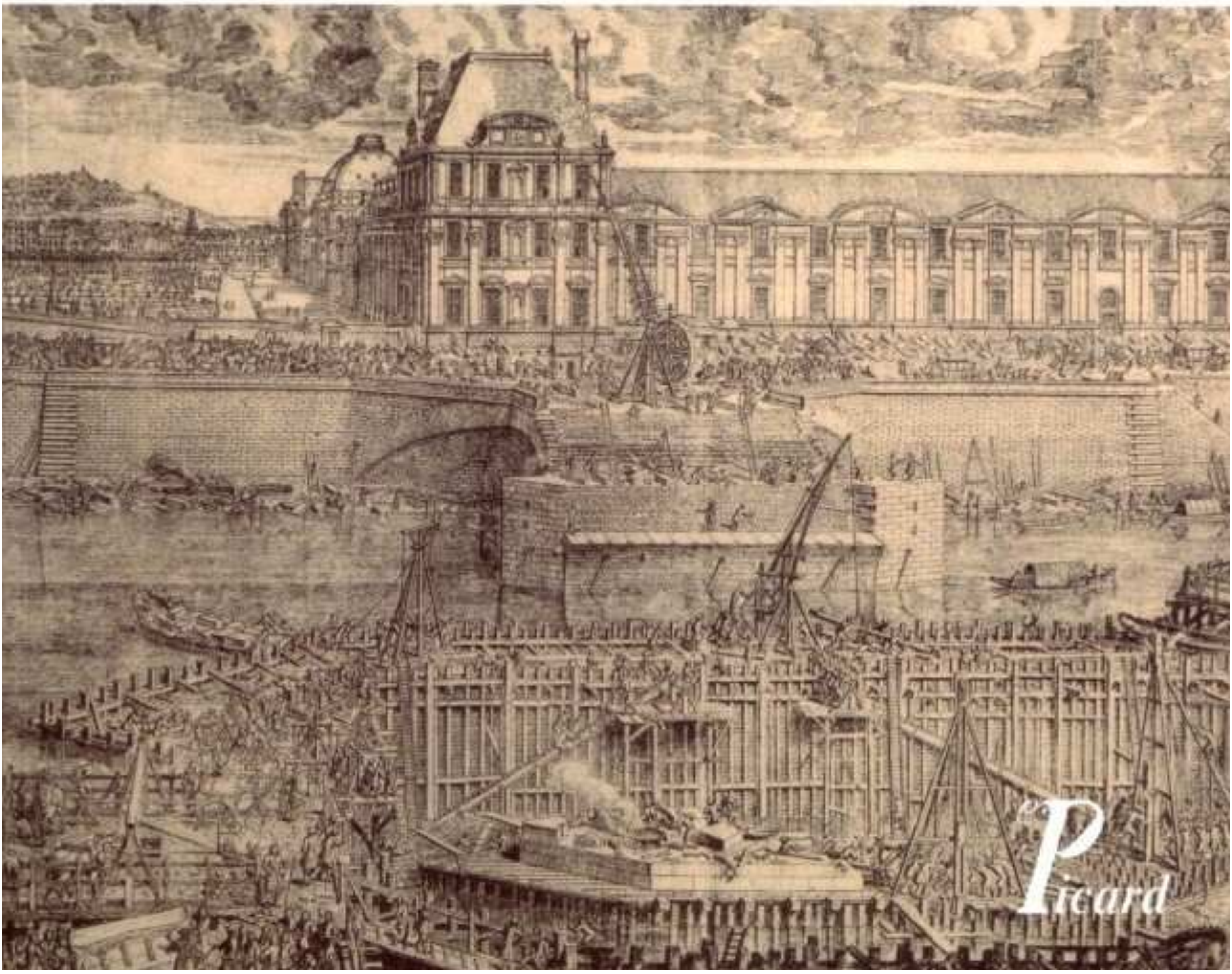
Nuts & Bolts of Construction History

Culture, Technology and Society

Vol. 3

Edited by: Robert Carvais, André Guillerme, Valérie Nègre, Joël Sakarovitch



Picard

This collection presents a state of international research in the history of construction, like a palace organized through 240 independently constituted elements. It defends a history of construction open to all cultures, desiring to balance the engineering sciences with the humanities and social sciences. It seeks to update existing axes of research by taking into account the profound changes sweeping across our planet through the framework of sustainable development and cohabitation. Building is thus excavated by archaeologists, leafed through by archivists and construed by historians and practitioners. They are all there, men and women, both famous and forgotten: masons, carpenters, locksmiths, roofers, draftsmen, architects, engineers, contractors, developers, experts, economists and lawyers. Equally present are the forces that have shaped the constructive field: institutions that direct, companies that innovate, work forces that produce and controversies that emerge.

