THE "MIXED STRUCTURES"
OF THE SANATORIUMS BUILT IN THE 30S IN ITALY

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ABSTRACT

This paper reports the first results of the research aimed at the knowledge of the way of building in Italy in the 30s through the historical and technological study of existing buildings. The study concerns the "sanatoriums" built in Sicily between the two world wars, well known by the typological and therapeutic viewpoint, but not yet by the technological one. They are an interesting example of so-called "mixed construction" where traditional techniques and testing of new materials, particularly reinforced concrete, co-exist. The building practice for ordinary buildings of the period concerned with load-bearing masonry construction, wooden roofs and reinforced concrete elements only for floors, stairs and overhangs. In public constructions (schools, hospitals, etc.), in which, due to specific use, wide lights and roofs were necessary, designers and companies tested the potentialities of reinforced concrete for the whole structure (beams, pillars, foundations, floors and roofs). The historical and constructive study of chosen buildings was carried out through non-destructive tests and surveys to define the building static scheme and draw the main technical details. Thermography was used to detect the presence of reinforced concrete columns and beams, hidden in the wall thickness, still performing load-bearing function. In the examined roofs, complex systems of reinforced concrete beams were found instead of traditional wooden trusses, together with tiled and wooden plankings. This study contributes to the rare knowledge of materials and construction techniques of the twentieth century Italian architecture, unfortunately arising at every intervention aimed at the preservation and reuse of these buildings.

Keywords: History of construction building technologies and materials, Mixed structures, Reinforced concrete, Twentieth century Italian architecture

1. THE SANATORIUMS BUILT IN SICILY IN THE NINETEEN THIRTIES

1.1. The history

In the nineteen thirties, the fight to defeat the high incidence of tuberculosis became a fundamental objective of social policy of the fascist regime thus proceeding to the construction of a large number of sanatorium hospitals throughout the country, realizing at least one for each province. This massive operation was possible thanks to funds provided by the tuberculosis insurance mandatory for employees by the Law No. 1132 of May 20th, 1928. The agency responsible for managing these funds and therefore also the construction of sanatoria was the National Fund for Social Insurance (CNAS), which in 1933 became the Fascist National Social Security Institute (INFPS). Particularly in Sicily, six lowland sanatorium hospitals were built between 1930 and 1937, set just outside the main cities, suitable for seriously ill hospitalized patients, especially curable in lowland climate. These were the "A. Dubini" sanatorium in Caltanissetta (1933), the "G. F. Ingrassia" one in Palermo (1937), the "G. B. Odierna" one in Ragusa (1935), the Torrebianca one in Trapani (1936), the one in Syracuse (1933) and in Catania (1937) [1]. The construction of these sanatoriums took place in a very short time to respond quickly and eradicate the disease. In June 1930 the construction of Caltanissetta and Syracuse sanatoriums were already in progress or at least contracted, while at the final draft the ones of Palermo, Ragusa and Trapani. For the sanatorium hospitals of Catania and Messina, however, at that

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time the most suitable site was still under study. All these sanatoria show the same typological architecture designed by a specially created office, headed by Ing. Guidi, under the supervision of the commission composed by Hon. Prof. Morelli (health adviser of the Fund) and engineers Ugo Giovanni Muzi and Giulio Marzoggi. The design of the new building type, answering to very specific therapeutic needs, was created, in fact, by the close collaboration of phthisiologist doctors and technicians (engineers and architects). At the beginning of the Second World War, the INFPS managed forty-nine sanatorium hospitals, not more than 16200 beds, just insufficient to handle the tuberculosis patients gradually increasing. The number of beds in the sanatorium hospitals were, therefore, increased, new hospitals and pavilions were opened and thermal colonies transformed. After nearly three decades of intense activity, thanks to medication discovered in the sixties for the treatment of tuberculosis, sanatoriums were gradually abandoned or transformed, in most cases, into health or care services. Nowadays the sanatoriums of Palermo, Catania, Ragusa and Syracuse are used as hospitals and those of Caltanissetta and Trapani are in complete disrepair.

