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Structural safety of historical buildings made of reinforced concrete, from Banat region – Romania

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ABSTRACT

At the end of the nineteenth and early twentieth century, in western part of Romania important buildings of reinforced concrete were built such as: water towers, bridges, industrial buildings. There are some buildings that used only reinforced concrete elements such as slabs, beams, walls and framing. Currently, these elements have low bearing capacity, putting at risk the security of buildings and their historical value. The main reasons are: low grade concrete, reinforcements without ductility that are highly damaged, low percentages of reinforcement. Different types of reinforcements do not provide the necessary ductility for buildings located in the seismic zone Banat, Romania. The article presents the state of degradation of these constructions and different ways to strengthen these historic buildings with reinforced concrete.

1. Introduction. Research aims

In the last 150 years reinforced concrete was recognized world wide for its high strength and its ease to take any shape. If at the beginning its inventor, Joseph Monier used it for making flower pots, he continued to find new uses for the material: pipes and basins (1868); reinforced panels for building façades (1869); bridges (1873); reinforced concrete beams (1878), floors. In 1875 the first reinforced concrete bridge ever built was constructed at the Castle of Chazelet. Monier was the designer of the first reinforced concrete water tank from Clamart (1891). It is due to these properties that it is used on large scale for special civil buildings as highrise or modenr free shaped buildings. Although reinforced concrete is a rather new material in comparison with wood and bricks, it has begun for more and more reinforced concrete buildings to be declared monuments. The paradox consists in the fact that in current practice, the use of reinforced concrete in monuments consolidations is slightly used because it doesn't respect the intervention reversability principle. In this article there are presented reinforced concrete monuments from the Banat seismic region, damages and the consolidation solutions for these buildings are described from the point of view of the structural frame. Research studies have been prepared by a team from the Faculty of Architecture in Timisoara in the field of risk and vulnerability of historic buildings [1–6] and green building solutions [7].

2. Structural damages and consolidation solutions for reinforced concrete monuments from the Banat region, Romania

2.1. Introduction

With the channeling of the Bega river, the history of reinforced concrete buildings begun. In 1793, the duch engineer Fermaut continues the channeling implementing dams for the regulation of the Begej watercourse. Between 1900 and 1916 on the 144 km Bega channel there is built the system of locks. Reinforced concrete was then used for the first time. In Fig. 1 it is presented a photo with the lock from Sanmihaiul Roman in the Timiş county. In total, six locks were built. Two of which are on romanian territory and four on serbian terrain. Fig. 2 presents the original project of the lock. Romanian comunist authorities shut down the transport of goods in 1958 and the passenger transport in 1967. Today, all hydrotechnical nodes are considere monuments and the reinforced concrete buildings were not consolidated. Due to poor maintenance, the concrete and reinforcement are very degraded.

2.2. Reinforced concrete historic bridges

As a consequence of the construction of the Bega waterway, in Timişoara were built a series of reinforced concrete and steel bridges. The most famous bridge is the Decebal Bridge which was

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Fig. 1. Sanmihai lock.

built in 1909 and it was, at that time, the bridge on reinforced concrete beams with the largest opening in Europe. It has a total length of 58 m with a span of 39 m and a width of 9 m (Fig. 3). Romanian engineer Mihailich Győző designed the bridge. The project obtained its honor diploma, at the International Exhibition, Paris 1910. Today, the bridge is declared a monument and it is fully functional. The structural frame didn't need major consolidations untill today, but experimental tests performed on the reinforced concrete beams of similar bridges built in Timişoara have indicated the fact that the reinforcement is severly corroded and as a consequence the reinforcement area is no longer insured.

2.3. Reinforced concrete water towers. History. Materials

For the water supply of Timişoara, there were built two water towers (Fig. 4) between 1912 and 1914. The structural frame was designed at Budapest (Fig. 5) according to the plans of Laszlo

Fig. 3. Decebal bridge in Timişoara.

Szekely architect from Timişoara. Today, the towers are declared monuments, they are not functional and they are not private property. The structural frame is made of reinforced concrete walls with perimetral circular columns. The concrete was prepared and cast in situ. The walls have reinfocing rebars of maximum 12 mm with grooves to insure a good bond with the concrete. The reservoir area is composed of reinforced concrete walls and it separated from the staircase through a reinforced concrete slab supported on beams. The stairs are made of precast concrete. The roof is made from reinforced concrete and covered with ceramic tiles. The water reservoirs are made of steel and have been disabled since the 70's. Poor maintenance is the main cause of the damages in the structural frame. Due to rainwater infiltrations through the roof and windows, the reinforcement has corroded and the concrete cracked as a consequence of the freezing and thawing process. On a height of 1.50 m from the base, the walls are permanently moist due to the lack of exterior waterproofing and between the foundation and walls. There are areas where the concrete cover is missing and the reinforcement is very corroded. Major cracking occured due to shrinkage of the concrete caused by the reduced area of reinforcement in the walls cross section. Damages were reported

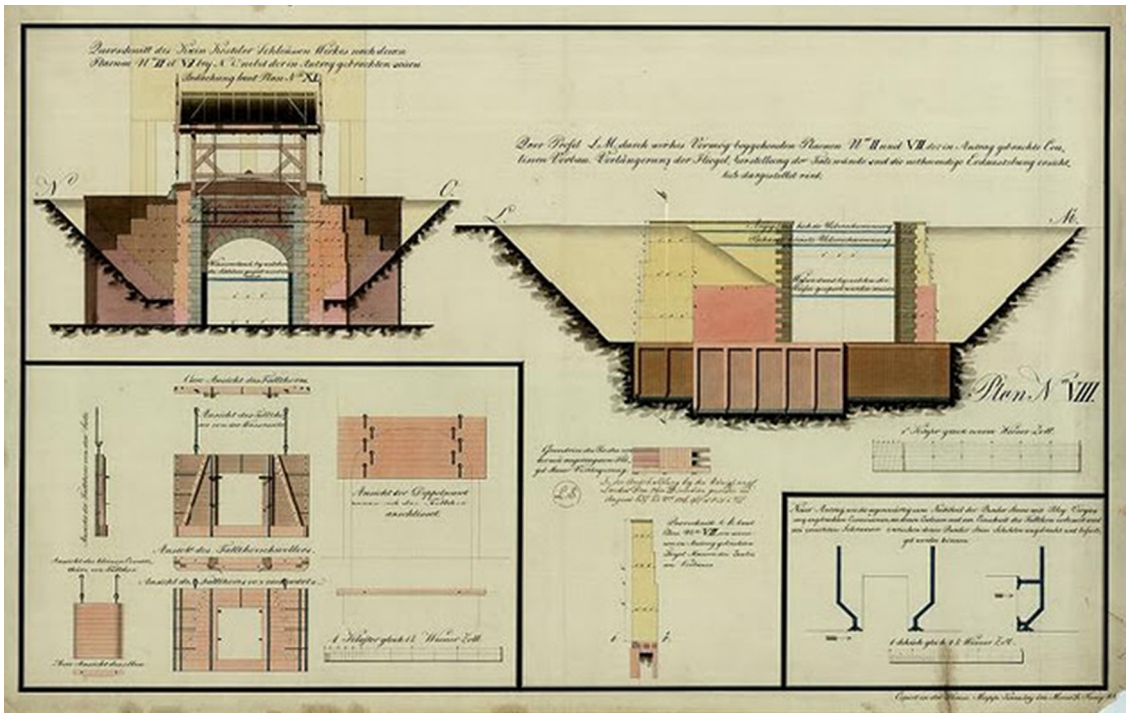

Fig. 2. Original project of Sanmihai lock.