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First applications of reinforced concrete in Sardinia The «Porcheddu Company Engineer G.A.» and his plan archives

Antonella Sanna

Plus d'incendies dèsastreux
F. Hennebique

First Applications of Reinforced Concrete

In order to validly reconsider the phases of development and diffusion of reinforced concrete, first of all, it is necessary to agree on definitions; to this end, it is possible to refer to the definitions of Mörsch[1] and Le Corbusier,[2] who, in different periods and from the opposite perspectives of calculation theory and architectonic practice, both agree in underlining that the essential characteristic of the new technique does not actually consist of pairing off iron and concrete *tout court*, but rather of the rational distribution of static functions between the two materials according to their different aptitudes. These authors, therefore, point out their awareness of one necessary factor: the collaborative behaviour of both materials, which constitutes an inescapable fact in order for reinforced concrete to be recognised as such. However, the mature form of the new construction technique is preceded by numerous attempts and intuitions, which, although not rigorously adhering to the definition of reinforced concrete, have nevertheless constituted its fundamental assumptions. In fact, it is in the scientific and economic environment that took shape in Europe after the Industrial Revolution, that numerous patents for small construction works in «cemented iron»[3] were taken out, this name reflecting that of «reinforced concrete», arises from the differences in the proportions and in the role of the two materials: indeed, they consist of metal mesh, essentially self supporting, upon which quite a dry layer of grout is spread, with the prevalent function of abutment stone, but not contributing to resistance. In 1890, the

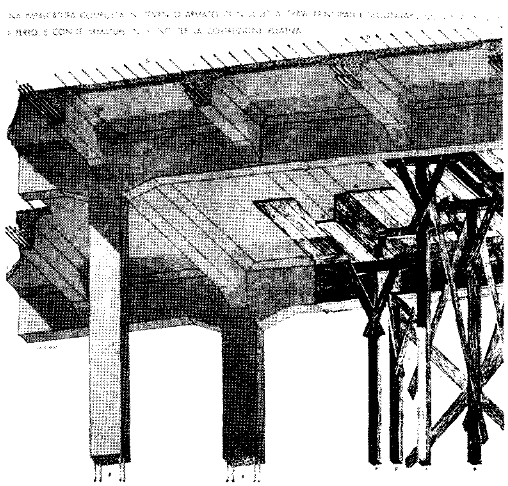

Figure 1
Typical reinforced concrete structural system, consisting of pillars, main and secondary beams and slab, constructed according to the Hennebique patent. (Formenti 1893)

Cottancin system for reinforced beams cast in disposable moulds in hollow bricks, still represented a hybrid between medieval masonry ribs and the framework in reinforced concrete. Shortly after wards, it was thought that the iron-concrete combination could be used for small slabs,[4] marking the first turning point towards real reinforced concrete, as defined above.[5] However the authentic technological revolution arrives with Françoise Hennebique, who, between 1892 and 1898, invented, improved and patented in France a new construction system which rationally combines the ability of concrete to resist compression and that of steel to resist tensile stress. This new system also eliminates the danger of fire and permits more audacious construction and longer spans, with load-bearing structures characterised by minimum encumbrance.

The innovation in respect to Hennebique's contemporaries, clearly visible in the drawings of that period, is the understanding of the relationship between the arrangement of reinforcement and the distribution of internal stress, leading to a particular lay-out of the lower iron rods, some of which are bent to bring them to the upper edge near the fixed joint, where inversion of the bending moments takes place and the action of iron is therefore necessary. In addition to this innovation, we should add the contribution, made by the 45° —inclined portions, to the absorption of shearing stress, to which the U-shaped flat iron stirrups also contribute.

His fame as the «father» of reinforced concrete is rightly justified by the astonishing similarity between his original drawings and the present shape of the reinforcements, by the fact that he was the first who thought rationally in terms of «load-bearing skeleton» and «frame» and by the fact that he understood, without giving a scientific explanation but proposing remarkable practical applications, the existence of plastic flow in addition to the already-known elastic strain. The great success of the reinforced concrete technique, once initial mistrust was overcome, all is above due, in addition to the intrinsic qualities of the material, to the popularizing and promotional activities of Hennebique himself (Delhumeau 1999). His activity was not only confined to the commercial diffusion of the patent, but more generally, to advertising the general virtues of the system. Thanks to his strong company structure, he managed to organise conferences, publish reviews and above all create a network of agents and distributors all over the world that produced a substantial number of constructions and experiences. We can affirm that modern reinforced concrete is definitively defined by the Hennebique system and from now on research will be directed essentially to improving quality and reducing costs, without introducing substantial changes in the system of pillars, beams and floors.

ENGINEER G.A. PORCHEDDU AND HIS COMPANY

Although he has been forgotten in present-day Sardinia in the first few years of the last century, Giovanni Antonio Porcheddu merited international fame (Sole 1976). He was born in Sardinia in 1860 and died in Turin in 1937. Coming from a humble family, like Hennebique, he began working as a hod man in building yards, where he acquired the practical skill that will be very useful when, during is first years of activity as agent for the French patent, he himself did calculations and even trained the first workers in the yard. In 1890, he got the first of three degrees in engineering and, only four years later, became Agent and General Dealer for Northern Italy of the Hennebique system.

