REPAIR OF THE BRIDGE OVER THE RIVER RESNICE IN KOCEJEVA

АНУАЦИЈА МОСТА ПРЕКО РЕСНИЦЕ У КОЦЕЉЕВИ

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Summary: This paper presents project of rehabilitation of the bridge over the river Resnica in the municipality of Koceljeva based on the documentation on the current situation. The existing bridge is road, reinforced concrete, beam system bridge, with the middle span of 4.15m and cantilevers of 0.64m and 1.05m. At the point of support of the road structure, transverse beams of variable cross-section are made, which rely on the perimeter walls of the bridge. The terms of reference required the bridge to account for a V600 vehicle and to extend it from two pedestrian paths. The static calculation of the bridge was done in the Radimpex Tower software.

Keywords: V600 vehicle, bridge, rehabilitation

1. INTRODUCTION

The existing bridge is reinforced concrete, beam system bridge, with the middle span of 4.15m and cantilevers of 0.64m and 1.05m. At the point of support of the road structure, transverse beams of rectangular cross-section at both ends of the bridge are constructed, which rely on the perimeter walls of the bridge. The road

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construction is a full reinforced concrete, 22cm thick (d=22cm), constructed on site, slab. The existing width of the bridge is L = 5.725-6.23m, with no footpaths. The planned width of the rehabilitated driveway on the bridge is 5.50m with footpaths 2x1.05m. Pedestrians are protected on the bridge by 20cm high curbs and 1.18m high pedestrian fence. The rehabilitation of the bridge is envisaged so that the footpaths rely on the new reinforced concrete beams with "g" cross-sections (dilated from the existing structure along the span except on part of the supports), which rely on vertical edge columns. Lower parts of edge columns are relying on the existing foundation. Foundation was executed on the strip foundation, and the control static calculation included the derived condition. Due to the lack of design and technical documentation of the bridge, the following is foreseen for the preparation of the rehabilitation project:

- detailed survey of the geometry of the bridge (all supporting positions),
- determination of embedded materials (reinforcement, concrete),
- Static calculation of the rehabilitated bridge

From the above, the necessary data are obtained, on the basis of which the necessary measures of rehabilitation of the existing bridge will be given.

Figure 1 – Cross-section of the existing bridge
2. CONDITION OF THE CONSTRUCTION OBTAINED BY EXAMINATION

Based on performed measurements and conducted static and deformation analysis, it was found:

The size of the test load was approximately 300 kN, which corresponds to the load that would have been applied to the bridge structure if a test vehicle V300 had been applied, and therefore the coefficient of efficiency of the applied test load was approximately 1.0, which is in accordance with the applicable standard SRPS U.M1.046. Inspection of the structure during the test load test revealed defects / damages of the bridge and its immediate surroundings (shoreline), which cast doubt on its reliability and stability, indicating the possibility of a reduced load-bearing capacity of the structure if it is not brought into a technically correct condition. The concrete compressive strength test was conducted using an electronic sclerometer. The following results are determined by given measurements:

- concrete age: assumed over 20 years,
- concrete surface: unprotected,
- protective layer: 15-20 mm, estimated concrete compressive strength by testing (based on non-destructive concrete diagnostic results): $\sigma=33.73$
MPa, reinforcement is established in the lower bridge area (16/15cm).

3. STATIC ANALYSIS OF THE BRIDGE

The load analysis included: constant load (surface and line), traffic load from V600, concrete shrinkage and flow, loads on bridge railings, uniform temperature changes, uneven temperature changes, vehicle stops and starts, snow. Due to the large size, no detailed calculation is shown, while only the diagram of the required reinforcement is shown in the lower zone of the newly designed bridge slab.

Слика 3 – Новопројектован 3D модел моста у Toweru
Figure 3 – Newly designed 3D model of the bridge created by Tower software
Figure 4 – Traffic Load Scheme - V600 Vehicle

Figure 5 – Diagram of required reinforcement in lower zone of slab of newly designed bridge
4. REHABILITATION MEASURES

Due to the extension of the bridge for footpaths, the formation of reinforced concrete beams on both sides of the bridge (upstream and downstream) is foreseen, which rely on new reinforced concrete columns. The connection between the existing edges of the bridge is connected to the existing supporting part of the bridge, and is dilated along the rest of the span. The columns and foundation connections were made by installing anchors in the existing foundation. The rehabilitation project foresees that the underside of the bridge slab must be repaired.

The control static calculation of the existing bridge provides the necessary reinforcement for the existing static system $Aa_1 = 25.84 \text{ cm}^2$. The measured built-in reinforcement is $\phi 16 / 15 (13.04 \text{ cm}^2)$, which is less than the required reinforcement. Reinforcement of the bridge needs to be executed. It is foreseen that the rehabilitation should be carried out by adding carbon strips according to the dimensioning of the carbon strips of the Sika manufacturer, by the Sika CarboDuo program. The adopted axial distance of carbon strips is 250 mm.

