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# The Rehabilitation of The Road Bridge Over The Nišava in Niš

**Vladimir Radojičić ,Tomislav Radojičić**

***Abstract*** **- The road reinforced concrete bridge over the Nišava in Niš is a continuous girder bridge 36+62+36 in span, total length 134 m. The total width of the pavement is 13 m out of which there are two traffic lanes, each is 6,5 m wide and two footways, each is 2 m wide and they are raised 30 cm from the pavement.**

**The bridge is of great importance for the city traffic. It represents the shortest connection to the north east part of the community.**

**It was projected by the planning engineer Radojičić and constructed in the period 1978-1979 to satisfy the needs of self managing organization.**

**The bridge was put into operation in 1979. But in 1982 the bridge was put out of operation.**

**The bridge was put again into operation in 1985.**

***Index Terms*****: rehabilitation, reinforced concrete bridge, the continuous girder, the epoxide glue** .

## I. INTRODUCTION

It is customary that the public in general and the authority are familiar with the technical building solutions and the principles which mostly represent the basic principles in the construction of building bridges and other objects.

We can be sure that not many constructions satisfied all the criteria.

In this paper we tried to present an unusual reinforced concrete road bridge construction, fulfilling economic and professional interests.

A series of contradictions followed this case of the bridge. A little member of people knew the truth. In other words, the official newspapers paid little attention to the real state of the bridge.

We think that all disadvantages (omissions) and neglects mustn't be hidden for any reason. All that should be done in the name of professional and scientific reasons.

In one word we discuss about the road reinforced bridge which was not constructed according to the official project.

Because the team of supervisors of the work , done from (1979-81) gave the report "that they noticed the cracking on the longitudinal ribs of the box girder". The state of the level didn't function the best way, so they suggested the work which was done couldn't be accepted. The bridge should have been excluded. They suggested the sanation of the bridge.

The supervision of works and trial load testing of the bridge structure were carried out by the IMS from Belgrade.

In 1985 the bridge was put into operation for the second time.

**Dr Radojičić Vladimir** , Faculty of Civil Engineering , Niš,Serbia,
**Dr Radojičić Tomislav**, Faculty of Civil Engineering , Niš,Serbia,

Fig.1 Photo of the road bridge over the Nišava

## II. THE OMISSIONS AND THE DEFECTS IN THE ON THE CONSTRUCTION OF THE ROAD REINFORCED CONCRETE BRIDGE OVER THE NIŠAVA IN NIŠ

The road reinforced concrete bridge over the Nišava was planned as the continuous girder bridge with three openings, two of them are 36 m+36m and one 62 m.

The main girder is of the pillar-box like and of the transversal cross-section ; it's inertia moment is variable .

The bridge leans on the supports trought reinforced concrete panels 40 cm thick and 80-120 cm high .

The cross section of the bridge consists of five units .

The abutments were made of concrete and reinforced concrete founded on three wells whose diameter was 3m each . The midle supp orts were made of reinforced concrete MC 40 whose hight is of the variable cros section . They were founded on two wells whose diameter is 6 m .

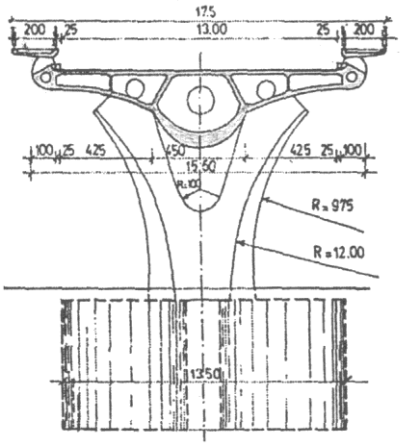


Fig. 2a

Fig.2b Cross section of the bridge

They are three movable bearings free end and (bearing) fixed end on the left abutment.

The intrados of the main girder is variable according to the square parabola.

The longitudinal and oblique ribs have the constant height and the variable thickness from 20 cm in the spans up to 50 cm on the abutments.

The cross bridgings are on every 6m in the last spans and in the middle part they are made in every 6,2 m.

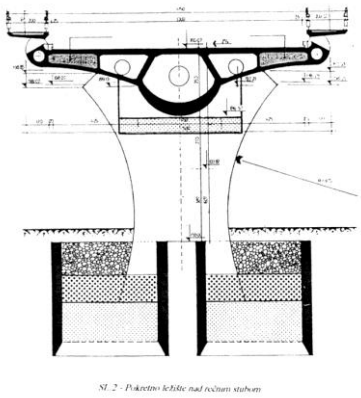

Fig.3 Cross section of the bridge over the piers

The bridge was projected and made by (SIZ – in Niš) the Management and the land structure of the city of Niš.

The construction work of the bridge began in July, 1978 and ended in September 1979.

The research laboratory of the Faculty of civil Engineering in Niš did the trial load testing on the 14th September, 1979.

The bridge was put into operation without the report of the technical acceptance.