1.2. Morphology and typology
Based on the experience of sanatoriums made in Europe and in Italy in the twenties, the team headed by the world-renowned phthisiologist Morelli designed two types of building for sanatoriums: "Southern type" and "Northern type", “depending on whether or not the main facade corresponds to the exposure of the verandas, which must necessarily be directed to the South” [2]. These two designs were derived from the close connection between building types and care needs. Key role in these buildings was assumed by the outdoor venues, i.e. the verandas and terraces exposed strictly to the south. The spacious "care" verandas facing the hospital rooms and directly accessible by these, were almost an extension of the rooms to the outside. Their size must allow the passing and the convenient installation of the beds. In addition, these ones, being used in both summer and winter, were protected by a sunscreen system to ensure the maximum welfare in different climatic conditions. Also the balconies could be used in summer, due to the sunscreens provided for the entire length of the front and in the winter thanks to the excellent exposure sheltered from the wind. The terraces on the top floor had to be used not only for recreation but also for heliotherapy. In the building parts exposed to the north, however, were placed the services. Several requirements were also developed for the sizing of the rooms and the windowed parts, for the characteristics of materials for the walls and floors in order to ensure maximum hygiene. It is possible to state that the sanatorium architecture enclosed and presented for the first time the dictates of hygiene, health, lighting and ventilation at the base of the Modern Movement. With a capacity up to 250 beds, the sanatorium buildings were built as monoblocks, as the Swiss German school types, where services and the wards coexisted both for men and women. In the case of hospitals with greater number of beds the layout in pavilions of different uses was preferred, as in France and United States [3]. This is the case of the sanatoriums of Rome (1400 beds), Naples (1372 beds), Milan (900 beds), Venice (400 beds), Genoa (324 beds), etc. In particular all the sanatoriums built in Sicily belong to the monoblock type being designed for approximately 250 beds. The provincial sanatorium hospitals had, in fact, to accommodate at least 120 beds, as that the construction and management proved economic, but not more than 250 beds otherwise the cure would have suffered. In these monoblock buildings, the sanatorium plan was a simple T-shaped in the Southern type or double T-shaped with shortened wings of the main facade in the Northern type (Fig. 1) [4].

Fig. 1 Plan of the Southern type sanatorium of Trapani (left) and the Northern type one of Palermo (right)

To this type some variations depending on the sensitivity of the construction engineer on the particular formal aspect were applied. Examples of the Southern type are the sanatoriums of Trapani, Bari, Jesi, Foggia, while the Northern type sanatoriums are those of Lucca, Caltanissetta, Palermo and Venice.
This type of plan, including both T-shaped and double T-shaped, allowed a perfect symmetry with respect to the median corridor of the central body, at the axis of the main entrance, which was repeated for all the levels. In this way, the entire building could be split vertically into two parts set aside one to men and the other to women. In both cases, the central body was designed for services and the southern bodies to the wards. In the case of the Northern type, the building being larger, in the shortened wings, beyond the main entrance, medical services (room visits, workshops, etc.) and administration offices were set. The typical and most common shape of the monoblocks avoided as much as possible the creation of closed courtyards, making difficult air circulation, insolation and natural lighting of the lower floors [5].

