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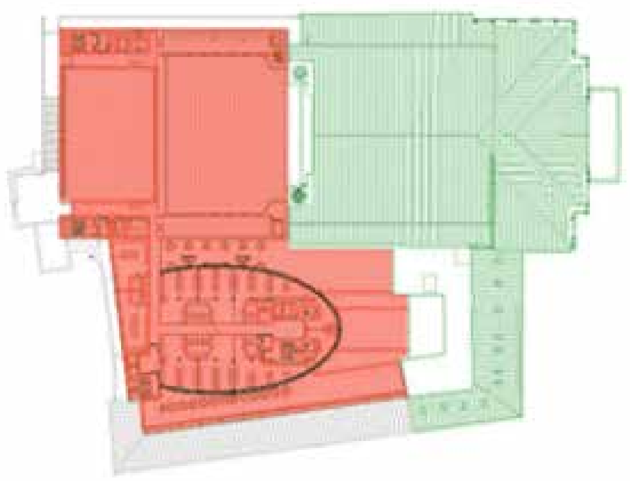
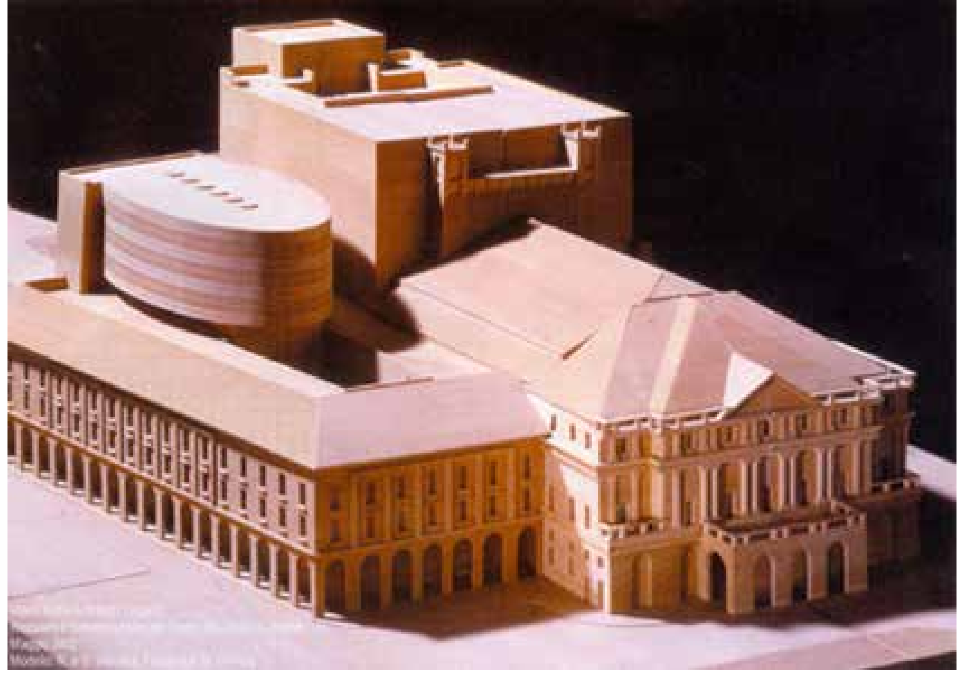
LA SCALA OPERA HOUSE

LA SCALA OPERA HOUSE / MILAN

With the design by the architect Mario Botta, La Scala in Milan is destined to become the largest opera house in Europe.

Mario Botta: "*I designed the body of the fly tower and the elliptical structure by simplifying the volumes as if they were technical towers, but with their own beneficial representation.* ***I designed them in Botticino stone, which will have and give a surrounding vibration.***"

