A long span structure in Romania

Zoltan KISS
Professor
Technical Univ. of Cj. N.
Cluj Napoca, RO
kiss.zoltan@plan31.ro

Karoly BALINT
Civil Engineer
Plan31 Ro
Cluj Napoca, RO
balint.karoly@plan31.ro

Nicu TOADER
Civil Engineer
Plan31 Ro
Technical Univ. of Cj. N.
toader.nicu@plan31.ro

Zsolt NAGY
Lecturer
Technical Univ. of Cj. N.
Cluj Napoca, RO
zsolt.nagy@gordias.ro

Summary

The authors will describe in the following pages the reasons why the project of the Multi-functional Sports Hall from Cluj Napoca is attractive. The main lines of the building are: a hall with a capacity of 7000 seats, a structure dominated by precast concrete elements, a long span roof and an advanced analyze of the connections, all well-kept into the limited funds. The roof solution consists in using steel space trusses made out of square hollow sections (SHS). The truss has a clear span of 63.90m, a total length of 76,10m, a maximum height of 4,00m that is reduced on the length of the structural element, and a triangular cross section being 3,60m wide. Global stability checks and specific local stability problems were performed and are exposed in the following paper. For the fabrication of the space truss, welded joints between the SHS profiles were designed. As a result of the fact that for characteristic failure checks of the welded TT and KK joints analytical methods are based only on a semi-empirical formulae, developed for Φ=90 degrees (the angle between the diagonal planes), for the design of joints finite element modelling was used. Good agreement between the results of the developed finite element joint model and the analytical method for TT and KK joints has been found, even though the semi-empirical formulae are applied for the analysed truss which had Φ=50 degrees.

Keywords: large span space trusses; precast concrete; joint analysis.

1. Structure overview

The Multi-functional Sports Hall is organized on five levels: underground level, ground level and three stories (Figures 1 and 2). Underground level is a parking with 447 car capacity. Ground level together with first and second level includes public, officials, media, shopping and administration areas. The building is a concrete frame structure with a characteristic bay of 8,40x10,60m, for the arena area. On sides the bays are smaller and with varying dimensions. The concrete frames consist in precast concrete columns fixed in foundations using dry connections (Figure 3), except the columns supporting the steel roof which are cast in situ. The last ones, having the cross section 60x120cm, the transportation together with the control and site erecting it would have been difficult to perform.

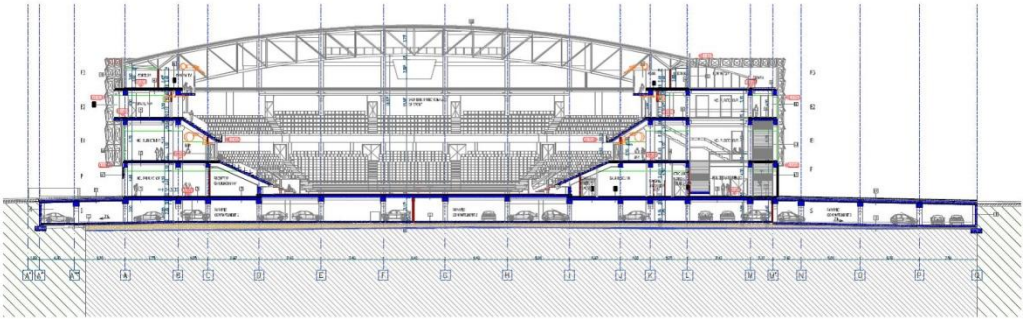

Fig. 1: Transverse section through the building

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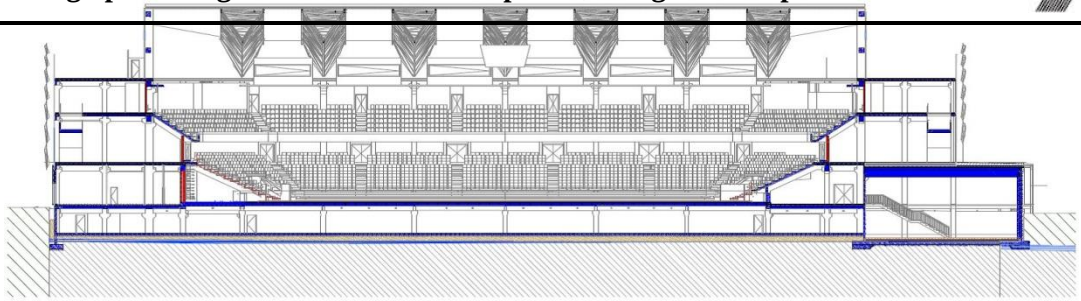

