

## REVITALIZATION OF THE “VARADINSKA DUGA” BRIDGE

### Abstract

*Military operations on the Serbian territory resulted in a large scale destruction of infrastructure and other capacities vital for the Serbian economy. The bridges suffered the most damage, and Novi Sad is certainly the city with the biggest number of bridges destroyed. During their reconstruction, welding and congenial technologies took an important place. The paper briefly presents some of the activities, and discusses some of the problems concerning the reconstruction of bridges, damaged by bombs and missiles, as well as the measures for reaching a desired quality of accomplished works. A special attention was paid to the reconstruction of the “Varadinska Duga” bridge on the Danube River, between Novi Sad and Petrovaradin. The experiences of one of the executants, as well as the results of the work are analyzed in more detail.*

**Key words:** bridge, Varadin Bridge, Varadinska Duga, NATO, welding, cutting, revitalization

### Introduction

From March 1999 till June 1999 Serbia was exposed to heavy bombing by NATO alliance. The war operations on its territory resulted in a large scale destruction of infrastructure and other capacities vital for the Serbian economy. The crisis that followed the military operations was no doubt one of the deepest a European country had experienced in the past 60 years, and has been an object of many analyses. Without getting into the reasons that led to the bombing, an experience will be presented here, related to the revitalization of the infrastructure in Novi Sad, just after the end of war actions.

Novi Sad is the capital of the northern Serbian province of Vojvodina and is the second largest town in Serbia and Montenegro. Novi Sad has a population of around 300,000. Although 350 km far from Kosovo, it is, probably, the city that sustained the most damage from the NATO attacks. All of its bridges were bombed.

The “Varadin Bridge” was the first bridge struck by the bombs. It was destroyed at 4:55 on April 1<sup>st</sup>, 1999. The bridge was built over the Danube in the southern part of Novi Sad where the river angularly changes its direction. Later, it was realized that its height was insufficient for the demands of modern shipping prerequisites, but the “Varadin Bridge” was inevitable part of the panorama of Novi Sad.

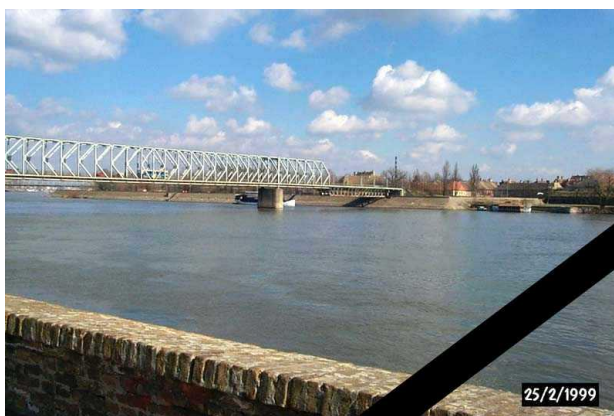


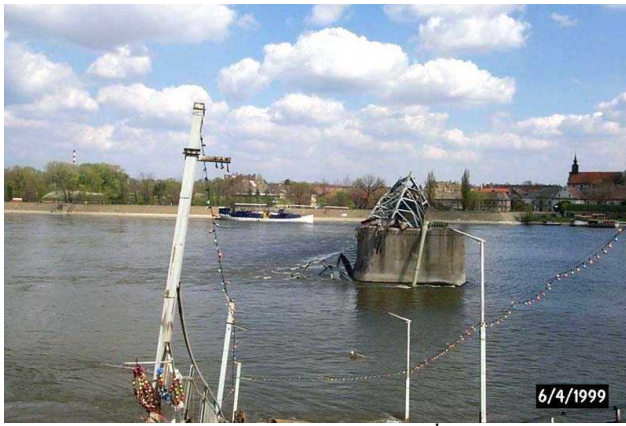
Fig. 1 Varadin Bridge on February 25<sup>th</sup>, 1999



Fig. 2 Varadin Bridge on April 1<sup>st</sup>, 1999  
(Zezelj's bridge is seen in the background)

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*Fig. 3 Varadin Bridge on April 6<sup>th</sup>, 1999*