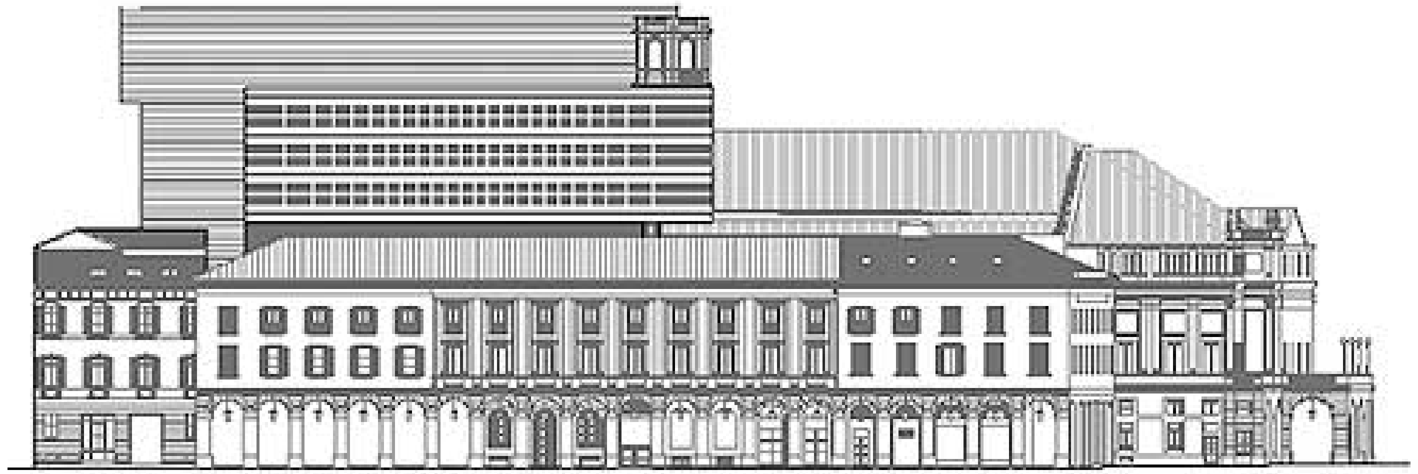
Location	Architectural design	Stone contractor
La Scala Opera House Milan	**Mario Botta** Lugano	**Team Ghirardi** Brescia

THE PROJECT

The work carried out on La Scala Opera House in Milan involved the preservation and restoration of the foyers, stage, auditorium, circles and boxes, and the refurbishment of the fly tower, offices and stage facilities, with the modernisation and adaptation of the structure and the technological equipment.

Two new structures were built, one in the shape of a parallelepiped and the other elliptical, leaving the original Piermarini design structure intact, which was only scheduled for preservation work.



Two main bodies shape the project:

THE ELLIPSOID

This building has been designed by the architect Botta, and contains administration departments, dressing rooms, rehearsal rooms for the orchestra, chorus and dancers.

The elliptical structure rests on the side of the building to the left of the facade.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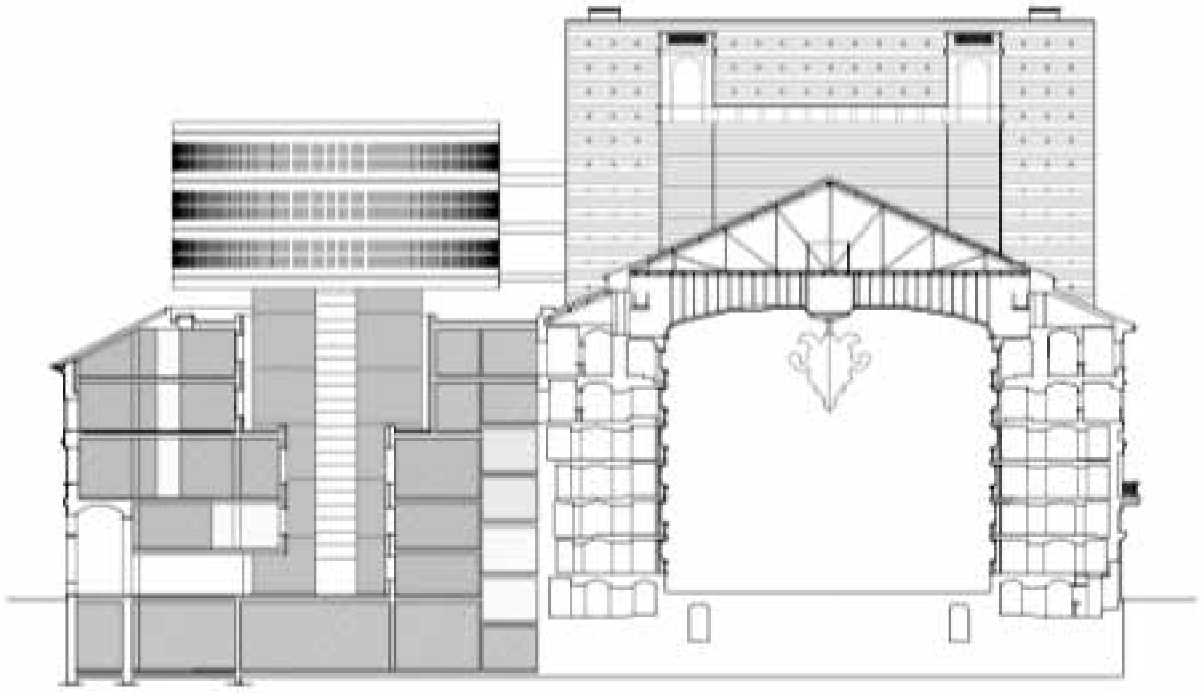
THE FLY TOWER

The fly tower is the heart of the theatre, where stage machinery and cutting-edge equipment required for shows, sets and lighting are situated.

