Design of a High Speed Rail Arch Bridge over the Alcántara Reservoir (Spain)

Guillermo CAPELLÁN
Technical Director
Arenas & Asociados
Santander, Spain
gcapellan@arenasing.com

Héctor BEADE
Designer and Project Manager
Arenas & Asociados
Santander, Spain
hbeade@arenasing.com

Juan José ARENAS
President
Arenas & Asociados
Santander, Spain
jjarenas@arenasing.com

Ignacio MEANA
Head of projects
Adif
Madrid, Spain
imeana@adif.es

Pascual GARCÍA
Civil Engineering Manager
Idom Madrid
Madrid, Spain
pga@idom.com

Summary

The Almonte River arch bridge over the Alcántara Reservoir, which is part of the Madrid-Portuguese Border High Speed Rail (HSR) link, is a challenge for bridge design, engineering and construction. Its 384-m main span will make this major project become the largest HSR arch in the world and the largest railway bridge in Spain. With the aim of giving response from the design stage to the specific problems of a HSR crossing with large span and length, a formally and structurally innovative design has been used: the arch, linked to the deck at the crown, has an octagonal section with variable depth and width in its central 210 m, from where it splits itself into two legs with irregular hexagonal section until its springings. The design joins together structural efficiency, out-of-plane stability (as HSR horizontal deflection limits require), improved response to wind loads (as exhaustive wind tunnel tests have proved), transparency, aesthetics and durability.

Keywords: Deck-arch bridge; High Speed Rail; main-span world record; high-strength concrete; transversal stability; dynamic behaviour; durability; sustainability; wind tunnel test; holistic design.

Fig. 1: Photomontage of the viaduct in the natural environment

1. Introduction and context

HSR traffic nature requires infrastructures with strict design parameters both in horizontal and vertical (alignment and profile) leading to numerous bridges, commonly with significant lengths and sometimes also heights. These bridges and viaducts, which are inevitably flexible elements of these infrastructures, are subjected to heavier vertical and horizontal loads than road bridges. They have also to comply with strict deflection and vibration limits in order to guarantee passenger comfort and traffic security (assuring that railroad geometry and curvature, together with wheel-rail contact, are kept). Additionally, HSR bridges are exposed to considerable dynamic effects, are prone to suffer from fatigue problems due to the intensity and repetitiveness of the loads, and have global-length limitations due to rail expansion joints capacities and track-structure interaction.

As a consequence of these particularities, HSR bridge spans tend to be shorter than the average of bridges carrying other type of traffics. Nevertheless, there are sometimes obstacles which inevitably force to span lengths over the customary or even to exceptional ones with independence of the traffic type, as the case of the bridge this article is about. The new HRS line Madrid- Portuguese

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