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Original Research Article

RESTORATION OF A BRIDGE STRUCTURE ON THE EXAMPLE OF A BRICK RAILWAY VIADUCT IN ZIELONA GÓRA

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A b s t r a c t

The article presents the successful restoration of a railway viaduct in Zielona Góra. The carried out reconstruction, in the scope of increasing the clearance gauge under the bridge, made it possible to increase operational safety while maintaining the existing structure of the object. The described case serves as an example of actions facilitating the further historic use of transportation infrastructure structures while limiting financial outlays for adapting them to current expectations.

Keywords: historic bridge, reconstruction of railway viaduct

1. INTRODUCTION

The constant increase in needs connected with transportation requires the realization of subsequent investments connected with the transportation infrastructure. Currently, there are many new road connections under construction in Poland. Different is the situation of railway lines, which were created mainly in the 19th and the beginning of the 20th century and are nowadays frequently completely taken apart and reconstructed from scratch. In many cases it is possible to restore such structures with the aim of returning the infrastructure to

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normal use, or carry out restoration in the form of adapting them to a new manner of use. This is particularly important in the case of bridges, which are structures characterized by high costs of construction and a relatively long service life. Examples of such actions have been described in literature [e.g. 2-6].

Existing engineering structures, often of a historic nature, nowadays often constitute a transportation barrier for developing transport, and hence – increased requirements regarding their characteristic parameters. Since the 90s of the past century, road transport has been undergoing many changes. Currently, loads of increased dimensions are being transported, with a significant share of trucks having a higher permissible carrying capacity than the rolling stock from the end of the past century. As a result of this, bridge structures oftentimes have insufficient load-carrying capacity or clearance, and thus do not fulfill the requirements posed by the binding laws and technical conditions [8]. In many cases, the reconstruction of a bridge allows for maintaining the historic structure while limiting the financial outlays for removing the transportation barrier.

An example of such actions is a railway viaduct constructed in 1871 in the form of a brick arch located in Zielona Góra as part of the Wrocław-Szczecin arterial railway line No. 273.

A general view of the described viaduct has been presented in a photograph in Figure 1.

Fig. 1. General view of the railway viaduct

Basic technical parameters of the existing structure have been compiled in Table 1.

Table 1. Basic technical parameters of existing structure

No.	Described technical parameter	
1.	Type of structure	brick arch
2.	Total length of structure	5.00 [m]
3.	Horizontal clearance of structure	4.40 [m]
4.	Vertical clearance span of structure	4.00 [m]
5.	Vertical clearance gauge of structure	3.00 [m]
6.	Structural height of structure	2.40 [m]
7.	Number of tracks on the structure	2
8.	Maximum speed of passenger trains	160 km/h

2. DESCRIPTION OF THE STATE OF THE EXISTING BRIDGE STRUCTURE

Foluszowa Street in Zielona Góra, over which the viaduct under study is found, is the main access route to the industrial area from the basic road network of the city. Service-trade as well as manufacturing structures, which require the transport of raw materials such as aggregates, are located in this area. The transport of large quantities of materials, in order to ensure constant supplies, most often takes place with the use of tractors with semitrailers. The clearance gauge of the viaduct, in this case, posed a problem for the safe passage of heavy goods vehicles, which led to the successive damage of the bottom part of the brick vault of the bridge structure by the highest elements of the vehicles. Another difficulty for drivers of heavy goods vehicles was the horizontal arch of the structure located on a turn of Foluszowa Street with merely a 65 m radius.
The described damage is well illustrated by the photograph found in Figure 2.
In an attempt to minimize the existing transportation barriers, an expert opinion [1] was prepared, the aim of which was to assess the damage to the viaduct as well as analyze the possibility of increasing the vertical clearance gauge of the structure.
The expert opinion covered the verification of the dimensions of the structure as well as the analysis of the foundation of the structure based on local uncovers of the foundation. It was determined that the current state of scratches is of a superficial nature, lowering the esthetic value of the structure, and does not comprise damage which may affect the safety of the operation of the viaduct structure..
Under the expert opinion, the depth of the foundation of the structure was verified accounting for the freezing depth, and the structure of the foundations was determined..

Fig. 2. View of the outline of the brick vault of the railway viaduct

As a result of the uncover, the following was confirmed:
- the structure is located directly on the ground,
- the bottom of the brick corpus is found at the depth of 0.90 m,
- the minimum depth of the foundation is 1.45 m,
- the thickness of the foundation is a minimum 0.55 m.

After an analysis of the assessed structure, the applied materials and climatic conditions, the conclusions of the expert opinion found that there is a technical possibility of lowering the gradeline of the roadway of Foluszowa Street within the viaduct by 0.50 m below the existing level of the road. In an effort to increase the vertical clearance under the railway viaduct, the reconstruction of a segment of the road on both sides of the structure was necessary.

3. RESTORATION OF THE VIADUCT

In an effort to realize the investment, working plans for lowering the gradeline of Foluszowa St. within the area of the viaduct were prepared [7]. The results of the mentioned technical expertise, which unanimously showed that lowering the roadway in the area of the viaduct is technically feasible and does not pose a threat to the safety of its foundations, were the starting point for the project.
The street under study does not have sectioned off pavements, and pedestrian traffic sometimes occurs on the shoulder of the road. Due to the existing

horizontal clearance remaining unchanged, a narrowing of the roadway to a single traffic lane was planned under the viaduct.
The working plan included lowering of the gradeline of the roadway under the viaduct by 0.50 m, which forced the necessity of changing the access roads to the structure on a length of 40 m.
Figure 3 shows the longitudinal view and section of the viaduct, accounting for the designed changes.