As word of the daring constructions of the Porcheddu Company spread, a chain reaction was triggered which, passed by word of mouth among the industrialists of the country and fomented by the publishing of his works in the technical journals of


BUREAU TECHNIQUE
ET AGENCE GENERALE
pour l'exploitation des
BREVETS HENNEBIQUE
dans l'Italie du Nord
G. A. PORCHEDDU, Ingénieur
TURIN, Place Cavour, 2

Figure 2
Porcheddu's label used to mark drawings and calculations. Archivio Porcheddu di Torino, henceforth APT

that period, would rapidly bring about an increase in orders and the construction of more and more audacious structures. Starting from the end of the first decade of the last century, the influence of the Porcheddu Company spread outside Northern Italy and in 1914 the whole peninsula considered him the only agent of the Hennebique system. In addition to the French system, his company also used other patents such as Siegwart beams and foundations with Compressol piles; he also invented a special section of reinforcement irons which increased ahderence to concrete. Among the thousands of jobs carried out by the Company, some record-breaking structures which brought Porcheddu international recognition stand out, among them the grain silos in Genoa, the biggest structure of that period entirely built in reinforced concrete, and the Risorgimento Bridge in Rome, with the largest opening covered by a single span up to then. To that, we can add other buildings, not record-breaking but just as famous as the previously-mentioned ones, like the Fiat Lingotto factory in Turin, the Assicurazioni Generali Palace in Milan, the hangar for dirigibles in Parma and the rebuilding of the San Marco bell tower in Venice.[6]

He had the merit of foreseeing the enormous potentialities of the new building system, also taking into account the abundance of concrete and the scarcity of iron in Italy which made the affirmation of iron and glass structures problematic, all factors leading to the success of the new reinforced concrete technique. Given the still hybrid nature of construction and the yard, the Porcheddu Company intervened only in the planning and building of structures in reinforced concrete, depending for all remaining tasks on the contract holders and those responsible for the work as a whole. Porcheddu agreed to provide specialised workers to coordinate the assembly of moulds, the folding and placing of the rebars and the casting of concrete; the reinforcement came directly from the ironworks of the company in Genoa and the concrete was also made on the mainland. Local firms had to provide water, aggregate, wood and non-specialized workers to assist with the concrete castings and assemble and disassemble the moulds. In comparison to masonry buildings, this type of job organization, among other things, made the work faster and more rational. It was, in fact, possible to carry out all necessary work contemporaneously, in different areas of the building, applying modern optimization theories of productive processes through the fragmentation of various tasks.

When building in reinforced concrete became required by national law, sole rights were lost; however, the experience accumulated by the Company was such that for many years it continued to hold a virtual monopoly, even in view of the empirical and non-rigorous nature of calculations, which often led to simplifications or applying hypotheses on the behaviour of structures that only long experience could justify. The success story of the Porcheddu Company ended in 1933, four years before Porcheddu's death, due to the widespread use of reinforced concrete, rendering problematic the survival of a company whose strong point was its exclusive practical know-ledge.

The Porcheddu Company and Sardinia

Whilst Porcheddu improved and consolidated his firm in Northern Italy, in Sardinia authentic industrial development had not yet started, due principally to geographic isolation and a still mostly agricultural economy.[7] Entrepreneurs coming from Liguria and Piedmont were the first to establish their factories, linked mostly to the processing of cereals, in Sardinia. Thus it was that in 1904, some years after the building of a mill for the Italian Semoleria at Sampierdarena (near Genoa), Porcheddu was given the order, by the above-mentioned entrepreneurs, to construct a similar building near the port in Cagliari.

The appearance of the Porcheddu Company in Sardinia allowed him to begin creating a commercial network, basically linked to the supplying of yard materials (Boggio, Di Felice and Sapelli 1995; Del Piano, Fadda and Sirchia 1995). Moreover, in the wake of the construction of the Semoleria in Cagliari, news of the advantages of the new technique spread among the middle class, and reinforced concrete began to be used for the new factories, as well as for exclusive homes. Porcheddu's activity was supported and promoted, on the national level, by the Banca Commerciale Italiana, a Milan-based bank which would provide financial capital to promote the development of the transportation system and the huge inland hydraulic installations that, along with the mining industry, were of particular interest to the Company. However, the beginning of the First World

War on the one hand, and changes in the Sardinian banking system, with the Credito Italiano replacing the Banca Commerciale and the consequent rise and decline of the firms connected to them on the other, contributed to a decrease in orders for the Porcheddu Company and smoothed the way for Ferrobetòn, a Rome-based firm also specializing in reinforced concrete, which constructed the extensive hydraulic and electrification works in the Tirso river basin.

