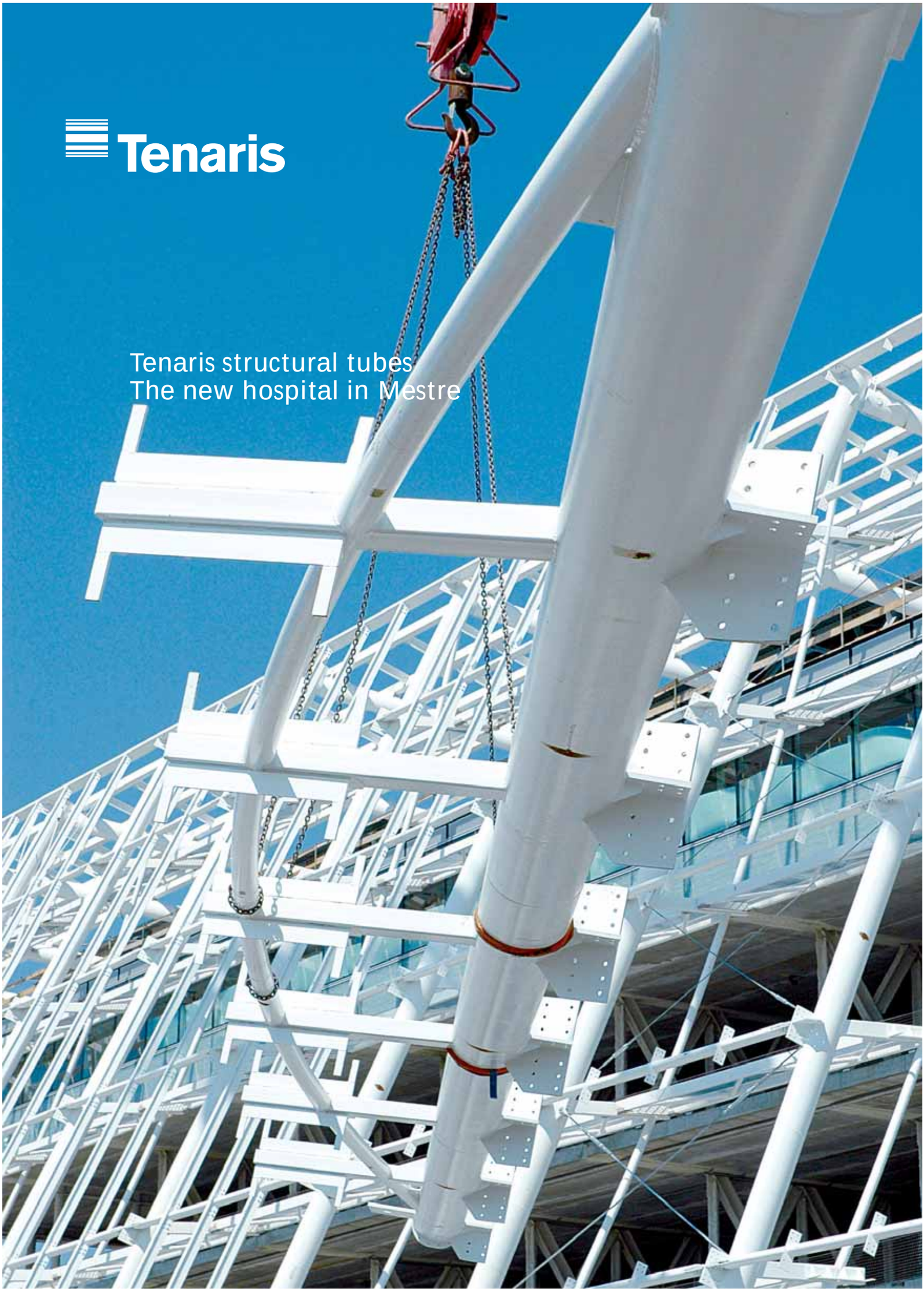

Tenaris
Tenaris structural tubes
The new hospital in Mestre

Tenaris

Tenaris S.A. operates through companies strategically located around the world

Tenaris is the leading global manufacturer and supplier of tubular products and services used in the drilling, completion and production of oil and gas and a leading supplier of tubular products and services used in process and power plants and in specialized industrial and automotive applications. In addition to Italy, Tenaris has production units in Argentina, Brazil, Canada, Columbia, Japan, Mexico, Romania, the United States of America, and Venezuela, with a total steel tube production capacity of 6 million tons a year and 23,500 employees, as of May 2007. Thanks to the worldwide integrated network of production sites, research and development centers and service centers, Tenaris satisfies the needs of its clients efficiently with high quality, high performance products in increasingly complex operating environments.

