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# Assessment of Technical State and Method of Repair of Three-span Viaduct over Railway Line

**ARKADIUSZ GRZEGORZ MORDAK**

*Opole University of Technology, Poland*

**DAMIAN BEBEN**

*Opole University of Technology, Poland*



# **PLAN OF THE PRESENTATION**

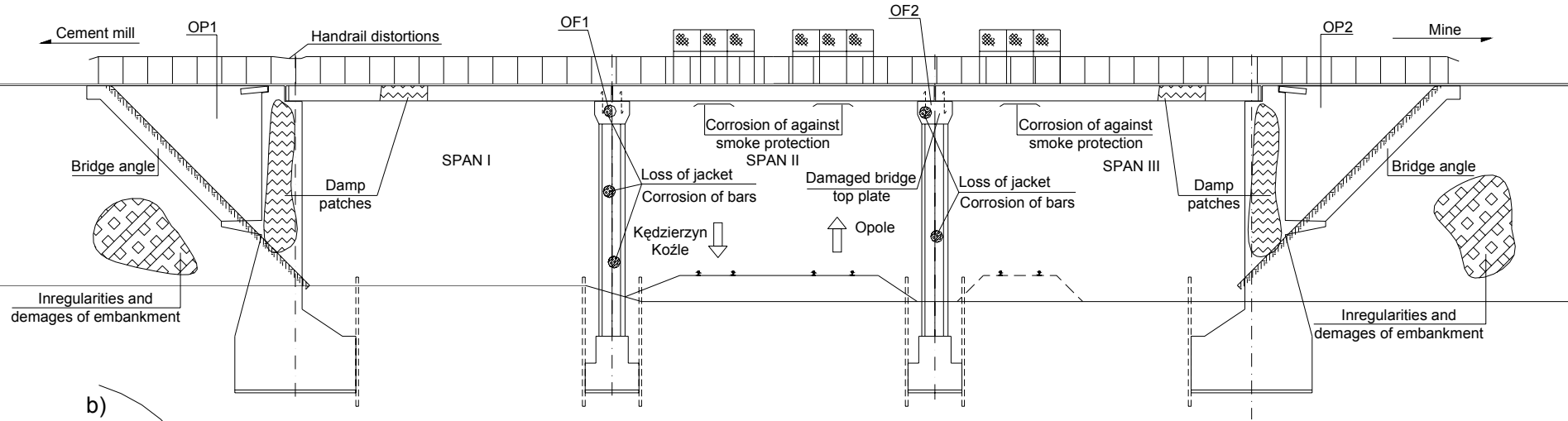
- 1. Introduction - bridge structure description**
- 2. Assessment of viaduct technical condition**
- 3. Concept of bridge structure protection and strengthening**
- 4. Final remarks**

# 1. Bridge structure description

1. The subject – road viaduct located over Kedzierzyn Kozle city – Opole city railway line during technological route from Gorazdze cement mill to Gorazdze lime stone mine.
2. Load capacity structure: three simple supported beam span structures consists of 25 Gromnik type main beams (height amounted to 0.56 m ) 8.
3. Effective bridge spans: 11.50 m.
4. Viaduct dimensions: length 39.04 m, width 13.00 m.
5. Road width on the object is 8.00 m, pavements width is about 1.5 m.
6. The viaduct is located in skew ( $71^{\circ}30$ ) in relation to the obstacle (railway line).

