CONTRIBUTION TO THE NEW SOLUTION OF STEEL MULTI-STOREY DEMOUNTABLE CAR PARKS[1)]

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Abstract: *Rapid growth and expansion suddenly brought about parking problems in larger cities in Serbia, so it became necessary to set up the demountable car parks. Accomplished researches and analyses show that there is a real demand for setting up the steel demountable multi-storey car parks in cities of Serbia whose number of citizens exceeds 20000. The number of needed demountable multi-storey car parks is greater in larger cities. The main goal of these researches considers the development of new solution adapted to our conditions, the advantages of which are: more storeys, easear assembling, lower price, engagement of domestic firms in production, assembling and accessory works.*

Keywords: *multi-storey car parks, module, steel construction.*

1. INTRODUCTION

Accomplished researches are related to the development of new solution accommodated to our conditions and should be distinguished with set of advantages such as: increased number of storeys, appreciably lighter construction, modular character of construction, lower price in comparison with imported ones, fast and easy assembling, disassembling and dislocating to new location without any extra work. By this research a new technical and technological solution of steel demountable multi-storey car park has been developed which meets the conditions and needs of our cities. The main activities which are to be performed are based on improving the single module variant solutions in order to obtain the original one. Designed modular solution should satisfy the wide rang of requirements of our market with capability of selling abroad, especially in contiguous countries. The development of this solution brings about the possibility of competitive domestic product by price and quality.

By now, the steel demountable multi-storey car parks have been imported from abroad exclusively, with many limitations with respect to conditions of usage in our cities, highly priced and with complex and non-efficient control and payment information system. By this project [1], a new solution has been obtained, suitable for our conditions with lighter construction and increased number of storeys.

Actually, the new multi-storey car park presents modular solution of multi-storey garage which can be easily accommodated to meet the wide range of requirements with respect to number of storeys and configuration of new car parks.

Also, the elements of construction are designed in such manner that they can be completely manufactured at domestic market, which is very important. The elements' shape and production technology are projected completely in accordance with capabilities of domestic middle rank companies, without extra investments in new high technology equipment.

It's very important to emphasize the advantage of this solution concerning the capability of easy demounting and dislocating to other locations, if required.

2. THE BASIC CHARACTERISTICS OF EXISTING SOLUTIONS

Italian company "Fast Park" is considered as the greatest manufacturer of demountable multi-storey car parks. The basic characteristic of that solution is that the carrying plate below the vehicle, made of reinforced concrete, is placed on steel tubular pillars by means of INP steel girders.

In some fields the braces are used as a stiffeners. This type of solution has satisfying carrying capacity and working stability. The main disadvantages of these solutions are: great mass of reinforced concrete plate (about 5 tons per field), difficult moving to new location, great number of engaged workers and machines in order to dislocate the car park to new location.

Just for these reasons, a new solution has been developed in the project [1], eliminating cited faults.

Examples of installed solutions of Italian company "Fast Park" are shown in figures 1-3.

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Fig. 1. *Storey car park - Bologna airport, capacity of 1500 parking places*

Fig. 2. *Storey car park -Empoli, capacity of 360 parking places*

Fig. 3. *Storey car park -Torino, capacity of 320 parking places*

It is often necessary to adapt the shape of storey car parks to the requirements, regarding the available location shape, the terrain configuration, the number of places, the outer look and shape, the existing buildings, etc. For these reasons, the shape of storey car parks could be irregular, which makes it much harder for the constructors and workers.
The examples of installed solutions, with special demands shown, are presented in figures 4-7.

