The Porcheddu company and the projects for reinforced concrete water tanks: Building models and construction site experiences (1912-1933)

L’entreprise Porcheddu et les projets de réservoirs d’eau en béton armé: modèles constructifs et expériences de chantier (1912-1933)

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Engineer Giovanni Antonio Porcheddu\textsuperscript{132} went into business in the field of civil and industrial construction in Turin in 1894. He had already purchased the northern Italian license for the patented French Hennebique process, and after 1914, he was the only Hennebique licensee in all of Italy. Porcheddu and François Hennebique knew and respected each other, and were friends. Hennebique provided support for the Italian company in the early years, delegating his offices in Brussels, Belgium, to help with calculations. However, after 1897, he gradually allowed Porcheddu greater autonomy, depending on the difficulty of the project. Porcheddu’s company also experimented with differently shaped metal reinforcement bars (other than round ones), and obtained improved adherence. They filed a patent on the system in 1906, and subsequently advertised it in the Italian magazine \textit{Il Cemento}.\textsuperscript{133} The following figures are indicative of both the escalation of the company and the success obtained by the application of the Hennebique patent in Italy: having completed 12 projects in 1895, Porcheddu expanded to 424 projects in 1902.\textsuperscript{134} The company grew steadily, and by 1909 had engaged in as many as 1,307 projects. However, by 1933,
the business was suffering and the company was liquidated between 1934 and 1935. During its period of activity (1894–1933) a total of 2,600 projects were carried out, but only 5 of them involved work outside of Italy: a locomotive depot and a water tank in Tripoli (Libya) in 1912, the Italian schools in Rhodes (Greece) and in Antalya (Turkey) in 1922, and the Italian hospital and a water tank in Tangier (Morocco) in 1926. Porcheddu was the leading contractor in the field of reinforced concrete water tower construction beginning in 1903. It had undertaken an unusually bold prototype at the Sforza Castle in Milan, presenting substantial difficulties. The assignment was to construct two concentric cylindrical tanks, the bottom one containing 480 cubic meters (126,800 gallons) of water and the top one, 1,600 cubic meters (422,000 gallons), to be placed inside the circular southern tower of the castle. These water tanks were designed to be integrated in architect Luca Beltrami’s plans for the reorganization of Milan’s drinking-water distribution system, involving the use of the Sforza Castle towers to store supplementary tanks. In the years that followed this showcase accomplishment, Porcheddu built other, much smaller tanks for other city water supplies.

The magazine Le Béton armé was particularly interested in exploring sizing and structural analysis. As early as 1900, it wrote “water-tower construction is one of the primary applications for reinforced concrete, and this kind of work has been an important source of business for all the reinforcement systems.”135 The magazine mentioned earlier works by Joseph Monier, such as the 200-cubic-meter water tank built in 1868 in Maisons-Alfort and the 119-cubic-meter tank built in 1872 in Bougival. In 1897, François Coignet had built 500-cubic-meter tanks with cylindrical base for the port of Toulon. In its early days, the Hennebique company usually designed tanks subdivided into at least two compartments, with a rectangular base. Dual tanks made it possible to supply water continuously, even during maintenance operations requiring that one of the tanks be drained. By 1900, Hennebique had already built over 80 tanks.136 They differed in shape (rectangular and cylindrical), location (underground tanks or water towers, supported by both pillar structures and a continuous wall) and inner subdivisions (one to more compartments).

The 260-cubic-meter tank, built in Saint-Marcel (Aude, France) by Rouverol and Teissier, Hennebique contractors and licensees in Montpellier,137 was a fundamental advancement in reinforced concrete water-tower construction. The technical measures and solutions that emerged from the project became references for later Hennebique water tower projects, such as the 2,500-cubic-meter tank built in 1926 in La Rochelle.138 The cylindrical shape of the Saint-Marcel tank facilitated the uniform distribution of water pressure inside the tank. It was supported by 28 reinforced concrete stanchions and a system of radial beams. To facilitate monitoring and maintenance of the water tower, the square space in the center of the stanchions was provided with a stairway and conduits for water draining and distribution pipes. To solve the problem of water overheating in concrete tanks (which happens even more often in the metal tanks most commonly used) the ceiling or upper terrace was covered with a layer of earth and grass that was watered regularly. After being completed, the tank was wrapped in brick, creating a spillway for excess water so that it would not percolate along the concrete walls. Openings judiciously distributed along the inner wall of the upper part of the hollow tower enabled excess water to evaporate. Moreover, only Hennebique licensees had access to a special waterproof coating called Pixoline, the qualities of which were often vaunted in Le Béton armé magazine.

