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3. Florence Municipal Stadium (Italy)

Owner: *Florence Municipality*
Designers: *Italo Gamberini, Loris Macci, Enrico Novelli, Giovanna Slocovich, with Orazio Miroddi – Architects*
Raffaello Bartelletti, Enrico Baroni, Alberto Bove – Structures
Salvatore Di Pasquale – Structural consulting
Contractors: *ISA Italstrade Appalti S.p.A. – Milano*
Magri Geom. Anselmo S.p.A. – Parma
Industrie Face Standard S.p.A. – Milano
Policarbo S.p.A. – Milano
Works duration: *30 months*
Service date: *1990*

The Florence Stadium was built in 1932 by Pier Luigi Nervi: its original and daring reinforced concrete facing structures made it one of the world-renowned modern masterpieces, protected as a national monument. Therefore, no significant change of the original complex has been made to increase its capacity, to comply with recent regulations and laws in force, and to give it the modern equipment necessary for the 1990 world football championship. Moreover, some spurious additions were removed in order to display the original structures in their pristine configuration. Among the diverse works, only the most significant ones, from a structural standpoint, will be outlined in this short paper.

With the aim to increase the covered seats, two cantilever steel covers were built; these are near the existing reinforced concrete one, but slightly apart, so that its perfect visibility is allowed (fig. 1). The new steel cantilevers are made by variable height I profiles and the intrados profile and the span (about 18 m) match those of the Nervi cantilever. The design characteristics of the cantilevers have been subjected to a couple of main conditions: firstly, very slender vertical tie-rods were requested on the back, so that their visual impact on the original main facade could be minimized. Furthermore, since the columns had to pass through the old stands, the demolition had to be limited within a single step, between two adjacent risers. The minimum size of such openings (about 40 cm) dictated the choice of the column section and had also to comply with the maximum values of the computed displacements, due to live loads (earthquake included). The tie-rods are fastened at ground level by reinforced concrete diaphragm walls, 14 m deep. The upper end of each tie-rod has been threaded so that a couple of adjustable rings can block the cylindrical casing of the cantilever back-end. Such a device allowed, during assembly, to easily adjust the pitch of each cantilever beam, until they were lined up with each other and with the reinforced concrete ones.

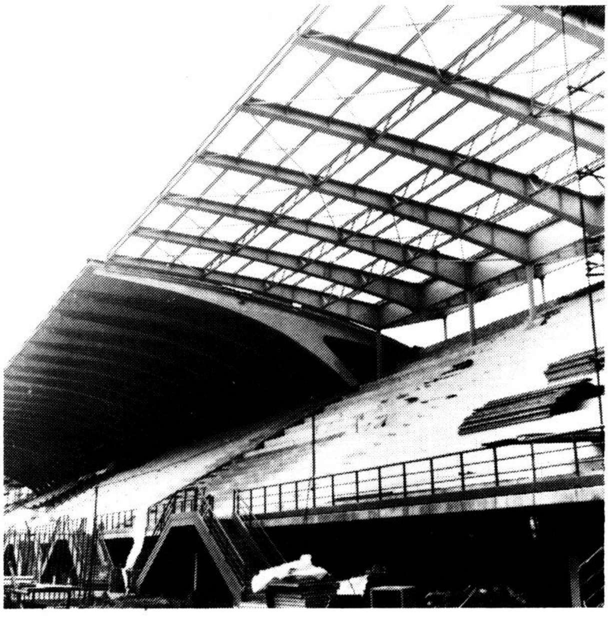

Fig. 1: New cantilever steel cover

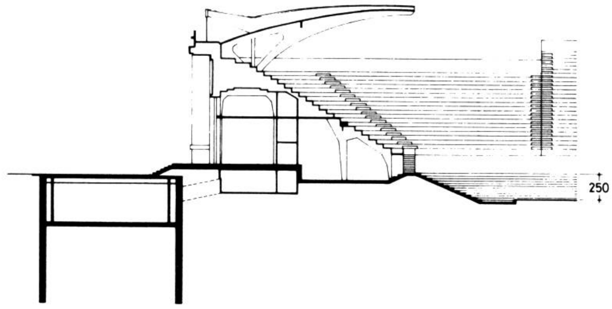

Fig. 2: Section where the lowered field may be seen

With the aim of making place for new tiers around the field, this was lowered (2.50 m) by a 40 000 m^3 excavation (fig. 2). Its feasibility had been previously ascertained by hydro-geological surveys and analyses dealing with the water-table depth and the stability of existing foundations. The new reinforced concrete stands cover roomy spaces for deposits and technical systems; there is no expansion joint between them, since they were mostly cast upon the ground. However, a sequence of castings and a series of provisional joints were provided, so that shrinkage effects could be minimized. New spaces for parking, gymnasium, swimming pool, electric and plumbing systems are in most cases underground, totalling about 60 000 m^3 (fig. 3). The retaining walls have been built as reinforced concrete diaphragm walls, dug into the ground by use of guided-bucket shovels and bentonite slurry. The diaphragm walls – 14 m deep and 0.8 m thick – were necessary because the new structures are close or even adjacent to the existing foundations. This technique also allowed to limit the drainage during excavation, even when the bottom level was slightly lower than the water-table, which is about 7.70 m deep. Because some underground building has sizable dimensions (the local authority parking, for instance, is 145 m long), some diaphragm walls have been