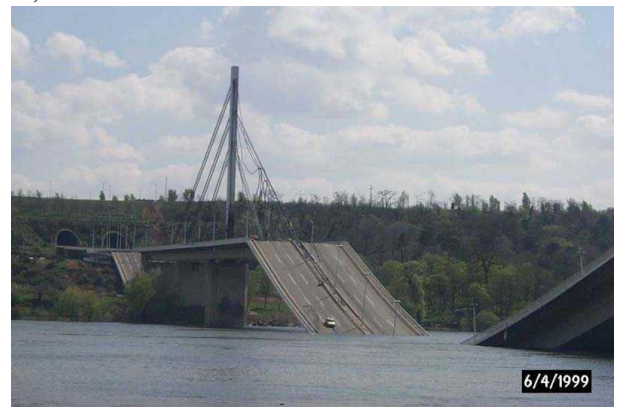


*Fig. 4 Varadin Bridge on April 15<sup>th</sup>, 1999*

NATO missiles struck the second bridge over the Danube river, that connects downtown Novi Sad with Sremska Kamenica, called "Most slobode" (Bridge of Freedom), too. Its construction is 1,312 meters long and 27.60 m wide with a six-lane motorway and pedestrian crossings. "Most slobode" was built in 1981, and destroyed at 19:55 on April 3<sup>rd</sup>, 1999.



*Fig. 5 "Bridge of Freedom" in 1981*



*Fig. 6 "Bridge of Freedom" with a car on it*



*Fig. 7 „Žeželjev most“ (Zezeljs Bridge) in April 1999*



On April 25<sup>th</sup>, the third bridge in Novi Sad, called "Žeželjev most", was destroyed. It was the last remaining bridge over the Danube River in Novi Sad.

After the end of war actions, an urgent revitalization of all important facilities and infrastructure was started. Corporate enterprises, especially heavy industry, were badly damaged by bombing. The highest priority at the state level was the revitalization of infrastructure objects. Enterprises gave priority to the revitalization and rebuilding of their own capacities to activate their previous production programs and their potential for rebuilding the country. How it seemed in reality it is possible to see in the example of the company "IMK 14. oktobar" AD Kruševac.

The company was very active in rebuilding a lot of bridges including "Varadin Bridge" in Novi Sad. The very first step in the company's recovery was clearance of production facilities in the damaged halls for welding and machining welded constructions, assembling structural, mining and

agricultural machines and process equipment. After that, the reconstruction and renewing of some of less damaged objects and equipment took place. The removal of machines to the renewed halls was carried out. The reorganization of the production process, and the above mentioned actions enabled the factory to re-start its own old programs, but also to join in the reconstruction of other objects in Serbia.

The list of the accomplished works could help to comprehend the extent of the problem:

- 10,000 m<sup>2</sup> of production halls were cleared up;
- 4,500 m<sup>2</sup> of offices were made feasible;
- 18,000 m<sup>2</sup> of roofs, including roof construction and roof covering, were renewed;
- Pipe network for technical gases, electric current network, and water supply were recovered;
- Heating system with factory's cauldron was also recovered;
- 15,000 m<sup>2</sup> of glass surfaces were established;
- More than 200 displaced machines were returned and activated;
- eight of the most important machines were repaired, revitalized and allocated to the new locations;
- dozens of other machines and equipments are also revitalized and activated, as well as
- A numbers of production programs were allocated to less damaged and repaired production facilities.

All of the mentioned activities were done by the factory's own resources, with a little support of the government, community, banks and some business partners.

## 2. Varadin Bridge

After the end of war operations, the State Agency for Reconstruction started working actively. The Agency was established on April 4<sup>th</sup> 1999, during the bombing. Its main objective was to carry out the reconstruction of destroyed structures in Serbia. Tenders for reconstruction of bridges were opened. Analyses had shown that for the "Varadin Bridge" it was more efficient to build a new bridge on the base of the old one, than to reconstruct the old bridge. One of the key reasons for this was a planned increase in the height of the bridge. The IMK "14.oktobar" was one of the companies working on the new bridge, with a task to make the steel construction of the middle part of the bridge.

Having in mind the situation the country was in, it was necessary to finish all the work within the shortest possible period of time. The quality of the bridge had to match the quality of bridges built in normal conditions, which was an additional challenge.