But, the Professional board noted in its inspection report for the work done on the bridge:

"The cracks appeared on the oblique ribs of box girder, the level was higher in the middle part and the settling in the end settling of level on the last spans."

By inspecting the project documentation it was concluded that during the process of building the bridge the smooth reinforcement was made in the longitudinal and oblique ribs instead of the ribbed reinforcement based on the project.

The sanation was suggested. The bridge contractor IMS from Belgrade pointed out the considerable deviation from the basic project in the process of building the bridge :

-The leveling of the bridge was not done in both ends because of the settling of one part of the scaffold.

-The bearings were blocked in the right bank support. The dilatation devices (instead of “combs” according to the inial project) allowed the dilatation of the construction 1,5 m and not 4 cm while they were into the roadway plaque in one part of the walkside.

-The enlargements on the connection of the longitudinal and oblique and vertical ribs (in the greater part of the ribs) were not done.

-The abatments were shortened 2,44 m (according to the initial project).

-The pendulum on the left pier was 78 cm instead of 120 cm (according to the project). The function of the pendulum was blocked. The protected reinforced concrete masks were 20 cm thick.

-The cracks disappeared in the longitudinal and oblique ribs and in the pavement after debroking.

## III. THE REHABILITATION OF THE BRIDGE

More solutions were discussed. The solution of the author of the project was accepted:

-The pendulums on the abutments were strengthened with the steel armors because of applying the normal process of the previous presstresed strain $Nk_{\infty}$=47000 kN of the polygonal course of the line of the cables; the transversal forces and the bending moment were diminished and the actions increased.

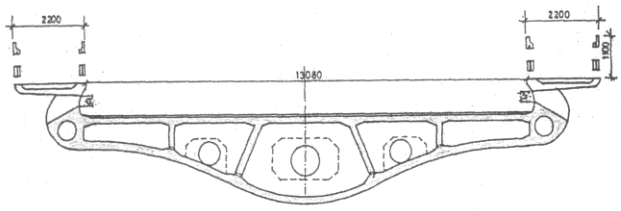


Fig. 4a

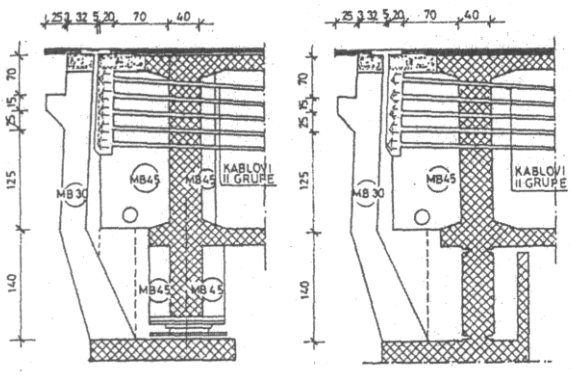


Fig.4b Variants of the pendulum over the piers

-The peak of the foundation of the well bed of the piers according to the project was lifted 1m.

On the right abatment and on the piers was set the steel envelope on the body of the pendulum and on the area over the necks joint in the diaphragm axis, before the formation of the necks joint.

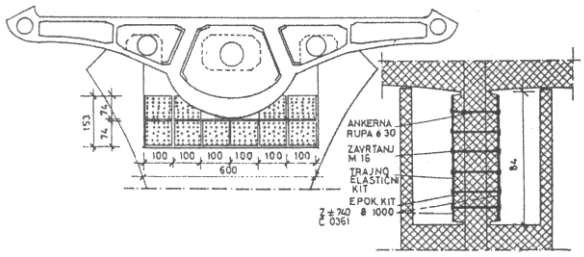


Fig.5 Variants of the rehabilatation of the pendulum over the piers

The drilling of the holes (diameter 20 mm) for the screw's setting (M16) was done by the diamante gimlets. The clearances between the holes and the screws were injected with the epoxy resin.

The necks of the joints 0,5 cm to 1 cm wide, 7 cm to 7,5 cm deep were cut by the panel for the concrete. All the newformed necks of the joints were greased with the epoxy primer and filled with epoxy elastic gypsum.

The pendulums rehabilite by steel armors and its tightening by screws were made it possible for the spacious state of stress.

The main girder was rehabilited by the linear presstresed stress applying the normal force $Nk_{\infty}$=47000 kN and sticking with three steel bands (flah) 8 mm thick .

The cables 134m long were stretching on both sides .