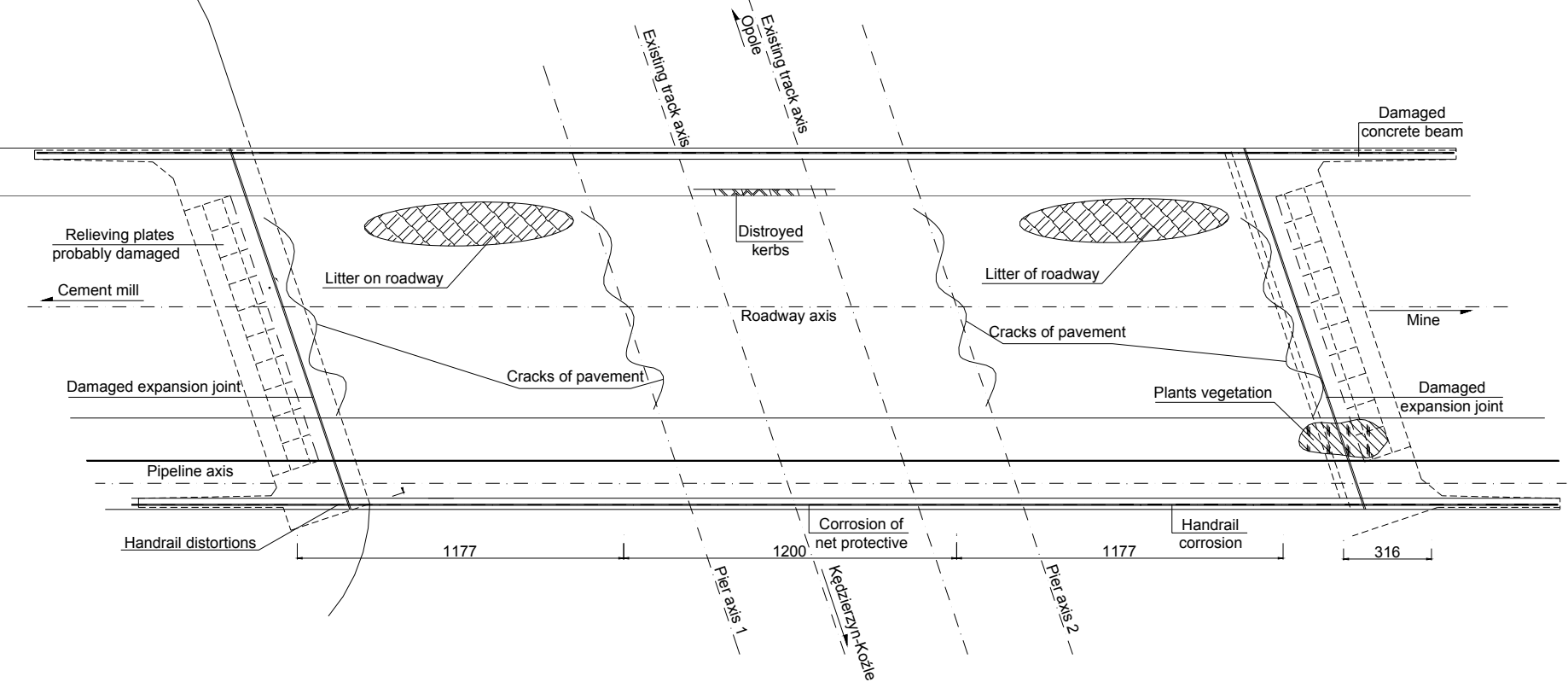
a)

