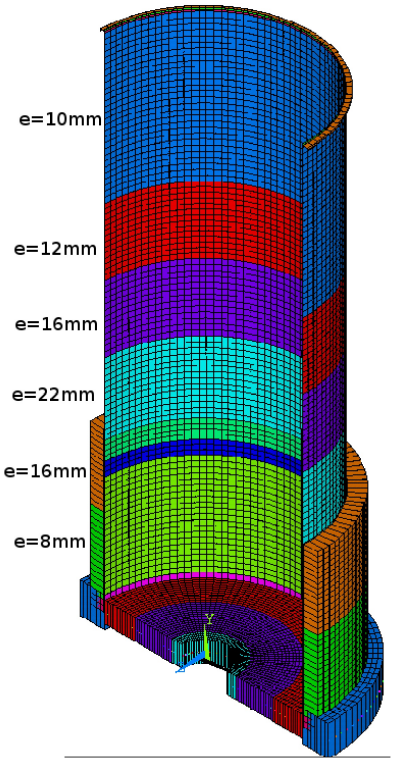
Torito Hydroelectric Power Plant

Located on the Atlantic slope side of Costa Rica, the Torito hydroelectric power plant has been constructed with the main objective of reducing the country dependence on oil derivatives to generate electric energy in order to cut the resulting pollution. It uses a maximum gross drop of 56 m and 136 m3/s of capacity of the Revantazón River to reach a total installed capacity of 50 MW and a mean annual generation of 305 GWh.



Surge tank

To absorb sudden rises of pressure (water hammer) a surge tank is directly connected to the conduction tunnel. It is composed of a cylindrical steel structure, 20 m in diameter and 43 m high.

The design and analysis of this structure is developed in the following phases:

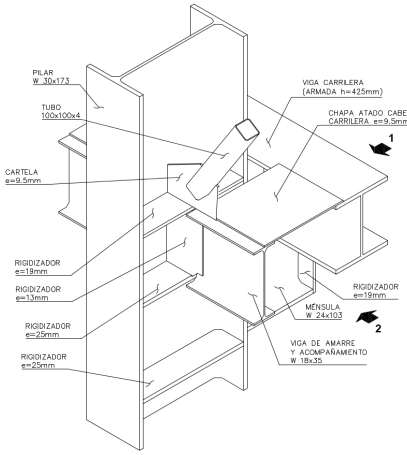
-Predimensioning, based on the simplified methods set out in standard API 650.

-Analysis of a finite element model elastic-linear.

-Successive non-linearities are incorporated to the model: geometric imperfections, out-of-roundness, elastic-plastic behaviour of steel, soil-structure interaction, ... Impulsive and convective fluid pressures are also considered on the tank when it's subjected to a 0.36g seismic acceleration.

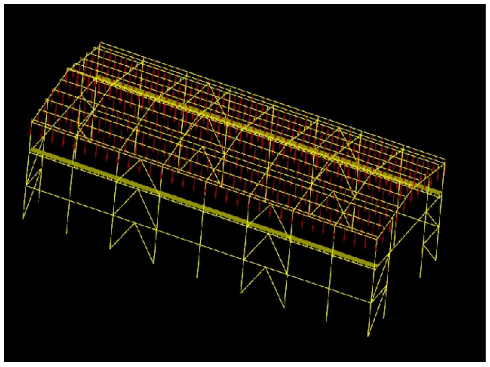
Power house

To house the two groups of turbine-alternator, a plant is designed having four floors of 40x17 m2 each. The superstructure is equipped with a bridge crane with load capacity up to 150 ton.

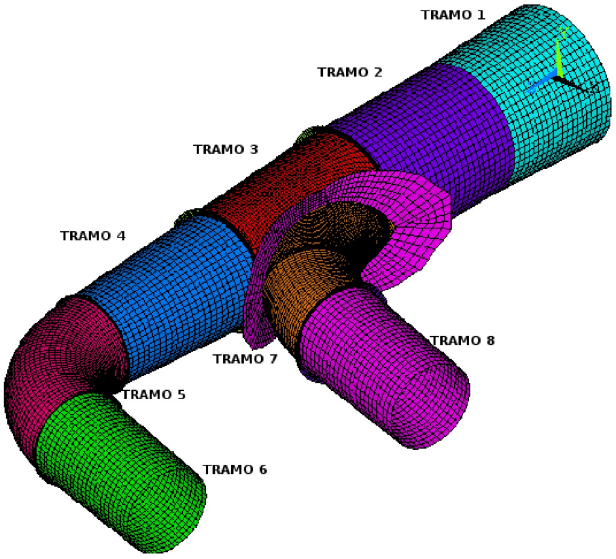


In order to ensure trouble-free operation of the crane, the horizontal displacements allowed in the steel columns that support the runway structure are limited to small values.

A P-Delta iterative calculation is carried out using the XC free finite elements program. The seismic response is calculated by a modal analysis.



The construction drawings are generated from a parametrized model of the metallic structure by writing python routines that work in the FreeCAD open source parametric 3D CAD modeler.



Bifurcation

The penstock, 6 m in diameter, is a gallery excavated in the rock, in which a steel shield is installed and embedded in concrete. To distribute the flow between the to groups of turbines, a bifurcation just upstream of the powerhouse is designed.

The analysis of this structure is done using a finite element model. To parametrize the complex geometry of the part (pipe branches, stiffeners, flange) a 3D CAD parametric model is programmed using FreeCAD. The bifurcation is designed for static pressure of 62 mca and for a pressure of 85mca due to water hammer.