ДГКМ **ДРУШТВО НА ГРАДЕЖНИТЕ КОНСТРУКТОРИ НА МАКЕДОНИЈА**

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МОСТОТ ПРЕКУ РЕКАТА ДУНАВ КАЈ БЕШКА, СРБИЈА ИДЕЕН ПРОЕКТ

Откупен труд на меѓународен натпревар

РЕЗИМЕ

Идејниот проект на мостот преку реката Дунав кај Бешка близу до Нови Сад претставува победник на меѓународниот натпревар. Во согласност со условите од натпреварот новиот мост треба да биде изграден веднаш до постоечкиот бетонски мост со целосно пратење на неговата силуета.

Авторите препорачуваат главниот мостовски дел да биде челична континуирана греда (60+105+210+105+60=540.0m) со сандачест попречен пресек и ортотропна коловозна конструкција. Крајните пристапни мостовски делови се состојат од повеќе композитни континуирани греди. Нивниот попречен пресек е составен од два челични сандака кои се спрегнати со бетонската плоча преку горната фланша. Должината на десната страна од пристапниот дел на мостот е 180.0м., додека должината на левата страна е 1492.55м.

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THE BRIDGE OVER THE DANUBE BY BESKA, SERBIA CONCEPTION DESIGN

The purchased work on the international competition

SUMMARY

The conception design of the bridge over the Danube by Beska near Novi Sad, presents the purchased work on the international competition. According to the conditions of the competition the new bridge should be constructed next to the present concrete bridge and its silhouette should be fully folowed.

Authors suggested that the main bridge part should be the steel continuous girder (60+105+210+105+60=540.0m) which cross-section is box with orthotropic roadway construction. The access bridge parts over river inundation are consisted of more composite continuous girders. Their cross – sections are two steel boxes which are composed to concrete plate by upper flanges. The length of the right side of the access bridge part is 180.0m and the length of the left side is 1492.55m.

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1. Introduction

The review of the conceptual design of the new bridge over the Danube River at Beska on downstream, left lane of the motorway E75, section Novi Sad - Belgrade is presented. This conceptual design, the work of the authors named above, is one of the three ransom works on the International competition that was queried by Republic Traffic Agency of Republic of Serbia in May 2002. The condition of the open competition, it was required that the new bridge should be the "twin – bridge" to the existent concrete bridge that was designed by academician professor Branko Zezelj. The new bridge is supposed to follow the shape of the present bridge in longitudinal as well as in transverse direction, while common lighting is provided.

As competition was international, among the authors from Yugoslavia there were experts from Danish, Portuguese and Slovenia. On these anonymous competition there were twelve partakers, while nine works fulfilled the competition conditions, among them three projects were rewarded and three projects were purchased.

2. The bridge layout

Considering the given conditions to design "Twin Bridge" to the present Zezelj's bridge, that limited the spans and dimensions of the structure, authors adopted the bride layout shown on the figure 1.

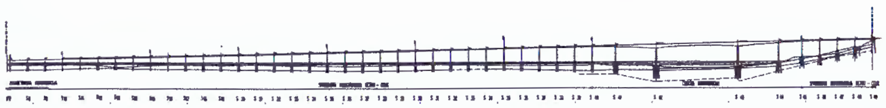

Figure 1 - The Bridge Layout

The bridge structure consist of the main bridge, above the river, that is the steel continuous girder which cross-section is box with orthotropic roadway construction and the approach structures that are composite continuous girders.

Total lengh of the bridge is 2212,55m with the total width of15,0m. The carriageway is 11,0m wide. On the both side of the carriageway there are footways with the width of 1,75m (Figure3 , Figure.5).

3. The bridge structure

The main bridge structure (above the river), shown on figure 2, is continuous girder over the five spans 60,0+105,0+210,0+105,0+60,0=540,0m, with the steel box cross section with the carriageway of orthotropic deck (figure 2).

