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Robot helps us to rehabilitate an Over Pass in Resita

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Summary

The over pass to be rehabilitated is situated in the northern part of the city Resita and passes the switch yard for railways and the Barzava river.

The substructure of the over pass, consisting of two spans situated on the left bank of the Barzava river, is under passed by a junction arm for the access on the over pass.

In the winter of 2007 an over gauged transport has heavily hit the three monolith reinforced concrete girders of the superstructure.

In spite of the significant damages, the superstructure has kept its bearing capacity needed for a light traffic with a maximum load of 3,5 t.

The paper presents the damages of the superstructure and also the rehabilitation solutions, which involve the adjustment of the geometry of the under passing junction arm as well.

KEYWORDS: Over pass rehabilitation, Reinforced concrete, Lifting system, Road geometry adjustment

1. GENERAL ASPECTS

The over pass over the switch yard for railways afferent the station Resita North, situated in the city Resita, assures the connection between the national road 58B Resita – Voiteni and 58 Resita – Caransebes [2]. In addition to this, the over pass facilitates the connection between the Lunca Barzavei neighbourhood in the north of the city and the anchient and industrialized part situated in the south (Fig. 1).

As an entirety the over pass consists of two parallel structures, the first one, situated in the North, executed in 1965 as a monolith reinforced concrete solution, and the second one, situated in the south, executed in 1989 in prestressed precasted concrete solution. Both structures of the over pass were dimensioned for the loading class E.

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Figure 1. Lateral view towards the first hit beam

The initial structure consists of three sections:

- one section from the west part, curbed, assures the access towards Timisoara;
- the second sections from the west part, also curbed, provides the access towards Resita South but also the passing over of the junction arm afferent the direction Timisoara-Caransebes;
- the third section is streight and assures the passing over the switch yard of the railway.

The execution of the new structures in 1989 allowed the increase of the gauge up to 4 traffic lanes an the emplacement of the tramway in a separate track. The older structure, from 1965, is aimed only for vehicle and pedestrian trafic.

The superstructure build as a frame affected by the intervention works, consists of two spans of each 22 m, simply beared on the marginal infrastructures, pier and abutment, and has fixed ends on the central pier (frame knot).

The total width of the over pass is 12,80 m and includes the carriage way of 8,20 m, a footway of 2,60 m on the right side and a safety area of 2,00 m on the left side, next to the tramway.

The cross section has three girders out of monolith reinforced concrete having an interax distance of 4,00 m. The girders are 1,80 m high. The spatial compound effect of the bridge deck is assured by 3 cross beams situated in the field and the ones from the bearing sections.

The degraded structure of the over pass is passing the junction arm between the national road 58B Resita - Voiteni and 58 Resita - Caransebes.

This road bears all kind of traffic gauge, in the direction Resita – Timisoara, respectively Timisoara – Caransebes via Resita.

The way has asphalt coating with disleveled border stones having a width of 7,00 m for two traffic lanes.

It has to be pointed out that the inferior gauge of the over pass is only 4,20 m, fact that is against the effective standards, which foresee a hight of 5,00 m. In this situation accidents, which could affect the integrity of the over pass structure, can occure.

2. DEGRADATIONS AND THEIR CAUSES

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In the first decade of December 2007 an over gauged transport has under passed the over pass. The restriction for the maximum height of 4,20 m established when entering the under passing junction arm, was not considered and the impact was followed by the heavy degradation of the three reinforced concrete beams, in the central area of the marginal span, between the current cross beams.