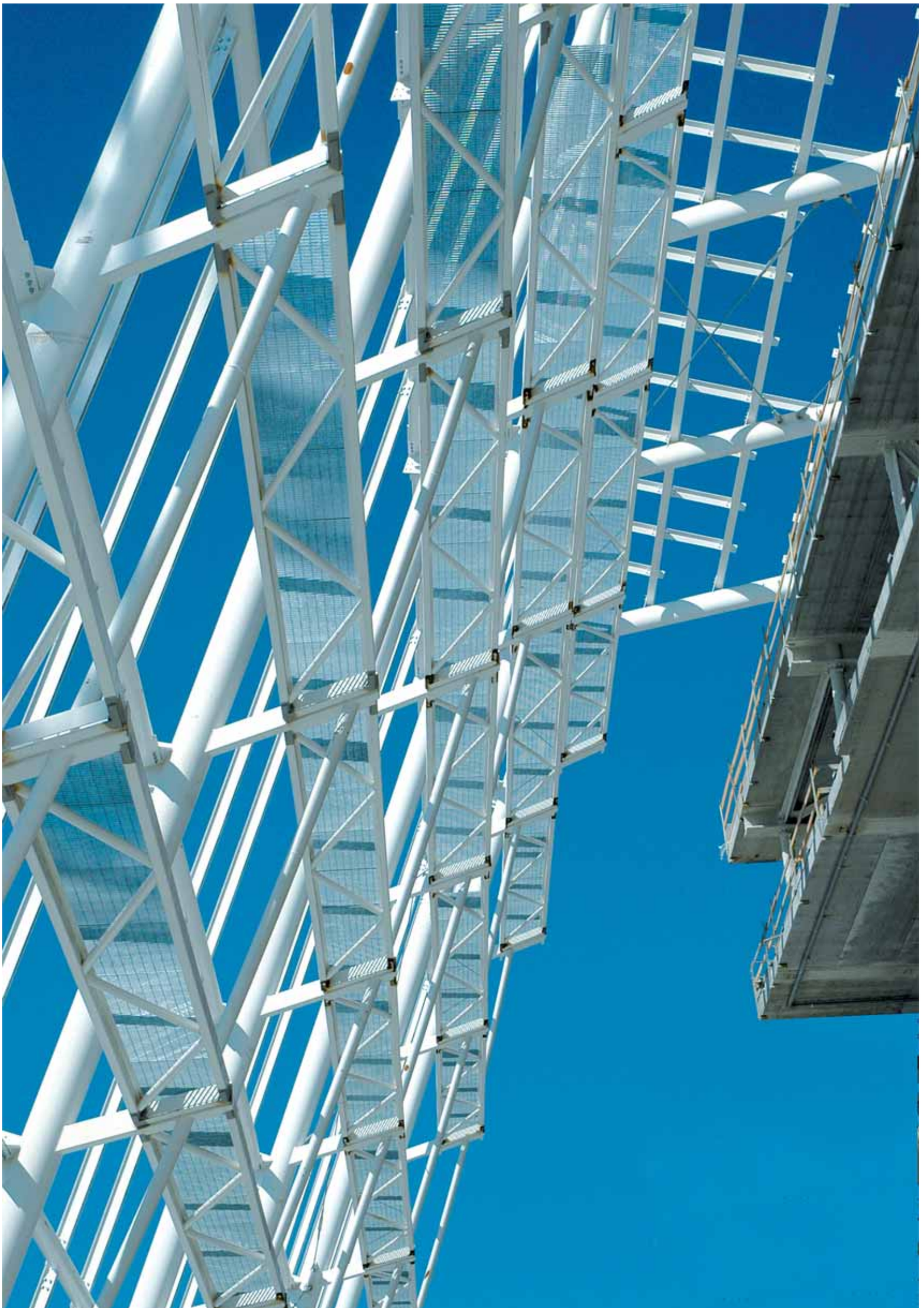
Tubular solutions for construction

Tenaris produces a wide range of tubular structural hollow sections, in different steel grades for use in the construction field. The structural tubes have applications in civil construction (stadiums, bridges, airports, etc.) and industrial (hangars, commercial buildings, industrial units, etc.).

The uniform mechanical characteristics and excellent weldability guarantee the steel tube's use in engineering applications; this quality makes the tubes ideal for use in architectural designs where structural lightness is requested.

Around the world there are many examples of modern architecture using steel structural hollow sections: this profile is usually chosen to give pleasing aesthetic and functional results.

The Tenaris offer does not just stop at production of high quality steel tubes, but also includes specialized consultation services, both for design as well as project development.