![Fig. 2 The project of the sanatorium hospital of Foggia, neoclassical elements are evident](image1)

![Fig. 3 The main facade of the sanatorium of Bari, rationalist elements are evident](image2)

The building is generally developed on three or four levels, including the basement, used for services, the first and second levels for the wards and the additional one taking up only partially the surface of the building. In the basement the service rooms, organized into functional areas, were located: the dining area with the kitchens (often at the first level adjacent to the dining halls in the Southern type), the warehouses for food, the wine cellar, the area of the thermal power plant with boilers, the coal deposit, the engineering shop, the area of the dormitories and the dining room for service staff and then another area for the disinfection laundry, drying, ironing and the wardrobe, connected directly to the upper floors through service ducts and freight elevators. The organization of interior space provided vertical freight elevators by means infected materials were conveyed to areas of disinfection placed in the basement and only after treatment were brought back to the wards. On the ground floor, where the main entrance was set, through a hexagonal hallway in the Northern type and polygonal one in the Southern type, gave access to other corridors and vertical connections. In the centre body, the dining rooms were placed with their office. In the lateral bodies, however, patient rooms were located. In the eventual northern head, the health services were located. The same approach was repeated for the upper level, but in the centre body, the chapel and the operating room were located. On the top floor, the terraces were located together with the area to the exclusive use of the nuns who managed the sanatorium, with their rooms and related services (dining hall, chapel and kitchen). While from the typological point of view, these buildings constituted an innovation, from the formal one, they drew on the neoclassical style well suited to represent the monumentality required by the Fascist regime, despite the structural innovations due to the use of reinforced concrete. In the rest of Europe, in fact, in the same period, the use of reinforced concrete had also affected the figurative aspect of the construction, giving the possibility of large buildings spans, wide cantilevers and large windows. In Italy, however, the use and potentialities of reinforced concrete technology were limited, relying more on the bearing capacity of the masonry. In
particular, the facades of the Sicilian sanatoriums were designed in the neoclassical style according to strict rules of classical symmetry, with two or three rows of windows, differently decorated on every floor, remarked with frames and bands typical of the sixteenth century style. Long vertical pilasters marked the facades and arch or tympanum decorations surrounded doors and windows (Fig. 2). Only the facade of the ward, characterized by long verandas with wide cantilevers and large openings, however, show, in some cases, references to the rationalist style (Fig. 3).

2. THE MIXED STRUCTURES OF SANATORIUMS

2.1. Historical and constructive analysis

Although sanatoriums built particularly in Sicily and Italy in the 30s are well known from the typological point of view, thanks to various specialized publications of the time, nothing is reported on either of these or other sources about the construction techniques adopted for the realization. To investigate this area, it was first conducted archival research that led to the discovery of the plans of all sanatoriums built in Sicily at that time. But these plans do not report the presence of reinforced concrete elements, although present, as the practice of contemporary buildings followed. Due to the limited documentary knowledge on the subject, it was, therefore, necessary to perform a direct investigation of the buildings. The research in this phase was limited to investigate the former sanatorium “A. Dubini” of Caltanissetta, representative of the structural features of contemporary Sicilian sanatoriums. The study carried out by photographing, mapping and non-destructive investigations (thermal and magnetometric ones) was useful to detect the existence of the blend of traditional building techniques and materials and reinforced concrete elements (columns, floors, roof elements, lintels, stairs and brackets) typical of those buildings well-known as “mixed structures”. In this period, in fact, in Italy, the traditional technique of load-bearing masonry was still preferred for common construction by the construction industry. Only for particular types of public buildings, which were the sanatoriums, the contemporary technology of reinforced concrete, although still concealed by the decorative “style”, was started to be experienced. In most cases, reinforced concrete was considered and finally used at the end of the entire design process to solve structural problems related to the different use of traditional masonry techniques.

2.1.1. The static scheme

After choosing the former sanatorium “A. Dubini” as the case study, the historical and constructive analysis was, therefore, carried out through non-destructive tests and direct surveys, which led to identify the structural and material characteristics of the various technical elements and the reconstruction of the static scheme of the entire building. The load-bearing structure of the building was realized, supporting the traditional building technique based on blocks of limestone by reinforced concrete portals for the construction of some internal parts not feasible with the load-bearing masonry. Through detailed thermographic investigation the absence of reinforced concrete pillars within the walls was in fact highlighted as it was widely practiced in contemporary buildings. Through the thermogram, compared with the visible image (Fig. 4), the temperature difference, represented with different colors, between the surface of the stone materials constituting the masonry and a cooler one, of low thickness, spreading over the whole facade (blue line), probably representing a reinforced concrete floor.