These essays bring to life centuries of a history built, recorded, lived and ruined according to the changing temporalities of cities and sensibilities of societies. After Madrid [2003], Cambridge [2006] and Cottbus [2009], Paris celebrates in 2012 the 4th International Congress of Construction History with this collection. The themes revolve around three pillars: knowledge, people and objects. Methods and tools are improving through the development of heritage restoration and digital technologies. New historical thematics are appearing such as energy, natural and technological risk prevention, material recycling, diffusion and transfer of knowledge in colonial situations, modern re-appropriation of old techniques, legal frameworks, economics and institutions, craftsmen's tasks, construction site organization, labor in construction, contractor responsibility and public authority involvement in building industries.

Two thousand pages in three volumes covering 12 millennia: a monumental challenge equal to a constructive venture.

120 €
Les 3 volumes ne peuvent être vendus séparement.
ISBN : 978-2-7084-0929-3

Table of Contents

Volume 3

[For the complete Table of Contents, see the end of this volume]

– Shells & Thin Vaults

– Wood Structures

– Metal Structures

– Interior Environment & Energy

– Prefabrication & Industrialization

– Natural & Technical Risk Prevention

Technical Systems and Networks for a Modern High Altitude Settlement: The Construction of the Sanatorium Village in Sondalo [1932-1946]

Davide Del Curto, Francesco Carlo Toso
Politecnico di Milano, Milan, Italy

The fight against tuberculosis

Along with malaria, tuberculosis was probably the main public health issue in Italy during the first half of the 20th century (Cosmacini 1987). The social nature of these diseases led to a strong interest by the Fascist regime that tried to fight them under the motto "the most important reclamation is the reclamation of the Italian people" (I.N.F.P.S. 1937). Malaria affected above all people living in the marshlands and was fought with a wide campaign of land reclamation (Nicoloso 2008). Tuberculosis attacked both urban and rural populations and it has often been described as a social disease of the industrial age because it especially attacked the weakest and the poorest living in poor hygienic conditions and malnutrition. The antibiotic treatment of tuberculosis began to be effective and in use only since the 50s. Until then, hospitalization in a sanatorium was the only available palliative treatment. The patients were admitted in sanatoriums for the dual purpose of isolating them from the healthy population, thus reducing the risk of infection, and treating the symptoms of the disease by rests in the open air and good nutrition. Since the 1860s, sanatoriums have been designed by architects in collaboration with doctors. The architectural style of the sanatoriums has gradually improved along with the progress of medical therapy. The veranda is the core of the sanatorium treatment, and the design of its style has gradually evolved from historicism to modernism. In fact, the typological study of the sanatoriums is guided by the same design principles based on hygiene, sun and air that inspired the social approach of the Modern Movement (Miller 2002; Cremitzer 2005; Grandovinnet 2010).

The Sanatorium Village in Sondalo

The Sanatorium Village in Sondalo [nowadays known as Morelli hospital] was built by the National Fascist Institution for Social Security [INFPS] between 1932 and 1946 on completion of the large national scheme for the construction of sanatoriums to fight tuberculosis in almost every district. Through this extensive campaign for public health building, the Italian government wanted to fight the disease locally throughout the whole country (INPS 1947; INPS 1967). The national building program against tuberculosis included the construction of several buildings designed to treat the disease at different stages of its development [initial, overt, convalescence], addressing specific segments of the affected population [women, men, children, seniors, workers] in different geographical settings [sanatoriums in cities, hills, mountains and marine colonies] (Del Curto, 2010).

The Village of Sondalo was built in the Valtellina valley, in the Lombardy region, marking the culmination of the building program and representing a national landmark in size and level of specialization. As the majority of the sanatoria built since the end of the 20s consisted in single-pavilion institutes to isolate the patients from the urban context and to provide a local treatment of the disease, the Village was designed to be a national landmark for treatment at high altitude. The Village consists of eight in-patient pavilions, a surgery pavilion and a pavilion built in a higher position which accommodates administrative services, health management, warehousing, laundry, kitchen, disinfection. There are also several smaller service buildings: heating and electric power plants, workshops, garages, a church, anatomical pathology and histology laboratories and mortuary services. The total volume of the buildings rising above ground is about 600,000 cubic m. The typical in-patient pavilion consists of a nine floor slab type building with a three floor basement used for various services, five floors above ground for the rooms and one last floor for staff accommodation. There are 284 beds in each pavilion. With about 320 beds in the surgery pavilion, the whole complex houses over 2500 beds for inpatients. The staff included about 1500 employees, so the overall amount reaches about 4000 beds (Rossattini 2002).