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Technical-Architectural Principles

An innovative example of Project Financing public works, integrating architecture into the environment

The new hospital in Mestre constitutes one of the best examples at national level of public works being realized through Project Financing. With a total investment of 220 million euro, the major part of the amount will in fact be repaid through management of various hospital services granted by ASL12 for 24 years.

The first stone was laid on 20th February 2004 and the completion of work is expected in 2007.

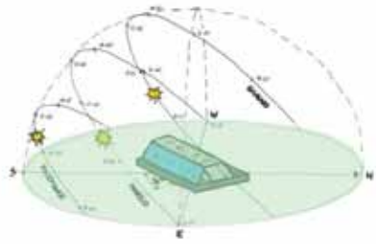
A healthcare structure of great importance which will care for the Venetian basin (300,000 inhabitants) as well as the province (800,000 inhabitants) and will be home to the *Banca degli Occhi del Veneto* (The Veneto Eye Bank) with its epithelium staminal cell unit.

Architectural thought

This structure is located in the northwest of the Mestre municipality, city near Venice , an area that is still almost rural. The project, therefore, was born from an architectural philosophy characterized by respecting and improving the area, both in environmental terms as well as in consideration of the already exisiting infrastructure.

Another of the project's guiding elements was to research functional flexibility of the structure, at the same time guaranteeing a hospital environment as near as possible to the typical needs of an urban-residential panorama.

The impression of 'size not perceived' is the strong point of this design by Alberto Altieri, who, together with Emilio Ambasz, who provided the artistic consultation, are the creators of this 'green hospital'.



‘Green’ because it is surrounded by greenery and small lakes, as well as bringing green inside, so much so that it seems to be the perfect synthesis between a green house (southeast) and a descending terrace (to the northwest). Glass, steel and even more green produce a dynamic series of architectural surprises. On one hand, it is an impressive structure of glass and steel, on the other, hanging gardens on a descending terrace effectively reduce the hospital’s structure, which is immersed in a large park. The transparent façade to the south and the terraced garden to the north contributes to camouflaging the hospital in the landscape avoiding visual shock. As architect Altieri underlines, the visual impact will be unique in its genre thanks, in particular, to the lattice created by the structural tubes on which a window of more than 6,000 sqm is mounted.

“For the Mestre hospital I thought of Michelangelo - explains architect Ambasz, who adds - *I thought of it as a machine for healing, not a place where you stay in bed. The philosophy of the new hospital is the one which I’ve always held to: green over gray. I try to reconcile the impossible. The new hall, in particular, will be accessible to everybody. I imagined two walls that seemed to touch each other, an enormous hall, full of light. It’s a very strong image but totally clean.”*

In the architect’s concept you can see the clear objective of limiting the imbalance between the landscape and the urban shape. This can be seen in how vegetation has been used as a design element, hiding the concrete structure, giving back to the environment the green that has been taken. The sail in glass and steel will remain as the only element that highlights its presence.

Project and material choices

An aspect which characterizes this significant public works contract is the quality of the materials and the solutions adopted. As an example, among many, the realization of the double façade covering the wardrooms can be cited. It is a solution that only a few modern skyscrapers have used; thanks to this type of large window, made of quadruple glazing, the air trapped inside and heated by the sun is aspirated in a way that 'helps' the heating system in the winter months.

Returning to the architectural aspects: the ward structure is of particular interest; the floors are not simply one over the other as in a skyscraper, but rather, are staggered, cantilevered, and serve a functional purpose for both the window and the overall structure.

Descending on one side (so much so that it appears to be a terrace), jutting out on the other, two and a half meters every floor, for a total of 12.5 m.

This architectural design with its striking ‘sail’ in steel and glass serves a functional purpose, not only will it provide a noise barrier for the wards on the southwest, but will encourage a microclimate in the entrance hall, giving a temperature halfway between the wards and outside.

Additionally, joining the structure in concrete and steel reclaims an internal space that serves the traditional role as a gathering point for visitors in the large hall, which is illuminated by the light coming form the southern window.

An ideal ambience contributes to a gentle approach into the hospital environment, providing, among other things, a series of services to reach the outpatient departments, the wards on the upper floors (escalators and lifts) and shops.

To produce the large façade in steel and glass, which are characteristic elements of the building’s interior, the fabricator chose Tenaris structural tubes for their reliability, versatility, ease of assembly and final aesthetic impact.

The realization of the grand ‘sail’ façade

A structure in steel tubes, realized in a novel profile

In close collaboration with all parties involved in the design and construction of the new hospital in Mestre, Tenaris has supplied a range of structural tubes to realize the large cover in steel and the entrance hall façade, as well as the external facing in glass panels. The entrance hall façade has a length of about 180 m at the base and 160 m at the top, the top being connected to the roof, which is 8 m in width. The two structures are linked in such a way as to form a right angle.