In Sardinia, the rise and fall of the Porcheddu Company was relatively rapid, although characterized by work that aroused great interest in local public opinion and contributed to dispelling mistrust of reinforced concrete. A list works ranges from the industrial sector, to residential areas and service structures, even taking on historical buildings, like the roofing of the Bonaria Basilica and the choir stalls in S. Lucia Church.[8]

The man who more than others linked Porcheddu's business to the Sardinian productive and economic environment was engineer Riccardo Simonetti[9] who took his degree in Turin, like all the other Sardinian engineers of the time, in 1898 and, once he came back to the island, soon entered the promising new field of reinforced concrete buildings. Only in 1906 did Simonetti and Porcheddu meet; the former designed the Picchi house in Cagliari, while the latter produced the flat slab floors in reinforced concrete. In business correspondence preceding this date, it was Porcheddu who, from Turin, dealt with Sardinian customers, while in 1909 Simonetti himself gave orders and instructions for structures in reinforced concrete, a sign that the young engineer was already an expert in the new construction system and, above all, enjoyed Porcheddu's confidence. Only afterwards will he be indicated as the local representative of the Turin-based Company. Simonetti's role is not only that of building supervisor, but above all that of dynamic dealer. This is demonstrated, for example, by the industriousness with which he promoted, among the Mercedari Fathers, the system of reinforced concrete for the Basilica of Bonaria dome in Cagliari, overcoming the opposition of some believers (Sulis 1935, 166–167), or by the way in which he tried, although without success, to ensure Porcheddu's participation in the huge hydraulic installations on the Tirso river.

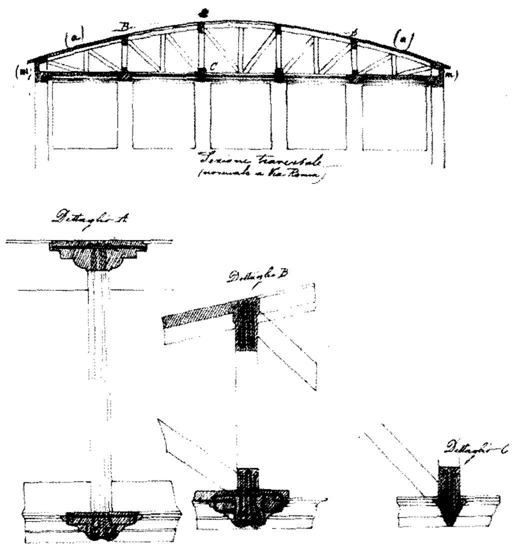

Figure 3
Reinforced concrete frame proposed by Porcheddu for the glass roof in the New Town Hall Honour Court in Cagliari, 1906. (APT)

Archives and Work of the Porcheddu Company

We know how every architectural work originates and is transformed in the course of time, often leaving a documentary trace of the plans, construction and of its evolution; this is even more true as regards twentieth-century architecture, for which the availability and completeness of archives often offers vital information for research. The precise working methods and the rigorous organization of the Porcheddu Company, directly modelled on the *maison* Hennebique, has led through the years to the accumulation of numerous important documents, meticulously catalogued and preserved.

In the Department of Engineering of Territorial and Building Systems (DIS ET) at the Polytechnic in Turin, hundreds of files concerning 2600 projects carried out by the Porcheddu Company between 1895 and 1933[10] can be consulted. The archives, presumably complete, are organized according to geographical areas and, secondarily, in chronological order; works are concentrated principally in Liguria, Piedmont and, to a lesser extent, in Lombardy and Veneto. There are few constructions in the Rome

Figure 4a
View of the Risorgimento Bridge, before striking the reinforced concrete centres, Rome, 1911. (APT)

area, but among them, there is the Risorgimento Bridge on the Tiber, certainly the most innovative work from the technological point of view, where it seems that Hennebique, collaborating on the project, understood and used the existence of plastic flows, until that time unknown in classical theory.

In addition to the rebuilding of Messina and Reggio Calabria after the earthquake in 1908, Sardinia and the colonies in North Africa complete the list of regions «conquered» by the Turin Company.

In the Turin Polytechnic archives we find, for each order, all the documents regarding the carrying out of the work and the business dealings between clients, planners and the Porcheddu Company: architectural plans, calculations for the reinforced concrete and orders for the reinforcement, various business correspondence and contract drafts, all preserved and neatly subdivided in to files. However, the most important documents useful in understanding the inner composition of structures are either missing or very rare: the executive designs of the iron bars, sent to the yard for working, are very rare among the archive documents. In any case, we not only have technical information regarding calculation methods and the construction techniques of structural elements, but the economic and industrial situation of the time also emerges in the background.

Together with the archive documents, witnessing to the attention paid by the company to yard documentation, above all for the most difficult project, there is a rich photographic repertoire. This material also permits very useful interpretation of manufacturing processes and of the inner structure of work, that principally in the initial period, systematically masked the new construction system, which, on the contrary, photographic images of the yard unavoidably reveal.

Among the work that Porcheddu did in Sardinia, we have decided to illustrate two projects: the milling factory for the Semoleria Italiana and the roof of the Bonaria Basilica, both located in Cagliari. The reasons for such a choice derive from the fact that the former is the first and the largest Sardinian project, while the latter is certainly the most important and technically difficult as far as solving the problems of the connection and harmony with the pre-existent ancient structure is concerned.

