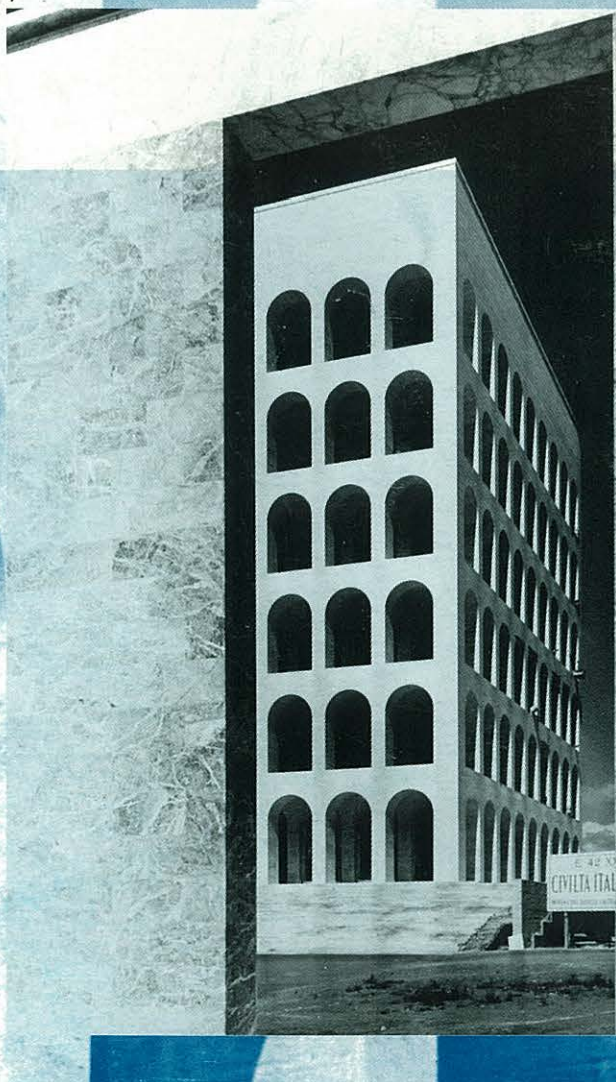
do.co.mo.mo

international working party for
documentation and conservation
of buildings, sites and neighbourhoods of the
modern movement

Stone in Modern Buildings

Principles of Cladding

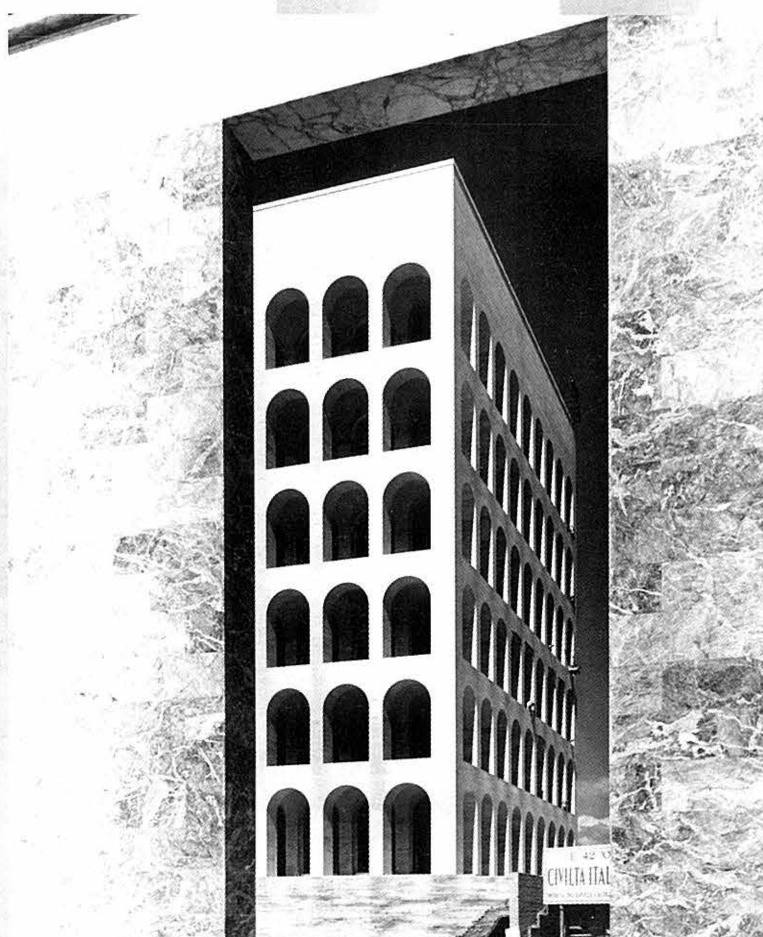


preservation technology
dossier 6
april 2003

international working party for
documentation and conservation
of buildings, sites and neighbourhoods of the
modern movement

Stone in Modern Buildings

Principles of Cladding



preservation technology
dossier 6
april 2003

Colophon

Stone in Modern Buildings
Principles of Cladding
Proceedings of the Sixth International DOCOMOMO Seminar
November 30, 2001, Rome, Italy

Sixth International DOCOMOMO Seminar
November 30, 2001
Sala Quaroni, EUR SpA Headquarters, Rome, Italy
December 1, 2001
Mariotti SpA Travertine quarries, Tivoli (Rome), Italy

Editors
Maristella Casciato (DOCOMOMO International)
Cristiana Marcosano Dell'Erba (DOCOMOMO Italia)
Rosalia Vittorini (DOCOMOMO Italia)
Ola Wedebrunn (ISC/T)

Translations
Simon Turner
Orietta L'Abbate Clifford

Editing assistance
Barbara McGilvray

Graphic Design
Marco Biuzzi, Rome

Original cover design
Kees Ruyter, Amsterdam

Printing
O.GRA.RO. SrL, Rome
april 2003

ISBN
2-9519819-0-2

Cover photographs
Palazzo della Civiltà Italiana, [1940] Photo Vasari
(Archive Giovanni Guerrini, Rome)
In the background:
Palazzo della Civiltà Italiana, [1940] Photo Cartoni
(Archivio Centrale dello Stato, Rome)

The editors have endeavoured to check all photo credits. If a photo credit is found incorrect or incomplete, please contact the DOCOMOMO International Secretariat.

Sterring Committee
Pier Giovanni Bardelli
Maria Luisa Barelli
Liliana Bazzanella
Maristella Casciato
Luciano Cupelloni
Cristiana Marcosano Dell'Erba
Caterina Mele
Sergio Poretti
Rosalia Vittorini
Ola Wedebrunn

Organisation
- DOCOMOMO Italia onlus
- DOCOMOMO International Specialist Committee on Technology (ISC/T)
- Department of Civil Engineering, Università di Roma Tor Vergata
- School of Engineering and School of Architecture, Politecnico di Torino

In cooperation with
- EUR SpA
- Mariotti SpA
- Assomarmi

DOCOMOMO Italia Executive Committee
Maristella Casciato (secretary)
Luciano Cupelloni
Margherita Guccione
Cristiana Marcosano Dell'Erba
Giorgio Muratore
Sergio Poretti (president)
Luca Veresani (treasurer)

The editors wish to thank EUR SpA for the generous support. Special thank to Raffaele Ranucci, Paolo Novi, Carlo Bertilaccio, Paola Pederiva and Francesco Innamorati. We also acknowledge the collaboration of Luciano Cardellicchio and Marzia Marandola (Università di Tor Vergata).

