THE MOST SIGNIFICANT POST-TENSIONING PROJECTS OF 2014. IN CROATIA

Professional paper

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Abstract

In this article we will present two examples of Post-tensioned constructions.

The first one is VMD Towers in Zagreb, Croatia, where we have achieved savings with construction speed and simplicity of construction.

The second is International Airport Zagreb New Passenger Terminal where Investors wanted to avoid prefabricated construction for such representative building. Post-tension technology was the only solution for span dimensions 14.4 x 14.4 m, This Project is still under construction and it is going according to the plan."

Keywords: *Post-tension, savings, construction, spans, BBR*

1. VMD towers, Symbols of European Croatia

1.1. Team & Technology

Owner/Investor: VMD PROMET d.o.o.

Main contractor: TEAM d.d., Mursko Središće, Croatia

Designers: Josip Galić, Croatia

Predrag Presečki, Croatia – for Post-tensioned (PT) slabs

Technology: BBR VT CONA CMM 0106

BBR Network Member: BBR Adria d.o.o., Zagreb, Croatia

1.2. General building characteristics

Figure 1. A view on the smaller tower which is finished and on bigger under construction

Attractive location near the city center has many advantages one of which is good transport connection, and especially closeness to the infrastructure of urban and suburban traffic, which makes customers everyday communication easier. In the near vicinity there are bus and railway station. One of the most important elements of green building that was used in this project is a system for collecting rainwater from the roofs and the environment which is stored in a separate tank ,and is then used for irrigation of green areas and for the car wash.

Figure 2. View of the taller tower during construction and the finished phase

When designing and building special attention was paid to details in order to ensure durability and reliability over a long lifetime of the building. For this purpose material of best quality and long lasting were used, together with PT system, which also contributes to the quality.

The complex consists of an underground garage and 6 overhead structure (2 residential and 4 commercial).

- 83,000 BRP total (51 000m^2 overhead and 22000 underground m^2)
- 60,000 BRP's business section
- 23,000 BRP residential section

The underground part of the 4 floors consisting of 839 parking spaces and garages

Overhead part consists of:

- 4 commercial buildings (one of 25 stories is the tallest building in Zagreb (after the Cathedral) with approximately 30 000 net sales office space
- 2 residential buildings (110 apartments)

The project shall be in function from January 2015.

40 different companies worked as subcontractors at this site with 500 to 1000 employees throughout the past period of 2 years.

The project value is approximately 100 million EUR.

High technology solutions including energy efficiency category A for office space allowed the sale and rental for very demanding companies (foreign and domestic).

Two skyscrapers , as a part of commercial buildings, were built with BBR VT CONA CMM -Unbonded Post-tensioning System.

Skycrapers are 14 floors and 25 floors high with area around 850 m^2 per floor.

Tower A has a trapezoidal shape footprint with dimensions 35.6 x 39.15 meters (longer side) and 32.2 x 15.9 meters (short sides). Post-tensioned slab has a thickness of 18 cm, with a capital above the central pillar. Along the edges there are peripheral beams with the cross section 100/45 cm. For Tower B due to a smaller spans, slab thickness is 16 cm, and the beams are 100/50 cm.

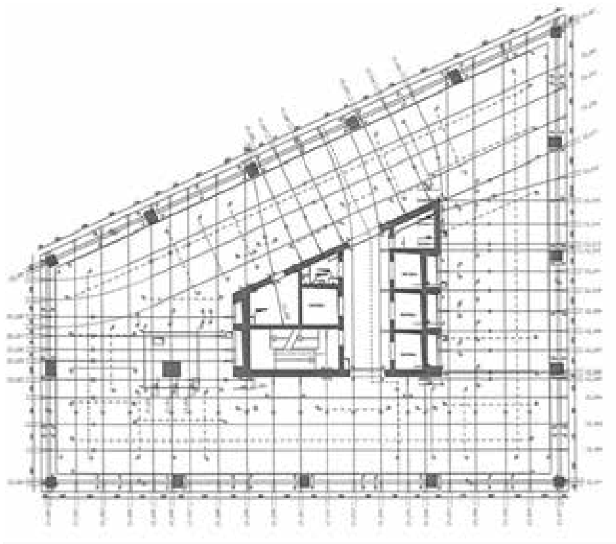

Figure 3. Structural drawing, with PT tendons, of typical floor layout

Figure 4. Reinforcement and unbounded tendons (smaller tower)

Construction speed of each floor was the key for winning this job. We worked following the system „each week – one floor“. That was at least 3 days faster than the speed of the classic reinforcement floor.

