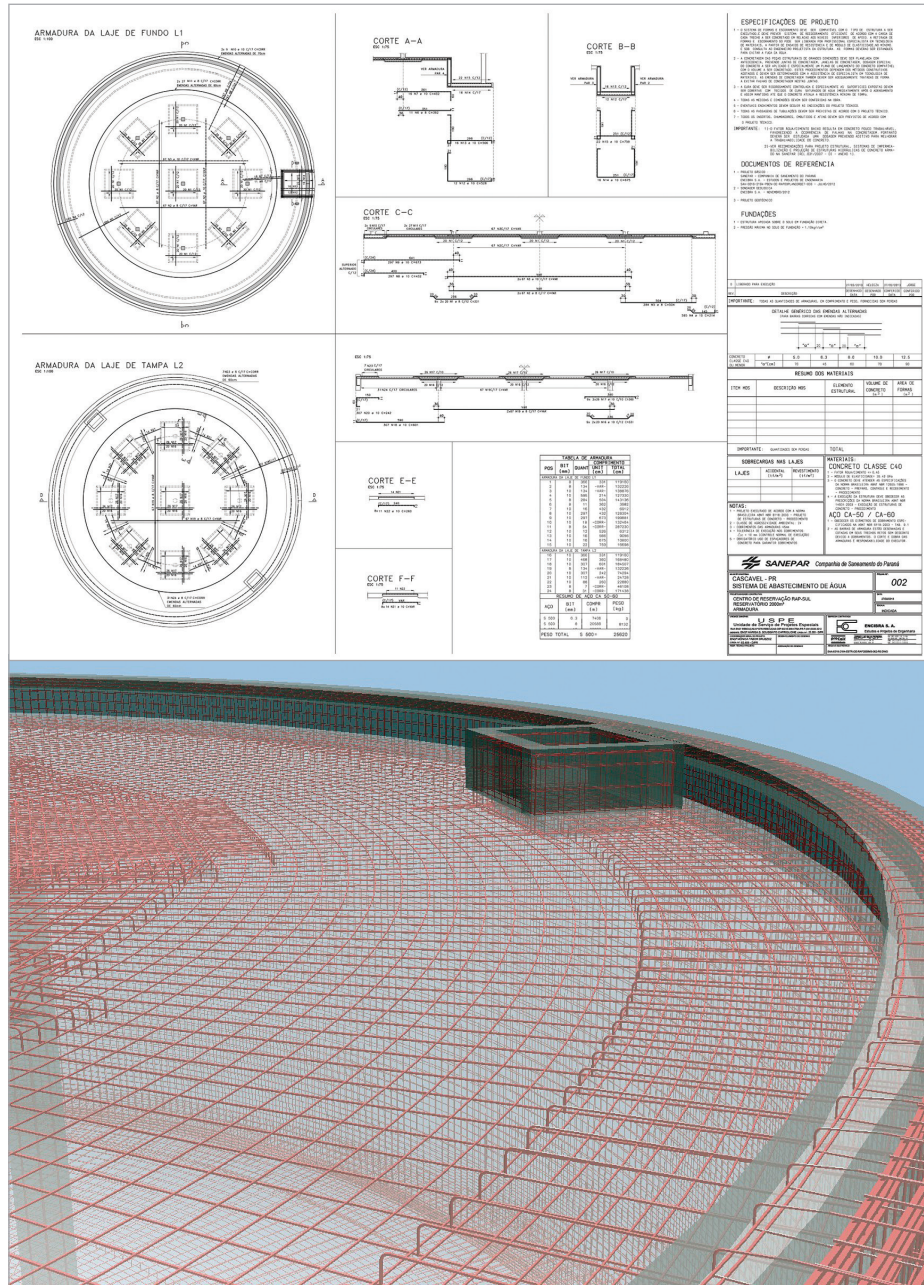


# Supported Tank 2,000 m<sup>3</sup> Cascavel - Paraná, Brazil



The tank is a monolithic structure in reinforced concrete, supported directly on the ground, for the storage of treated water. Its capacity is 2,000 m<sup>3</sup>. As the water is treated with chlorine, the internal environment of the tank is extremely aggressive due to the presence of chlorine gas in the air cushion between the water surface and the lower face of the tank lid. Due to the presence of the chlorine gas, a flat slab with capitals was chosen as the tank lid to avoid the formation of a gas retention chamber under the lid with the enhancement of the aggressive effect on the structure. Another design challenge was to adapt the tank to ground conditions to obtain a more economical solution in the direct foundation (raft), within the limits of the admissible soil tension.

