New footbridge completes greening of Spanish ravine

A footbridge which has just opened in Guadalajara in Spain offers a route for pedestrians over a former ravine. The Alamin Footbridge has been built over what used to be a disused ravine with an underground sewer into a public park. The project called for a 70m-long connection to enable residents in a new housing development to walk to the town centre.

The first sketch by architect Javier Delgado envisaged an observation platform supported on stick-like columns at a short distance from each abutment. A shallow arch rose from these platforms to span the 50m between the columns.

But the need to integrate the footbridge into the landscape demanded longer approach spans to give a more balanced ratio between the main spans and the approach spans. The approaches are also designed as shallow arches, supported by the abutment and columns, cantilevered out from the columns to form observation platforms.

In plan view the bridge is a polygon angling out from the cross-sections of the intermediate columns. A continuous three-span system was devised for the bridge deck. Retaining the original concept, the deck consists of three shallow arches, the two outer ones spanning respectively 18m and 13m and the central span of 36m. In plan view, the access from each abutment to the respective observation platform is eccentric to the arch of the outer span and shaped by a horizontal beam that rests on the abutments and the intermediate column. Arch and beam are connected at both ends, by the supporting diaphragms at the abutment, and in the platform area, by the stairway leading from the observation platform to the bridge deck. This solution means that the beam that forms the access to the platform is also a tension member that resists the horizontal thrust of the outer arch.

Each column has four slanted shafts of circular hollow section steel profiles with a diameter of 273mm, giving slenderness ratios of up to 35. The cantilevered observation platform and the bridge deck are supported by two shafts each and one of the four stretches above the deck as a lighting column.

Both the 3m-wide bridge deck and the platform are composite members, consisting of an open trapezoidal steel box and a 110mm deep composite slab. While the standard section height is 500mm, on the arches around the internal supports it increases to 7m, hence the main span behaves more like a beam than an arch. Given the absence of ties in the central span, this is the preferred resistance mechanism to prevent the transmission of horizontal thrust to the adjacent spans and abutments. In the area around the internal supports of the composite beam, the bottom flange of the box girder is also composite for greater hogging bending strength and system ductility.

The main difficulty posed by the Alamin footbridge was to find an appropriate mechanism to transfer the load from the bridge deck to the columns, because the access box girders and the main spans are continuous and their axes form angles, both vertically and horizontally. Furthermore, the four slanted pier shafts are connected at different angles to the box girders they are supporting.

Loads are transferred from the webs of the box girders to a twin diaphragm comprising two steel plates spaced at 690mm and set parallel to the intersection between the steel box forming the accesses and main spans. Loads are transferred from these transverse plates in turn, to two longitudinal steel plates, each of which runs along the axis of one of the pier shafts that extend into the box girder and to which they are welded. The shafts transfer the loads to the foundations.

The structural engineering was carried out by Cesma Ingenieros, the main contractor was Acciona and the steel subcontractor was Incombet. The cost of the bridge was US$332,000.

Peter Tanner
Cesma Ingenieros

Footbridge crosses a former ravine in Guadalajara (Paco Gómez)