Damaged surface should be removed and the concrete area should be treated. The cavities and openings should be filled with suitable repair mortar. Substrate preparation materials should be compatible with the adhesive. Concrete should be over 28 days old.

The concrete surface should be cleaned of oil, grease and other impurities, as well as loose particles and dust. Substrate moisture should be less than 4% (measured by weight).
5. **CALCULATION OF ALLOWED BEARING CAPACITY OF THE FOUNDATION**

On the basis of the results of field investigations in the bridge area, a geotechnical model of the terrain was defined for the purpose of carrying out the calculation of the permissible bearing capacity. The allowable load calculations were made for the determined dimensions of the $B=2.2m$ width, base strips, and for the minimum adopted values of physical-mechanical parameters. The payload calculations are performed according to the Rulebook on technical standards according to the formula:

$$q_a = 0.5 \cdot \gamma \cdot B \cdot N_y \cdot S_y \cdot \gamma \cdot i_y + \left( C_m + q_o \cdot \tan(\phi m) \right) \cdot N_c \cdot S_c \cdot d_c \cdot i_c + q_o$$  \hspace{1cm} (1)
Calculations of the permissible load-bearing capacity of the soil were made for 2 variants - for the present condition of the bridge and foundations and for the state of minimum intervention measures on the foundations. As the examination of the terrain and the condition of the bridge revealed that the foundations of the bridge were partially discovered, the most unfavorable condition was adopted for the foundation depth - that the depth of the foundation is equal to 0, that is, the foundations of the bridge are supported on the surface of the ground without burial, and that the bridge is grounded respecting the minimum frost protection criteria at a depth of 0.8m.

For the foundation depth $D_f = 0m$ (existing condition), the stress in the base coupling is $q_a = 52.33kN / m^2$. Such a low value of the load bearing capacity of the soil for the existing condition of the foundation of the bridge (about $52kN / m^2$) is a consequence of the shallow burial of the bridge.

As part of the rehabilitation of the existing bridge, it is also necessary to anticipate interventions in the foundation area of the bridge in order to increase the allowable carrying capacity of the ground. As an intervention measure to increase the payload, it is proposed to increase the foundation depth to 0.8m.

For the foundation depth $D_f = 0.8m$ (existing condition), the stress in the base coupler is $q_a = 87.84kN / m^2$. Прорачун дозвољене носивости тла су рађени за 2 варијанте – за садашње стање моста и темеља и за стање минималних интервентних мера на темељима. Обзиром да је прегледом терена и стања моста, утврђено да су темељи моста делом откривени, за дубину фундирања је усвојен најнеповољнији услов – да је дубина фундирања једнака 0, односно да су темељи моста ослонjenи на површину терена без укопавања, као и да је мост фундиран поштујући минимальне критеријуме заштите од утицаја од дејства мраза на дубини од 0,8m.

За дубину фундирања $D_f=0m$ (постојеће стање), напон у темељној спојници износи $q_a=52,33kN/m^2$. Овако маJa добијена вредност носивости тла за постојеће стање темеља моста (око $52kN/m^2$), је последица плитког укопавања моста. У склопу санације постојећег моста неопходно је предвидети и интервенције у зони темеља моста у циљу повећања дозвољене носивости тла. Као интервентна мера за повећање носивости се предлаже повећање коте фундирања на 0,8m.

За дубину фундирања $D_f=0,8m$ (постојеће стање), напон у темељној спојници износи $q_a=87,84kN/m^2$. 


6. CONCLUSION

Based on the conducted static analysis of the results obtained for the relevant impacts, for the existing pavement reinforced concrete slab, it is concluded that the existing main reinforcement $\phi 16 / 15$ ($13.40$ cm$^2$ / m) does not satisfy the required reinforcement, so that the roadway slab is necessary. Rehabilitation will be done by adding carbon strips according to the sizing of carbon strips manufactured by Sika, using the Sika CarboDuo program.

Geotechnical tests of the soil bearing capacity at the level of the existing foundations were executed in order to determine the allowed bearing capacity of the soil. When performing the bridge rehabilitation work, the thickness of the foundation must be confirmed and additional reinforcement of the existing foundation should be made. As part of

6. ЗАКЉУЧАК

На основу спроведене статичке анализе добијених резултата за меродавне утицаје, за постојећу коловозну армиранобетонску плочу, констатује се да постојећа главна арматура $\phi 16/15$ ($13.40$ cm$^2$/m) не задовољава потребну прорачунску арматуру, па је неопходна санација коловозне плоче. Санација ће се извести додавањем карбонских трака према димензионисању карбонских трака произвођача Sika, програмом Sika CarboDuo.

Ради утврђивања дозвољене носивости тла су извршена геотехничка испитивања носивости тла у нивоу постојећих темеља. Приликом извођења радова на санацији моста потребно је потврдити дебљину темеља и евентуално извести додатно ојачање
the rehabilitation, work is also being carried out on the bank of the stream bed.

REFERENCES