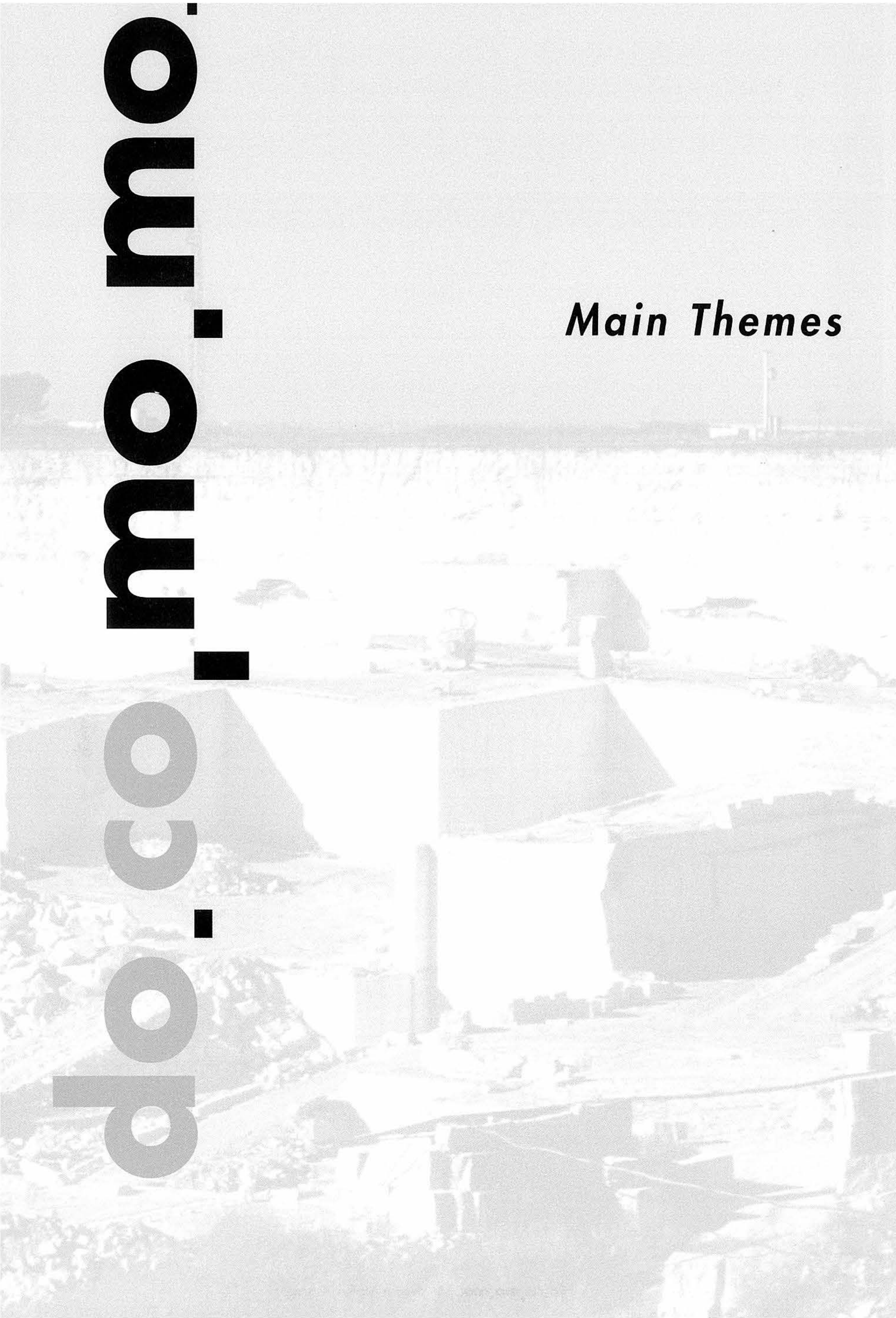
do.co.mo.mo_

Contents

Cladding: an International Conference in Rome

Why a conference on stone cladding, a solution that seems anachronistic at a time when we have an explosion of cladding in steel, zinc and titanium, cladding with grids and cladding with screens – and even more so after our infatuation with the curtain wall? Perhaps simply because we have never stopped believing that architecture is, first and foremost, an expression of *firmitas*, and that stone, whether squared or cut in slabs, rough or smooth, leached and corroded or modelled and sculpted, conjures up the very origins of building.
Why a conference in Rome, among the marble-clad buildings of EUR and on the subject of cladding which was one of the most controversial for modern architects of the 20th century? Surely because the spirit of Romanness, which owes much to the message of durability and strength inherent in the classical architecture of imperial Rome, has fully expressed its immortality through the noble material in the form of slabs, facings or fragments of various kinds which have been used to mask its imposing structures. Whether the cladding was in large blocks, which in fact are self-supporting, or cut in thin slabs (from the Augustan age onwards) which allowed highly refined decoration to be carried out, it had symbolic value and carried a message of power. Today Rome is still a city of stone and its genius loci has the dignity of those materials imprinted on its marble structures.
But not only Rome: the quarries of Tuscany, Piedmont, the Veneto and other regions as well as those of the Roman hinterland have provided modern architects all over the world with their precious materials.
Again, why a conference on the restoration of stone cladding in modern buildings? There is no doubt that one of the most typical areas of debate for 20th-century architects, who recognised cladding as an intrinsic element of architecture, was the composition of the facings, the finishing of the slabs, the design of the joints and the effect of the veining. To lose the subtleties of that speculation and inquiry would be like denying the very meaning of architecture.
The speakers in the Quaroni Room at the Palazzo degli Uffici in EUR did not talk about cladding simply as ornamentation, or about Loos's "principle of cladding"; instead they addressed the themes of extraction and work at the quarry site and analysed project documentation and problems of fixing and anchoring.
As the images flowed, what stood out were the marbles, whose polished beauty was as much a metaphor of a different kind in 1930s Italy as it was an aesthetic emblem. "Italy, with its wealth of natural stones, is in the fortunate position of being able to provide its modern architects with the right solution to the problem of the vast bare walls which an accurate interpretation of modern architecture requires in our buildings…", wrote Terragni in "*Marbles*" (1938). "In this *Casa del Fascio*, the special qualities and possibilities of that material are pushed to their maximum… Architects from other countries who visit our buildings have often remarked on the extensive use we Italians make of marble; once acquainted with the cost of this material… they realise the advantage we have in being able to use such an excellent and elegant surface covering".
The conference, which took place over two days, was attended by a large number of Italian professionals, scholars and teachers as well as a sizeable group of students, and by many international experts. On the first day, devoted entirely to the presentation of papers, the topics were divided into two parallel streams: the opening talks addressed the historical origins of cladding, the myth of cladding as a cipher for modernism, chemical and physical changes in cladding, and technologies employed in modern building. Next there was extensive analysis of case studies in Italy and elsewhere which illustrated cladding solutions, together with the successes and failures of the relative restoration projects, covering half a century from the first decade of the 1900s to the 'sixties. This generated a lively debate.
On the second day the participants moved to Tivoli; here they were able to watch the centuries-old procedures followed in the travertine quarries, where the stone is measured, cut, shaped and finished using machines alongside human craft skills and knowledge. And then, last but not least, there was the majestic architecture of Hadrian's villa which presents cladding in buildings of extraordinary power.