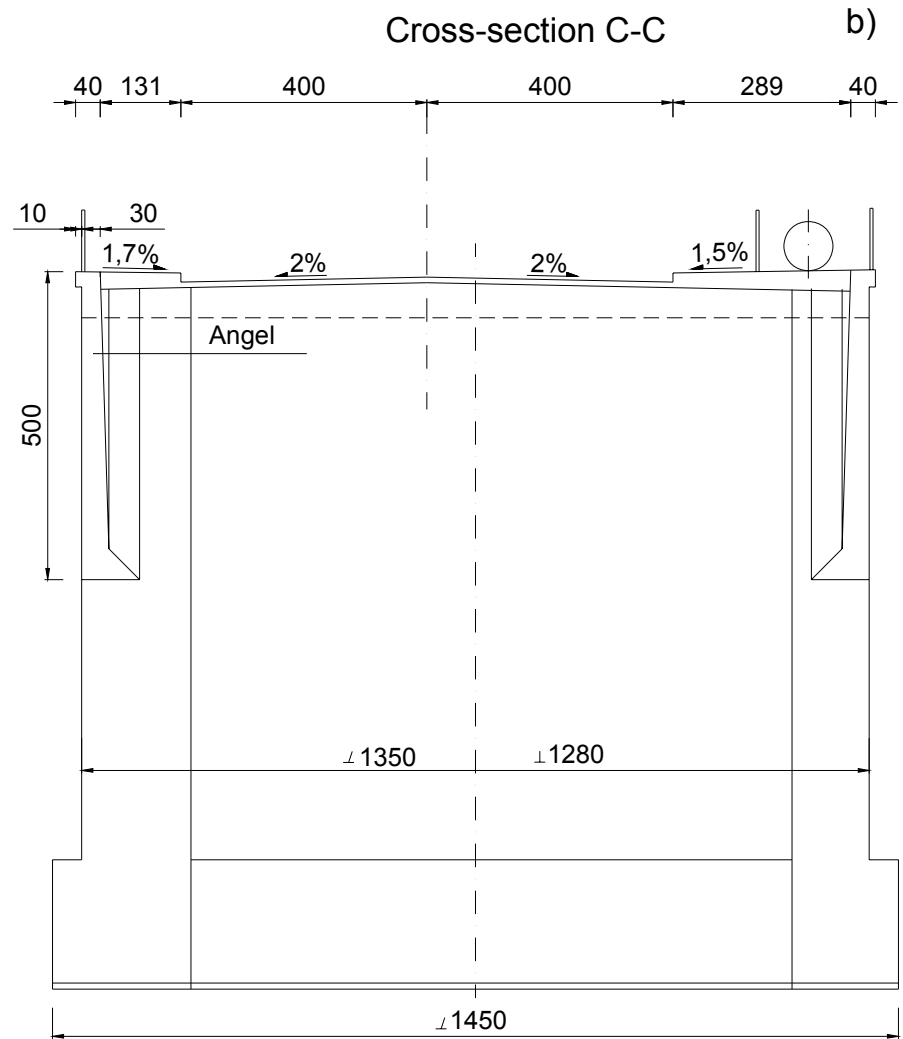
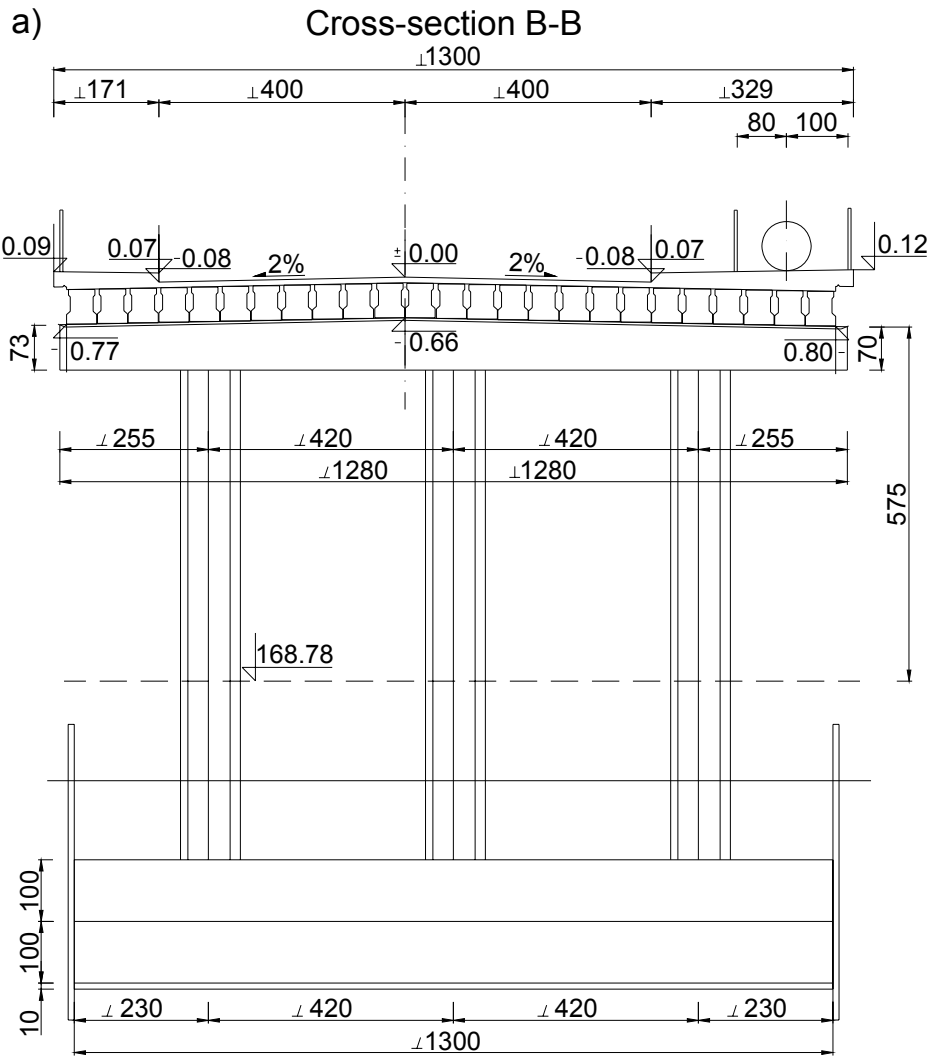
SIDE VIEW



b)