Also the constant slab thickness was one of advantages of PT technology instead of 3 different heights as it was in design with classic reinforcement slab.

Figure 5. View on a slab after removing of the formwork (smaller tower)

The tendons in the slabs and beams are placed following the rule „Free tendon layout". Modeling Post-tensioned slab was done by the software program called GRAFeM using kinematic connections for nodes. The concept of the main structure with a core located in the central part of the plan (zero zone displacement of elastic shortening of the slab), so the afterward monolithic connection between slab and core walls is not necessary.

130 tons of tendons were embedded in Project Strojarska.

This project is one of the most significant projects of BBR Adria in the last 10 years.

2. International Airport Zagreb, New passenger Terminal, Croatia

2.1. Team & Technology

Investor: International Airport Zagreb, Pleso bb, 10150 Zagreb
Main contractor: KAMGRAD d.o.o., Zagreb, Croatia
Designers:
Jure Radić, Croatia
Milan Crnogorac, Croatia
Predrag Presečki, Croatia – for Post- tensioned (PT) slabs
Technology: BBR VT CONA CMM 0106
BBR Network Member: BBR Adria d.o.o., Zagreb, Croatia

2.2. General building characteristics

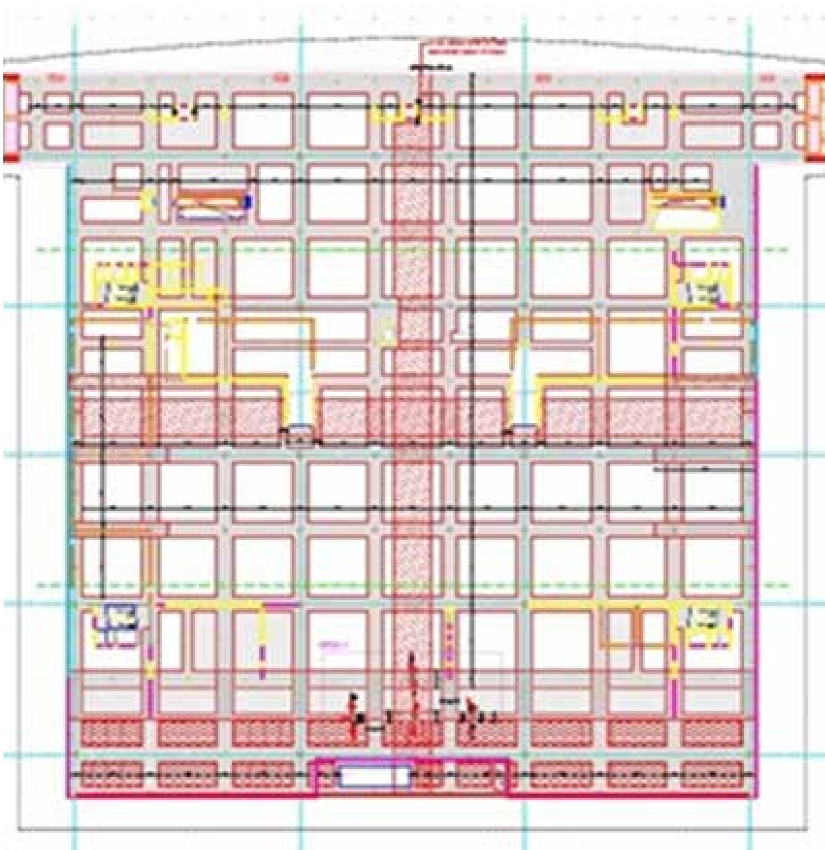

Figure 6. Plan of the first floor slab, usual span is 14.4x14.4 m, horizontal and vertical pouring strip will be closed after

Figure 7. Tendons on parterre slab

The new airport terminal is being designed and carried out in accordance with the international tender's winning design (authors Kincl, Neithard, Radic). The funds are provided by the French concessionaire (concessions for the period of 30 years), and project documentation holder is IGH Zagreb.

Start of construction was planned for the summer of 2014. Concrete construction should be completed in January 2015, and the opening of the new airport is planned for late 2016. The total area of the corrugated steel roof is 65,000 m^2, while three concrete floors have an area of about 45,000 m^2.

