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## PROBLEMS OF CONSTRUCTION PROJECTS REGARDING HISTORIC ROAD BRIDGES

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### PROBLEMY PLANOWANIA PRZEDSIĘWZIĘĆ BUDOWLANYCH DOTYCZĄCYCH ZABYTKOWYCH MOSTÓW DROGOWYCH

#### Abstract

The paper describes the comparison of different approaches to reconstruction and the problems in the selection of implementation for a historic bridge over the Vistula River in Tczew. A compromise reconstruction is shown, taking technical, historical and aesthetic aspects into account, as well as the needs of the local community.

*Keywords: construction, reconstruction, technology, bridge, monument*

#### Streszczenie

W artykule opisano zabytkowy most przez rzekę Wisłę w Tczewie. Porównano różne koncepcje jego przebudowy oraz problemy przy wyborze wariantu realizacyjnego. Przedstawiono rozwiązanie kompromisowe odbudowy uwzględniające aspekty techniczne, historyczne i estetyczne, a także potrzeby społeczności lokalnej.

*Słowa kluczowe: energetyczne wykorzystanie biogazu*

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## 1. Introduction

Tczew is a historical city with unique cultural heritage, which includes a historic bridge called “Lisewski”. The city is currently undergoing a period of renewal and revival to raise the quality of life. Being aware of and making use of specific historical monuments add to the cultural, recreational requirements of the city, and in doing so boost tourism. Due to this, the Tczew revitalization includes a reconstruction of the bridge, which is currently out of service and undergoing destruction. This is a multi-threaded and costly project which will be carried out over many years, in which the support from the EU funds is highly appreciated. The project implementation will help to restore and develop the social, cultural and tourist function for deprived areas in the region. This will be possible due to the complexity of the planned activities. An essential element of these activities is to analyze the possibility of rebuilding the bridge for reasons of cost and of image. The results of the analysis are presented in this paper.

## 2. Characteristics of the historic road bridge

### 2.1. Historical background

National road networks still operate bridges built in the mid-nineteenth century, which were pioneering at that time of construction. One of them is a bridge in Tczew, which was put into operation on October 12, 1857. The total length of the bridge was 785.28 m, one of the largest spans in Europe at that time. The supporting structure was made as three two-span steel grates in the form of a dense grid of intersecting elements.

The bridge consisted of the neo-Gothic towers founded on five bridge pillars and abutments topped with massive gates from the direction of Tczew and Lisewo (Fig. 1).



Fig. 1. Project of the bridge in the figure of Carl Lentze [3]

The architect was Carl Lentze, the author of static calculations and design solutions Eduard Rudolf Schinz, a designer of portals and towers – Friedrich August Stüler.

The conviction that this bridge is a leading design of this type on the European continent and deserves international recognition has led to enter it in the register of the “International Civil Engineering Monument” American Society of Civil Engineers: ASCE. Therefore, on



24 September 2004, it was held the unveiling of a plaque commemorating the event with the participation of representatives of state, local and Gdansk University of Technology and the U.S. Embassy in Poland [1].

## 2.2. Description of the current bridge structure

Due to the turbulent history, at the moment the object is composed of five different types of structures that were created at different times (Fig. 2). They are briefly described below [2].

**Type I – a span no. 1:** the span supporting structure consists of four main girders made of rolled composite with reinforced concrete slab bridge.

**Type II – spans 2 and 3:** a supporting structure creates a two-span continuous grate, temporary ESTB type with driving down.

**Type III – spans 4, 5 and 6 with a truss:** a supporting structure form a two-span continuous grates called “Lentze grates” and are covered by the entry into the register of monuments Pomeranian province under number A-1705.

**Type IV – spans 7, 8, 9:** a supporting structure of spans form free supported grates, riveted, with parallel stripes of W grating with posts, driving up.

**Type V – spans 10, 11, 12:** a supporting structure of spans form free supported grates with a secondary hanger, riveted, with parallel stripes of grating with posts, driving down.