Plan on roadway level





- 7. The abutments are founded directly on the ground by the solid reinforced concrete foundations.**
- 8. The reinforced concrete bridge angels of variable thickness 0.30–0.44 m and length of 6.50 m are applied from each side of abutments.**
- 9. The roadway level on viaduct sets the longitudinal downgrade of 0.42% and the two-sided transverse downgrade amount 2.00%. The transverse downgrade of 1.5% (from one side) and 1.7% (from the other side) are constructed on the sidewalks.**
- 10. On the viaduct approaches the relieving plates of 1.00×1.00×0.20 m are applied.**

a)



b)



**General side view on the road viaduct: a) from Kedzierzyn Kozle side, b) from Opole side**

a)



b)



**General view from the road level on road viaduct: a) from the lime stone mine side, b) from the cement mill side**

## 2. Viaduct technical condition assessment

During bridge structure observations and technical condition investigations it was affirmed:

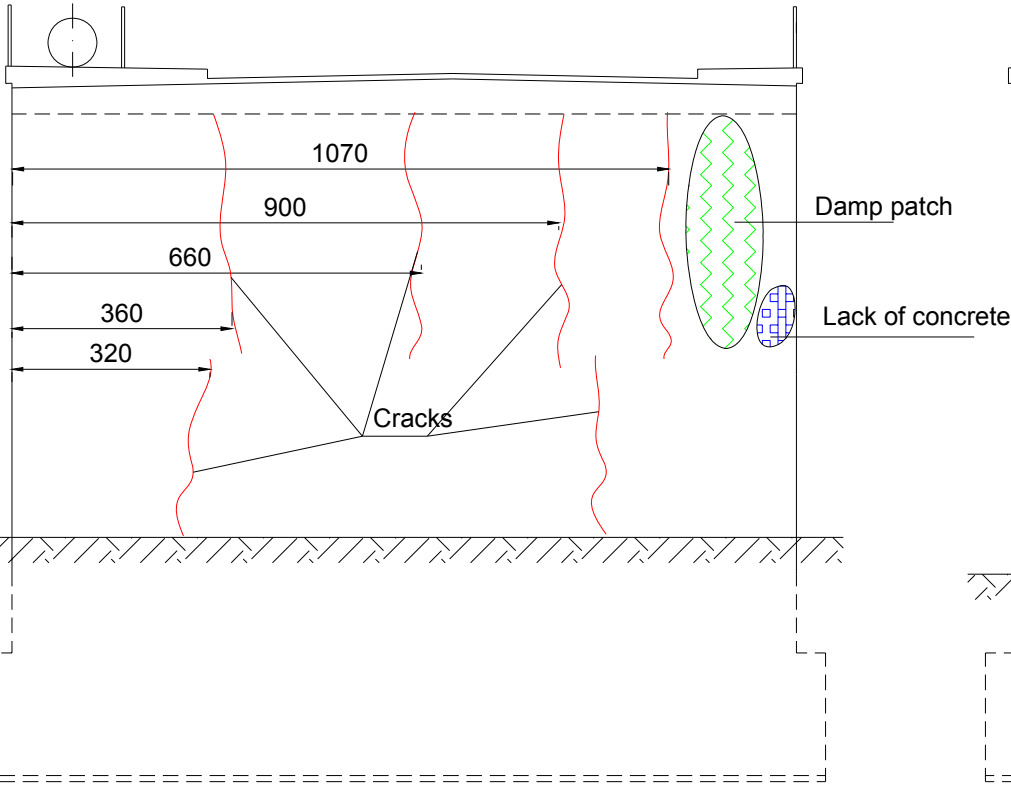
- ❑ a lot of reinforcement lagging lacks of reinforced Gromnik type concrete girders - it was the reason of progressive concrete girders steel reinforcing bars corrosion 1,
- ❑ a lot of damp patches, blooms and icicles from the bottom side of the spans. It provides that insulation of the bridge deck was not tight and non-effectiveness of drainage system 2,
- ❑ concrete corrosion in some main girders (decorticates) 3,