The central unit of the terminal building footprint is 130 x 136 meters, without dilatation, due to an unfavourable distribution of seismic walls located near the very ends of the ground plan. The structure was initially designed as prefabricated concrete construction, and at the proposal of the contractor in a very short period was redesigned to the monolithic post tensioned concrete construction.

Horizontal ceiling structure solved as post tensioned-concrete construction. All three levels of ceiling panels have longitudinal a3nd transverse work interruption (“fly”). These interruptions reduce the surface area of the first phase of construction on the sections of maximum length of 60-70 meters. The predominant ranges plates are 7.2x14.4m at ground floor slab (Item 200) and 14.4x14.4m slabs of first and second floors (item 300 and 400).

Figure 8. View of the building site form one of six cranes

PT slabs are designed as reinforced shallow wide beams. At the 1st floor slab (Item 200),beams are extending in the direction of larger, 14.4 meter range. These beams are in dimension 160/55cm, between which is a slab thickness of 18cm. Beams of the upper plate of the ranges 14.4x14.4 meters (item 300 and 400) are provided in both directions with the strips in dimensions 300/55cm. The slab between beams (11.4x11.4m) has a thickness of 25 cm.

Larger openings that interrupt the continuity of these beams are solved with reinforcements by the edge of openings so that the loads are transferred to the adjacent beems. A special case is the situation when the pillars of the top floor (item 300) are offset from the line of the major axis and their forces are taken by reinforced beams. These beams therefore have a greater thickness (300/85cm).

Prestressing is made by cables BBR VT CONA CMM 0106 (single), area Ap= 1.5 cm^2, characteristic tensile strength FPK = 1860 MPa. The rope is in a plastic tube with a protective grease (called unbonded tendons).

This technology gives positive effects due to the factory solved corrosion protection, speed and ease of laying, larger arrows, and small losses of friction allowprestressing on large sections (60-70 meters). A large number of cables are grouped in a reinforced straps, while passing through the slab at equal distances. Guidance line in beams in the range 14.4 m is divided into thirds so that towards supports makes parabola 2”, while in the middle third of the guiding is in a direction. Radius of curvature of the cable above the columns is R = 4 m, which gives the optimal reduction of the breaking force component.

Line keeping of the cables out of the beams zone to the slabs which are 18 and 25 cm thick is free (the free tendon layout) which significantly simplifies and accelerates their installation. According to the

Figure 9. A view on the first floor slab with span 14.4x14.4 m, middle zone, columns height 10meters thru two levels

agreement with the investor cable grouping is done in such way that in beams 300/55 in the zone of columns provide a zone (4 places footprint 40/40 cm) in which later could cut openings without the risk of interruption of cable. Modeling Post-tensioned slab and beams was done by the software program called GRAFeM using kinematic connections for nodes of finite elements. Analysis, according to EC2, contains control of vertical oscillations, deflections, stresses and design of reinforcement. The final deflections of rheology generally not exceed L/500. The compressive stresses, as is common in the plate PT, are far below the permissible compressive stress. Some seismic walls due to the high stiffness will be subsequently monolithed with the slab, and until then will rely on temporary short columns.

Figure 10. Pouring strip zone before monolithization

Figure 11. View of the roof structure

References

[1] Obrein, E. J.; Keogh, D. L. (1998). Upstand finite element analysis of slab bridges, Computers and Structures, 69, pp. 671-683.

[2] Bathe, K. J.; Wilson, E. L. (1980). Numerical methods in finite element analysis, New Jersey, Prentice-Hall, Inc.

[3] Presečki, P., Kovač, M.(2006). Implementation of kinematic restrictions in analyses of complex spatial models, Dubrovnik, International conference on bridges.

NAJZNAČAJNIJE NAKNADNO PREDNAPETE GRAĐEVINE 2014. U HRVATSKOJ

Sažetak

U ovom radu predstavit će se dva primjera prednapetih konstrukcija.

Prvi je VMD Tornjevi u Zagrebu, Hrvatska, gdje smo postigli veliku uštedu vremena pri gradnji i pojednostavljenje konstrukcije.

Drugi primjer koji smo uzeli je nova Zračna luka u Zagrebu, Hrvatska, gdje je želja investitora bila izbjeći prefabriciranu gradnju za tako reprezentativnu konstrukciju. Tehnologija prednapinjanja bila je jedini mogući izbor kojim bi se postigli rasponi od 14.4x14.4 m. Ovaj projekt je još uvijek u izgradnji i sve ide prema planu.

Ključne riječi*: prednapinjanje, ušteda, konstrukcija, rasponi, BBR*

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