

International Milestone RCC Project



Salto Caxias Dam

in Brazil

Installed capacity	1240 MW
Normal water level	325.0 m
Storage capacity	$3.573 \times 10^6 \text{ m}^3$
Catchment area at the dam site	57,000 km ²
Long term average discharge	1,240 m ³ /s
Average discharge during construction	2,500 m ³ /s
Construction period	1995-01~1998-09
Height of dam	67 m
Downstream slope	0.75 H:1.0V below E.L 315.00 m Vertical above E.L 315.00 m
Total dam concrete volume	1,010,600 m ³

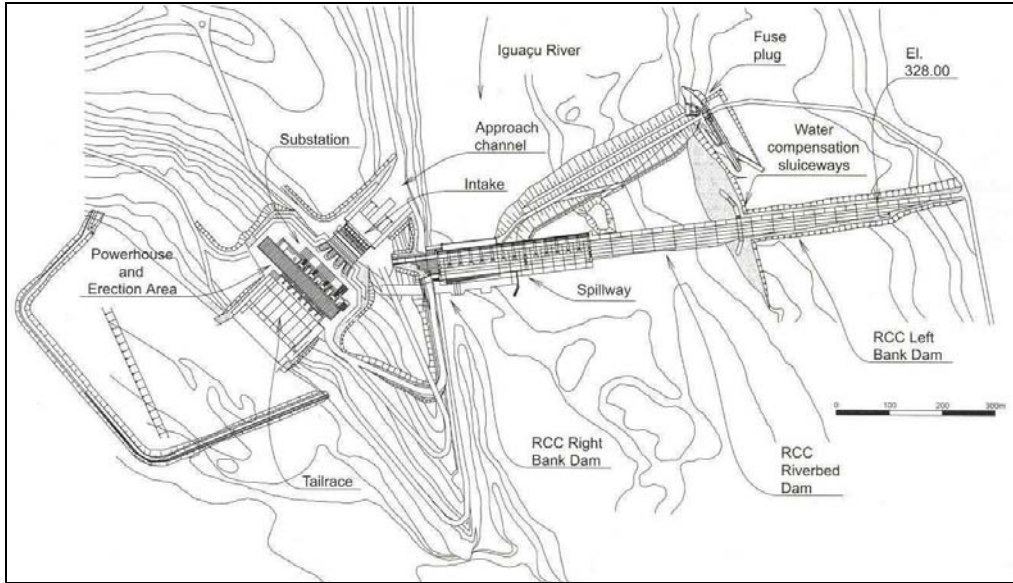
Salto Caxias Hydroelectric Power Plant, with a final installed capacity of 1,240 MW, is located on the Iguaçu River, at the border of the municipalities of Capitão Leônidas Marques and Nova Prata do Iguaçu, 560 km from Curitiba, in state of Paraná, Brazil.

The geological conditions consist basically of successive basalt flows with thicknesses varying from 15 to 50 m. No significant geological discontinuities are observed. The thickness of the soil overburden can reach 15 m.

The catchment area at the dam site is 57,000 km². The long term average discharge is 1,240 m³/s, although during construction (1995 to 1998) the average discharge attained 2,500 m³/s, more than twice the expected discharge. The reservoir covers 141 km² and holds $3,573 \times 10^6 \text{ m}^3$ of water at maximum normal water level 325.00m.

The civil works were awarded to “DM Construtora de Obras Ltda”, as a result of public bidding held in 1994.

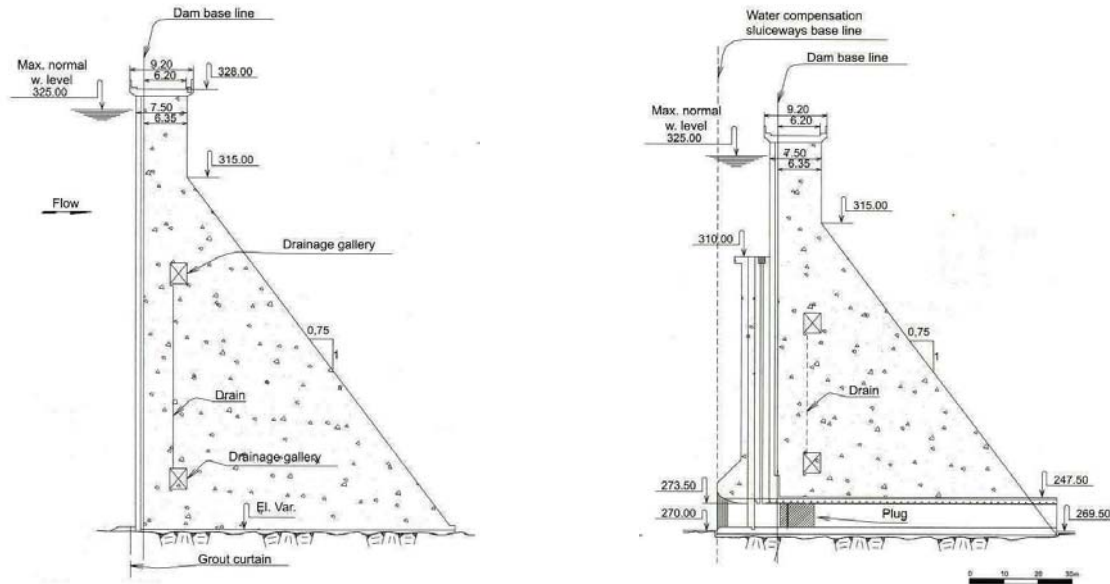
Salto Caxias Project comprises a 67 m high, 1100 m long – RCC gravity dam, across the main river valley, upstream from the falls; the power intake at the right bank; and the penstocks conveying the water, to the 4 unit powerhouse conveniently located downstream of the sharp curve of the river to the right.