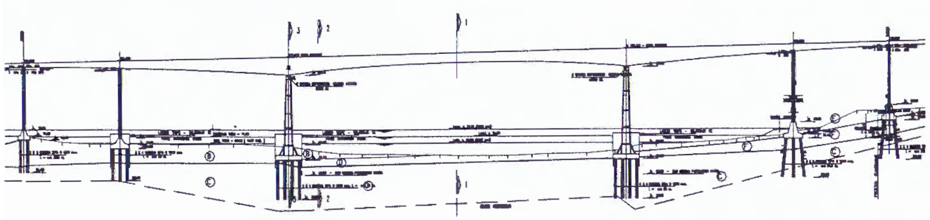

Figure 2 - The main bridge structure

The box cross section, varying in height, with the 2,50m above the end supports, 4,50m above the second supports, to 11,0m over the middle supports, while in the middle of the main span the section is 6,0m high. This dimension were requested so as the new bridge to have the same interdos and extrados as the existing one.

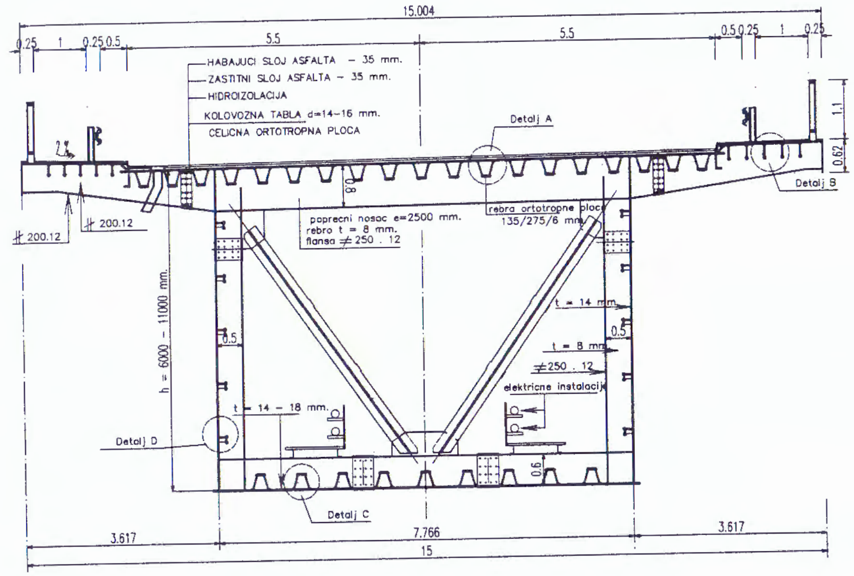

Figure 3- Cross section in the middle of the main span

As a material the C0361 steel is chosen, with the thickness of the deck plate from 14 to 20mm. This plate have the torsionally stiff trapezoidal longitudinal ribs under the carriageway (Detail A) and the flat stiffing ribs under the footway (Detail B). The trapezoidal ribs, which have the welded diaphragms on every 2,5m, goes through the webs of the lateral girders so as to remain continuous. The trapezoidal ribs are welded to the carriageway plate as well as to the ribs of the lateral girders. In that way the orthrotropic deck is formed.

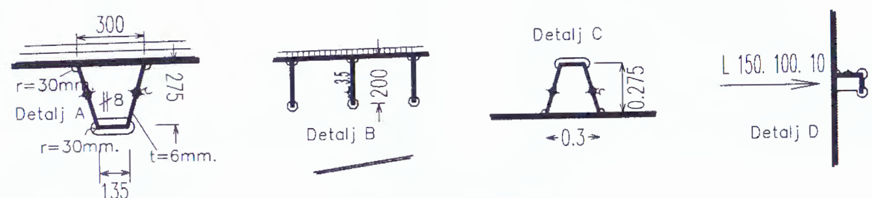

Figure 4- Stiffing ribs

The bottom plate has the torsionally stiff trapezoidal longitudinal ribs, so as to achieve stability of the compressed chord (Detail C). Beside that, on every 2,5m, lateral girders are placed for bracing of the box section. The trapezoidal ribs passes through the tongued webs of lateral girders as to remain continuous. The welded diaphragms of the stiffing trapezoidal ribs are right under the web of the lateral girder.

Vertical plates of the box bridge girder are stiffened on every 2,5m with vertical webs, with or without a flange (according to the statically design). That makes the box cross-section stiff on every 2,5m by the closed inside frame. Longitudinal bracing of the vertical plates of the box girder is achieved by longitudinal stiffeners welded on the inside of the plate (Detail D). That makes the vertical plates free only on space of 1,2x1m.