On May 28, 1912, the Porcheddu company presented a proposal for a 50-cubic-meter hexagonal tank, based on the design of the Saint-Marcel model, to the Italian Ministry of Colonies (General Directorate for the Civil Matters and Public Works), to be built on the breakwater of the esparto139 pier in Tripoli (Libya).140 Their bid
2000-cubic-meter water tank for the esparto pier, Tripoli, Libya (1912): Design for the reinforced concrete structure with 50-cubic-meter compartments, section and axonometric projection
Water tank for the esparto pier, Tripoli, Libya: Project for the reconstruction of a reinforced concrete reservoir, plans, section, and elevation, 1932
The many difficulties that arose on the construction site delayed completion of the projects by 91 days and a fine was imposed on the company. Some additions required by the Ministry regarded raising and widening the tank in order to add space for offices and a caretaker’s house, which implied structural reinforcements of the ceiling, introduction of a double bottom slab, and as a consequence, an increase in costs. At the end of the project, it was not possible to carry out tests on stability and waterproofing, because the seawater desalination plant had not yet been completed, and the Boumeliana aqueduct was not supplying sufficient water. The tests were therefore postponed to the following year (March and April 1913), leaving the tank inactive. In 1913, the tests on the structures had a positive outcome, while the waterproof tests turned out to be negative. During the winter of 1920, when the final payment was due to the Porcheddu company, the Department of Public Works in Tripoli started reporting cracks on the reinforced concrete structures of pillars and beams. Cracks were recorded on the edges between the vertical walls and the lower floor, due to non-uniform water pressure and the difficulty in bending the reinforcing bars. Furthermore, the coating was flaking off the walls of the tank, and the reinforcements started to rust. The situation seemed likely to worsen, arousing fears that the tower would collapse. As a result, the Ministry of Colonies brought a lawsuit against the Porcheddu company. The observations that appear from the minutes of the inspections performed by the Government-appointed experts mainly related to the construction methods. It is noted that “the Porcheddu company, wishing to do business in a country with a hot climate, failed to protect itself from the climate and certainly failed to reinforce certain risk prevention procedures. The gravels were not crushed finely enough and the steel bars were not properly covered. The proximity of the sea may have accelerated and intensified the damage due to these phenomena.” Porcheddu sent in technicians to carry out confidential inquiries, and concluded that the steel bars had rusted due to the

was rejected, probably due to the lump sum form of the contract and the need to contain costs. The Ministry of Colonies instead accepted the project for a much bigger tank (2,000 cubic meters of water), more conventionally shaped. Porcheddu agreed to build a four-compartment, square water tank on a reinforced concrete stanchion-and-beam structure. It was designed to contain both the small amount of water coming from the Boumeliana aqueduct, and that coming from a seawater distiller which was under construction.
proximity to the sea. However, they rejected the allegation that seawater, sand, and salt gravel had been used for the preparation of mortar and concrete mixtures. The company had declined to use the rubble of Ain Zara and preferred the more expensive and heavier sands from Sicily. The tank was kept in full operation until September 1929, when a surprising decision was made to demolish it because “its low position does not provide sufficient pressure, and for esthetic reasons.” An undated, unsigned "reminder" explained that the Porcheddu company was willing to pay the fine for the delay, but also underlined that the company’s presence in Tripoli had driven down construction prices. There was a shortage of work, and local companies had lowered their rates, hoping to win contracts for large Italian government projects in Libya, like the new Tripoli aqueduct dating from the early 1930s. The legal wrangle between the Ministry of Colonies and Porcheddu continued until 1939, when it was interrupted.
by World War II, even though the company had gone out of business in 1933. Porcheddu would never succeed in reestablishing a good relationship with the colonial administration, even though it offered to lower prices and waive profits on the construction of new cylindrical tanks according to revised and updated plans submitted on August 18, 1932.

Despite this negative experience, the Porcheddu company was able to participate in other construction sites in the Mediterranean thanks to the involvement of the ANMI (Associazione Nazionale per Soccorrere i Missionari Italiani - National Association for the Assistance of Italian Missionaries) established by the archeologist Ernesto Schiaparelli, who personally donated a large estate, the former palace and garden of the Sultan Moulay Abd al-Hafid in Tangier, Morocco, purchased on behalf of the Italian Government in 1926. One year later, an Italian hospital was built on the property, based on plans by engineer Piero Molli, an alumnus of Politecnico of Turin, like Giuseppe Porcheddu. Some sketches for the project, dating back to 1927–1929, show plans for a rooftop water tank for the facility. It was designed in full conformity with the Hennebique method, featuring a reinforced concrete stanchion-and-beam structure, incorporating the standards developed for the Saint-Marcel water tower on a smaller scale. The reinforced concrete tank was
circular, with a single compartment, equipped with a hollow inspection cylinder inside. It was supported by four reinforced concrete beams forming a square tangent to the inner cylinder. A decorative outer structure, coated with plaster, protected the tank and made it look like an Oriental tower. Gradually, the technical experimentation on the design of water tanks was enriched by an effort to beautify them architecturally. Soon, they would be appreciated as landmark structures in the urban landscape.