Semoleria Italiana-SEM (Italian Mill)
Cagliari, 1904–5[11]

Coinciding with the late start of the modern age in Sardinia, the Cagliari future industrial area began to emerge near the port and the railway station;

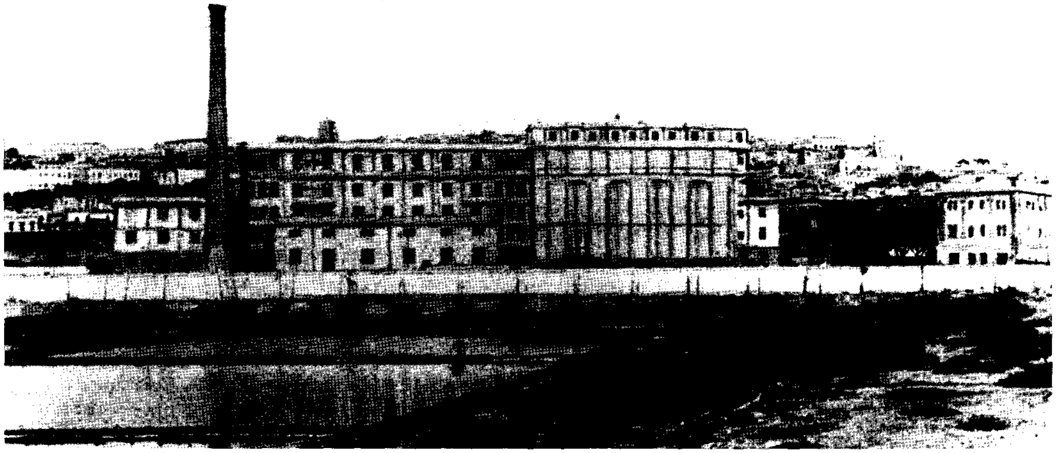

Figure 4b
Semoleria Italiana: the newly-completed mill, 1905. Archivio Storico del Comune di Cagliari, henceforth ASC

exploiting its privileged position as regards the transport system, it would see the rapid rise of the first industrial plants. The agricultural, and particularly cereal production, of southern Sardinia above all favours the grinding and transformation of grain. The SEM mill, inaugurated on the 21st February 1905, was, at that time, one of the biggest factories in the Kingdom, and the Company-Società Anonima Semoleria Italiana, the owner of similar structures in Liguria and Leghorn, was the biggest national milling industry.

The work in Cagliari constituted the first Sardinian project carried out by the Porcheddu Company and, considering its four-hectare extension, also the largest and the most complex; in fact, it also included silos for the preservation of corn, the grain press for milling and the storehouse for grain and flour. A power station, administrative offices and a small block of flats for workers are also provided. The heterogeneity of buildings, the important size of loads acting on the structures, the distance of the yard from headquarters, Porcheddu's need to establish relationships with suppliers and, finally, workers with no previous experience in building with reinforced concrete, all complicated the project. The innovative aspect, for the island, is also witnessed to by the fact that the yard in Viale La Plaja, with its daily 400 workers, soon aroused the interest of citizens too such an extent that the Prefect of Cagliari went in person to visit the buildings under construction to watch the casting of a floor in reinforced concrete, the first in the history of Cagliari.

The most evident characteristic of the SEM complex is that, even though it represented the beginning of the new constructive technique in Sardinia, it already benefited from Porcheddu's long experience, using the frame system in an absolutely modern way. Thus, it was possible to obtain large internal spaces for storage and working, lit by several skylights in the ceiling and see-through fronts with large windows, typically industrial and modern; traditional continuous masonry is still used only for lower buildings, in any case roofed with reinforced concrete.

All ceilings are of the Hennebique type, and all archives documents demonstrate that, for all inflected structures the principle is scrupulously applied according to which, in correspondence with fixed joints, iron bars are taken from the lower to the upper edge of the beam section, following moment inversion.

The main characteristic of the SEM complex is the ten vertical silos, almost 15 metres high: they are full masonry cylinders, bordered by hooping edgebeams

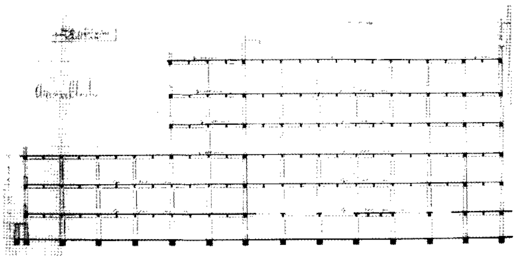

Figure 5a
Semoleria Italiana: a corn store vertical section, evidencing the pillar frame, Cagliari, 1904. (APT)

made of reinforced concrete. Silos are located in two lines, made up of five elements each connected by perimetrical bearing walls that, along with the flat covering floors and the trunk-conical ones of the lower hoppers, act as a further control on the whole system.

