A R C H I W U M I N S T Y T U T U I N Ż Y N I E R I I L Ą D O W E J
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# CONSTRUCTION OF PEDASTRIAN CROSSING UNDER ELECTIFIED MULTITRACK RAILWAY LINE[1]

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Paper presents an alternative solution to the classic issue - a flexible burried steel structure as the superstructure of pedestrian underpass at Kapitulna street in Wloclawek which provides crossing under the tracks of the electrified railway line Number 18 Kutno–Piła. Underpass was built in 2012 by HUSAR BUDOWNICTWO INŻYNIERYJNE commissioned by Włocławek city.

The use of the corrugated steel structure allowed for a very quick execution of the investment, without detriment to aesthetics and functionality of underpass.

Key words: Buried steel structures, underpass, railway line, infrastructure

## 1. INTRODUCTION

Modernization and expansion of urban infrastructure, due to the nature of the project area, is associated with a number of technological problems, but also the need to make the traffic possible over the reconstructed structure, at least in a limited scope. The total closure of traffic in this case means more funding and social costs.

The most critical point of the entire project was very tight work schedule. The reason for that was the fact that the proposed pedestrian crossing was located under electrified multi-lane railway line, the complete closure of which was impossible. In addition, the construction site was located close to the city center and prolongation closure of the communication would be burdensome for citizens.

Work was carried out in stages, and due to the use of corrugated steel plates as the superstructure it was possible to limit the time of technological breaks, and execution time of the entire project to minimum. In the conventional solution, in which concrete is used, it is necessary to make work breaks due to the maturation of the concrete. Thanks to possibility of assembly of steel superstruc-

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ture in parts outside the designed location and the closure of part of the railway tracks, the task could be completed without any delay.

## 2. CHARACTERISTICS OF DESIGNED STRUCTURE

### 1.1. Primary solution using precast concrete

Main parameters of structure:

- Dimensions of cross section: 4.50x3.00 m
- Length: 49.85 m
- Length of precast elements: 2.49 m
- Concrete of precast elements: B50
- Concrete of headwalls: B40
- Reinforcing steel: A-IIIN

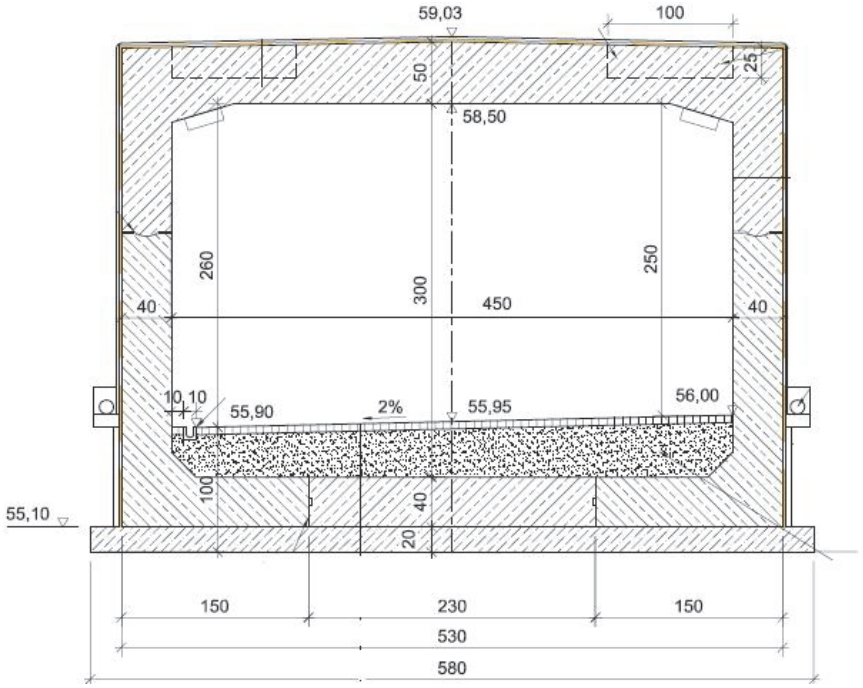


Figure 1. Cross section of primary solution

Structure was designed as frame made of precast concrete elements with inlet and outlet as reinforced concrete retaining walls. Function of structure is pedestrian underpass which provides crossing under the tracks of the railway line

Number 18 Kutno–Piła. Superstructure of underpass was calculated for rail load $\alpha k$=+2[2].

Because in primary solution, in which concrete is used, it is necessary to make work breaks due to the maturation of the concrete, contractor began searching for alternative solution which would speed up works requiring partial closing of railway no 18.

### 2.2. Alternative solution using soil-steel structure

Main parameters of structure:

- Clearance box of underpass: 4.50x3.00 m
- Dimensions of culvert in cross section: 4.91x3.95 m
- Corrugation: 200x55 mm
- Plate thickness: 5.5 mm
- Length of structure: 49.85 m
- Length of precast elements: 6.00-9.60 m
- Concrete of headwalls: B40
- Reinforcing steel: A-IIIN
- Steel of structure: S235JR