With respect to the front of the original facade, the fly tower structure and the backstage structures, which are inscribed into a parallelepiped that is set back, have been raised.

The increase in height was necessary for technical stage requirements, with the creation of a double technical grid up to a height of 38 metres above ground level (the total measurement is 56 metres including the lower areas in the orchestra pit). Backstage areas contain six rehearsal rooms that reach the height of the tower roof itself.

The stage configuration can be changed even during performances, thanks to split platforms. The upper machinery has 80 hoist lines silently powered.

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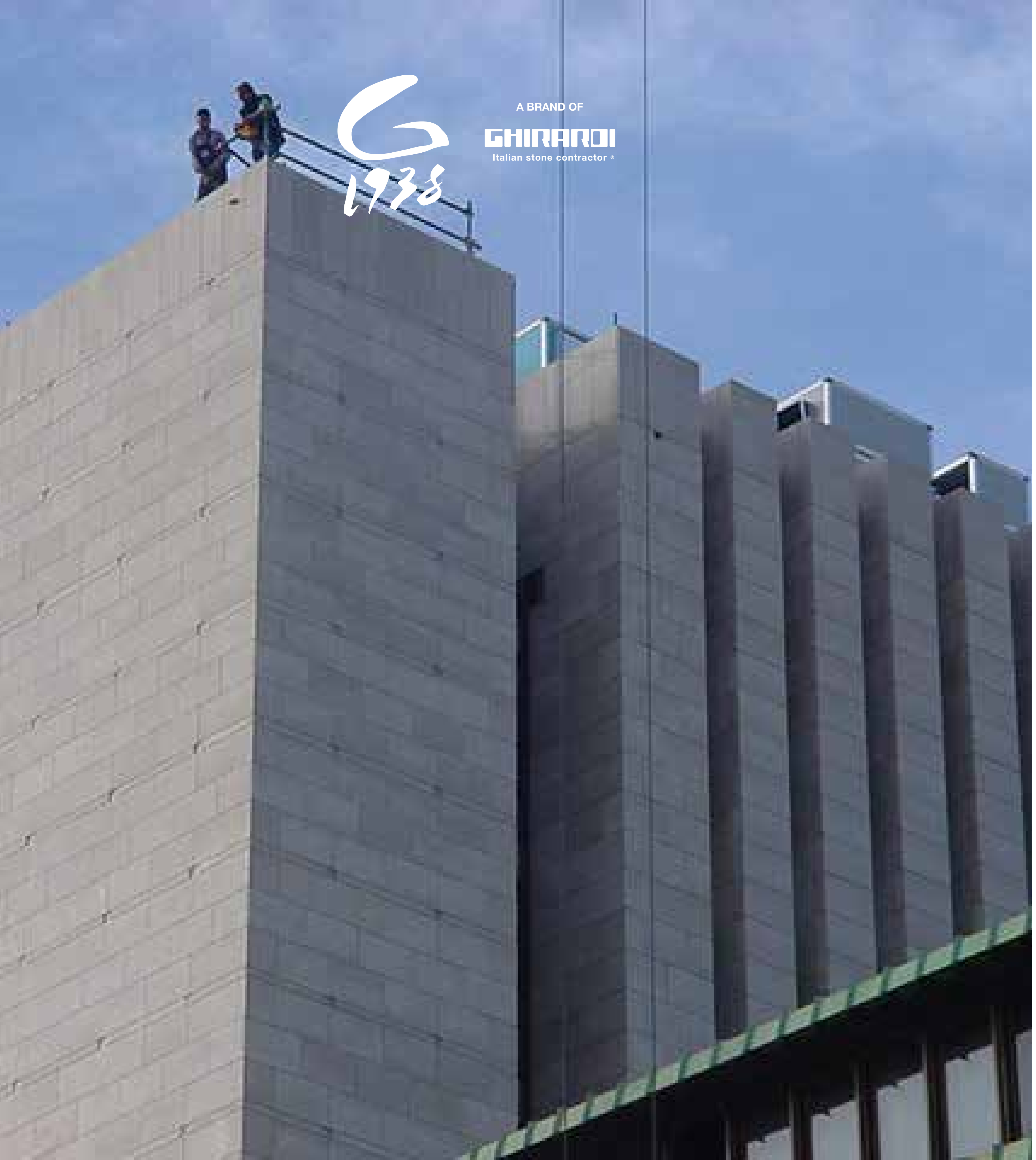

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USE OF MARBLE (TOWER)