The construction of the Village lasted for many years also due to the outbreak of World War II. The structures were completed in 1939, but it was still necessary to complete installations, to equip the complex and provide supplies to make it fully operational. At the end of World War II, the newly founded Alto Commissariato per l'Igiene e la Sanità Pubblica [A.C.I.S.], the first public health institution after the fall of the fascist regime, carried out extraordinary measures to provide medical aid for civilians and refugees infected with MTB, thus being the first institution to actually operate the sanatorium. The complex remained property of Istituto Nazionale per la Previdenza Sociale [I.N.P.S.], the national institute for social protection. In 1955 A.C.I.S. entrusted the management of the sanatorium to I.N.P.S., as testified by the official act, which comprises the complete listing of real and personal property. This set of documentation gives a clear picture of the complex as built, providing a detailed description of each building, infrastructure and piece of furniture (Archivio Storico Ospedale Morelli).

The design and construction of the village (Figs. 1 and 2)

The architectural design of the buildings is still the subject of a research which aims to determine

Fig. 1: View of the village of Sondalo before the construction of the Sanatorium Village (historical postcard, private collection).

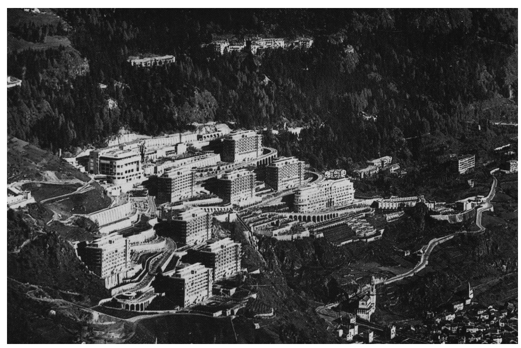


Fig. 2: General view of the village of Sondalo during the construction of the Sanatorium Village, approx 1940 (Archivio Storico Ospedale Morelli).

whether such ambitious and complex building was entirely designed by the I.N.P.S. technical office or whether some external designers could have cooperated (Moretti 1951; Trentin 2005).

On the other hand, today a wide technical archive is kept at the Morelli Hospital. The archive mainly consists of technical drawings for the construction of the village dating from the mid 30s. This large amount of drawings [approximately 2000 items, the archive has not undergone a complete arrangement] carefully records the making of the project both at the urban scale and at the architectural scale. What is most impressing, however, is not the study of architectural pavilions, which rather seem the adaptation to an alpine context of a pattern established in Rome for the construction of sanatoria throughout Italy (Morelli 1930), as much as the quality and accuracy of construction details [concrete structures, cladding, doors and windows] and the specification of the many works needed to transform the mountainside into a hospitable place for the foundation of a real "city of health." Hence, a notable part of the complex are its internal streets and their retaining walls, the underground facilities, the water supply, the sewerage and purification system, the futuristic cable cars system connecting the central station with each pavilion.

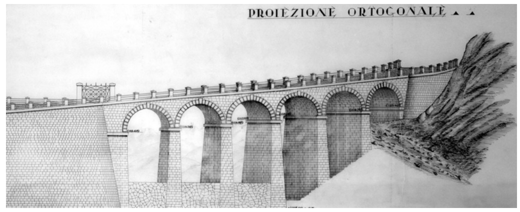


Fig. 3: Detail of the original project for a group of great arches supporting the internal street (Archivio Storico Ospedale Morelli).

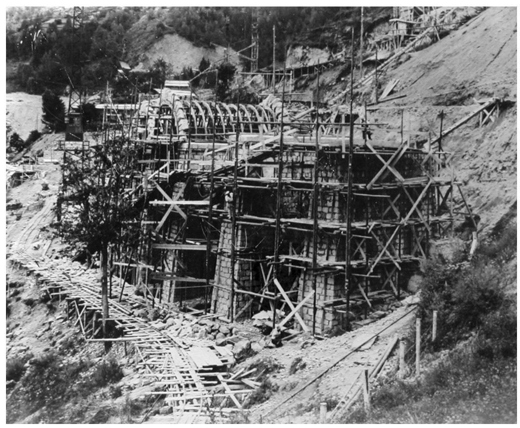


Fig. 4: Construction site of a group of masonry arches supporting the internal street, approx. 1935 (Archivio Storico Ospedale Morelli).