Maristella Casciato
Chair, DOCOMOMO International



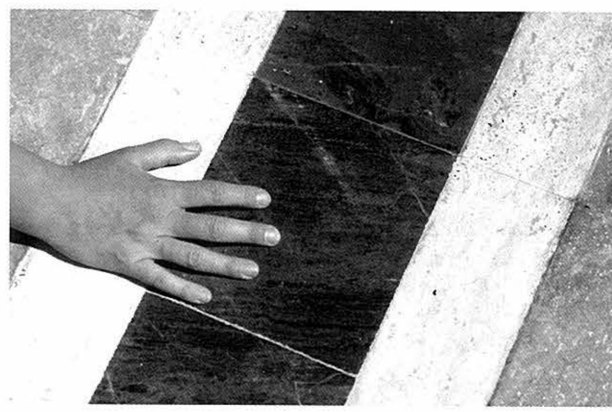
Main Themes

Experiencing Stone, Structure and Cladding

It is hard, heavy, unyielding, motionless within its boundaries: yet the individual's experience of stone might be soft, light and obedient.
Impressions of volume, surface, pattern, colour, and light reflection enrich the effect of materials. Touch and see the stones – as when you hear the echoing of stone slabs as you walk in a narrow alley; stone might even appear tasty. Thus from varied experience we learn to appreciate stone as having different characteristics: granite, sandstone, marble.

Ola Wedebrunn

Through the experience of character we even discover the meaning of the material. The meaning of stone might be monumental and solemn. In this respect stone and modernity seem to be a contradiction: stone as an age-old material and modernity as contemporary constructions looking toward the future. Nevertheless, when experiencing the stone of modern buildings there is no doubt that the interaction of immediate sensations of stone and technology make sense, and so stone is an important material in Modern Movement architecture.



Touch stone! Moschea in Rome, Paolo Portoghesi
Photo: Ola Wedebrunn

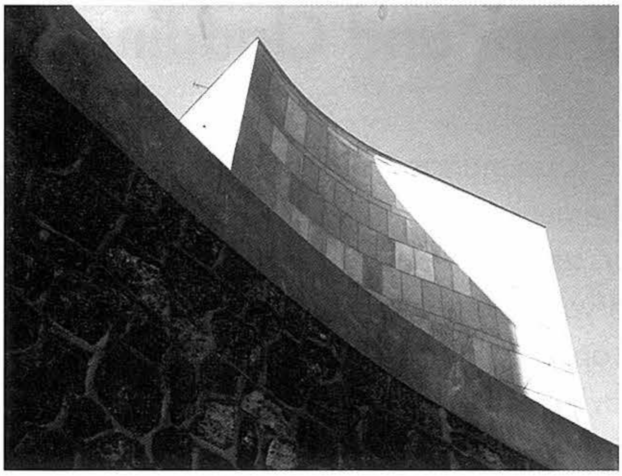
Surface and colour

Touching stone with your hand tells you about the treatment of the surface – and there are considerable differences. A stone split directly from the rock is rough; often it even reveals an individual identity characterized by a confident expression. As the mason encounters the stone, working with surface and volume, the stone changes in appearance. Split, pointed, chiselled, honed or polished, the work reveals a range of experiences, silent and unwritten. Persistent work with the stone becomes a dialogue with the material. Experiencing stone through the hands, with tools, instruments, machines, cuts, strokes, and with the mind establishes an outline of production and begins a continuous tale of light, texture and weathering.

In their 1931 book *The International Style*, architectural historian Henry Russell-Hitchcock and architect Philip Johnson describe their preferred surface as "a continuous even covering", believing that a rough surface would blunt the perception of the volume of a building and be likely to suggest mass. Although their ideal is a surface covering all of the building, they recognise stone slabs as a surfacing material: "As in the architecture of the past, the finest materials for wall surfacing are stones, granites and marbles. Unless they are large in area, however, the separate units are likely to appear like the faces of blocks of masonry, suggesting weight and mass."

Even Le Corbusier embraces stone as a material of modern buildings, not least by stressing contrasts in materials, as in the masonry of split rocks contrasted with smooth plaster surfaces in the Mme Mandrot house in Toulon.
In the Swiss Pavilion in Paris, Le Corbusier refines the diversity of scale in contrast by using split rocks as wall covering for the lower wing, and rectangular tiles of smooth cut stone to cover the higher main building. Finally, rocks distributed around the grounds seem to emphasise the transition from natural rock to the smooth machine-cut slabs of the main building. Thus the scale of varying treatment of the stone becomes an important expression of surface and volume.

The change from craft to industrialised machine work



Detail from Swiss Pavilion in Paris, Le Corbusier.
Photo: Ola Wedebrunn

The metamorphosis of water turning to stone is a main theme of the Fontana di Trevi in Rome, constructed by Nicola Salvi, 1732-51. Running water animates stone, figures, and the geometry of ornaments as lifecycle elements, becoming still in the sedimentary basin to mirror rocks, sculpture and architecture. Contrast of process becomes a sliding scale of conditions as well as a scale of contrasts. Photo: Ola Wedebrunn

could be explained technically, in terms of stereometry, as suppressing ornamentation and volumetric sculpturing of stone. Instead, the character of colour and the treatment of surface become the aesthetic expression of the material. Hence for those educated at the Bauhaus school in Weimar and Dessau, where the ability to experience, analyse, and synthesise material qualities were primary skills to be learned, the experience of matter in terms of contrast and scale was of central importance.

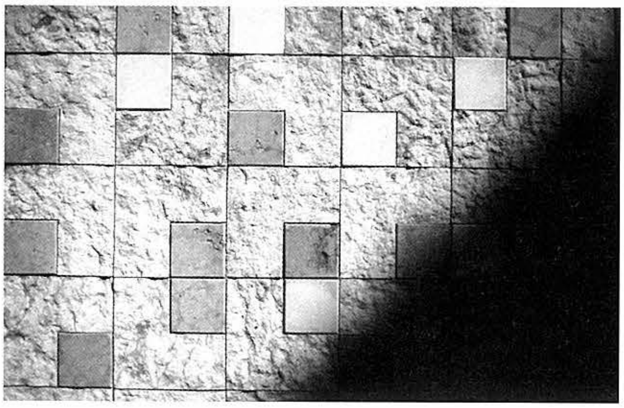
Inspiration was found in natural science and in oriental philosophy and was related to the technology of modern production rather than to traditional craft.

The meaning of stone

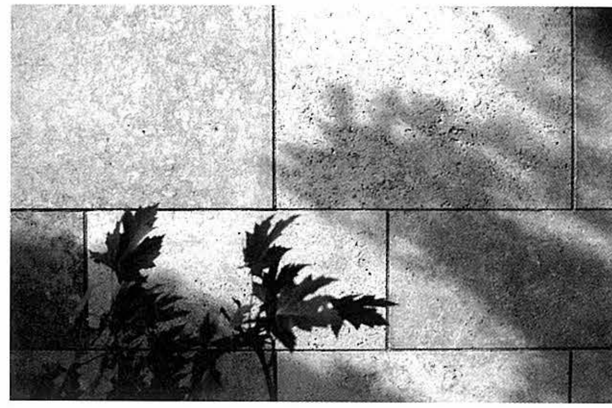
Meaning is often connected with the origin of the material. When it comes to stone, the origins go back to many sources, geographical and historical as well as physical.