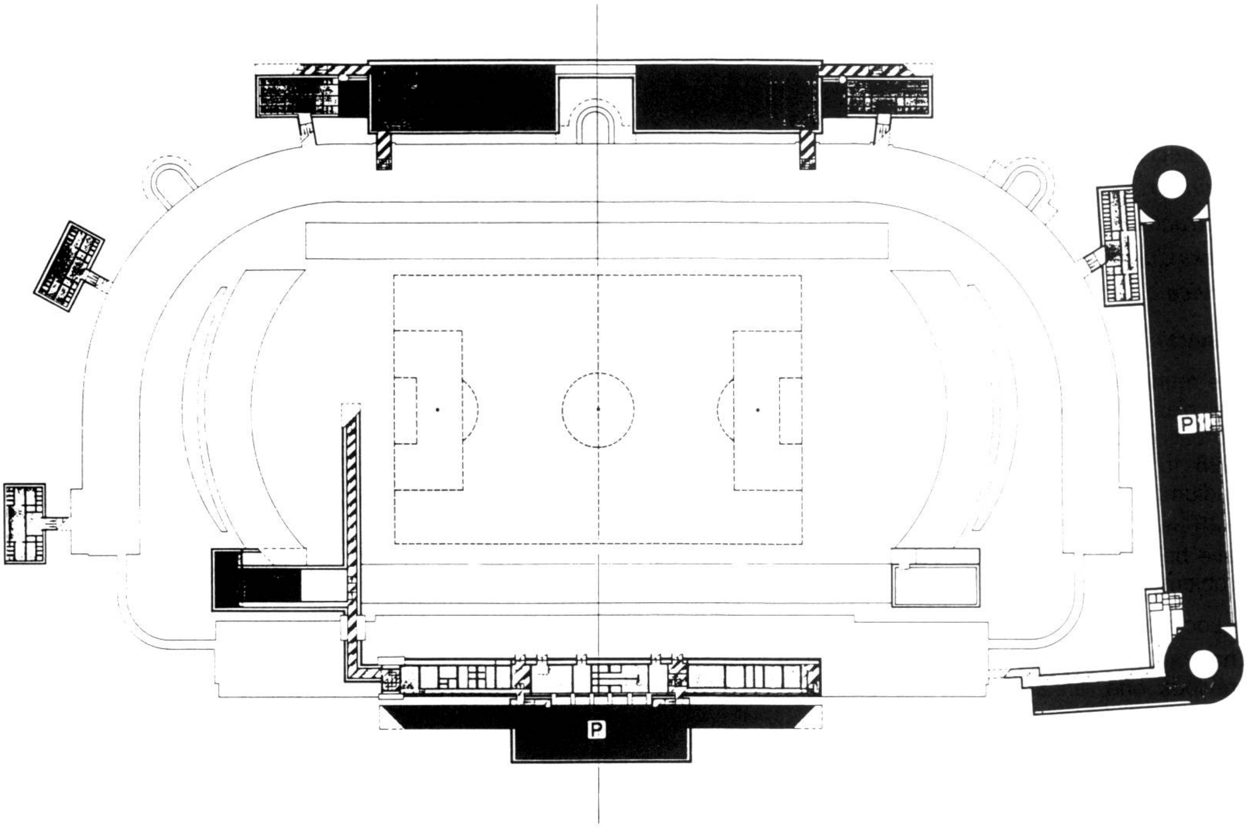

Fig. 3: Plan view of the underground constructions

shortened at the lower end, so that largescale changes in groundwater flow could be avoided. The bottom slabs, which are the lower floors of the underground constructions, are linked to the diaphragm walls by reinforcement stumps, previously placed under cover and then bent out, and also by reinforcement bars inserted in drilled holes, filled by non-shrinking grout. The slabs were designed with such characteristics that could counteract uplift pressures due to a possible long-term rise of the water-table. The upper storey is made by prefabricated prestressed reinforced concrete elements, acting also as struts or braces against the top of the diaphragm walls; on such floors the live loads of second class bridges have been taken into account.

The existing stands were heavily damaged and weathered due to the lack of shelters, the inadequate concrete cover, the thinness of the steps. It was therefore necessary to provide a thorough upgrading of materials and a durable protection. In particular, from the upper surfaces of the stands the existing levelling layers were removed, then the structures were restored and, finally, a finish-layer was made, with advanced concrete mixes and diamond-shaped reinforcement mesh. This was placed for static-consolidation purposes too, providing joints at 5 – 6 m intervals. Finally it is worth mentioning the building of 4 steel floodlight towers whose maximum height is 56 m; their foundations could be located (since room is available underground on the outside of the stadium) on the top of a set of 3 reinforced concrete diaphragm walls (dimensions: 3 × 3 × 14 m). A couple of new steel stairs were also constructed, close to the outer side of the stands (fig. 4).

Fig. 4: New steel stairs

(R. Bartelletti)