TECHNOLOGY EXECUTION OF THE CITY STADIUM
OF CLUJ-NAPOCA

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A B S T R A C T
This article presents, in introduction, problem who related in this article. The first part contains
the description of constructive solutions from foundations, basements and continuing with the
resistance of the structure of frames, floors, and beams of precast concrete, cover as a spatial trust
structure and the bracing. The second part concerns the technology to achieve the structural
elements of reinforced concrete monolith and the installation of prefabricated concrete elements
and metal trusses and purlins. It describes the types of equipment (formwork, scaffolding) and
used machinery, including tower cranes on the site location. In finish is presented conclusion.

Keywords: stadion, step, ferme metallic trusses, formwork, mounting, crane

INTRODUCTION
The article presents problems of location, height, the final form of the
stadium, constructive solutions in all phases of construction and technology
used in the work. It’s presented monolith end precast structural elements
and realisation of cooperation. It reported the solution adapted to the
stadium roof, execution (type of equipment and machine) used in the site.

MATERIALS AND METHODS
1. Constructive solution description
The City Stadium of Cluj-Napoca is located on the site, of the old
stadium, which was demolished, on the Tineretului road in the Central Park,
on the south side of the Somes River and it will be used for football,
athletics and cultural events. Figure 1 a) [1], [2] presents the final shape of
stadium, Figure 1 b) is presents stadium in one of the phases of execution.
The City Stadium was designed for a number of 30,500 seats, standards
imposed by FIFA and UEFA, with height: two underground levels, ground
level and two to five stories with the maximum height 36,60 m (fig. 3). The
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construction importance class is B (construction of special importance) as HG nr.261, GO nr.2/1004.

The stadium is divided into four corps in joints settlement: segment T1 between 1-20 axis, segment P2 between axes 21-35, the segment T2 between the axes 36-55 and segment P1 between axes 56-70. In turn these corps have seismic joints located between the axes: 8-8 'and 15-15' (segment T1), 28 to 28 ' (segment P2), 43-43' and 50-50 ' (segment T2), 63-63 ' (segment P1) [2], [3].

Fig. 1. City Stadium of Cluj-Napoca (a, b)

The foundation solution, for all corps, is isolated foundations of reinforced concrete (between -5.15 m - 8.05 m) under columns and continuous foundations under concrete diaphragms. The foundations were placed for all parts T1 and T2 in the layer of ground called diorite sand with a conventional base pressure of $P_{\text{conv}} = 750 \text{kPa}$ and for the parts P1 and P2 in the layer made of sand and grabble with a conventional base pressure of $P_{\text{conv}} = 450 \text{kPa}$ [5], [10].

Given the high level of underground water (before the excavation) temporary laths were beaten. Laths made of high quality steel, were installed at the free top and built-in layer of marl to the bottom, to create a sealed tank in which water was discharged through direct dewatering. Metal laths were reused, removal of land realised by vibration.

The contour basement elevations were equipped with reinforced concrete both at the bottom and top of the concrete ring. The vertical waterproofing elevation was made of with thermo-welded membranes protected with a Tefond-type layer and in the joint zone special joint pieces were placed. To withstand the pressure of underground water on the floor, the plate was made of 25 cm thickness.

Resistance structure was designed as a frame structure with pillars and beams of reinforced concrete. Depending on the corps and firms executing some constructive solutions have been adopted such as [3]:

- the lawn P1, beams and floors were made of prefabricated elements: thin concrete strips, precast beams with additional concrete.
- the rest of bodies, beams and floors frame of 20 cm thick were made of reinforced concrete cast in position.

The steps were prefabricated, railway section between the pillars, the only areas cast is these nodes. Precast: the steps and parapets have been completed under its own production of SC. ACI Cluj.SA, transportation to the site being carried out with low platform trailers (hardest prefabricated shipping 18 tons and a length of 10 m).

The shell is designed as a spatial truss structure (fig. 3), leaving the console over steps. Trusses are placed on a railway section for reasons of transport and handling, making it assembly with a joining and bolts of resistance tensioners. Boundary is the concrete structure through motherboards equipped with spurs to take over slip. After installation, the space between the motherboard and column respectively of spurs and holes are injected with expandable cement-mortar.