Every stone in itself might be considered a testimony

The use of differently-treated travertines displays a contrast of expression and emphasises the quality of the material. Detail from Casa Il Girasole in Rome, Luigi Moretti, 1950. Photo: Ola Wedebrunn



A more recent masterpiece signifying the experience of contrast in stone surface is Carlo Scarpa's combination of the rough and polished 'Pietra Verona' at Castelvecchio in Verona.
Photo: Ola Wedebrunn



Danish chalk stone cladding. Photo: Ola Wedebrunn

of production and time: a granite is volcanic in origin, limestone is a sediment of the ocean. Thus the way in which stone is conceived will affect its character in terms of the direction and density of sedimentary horizontal layers, for example, or more homogeneous layers with no direction.
As a fragment of the rock, stone is a holistic fragment of our planet in its geography, history and physical mechanics. In the Nineteenth - century, the testimony discovered through stone led to a battle about geological history between the scholars who believed the origin of stone and the earth was melting lava – Vulcanists – and those who believed the geological origin was to be found in the sediments of the sea – Neptunists. No matter which side you choose, stone remains a testimony to mechanics and represents a metamorphosis of organic as well as mineral origin. Human history proceeds and may even turn the conception of time itself around. Where history and time cease, stone signifies continuity; no wonder stone has become significant for monumentality.

Egyptian architecture is considered the epitome of stone construction, and we believe classical architecture is the transformation of wood into a monumental stone construction. A similar experience is possible even in modern building: for example the wooden Lenin Mausoleum in Moscow was eventually rebuilt as a red granite construction.

Alvar Aalto used the marble of Carrara for the cladding of Finlandia Hall in Helsinki and for the Museum of Art in Aalborg in Denmark as a sign and symbol of classical beauty and virtue. He also used it in parts of two buildings at the University of Technology in Esbo, the library and the Department of Architecture, in both cases using marble as a reference to a classical humanist tradition. However at the University of Jyväskylä, built in 1951-71, Aalto has used granite of a very light colour in combination with red brick for the meeting room of the university board, a building that seems archaically stylised.

Very often the choice of stone is motivated by economic factors. Thus the Danish Prime Minister Thorvald Stauning explicitly asked for several official buildings in the 1930s to be clad with marble from Greenland.
Danish chalk stone became an important material for cladding on many buildings from the thirties in Denmark. It was a suitable home-grown alternative to travertine, bright and durable, not without a certain dignity and pride.

Stones of Venice

Venetian architecture has a long tradition of beautiful stone claddings, from oriental and Byzantine inspiration to the Romanesque work of the Lombardo family.
In the book *The Stones of Venice* the 19th-century English artist John Ruskin, an admirer of Venetian architecture, argues in favour of the virtue of traditional stone constructions.
Ruskin's view of stone masonry, opposed to modern technology, rejected extensive use of iron and cement. Still, the way he depicted stone in drawings, words and watercolours reveals an experienced sensitivity that is modern in character. His appreciation of Venetian stone thus indicates a valuable experience in stone structure as well as cladding.
The Stones of Venice remain an inspiration.

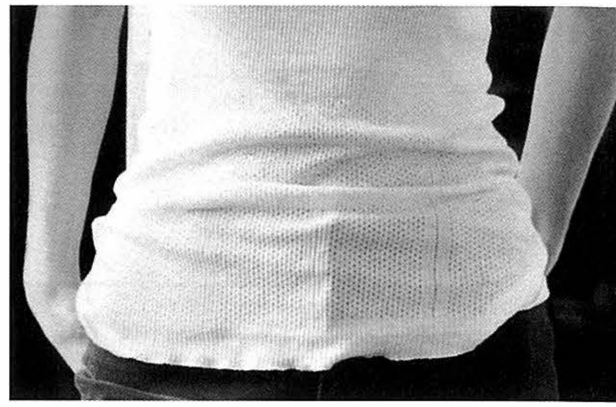
Just as the acoustics of a Viennese waltz are reflected in St. Marco's stone-clad façade, the pioneers of modern Austrian architecture seem to have been influenced by the stones of Venice[1]. The Austrian architect Adolf Loos, as the son of a stone-mason, grew up in close contact with the wordless experiences of materials and craftsmanship. Venice was not only the Mediterranean resort closest to Austria, it was actually part of that country from the Napoleonic wars until 1866. Loos discovered the modern pleasures of Venice during a summer holiday at the Lido in 1913. Even without written sources it was certainly possible for the inspiration of Venice's stones to be reflected in Loos´ work and in modern stone buildings.

Principles of Cladding

Like Ruskin, Loos appreciates material for what it is. It is as if the experience of material enables him to free matter from ornament and conventional meaning. When it comes to symbolic value however he returns to tradition, using classical Doric columns. At Looshaus on Michaelerplatz in Vienna, built in 1910, monolithic load-bearing stone columns of green Cipollino marble from Euböa are erected with the lines in the marble raised vertically[2].
Often stone cladding is used as a conscious choice in Loos interiors, precisely for its colour and texture as a lining material. Materials such as stone and wood enter the space to dress the structure of architecture. When it comes to stone in modern buildings, the Barcelona pavilion by Mies van der Rohe must unquestionably be seen as the most central in importance. The Italian architect Benedetto Gravagnuolo puts the pavilion in the tradition of Loos, as a silent minimal experience of architecture, as the expression of matter. It shows a vast podium covered by travertine, walls of onyx from Algeria, green marble from Belgium, dark green marble from the Greek island of Timos, smoke coloured and opalescent glass, chrome columns, red velvet curtains and white leather seats. The Barcelona pavilion must be considered a true Modern Movement masterpiece of stone and space.

Structure and Cladding. Model and Garment

Modern concrete and steel construction challenges the classical understanding of horizontally load-carrying wall constructions of stone laid upon stone. Mainly we could say that reinforced concrete has changed our perception of gravity and space in constructions. As structure becomes continuous, it rests in its own centre of gravity independent of any foundation. Thus the cladding of a structure even increases its independence of gravity.
As the cover doesn't need to be part of the structural system of the building, its dimensions can be minimal.



"Model" Dress. Photo: Detail from *NU, Nordic Art Review*

Instead of taking weight, stones as cladding have to deliver weight to the structure, like a dress or a cloak swept around a model.
Changing from an integrated part of the structure into an independent cladding, the façade becomes the dress of the building. Like thread in the fabric of a dress, the geometry of tiles and joints makes the cladding[3]. By combining with new technology stone cladding, like a new fabric, becomes a modern building material.
As the structure of gravity is different from the structure of cladding, cladding is a construction in itself. Tiles and joints are the elements in the fabric of the cladding just as cloth is in a garment. Thus the cladding is not necessarily dependent on the same effects as the structure of gravity.