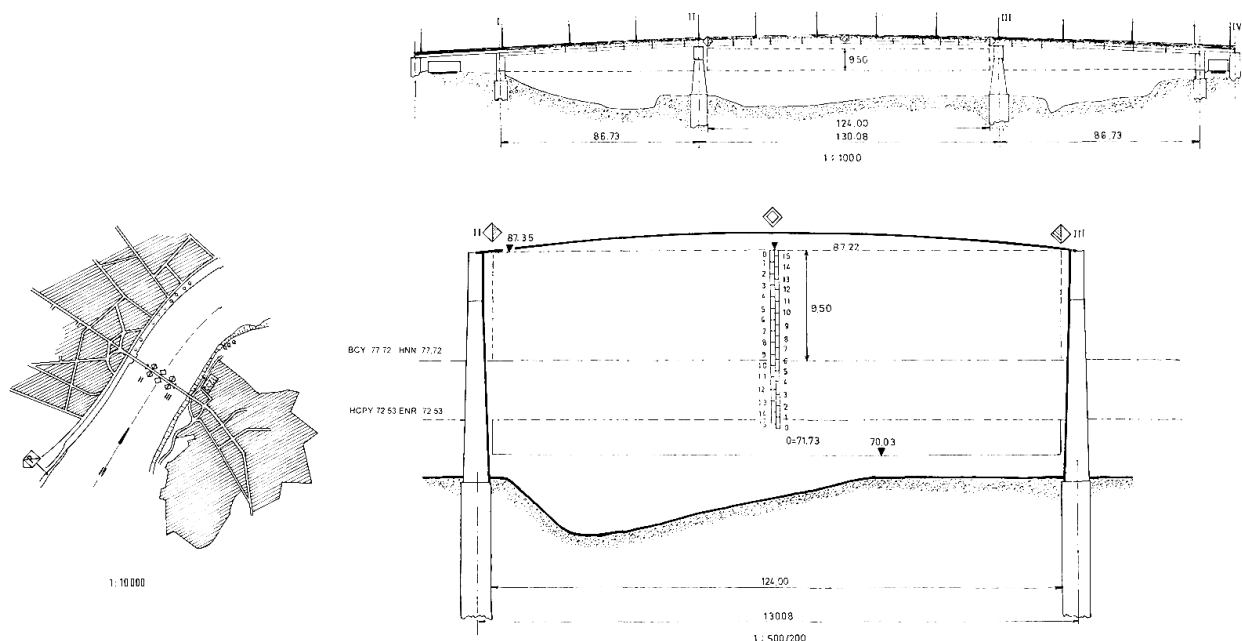


Fig. 8 The Danube – Navigable line: 1255 km – "VARADINSKA DUGA" - Novi Sad

It was anticipated that the new bridge was to be of steel construction and made in the style of “steel continual beam”. The main stages were:

- Making the bridge steel construction which includes:
  - Workshop documentation according to the main project;
  - Supply, manufacture, probationary assembling, anti corrosive protection and transport to the final location (around 290 km);
  - Assembling the construction
  - Provision and mounting the bearings and dilatations;
- Manufacturing new and repairing of old pillars;
- Insulation and asphalt works on road, pedestrian and bicycle lanes.

It was estimated that 70 days were needed for pulling out the Varadin Bridge from the river and all the additional tasks. The work on the bridge was estimated to take 6-8 months. Due to the urgency of work, the deadline was set to 6 months from the day the contract was signed. All this reminded of the previous history of the bridge. The construction of the Varadin Bridge started just before the end of World War Two, and the bridge was opened for traffic in 1946. The only available materials for the construction in those post-war years were the remains of the Railway Bridge, which had been destroyed during the war. The bridge was built in 160 days and was the first permanent steel bridge in Europe after World War Two. This time, the main difference was that there were no remains to be used, and the Agency had to provide the steel for the construction.