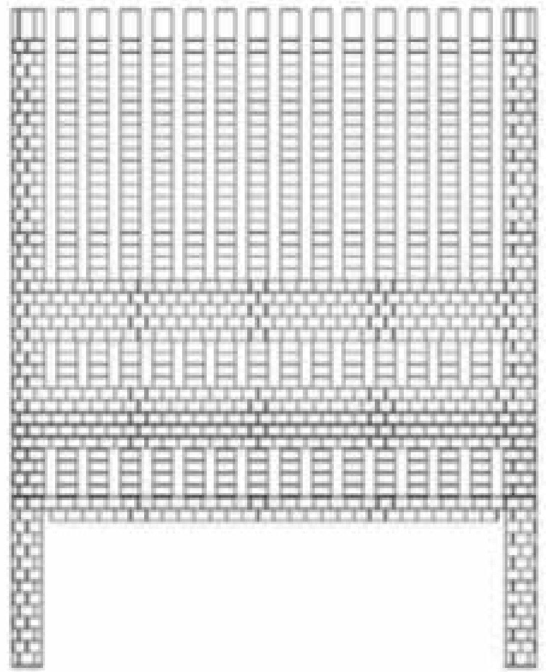
Ventilated cladding

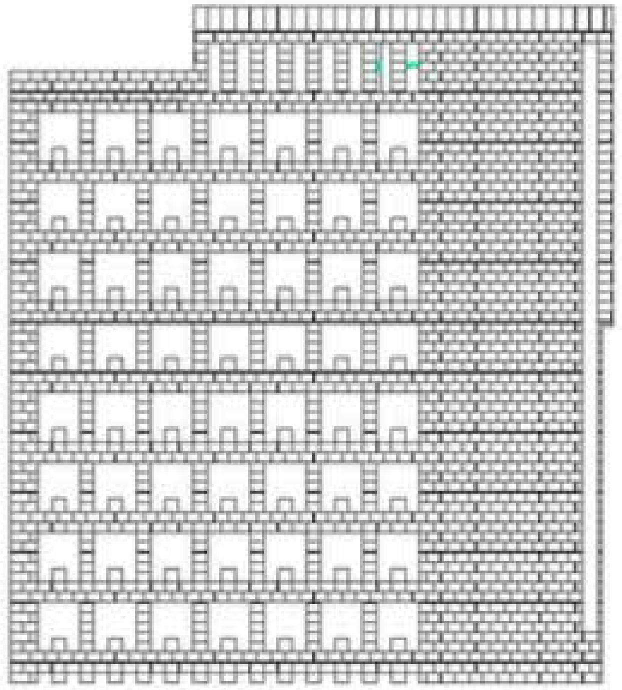
The external wall cladding is made of Botticino brushed stone 30 mm thick for a total of 5,000 m2 (amounting to approximately 13,000 pieces).

The panels have multiple dimensions depending on the facade, and are all secured with an effective joint of 10 mm.

A **ventilated system provides the fastening mechanism**.

Special parts were pre-assembled in the workshop for the numerous window openings, with a mechanical system with dual stainless steel support embedded in the upper and lower cavities, and approximately 1,600 lin.mts of **glued elements** and corresponding exposed eges with a brushed effect.





USE OF MARBLE (ELLIPSE)

Sunshade strips on the ellipsoid

The elliptical structure housing various theatre service departments has external cladding in brushed Botticino stone with 80x100 mm sections in varying lengths for a total of 6,500 lin.mts.

It acts as a sunshade, as the entire curved facade is made of continuous glazing.

The strips were pre-assembled on a metal curved structure with irregular radii following the curve of the ellipsoid.

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An **innovative fastening system** was used for the marble strips, based on concealed truncated cone inserts fastened at the back to the structure.

Special focus was placed on **checking the strips were secured satisfactorily**, as they hang on two anchoring points only. Stainless steel plates were therefore inserted on the sides that are not visible, with the function of reinforcing the full stone body, especially given the considerable lengths involved (up to 2,480 mm).

A **special machine** had to be constructed specifically to make the strips, in order to comply with the technical requirements and tight delivery timescales.

