



**ITASCA™**

# Lake Livingston Hydropower Plant

CIVIL • ENVIRONMENTAL • MANUFACTURING • MINING • OIL & GAS • POWER GENERATION

## PROJECT DESCRIPTION

Stanley Consultant

Texas, USA



**FLAC3D™**



**FLAC®**

The project involves a cut-and-cover derivation tunnel that delivers water to the power house where the turbines are located. All the components of the plant (headrace, Intake, penstock, powerhouse, and tailrace) require earth retaining structures during construction. In general, this type of retaining system is realized with Sheet Pile Walls (SPW) with different types of support, such as anchors (for the headrace and tailrace), struts (for the penstock) and concrete rings (for the intake and powerhouse cofferdam).

Particularly challenging was the design of the powerhouse excavation which is approximately 60 m in diameter and 13 m deep, below the water table, and subject to artesian water pressure. Additional challenges included high horizontal stresses ( $k_0 > 2$  in the clay) and non-linear material strength envelopes.

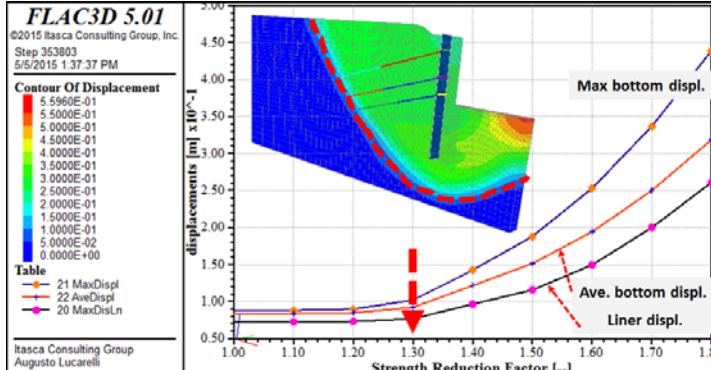
## ITASCA'S ROLE

Itasca a) programmed and interpreted in-situ geotechnical investigations; b) estimated and calibrated the constitutive model mechanical properties; and, c) evaluated the stability of the major power plant structures.

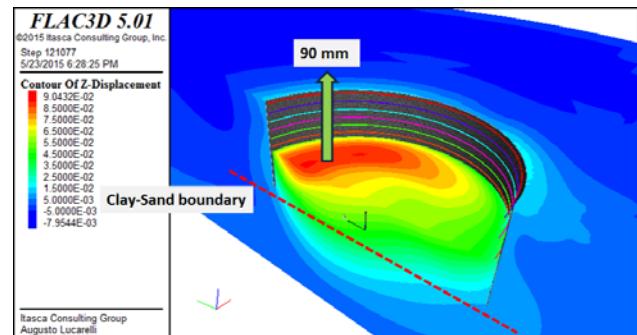
Triaxial strength tests had shown that Mohr-Coulomb strength envelopes were not appropriate to describe the soil strength behavior at the different confinement levels anticipated. Therefore, Itasca employed the advanced Plastic Hardening (PH) constitutive model for both the 2D and 3D analyses.

## PROJECT RESULTS

Itasca was able to meet the challenges presented by this project relatively easily given the flexibility of *FLAC* and *FLAC3D* software, including parameter variation with depth directly correlated to field test data. The *FLAC3D* models allowed for structural optimization in terms of SPW section, concrete ring loads, embedment lengths, and safety factor evaluation.



*Displacement versus Strength Reduction Factor (SRF) at the base of the powerhouse and liner.*



*Vertical displacements in the base of the powerhouse at the end of excavation.*