

## Puente Mercosur – Truss Girder Bridge across the Orinoco

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## Summary

With the aim of developing the Southwest of Venezuela and enable its connections with the rest of the country, a third bridge over the Orinoco River was designed between the cities of Cabruta, State of Guárico in the north and Caicara del Orinoco in the south.

The combined highway and railroad bridge Puente Mercosur will be the third crossing of the Orinoco with a total length of 11.125 km. The stay-cable main bridge with 360m main span and the adjacent approach bridges with a length of 2 x 720m are comprised of a steel composite truss girder with a depth of 12.0m. The pylons and piers are founded on piles with a diameter of 2.50m resp. 2.00m and a length of up to 80m.

The deck for the approach viaducts and the side spans of the main bridge is assembled in construction yards adjacent to the southern and northern abutments, before launching each into its final position using Teflon plates on top of the piers, and lifting devices at the front and end of the sections to compensate deformations of the superstructure during launching. The centre segment of the main bridge with a length of 120 m and a dead weight of 2400 ton will be lifted from a barge. A non linear time history analysis has been performed for the earthquake design of the shock transmitter bars in the approach viaducts.

**Keywords:** deep water foundations, incremental launching bridge, heavy lift, cable-stayed bridge for railroad, steel composite truss girder, double composite action, shock transmitter bars, non-linear time history analysis, ship impact

## 1. Introduction

The Third Bridge across the Orinoco, or Puente Mercosur as it will be called after completion, is a combined highway-railway bridge which will connect the two villages of Caicara del Orinoco in the South and Cabruta in the North.

In order to start developing the unexploited central part of the country an investment of about one billion dollars was designated for the construction of the third bridge across the Orinoco River, a project of the Bolivarian government with the Brazilian construction company Odebrecht.

The Third Bridge across the Orinoco is located about 300 km upstream of the first bridge in Ciudad Bolivar and about 400 km of the second bridge in Ciudad Guayana.

Besides the construction of the river crossing it is necessary to build the roadway between Caicara del Orinoco and Ciudad Bolivar, and between Cabruta and San Fernando de Apure. The railway connection on the northern side is currently under construction.

Construction of the bridge started in 2006.

## 2. Description

This combined Rail and Road Bridge has a total length of 11.125 km crossing the Orinoco River and its floodplain. The link consists of the river crossing and approach viaducts on either side. The 2280m long double deck river crossing is composed of an 840m long stay-cable main bridge and two 720m long approach bridges.

The deck for the combined Rail and Road Bridge is comprised of a steel composite truss girder whereby the 4 lane road traffic is located on the 19.9m wide upper deck and the rail is located inside the truss on the lower deck. The depth of the truss is constant 12.0m along the 2280m long river crossing. A cable-stayed main bridge with 360m main span and central cable plane is designed for the crossing of the 320m wide navigation channel. The side spans of the cable-stayed bridge as well as the spans of the double deck approach bridges have regular lengths of 120m.

The substructures are designed to resist the ship impact and earthquake loads. The diamond shaped concrete pylons have a height of 135m and are founded on 39 piles with a diameter of 2.50m. The piers of the double deck river crossing are founded on 18 piles with a diameter of 2.00m. The piles have lengths of up to 80m.



Fig. 1: Visualization of Main Bridge

The basic design parameters are:

- Minimum horizontal clearance of 320m and minimum vertical clearance of 40m in one navigation channel
- Impact loads due to ship collision has been considered in the design of the main structure
- Varying water levels between 0 and +12.5 m
- Scour up to 12m in the area of the CSB and approach viaduct A1
- Maximum slope for rail traffic 1.5 %
- 4 lanes for roadway and 1 railway line
- Steel in weathering steel A-588 without coating.

The deck for the approaches viaducts and the side spans of the main bridge is assembled in construction yards adjacent to the southern and northern abutments. This process is carried out by assembling the lengths between expansion joints into complete sections, before launching each into its final position using Teflon plates on top of the piers, and lifting devices at the front and end of the sections to compensate deformations of the superstructure during launching. The centre segment of the main bridge with a length of 120 m and a dead weight of 2400 ton will be lifted from barge.

Client:	Ministerio de Infraestructura, Fundación Propatria 2000, Venezuela
Construction:	Construtora Norberto Odebrecht S.A., Sao Paulo, Brazil
Preliminary & Basic Design:	Leonhardt, Andrä und Partner, Stuttgart, Germany
Detailed Design:	Consorcio BRAVE, Caracas, Venezuela and Sao Paulo, Brazil
Construction Engineering:	Leonhardt, Andrä und Partner, Stuttgart, Germany
Independent Checking:	Leonhardt, Andrä und Partner, Stuttgart, Germany Smolczyk und Partner, Stuttgart, Germany (Geotechnics)