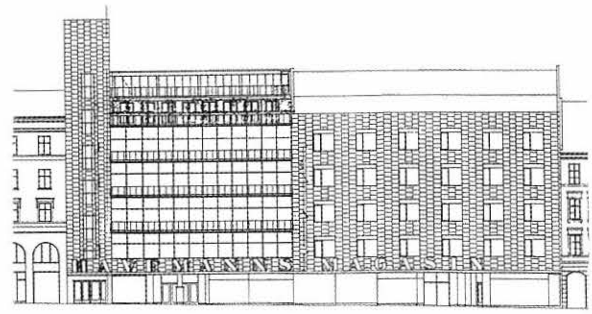
Prinzip der Bekleidung: Pattern and Structure

In the article called *Principles of Cladding*, Adolf Loos writes: "Ein jedes material hat seine eigene formensprache, und kein material kann die formen eines anderen materials für sich in anspruch nehmen." He attributes the principles of cladding to Gottfried Semper, but goes further to define "Das Gesetz der Bekleidung": "Die möglichkeit, das bekleidete material mit der bekleidung verwechseln zu können, soll auf alle fälle ausgeschlossen sein."
Seen in relation to the principles of cladding, this means that as long as the cladding is not mistaken for the structure there is no deceit in cladding the structure. The principle might also be expressed as Henry-Russell Hitchcock and Philip Johnson´s recommendation to "use plates so that their true character of sheathing is evident" and large areas of stone slabs to express surface. Hitchcock and Johnson stress the importance of not confusing the expression of stone cladding with load-bearing constructions by using small-sized stones suggesting mass and weight. Thus when it comes to experiencing stone in modern

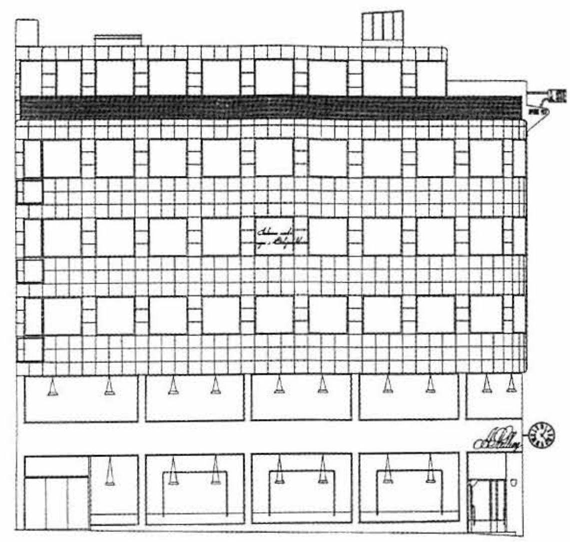
buildings, it is worth considering what Loos, Hitchcock and Johnson, for example, have written.

The size of the tiles and also the geometry of the cladding distribution are important for the experience of the façade. There are many different ways to arrange cladding. The geometry and size of the tiles and the pattern of the bond are important expressions of the façade.
Vertical rectangular tiles distributed with continuing horizontal joints, horizontally laid rectangles and continuous vertical joints, or square tiles where horizontal as well as vertical joints are continuous could all be regarded as expressing volume rather than mass, emphasising cladding as a cover of the supporting construction.

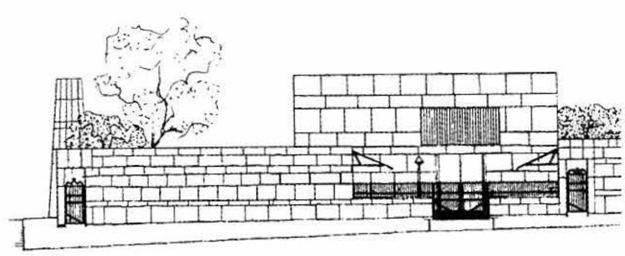
A study of historical references and theories can assist understanding, especially when references to single buildings are available. But still nothing can replace the experience of standing before the building itself.



Tiles of horizontal rectangular shape and continuing vertical joints at Havemann's Magasin in Copenhagen, architects Henning Ortmann and V. Berner Nielsen, 1938. Drawing: Ortmann and Berner Nielsen



Square tiles with continuous horizontal as well as vertical joints, Stelling House in Copenhagen, architect Arne Jacobsen, 1937. Drawing: Arne Jacobsen



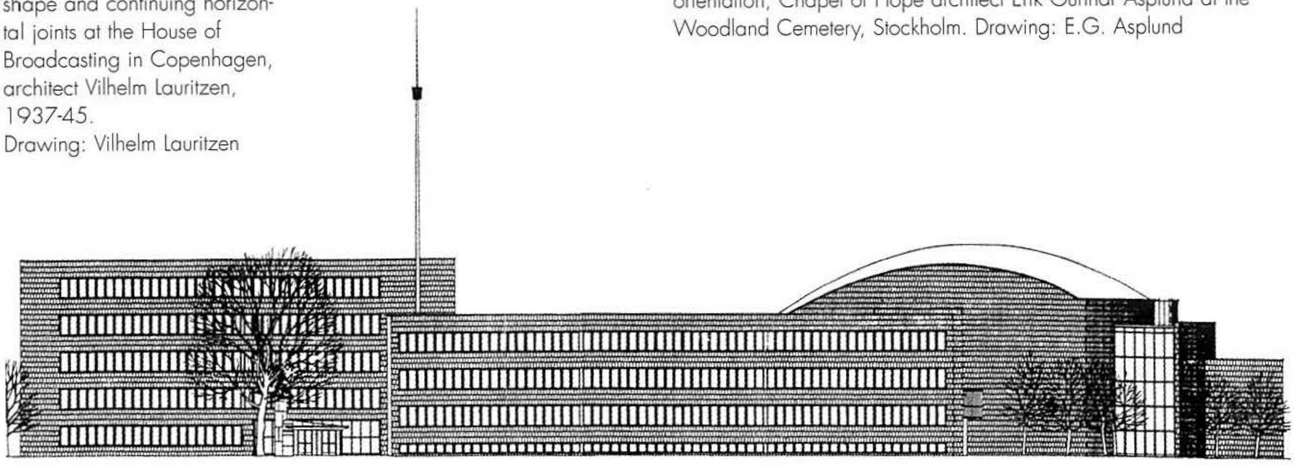
Asymmetric distribution of cladding gives a façade surface free from orientation, Chapel of Hope architect Erik Gunnar Asplund at the Woodland Cemetery, Stockholm. Drawing: E.G. Asplund

Sources

Henry-Russell Hitchcock and Philip Johnson, *The International Style*, 1932
Adolf Loos, *Prinzip der Bekleidung*, 1898
John Ruskin, *The Stones of Venice*, 1851

Notes

1. Otto Wagner Postsparkasse in Vienna or Joseph Hoffmann's Palais Stoclet in Brussels.
2. Gravagnuolo Benedetto, *Adolf Loos*, London 1995.
3. As early as the 19th century the German architect Gottfried Semper described cloth as the origin of architecture and weaving as the origin of technology.



Tiles of vertical rectangular shape and continuing horizontal joints at the House of Broadcasting in Copenhagen, architect Vilhelm Lauritzen, 1937-45.
Drawing: Vilhelm Lauritzen

Marble Sheeting in Modern Architecture

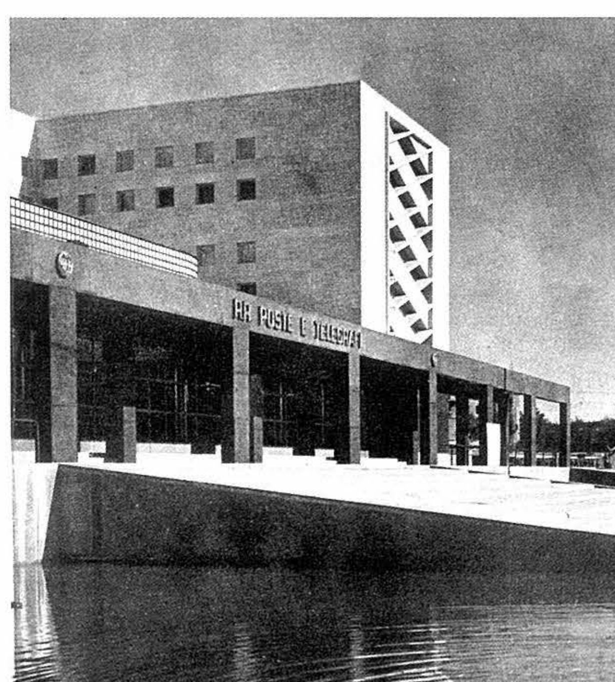
What role does marble slab facing play in modern building construction and architecture? Taking as a comparison the experimentation conducted in *fin de siècle* Vienna, the essay considers the key role of marble sheeting in Italian architecture during the 1930s in relation to the technical considerations which characterised the contentious passage from the traditional marble stonework to the thin marble slab covering of modern technology.