Fig. 4. *Storey car park -Stockport, capacity of 232 parking places*

Fig. 5. *Storey car park -Charleroi, capacity of 204 parking places*

Fig. 6. *Storey car park -Via G. Borea, capacity of 320 parking places*

Fig. 7. *Storey car park -Ospedale di Circolo, capacity of 239 parking places*

3. THE BASIC CHARACTERISTICS OF NEW SOLUTION

In order to make an improved solution of constructing the metal demountable storey car park, it is necessary to consider the wide range of real demands at certain locations. We need to take the most important demands from the great number of them, by whose solving we get the solution that fulfils the greatest number of technical conditions for construction. Defined urban conditions in cities are the key element for forming the variety solution, because these conditions define the significant parameters in projecting, such as: drives, height and global shape of modular demountable storey car park.
Some of specific demands are shown in figure 8, regarding the location shape, and in figure 9 the terrain configuration.

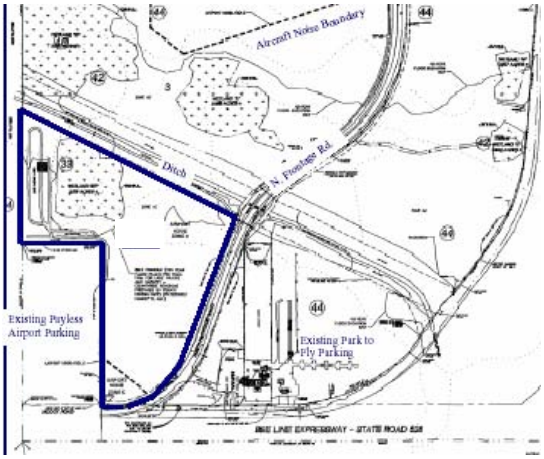

Fig. 8. *Complex shape of location for car park assembling*

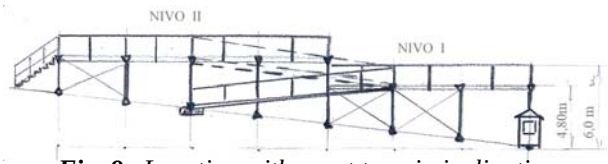

Fig. 9. *Location with great terrain inclination*

These parameters are determined beforehand by urban conditions and modular solution is planned in such way that it can be adjusted to all real regulated demands met in practise.
It is also necessary to take into consideration all the demands from the domain of traffic, which are defined by appropriate regulations regarding the determined inclination of paths for cars coming up and down, the size of drives, reciprocal position of approaching and leaving ramps, fire exit position, paths for people coming up and down - car park customers and working stuff.
The demounting storey car park module must be planned so that its combining with itself forms multi-storey car park in accordance with customers demands and regulations.
When the shape and large scale dimensions of module are achieved, it is necessary to develop its constituent elements.
In this activity it is especially important that the designed elements of module have the following characteristics emphasized:

- simple shape
- satisfactory carrying capacity
- simple fitting with other elements of module
- relatively simple production
- simple assembley
- smaller mass
- kind of material built in that can be obtained in domestic market.

After projecting the variety module solutions, it is needed to make the criteria for choice of the optimal one. The criteria for choice of optimal solution must contain elements of technical and technological conditions and limitations, as well as the economic indicators.
When criteria defining is finished, the analysis of proposed solutions and optimal variant choice are done. The look of plates carriers elements bond and two different storeys is shown in figure 10.