![Fig. 4 The thermography and visible image of the northern-east facade](image-url)
However, this is a very regular structure with main beams placed in continuation of the masonry walls to close the structural grid and other beams, so-called “section-breakers”, located only to reduce the span of the floors in the few cases where this was more than 6 meters (boiler rooms, laundry room, cloakroom, dining halls, chapel, etc.), allowing the construction of floors with ordinary spans of 3 and 4.5 meters. These beams are set in most cases on perimeter walls or brick pillars. This structure is repeated equally at every level although in each level both load-bearing masonry walls and beams have dimensions gradually decreasing towards the upper floors (masonry of 70 cm in the basement with offsets of approximately 5 cm at every level). It was also observed the presence of transverse load-bearing walls and portals (with brick piers of considerable size and reinforced concrete beams) in correspondence of the corridors to close the structural grid and implement a suitable bracing. The magnetometric tests had further confirmed the presence in the masonry of concrete pillars. A row of pillars in the wards divided, in fact, the corridor from the rooms. This structural choice derived from the necessity to create 6 beds rooms, whose dimensions were 6.20 meters depth and 6.50 meters width, providing a surface for effective bed of 6.70 square meters (higher than that provided for the common hospitals). For a high span, it was, therefore, necessary to build beams of sufficiently high to realize reinforced brick floors. This choice was also due by the need for large openings (4.5 × 3.6 m) to connect the rooms to the care verandas, thus realizing large portals with brick piers and reinforced concrete beams (Fig. 5).

Fig. 5 The static scheme of the building

The beams, having to bear the floors, as to counter the negative bending moment in the joint area and to avoid, therefore, very high stresses in the concrete, showed a higher height in the joint than in the middle, as it was typical in the early applications of r.c. This increase in height was achieved with triangular brackets, with an inclination in the lower part that was not more than 1/3 of the width of the bracket itself. In some cases, especially in large spans beams, “dovetail” brackets were found showing in correspondence of the joint, in addition to the increased height, also an enlargement of the beam than in the middle, thus contributing to maintain the joint compression stresses within acceptable limits (Fig. 6). This structural choice was possible by the remarkable thickness of load-bearing masonry which the beams were jointed. Often these beams are concealed as easily found place in the thicknesses of the traditional load-bearing masonry structure, ranging from 60 to 70 cm. Reinforced concrete was used exploiting its potential for foundation, stairs, floors and cantilevers of verandas and balconies. Foundation, as showed by the photograph of the period, consisted of a dense grid of reverse beams placed perpendicular to each other to form closed meshes (Fig. 7). Even the stairs are made in reinforced concrete structure. In particular, the two symmetrical and hexagonal stairs, characterizing every Sicilian sanatorium of this period, from a visual and instrumental analysis, were built with a trapezoidal cross-section slab cantilevering from the perimeter.
By some archive drawings, it was found that the two external stairs provided to access directly from the wards to the park, never been realized, were designed with a r.c. central load-bearing core and cantilever steps.

Fig. 6 Beams to counter the negative bending moment in the joint area

Fig. 7 Pictures of the construction of sanatorium of Caltanissetta

In some corridors, floors were found in reinforced concrete slab, ribbed slab floors with double framework, thus creating a caisson, were found to cover the great spans of the chapel and the octagonal hallway at first floor. Most floors, instead, were reinforced brick ones in situ, both for indoor and the cantilevers of verandas up to 3-4 meters depth. Another type of floor made of iron profiles and hollow brick vaults, with concrete slab, was found in the flat parts of the top level. Even the balconies drawing on the shapes and sizes of the tradition with marble slabs and stone brackets, were made entirely of reinforced concrete. Even all the window sills and balustrades of the balcony set above the main entrance of the building were made of reinforced concrete. For sloping roofs, however, the structural type, typical of the previous constructive tradition, was found with the mixed use of r.c. and wooden elements quite unusual, whose complexity required a detailed study.