Pavings and street furniture (Figs. 3 and 4)

The construction of the road network represented a great "work within the work" resulting in a unified overall design for the entire complex, the park, the networks and the system of central services.

When visiting the complex, the coherent conception of the road system is still evident, even by its appearance. All principal and secondary roads are paved in porphyr blocks. The sidewalks are also paved in porphyr, with a granite perimeter. All banisters consist of approximately 950 granite posts, 115cm, eight with a 40cm base diameter. Each pair is connected by three enamel-coated Mannesmann seamless steel tubes, while the retaining walls are decorated with artificial stone flower boxes. The roads are fitted with concrete gutters at both sides, covered in steel grids and *beola* slabs [local gneiss stone]. The street furniture on the squares and forecourts includes pergolas with artificial stone columns and larch beams, ornamental fountains with artificial stone basins and granite claddings, using stones extracted from local quarries, such as *ghiandone*.

The great arches that reinforce the stone retaining walls, tracing the curves of the roads along the slope, are works of merit, even from an aesthetic perspective. More than the buildings themselves, they display an ability to interpret the spirit of the place through the use of local stone. The road system was intended to dig and shape the side of the mountain so that it could accommodate buildings in an apparently unsuitable location. The imposing modernist buildings, on the other hand, do not show any effort to adapt to the mountain context. The road winds between the pavilions and introduces the concept of floor, a horizontal plane in a naturally sloping context. Since the street connects the zero floor of each building, what is below and what is above ground depends on vwhether it lies below or above the road level.

The park

The streets and sidewalks were planted with linden trees, elms and maples. In particular, the linden trees dominate the main road and give an almost urban quality to the Village. Starting from the seventies, lay-bys and areas with benches were decorated with numerous specimens of *Ginkgo biloba*, a species not contemplated in the original project, which acquires a bright amber colour in autumn. The retaining

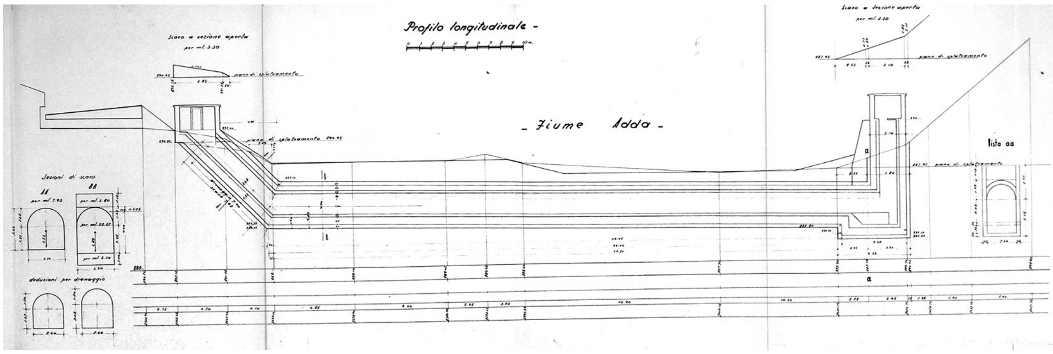


Fig. 5: Water supply duct under of the Adda river (Archivio Storico Ospedale Morelli).

walls of the streets were covered with ivy and wisteria. In the upper part of the Village, next to the services pavilion, a high hedge of *thuja plicata* delimited and shaded the tennis courts.

The village park designed with the sanatorium stretched for about 400,000 square m. and was divided into two areas. The northern area, called "Sortenna wood" consisted of a coniferous forest of 1500 spruces and larches, for the most part still existing. The southern area, originated from the digging of a large stretch of the slope, where the soil is composed of limestone and gravel, is further divided into 23 gardens and 15 avenues.

The whole area, deforested to make room for the construction site, was planted with more than 7000 different species of new trees [firs, pines, Austrian and Atlantic cedar, thuja, Horse-chestnut, Douglas fir]. These new trees adorned a series of gardens and the intention to characterize each designed area with a tree species is still clear. For this reason the area in front of the surgical pavilion is called the "cedar garden." The lower terrace is dominated by strobe pine. The open air games court near the seventh pavilion is dominated by black pine trees with dense dark green foliage (Cossi 2009; Cossi 2010). The irrigation system was designed at the same time as the aqueduct and includes 80 fire hydrants.