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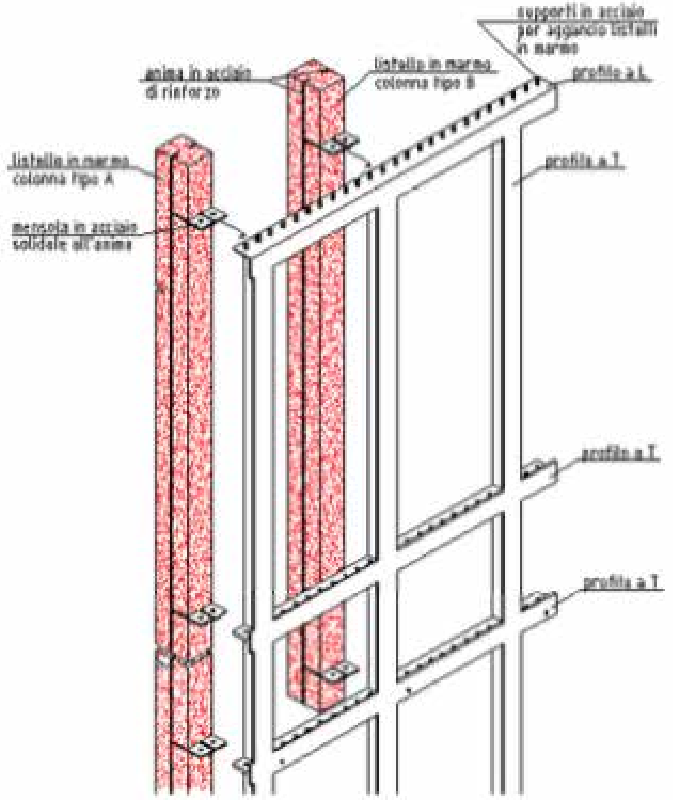
PRELIMINARY DESIGN OF THE FASTENING SYSTEM (ELLIPSE)



The strips were secured to the steel panels with a dual fastening technique on horizontal T profiles, drilled at each piece.

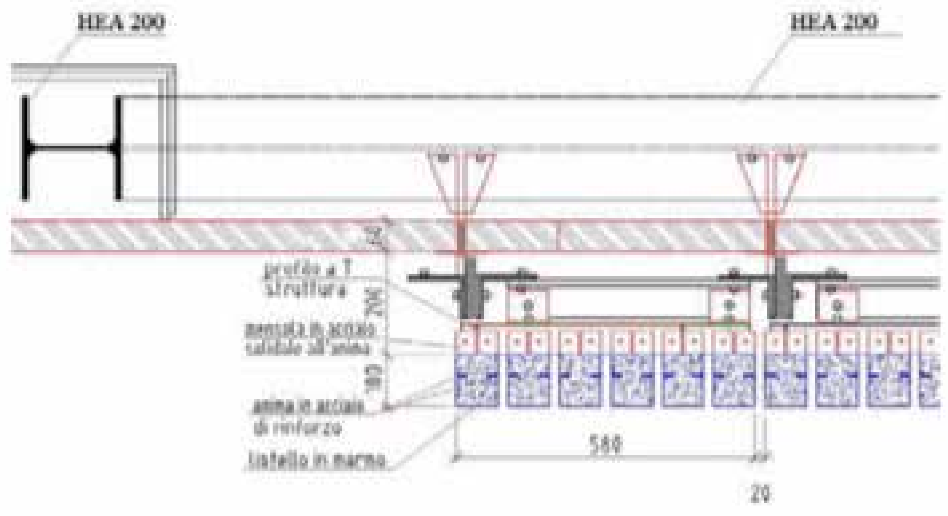
The supporting bracket is joined centrally and embedded in the side of the stone strip.

Continuous central notches were made in the sides of the marble, and 2 crosswise notches to accommodate the brackets.

The panel is adjusted using spacers and oval-shaped holes.

An alternative upper fastening system with pins and a lower system with screws and bolts is provided for the replacement of elements as necessary, so they can be removed from above, ensuring maximum strength.

The full metal panel follows the curve of the ellipse, and fastens to the building's steel structure (edge floor beams).



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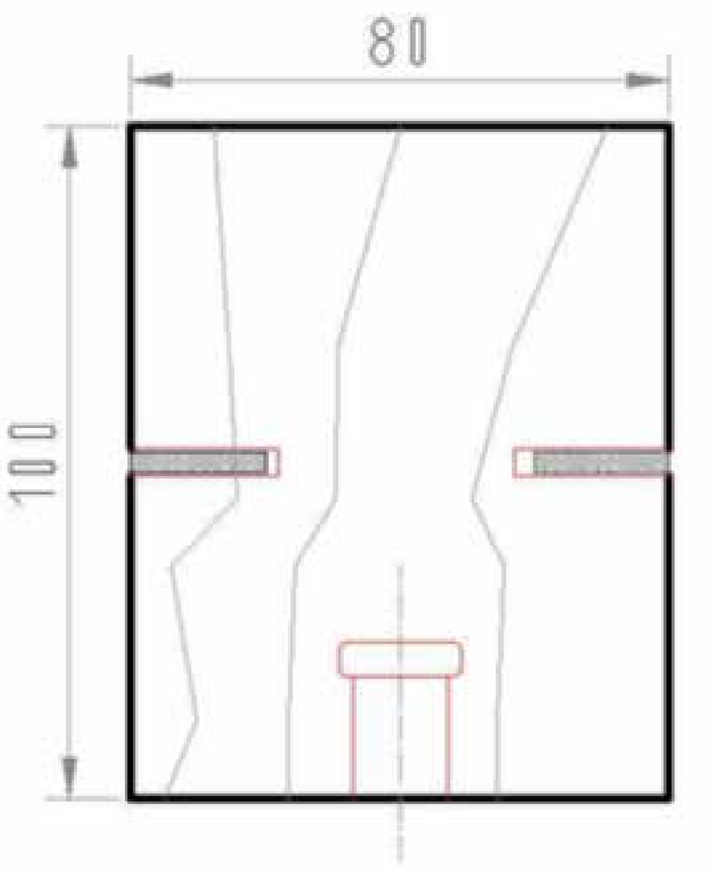
GEOLOGICAL ANALYSIS ON THE USE OF THE SLATS (ELLIPSE)

