

## BRIDGE OVER VISTULA RIVER IN CRACOW: THE FIRST RAILWAY NETWORK ARCH BRIDGE USING COLD-BENT HD SECTIONS AND COMPOSITE DOWELS

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### ABSTRACT

For several years, Poland has been extensively implementing the National Railway Programme. Many interesting and innovative constructions have already been built or are under way. The paper presents design solutions and construction methods for a railway bridge over the Vistula River in Cracow implemented as part of the project "Works on the E30 railway line on the Kraków Główny Towarowy - Rudzice section along with the extension of the agglomeration line." The object is the first network arch type railway facility implemented in Poland.

**Keywords:** *Network arch, composite dowels, railway bridge, steel bridge, arch bridge.*

### 1. INTRODUCTION

The new network arch bridges along the E30 railway line crossing the Vistula River in the center of Kraków represent a significant step in bridge engineering. The entire bridge crossing consists of three independent bridges (two single-track bridges and one two-track bridge), each consisting of three arched spans 49.5, 116 and 63.5m. The superstructure of each span is a new form of network arch, whose basic elements are cold-bent HD rolled sections (normally used in high-rise buildings) and new composite elements using T-sections connected to the concrete body using composite dowels. In the 116m span, a HD400x818 profile with 97mm flange thickness and 60.5mm web thickness made of S460HISTAR steel has been used. The prestressed concrete deck is suspended to the arch using hangers made of round bars. The bridge has been designed for  $\alpha=1.21$  according to PN-EN 1991-2:2007.

The solution obtained is characterized by a very slender arch and deck, and the innovation of the span construction (on a global scale) is that:

- (1). this is the first railway bridge using the cold-bent HD profiles,
- (2). a new type of composite element from two curved T-sections connected with concrete filling to the space between them using a composite dowel shear connection has been used in the construction, which is a completely new type of a structural element in construction,
- (3). for the first time a T-section (that was cut out from a rolled I-beam to obtain composite dowels) was cold-bent in the belt plane,
- (4). the composite dowels used are so far the thickest ones used in construction.

The use of a new type of composite element in the arch enabled the desired rigidity of the portal arch frame to be obtained, and the smooth transition of the steel structure of the arch into a longitudinally prestressed concrete deck. The first bridge was built (2019) and it is a single-track structure. In the next bridge under construction, which is a two-track structure, another very innovative solution has been designed (5): it involves anchoring hangers in a concrete deck using a new type of plates with composite dowels. Due to the large width of the deck, prestressing of the deck in the transverse direction has been designed, which in combination with