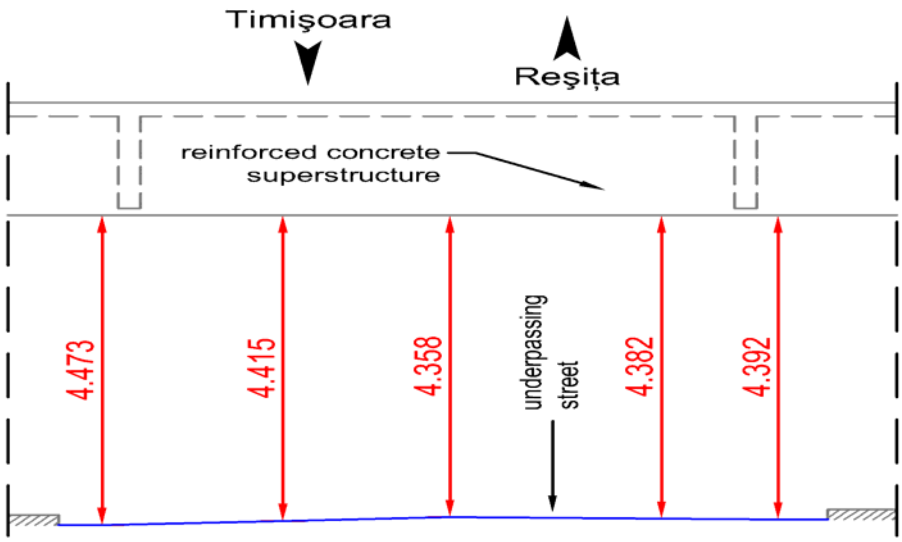

Figure 2. The vertical gauge under the first hit beam

In order to clarify the causes which lead to the mentioned degradation, measurements for the vertical gauge were made by using electronic devices with laser [1]. These measurements were carried out in 3 sections in the over pass area: under the steel gauge restriction device, under beam 1 (from Timisoara) and under beam 3 (from Resita).

It is notable that from chronologically point of view, the impact occurred as follows: beam 1, beam 2, beam 3 [1]. Thus first was beam 1 hit having the minimum vertical gauge 4,358 m, with 0,158 m higher than the restriction height of 4,200 m (Fig. 2).

The girders of the span on the abutment side show important degradations of the concrete in the core and the flanges, respectively of the resistance reinforcement, with disrupted and deformed bars, some of these having a seriously diminished section (Fig. 3, 4 and 5).

Figure 3. Beam 1

Figure 4. Beam 2 (central beam)

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Figure 5. Beam 3

Due to this degradations, on about 40% of the reinforcement can not be counted anymore, fact that leads to a proportional diminishing of the bearing capacity of the over pass. It was estimated that the reserve of bearing capacity is satisfactory only for vehicles with a maximum load of 3,5 t. Therefore a tonage restriction was imposed in order to keep the traffic for light vehicles.

3. REMEDIAL SOLUTIONS

In order to establish the optimal rehabilitation solution, the structure was expertized and two posibilities were considered:

- rehabilitation of the structure;
- replacing the existing structure.

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Considering the fact that the replacing solution would mean intervention works at the bearing areas, which would had to be adapted to the designed cross section, and also the alteration of the intermediate pier beam (a highly complex operation), the option was to bring the structure to an adequate bearing capacity. This solution is advantageous as structural concrete is of good quality, C25/30 [2] (Fig. 6).

Figure 6. Concrete test rods from the superstructure

Considering opting for the replacing of the existing structure the following situation is reached:

- on the same traffic direction there will be two different structure types, as rebuilding the structure in a monolith solution is technicaly an obsolete aspect;
- the over pass will have three structures types with very distinct ages (1965, 1989 respectively 2009) which would request specific maintenance works.

Nevertheless bouth solutions impose the lowering of the grade line in order to obtain an appropriate gauge under the over pass, according to the standards in use.

For the rehabilitation of the degraded part of the over pass, three technological solutions were considered:

a) external prestressing applied on the affected girders, solution which was considered unfitting as the structure is realized with curbed girders having a

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radius of about 170 m; this leads to horizontal efforts aferent the longitudinal prestressing phenomen;

b) consolidation with carbon fibres apllied on the lower flange of the girders, solution which would not provided sufficient security of the consolidated area due to the unappropriate vertical gauge of the under passing street;

c) renewing of the degraded reinforcement by replacing the affected bars with new ones connected with the existing bars in the area where the concrete was not destroyed.

The third solution was retained as being the most convenient considering the execution and the behaviour of the structure.

The solution requests that, at the moment of the intervention, the efforts in the damaged reinforcement should be reduced close to zero. Only this way the new reinforcement will be active after the concreting similar to the existent reinforcement.

In order to bring the mounted reinfocement in a effort status similar to the one of the existing bars, the temperature of the new reinforcement will be modified, which will lead to the expansion of the bars before welding and to their contraction when cooling down and therefore to the stressing of the bars.