Beside these bracing frame, on every 5,0m diagonal transverse bracing is posed in order to stiffen the structure cross section against in-plane deformation. When the high of the vertical plates of the box cross-section exceeds 8m, another transverse lattice is attached, by posing a horizontal strut and two new diagonals in the lower part of the box.

Approaching structures (over the inundations) are composed of several structures. The part from Novi Sad (left side of the bridge) is composed of: reinforced concrete girder with the span of 7,5m, then continuous composed girder 3x45,0=135,0m and six continuous composed girders 6x(5x45,0m) = 6x 225,0m = 1350,0m; while on the part from Belgrade (right side of the bridge) there is a continuous composed girder 4x45,0m=180,0m.

Continuous composed girders of the approaching structures are composed of reinforced concrete deck and twin-box steel girders (figure 5). Cross section of the steel girder is consisted of two open boxes with the vertical walls of average high 2,26m(considering the transverse slope of 1,25%) with bottom chord 2,455m wide and upper flanges 0,3m wide in the middle of the span to 1,2m in the supporting zones. Lateral girders, spaced 3,75m, are extended under the cantilevers and connected with the concrete slab. Together with the concrete slab, they provide transverse flexural stiffness of the cross section. Furthermore on every second lateral girder (2x 3,75=7,50m) transverse lattice is provided as additional transverse bracing. On the level of the bottom chord, linking the boxes, longitudinal lattice wind bracing is placed.

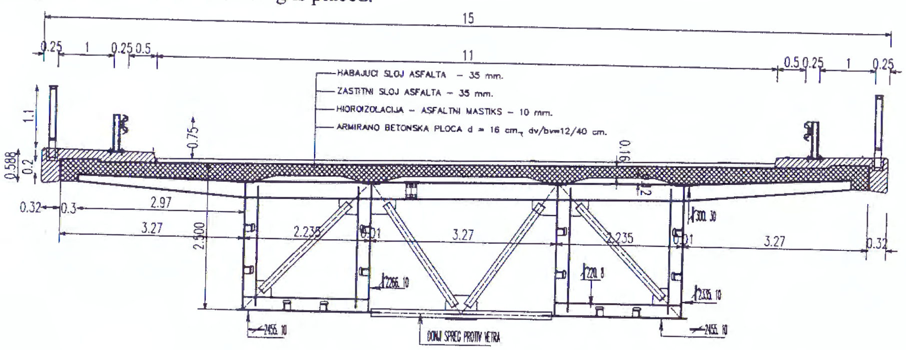

Figure 5 – Composite cross-section of the approaching structures

The thickness of the reinforced concrete deck slab is 16cm between the webs with additional thickness of 12cm over the top flanges of the steel girders. Ti is supported on the lattice girders as well as on the top flanges of the open steel boxes, so that it can be treated as two-way slab. It is reinforced in both zones ribbed reinforcement. Concrete grade is adopted as MB45 (according to BAB'87).

Composite action of reinforced concrete slab and steel girder is provided by the dowels with diameter d=22mm.

The steel part of the girder is firstly erected on temorary piers in the third of the spans (l=L/3=45m/3=15m) and afterwards the concrete deck is cast in sity, exept the parts over the permanent piers (part of the slab that should be in tension considering the composite action of the cross section). After the concrete harding, the temporary piers are dismounted and the rest of the deck is cast in sity. Conseqently, the resistence of the composite girder is selectively activeted for the part of the self weight. In order of limiting the tension stress in concrete, so as to avoid inadmissible cracks, imposed settlement of the intermediate supports is provided afrter concreating. Verification of stresses in steel box girder is performed in zones of the intermediate supports, excluding the concrete part of the section.

4. Piers and foundations

Respecting the condition that the new bridge is to be the "twin bridge" to the existent one all the piers are designed to resemble to the piers of the present bridge. The walls of the box cross

sections of the piers are, neverthelass, thinner then in the present bridge, that makes them lighter in weight. That fact as well as smaller self weight of the bridge construction and deeper foundations mimimaze unfavourably effects on the foundations and construction of the present bridge.