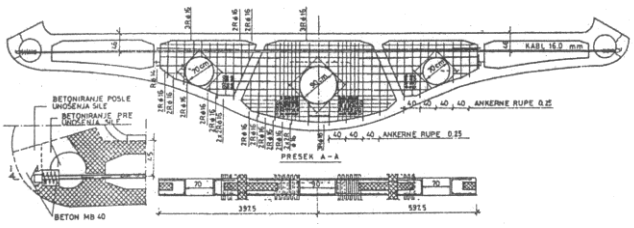


Fig. 6a

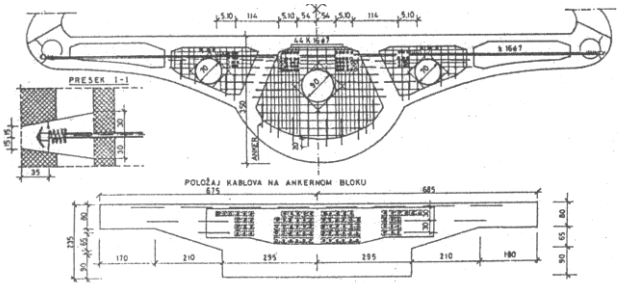


Fig.6b Placement of the cables

The steel bands were sticked on both sides of the longitudinal and oblique ribs with the epoxid glue unitil on three opposite units and two (units) of the middle opening they were sticked inside . After covering with sand they were protected with the epoxy primer.

All the cracks diameter 0,2 mm were injection by epoxid glue under the increasing pressure.

The reinforced protective masks, 20 cm thick on the piers were strengthened by the reinfortcement.

The contractor didn't move many horizontal profiles of the roadway tracks which he pulled through the masks and the pendulum (into the support of scaffolding). They remained in same place.

The pack of the foundation of the well bed of the piers (according to the project) was liffed 1 m.

The smooth reinforcement (240-360) was built in longitudinal and oblique ribs instead of ribbed reinforcement (400-500-2) according to the project.

The hydroisolation, although projected, was not made because the atmospheric rainfalls were accumulated in the last units of the bridge (we call them "dead" units) and they increased the load of the bridge approximately 4.500 kN.

The projected concrete make was not realized. It was conclusion of the Construction Institute "Makedonija" from Skoplje, based on the testing the "kerns" (measuring cylinder). It was from 23,6 MPa to 27,3 MPa in the longitudinal and oblique ribs and in the upper and lower bridge deck it was from 35 to 45 MPa what was opposite 45 MPa to the project. Because of that the bridge behaved as the continuous frame and not the continuous girder.

The longitudinal and oblique ribs were presstresed (partiality) and strengthened with the having three parts steel plates .

The anchorages with anchoring cables were made on the front of the bridge. The anchorages were made from the concrete whose concrete mark was 45.

The cables which are placed in PVC pipes are free all along the bridge and they are dragged through the openings on the diaphragms. They were pulled after the injection of the cracks on the roadway and on the longitudinal and oblique ribs, first, by the transversal cables by initial force $Nk_{\infty}$=784,4 kN afterwards longitudinal by initial force $Nk_{\infty}$=720 kN. All cables were injected by SIK - 042.

The diaphragms were strengthened by adding a concrete layer 2x10 cm on the span and 2x40 cm over the middle pier so that they could accept the influence of the turning forces (The bridge is in the horizontal curve 60 m radius and the line of the cables is of the polygonal cource).

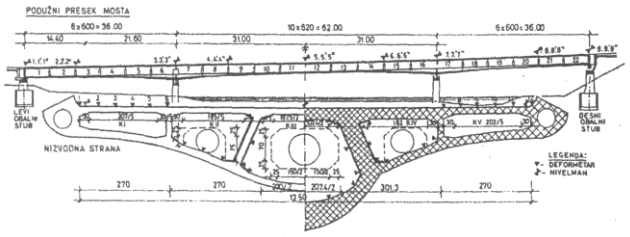


Fig.7 Placement of the instruments of measurement

The having three parth plates (lhlahs) accept the transversal forces .

The rigged surface of the the longitudinal and oblique ribs was corrected and filled with sand and with the epoxid mortar.

The bridge was partially and transversally prestressed with three cables (diameter 16-7 mm) of the straight course among the cross stiffeners (diaphragms).

The deflections before and after the rehabilitation of the bridge were about 2,5 cm.

The bridge was tested to the initial load with the same constellation (mass 255t) as well as after its construction according to the basic project.

The dynamic test of the bridge made after the derived hydro isolation and the asphalting the road surface showed that the stress and the deformations were in permeable limits. The bridge was capable to accepte the projected load.

The bridge was put into operation.

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## IV. CONCLUSION

The process of the construction of the bridge is very complex. The great number of the performers includes the different levels of the education and the experienced knowledge: from the civil engineers to projecting and realizing to the technicians and the workers of the different professional profiles.

For this highly responsible task in the technic-tehnological, economic and moral sense there are rules from the actual book of regulations following the building technology.

As for this case, it was not sufficient.

It was necessary the personal supervision and the responsibility most of all as well as the responsibility of all individual person in the whole team work.

And there was no of control in the construction of the bridge. The alternative reading of the project missed.

The ribbed transversal reinforcement in the oblique linear ribs was constructed instead of the smooth reinforcement.

It is our opinion.

Beside the technical knowledge the instruction, the applying regulations, suggested regulations from the Book of regulations, the omissions were possible.

We think that the official use of the ribbed armature should be included into the law for building constructions.

In that case, the smooth reinforcement should be excluded totally.