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## 9. The New Football Stadium, Torino (Italy)

**Owner:** *Societa' Dell'Acqua Pia Antica Marcia*

**Designers:** *Arch. Sergio Hutter; Arch. Tony Cordero; Ing. Massimo Majowiecki; Ing. Francesco Ossola*

**Contractors:** *Costruzioni Generali Prefabbricate S.p.a., Cogeco S.p.a., Ctip S.p.a.*

**Works Duration:** *15 months*

**Service date:** *April 1990*

The tensile-structural system which has been adopted to cover the new stadium of Torino consists essentially of (fig. 1):

- a radially oriented set of cable trusses
- an inner tension ring
- two cable nets with hyperbolic surfaces
- an external stayed anchorage system
- a gravity foundation system.

### Radial cable trusses

The cable trusses are formed by two load bearing upper cables, two lower stabilizing cables interconnected, in vertical planes, with hanger cables spaced every 5 m. They are placed in radial directions as to centers C1 and C2 of the polycentric homothetic curves which generate the general geometric scheme of the stadium.

Depending on the stress and deformation state, the cable structures have been dimensioned differently and collected into two groups. The main geometrical and mechanical characteristics of the system are shown in Fig. 2.

All the cables are spiral zinc-coated steel structural strands (class B) and have a locked and/or open section;

they have an elementary resistance greater than 1570 N/mm<sup>2</sup> for the external «Z» – shaped wires and greater than 1770 N/mm<sup>2</sup> for the internal circular ones.

A secondary transverse structural system is suspended at the stabilizing cable level. The arrangement adopted for this system is that of a simply supported (hanging) spatial truss with triangular section made of tubular steel elements.

The covering system which is placed on the extrados of the secondary beams and connected to it, is formed by aluminium corrugated plates, with height of 200 mm and thickness of 12/10 mm, by an insulation layer and by an impermeable extrados mantle consisting of two thin aluminium plates which are mechanically connected to the intrados plates with anchor bolts.

### Internal tension ring

The internal ring, whose main function is to balance the horizontal forces transmitted by the radially oriented cable system in a locally closed system, is geometrically configured in the design by four circular arches of radius 56 m.

In order to increase the curvature and consequently to reduce the tension forces, it has been necessary to introduce a transverse tie bar characterizing the bilobate polycentric configuration of the inner ring.

The ring is formed by 6 zinc coated, locked section spiral shaped cables of diameter 84 mm; they are arranged on horizontal planes at a height of + 41.00 m and are vertically spaced in order to allow a functional connection to the radial trusses. The cables of the internal tie bar have a 2 × 6 diam. 66 mm being the same as for the previous cables.