Fig. 8 The internal r.c. stair (left) and the plan of the unrealized external r.c. stair (right)
2.1.2. \textit{The mixed roofs}

An interesting solution for reinforced concrete was found in the load-bearing structure of the roof of the former sanatorium “A. Dubini” in Caltanissetta. It was a complex system of r.c. beams instead of traditional wooden beams or trusses, which was redesigned together with the structural engineer construction details. These drawings are the most original summary of the study of the building. The building showed a large rooftop terrace corresponding to the transversal ward of the lower levels and double pitched roofs in the central longitudinal body and the two transversal bodies of the shortened wings of the double T-shaped building. In particular, the roof of the central body is made by two pitches ending on one side with the hip-roof and on the other with a masonry tympanum. The lateral bodies of the double T-shaped building, L-shaped, are instead covered by the intersection of two pitched roofs ending on one side with the hip-roof. The structural system of the pitched roof may apparently seem like a complex system of trusses with no chain. Through a careful study it was possible to understand the structural scheme used is just one of the most common in Italy for traditional wooden roofs i.e. the “Piedmont” scheme, where the spine wall is replaced by a beam. In this Piedmont scheme, the struts are made of reinforced concrete and rest on the one hand on the outer longitudinal wall and the other on pillars joined on the longitudinal spine beam which is also in reinforced concrete, placed in correspondence with the center of the roof. This spine beam rests in its turn the two ends on the perimeter structure and in the center on a r.c. pillar.

To complete the structure of the roof, there are wooden purlins (10 × 10 cm) placed at regular distances, bound to the r.c. struts (40 cm height and 20 cm width), thanks to a special support system preformed in the struts themselves. Wooden joists rely on the purlins, on which the support layer of Marseilles tiles made of clay tiles instead of the traditional wooden planking (Fig. 9, 10, 11).

Finally, the bottom surface of the last level was made up with a wattle and plastered ceiling hiding the entire structure above the roof. The technological solution of this roof is the most representative example of the mix of traditional techniques and materials with new materials such as tiles and r.c. Slightly more complex is the technological solution adopted for the pitched roof of the central body which is always based on the same “Piedmont” scheme and therefore requires a reinforced concrete beam in correspondence of the middle of the roof to support the struts. The first difficulty was in the supports of this beam placed on brick pillars located along the corridor. The struts in this case are in part wooden elements and in part r.c. ones. In correspondence with the load-bearing walls, thanks to the brick pillars resting on them, with different height as to follow the slope of the roof, wooden beams arranged in sequence were made. In the absence of transverse load-bearing walls, instead, the entire slope was realized by means of inclined r.c. beams, resting one hand on the perimeter wall and the other on the spine beam (Fig. 12).
Also in this case, the roof was completed with wooden purlins and currents and clay hollow tiles. Analyzing such structural scheme from the static point of view, it is possible to state that it is a pushing structure, whose pushing action on the walls is partially countered by the high thickness of the reinforced concrete beam that runs along the entire perimeter of the roof, about 1 m high, performing both function of assemblage and distribution of loads.

3. CONCLUSIONS

The research adds one more step in the limited knowledge of materials and construction techniques of the housing built in Italy in the period between the two wars. The lack or scarcity of such information is apparent at every intervention for the preservation and reuse of these buildings and has often led to interventions having compromised the conservation of these buildings, from the structural but also formal point of view. Contemporary architecture gives evidence of technical solutions, formal studies, yard cultures and it is still not possible to outline a definitive historic evaluation that will require insights and comparisons, possible only through the physical survival of the buildings and their archival documents.

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