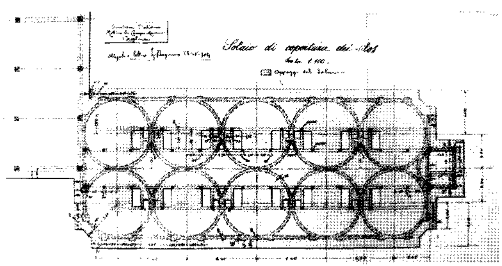

Figure 5b
Semoleria Italiana: a corn silo horizontal section, Cagliari, 1904. (APT)

As regards the internal composition of the reinforced concrete, we have no precise information, as in the archive files, all the strictly technical and descriptive data on the structures and rebars, destined for the yards has been lost. The only thing that can surely be affirmed is that the Hennebique system was rigorously applied, since from a packing list of the ironwork from Genoa, the shipping of bars and «metal strips» (the typical flat iron for the stirrups) emerges, and in a bill of iron quantities, we can find the difference between bars with a circular and «half-round» section, which we said was a personal

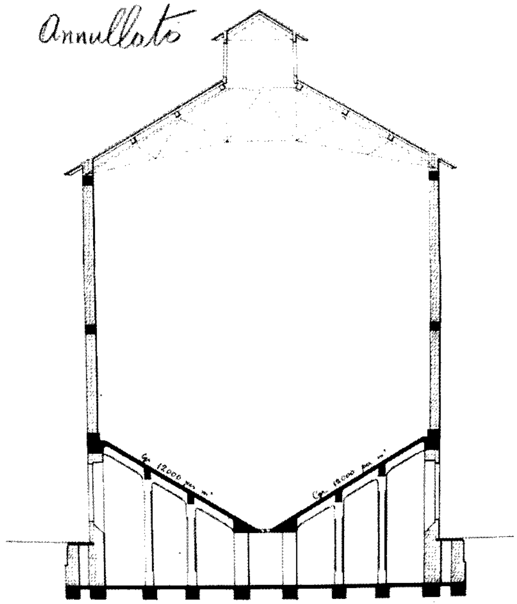

Figure 6
Semoleria Italiana: a corn silo vertical section, showing the reinforced concrete cross-ribbed hoopers and foundations, Cagliari, 1904. (APT)

Porcheddu patent for improving the adherence between iron and concrete. The floors are double framed with visible ribs, as was common for industrial premises. The foundations are also made of reinforced concrete, on plinths for the pillars and continuous along the outer walls. With the exception of two overhanging balconies on the mill building produced by prolonging the bearing beams of the floor beyond the facade, there are no projecting elements.

Given the purely industrial nature of the buildings, there is no space for decoration, although in one sense it is indirectly expressed by the crowning cornices on front which, together with the relief profiles of vertical structures, seem to follow in the wake of Perret's «structural classicism», resulting from the coupling of giant order pillars and overhanging «trabeations» of reinforced concrete. It is possible to find another very slight decorative element on the fronts of silos, necessary closed, whose structural niches are profiled by sinuous liberty scrolls that

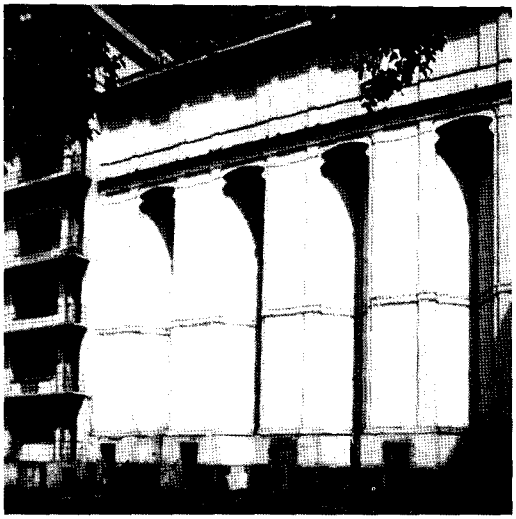

Figure 7
Semoleria Italiana: the corn silos external appearance, Cagliari, 1990

mitigate the exclusively functional aspect of grain silos.

The art-nouveau friezes blend with the agricultural nature of the work done in the factory. This is witnessed to by the decoration of the entrance, modestly framed by ears of corn and volutes in contrasting colours with the words «Semoleria Italiana» inscribed on the arch. This extremely complex structure was further enlarged only two years after the drawing up of the first plans, with the creation of additional warehouse construction of workers' lodgings. The SEM in Cagliari could be compared with the grain silos in the port of Genoa. Their complex plan, concerning all aspects of the project, from the arrangement of surrounding areas and shipment docks to details for grain-lifting equipment, was entirely conducted by the Hennebique headquarters in Brussels. In addition, the affinity between the two buildings is demonstrated, in addition to their similar use, though on a very reduced scale, by the fact that the SEM planner, engineer Carlo Bagnasco, was one of the managers of the Genoa branch of the Porcheddu Company, and he certainly supervised the building of the big silos.

Our Lady of Bonaria Basilica
Cagliari, 1911[12]

Among the Porcheddu Company's work in Sardinia, the completion, in an almost Brunelleschian way, of the Basilica, stands out for its originality and importance. The building of the church began on the 25th March 1704, alongside the older Gothic-Catalan sanctuary, with the intent of building « . . . el mejor templo, y mas capaz de todo el reyno» (Sulis 1935). However, from the beginning, the building history was a troubled one, so much so that in 1804, work was interrupted, leaving the high coupled columns and the outer walls at the mercy of the inclement weather. In 1866, with the expropriation of ecclesiastical property by the Italian State, the area of the new church became city property, and finally in 1910, thanks to the generosity of the citizens of Cagliari, funds for its completion were made available.