**Fig. 1:** Working model of the stadium

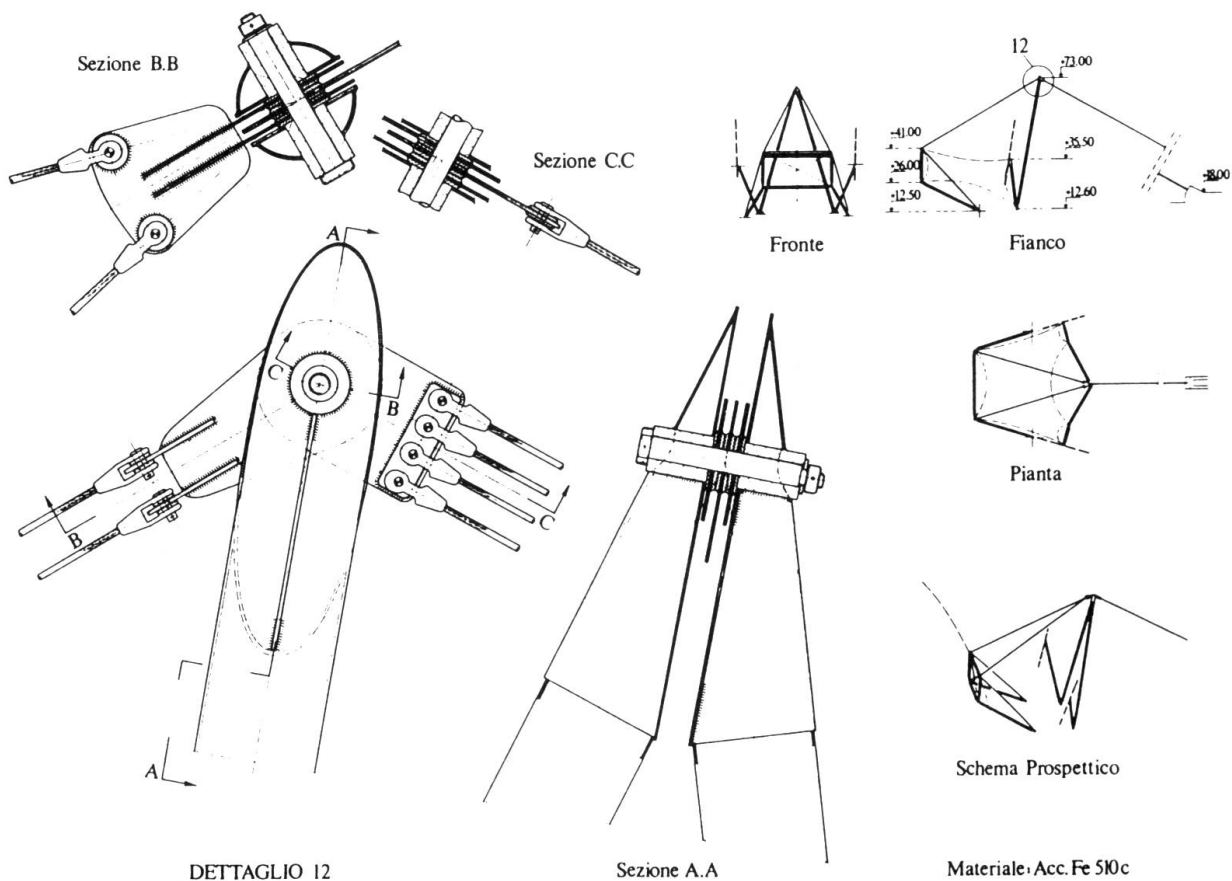


Fig. 2: Main details

### Cable nets

Two cable nets with quadrangular mesh and with negative total curvature surfaces (saddle-shaped) are arranged in the central areas of the North-South curves. The cable net is anchored to the central ring at + 41.21 m height, to the boad bearing structure of the third level of the grandstands at + 31.51 and at + 21.00 m respectively and to the foundation at a level of + 8.21 m.

The covering of these areas is linked to the general covering in a sector of the stadium where the third level of grandstands is missing.

The covering adopted for the cable nets is a membrane system made of fiber-glass and PTFE (Poly Tetra Fluoro Ethilene) with 60% translucence.

The membrane is fixed to the net on lines and/or points through mechanical connections.

### Anchorage systems

The anchorage system of the cable trusses and cable net consists of external stayed frames with tubular columns and stay cables.

As to the rectilinear areas, the anchorage frames are placed on the structures of the third level grandstands at a height which varies between + 35.53 and 35.55 m. The tops of the columns are placed at heights between + 50.86 and + 60.83 m. The anchorages of the stays are set at a height + 21.05 m.

The steel tubular columns have diameters of between 508 and 762 mm and thicknesses between 10 and 14 mm.

The quality of the material is Fe 510 C. The upper and lower stays have been realized with the same cables that have been used for the supporting and stabilizing cables.

Also the anchorage system of the cable nets and of the ring in the curve is formed by an anchorage frame consisting of tubular columns having a diameter of 1600 mm and a thickness of 28 mm. They are positioned in a «V»-shape and have an inclination of 10° toward the outside of the vertical axis. The top of the «V» is placed at a height of 73.52 m and the base (with width of 35.8 m) is set at a height of 9.90 m. The stays were realised with 4 cables having a diameter of 80 mm are anchored along the longitudinal axis of the construction at a distance of 237.5 m from the center of the playing area and at a height of + 15.00 m from the playground.

### Gravity foundation system

The foundation system adopted in order to equilibrate the tension forces transmitted by the cable stay anchorages are of the gravity type. All the adjustable connections provided to introduce the pre-tension forces are placed at the top of the specially shaped concrete anchorage blocks.