Sergio Poretti

Viennese wall coverings and Italian veneers

What is the role of marble cladding in modern architecture?
Certainly it is not among the more orthodox architectonic forms in the works produced by European rationalism or organic architecture. Indeed, the latter is based on structures built on a frame with the consequent disappearance – or disarticulation – of the masonry wall. Nor is stone cladding by any means the most suitable type of finish for the abstract stereometry of the so-called "international style" or for naturalistic organic shapes.
Stone cladding was, however, used in some of the lateral trends that developed in the 20th century preceding or alongside the mainstream modern movement. These include 1930s architecture in Italy which made extensive use of stone cladding. In this context (and making use of a few studies carried out some years ago), I want to look again at the crucial role played by stone cladding in this period, particularly in the experiments of some young Italian architects. I shall attempt to relate this type of cladding to the technical aspects which were a feature of the difficult switch from traditional wall surfaces in stone to modern cladding with thin slabs.
Before taking up the main theme, however, I should like to take a brief look at the most important precedent using thin slabs of marble at the beginning of last century: the experiments first carried out in Vienna towards the end of the previous century by Otto Wagner, later taken up by leading figures of the German secessionist movement.
In Wagner's works the stone facing is, to all intents and purposes, a mask. The overall architectural image takes on acquired an abstract, non-architectonic appearance. It no longer reflects the elements of the masonry work, either directly or through the traditional decorative canons. On the other hand, however, it does not reveal the frame structure and lightness either, unlike later examples in the more orthodox languages of modern architecture.
The structure, normally a hybrid combination of walls and frame, is completely hidden. The final appearance is simply the configuration of the external surfaces.
What are the elements used as a basis for the design of the surfaces?
Almost as though compensating for the abstractness of the overall structure, the new language is based on a meticulous and literal emphasis on the elements used

Post Office Building in Rome, A. Libera, M. De Renzi, 1933-35. From: Archivio delle Ferrovie dello Stato, Ministero delle Comunicazioni, Rome

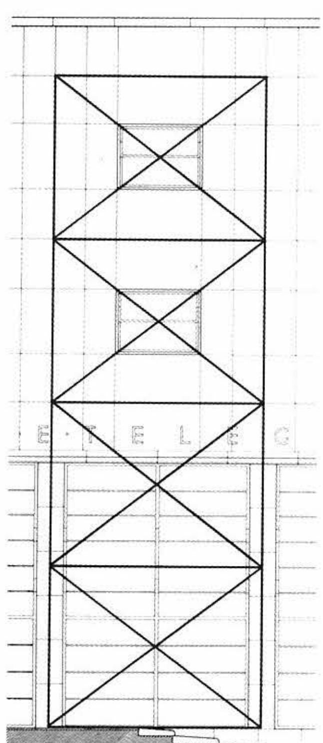


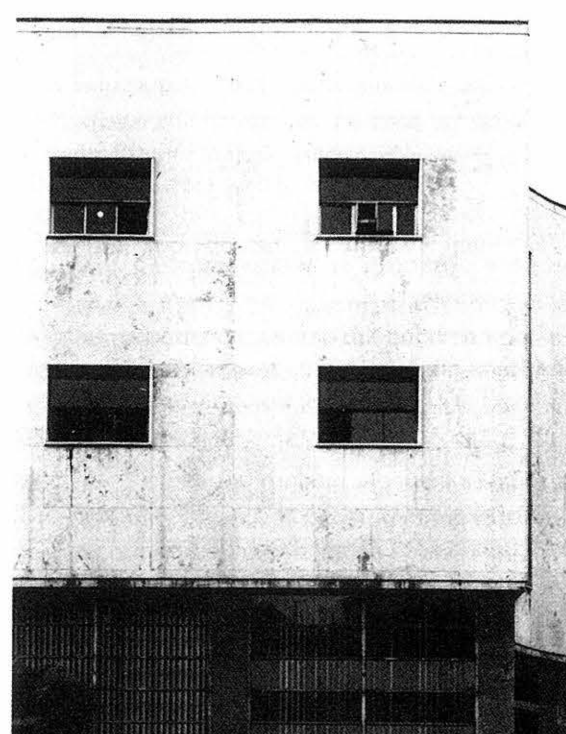
to create the cladding. In the Postparkasse, the slabs of Ratschinges marble are fastened by nails trimmed with aluminium bosses. In St Leopold, a nail fastened the upper part of the slab while mortar set around it, creating the effect of a hanging curtain. While the nails, clearly visible in Wagner's architecture, create a quilted effect in the Stoclet building, the Norwegian Turili slabs appear as canvases fastened at the edges by shaped frames in gilded and black metal screwed onto wooden strips.
This was in any case a sort of epidermal constructive realism, conforming perfectly to Semper's theory of cladding and his references to the leading role attributed to textile art in the birth of classical architecture.

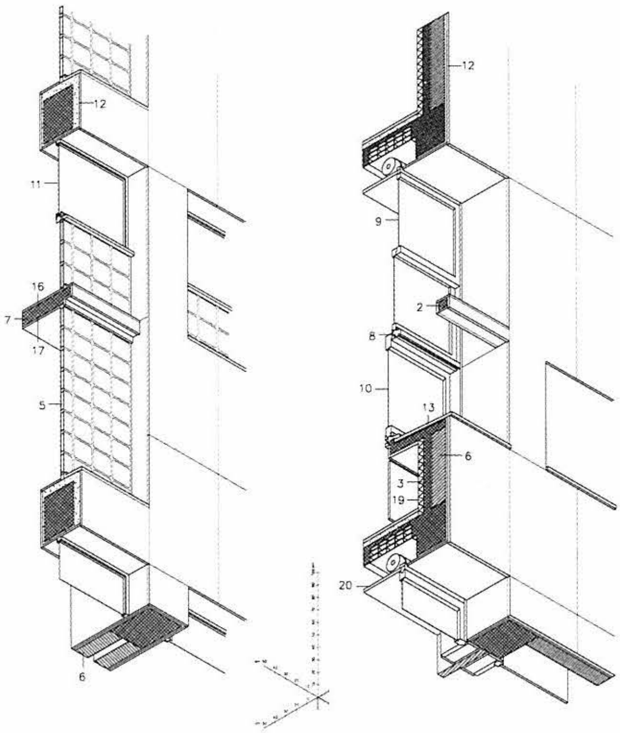
The smooth marble veneer of some Italian constructions of the 1930s had little in common with any Viennese "wallcoverings".
In Vaccaro's Post office building in Naples, the total stone cladding of the facades – one of the earliest applications of stone on a reinforced concrete building – gradually became more modern as the work progressed.
In Libera's Post office in Rome, the contrast between the facades clad in travertine and the arcade in front with violet Predazzo porphyry accentuate the building's fairy-tale quality.
In Samona's Post office, again in Rome, the travertine cladding above and the slabs of Samolaco gneiss in the row of pilasters below highlight a level of sophistication which everyone thought dangerous (it is no accident that no further major projects by this Sicilian were built before the war...).