Fig. 2: Longitudinal section through the building

All frame beams and stair beams are precasted, reinforced concrete or prestressed concrete. The beam-column joints are moment-resisting (floor level ±0.00m) and pinned for the upper levels. For the frames connected directly to the roof`s steel truss, rigid connections have been used for the beams which are in the same plane with the space truss.

2. Space steel truss with SHS elements

The roof structure consists in 7 trusses with a clear span of 63,90m, and total length of 76,10m, supported by concrete frames and lateral interconnected with the rest of the structure through horizontal and vertical steel bracings. The space steel trusses are mounted using a spacing of 10,50m (Figure 2). Choosing the most appropriate roof structure solution has been driven by a number of factors including the span, roof geometry, load to be supported, economy and aesthetics. The truss section is 3600 mm wide and approximately 4000 mm deep (variable along the span). The steel trusses of this size are able to span such distances as simply supported elements, but large vertical deformations and horizontal reactions were necessary to be managed. Several options were investigated to keep the sizes to a minimum, the system that was decided combines the advantage of this system is that the end cantilever with the vertical tying elements of the truss effectively reduces the vertical deformations and axial forces in mid span, as well as allowing the continuity of the roof structure over the lateral annexes. Providing pinned supports for the roof trusses, positive effects in the internal effort distribution and the highest horizontal reaction over the concrete structures, were obtained (Figure 4).

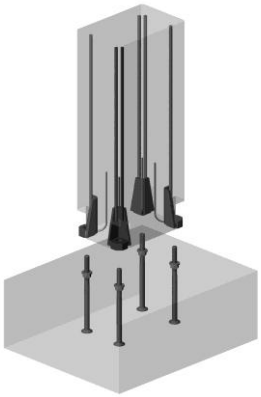

Fig. 3: Precast concrete column base connection

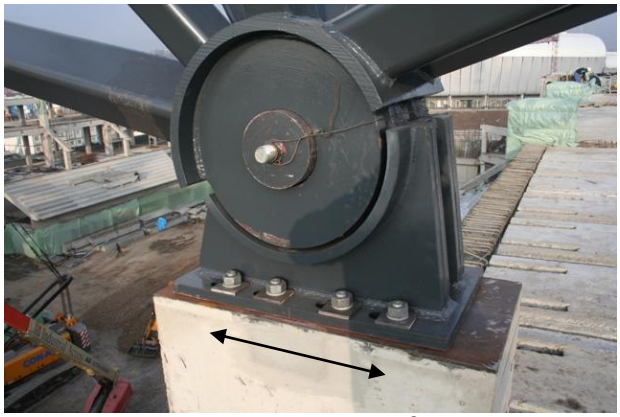

Fig. 4: Sliding possibility of the support

This paper describes the key aspects of matching a precast concrete structure with a large span space truss and searching for the optimal solution in this issue, from the safety point of view but also from the economical one too. Covering a large span area always arise problems even if we deal with a building of a small height (like a greenhouse for instance). But when the roof, in this case a space steel truss, is placed on top of a concrete structure several new issues need to be taken care off, like: the compatibility of the two types of structures (steel and concrete) that need to work together (displacements due to gravitational loads, horizontal loads, temperature differences), the construction stages (starting with mounting the first parts of the truss, continuing with the final assembling of the first truss and next the completion of the whole roof, and last but not least the final touching – in this case turning the simple support into a perfect pinned hinge) and other problems that may appear like the connection between SHS elements.