### Structure Description

The tank has an inner diameter of 22.00 m and a height of 5.37 m. The bottom slab, which acts as a raft, has a thickness of 20 cm, with the capitals thickness of 30 cm and dimensions of 2.40 m x 2.40 m under the columns. Along the outer circumferential wall, the bottom slab thickness is increased to 30 cm, with a width of 1.00 m. This forms an outer flange cantilevered projection 50 cm beyond the outer face of the wall. This flange has the function of reducing the contact pressure between the structure and the foundation soil beneath the exterior walls. The nine columns have internal dimensions of 30 cm x 30 cm, with eight of them radially distributed and one central column. The tank lid is 20 cm thick, supported by columns via capitals with a thickness of 30 cm and dimensions of 2.40 m x 2.40 m. The entire structure has been designed in reinforced concrete.

### Standard Codes Applied

Eurocode (Scia), NBR-6118:2003 - Design of concrete structures, NBR-6120 - Loads for calculation of edification structures and other Brazilian norms.

### Exposure Class, Materials and Concrete Cover

According to Table 6.1 of NBR-6118, the structure is classified as aggressive with a very strong risk of structural deterioration, Class IV Environmental Aggression. According to Table 7.1 of the same norm, Class C40 concrete with a water/cement ratio mass

≤ 0.45 was adopted. According to Table 7.2 and specifications of the contractor, all of the adopted concrete covers are 45 mm. The used steel was CA-50.

### Loads considered

The loads applied to the bottom slab were 5.37 tf/m<sup>2</sup>, equivalent to a height of 5.37 m of water and a constant load of 0.25 tf/m<sup>2</sup> for adjustment and trims. A permanent load of 0.25 tf/m<sup>2</sup> for the settlement and trims and an accidental load of 0.15 tf/m<sup>2</sup> were applied to the tank lid.

### Modeling and Analysis

The structure was modelled in 3D Scia. Various stress diagrams, areas of rebar and contact stresses of the model were obtained. After some adjustments to the dimensions of the structure and soil parameters, the final model was settled and it provided parameters for the design and detailing of the structure. According to the diagrams of the contact stresses, the maximum tension in the soil reached a value of around 1.00 kgf/cm<sup>2</sup>.

### Design and Detailing

From the information obtained from Scia, the design of the reinforced concrete members conducted by the Eurocode program were checked using the criteria and requirements of the Brazilian standard for critical sections, making sure of the compatibility between standard norms. After the definition of the design of the structural parts, the detailing of the most important pieces was made and the general criteria of drawings from other parts were established. This information was relayed to the engineer responsible for the use of Allplan, who developed all the detailing of all the reinforcement in the program. Scia proved a powerful tool that caters for issues such as the reliability of results and productivity gains. There is great ease in the creation and display of input data as well as results obtained by the settable graphical user choice. The interpretation of results is quite intuitive and interactive.

### Drawing and final presentation

With all the reinforcement detailed in Allplan 3D, specific drawings were developed for each structural piece as forms and reinforcements.

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**Origin:** The company proCalc Associated Engineers was founded in August 1989, in Curitiba, Paraná, Brazil, as proCalc Structures Ltd.

**Objective:** Project development of structures in reinforced concrete and prestressed in general; prefabricated structures and structural masonry projects.

**Quality:** We apply the extensive experience of our professionals, in tandem with technological resources, for the careful study of structural solutions. We always seek the best technique, economy and ease of execution. We always look for and adopt the most modern resources of an international level in programmes for structures.

**Products:** We operate in the following areas: residential, commercial and corporate projects, high-rise buildings, industrial, sanitation and buildings for public works, reports, investigations, structural reinforcement projects and project reviews.

**Collection:** We have designed more than 2,500,000 m<sup>2</sup> of building structures, over 400,000 m<sup>3</sup> of reservation capacity in sanitation and more than 500,000 m<sup>2</sup> of industrial structures.

## Project information

Owner	Companhia de Saneamento do Paraná - SANEPAR
Architect	Companhia de Saneamento do Paraná - SANEPAR
General Contractor	Encibra S.A. - Estudos e Projetos de Engenharia
Engineering Office	proCalc Engenheiros Associados S/S
Location	Paraná, Brazil
Construction Period	01/2014 to 01/2016

## Short description | Supported Tank 2,000 m<sup>3</sup> Cascavel

The tank is a monolithic structure in reinforced concrete, supported directly on the ground, for the storage of treated water. Its capacity is 2,000 m<sup>3</sup>. As the water is treated with chlorine, the internal environment of the tank is extremely aggressive due to the presence of chlorine gas in the air cushion between the water surface and the lower face of the tank lid. Due to the presence of chlorine gas, a flat slab with capitals was chosen as the tank lid to avoid the formation of a gas retention chamber under the lid, with the enhancement of the aggressive effect on the structure. Another design challenge was to adapt the tank to the ground conditions to obtain a more economical solution in the direct foundation (raft), within the limits of the admissible soil tension. In association with a team of geotechnical professionals, the solution found was to replace and improve the soil layers to obtain the admissible tension from the tank model within the economic viability of its execution.