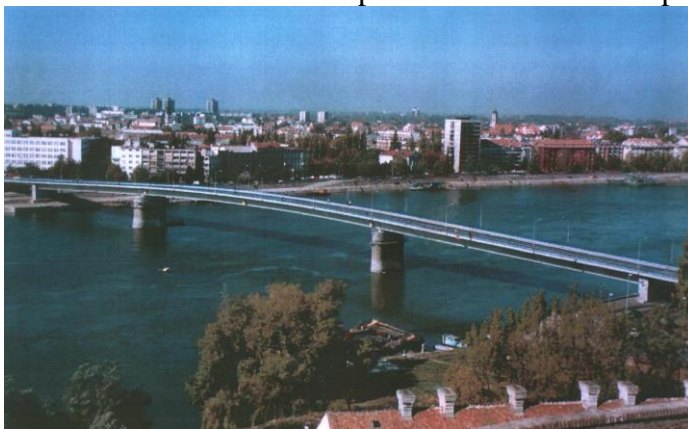
Because most of the work took place in the downtown area, near the only functioning bridge in the city – the temporary “bridge on barges”, the company that was carrying out the work also had to provide normal and unobstructed functioning of traffic.

The IMK “14. oktobar” was facing many challenges in regard to both providing conditions for normal production and providing qualified staff to perform the work. A good circumstance was that the factory had already had big experience working with different types of metal constructions. Although big, the metal parts used for the construction of the bridge had a simple shape, and the main problem was the welding.

The IMK “14. oktobar” fulfilled all the conditions for performing the assigned tasks. It also had its own Institute “14. oktobar” Kruševac with a JUS ISO 9001 certificate, an independent Agency for Quality Control, and a Technical laboratory. The Laboratory was a special convenience, because the quality checks of material, dimensions and welding could be performed independently after every operation.

For every construction the company had to provide the documentation that proved that all the quality related requirements had been met (quality attests, material attests, control lists, etc.)

For the new highroad bridge over the Danube, at the location of the former Varadin Bridge, “Varadinska duga” (Varadin’s Rainbow), a construction documentation was made, and more than 550 tons of steel were incorporated into the central part of the bridge (Fig. 9)



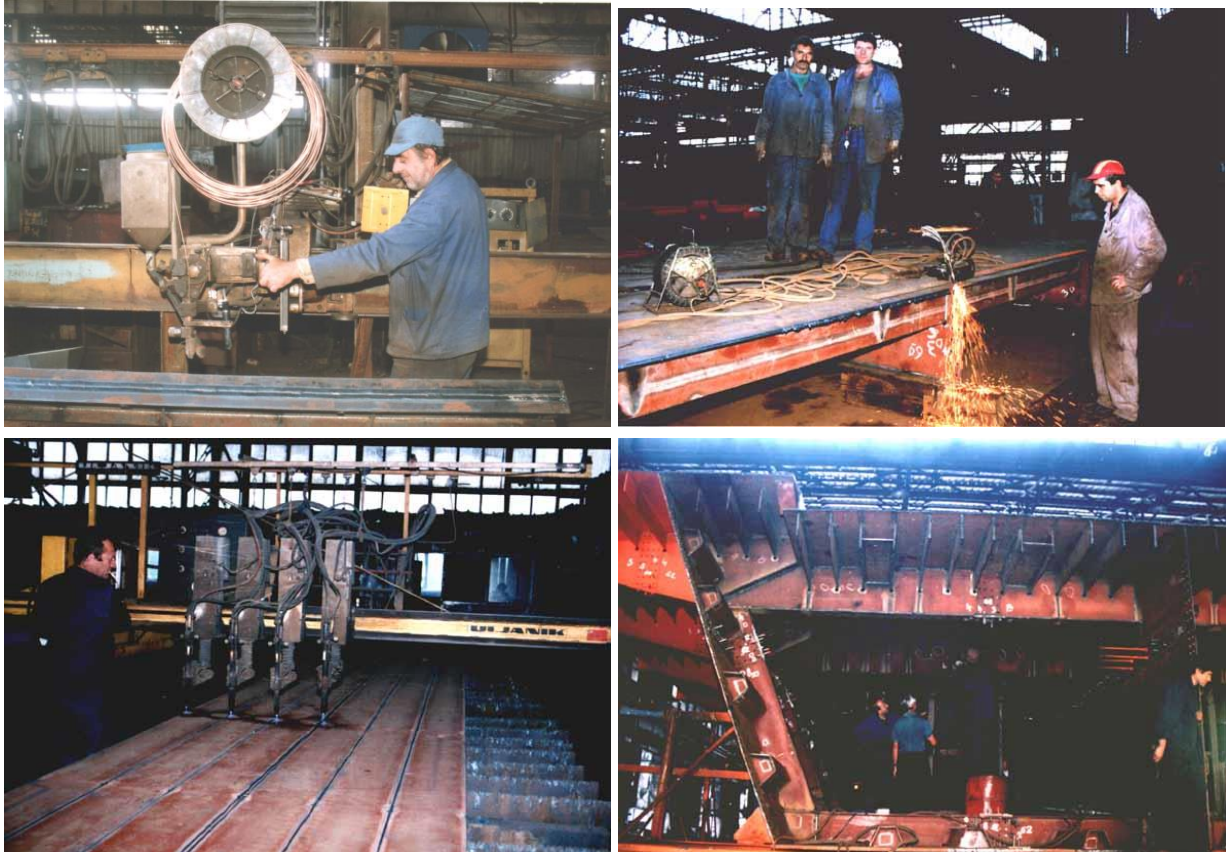
*Fig 9. Bridge “Varadinska duga“, a view of Novi Sad*