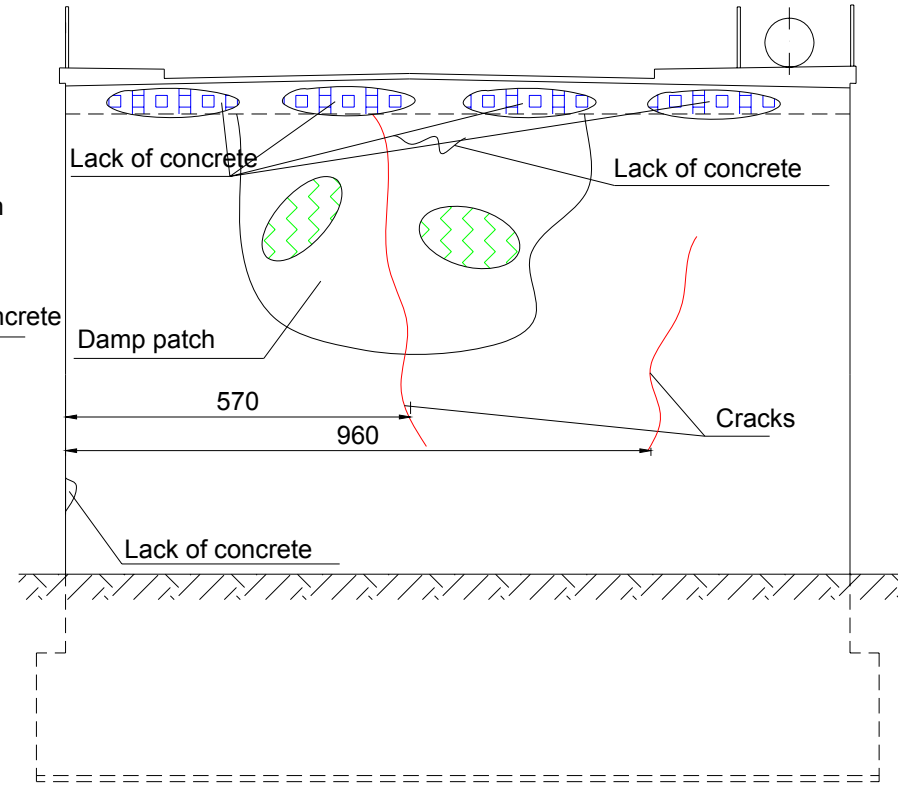
## During viaduct abutments it was affirmed:

- ❑ 6 cracks thickness less than 1.0–1.5 mm on the left abutment (from the cement mil side). Four of them run across the whole pier height (from bridge deck plate to foundation), what can provide unequal settlement of the pier 6,
- ❑ two cracks, thickness less than 1.0 mm on the right abutment (from the lime stone mine side). One of them run across the whole pier height and additional visible damp patches and vegetation of moss ,
- ❑ visible reinforcement lagging lacks, concrete corrosion of both abutments (decorticates), and corrosion of reinforcing steel bars too 7.

a) View on the abutment from cement mill side



View on the abutment from the mine side b)



**View on the road viaduct abutment head damages:**

**a) from the cement mill side, b) from the lime stone mine side**

# Assessment of bridge structure elements technical condition:

No.	Element	Damages type								Note
		NA	UA	WA	RA					
1.	Road pavement	NA	UA	WA	RA					3
2.	Hand rail and railings	DS	RS	AS						4
3.	Drainage	NA	WA							2
4.	Bridge deck insulation	UF	ZF	CF						2
5.	Load capacity structure	CB	RB	UB	ZB	OB	KS			3
6.	Abutments	AB	RB	CB	OB	UB	WB	KS	KB	2
7.	Piers and piers cap	WB	UB	AB	KS	KB	CB	OB		2
8.	Embankments	NT	UT							3
9.	Obstacle	NT								4
10.	Bridge approaches	DA	ZA							4
11.	Expansion joints	ZP	DP							2
12.	Accessory devices	NS	WS							4
General note (arithmetic average)										2,92

Damages: N – impurity, W – plants vegetation, C – damp pach, O – lees or efflorescence, A – damages of anty-corrosion protection, R –cracks, D – deformations, U – lack of material, Z – material structure failure, K – corrosion.  
 Material: K – stone, S – steel, A – asphalt, T – soli, F – insulation, B – concrete, P – felt.

## 4. Concept of bridge repairs

According to executed analysis arise the proposal of two phases of viaduct repair. The first one – immediate repair (stage I) and main repair (stage II):

### ***Stage I – immediate repair (temporary repair)***

- verify the propagation of the cracks by glass seals gluing 5,
- if the cracks were stabilized it was necessary to inject the cracks by injecting emulsion and complete uncovered reinforcement lagging lacks by suitable PCC mortars,

- ~~clean~~ and anti-corrosion protect uncovered reinforcing bars,
- complete the reinforcement lagging lacks of reinforcement,
- rebuild of piers cap,
- exchange of expansion joints,
- clean the concrete surfaces from blooms and damp patches,
- clean, complete and execute of cover layers on concrete elements.

