

Kopitnari International Airport – Structure of Terminal Building – Design, Fabrication, Erection

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Abstract. The construction of Kopitnari International Airport was one of the most important Georgian brownfield investments in 2011-2012. The 5000 m² steel terminal building with timber interior, a spectacular member of the complex, had been designed by the Dutch architect office UNStudio; under the egis of MTM Ltd. the super-structural design had been executed by CEOS Ltd. The whole project had to follow a tight time schedule: the design process started in autumn 2011; the Airport opened its gates on the 15th September, 2012. The structural design was performed by using Hungarian FEM software for analyses and the integrated BIM system, TEKLA for 3D modelling. The fabrication of the 500 tons steel structure was done by Hungarian Rutin Ltd. Every element was road-transported to the 3000 km far Kutaisi. The terminal's structure arrived in 4 parts according to the layout-quarters. The erection process had been done by Rutin Ltd. as well, 10 workers spent 5 weeks in Georgia while finishing the complete structure. Design, BIM, fabrication and site work together led to the final result: The supporting structure was erected in time, no site corrections were needed. After finishing a Georgian member of the team made the statement: "Hungarian engineering and construction in Georgia guarantee the success!"

Keywords: Kopitnari, Airport, Georgia, BIM, Kutaisi, airport building structure.

1 Design

Rare fortune for a civil engineer to have the possibility of being the designer of airports, stadiums, river bridges or other public structures with similar order of magnitude. Not an ordinary chance to show the talents, when Hungarian engineers have the opportunity to work on the design and Hungarian firms manufacture and erect the structure of a significant foreign state-project. Kopitnari International Airport was one of the most important Georgian brownfield investments in 2011-2012. The government's aim was to establish a brand new international airport on the ruins of the existing, but very bad condition former military airport. The new complex is formed by the 58 m high reinforced concrete control tower, RC office buildings and the 5000 m² steel terminal. (Fig.1)



Fig. 1. UNStudio's concept

The Georgian Government charged the Dutch UNStudio with the architectural design of the complex; the architects had had positive experiences with the Hungarian SMG-SISU Ltd. (building service engineering) and MTM Ltd. (structural engineering), so they started the work together since the very beginning. Having a long term, successful cooperation with Erick van Egeraat's office played an important role in the assignment of the Hungarian parties.

The project was planned with a very tight time schedule. The design process started in autumn 2011, the opening date was settled on 15th September 2012. The significant building volume and the tight time schedule together let other Hungarian firms to join the project in every fields, this is how CEOS Ltd. got the assignment in December 2011 for the conceptual and execution design of the terminal building's superstructure.

Because of the tight schedule the architectural design was in conceptual phase too when we started working on the project. This led to an exciting design situation; contrary to Hungarian routine no finalized architect drawings were available, our work had to be done including real-time dynamic consulting with the Dutch architect colleagues. By working out and over several structural versions we could have an influence on the final architectural layout as well. Obviously this required a lot extra effort, but the final concept became free of unfeasible structural details.

A dominant principle was the building's airy, spread wing-shape appearance. From the structural perspective it required long cantilevers and small structural height. No truss-kind structural solutions were allowed to use, even though it would have been reasonable from the span's and load's perspective. The horizontal main supporting structure was designed with using 1000 mm structural height welded 'I' and box sections. The airy appearance was a basic architect demand for the vertical structures too. The broken-axis umbrella beams, the inner RC block and the fixed columns let the building become real slender and require minimal extra bracings. An extraordinary part of the terminal was the central leaf-shape Pattern, made by glued laminated timber beams.

Despite of the regular ground-plan, – 92 m * 62 m rectangular shape with 7.40 m inner height (Fig.2) – the hierarchic structural system was disturbed in several locations by the canopy running around the terminal. The North-eastern building corner's 12 m long cantilever changed the structural system's behavior rather space-truss like. The deflection limitation caused further difficulties, as according to the architectural concept we had to calculate with the load of a 15 cm thick extensive green roof above the trapezoid sheeting.

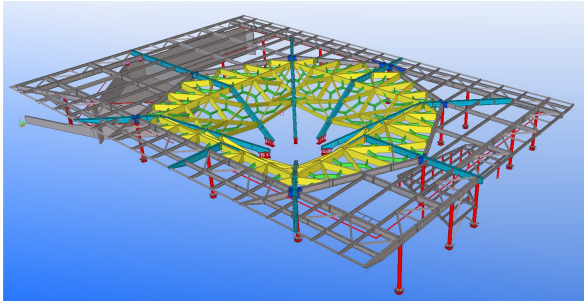


Fig. 2. Structural system of the Terminal Building

The significant self-weight of the green roof caused several problems to solve, not only from the vertical load-transfer's perspective; Magnitude 8 earthquake effect had to be taken into account in the structural analyses, which caused increasing structural heights, respectively increasing plate thicknesses because of the height-limitations. Beyond the regular loads we had to calculate with significant temperature-effect too.