*A view of the Petrovaradin Fortress*

Analyzing the production of welded constructions, as well as the production of the “Varadinska Duga” Bridge, it has been noticed that welding and similar processes take an important role. They take up over 70% of all works in production of welded constructions. The most frequent are the following operations:

- Manual gas cutting and welding by using mixtures of acetylene-oxygen and propane-butane-oxygen;
- Machine gas cutting by using firing mixtures of acetylene-oxygen and propane-butane-oxygen;
- Manual and machine plasma cutting;
- Laser cutting by CO<sub>2</sub> lasers;
- Manual electric arc welding;
- MIG/MAG welding;
- TIG/WIG welding;
- Metallization;
- Resistance welding.

Fig. 10 presents some details from the production hall during the production of the elements of bridge construction and probationary assembling of the “Varadinska duga” Bridge.



*Fig. 10 Details from the production of the elements of welding construction of the “Varadinska duga” bridge in production halls of IMK “14. oktobar” AD Krusevac*

After completing the bridge components in the factory, probationary assembling took place, and then the bridge was dismantled and transported to today’s location. In every bridge building, the most delicate is the operation of lifting the bridge construction, and its positioning at the desired site. This part of the job was done by the specialized enterprise and main contractor “Mostogradnja” AD – Beograd. Thanks to the applied methodology and full control of materials, processes and the final product, the steel construction of the bridge was made with great precision and in good quality, so the final mounting was finished without any noticeable problems.

### 3. CONCLUSION

Crisis situations, especially crisis situations caused by war, cause heavy consequences for every country’s population and economy. A devastated country needs to get back to the previous condition before it can start working on improving the living conditions. Traffic connections are one of the top priorities of every reconstruction. Experience has shown that with joint participation of all parts of society, destroyed structures can be rebuilt relatively quickly. It has also shown that engagement of all available resources is necessary, as well as helps from others. The psychological factor is also very important, because of the enthusiasm felt by the most of the population after the

end of crisis. This was confirmed after the end of World War Two, as well as after the end of NATO bombings. Unfortunately, enthusiasm disappears quickly, so most of the destroyed structures never get back into use, and traces of crisis remain visible for many years. The main goal of every leadership, and especially of every government, should be to avoid crisis situations in every possible way.

#### **4. LITERATURE**

1. Đurić S, Đorđević Lj, REVITALIZACIJA OŠTEĆENIH ČELIČNIH KONSTRUKCIJA, Naučno stručni skup Značaj i primena zavarivanja i srodnih tehnologija u obnovi i izgradnji zemlje, Kruševac, Srbija i Crna Gora, 2000
2. [www.vojvodina.srbija-info.yu](http://www.vojvodina.srbija-info.yu)
3. [www.plovput.co.yu/plovni\\_put\\_mostovi\\_full\\_1255.htm](http://www.plovput.co.yu/plovni_put_mostovi_full_1255.htm)