## ***Stage II – main repair***

**Works should be made in the mode of strengthening of the bridge connected with possible increase of load class (up to 50 Mg) .**

**To make it possible it is necessary to make detailed research and static-strength calculations of this object, to estimate the possible limit state of particular its elements and regard the CFRP strips to strengthen the main girders.**

## ***Stage II – main repair***

**It is also necessary to provide in the range of this bridge repair (except of stage I of repair range) following works:**

- increase the thickness of the deck slab (min 0.21 m),**
- exchange of relieving slabs for longer (min 4.00 m),**
- execute the new deck plate insulation,**
- execute of new pavement on the bridge road,**
- repair (straighten) and painting of the hand-rails.**

## **5. Final remarks**

**On the analyzed object menace was affirmed due to cracks of the two abutments and sufficiently reinforcement lagging lacks of reinforcement in many elements of the bridge.**

**It was recommended to apply suitable road marks for limiting weight (to 30 Mg) and velocities (to 30 km/h) of heavy trucks. It was developed to protect the bridge from current load capacity violate.**

**After the comprehensive analysis of viaduct technical condition it was recommended to execute proposed stages of repair, what permit on safe exploitation of this object by 25–30 years.**

**Thank you for your kind attention!**

***e-mail: [a.mordak@po.opole.pl](mailto:a.mordak@po.opole.pl)***

A photograph showing the underside of a concrete structure. The main girders are visible, showing signs of wear and graffiti. The concrete is light-colored with some darker spots and stains. The structure is supported by a concrete pillar on the right. The background shows some trees and a clear sky.

**Bottom view on the  
main girders of the  
first span from the  
cement mill side**

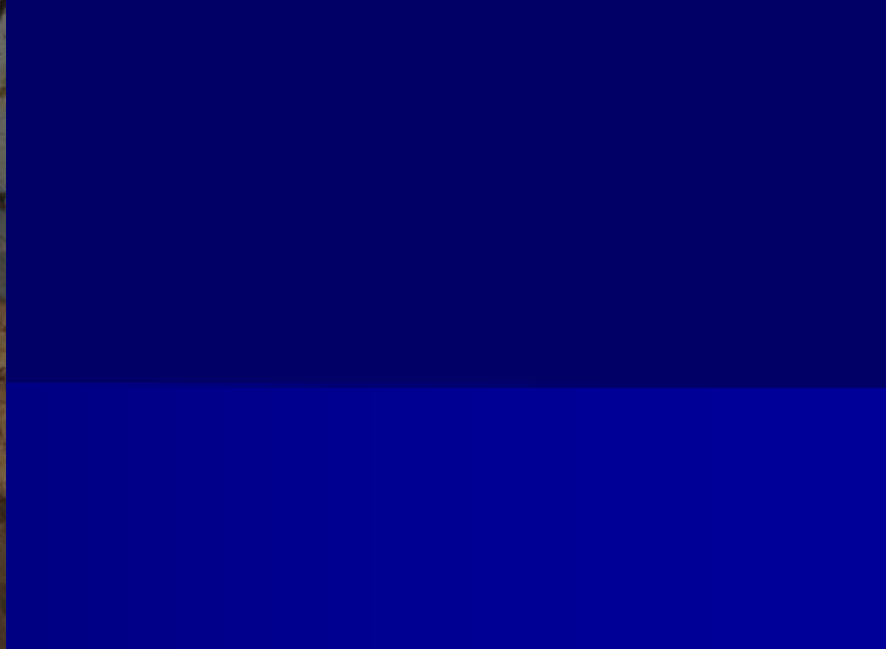
A close-up photograph of steel reinforcing bars (rebar) embedded in concrete. The rebar is heavily corroded, with a thick layer of rust visible. The concrete surrounding the rebar is also stained and discolored. The background shows some trees and a clear sky.

***Visible: progressive  
concrete girders steel  
reinforcing bars  
corrosion***



**Bottom view on damages and reinforcement lagging lacks of main girders and piers cap**





**Bottom span view.  
Visible damages of main  
girders and piers cap  
(concrete corrosion,  
decorticates, damp  
patches).**





**View on the glass seals glued to the cracked surface of the abutments**