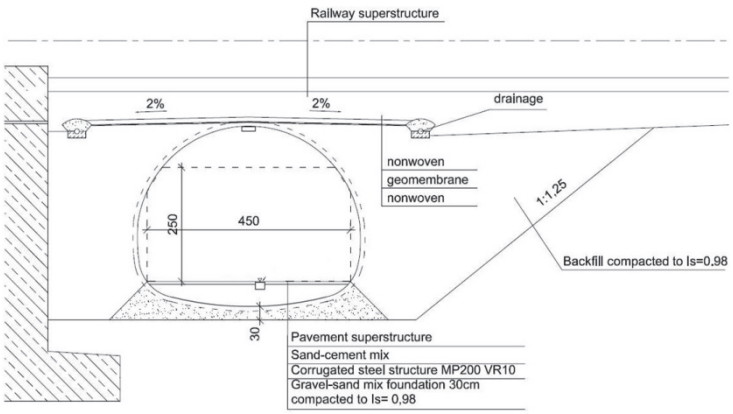


Figure 2. Cross section of alternative solution

Alternative solution was based on steel-soil structure made of corrugated steel plates joined by M20 class 8.8 bolts. Cover above superstucture of underpass measured from bottom of tie to neutral axis of corrugation was 1.15 m. Solution regarding the inlet and outlet remained unchanged. It was only adapted to the shape of the steel structure. Due to the closed shape and relatively good

[2] Acc. To Polish Standard PN-85-10030 $\alpha k$=+2 define the class of the railway line. Due to this an extra live load coefficient 1.21 is used.

soil conditions, foundation was proposed as 30 cm layer of sand-gravel mix compacted to Is=0.98. The applied thickness 5.5 mm and additional anti-corrosion coatings allowed to achieve capacity allowing rail load $\alpha k$=+2 while maintaining estimated durability of over 100 years. From the inside the structure was protected with a zinc coating witch thickness acc. to PN-EN ISO 1461:2000 and epoxy paint coating with thickness of 200 µm. From the outside, zinc coating was also used with additional coating based on bitumen with a minimum thickness of 4 mm. To protect the object against rain water leaking through the backfill designed as "umbrella" protection in the form of geocomposite (nonwoven 500 g/m$^2$ + geomembrane HDPE + nonwoven 500 g/m$^2$). Drainage was done via 2.0% two-sided decrease in cross-section that carries rainwater to the drain on both sides. In the case of steel-soil structure backfill compacted to Is=0.98 is inherent. It should be built symmetrically in 30 cm layers on both sides of the steel structure. As the material had to be used to backfill of sand-gravel mix fraction of 0-45 mm, uniformity coefficient Cu>5.0 and coefficient of curvature 1 <Cc<3

## 3. CONSTRUTION OF THE UNDERPASS

### 3.1. Stage I

The task could be divided into four key stages. Work began with the demolition of the existing embankment. Wall of excavation was secured by berliner wall. This allowed for the execution of works related to the partial demolition of the existing abutment of overpass above Kapitulna street.


Figure 3. Excavation of existing embankment

### 3.2. Stage II

The next step was closing five of seven railway tracks and partial construction of the object. Before earthworks started there a retaining wall of steel sheet piles was made which served as a protection of the excavation necessary to build the object. The schedule included building a 26 m sheet piling to a depth of 6 m in less than 6 h.


Figure 4. Assembly of steel structure

Parallel to the works related to the excavation, gravel-sand mix foundation and foundation of headwall, a partial prefabrication of superstructure was carried out with the implementation of external paint coating based on bitumen. The use of the structure of corrugated steel plates, significantly lighter than originally designed precast reinforced concrete, allowed for use of longer segments without the use of heavy equipment. 3 sections were precast with a total length of about 35 m. Assembly of superstructure with the implementation of paint coating took 4 days in total. Before backfill was built in it was necessary to make reinforced concrete headwall. B40 concrete reinforced with steel A-IIIN was used for the headwall. The quality and degree of compaction of backfill has a very significant impact on the soil-steel structure capacity, therefore each 30 cm thick layer of backfill was supervised. All works associated with the construction of the culvert under five railway tracks were carried out within 16 days while maintaining the technological regime.

### 3.3. Stage III

Work on the remaining part of the underpass began after the traffic was restarted on the reconstructed tracks. As in the earlier stage, superstructure was precast.


Figure 5. Merge between two phases of construction

Merge between two stages was made after a hole in sheet piling was cut.

Inlet was also made as reinforced concrete head wall. For aesthetic reasons, the joint of the headwall and steel structure was hidden under steel collar. Works related to building the second part of superstructure took a total of 6 days.

### 3.4. Stage IV

The final stage was rising the track mechanically in order to achieve the designed elevation of the rail head. Additional activities which no longer required the closure of the railway tracks consisted of finishing works and the construction of a MSE wall system ViaBlock, the aim of which was to secure the unstable slope along the sidewalk.

## 4. SUMMARY

Time of work execution was in this case a key aspect of the planning and optimization of a design. Contractual penalties associated with any delays that may have affected the traffic on the railway line No. 18 Kutno-Piła were 1.164 mln PLN (0.277 mln EUR) per day which was a third of the total value of the works.

Figure 6. Finished structure

The tasks were conducted 24 hours a day, 7 days a week while the schedule was planned to the hour. Dividing the works related to the superstructure of underpass into two stages allowed for the traffic of passenger and freight trains with access to the station platform Włoclawek without the need for substituting means of transport. The time for completing the task was 11.07.2012 to 15.11.2012 while the works related to the superstructure of underpass required the closure of the railway line for a total of 29 days. Despite the short notice provided for works related to the railway being occupied, works were completed on schedule, with full technological regime and with adherence to good building practices.

## LITERATURE

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