For an important diminishing of the unit stress in the reinforcement in the affected area, the bridge deck will be supported provisionaly with steel tubes. On these tubes hydraulic jacks will be mounted which will be used to modify the anti-gravitational loads upon the structure and therefore the stress state [3] (Fig. 7).

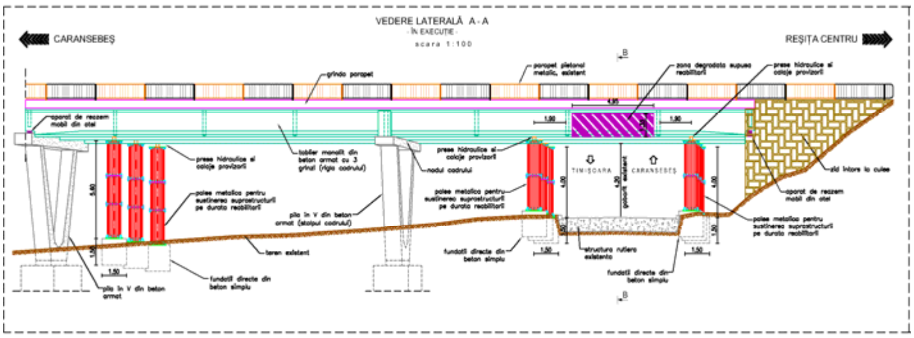

Figure 7. Provisional support of the structure

Due to the characteristics of the frame structure, additionally supports for the superstructure were necessary also in the unaffected span. In this way the loading level in the frame elements was maintained at a maximum value comparable to the one the structure was initially designed for (permanent load + special vehicles V80 convoy) (Fig. 8).

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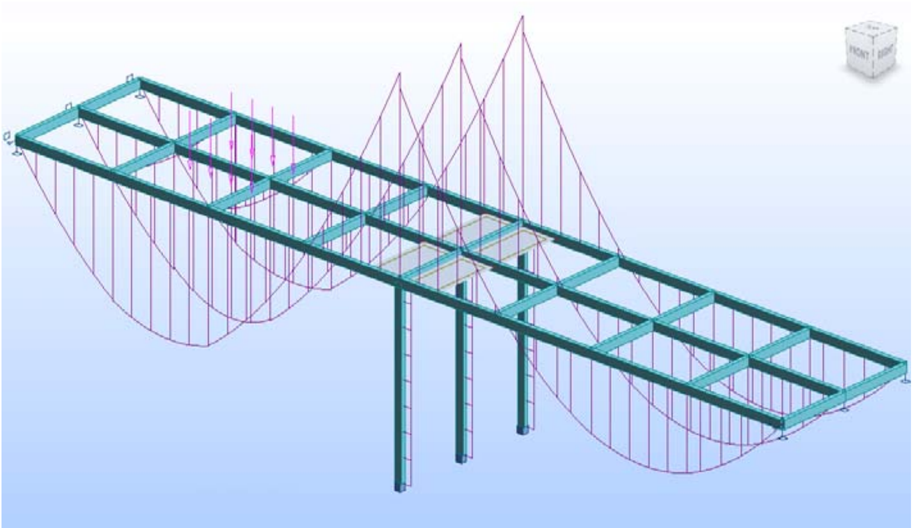

Figure 8. Bending moment from permanent load + V80 convoy

The principle of superpositioning the effects made possible to find a load combination in the 3 supporting lines with jacks, which lead to a minimal load value in the degraded area and to acceptable values in the other characteristic sections (lower than the loads the structure was designed at) (Fig. 9 and 10).