Fig. 2. A view of the current condition of the bridge

## 2.3. The current technical state of the object

The current overall, the general condition of the bridge is very bad. The analysis carried out showed that the object in its current state, does not meet even the lowest class E capacity according to the existing standard PN-85/S-10030 (max weight of authorized vehicles – 150kN). The capacity of individual spans is not determined by main girders, but by elements of the bridge and roadway. This forced the County Road Administration in Tczew to close the bridge to traffic. Closer observation shows localized deformations of individual elements of the grid as well as cracks and scuffs in the concrete. Water damage to the deck slab is one of the reasons for the advanced corrosion of steel parts. The precast deck panels show visible damage in numerous places, which reduce their capacity. Within the pedestrian path there are



defects in the boards and railings, as well as rotten wooden elements. Deficiencies in basic security can lead to disastrous consequences. Degradation of elements of the historic brick towers can be observed as defects in brick walls, stains, numerous scratches and cracks. To sum up, all parts of the bridge require general repair or replacement, starting from the platforms and through to the main girders, elements of equipment and ending with the historic towers [4].

#### 2.4. The importance of the object

The importance of the bridge in Tczew is very diverse. It is a symbol, a repository of knowledge, as well as a tourist attraction. Some of the functions of the monument are as following.

Table 1

**The role of a bridge over the Vistula River in Tczew**

<b>The educational role</b>	The bridge currently consists of different types of spans that perfectly illustrate the development of bridge engineering from the mid-nineteenth century to the 70's of twentieth century. It is a source of interest for students from technical high schools as well as those from construction and civil engineering backgrounds.
<b>The economic importance.</b>	This is certainly a historic building that could attract tourists. Expenditure on construction works are an investment that is sure to return.
<b>The functional role</b>	After rebuilding the monument could act as a „link” on the tourist road connecting Gdańsk with Malbork – cities with very large tourist values.
<b>Social usefulness</b>	The local community feels great attachment to the bridge. The object induces a sense of community identification with the place.
<b>Political meaning</b>	The bridge built by the Prussians became a symbol of the development of German engineering. It is one of the few remaining „miracles” of the industrial revolution. In contrast, the sacrifices made by Polish railway men, defending the bridge against seizure, was a symbol of struggle and martyrdom of the September Campaign in 1939.

### 3. Concepts reconstruction

#### 3.1. Option 1 “historical”

The “historical” option involves recreating the look of the bridge as it was before 1939. The supporting structure of the bridge in this option will create nine spans visually two types, structurally three different types: the so-called “Lentze grid” will be restored, with the new grid welded to reflect the original appearance of 1912. For all spans the entire length of the bridge deck is made from an orthotropic steel plate. In addition, a pavement along the entire length of one side of the bridge is planned, while on the other side cycle path will be added [5].

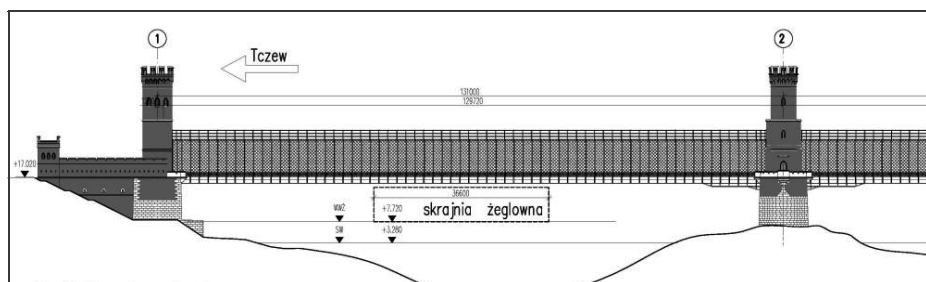


Fig. 3. Bridge project in “historical” option [5]

### 3.2. Option II “modern”

This option protects the traditional historic look of the bridge while at the same time establishing new structures by exchanging spans to the historic character of the object. It is also important to add all portals gates and towers in places where they were before 1939 that its appearance will refer to the characteristics of spans. Also the height of the newly designed gates and an entry portal from the Lisewo will be changed. The supporting structure of the bridge, using the “modern” option will create 10 spans and about three different types of structure. For all spans across the entire length of the bridge, the deck will be constructed of steel orthotropic plate. In addition, along the entire length of one side of the bridge is a planned pavement and the other a cycle path [5].

