

# Geology, Geotechnics and Seismic Risk

## Diagnosing the Earth

CESEL S.A. is a consulting company with more than 40 years of experience in developing engineering with several integrated disciplines. Its headquarters are located in Peru and it has branches and offices in several Latin American countries. CESEL develops studies, designs and engineering projects; studies, works and assembly supervision; factory inspection; environmental studies and comprehensive management of engineering and construction projects through its twelve operating divisions and six technical departments. The Geology, Geotechnics and Seismic Risk Division is described as follows:

### Services

- Basic engineering.
- Pre-feasibility.
- Feasibility.
- Detail engineering

### Software

- Slide.
- Macstars.
- Plaxis.
- Midas 3D.
- Seisimager 2D.
- Zmap.
- Crisis 2007.
- Feflow.
- Dips.
- Rocfall.
- Rocplane.
- Swedge.
- Unwedge.
- Phase.
- Autocad Civil 3D.
- MS Project.

## Areas

### Geology

- Surface and underground local geological evaluation, geomorphology studies, geodynamics and geological risks.
- Structures sampling, veins, mantles, alteration areas, deposit types definition, mineralization hydrothermal levels and geophysical and geochemical interpretation.
- Geological-structural analysis for the geotechnical design of the slopes and tunnels support.

### Geotechnics

- Soil mechanics study, admissible capacity and soil maximum deformation analysis for superficial and deep foundations.
- Geomechanical evaluation to qualify the rock mass in tunnels, foundations and slopes.
- Geotechnical studies focused in soil and rock slopes stability analysis, solution alternatives design in critical scenarios (gabion walls, MSE walls, meshing, anchoring, etc.).
- Dams geotechnical design for reservoirs, tailing deposits, dumps, open pits, etc.
- Evaluation and design of the type of support and slopes based on the rock mass geomechanical behavior.
- Evaluation and design of the type of tunnels support based on the rock mass geomechanical behavior.
- Numerical modeling through 2D and 3D finite elements for the soil and rock non-linear behavior simulation, static and dynamic stress-deformation analysis, construction simulation per stages, geotechnical structures construction, such as, dams, embankments, foundations, excavations and tunnels, filtrations analysis and rapid water release, slopes stability analysis and liquefaction potential evaluation.

- Structures and moving soil mass monitoring and control through geotechnical instrumentation installation and supply (piezometers, inclinometers, tiltmeters, etc.).
- Quality assurance and control (CQA and CQC) in the construction process of the mining projects, such as leaching pad, tailing dams, dumps, etc.
- Geotechnical investigations for projects regarding dams, hydroelectric power plants, highways, tunnels, ports, airports, transmission lines, mining facilities, buildings, etc.
- Geophysical prospections execution through seismic refraction, MASW, MAM, SEV, Down Hole tests, etc.
- Quarries evaluation; use, efficiency and exploitation.
- Laboratory tests conduction in soil, rock, aggregates, green and hardened concrete samples, and soil and water chemical analysis.
- Diamond drilling control and supervision.

### Seismic risk

- Seismic hazard studies through probabilistic and deterministic methods; defining the land seismic movement maximum acceleration levels for the maximum consider earthquake (MCE) and the operation base earthquake (OBE) by the probabilistic method; and for the maximum credible earthquake (MCE) by the deterministic method according to the International Building Code (IBC).
- Seismic amplification analysis through linear, equivalent linear and non-linear methods for developing the design response spectrum.

### Hydrogeology

- Hydrogeological studies, ground water flow numerical modeling, hydrogeological parameters monitoring and control, drilling supervision for wells.



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## Projects

- Carahuacra Norte open cut seismic risk study update and physical stability of Volcan S.A.A. dump. Junin, Peru.
- Soil works quality control and assurance in Cobriza tailing dam projects. Huancavelica, Peru.
- Tablachaca Reservoir. Underwater drilling execution. 13 drillings (diamond drillings). Huancavelica, Peru.
- Lagunas Norte Mine leaching PAD, Barrick MBM (phase 2, phase 3 and 3A). Quality control service for the construction. La Libertad, Peru
- "Collapse 5" stabilization works. Final study and detail engineering. Tablachaca reservoir stabilization works final design. Huancavelica, Peru.
- Slopes stability analysis. Huehuetenango 230 kV Substation. Guatemala.
- Geological - geotechnical analysis for intake, tunnel and power house works. Topo hydroelectric power station. Tungurahua, Ecuador.
- Quality control assurance supervision (CQA). Butters Project - MBM. Ancash, Peru.