The water supply system

The site for the sanatorium was chosen mainly according to climatic and orographic criteria, posing the problem of water supply. Suitable springs to supply the complex were located northwards on the opposite side of the valley. The aqueduct was built to take the water downhill, cross the valley across a stream and the Adda river, then regain altitude on the opposite side. A preliminary design solution by means of pipe bridges was discarded in favour of underground conduits.

The intake works consist of a concrete infiltration gallery, internally plastered and fitted with a ceramic drain and a sidewalk. The gallery leads to the main tank, connected to the load-tank from which the pipe starts. An artificial distributary channel departs from the main gallery, transporting water to a secondary tank for discharge measurement. The piping is made of Mannesmann seamless steel tubes, air release valves and drain valves are situated in concrete valve boxes along the pipeline, signalled by smoothed concrete markers bearing the inscription, I.N.F.P.S. The pipeline is protected all along by dry stone walls.

At the first crossing, at the stream named Rezzalasco, the piping is preceded by a 55m. stone and concrete arch weir. The one m. high, 1.5m. wide underground passage is also made of stone and cement mortar masonry, with tapered walls built on 60cm thick, three m. wide foundations. It is accessible from both ends by concrete wells fitted with iron doors and steel-rod stairs. The road crossing is built in a similar fashion, while the crossing at the Adda river is built with additional precaution (Fig. 5). The first section, sloping at an angle of 45 degrees underneath the river

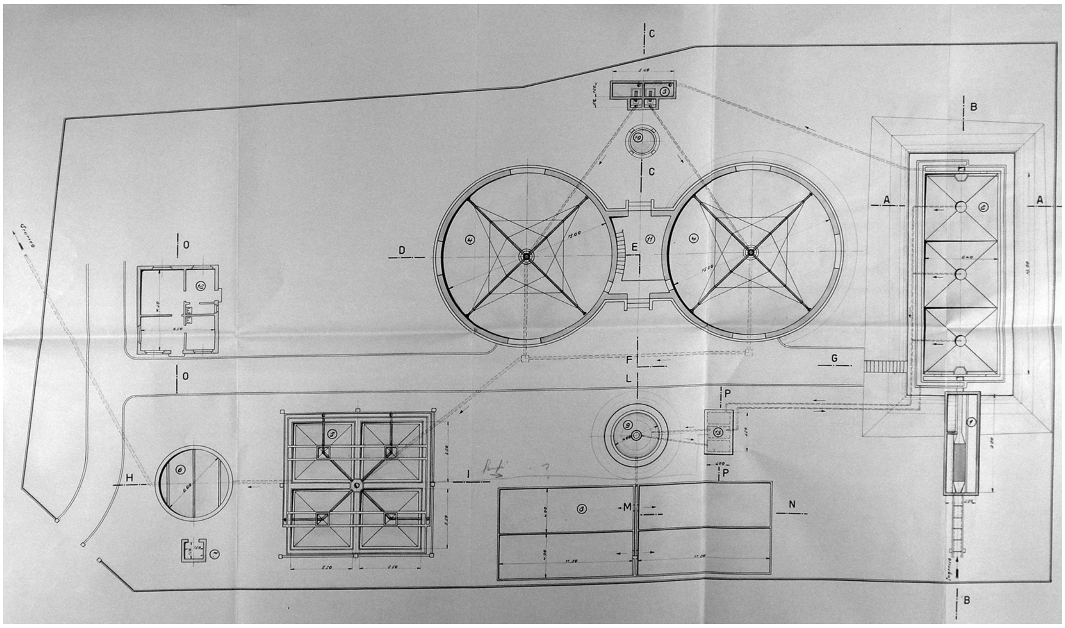


Fig. 6: Plan of the sewage treatment plant (Archivio Storico Ospedale Morelli).

bank, is accessible from a booth which leads to a flight of stairs. The walls and vault of the underground passage are entirely made of concrete and internally covered with a layer of tarred jute sheets and a 25cm thick brick and mortar cladding. The whole gallery is externally covered in dry stone. On the other side of the river, the duct is accessible from a vertical concrete well, protected by a wall of stone and cement mortar.

The final section of the aqueduct leads to a ground water tank, wholly built in reinforced concrete, with an internal layer of tarred jute in the walls and bottom. This constitutes the water reservoir for the complex.