Salto Caxias Project Layout

RCC Dam

Salto Caxias dam is 67 m high and 1,100m long, and the total concrete volume is 1,010,600 m³. It is a gravity roller compacted concrete – RCC dam with a maximum height of 67 m and length of 1,100 m, including the spillway. The dam is built with RCC up to El. 327.00 m, and the crest finished with conventional concrete (CVC) to El. 329.30 m. The 10.00 m wide crest includes the roadway, the walkway and the parapets. The upstream face is vertical and built with CVC. The downstream face, also built with CVC, in steps, has a 0.75 H:1.0V slope below El. 315.00 m and is vertical above this elevation.



RCC Dam Typical Sections

The RCC is placed in 30cm thick layers and compacted with 10t vibratory rollers. For the purpose of improving cohesion and reducing permeability, a 1cm thick mortar layer is placed between the RCC layers. On the upstream face, in order to improve the embankment watertightness, CVC is placed simultaneously with the RCC, in a 75cm wide band from the base up to E.L.315.50m

The design mix adopted the high fines content approach, using low cement content (100 kg/m³). The cement had a pozzolan content ranging from 25 to 27% (Itambe trademark). In order to improve cohesiveness and permeability of RCC, crushed powdered aggregates were used in the mix with content rage from 160 to 200kg/m³.

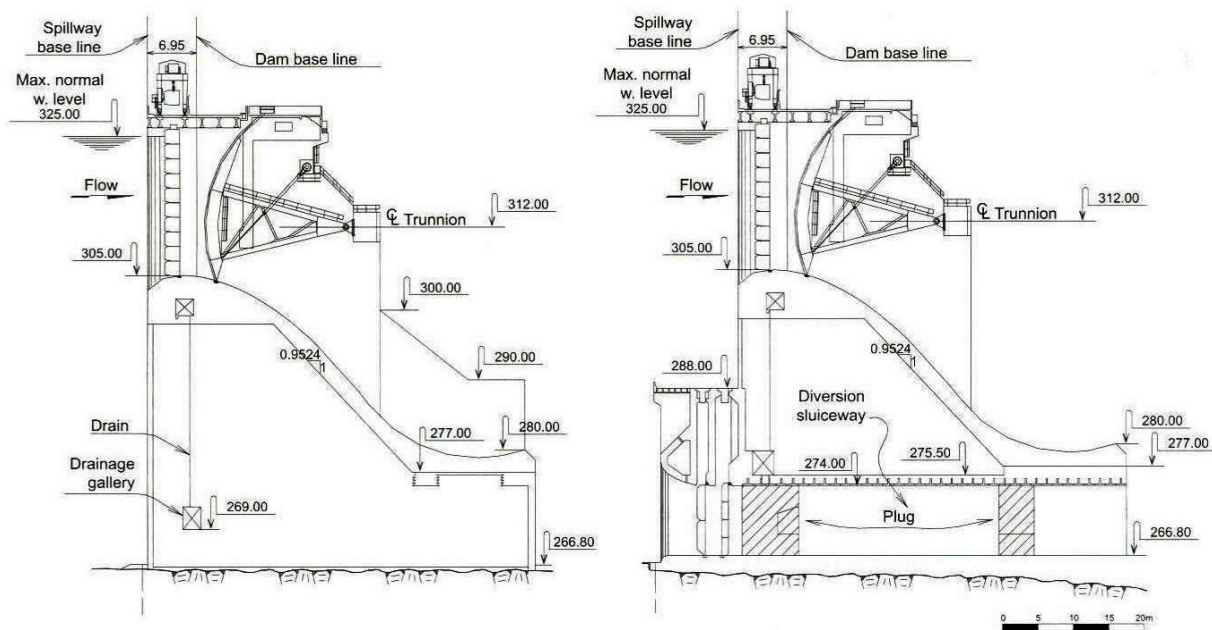
The characteristic compressive strength (80% quartile) at 180 days, of molded samples, was 10.2MPa, almost 30% above the specified 8.0MPa strength.

The average density and water content measured with the nuclear densimeter was 2,602 kg/m³ and 140 kg/m³.

The results of the core drilling program were very similar to the molded samples results (10.5 MPa for compressive strength and 2,612 kg/m³ for density). The permeability tests average for drilled core samples was 4.61×10⁻⁹m/s.

Spillway

The spillway structure consist of 15 RCC blocks lined with CVC, each one 20.5m wide, except for the 2 side ones which are 12.0m wide, for a total length of 290.5m. The spillway is designed for a discharge of 49,600 m³/s. This gated spillway is placed over the RCC main dam, discharging through a flip bucket directly in the river channel. The outflow is controlled by 14 radial gates, 16.5m wide by 20.0m high. For future maintenance work, there is a stop-log made up of 10 interchangeable panels.



Dam Spillway Cross Section

Construction and Diversion



Dam Overtopping

Salto Caxias Dams sluiceways have been incorporated to the dam body, and they consider a maximum flow of 7,000 m³/s.

During constructions, the dam has been overtopped five times. The biggest inflow during overtopping was 18,000m³/s, and the RCC dam did not presented any problem. The damages occurred only in the downstream rock foundation, and the downstream foundation damages and the foundation repair works are shown in the figures.



Sluiceways: downstream view



Sluiceways: upstream view



Downstream Rock Damages and Foundation Repairs

Companies Involved in the Project

Owned and operated by: ***Companhia Paranaense de Energia (COPEL)***
Designed by: ***Consortium Intertechne-Leme-Engevix-Esteio***
Constructed by: ***DM Construtora de Obras Ltda,***