Figure 8a
Basilica di Bonaria: view of the unfinished church, Cagliari, 1854. (ASC)

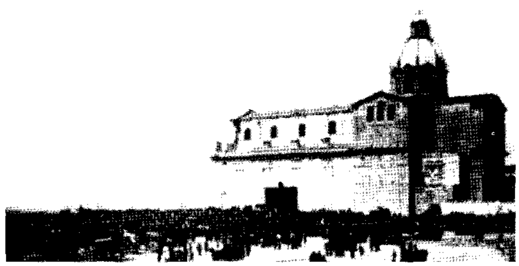

Figure 8b
Basilica di Bonaria: view of the newly-completed church, Cagliari, 1926. (ASC)

In 1926 the Basilica was consecrated, but in 1943 a bomb fell inside and destroyed the stuccoes without damaging the structure. After the War, it was restored, giving it its present appearance, without restoring the caisson. The choice of not superimposing decorations on the plastered structures make the different nature of the limestone columns and the reinforced concrete vault explicit, highlighting the heterogeneous techniques, a mixture of tradition and innovation, that characterise the Basilica.

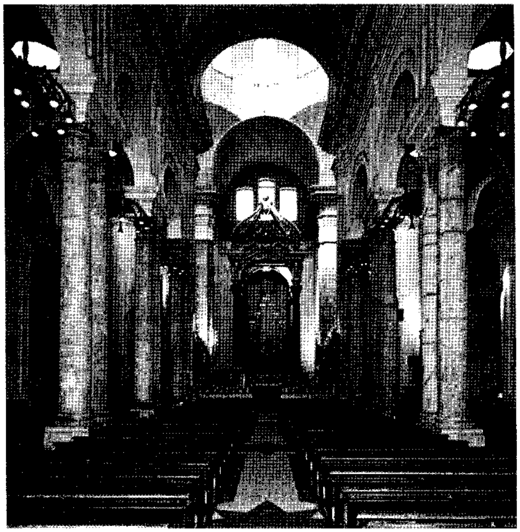

Figure 9
Basilica di Bonaria: church interior showing the twin columns in limestone blocks and the overhanging reinforced concrete slabs, Cagliari, 1990

The work carried out by the Porcheddu Company concerns roofing and the dome. Simonetti's role as planner as well as supervisor of the structures, was decisive in the choice of reinforced concrete rather than a traditional vault made of bricks. Starting in 1910, before roofing, it was necessary to consolidate the existing structures, reinforcing the foundations, the drum limestone columns the walls, not sufficiently stable.

Archive correspondence between Simonetti and Porcheddu meticulously lists all the parts to be built: the roof of the nave, the aisles, the transept, the

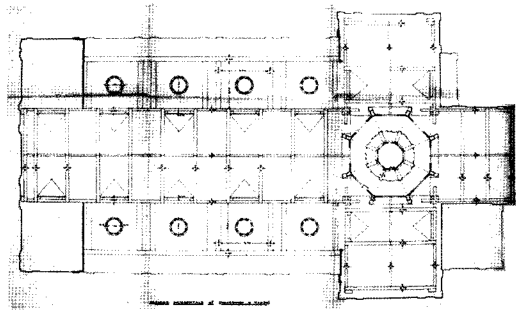

Figure 10
Basilica di Bonaria: plan of the church with the vaulted roof projection, Cagliari, 1911. (APT)

pronaos and the dome at the intersection of the nave and transept.

The principle applied was that of preparing a load-bearing skeleton directly supporting all the covering structures and masked at the intrados by thin barrel and cross shaped slabs of constant thickness, variable between 10 and 20 cm, which worked as a «period» false ceiling, imitating brick vault. Fortunately the availability of all the plans and the calculation note-book for all the church structures, dated 1 December

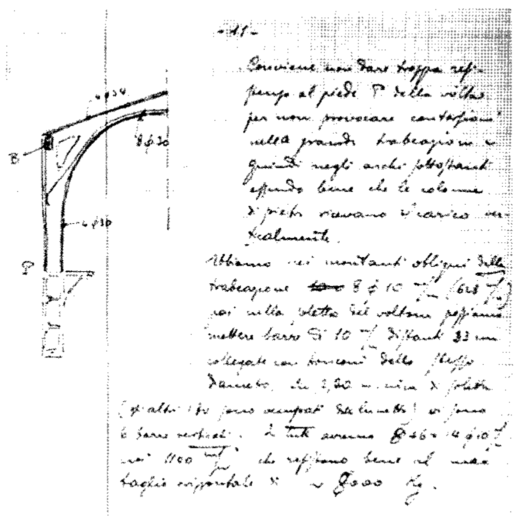

Figure 11
Basilica di Bonaria: part of the calculation notebook concerning the central nave roof, Cagliari, 1911. (APT)

1911, with the indication of static schemes, of stress and of reinforcement dispositions, precisely annotated by the calculating technician, provides a useful tool for the understanding of the technical aspects and static functioning of this unusual mixture of reinforced concrete and traditional structures, which presents, compared with other examples in Cagliari, some distinctive technological characteristics.