The sewage and water purification system (Fig. 6)

The sewers and water treatment was designed by S.I.A.F, Società Italiana per Acquedotti e Fognature, based in Milano. All the branches of the sanitary sewage system are connected to two main sewers that join in the last segment heading to the water purification plant. Each main sewer is made of straight ceramic pipes, connected by concrete manholes. The purification plant, situated downhill near the village of Sondalo, collects waste through a bar screen into a 7.60m. long, two m. wide concrete grit chamber, followed by a 18m. long, 6.40m. wide primary sedimentation tank. From there, a duct leads to a small pumping station and subsequently to a circular sludge digestor. The sludge is then de-watered in four open-air basins with a draining bottom and a brick and cement roof.

Another duct transports the sewage to the oxidation basins and subsequently to two tickling filters. These are 11m. in diameter, built over a concrete foundation, with side walls made of stone and cement in the lower part, and concrete blocks in the upper part culminating in a concrete cap. The walls and roof of each tank are internally plastered, while the bottom is filled with a bed of stones, on which sewage settles and is sprayed constantly by rotating sprinklers, consisting of four arms suspended from the central rotating rod by means of steel cables. The pipe then leads to the secondary clarifier, where the sewage is poured into four hoppers, each one surrounded by a drain. Each hopper is internally plastered and ends at the bottom with a cast iron tube that extracts the sludge. The last section of the water treatment plant is the chlorine contact chamber, a circular concrete tank, six m. in diameter, internally plastered, where the remaining water is mixed with chlorine gas before flowing to the final drain.

It is interesting to note that the whole water purification system, though with minor modifications, has been in use until the present day. The file containing the original design includes also an extract of the 1938 manual "Modern Sewage Disposal" (Heilmann 1938), including the scheme of the tickling filter, and a 1938 article from the French journal "Le Genie Civil" about the same topic (Blunk 1938). This rare example of an explicit reference to the technical literature of the time suggests the concerted effort to provide the complex with state-of-the-art services.

Underground utilities (Fig. 7)

The underground utilities network clearly shows how the complex was conceived to work as a whole and how the conduits were planned from the beginning to accommodate all the needed wiring and plumbing, linking centralised services to the single buildings. Accessibility and maintenance is thus guaranteed through a network of galleries, departing from one main tunnel and reaching the buildings that can be inspected at every junction through manholes. The cross section shows a concrete vaulted tunnel, with a floor made of prefabricated concrete slabs hiding two ceramic ducts, for sewage and grey-water. Piping and wiring hangs from the side wall, including insulated hi-tension and low-tension cables, cables for the internal lighting of the tunnels, telephone and radio cables, cables for distance temperature monitoring, piping for garden irrigation, drink-

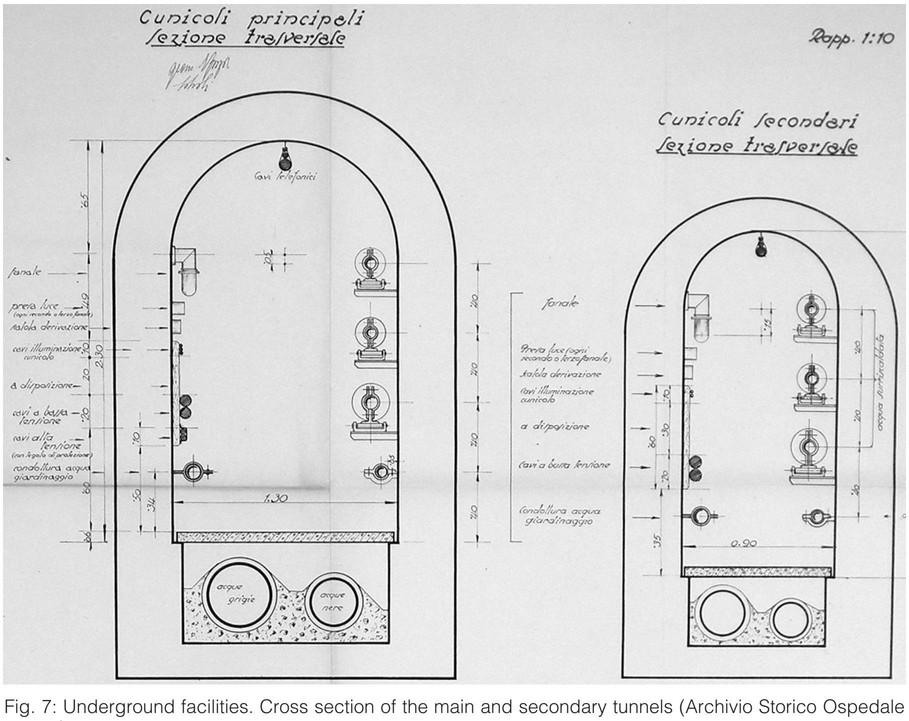


Fig. 7: Underground facilities. Cross section of the main and secondary tunnels (Archivio Storico Ospedale Morelli).

ing water and hot water pipes, the latter thermally insulated with a glass-reinforced plastic layer.