Botticino stone was chosen to cover the elliptical building in the restoration and refurbishment project for La Scala in Milan.

The elements used are sections measuring 80x100 mm of varying length between 320 and 2,480 mm, reinforced with steel plates and fastened to a metal substructure.

The individual elements have to withstand shear stress. The material was chosen considering its resistance to bending.



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The raw material is extracted such that the length of the elements is kept parallel to the natural orientation of the material, identifying it with a sufficiently precise angle in the source used.

It is worked and installed such that the stress release surfaces are vertical and perpendicular to the surface of the elliptical body. As a result, any weak surfaces highlighted by annual cycles of cold/heat will not cause particular issues in the event of elements fracturing.

Tear resistance tests were carried out in specialist laboratories and gave reassuring results (tear resistance 16,000 N).

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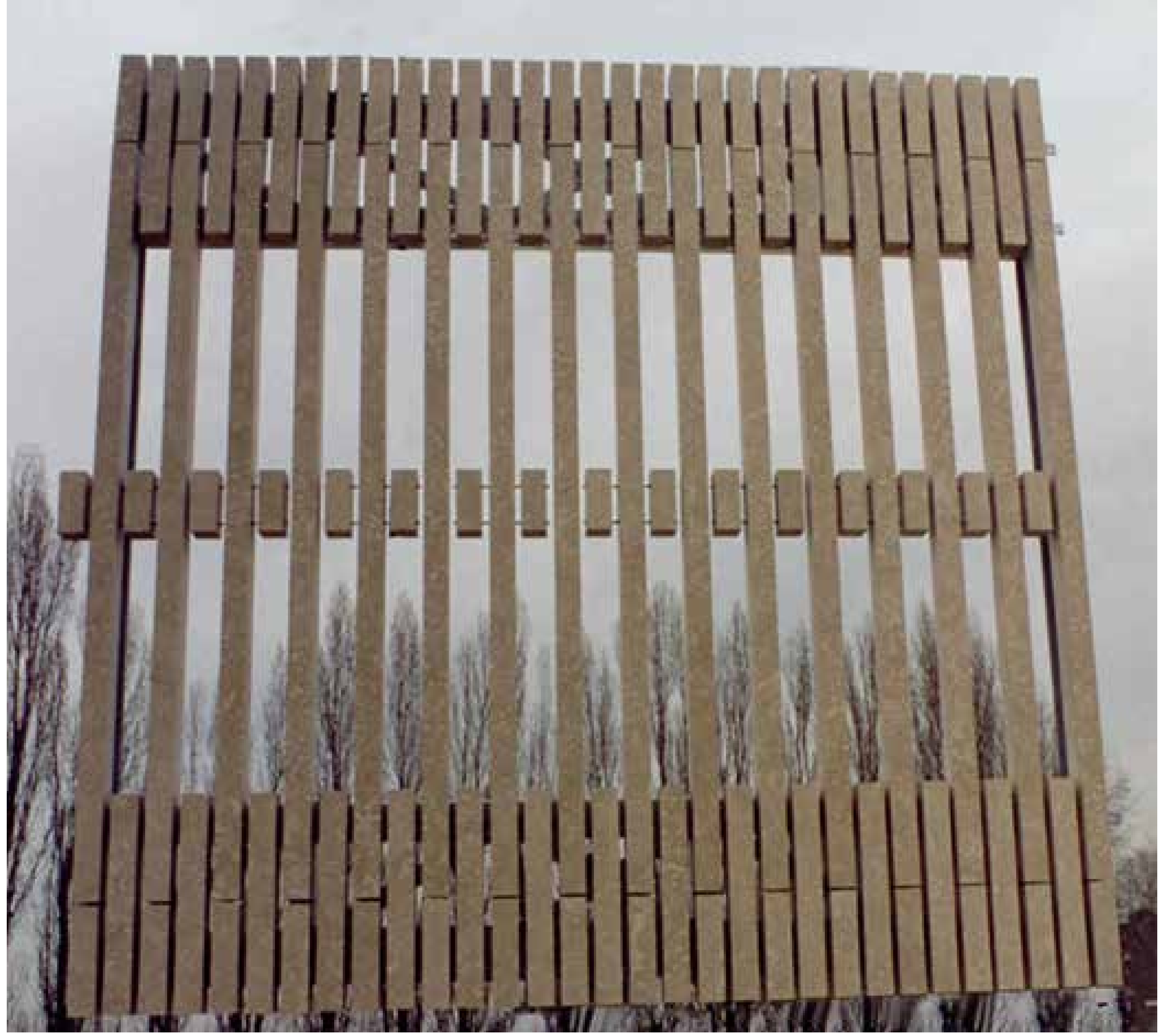
SUNSHADE SAMPLE
(ELLIPSE)