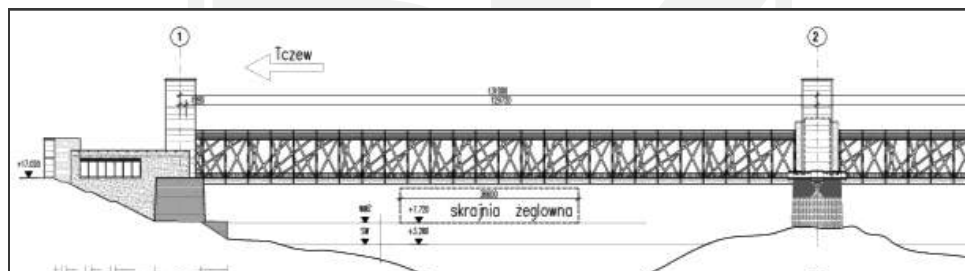


Fig. 4. Bridge project in “modern” option [5]

### 3.3. Materials and colors

Current historic parts of the bridge are constructed from Iron and steel bridge construction are shown in gray, clinker brick in light color (beige and sand), sand stone elements, the elements of granite stone. Supporting structures of newly built towers and gates portals are designed as reinforced concrete covered with clinker façade tiles and slabs of sandstone. The gate from Tczew side will be made from brick, stone and concrete. The applied colors on the towers are like the colors of horizontal ceramic slats and hand bricks in warm tones inspired



by the bright colors of brick and stone occurring in the historic towers. Proposed color at the concept stage refers the existing materials and colors. The colors of the bridge structure have been gently emphasized and show historical and newly constructed elements, taking the stages of creating the bridge, including its elongation from the Lisewo in 1912 into account [5].

#### 4. Analysis of the economic, technical and social aspects

Possible methods of reconstruction were analyzed in three aspects: economic – technical, taking into account the position of the conservator and ensuring the demands of the local community. Economic criterion as well as the conservational aspect pointed to a “modern” concept. Reconstruction of the bridge using the “historical” option will cost 133 mln zł (the spans and supports of the bridge will cost one hundred eighteen million zł), while in the “modern” option – 136 mln zł (the spans and supports of the bridge will cost one hundred twenty-two million zł). The cost comparison for selected elements of the two approaches are shown in figure no.5

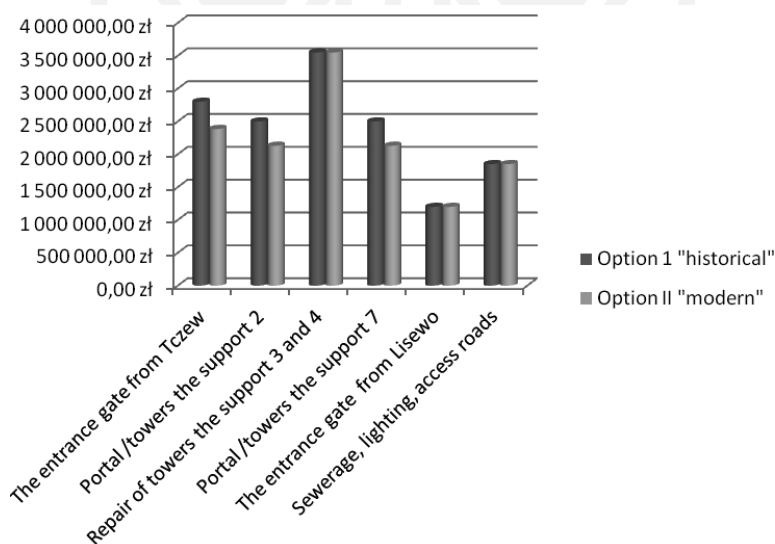


Fig. 5. Compare the costs of two variants on the basis of indicator cost estimate

In the opinion of the Provincial Conservator, the variant presented will positively affect the preservation of historical architectural value by exposing the surviving parts of the bridge from 1857.