In Ponti's Mathematics Faculty, the glaringly simple geometry of the square-cut texture of travertine cladding puts a graphic accent on the quintessentially Italian character of the building.
In Moretti's Casa delle Armi, entirely clad with slabs of veined statue marble from Carrara, the regularity of the pattern set against the controlled randomness of the streaks the overall appearance a lyrical touch.
In the Casa del Fascio in Como, the total cladding in Botticino limestone, designed by Terragni while work was still in progress, provides a symbolic classical composition.
Despite the fact that the complex debate about modern architecture and Fascism led young architects to adopt conflicting stances, it is possible to speak of "modern Italian classicism" in the case of these and other buildings, which are very different from the Fascist style of the major buildings erected in town centres. This is due to the close similarities in the intrinsic characteristics of the buildings and particularly to the new and experimental use of stone cladding.
Indeed, it was not only the decoration belonging to

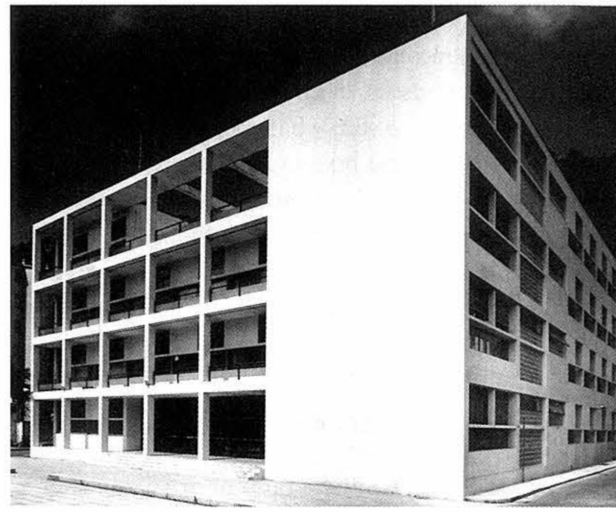
Post Office Building, Rome, G. Samonà, 1933-35.
From: Archivio delle Ferrovie dello Stato, Ministero delle Comunicazioni, Rome.
Drawing: R. Capomolla



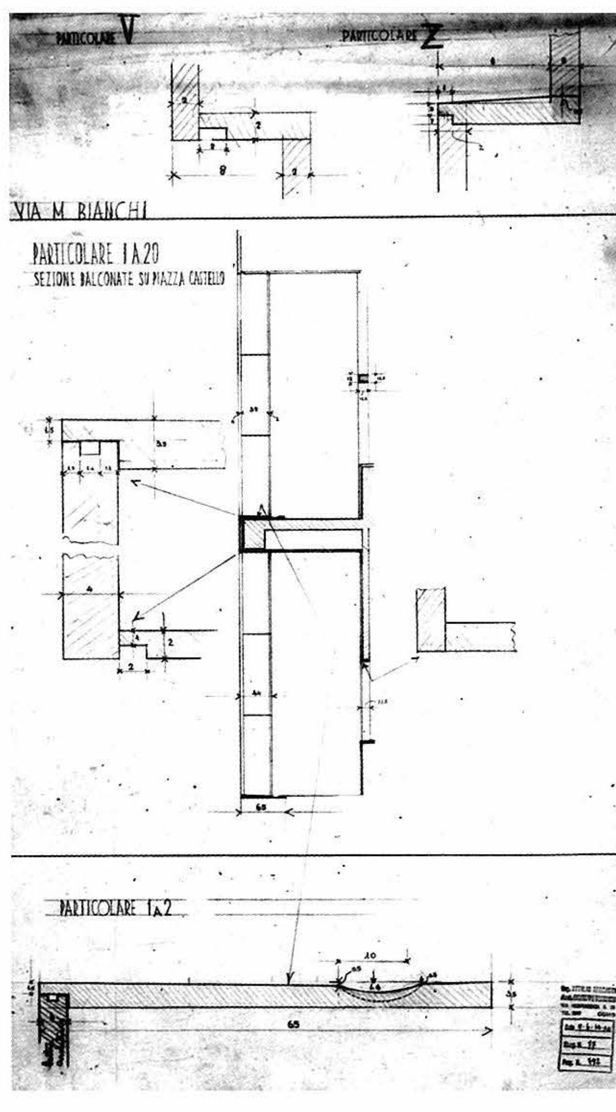




Casa del Fascio in Como, G. Terragni, 1928-1936.
Axonometric drawing: T. Iori



Casa del Fascio in Como. From: Archivio G. Terragni, Como



Casa del Fascio in Como. Detail of the stone cladding.
From: Archivio G. Terragni, Como

the specific architectural order that was abolished in these buildings, but decoration of any kind. Even the assembly system is invisible: the entire system of frames, joint covers, bevelling, masks and so on, traditionally used to solve the architectural and technical problems of placing the slabs, was removed from sight.
What remains is a uniform layer of stone, a smooth skin entirely (or almost entirely) dressing the structure. Why is the building clad in precious marble? To hide it? Or, on the contrary, to highlight its construction? With such indiscriminate "plating", the structure is both enhanced and camouflaged. Through its very emphasis it acquires a purely figurative character. It becomes abstract. It is stripped down to its purely figurative essence.
On the one hand this structural emphasis, manifested in a figurative and theatrical way, appears to coincide perfectly with the primarily representative function attributed to architecture in Italy. But at the same time, in some of the more modern and experimental works, the transfiguration in the end contributes to an escape from the rhetoric demanded by Fascism.

The technical issues

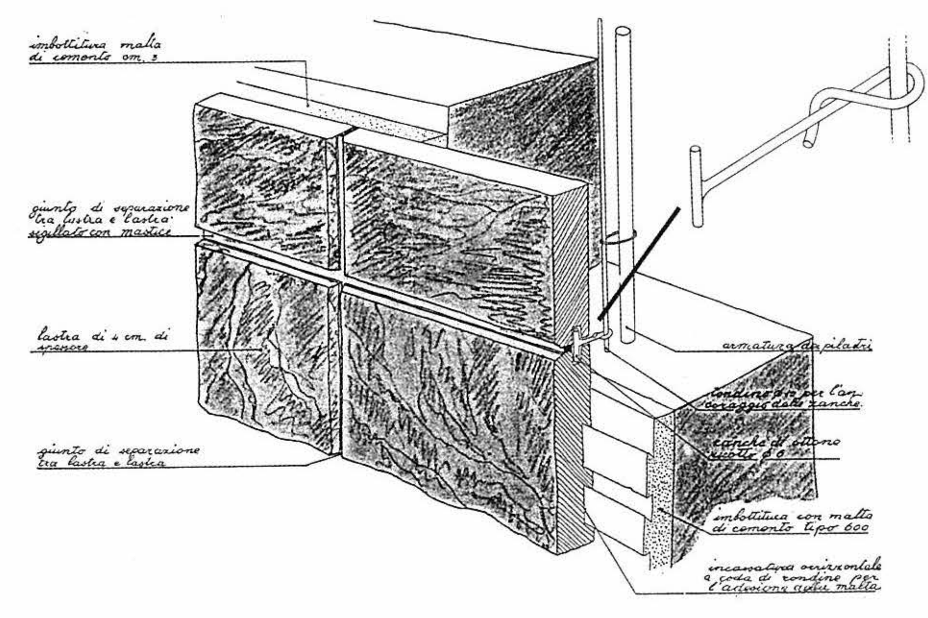
Apart from the architectural differences, a series of technical consequences arose from the fact that stone cladding was considered as a "veneer": thin slabs, complex geometrical arrangements, smooth joints and invisible connecting elements.