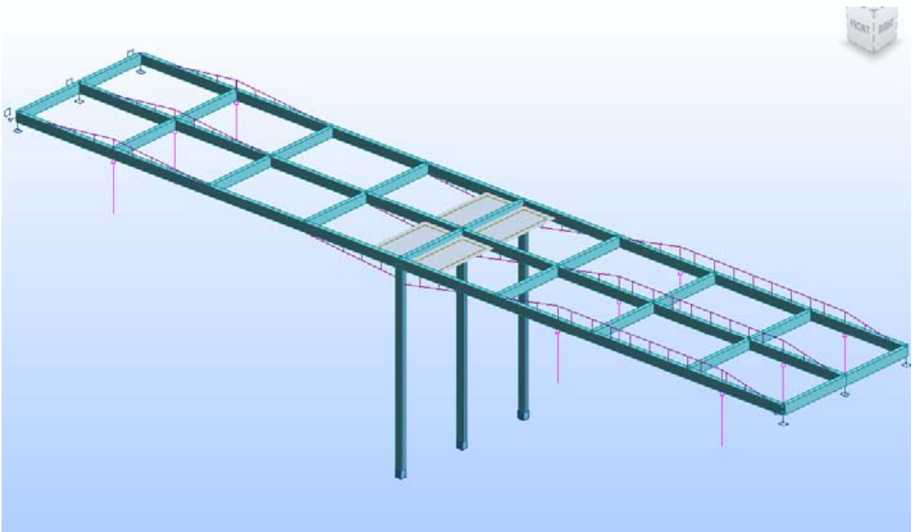

Figure 9. Bending moment from aditionally loading from the hydraulic jacks

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Figure 10. Bending moment from aditionally loading from the hydraulic jacks and permanent load

Thus the replacing works of the degraded reinforcement can be carried out at 23% of the load afferent the permanent loading (Fig. 11).

	K x	M max [kNm] in point 20/100				M max [kNm] in point 8/100			
		girder G1 TM		girder G2		girder G1 TM		girder G2	
		in use	in rehab.	in use	in rehab.	in use	in rehab.	in use	in rehab.
Structure		1206	1206	1210	1210	731	731	735	735
Dead load		1166	1166	1166	1166	714	714	713	713
S+D+2A30		2372		2376		1445		1448	
S+D+V80		2518		2507		1498		1499	
jacks line 1	4.5		-794		-794		-1121		-1121
jacks line 2	4		-976		-976		-359		-359
jacks line 3	4		139		139		51		51
demolition G1			-118		-57		-43		-30
demolition G2			-59		-88		-32		-28
demolition G3			-22		-57		-14		-30
TOTAL			542		544		-72		-69
			23%		23%				

Figure 11. The optimum value of the aditionally loading from the hydraulic jacks

After the renewal of the degraded reinforcement, the core and the flange of each girder will be reconcreted.

When the rehabilitation works are finished, the provisionaly steel tubes will be removed together with the afferent foundations.

The works will be finished by modifying the geometry of the under passing street aiming to provide an appropriate vertical gauge (Fig, 12).

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Works for the renewal of the sewage respectively for the street lighting will also be executed [3].

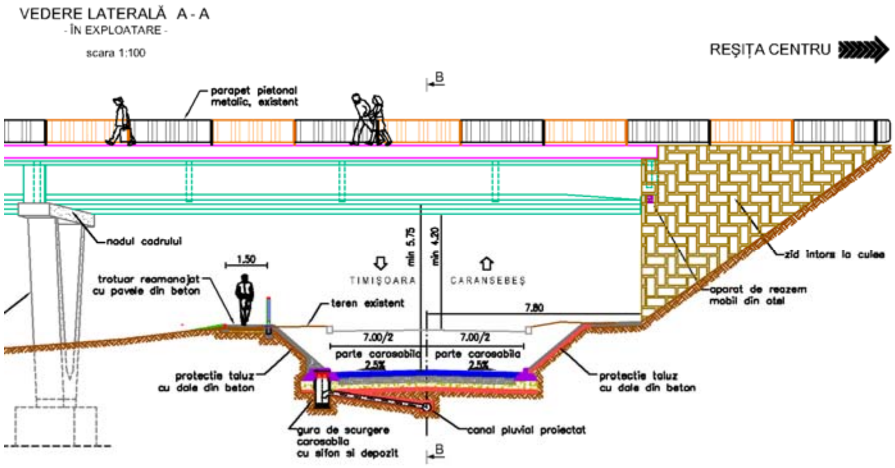

Figure 12. The designed under passing street

4 CONCLUSIONS

By carrying out de rehabilitation works, the following objectives are reached:

- bringing of the bearing capacity of the over pass at the level of the loading class E;
- keeping the structural assambly of the over pass as a monolith reinforced concrete structure;
- obtaining an appropriate vertical gauge under the over pass for a street with 2 traffic lanes and footway;
- providing all safety conditions for the traffic development on and under the over pass.

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