Organization of the building

Underground

Logistics services and basement parking

Ground floor

A piazza-garden illuminated by the light entering the glass sail, which will lead to the hall from where stairs, lifts and escalators enable you to access all areas. Here there will be an Accident Emergency department, 16 operating theatres, a day surgery area with a further 4 rooms, radiology and intensive care.

First floor

Outpatients’ department and day hospital

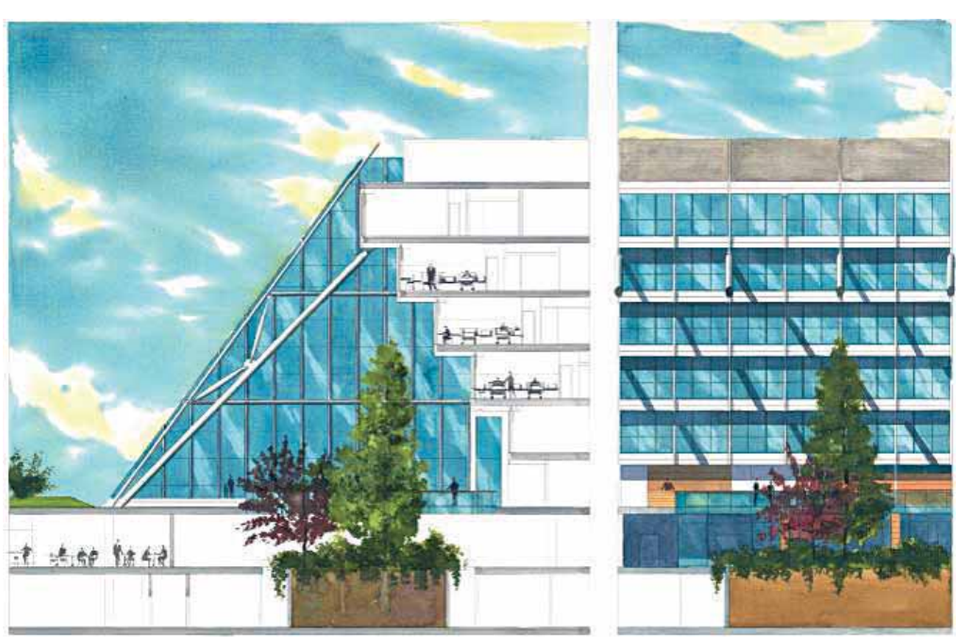
Second floor

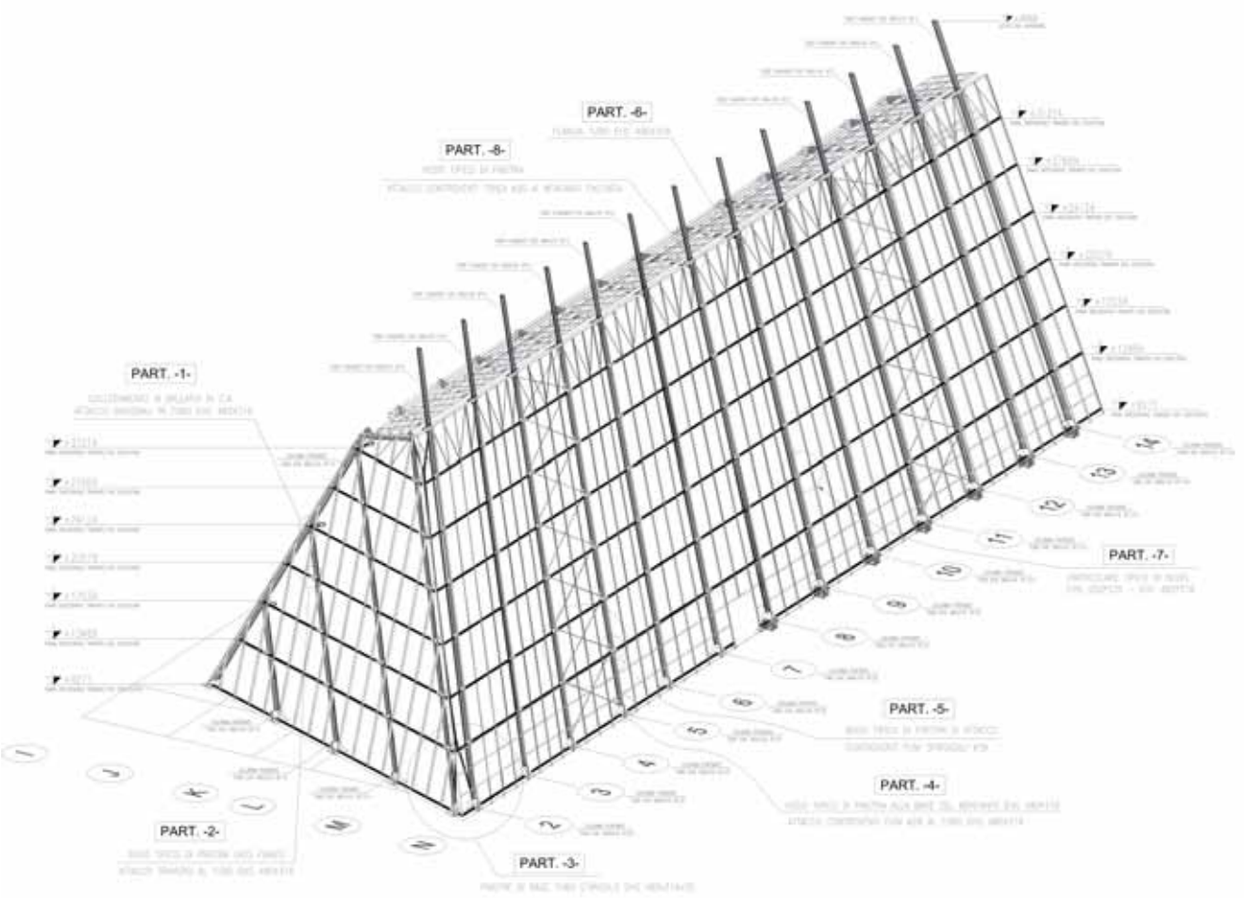
Offices and healthcare administration

Upper floors

Wards

680 beds: 35 for dialysis and 20 cots, divided into 350 rooms of one or two beds, each having a bathroom and toilet.

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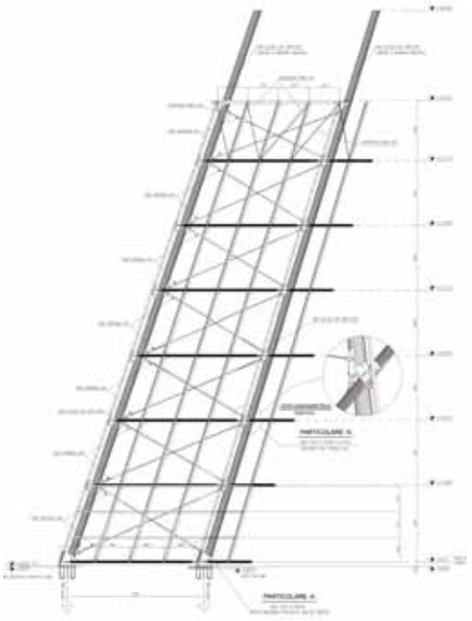
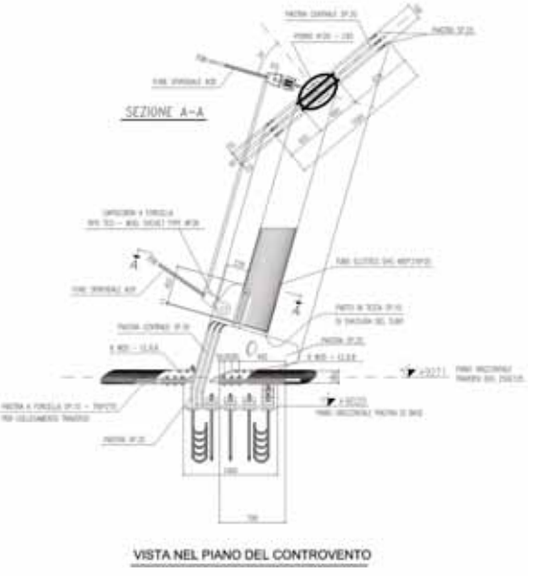
PART. -8-




SEZIONE A-A
VISTA NEL PIANO DEL CONTROVENTO

Outside

The hospital area will house an amphitheater for various services and a pavilion with a laboratory for staminal cell research linked to the Eye bank. There will also be a nursery for the benefit of employees.

Additional services

Shops, bar, restaurant/canteen, conference hall.

External parking

The car park, opposite the hospital, is on 3 floors. One floor reserved for hospital personnel (535 places) and two for visitors (557 places). A system of escalators and lifts will access the hospital.

Components of the 'sail'

The columns - Inclined and with elliptical profiles, the columns are the elements that make up the façade in steel. With a maximum length of about 26 m, they have been produced from tubes with circular section of 406 mm, tapering in thickness from the bottom to the top, starting at 25 mm and arriving at 10 mm, in such a way as to guarantee structural lightness at the top.

A secondary framework in steel elements transfers loads to the primary structure.