A set of full-scale samples were made before work implementation, which were tested at Marmi Ghirardi workshop to anticipate the final effect.

An entire sunshade panel secured to the metal structure was moved using a bridge crane, in order to observe it from various perspectives and appreciate the surface finish.

The creation of such a mock up work made it possible to verify the feasibility of the unique and innovative design and optimise production methods.

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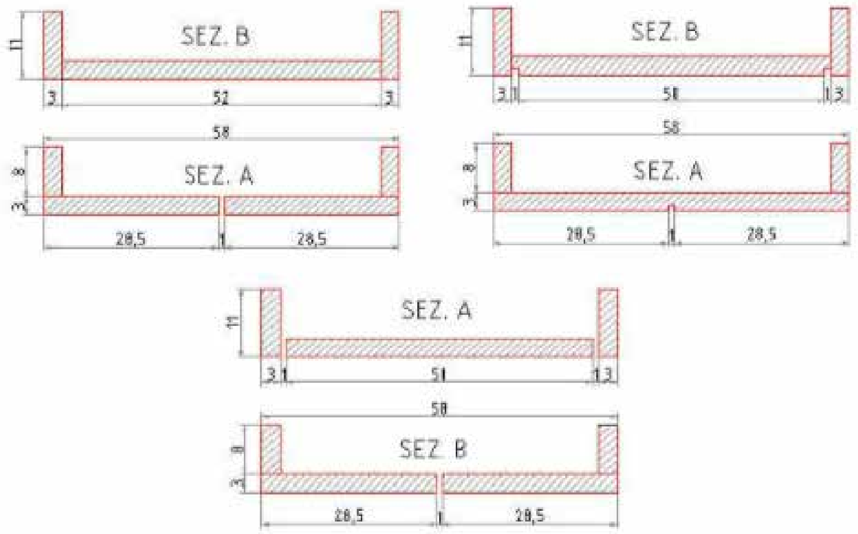
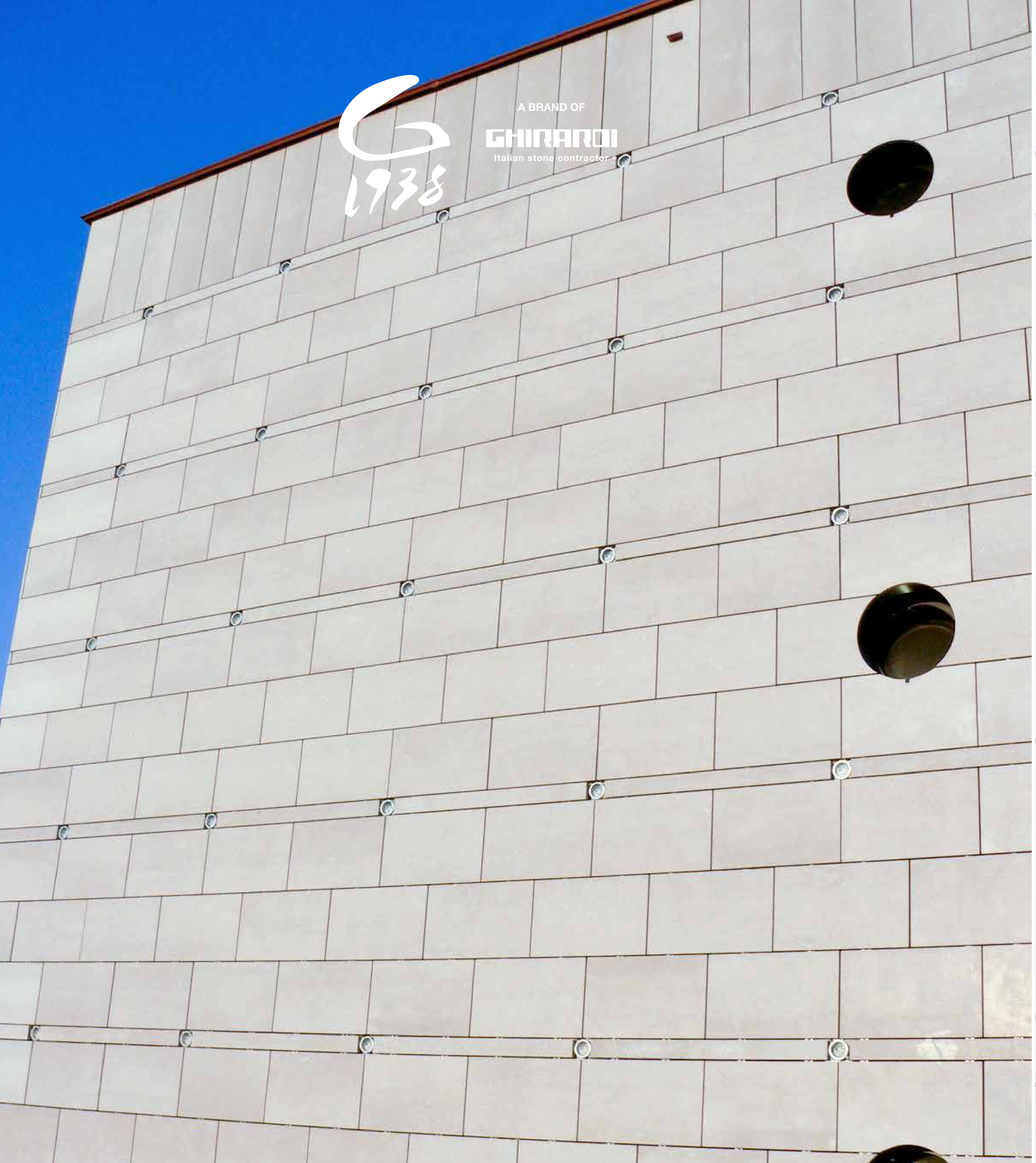