Bracing and fastening systems of farm items and panels are made of cross-diagonal system made of bars with clamping sleeve. The end bays are disposed transverse bracings. Longitudinal bracings (fig. 5 a, b, c) are
among the first pane of the top console, between the panels of the curve area and bearing of the farm, the roof plan. There are fixing elements of bars compressed, tie rod connected to the sole bottom of the purlins in the console zone. In the support area there are vertical bracings (type tie rod) between upper and lower sole frame truss [6], [8], [9].

2. Execution Technology

Companies participating in execution of Municipal Stadium in Cluj-Napoca are:

- S.C. A.CI. Cluj S.A. – to segment T1, P2 and its general contractor,
- S.C.CON-AS.R.L. – to segment P1 and metal structure,
- S.C.TRANSILVANIA CONSTRUCŢII S.A. – to segment T2.

Monolit reinforced concrete elements have been made with minimum class C25/30 concrete. Mixing plant (fig. 6) was located on site near the target running, for the distance at transport of concrete to be minimum. Aggregates, in the construction phase were deposited in a bunkers for storing: four sorts of aggregates and three silos for storing cement.

Reinforcement was assembled by binding with wire (fig. 7) or with butt weld in shell. Were used mixed formwork with bakelited multi-layer sheet and local stiffening of steel or aluminum (provided by Doka and Hünnebeck companies) and metal formwork. To support (fig. 8) were used scaffolding own and struts and scaffolding that made the company Hünnebeck [4].

Pouring concrete was done by stationary pump and auto pumps, made by Putzmeister and tower crane equipped with vertical bucket. For vibrating
compaction of concrete were used Sifee vibrators with diameters ranging from 25 mm and 58 mm, vibrating the outside (shell) VEM300 and rulers vibrant Euroscreed.

Prefabricated concrete elements with minimum class C25/30 concrete were made SC.ACI Cluj.SA and were transported to the site using low platform trailers of 40 tons.

Storage was on the ground so that each prefabricated assembly can be achieved through direct acquisition by mobile crane (working radius chosen according mounting weight and respectively mounting height) equipped with handling and assembly type. Considering the position of the self-propelled crane the assembly was done in a circle is around the locus of its center of gravity position. Figure 9 presents ground storage of prefabricated elements type steps. After installation, the joints between the monoliths were mortar MPA35 and silicone SIKA.
Metallic trusses were made of 5 sections each, made under own SC.CON-A.SRL in town Şelimbăr, where they were transported and stored on the ground (fig. 10) within range of cranes that was direct mounting position. Assembling the truss sections (fig. 11) was done manually and to support workers at height were used telescopic platforms. In the next stage panels were installed using both platforms and telescopic cranes (fig. 12) [3].

In areas where possible, installing the first three sections of the truss was outside the stadium enclosure, and the last two inside. In the case of the elements of the Hotel Sport all sections were mounted inside.
Tower cranes: 1 MTA 125 and 5 POTAIN model MCT 58 and respectively MCT 68, used to mounting and lifting prefabricated building materials and technological equipment type formwork, scaffolding, scaffolding etc. were positioned (fig. 13), for construction work executed by S.C. TRANSILVANIA CONSTRUCȚII S.A. the axes 45-46 inside și 50-51 inside; and for the executed by S.C. ACI Cluj S.A. the axe 5-6 outside, 11-11’ outside, 23-24 outside and 27-28 inside [3].

Fig. 13. Placing the site of the 6 tower cranes (a, b)

Cranes that were used are: Liebherr LTM 1030/1, Faun ATF80-4, Saan Ruttrans and a high capacity crawler crane, with laticed arm of to type Sennebogen 3300.

Non-structural walls were made of:
- The walls of the gyms rooms - of ceramic blocks with goals CEMACON;
- The stairway walls and part of the closing wall - of brick masonry MACON Deva;
- Subdivision walls - of VG-ORTH-Multigips,
- The exterior walls of glass.

Sloping ceilings under steps were made from thin-walled sheet metal profiles, including ordering a layer of 15 cm of mineral wool for thermal insulation and 2 layers of plasterboard then GECAF.

CONCLUSIONS

The structure of the municipal stadium in Cluj-Napoca contain diverse building elements such as monolit and precast concrete and metal elements (trusses, purlins) designed to combine pleasing aesthetics with good functionality but with a reduced execution time. The three companies involved in the execution, who worked at the same time, they used
equipment (formwork, scaffolding, scaffolding) performance and specific type of work equipment. The six tower cranes covered by their working area, the entire stadium, and mobile cranes and crawler and telescopic cradles were chosen for optimal installation and assembly steps, spatial trusses, panels etc.

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