The cable cars (Fig. 8)

A late addition to the design of the sanatorium complex, the cable cars were meant to link the central services pavilion with the inpatient pavilions, to transport meals and linen from the central kitchen and laundry service. The system was designed by Ceretti e Tanfani, a company based in Milano, and comprised nine vehicles. All nine terminals are still situated on the upper floor of the central pavilion, along with a room containing the control panel to operate all nine engines. A stationary steel cable and a haulage rope, the propulsive continuous loop cable, reached the terminal on the upper floor of each pavilion, shuttling the cars back and forth [the cable system and the cars are now dismantled]. Each terminal consists of a steel frame structure with an electric engine operated bullwheel and four safety switches, an electromagnetic brake that would stop the rope in case of blackout, manual controls and a metal box containing optical and acoustical signalling devices. All terminals are closed by a gate and a switch prevented the engine from starting while the gates were open. The cars were made of welded steel plates and steel frame, with four wheels constituting a fixed grip on the haulage rope, therefore the cars were not detachable. Each car was equipped with a trolley for meals and a bucket on wheels to transport linen and the system was designed for an overall loading capacity of 490kg. For three of the nine lines, a pylon was necessary to support the cables halfway.

The cable car system clearly exemplifies the unitary functional conception on which the design of the Village is based. The centralisation of the kitchen, laundry and disinfection facilities within a single building was meant to maximise hygiene and to leave the strictly medical function to the inpatient pavilions, leaving out those functions that could potentially conflict with the strict rules of hygienic therapy. The use of cable cars was also meant to reduce street traffic, noise and pollution, thus confining the pavilions in the therapeutic silence of the pine woods.

Fig. 8: The cable car running towards the sixth pavilion in a picture dating back to the sixties (Rossattini 2002, p. 185).

Despite giving a strikingly futuristic feel to the Village, the cable cars have hardly been used to transport food, as in fact the duration of the journey was too long, resulting in cooled and overcooked meals. Before the Village became fully operational, A.C.I.S.P. opted for replacing the central kitchen with smaller kitchens in each inpatient pavilion, using the cable cars only for the transportation of food supplies and linen (Rossattini 2002, 184-185).

The conservation, rehabilitation and reuse of the sanatorium real estate is nowadays a relevant issue, given that these large complexes have long lost their original intended function. In Italy and other European countries (Tavares 2005; Tobè 2006) new health or accommodation facilities have been introduced in early 20th century buildings. In Italy the many sanatorium buildings built by I.N.P.S. were entrusted to the national Italian health care service in the early 70s, suffering different fates, and have been protected by the heritage law only recently. Regional laws have often favoured the switch from the healthcare function, entrusting the buildings to different public sectors. In some cases the healthcare service has evolved towards specialised assisted living (Zaccardi 2005), while in many other cases the buildings are underused, partially or wholly abandoned (Del Curto 2010).

The Sanatorium Village in Sondalo is extremely relevant for its scale and its remote location. Starting from the late 70s, the defeat of tuberculosis was the reason for the closure of four pavilions out of ten. The Village is today a hospital while the remaining six pavilions are partially underused. As for the conservation of the buildings, interventions by the public sector are limited to the maintenance of roofs, to avoid the inevitable decay of the abandoned structures. The historical and technical assessment of the complex represents a first approach to the definition of a conservation and reuse strategy. The peculiarities that emerge from this contribution highlight that the unitary quality deriving from the original function is still clearly readable. The fragmentation of such complex in smaller units, as experimented in other similar cases (Grandvoinnet 2004), is difficult to implement in Sondalo because of how the facilities network was conceived, hence requiring the study and development of an overall strategic approach.

Acknowledgements

The authors would like to heartily thank Avv. Monica Fumagalli, Ing. Graziano Baldini, Geom. Bruno Gianola at Ospedale Morelli in Sondalo for their kind helpfulness and courtesy during the study and research time. Many thanks to Professor Luisa Bonesio and arch. Giacomo Menini.

