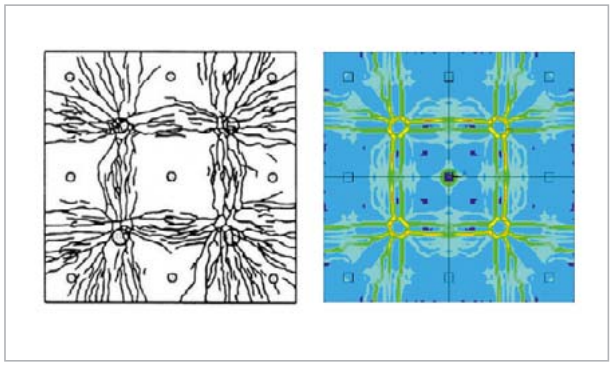


Fig. 4: Analysis plots | test (left), simulation (right)

Since ANSYS v17, multiPlas is owned by ANSYS Inc. The material models are available in the Geomechanical Toolbox of regular ANSYS Mechanical versions. Dynardo continues to develop and distribute the standalone version offering material models that are currently not available in ANSYS mechanical.

## Material models

- Jointed rock softening material model
- Combined Mohr-Coulomb-Rankine softening model for soils, e.g. sand
- Generalized Cam-Clay model for soils, e.g. sand, clay
- Modified Drucker-Prager model for concrete (plain, reinforced, prestressed, fibre reinforced), mortar, ceramics, lightweight concrete, aerated concrete, roller compacted concrete, UHPC, sand-lime brick
- Temperature dependent modified Drucker-Prager model (e.g. for fire loaded masonry, refractory materials)
- Time dependent modified Drucker-Prager model (ageing, hydration)
- Menétrey-William concrete model for concrete (plain, reinforced, prestressed, fibre reinforced) UHPC, mortar
- Combined Rankine and Drucker-Prager model for concrete
- Masonry model with multi-linear and non-linear softening (Ganz)
- Orthotropic boxed value model for timber
- Combined non-linear isotropic (Voce Model) and kinematic (Armstrong-Frederik) hardening model (e.g. for cyclic loading of Bauschinger-Effect)
- Support of user defined material models within the framework of multi-surface plasticity

**Based on the material models implemented in multiPlas, the following phenomena can be analyzed:**

- Isotropic / anisotropic elasto plasticity
- Associated / non associated plasticity, scattering of the dilation behavior
- Hardening and softening, nonlinear stress and strain behavior
- Residual strength, tearing
- Deterioration
- Temperature dependencies
- Time dependent material properties of concrete

Geomaterial properties often contain large uncertainties and, thus, need to be identified from available measurement data. By connecting multiPlas for ANSYS Mechanical to Dynardo's optiSLang, a sensitivity analysis can be conducted that detects the identifiable sensitive parameters. For more applications and detailed information about the calibration of material parameter refer to:

- www.dynardo.de/en/library/industries/civil-engineering
- www.dynardo.de/en/library/industries/geomechanics