The Roof - The roof consists of elliptical beams of various dimensions but all of the same length. Positioned perpendicularly (seen in profile) to the façade at a distance of 1.9 m one from the other, they are connected to one another by additional elliptical beams positioned parallel to the façade at an average distance of 2.7 m, supporting elements that can be opened to release any possible fumes.

The covering - The mirrors, that form the covering of the visual work, are made up of neutral laminated glass elements with tempered external panes and semi-tempered panes internally, appropriately sized to absorb loads. The glass, supported on aluminum profiles with suitable stripping, is able to absorb possible heat expansion, as well as the movement of the structure. They are irregular trapezoids, formed as truncated cones projected on a plane with four sides of variable length.

Static plan of the ‘sail’

A three-directional load transfer to the foundation was hypothesized for the static plan.

The principal basis for this system envisages that the principal and secondary lattices made of both circular and box profiles in steel, have a load-bearing function for both the mirrored covering and service platforms. Aluminum profiles fitted with seals are attached to the load-bearing structure by means of bolted connectors, that serve as supports to the covering sheets and/or glass, while a further silicon seal guards against rainwater penetrating underneath the covering and across the façade.

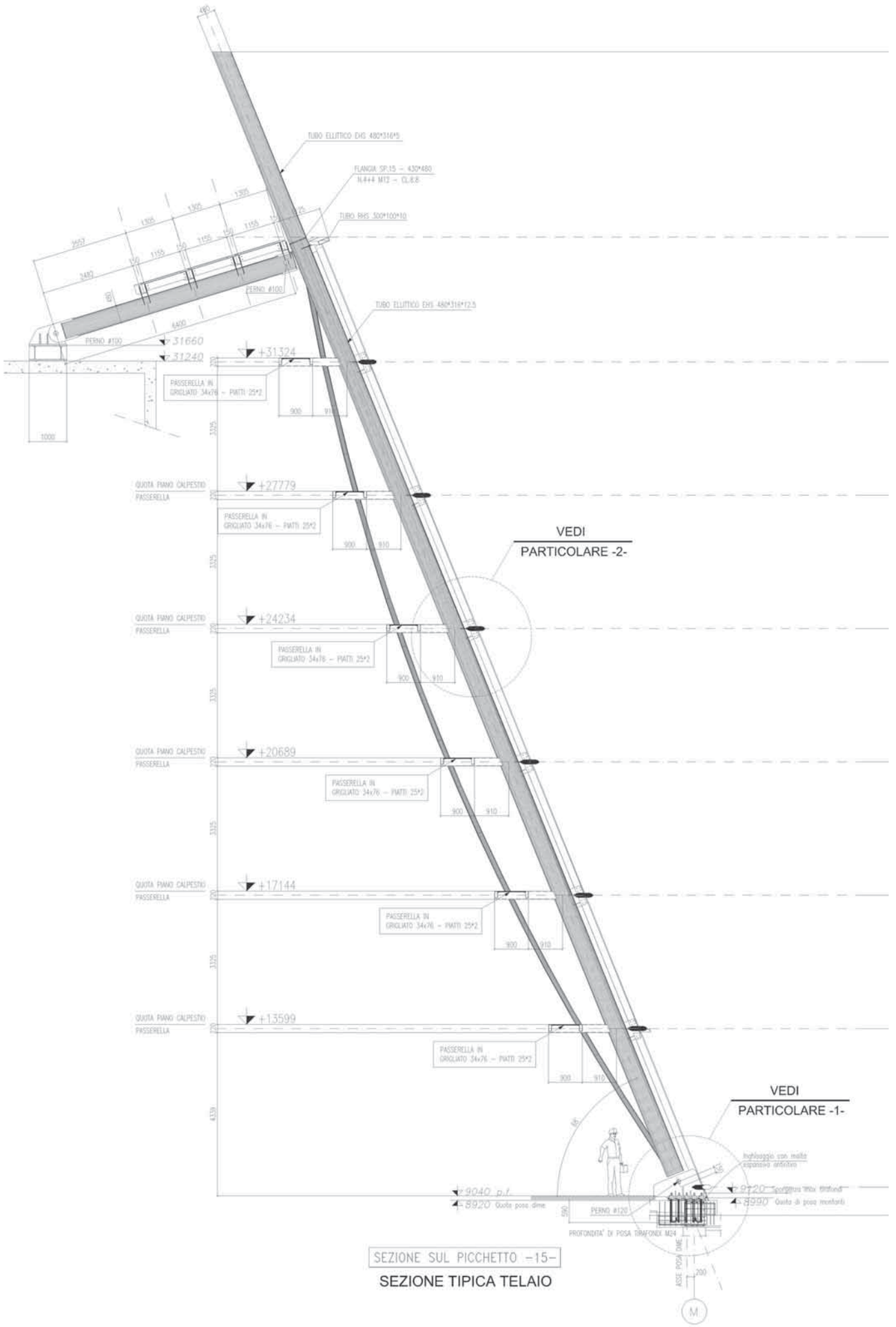
Technical-performance characteristics of the roof elements

Foundation structure anchorage - A suitable system of bolts, of appropriate dimensions to bear loads produced by external sources acting upon the cover and façade, fastens the load bearing metal structure to the foundations.