CLADDING SAMPLES
(TOWER)

Various samples were made to see the general aesthetics and the type of surface produced.

A panel with 30 mm ventilated cladding was set up, in addition to a column for selecting the alignment of joints and the various solutions for the pre-assembly of the corner pieces.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PRODUCTION (ELLIPSE)

The architectural design of the strips, produced in exceptional quantities with superb characteristics, required the design and construction of a customised machine for this project.

There were no machines on the market that could perform the operations required. These included horizontal surface calibration (for a standard thickness), surfaces brushed as required by the designers, the implementation of feed-through cuts (for the insertion of stainless steel plates by means of special resins), vertical edge calibration (to remove excess resins and clean the exposed surface), and the cutting of various pieces according to the required measurements.

Truncated cone holes were used to **support the strips**. These required a circular hole to be made and countersunk to the necessary depth in the marble element, to which the insert was then fastened. This system enables a high load capacity.

To move the elements measuring more than 3,000 mm long, special suckers were designed.

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PRODUCTION (TOWER)

Pre-assembly and special parts

There are pre-assembled elements measuring 1,500 lin.mts at the glazed openings, and ceiling and wall angles.

Aside from the edges adjacent to the slabs, bonding is implemented with a mechanical system consisting of stainless steel L-bars inserted in upper and lower notches on the marble cladding and embedded in the adhesive.

Special pre-finished parts were made for the circular openings and wall light fittings.

ASSEMBLY (ELLIPSE)

The marble strips are secured to the metal panels that follow the irregular curvature of the ellipsoid perimeter. The fastening system consists of special truncated cone holes that house stainless steel inserts.

The inserts are held using screws, and the stone element then secured to the panel plate. The marble/panelled body was fully pre-assembled in an off-site area away from the centre.

The complete marble structure was installed on site using special cranes at night, to facilitate the transport of large complete elements in the centre of Milan.




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ASSEMBLY (TOWER)

A ventilated installation method was used.

Elements were fastened to the reinforced concrete walls using spacers supporting vertical runners not adhering to the wall.

The runners contain a groove where the marble support brackets slide along.

A single-point anchoring method was used, and horizontal notches were made in the upper and lower edges of the marble slabs for the insertion of metal pins (with plastic covers to extend the contact surface) to facilitate installation.

Rock wool insulation has been installed on the surface of the building in the cavity between the reinforced concrete wall and the marble, without being in direct contact with the stone surface.


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