Reference list

Archival Material

Archivio Storico Ospedale Morelli
– *Verbale di consegna tra L'Alto Commissariato per l'igiene e la sanità pubblica e L'Istituto Nazionale per la Previdenza Sociale* 31 luglio 1955, Sondalo.
– Folder : Fognatura, S.I.A.F. Società Italiana Acquedotti e Fognature, November 1939. *Disegni*
– Folder : Teleferica. Ceretti e Tanfani S.p.A, February 23, 1953. *Teleferiche al villaggio sanatoriale di Sondalo. Relazione descrittiva e di calcolo.*

References

Blunk, H., 1938. *L'épuration des eaux d'égout par lits bactériens soufflés.* Le Genie Civil 9 July 1938, 37-40.

Cosmacini, G., 1987. *Storia della medicina e della sanità in Italia*. Bari: Laterza

Cossi, F., 2009. Il parco dell'Ospedale Morelli di Sondalo. *Bollettino sorico Alta Valtellina* 12. Bormio: Centro Studi Storici Alta Valtellina, 275-298.

Cossi, F., 2010. *Il parco dell'Ospedale Morelli di Sondalo*, in *Il Villaggio Morelli. Identità paesaggistica e patrimonio monumentale*. L. Bonesio, D. Del Curto (eds.). Reggio Emilia: Diabasis, 117-145.

Cremnitzer, J.B., 2005. *Architecture et santé. Le temps du sanatorium en France et en Europe*. Paris: Picard.

Del Curto, D., 2010. *Il sanatorio alpino. Architetture per la cura della tubercolosi dall'Europa alla Valtellina.* Rome: Aracne.

Grandvoinnet, P., 2010. *Histoire des sanatoriums en France (1915-1945). Une architecture en quête de rendement thérapeutique.* PhD diss., Ecole Nationale Supérieure d'Architecture de Paris-Belleville.

Grandvoinnet, P., 2004. *Le sanatorium Martel de Janville, (Haute-Savoie)*. Thesis [mémoire de DEA], Institut d'Architecture de l'Université de Genève.

Heilmann, A., 1938. Sewage Treatment in Germany. *Modern sewage disposal: anniversary book of the Federation of Sewage Works Associations*. New York: Federation of sewage works associations.

I.N.F.P.S., 1937. *Tutela sanitaria e sociale del lavoro e della razza, quaderno di propaganda di « Difesa Sociale »* 4. Rome: organo dell'Istituto Fascista della Previdenza Sociale.

I.N.P.S., 1947. *L'Istituto Nazionale Previdenza Sociale nella lotta contro la tubercolosi*. Rome: INPS.

I.N.P.S., 1967. *Relazione Quadro sull'organizzazione e sulla gestione dell'assistenza antitubercolare svolta dall'Istituto.* Rome: INPS – Servizio Case di Cura e di Ricovero.

Miller, Q., 2002. *Le Sanatorium, architecture d'un isolement sublime*. Losanna: Ecole Polytechnique Fédérale de Lousanne – Departement d'Architecture.

Morelli, E., 1930. Applicazione della legge sulla assicurazione obbligatoria contro la tubercolosi. *Lotta contro la tubercolosi.* Rome: INPS.

Moretti, B. and F., 1951. *Ospedali generali e di specialità, cliniche servizi, trattazioni di tecnica ospedaliera riguardanti la costruzione e l'organizzazione, illustrazione di 103 ospedali scelti fra i più moderni di tutto il mondo.* Milan: Hoepli.

Nicoloso, P., 2008. *Mussolini architetto. Propaganda e paesaggio urbano nell'Italia fascista*. Torino: Einaudi.

Rossattini, S., 2002. *Un villaggio straordinario.* Bergamo: Litostampa.

Tavares, A., 2005. *Arquitectura Antituberculose*. Porto: FAUP publicacoes.

Tobè, A., 2006 (ed.). *Les quinze glorieuses de l'architecture sanatoriale.* Plateau d'Assy: Centre de recherche sur l'étude et l'histoire d'Assy.

Trentin, A., 2005. Mario Loreti: i luoghi della cura tra il mare e le alpi. *Architetture per le colonie di vacanza. Esperienze Europee conference proceedings.* V. Balducci (ed.). Cervia, 4-6 march 2005. Florence: Alinea Editrice, 79-82.

Zaccardi, L., 2005. *L'ex Ospedale Sanatoriale P. Grocco di Perugia: il problema di Restauro e Riuso di un Nosocomio del '900.* Thesis, Università degli Studi di Firenze, Faculty of Architecture.