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# Historical Beam Bridge Model Identification after Changing Its Structural System into an Arch

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**Abstract**

Historical steel beam bridge over Gliwice Canal located in a small city close to the eclectic palace from 19th century has been strengthened by suspension to new steel arches. The old structure was insufficient for fulfilling current demands of road traffic and clearance. Another issue was its localization in the vicinity of the palace and the lake, which are attractive recreational areas. Therefore, the new structure should be also ready for safe pedestrian and bicycle traffic.

To fulfil those conditions and also to create a landmark bridge in this interesting spot, an arch structure was chosen. Designer decided to use the old bridge and its abutments as a part of the new structure. The deck was renovated and suspended to two inclined hingeless steel arches. To accommodate pedestrian and bicycle traffic, two external footbridges were also suspended to the same arches on both sides. Static and dynamic load tests of the bridge were conducted. An Operational Modal Analysis method was used to identify the dynamic model of the bridge. Due to a limited number of transducers and the simple procedure of the test, the compromise between effort and quality was established. Good correlation between assumptions from the design stage and the response of the erected bridge was confirmed.



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## 1. Introduction

Almost one hundred years old bridge structures, whose parameters are insufficient for fulfilling current demands of road traffic and clearance are generally replaced for new ones. This is especially true with respect to the superstructure. If there is no will to preserve the historic structure, then rarely, rebuilding associated with strengthening and widening of the object is conducted, as it is not always economically justifiable.

Fig. 1. New bridge over Gliwice Canal in Plawniowice.

In the case of the bridge over the Gliwice Canal (Fig.1) located in a small city of Plawniowice, the designer has decided on a major overhaul including change of the static scheme. Old beam structure has been suspended to a hinge less arch which also caries additional two new parallel bridges for pedestrians. As a result of these procedures, a new arch bridge has been created holding separate walkways and meeting the requirements of the highest load capacity class.

## 2. Description of the structure

The structure was probably built in 1935-1939 during the construction of the inland water canal linking Odra river with the city of Gliwice. The original bridge was made as a single-span simply supported steel beam structure with driving. Riveted I-beam girders of the height of around 2.5 meters were connected to each other by I-beam riveted cross members. The bridge deck was additionally stiffened by stringers of rolled steel joists. On the top of that, concrete slab was laid. Described span was supported on massive reinforced concrete abutments which were sited directly in the casing with sheet pilings.

Constantly deteriorating conditions of the bridge, too little bearing capacity, and too small clearance and insufficient space for pedestrians were the causes of the decision to rebuild the structure. The designer decided to strengthen the “old” span by suspending it to the new arched girders. In addition, to accommodate the enlarged clearance for road within the boundaries of the old span, all cyclists and pedestrians traffic has been moved to the newly designed footbridges, which have also been suspended to the same arcs. With all these procedures, bridge over Gliwice canal radically changed its character - from a simple plate girder beam bridge it became quite a complex structure with three independent spans suspended to hinge less arch structure (Fig. 2).

Arches were inclined towards the axis of the road so that the middle hangers, supporting the “old” span, were vertical and the foundation of arches could be independent from the old abutments. External hangers supporting two footbridges suspended to arches are inclined at an angle of 40 degrees in the longitudinal plane of the bridge. This operation allowed to resign from the use of the fixed bearings under footbridges as hangers are responsible for longitude stability. Footbridge ends were supported on an elastomer bearing. In between the road and the pedestrian