



## Construction and Geometric Control of the Baluarte Cable-Stayed Bridge, Mexico

**Leonardo GUZMAN**

Head of Construction Department  
*Secretaría de Comunicaciones y Transportes*, Mexico  
lguzmanl@sct.gob.mx

**Salvador SANCHEZ**

Bridge Construction Manager  
*TRADECO Infraestructura*  
Mexico City, Mexico  
ssanchez@tradeco.com

**Eduardo REYES**

Technical Director  
*Consultora Mexicana de Ingeniería*  
Mexico City, Mexico  
eduardoreyesg@gmail.com

**Vicente ROBLES**

General Manager,  
*Procesamiento de Ingeniería Estructural*  
Mexico City, Mexico  
pie@estructuraspie.com.mx

**Alberto PATRON**

General Manager  
*Consultora Mexicana de Ingeniería*  
Mexico City, Mexico  
apatrons@gmail.com

**Ernesto MORALES**

Bridge Engineer,  
*Consultora Mexicana de Ingeniería*  
Mexico City, Mexico  
ing.emf@gmail.com

### Summary

The Baluarte is the most remarkable bridge on the new Durango-Mazatlán highway, and was opened to traffic in October 2013. The bridge is cable-stayed with a total length of 1124 m, the main span is 520 m long. It is the highest cable-stayed bridge in the world, with a maximum drop of 402.5 m from the deck level to the bottom of the Baluarte river. The access viaducts have a concrete deck, and were built by the symmetrical cantilever method. The highest pile of the viaduct is 147.5 m high. The main deck is made of composite material (steel/concrete), and was erected by the cantilever method. The bridge's site is very complex from the topographical and geotechnical points of view. It crosses the steepest part of the Sierra Madre Oriental in the north of Mexico. This region is also prone to high-speed winds caused by hurricanes. This paper presents the main characteristics of the bridge, the technical challenges and main stages of its construction. The erection methods and geometric control of its deck are also presented. And lastly, a comparison between the results of analytical models of staged construction, and the actual measurements of the bridge's deflections, is made.

**Keywords:** Piers, pylon, composite deck, cable-stay, prestressed concrete, geometric control.

### 1. Introduction

This paper includes several topics. Firstly, it provides a general idea of the location of the Baluarte Bridge; secondly, it presents the main characteristics of the bridge. Then, the stages of the construction process, for both the concrete and mixed segments, are shown. Thereupon, a brief description of the geometric control theory is given; this was the basis to carry out proper monitoring. Finally, all the results of this work are presented. These results are divided into: displacements, stresses, as well as the final profile.

### 2. The Baluarte Bridge

#### 2.1 Location

The Baluarte Bridge is located on the Durango-Mazatlan highway, in the limits of the states of Sinaloa and Durango in the north of Mexico. This bridge crosses a deep canyon named "*El Espinazo del Diablo*" ("The Devil's Backbone"), due to its dangerous highlands. Its location is shown in figure 1. The typical topography of the bridge site is shown on Figure 2.

#### 2.2 General Description

The Baluarte bridge is a unique structure, 1124 m long. It is a cable stayed structure and has 11 spans with lengths comprised between 40 and 70 m. The main span is 520 m length. The general configuration of the bridge is shown on Figure 3.