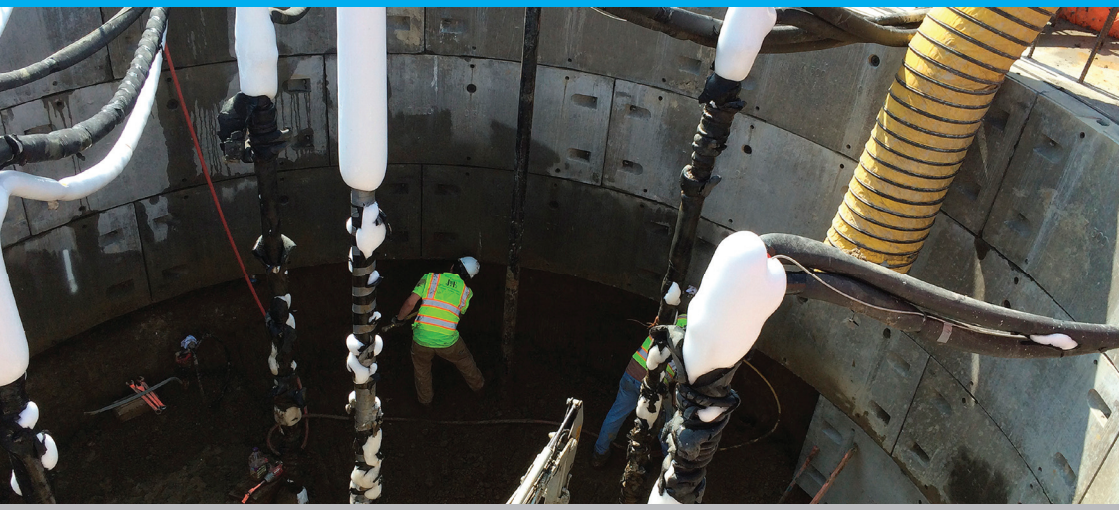
PLAXIS

essential for geotechnical professionals



THERMAL MODULE

The Thermal module is an extension to PLAXIS 2D. This module is necessary when the effects of heat flow on the hydraulic and the mechanical behaviour of soils and structures need to be taken into account in geotechnical designs. The implementation supports plane strain and axisymmetric conditions. The calculation can be performed in steady-state, transient, semi- and fully-coupled analysis.

The temperature gradient is one of the main causes for movement of heat and water in soils. Since groundwater flow plays an essential role in the transport of heat in the ground, thermal calculations are normally coupled with groundwater flow calculations, called the thermo-hydraulic coupling. In terms of thermo-mechanical coupling, the change of temperature influences the mechanical behaviour of soil, giving rise to thermal expansion.

The Thermal module offers the tools to analyse the thermal flow in soil and its implications on groundwater flow and the strains and stresses in the soil. This module broadens the range of geotechnical engineering applications in the tunnelling, mining, environmental, and energy sectors.

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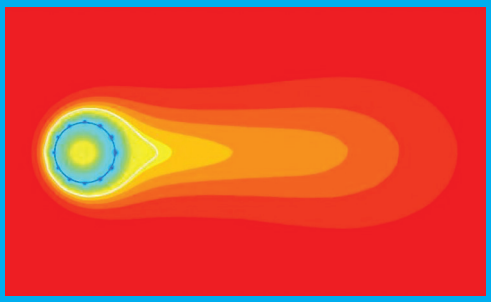

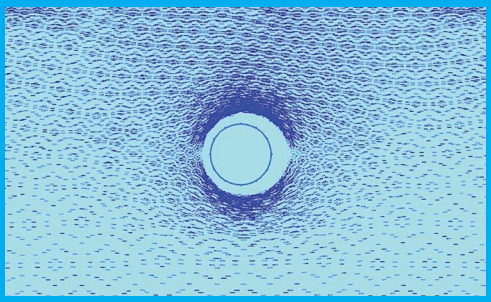

In many engineering projects, such as the design of pipelines, ground energy storage, roads or building in cold regions where heat transfer takes place in the soil, the effect of temperature on the behaviour of soil cannot be overlooked. In practice, thermal effects can be divided in high and low temperature effects, both can be caused by natural or man-made interaction with soil or fluids.

Thermo-hydraulic coupling
Artificial ground freezing is a process that can be used to temporarily stabilize a weak ground. As the temperature in the soil decreases due to freeze pipes, an ice wall is formed, making the soil watertight. Dry excavation can then be performed and permanent stability measures can be provided. The influence of the velocity of the groundwater on the formation of the ice wall can also be studied. The Thermal module facilitates the coupling between groundwater flow and thermal flow. In addition to groundwater flow boundary conditions, thermal flow boundary conditions can be assigned to the model, such as an imposed temperature, a heat flux, or a convective boundary condition. Besides cluster-defined temperature, energy conditions can also be applied to model a heat source or sink on a cluster.

Thermo-mechanical coupling
Coupling between thermal loading and mechanical process occurs when the temperature change in soils results in thermal stresses. One of the typical cases encountered in engineering applications is the deformation of a navigable lock due to sunlight absorption when it doesn't contain water. With the Thermal module, the effects of temperature changes due to weather conditions on stresses and deformations in the soils can be investigated by introducing climate boundary conditions into the model. Thermal boundary conditions can be either constant or time dependent following the linear, harmonic, or user-defined input value function.

Thermo-hydraulic-mechanical coupling
In PLAXIS, the results of semi-coupled steady-state thermo-hydraulic-mechanical calculations may be used to analyse the effects of temperature changes on pore pressures, stresses and deformations.

PLAXIS also allows for fully coupled transient thermo-hydro-mechanical problems in which the time dependent effect of temperature changes on stresses, deformations and groundwater flow are taken into account simultaneously. In order to maximize the full potential of the Thermal module in PLAXIS 2D it is essential to also have the 2D PlaxFlow module.

Applications
- Thermal expansion of struts
- Artificial ground freezing
- Frozen ground engineering
- Nuclear waste disposal
- Borehole heat exchangers in aquifer layers
- Pipeline or cable heat dissipation
- Temperature effects on structures

Request a free demo
To learn more about PLAXIS and to download a free demo version, visit **www.plaxis.com/demo**.

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