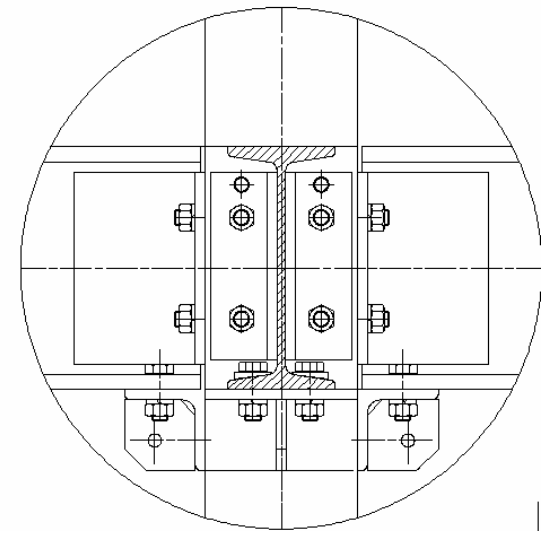

Fig. 10. *Bond of plates carriers and two storey elements*

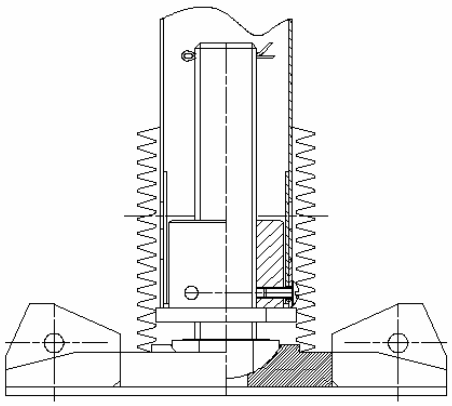

Fig. 11. *Pillar's support on concrete base*

The proposed solution enables easy levelling of storey car park on uneven terrains at which the construction stability is not endangered.

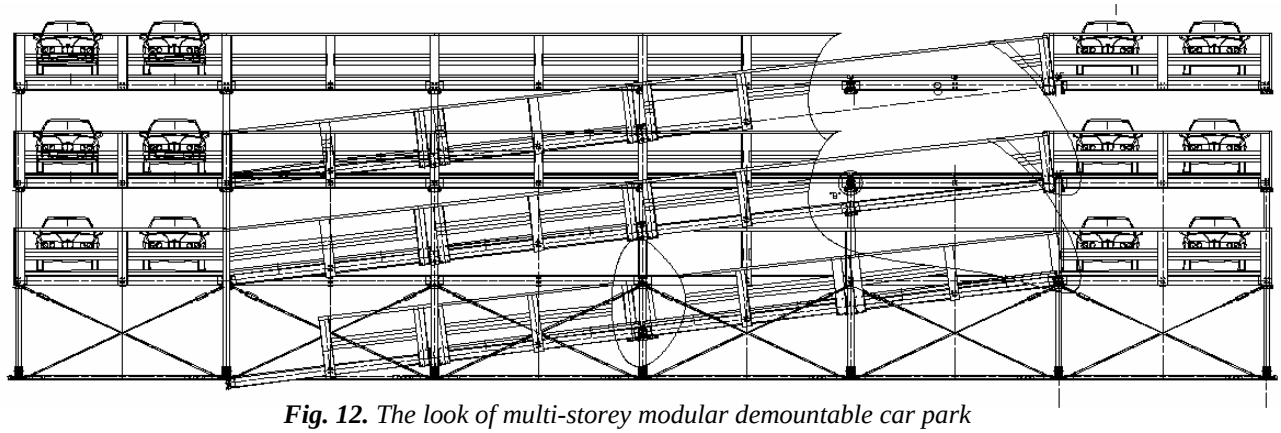

Fig. 12. *The look of multi-storey modular demountable car park*

Also, it is necessary to point out that carrying support plate of reinforced concrete is replaced by steel plate that in upper zone could be coated with thin layer of asphalt or perforated tin, depending on investor's demand. In this way we obtain significantly lighter construction of support plate itself, but also the skeleton of carrying steel construction.
New solution was successfully installed and researched on location in Jagodina (figure 13).

Fig. 13. *Storey car park - Jagodina, capacity of 139 parking places*

4. CONCLUSION

By making the new solution of modular demountable storey car park, we reached the basic demands which are represented in lighter construction, simple shape, satisfactory carrying capacity, simple fitting into surrounding with other module elements, relatively simple production and assembling. Analyses have shown that construction of one field is 30% lighter related to standard carryings out like "Fast park", that is 60% if the building in of complete metal support plate is done.
Also, analyses show that the price of making this solution, by the parking area unit, is about 25% lower compared to carryings out like "Fast park".

REFERENCE

[1] Rakanovic R., Gasic M., Savkovic M. and others.: New solution of steel multi-storey car park, Faculty of Mechanical Engineering Kraljevo, Innovation project, 2007.

[2] www.parkfast.com