The placing of reinforcement in the varying structural elements faithfully respects the precepts of the Hennebique patent: stirrups are always present, and arches are reinforced according to the moments, with the inversion of irons 30° from the impost; thin slabs are reinforced by mesh that follows the sweep of vaults, as a continuum of the lunettes, with the exception of the dome which, being subject to extremely variable stress, is prudently reinforced symmetrically on its two faces. The central problem in this work arises from the discontinuance in structure, due to heterogeneous materials; thus if on the one hand it is necessary to produce a cohesive whole, on the other hand fixing have to be such that they can transmit only vertical loads to the stone columns and the wall. Along the nave, it was decided to put a sequence of large arches which marked the spans on the coupled columns and a massive trabeation almost two metres high which constitutes a strong stiffening element and distributes loads longitudinally; transversally, given the impossibility of guaranteeing a lack of horizontal components, an attempt was made to create a hinge at the base of the trabeation, to avoid the transmission of bending moments to the columns; the articulated joint was obtained by driving reinforced irons into the stone for almost 50 cm. In addition, the structure supporting the roof itself is made up of continuous hut-shaped elements (an 11–metres aperture), while the non-supporting slab of the vault, with the lunettes continuing, is created by a slightly reinforced thin lamina, which transmits very low thrust.

Along the transept, lacking the action of aisles, the walls are made higher, bending them to the height of the 30°-plane of the arch, to build only at this height

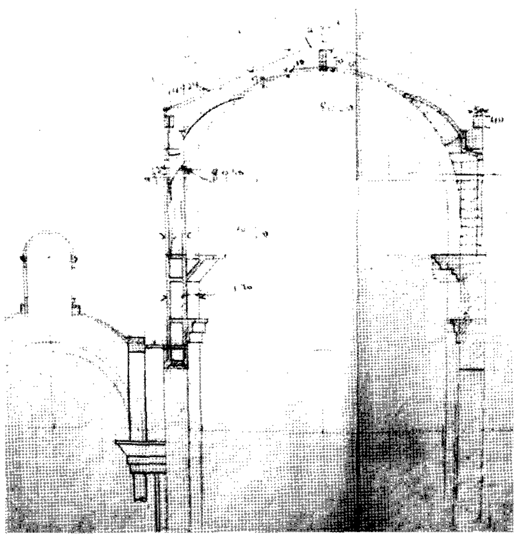

Figure 12
Basilica di Bonaria: central nave section bearing indications about reinforced concrete structure and iron bar diameters, Cagliari, 1911. (APT)

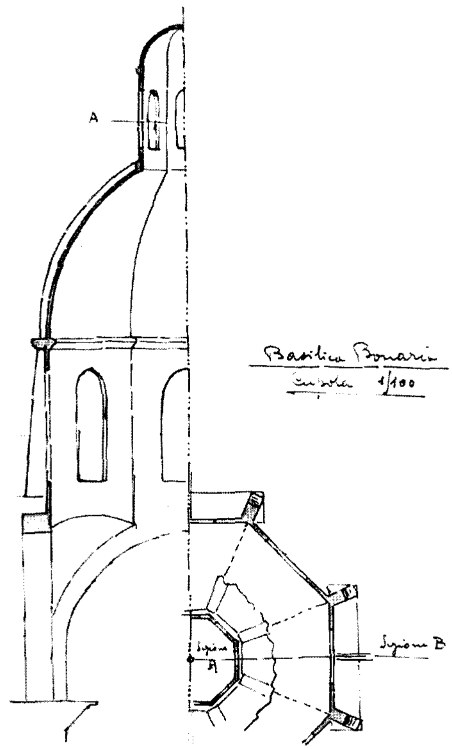

Figure 13
Basilica di Bonaria: plan and vertical section of the dome, Cagliari, 1911. (APT)

the polygonal structure of the roof, so that it is possible to have the joint at the point of minimum flexing moment. Moreover, the supporting section is reduced with respect to wall thickness and divided from it by the interposition of a paper sheet, so as to realise a sliding restraint, trying to completely annul the horizontal components and avoid overturning action on the masonry.

However, the pride of builders and citizens was the big dome, raised 50 metres above the floor and visible from every part of town. At the intersection of the Latin-cross plan, there are four vertical pillars which, joined by four spherical pendentives, support the octagonal drum from which the eight lightly ogival cones forming the dome, closed on the top by the lantern, branch off.

The shell that constitutes the dome is not simply a covering «skin», as it is in the naves, but with the help of stiffening ribs on the edges, is a supporting structure. The high shape is sufficient in itself, to render thrusts vertical; the combination of the two barrel vaults, the nave and the transept, which intersect orthogonally, is perfectly able to absorb all residual horizontal components, on condition that the system is firmly fixed to the piers, again driving the irons deeply into the masonry structures.

Although Porcheddu was new to extraordinary projects, the technical and building difficulties of Bonaria Basilica are also confirmed by the fact that himself recognised it as a rarity, asking Simonetti to take some photos of the yard during casting.

Within trends regarding the history of building techniques and the saving of twentieth century architecture, the research illustrated has allowed a precise analysis, though limited to Sardinia, of engineer G.A. Porcheddu's work, the functioning of his Company and the nature and structure of its archives. At the same time, the computational and construction methods of the first structures in reinforced concrete in Italy using the Hennebique method have been analyzed and reconstructed; we have demonstrated that such a method is the best suited for facing the test of time and the demise of the classic theory of elasticity.