Structural joints - In correspondence to axis, the building on which it is supported is equipped with a structural joint able to contain deformation through expansion equal to ± 2 cm. Therefore the ‘sail’ structure can bear this kind of deformation by utilizing the clearance between the aluminum uprights, the walls and the telescopic joints.

Structural behavior, typology, expansion and deflection - The structure of the building is able to bear permanent and envisaged accidental loads (wind, snow, etc.) and any necessary loads and possible work such as cleaning the cover and façade, as well as the replacement of any damaged glass along with expansion due to heat. A height of 26 m was considered the maximum for the columns due to the effects of combined bending and compressive stress and inflexional-torsional stress.

The structure is made up of columns and elliptical sections connected to each other by elliptical beams, positioned at right angles and either welded or bolted in place.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N.4+4 M12 - CL.8.8
TUBO RHS 500*100*10
PERNO Ø100
TUBO ELLITTICO EHS 480*316*12.5
PERNO Ø100
+31660
+31240
+31324
PASSERELLA IN GRIGLIATO 34x76 - PIATTI 25*2
QUOTA PIANO CALPESTIO PASSERELLA
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+24234
+20689
+17144
+13599
VEDI PARTICOLARE -2-
VEDI PARTICOLARE -1-
+9040 p.f.
+8920 Quota posa dime
+9120 Quota testa tirafondi
+8990 Quota di posa montanti
PERNO Ø120
PROFONDITA' DI POSA TIRAFONDI M24
ASSE POSA DIME
SEZIONE SUL PICCHETTO -15-
SEZIONE TIPICA TELAIO

Tenaris's experience applied in the project

Elevated technical and performance characteristics and versatility of the structural tubes at the heart of this significant design

Realization of the elliptical profile

After investigating the issues raised by the design and on the basis of the technical, organizational and services requirements, Ocam chose Tenaris as structural tube supplier.

The Ocam staff, at the design stage, considered the implications of using elliptical profile tubes, traditionally welded. The elliptical profile meant going beyond the production standards typical of closed and squared profiles, where the machines are already setup to produce whatever is needed for welding.

To produce a special profile, like for example the elliptical one for the Mestre hospital façade, the process of forming by welding demonstrated all its inherent limitations in the case of the work envisaged for the construction of this structure. Furthermore, the elliptical tube is a niche product, produced by very few companies around the world, who generally ask for a lot of time and place constraints on supply. Following the strains emerging from the calculus model, a tube with wall thickness of not less than 25 mm had to be used, a product not easy to find on the market. Besides, the thickness it was also necessary to act on the pillar inertia, augmenting the elliptic dimensions and increasing the base to 492 mm. From here arose the necessity to find a material of another type on the market, outside of the standard production norms, which would allow an elliptical shape to be formed, a fundamental characteristic of the architectural design.

The idea, therefore, was to obtain an elliptical profile starting from the cold forming of a closed circular profile and to that end two solutions were hypothesized: the first line of thinking was to squash the tube in a press, the second was to pass the tube under a "profile bender", duly modified. In the first case, in a press, lengths of a maximum of 3 m would be obtained. With the main pillars being about 28 m in length, using such short profiles would certainly have detracted form the aesthetic aspect and overall quality of the structure. The second option offered better lengths, allowing tubes of even more than 12 m to be profiled.

Tubular material characteristics

Tenaris has supplied material that meets the technical-applicative needs of the design, delivering to a defined timescale, in accordance with the assembly phases of the structural elements.

The steel, due to its beneficially calibrated chemistry, has shown excellent reliability characteristics, in particular in the cold deformation stages where the elliptical profile was produced and in the successive assemblage by welding.

Heat treatment, which the profile underwent during the production stages in the plant, has given it maximum homogeneity in its mechanical characteristics, besides a high impact strength (or toughness), namely the property that distinguishes quality steels and which allows the material to absorb high degrees of energy without compromising its integrity.

Tenaris possesses, in this field, extensive experience in the study of steel with the highest yield strength characteristics and also produces steel with yield values that arrive at over 700 Mpa, with guaranteed impact strengths of up to -50 °C.

The offer for Oscam resulted from this experience, identifying and offering a S355 J2H steel, with an impact strength ideal for the design's characteristics.