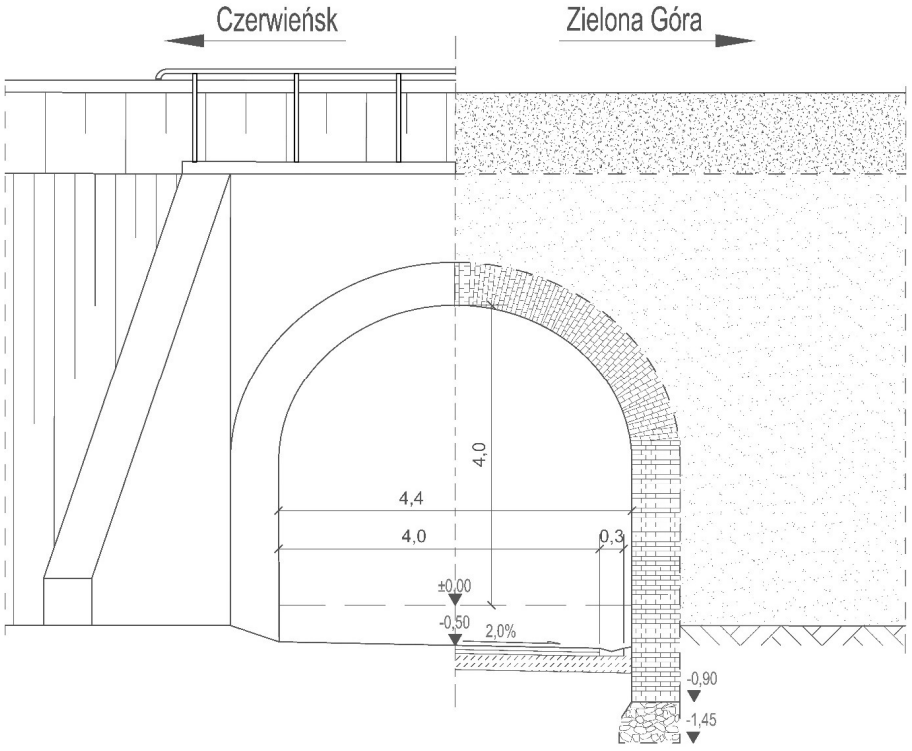

Fig. 3. Planned lowering of the roadway under the viaduct

The technical documentation called for removing the existing bituminous surface and preparing a new full construction of the roadway.
Additionally, in an effort to ensure an adequate expansion of the arch structure of the viaduct, a reinforced concrete slab, 0.25 m in thickness was designed under the structure of the road surface.
Selected elements from the carrying out of the investment have been presented in Figure 4.

Fig. 4. View of carrying out works on the bridge structure: a) preparing the road bed, b) preparing the expansion slab under the viaduct

Due to the necessity for the geometric correction of the access roads to the structure, an appropriate surface drainage system was designed, which serves to drain water outside the road crown while maintaining adequate slopes of the gradeline.

In effect, the total scope of work on the road surface covered a segment of the street 200 m in length. The existing underground infrastructure within the investment was also secured.

The railway viaduct prior to and following reconstruction is seen in photographs in Figure 5.

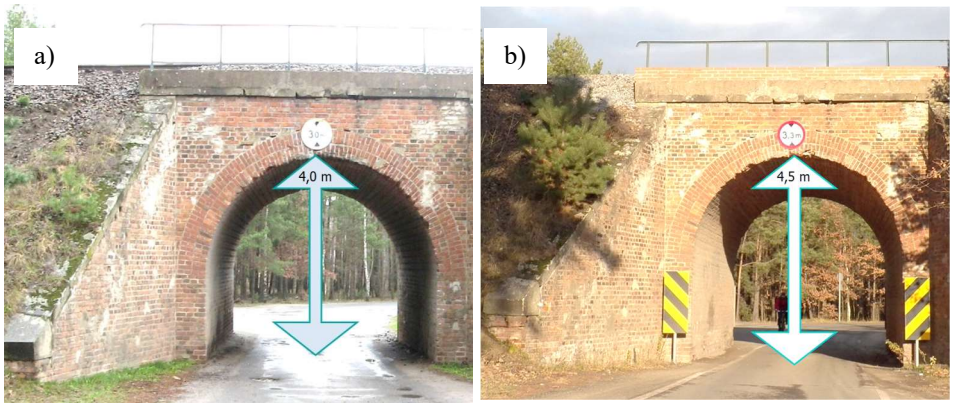

Fig. 5. View of railway viaduct in the course of Foluszowa road in Zielona Góra: a) prior to reconstruction b) following reconstruction

4. SUMMARY

The realization of the described investment made it possible to adapt the performance parameters of the structure to the requirements posed by

the currently used means of road transport. The alternative solution, which is the construction of a new viaduct, requires the engagement of significantly greater financial resources.

Failure to undertake such actions often leads to the further destruction of the vault, and in extreme cases, can lead to a construction disaster.

Lowering the roadway of Foluszowa Street Under the railway viaduct made it possible to increase the vertical clearance from 3.00 m to 3.30 m. Thanks to this, the level of safety, along with the durability of the structure were increased. The presented realization serves to show that the proper preparation of an investment makes it possible to limit financial outlays for eliminating transportation barriers.

As had already been mentioned in the introduction, existing engineering structures require reconstruction, mainly in light of continuously increasing transportation needs. Frequently, these structures are of a historic nature or are entered into the Register of Historic Monuments, which significantly limits the possibility of creating modern structures in their place. It is worth, for historic purposes as well as esthetic values, taking an interest to ensure a variety of bridge structures while maintaining their functional values, especially when this is economically validated.

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