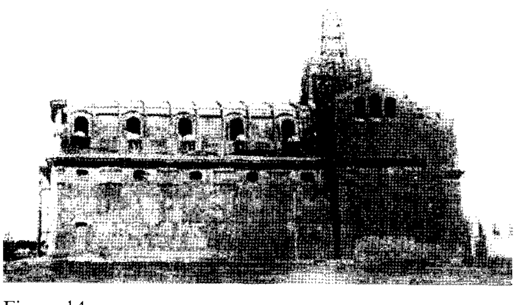

Figure 14a
Basilica di Bonaria: setting up the dome centre, Cagliari, 1911. (ASC)

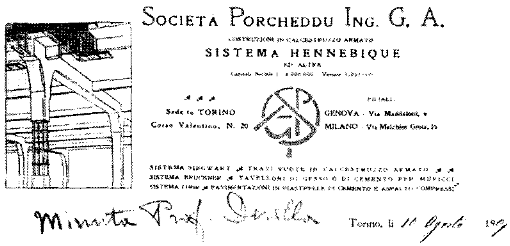

Figure 14b
Porcheddu's advertisement in an old review, 1912

Last but not least, we have highlighted the construction of some complexes and buildings, not only those illustrated here, which have contributed to the urbanistic, architectural and economic history of the city of Cagliari.

NOTES

The present work is an abridgement of the still unpublished research project entitled «La Sardegna e l'innovazione architettonica alle soglie del Moderno. L'ing. G. A. Porcheddu e le prime realizzazioni in conglomerato cementizio armato», carried out by the author under the supervision of Prof. Antonello Sanna, at the Dipartimento di Architettura dell'Università di Cagliari and with the financial contribution of the Regione Autonoma della Sardegna.

1. «As constructions made of reinforced concrete, we mean those realised with concrete or beton (slow setting Portland concrete, with sand and gravel) reinforced by an iron skeleton or, better, mild steel, plunged in it. The jointed use of the two materials, concrete and iron, is

done in such a way that they react to the external strain, leaving the concrete the duty to resist the compression stresses and to the iron that of opposing the stretch stresses». (Mörsh [1910]1923).

2. « . . . [the reinforced concrete technique] is the finest and the most precise and also the cheapest: It combines the opposite properties of heterogeneous materials such as iron and concrete to resist at opposite tension (traction and compression) that are generated in the same structural elements» (Le Corbusier [1946] 1965).
3. We are referring to objects such as Lambot's boat (1848) and Monier's flower box (1849).
4. We are thinking about the first small floors with very short span patented by Monier, Lambot, Coignet in France and Hyatt in the United States.
5. For an accurate study of the many Italian and foreign patents and their specific characteristics see Iori (2001).
6. For a detailed study of Porcheddu's activity in mainland Italy, see Nelva and Signorelli (1990).
7. On the social and economic environment in Sardinia during the first years of the XX century, see Berlinguer and Mattone (1998).
8. The list of the works realised by the Porcheddu Company in Sardinia: 1904–Milling complex of the Semoleria Italiana, Cagliari; 1905–Enlargement of the Semoleria Italiana, Cagliari; 1905–Workers' lodgings in the Semoleria Italiana, Cagliari; 1905–Floors in Picchi house, Cagliari; 1906–Town Hall, Cagliari; 1906–New Picchi House, Cagliari; 1908–Floors in the School and Town Hall, Meana Sardo, (CA); 1909–Floors in the Workers' Society building, Cagliari; 1910–Salesian Fathers' Oratory, Cagliari; 1910–Enlargement of the Liguori factory, Cagliari; 1910–Water cistern in S. Vero Milis (OR); 1911–Floors in Costa house, Cagliari; 1911–Severino pasta factory, Cagliari; 1911–Basilica of Bonaria, Cagliari; 1911–Floors in Balletto mansion, Cagliari; 1912–Choir stalls of S. Lucia Church, Cagliari; 1912–Floors in Severino house, Cagliari; 1912–Floors in Liguori house, Cagliari; 1912–Water cistern in Dolianova (CA); 1912–Bridge on Mannu brook in Portixeddu, Buggerru (CA); 1913/14–Balletto pasta factory, Cagliari; 1913/14–Building of the Banca Commerciale Italiana, Cagliari; 1914–New floors in Balletto pasta factory, Cagliari; 1914–Flat terrace floors in Balletto pasta factory, Cagliari; 1914–Presbytery floor in S.Eulalia Church, Cagliari; 1929/30–Bridge on Pedrosu brook, Bonorva (SS); 1929/30–Retaining wall and floors MVSN barracks, Bonorva (SS).
9. Short historical notes are available in the Archivio dell'Ordine degli ingegneri della provincia di Cagliari.
10. For a detailed description of the archive and of its contents, see Nelva and Signorelli (1990, 25)
11. Original denomination: mill near «Su Campu Mannu»; location: viale La Plaja, Cagliari; destination: milling factory; client: Società Anonima Semoleria Italiana, Genoa; planner: engineer Carlo Bagnasco of Genoa; building firm: Colombo-Ventini-Martino & C. Milan and Genoa.
12. Original denomination: O. L. of Bonaria; location: Viale Bonaria-Via Milano, Cagliari; client: Padri Mercedari; planner and work director: engineer Riccardo Simonetti; responsible for the structures: engineer G. A. Porcheddu and engineer Riccardo Simonetti.

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