Behavior of the material in cold roller leveling

The high quality of the material was evident above all in the bending machines: the seamless tube did not show any critical points which would have been produced in a welded tube.

When the material was squashed cold not a single piece was found to be cracked, demonstrating its full plasticity and capacity to resist cold deformation even at significant intensity.

360° Cooperation

Tenaris did not limit itself to just supplying quality tubes but worked along closely with the Ocam technical office to define optimal lengths, testing of the entire consignment and maintenance of an active interface for all the most critical aspects of assemblage. Furthermore, it supplied recommendations for the optimum use of the final materials and test materials used to test, in preliminary form, the cold roller leveling process.

PROJECT DATA	
Execution time	June-November 2006
Personnel involved	12 fulltime
Total amount of working hours for the cutting center, tacking and welding	18,000
Hours dedicated to assemblage	6,000

Hot finished seamless steel structural hollow sections EN 10210-1/2 in S355 J2H steel plain ends with EN 10204 3.1 and D.M. certification

DIAMETER	WALL THICKNESS	TOTAL METRES	TOTAL KGs
406.4	10	270	30,000
406.4	12.5	270	38,000
406.4	16	165	28,000
406.4	20	245	52,000
406.4	25	225	70,000

Welded Joints

The elliptical profiles for the principal and secondary elements of the 'sail' and the double T profiles, defined as tertiary elements were welded at the plant on rotating axes of from 10° to 140°. The tubes demonstrated excellent behaviour when welded to full penetration on heavy thicknesses permitting complete re-establishment of the surface profile. The columns were welded head to head and plates of sizeable thickness were applied; welds equal to 70% of the minimum thickness as per the norms were executed and in some cases from 8 to 10 continuous welds were performed.

As the Ocam manager for this specific operation, Roberto Salerno, underlines, *"the welders employed, all with a lot of experience and all highly professional, have demonstrated that the Tenaris product made it possible to effect welds in clearly prearranged and studied phases, without the profile suffering particular deformation. The reaction of the weld on the profile, above all when work had to be done on site using electrodes, was especially positive. This was due to the heat treatment uniformity and material's characteristic homogeneity, which guaranteed excellent weldability at whatever point of the profile and in critical ambient conditions."*

Assembly

The façade of over 8,000 sqm of glass surface between walls and roof has a frontal linear length of about 200 m and a height above ground of about 30 m. The principal columns and the inclined roof struts were conceived statically with a three-hinge design which is only stable once it is fixed at the base and top by bolts.

It was therefore indispensable in the assembly phase to lift in tandem and so two cranes had to be used. Using two cranes simultaneously, however, renders the operation particularly complicated and delicate because of the extremely strict safety procedures that needed to be adopted.

The plano-altrimetrical orientation of the columns along the foundation axis all with differing angles (3,680 construction elements were designed and executed requiring over 4,500 man-hours), has made it possible to achieve an aesthetic result of grand effect. If you were to stand inside the sail and look along, you would have a unique and matchless view, with nuances and details that change depending on your point of observation.

Appendices

The contract

The order for the façade was acquired by a temporary association of companies; ATI group leader, Teleya – a company of the Coop Sette group and Ocam Srl of Formigine (MO).

The principal Italian companies in the sector all submitted tenders. The Teleya-Ocam offer gave the best economic terms for the proposed production and assembly processes, offering notable reductions in costs for the work.

Parties involved in its realization

Grantor

State administration ASL 12 Veneziana which, in the role of Project Manager, was concerned with supervision and controls.

Concessionary

"Veneta Sanitaria Finanza di Progetto Società per Azioni", took over the contractor ATI in the role of concessionary.

The Concessionary looked after the planning and realization as well as the successive management of the New Hospital for a period of 24 years, commencing at the completion of the construction period.

ATI (Temporary Association of Companies)

Made up of companies who have been entrusted with the 'key in hand' contract for the design and realization of the hospital.

Within ATI, made up of Astaldi, Mantovani, Mattioli, Gemmo, Cofathec and Studio Altieri, the role of group leader mandatee was taken by Astaldi, whose duty it was to coordinate the activities related to the planning and construction of the new hospital.

For further information: www.nuovospedalemestre.it

Acknowledgements

Following the signing of the financial contracts, two notable specialist magazines recognized the 'Mestre Hospital' Project and best Project Finance at European level:

- **Project Financing International magazine** judged it the best public-private partnership project of the year, awarding it the "PPP Deal of the Year", recognizing it to be the first significant project finance contract concluded in Italy in 2005, demonstrating a technical-legal code of conduct adopted successively for other projects.
- **Euromoney Magazin** instead judged it the Project Finance Deal of the Year for the best project finance contract concluded in Europe in the healthcare sector, confirming the project's validity as well as the quality of the work of the parties involved.

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