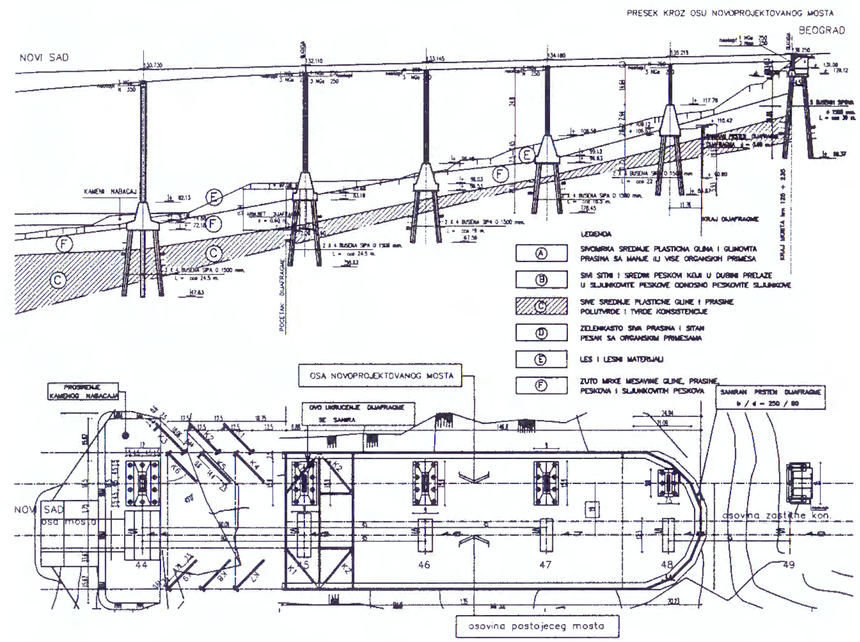

Figure 6- Foundations on the stabilised soil on the right bank

Special attention is paid on the foundations on the right bank so as not to endanger stability of the existing protecting structure. The piles were adopted reaching the layers with the reliable properties (much under the present diaphragm). Longitudinal section along the axis of the new bridge as well as the plan view is shown on the figure 6.

Piers S42 and S43 were analyzed as characteristic piers. Pier S43 is the river pier on the right side in the main span of 210,0m (the pier S42 is the left one of the same span). Pier S43 is the highest one. Authors adopted the foundations on drilled HW piles 1500mm in diameter, for piers S42 and S43 instead of caisson foundations that are on the present bridge. Bottom of these piles reaches the elevation of 35,0m, so that the reactions of the new bridge are applied on the soil that is 15,0m bellow the bottom of the caissons. In that way the unfavorable action of the superposition of the soil stresses. In order to avoid the whirling of the river and soil flushing of the riverbed between the present and the new foundations for the piers S41, S42 and S43, the space between them will be stuff with crushed stone up to the normal water level.

Number of piles under the piers S44 and S45 is enlarged to ensure embankment stability on the right bank. Under the pile cup of the pier S44 the battery of piles 3x4 =12 HW1500 is put, with the design load of 7000kN, while the maximum axial force in pile is only 3355kN. This reserve in bearing capacity should prevent the loss of slope balance, while the elongation of the piles should cut the sliding plane and increase resistance of the embankment.

5. Erection of the structure

The free cantilever method is adopted for the erection of the main bridge structure. Previously, the approach structures should be finished first.

As soon as the piers are built, the erection of the approach structures on the left bank is started, considering their total length and consequently the construction period. The approach structure on the right bank with the total length of 180,0m should be built in the some manner. Temporary piers are posed between concrete piers of the inundation spans on every 15,0m.

Side spans of the main construction are erected on the scaffold. At free cantilever erection of the main span, the elements are erected from the watercraft by the derrick crane.

Conclusion

Propounded solution for the bridge structure respects the competition conditions. The new bridge follows the silhouette of the existing bridge making unique entity with it. By choosing the steel as dominant material the construction is considerably lighter then the concrete structure of the present bridge. The internal forces in the piers as well as in foundations are consequently reduced which is most important for the piers on the right bank that are founded on the soil that should be stabilized because of the landslide area.