

THE STEEL STRUCTURES OF THE NEW FOOTBALL STADIUM OF OLYMPIAKOS F.C. IN ATHENS

*M.Majowiecki, **F.Zoulas

*IUAV – Università di Venetia, Venice, Italy

majowiec@iuav.it

**Consultant Structural Engineer, Athens, Greece

zuzu@otenet.gr

Abstract:

The main purpose of this document is to provide adequate information concerning the Steel Structure of the new Olympiakos Football Stadium in Pireus, Greece. The above mentioned Stadium occupies an area of approximately 32,000m², in plan view, and has a seating capacity to accommodate 34,000 spectators. In addition to the athletic event area the facility includes shopping center, restaurants, V.I.P. suites, offices etc. The steel structures, based on a reinforced concrete construction consisting of a deep foundation system and an above ground building facilities (that extend to the 6.44m level), is formed by the grand stand upper level and his global roofing system .

For the design of the grand stands and main roof steel structure, the following aspects were taken into consideration:

- The architectural conceptual design.
- The total coverage of the grand stands.
- Topologic and geometric arrangement of the spectator stands , taking into consideration the elevation difference of the V.I.P. suites.
- The necessity for the completion of the works in a very tight time schedule , imposing the utilization of simple methods of construction and erection.
- Cost optimization, without compromising, the structural quality, safety and aesthetic appearance.
- Total manufacturing of the steel components in Greece.

Brief description of the system:

Conceptual design of the steel structures

The Steel Structures basically consists of the following components:

- The grand stands supporting frame;
- The main roof macro-cantilever beams.
- The perimeteric internal triangular truss beam.
- The secondary roof-covering support beams.
- The roof covering membrane.

The grand stands supporting frame

With a constant average separation of around 6m (9m at outer part), 70 plane frames are oriented normally to the rectangular play ground. The frames consists of a steel composite box beam 40cm. wide and variable high, according the variability of the bending moments, from 30cm to 120cm; a central column of steel round pipe section and an external composite vertical column made of two parallel tubes, able to support inside the separation the supporting connection detail of the stand beam. The support stand beams , inclined according the visibility curve,are interconnected and wind braced every 5 frames corresponding to the main cantilever macrostructures.

Main Roof Macro-cantilever beams.

The macro cantilever beams are arranged in the same vertical plane of the Grand Stand frames and the distance from center to center of the adjacent beams is 39m. The total number of the main roof cantilever beams required for the completion of the project is fourteen. The free span of each cantilever beam is 35m and the maximum height reaches 10m. The cantilever is composed as a space macrotrusses arranged in a self-stabilized pseudo-pyramidal shape. The upper and lower layers are made of circular tubular sections. Each cantilever is counter-balanced by a rear mounted 7.80m in length lever-arm, made of similar tubular section as the cantilever beam.

Perimetric internal triangular truss beam.

The reticular space beam in reference , constitutes the internal perimeter of the roof structure and has a height of 2.0m and width of 2.10m. Triangular shaped in section, the space beam is made of tubular circular sections and, suspended from the ends of the main cantilever beams, is supporting the secondary roof beams. The suspension system give the possibility to create thermal expansion joints between main macrostructures . The differential displacements are not permitted during dynamic wind or seismic action by a visco-elastic actuators placed at the level of macrostructures oriented in tangential direction.

Secondary roof-covering support beams.

The secondary beams , radially oriented , support the roof covering system and are made of variable height rectangular box-section. They are supported at the one end from the triangular truss beam and, at the other end, from the vertical supports of the grand stand external columns.

Roof covering membrane panels.

The roof-covering consists of modular , prestressed double curvature surface membrane panels made with a composite polyester + PVDF high strength material. The roof membrane panels are supported by tubular II shaped steel frames , spaced 4,0m from each other creating a typical greek “meandros” pattern.

The roofing substructure is supported on the secondary beams by bolted flange connection details.

The above mentioned steel structural system and components were analyzed and verified under the action of the external loads in conformity with the Euro and Greek Design Codes specially concerning seismic actions. In addition, experimental tests in a wind tunnel laboratory have been executed in order to obtain the wind load distribution on the roof covering surface.

References:

- [1] CRIACIV , “Olympic football stadium in Pireus Greece – boundary layer wind tunnel tests on the wind induced pressures”, report 03/02;
- [2] G.Bartoli, P. Biagini, C. Borri, M. Majowiecki, M. Orlando, L. Procino ,*Wind-Tunnel Tests and Design Loads of the Roof of the New Karaiskaki Olympic Stadium in Piraeus”, IASS 2004, Montpellier.