Among the inhabitants of Tczew opinions definitely lean towards the “historical” option, which is more expensive primarily due to production of “Lenza” grates. Accordingly, the author has developed a compromise option taking into account the above demands (Fig. 6). Option compromise is a derivative of both reconstruction concepts in which the platform and



supports derived from the modern concepts and the entrance gate from Tczew side and towers retain the prototype appearance. After the cost estimation can be concluded that the towers and portal made using modern technology with the historical look with facing façade tiles in the described colors reduce the investment cost of about 1.150.000,00 zł.

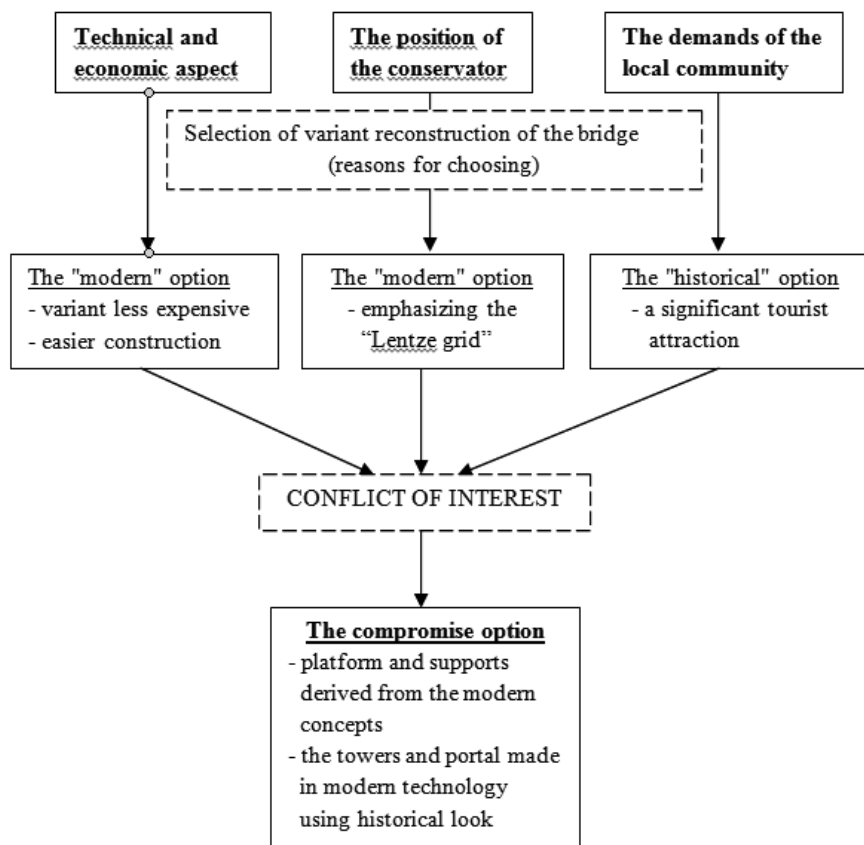


Fig. 6. Scheme for working out the compromise solution

## 5. Conclusions

Due to the historical character of the building – it is a wonderful monument of engineering, an object of European heritage and technical culture – thus it should be prevented from further degradation and reconstructed, so that it can actively work for many more years. The partial works covering only selected parts of the object should be avoided. Work must be carried out by the company and staff with experience in working on historic buildings.



In the event of the omission of any investment, the bridge will be subject to progressive technical degradation. The result will be a significant deterioration in the technical condition of the object and the increased risk to vehicular traffic within it. At the moment, the object is closed and traffic is directed to other crossings on the Vistula River. However, the renovation work on the border of the historic towers is carried out. An extreme result of a lack of technical improvements to the object as a result of progressive technological degradation process will result in the demolition of parts of object due to impending collapse. This option is particularly disadvantageous both for reasons of organizational functioning of Lisewo and Tczew, the protection of monuments (entered in the register of monuments) and indirect environmental hazards arising from the potential threat of the collapse of the object. Lack of investment implementation in the assumed range of road will result in significant deterioration for local traffic, particularly noticeable for the residents of Lisewo. On the basis of calculations of traffic for investment purposes, it was found that the studied object in the present day should be included to ease traffic, due to the lack of alternative means for communication road for Lisewo (with the exception of the object in Kwidzyń)

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