The structural analysis was executed with using both Hungarian developed FEM software. For seismic design and for the analysis of complex joint details we worked with Axis, for the quick and economic sizing of steel parts the ConSteel software proved to be a useful tool.

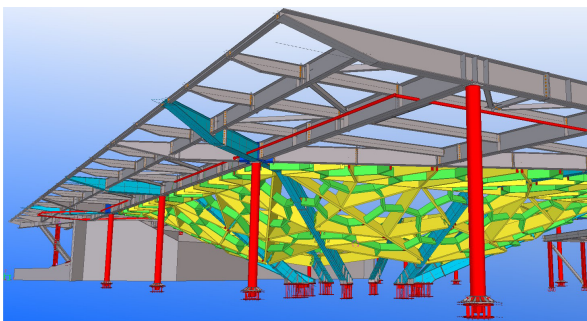


Fig. 3. Steel reinforced concrete and glued laminated timber parts in one BIM model

The complexity of geometry, the intensity of digital data-exchange, the filtering of possible clashes and the needs of manufacturing technology indicated, that the structure's full 3D BIM model has to be built before providing any drawings. The "multi-user" mode of TEKLA V17 allowed us to work on the model real time together with

other colleagues, additionally modelling could be done parallel with structural design. This way non feasible structural details could be filtered out directly, additionally the steel parts could be handled in one model together with the reinforced concrete building parts and the glued laminated timber pattern (Fig.3). The Pattern had direct sheared connections to the steel main beams, but it was manufactured in a different factory. Having the timber and the steel in one model was essential for all parties, otherwise timber erection could have been almost impossible.

2 Fabrication

In February RUTIN Ltd. in Dombóvár, Hungary was charged with the manufacturing of the terminal's steel structures. By that time our BIM model had been fully detailed, so it was obvious for all parties that our model should go forth into production. Only four weeks were available for preparing the shop documentation. After spending an intensive day in RUTIN's factory, getting familiar with all the specifications and needs of fabrication according to EN1090 the shop design started. All edge chamfers and welds were modelled, the structure was split into 4 parts according to erection scheduling, welded and rolled assemblies were split because of different fabrication location. Finally more than 1300 sheets were issued as single part or assembly drawing, additionally all lists were separated according to erection scheduling. From the designer's side we gave a continuous, real time support for fabrication, however thanks to the consistent BIM model, the high quality production and the previously fixed technical considerations minimal help was needed.

The production had to face two major difficulties. As the opening date of the airport was a politically fixed day, no delay was acceptable either in production or in site works. Facing purchasing difficulties of the S355 J2 raw material the tight schedule became even more strict, finally 10 weeks remained for the overall execution. Secondly the single parts and assemblies had to be produced in perfect quality (EN1090 EXC02 and EXC03), as no site corrections would have been possible. One single mistake could have deranged the schedules, and cause a delay of weeks because of the 3000 km distance.



Fig. 4. The first assemblies arrive to building site on 01.07.2012

The fabrication procedure was carried out with strict quality assurance. A mandated expert's responsibility was to check and approve the daily progression including single parts, assemblies, welding and surface treatment as well. The final control of heavy assemblies was done by geodetic instruments. Thanks to the effort and the hard work of fabrication, the complete structure was delivered without any fabrication mistakes (Fig.4).

Theoretically the building was split into four parts (quarters) by the longitudinal and transversal middle grids; fabrication, transportation and erection went clockwise following each other to enable continuous work.

3 Erection

The proposed erection-timing per quarter was one week. The erection process was executed by RUTIN Ltd as well, who delegated a brigade of 10 people from Hungary with all the tools and equipment needed for site work. The hoists and cranes were provided by local contractors. The first parts – columns and main beams – were positioned on a crosshair marked on the base plate by the local surveyor. The oversized slotted holes on the column base connections could eliminate the accidental inaccuracies of the foundation, so thanks to the accurate and precise fabrication no leak plates were needed, although several had been designed and produced for each moment-resistant joint.

The site work was hindered by the 2.50 m – 4 m wide floor channels running around in the reinforced concrete ground-slab. As the crane capacity was strongly limited, this problem had to be solved with farsseeing organization planning. Most of the structural joints were moment resistant head-plated connections with pre-stressed 10.9 metric bolts. The actual vertical displacements of the cantilever-ends at both building facades showed more obvious than any report if the bolts were not pre-stressed properly. Without torque preloading the cantilever ends (Fig.5) formed a spline, but with proper pre-stressing they straightened in order. The erection works were finished on 2nd August, one week before the deadline (Fig.6). After finishing a Georgian member of the team made the statement: “Hungarian engineering and construction in Georgia guarantee the success.”



Fig. 5. Side view of building frame



Fig. 6. Terminal building's top view

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