Montecatini Office Building in Milan, Gio Ponti, 1936-38
From: *Casabella - Costruzioni*, 138/140, 1939

It was an entirely new approach to facing work, and the experimentation did not provide immediate answers.
This emerged first of all at the construction stage: the Casa del Fascio incident – where Terragni was so strict in his demands for carpentry details in the unsuitable Botticino limestone that over half the pieces were discarded due to inevitable imperfections, causing a dispute with the IMV which dragged on until 1937 – was by no means an isolated case. The Post office building in Naples and the one by Libera in Rome were no less fraught with problems.
The main difficulty was in the fastening system. Initially, the traditional method was used, with overlapping slabs secured to the wall by a mortar filling and cramps or tie bolts. This system now proved to be unsuitable for a cladding which was designed as a thin veneer bonded to the masonry and reinforced-concrete structure. It was particularly difficult to perfect a new method for applying a thin layer of stone.
Proof of this is the fact that after difficulties at the design stage and on site, slabs continued to become detached not long after the buildings were opened. In Libera's post office, where the front colonnade was entirely clad in purplish-blue Predazzo porphyry, the large slabs repeatedly came away from the porch fabric. As early as 1940 numerous slabs of Botticino on the facade of the Casa del Fascio in Como had to be replaced and reinforced.
Thin cladding thus became a real national issue, with a small number of engineers working on it in the little-publicised construction phases.

First of all Professor Parvopassu of the Regia Scuola di Ingegneria in Padua showed how, due to the differences in thermal expansion between the cement mortar lining and the marble, there was a loss of adhesion resulting from the effect of alternation between hot and cold. This was not the cause of the detachment, since the bonding of the cladding material was ensured not only by the mortar infill but also by the cramps. But the experiment did enable the engineer Antonio Consiglio (possibly the person who

Montecatini Office Building in Milan. Stone-cladding detail.
From: *Colonna*, 1, 1942



commissioned the work) to deduce that a similar difference in thermal expansion occurred between the reinforced concrete structure as a whole and the stone cladding applied to it, and that this difference led to stress on the attachment between the tie-bolts connecting the slabs to the wall. When these effects multiplied, the stress was sufficient for the slabs to become detached.
With this knowledge of the behaviour of the reinforced concrete and the stone cladding – and especially with an understanding of the effects of thermal expansion – the engineer Bosisio perfected and patented a new anchoring system which was used on Palazzo Montecatini, designed by Gio Ponti and built between 1937 and 1938. The system was based on two main principles: each slab was fastened to the structure independently using clamps capable of bearing the weight, and an expansion joint was placed between the slabs.
The solution adopted for the Montecatini building solved the problem of thin cladding for reinforced concrete and paved the way for technological advances which, after the war, led to today's ventilated facades. However, his experiment proved to be a dead-end at the time, because a sudden change of direction brought about by the increasing autarky of the Fascist regime meant stone cladding was once again seen as a thick wall surface.

For a long time there was open aversion among critics, historians and even the general population for modern stone-clad buildings. Where marble was used as cladding for reinforced concrete buildings it was seen to be in conflict with the principles of modernity. This assessment is indeed perfectly comprehensible in a historical interpretation mainly concerned with the content and aims of architecture. The common element shared by architectural works with substantial use of marble, from Viennese modernism to modern Italian classicism, is their "superficiality": in other words, the principal expressive role played by their surfaces as compared with their spatial and volumetric characteristics. Their "superficiality" is not the result of an aesthetic preference, for it has a much deeper root in the preservation of architecture as one of the arts and its clear refusal to consider architectural design as one of the human and social sciences.
From this perspective, the containment of innovation in the language, the system of decoration or even in figurative aspects cannot but appear as the result of a more generally conservative position to modern historiographers who like to use as their yardstick congruence with the social aims of architecture.
Yet the situation in which historiographers find themselves has changed considerably over the past few years.
Today, in an environment where a more analytical and specialised approach to history encourages much closer examination of the works in order to understand their intrinsic nature, we are rediscovering their fascination.
Not that the impression of "superficiality" is attenuated by closer analysis – indeed we can understand it more fully and discover where it came from. It is just that as we enter the intricacies of architecture the automatic correspondence between programmatic conservatism and the nature of the works no longer applies.
If we take a more empirical and accurate look, we can distinguish between the principal characteristics of the individual works. We can see, for example, how abstract figuration, which is partly based on the stone veneering, was a way in which young architects were able to escape the demand for a rhetorical representation of the supposed values of the time, so perfectly represented by the Fascist style.
But it is not because these works are in some way closer to European rationalism, as has often been thought, but because on the contrary they clearly assert their Italian nature, linking modern architecture to the major figurative streams which developed in Italy during the first decades of the last century.
In fact the process of figurative abstraction mentioned above (of which thin stone cladding was an important part) may be seen as a counterpart to the way Futurist, Metaphysical and Novecento painting was based on the objective and expressive power of architectural archetypes.
In the end, the inclusion of architecture in this mutual give-and-take of the Italian figurative arts prevailed over ideological aims and directly influenced intrinsic characteristics. Over time, this inherent quality of a work long outlasted the significance it was originally supposed to have.
Otherwise how can we explain the fact that precisely those elements which combined to give these works their obstinate character – the misuse of marble in the service of theatrical effect – are the ones that make them so attractive today?

Prerequisites and Alteration of Materials in the Restoration of Modern Buildings

Choices and methods in the restoration of the buildings of the Modern Movement. The essay shows how an extensive and careful analysis of the weathering of materials and artifacts (in this case stone elements) can provide a useful support in the decision-making process.

Pier Giovanni Bardelli

First of all I would like to state a small premise and excuse myself if it appears obvious to many readers. It is a premise which may be taken for granted, but which I nevertheless deem important as it underlines the specific problems involved when deciding how to approach work to be done on Modern Movement buildings, and in particular on the most important construction elements including the facings in stone which are the subject of this paper.
The Modern Movement signalled a clean break with building tradition, the range of traditional materials and the approach to creating architecture.
We see the birth of a love affair with new techniques, new products and new materials, frequently accompanied by the abandonment of established "good practice". The assessment of a building's future was entrusted to a sort of "mental experiment" which was supposed to hypothesize concerning the future life of the innovative – at times extremely innovative – proposals.
Sometimes experiments were actually carried out, but usually these new options were simply thought up and debated, with attempts to imagine their future and also their value as examples of their school. It is necessary to recognize how difficult, but also how attractive such exercises in imagination were; nevertheless they could provide training and extremely stimulating and intelligent theoretical experimentation in the real sense.
Proposals sprang up for new approaches to architecture with new building procedures; not only were there new ideas for using materials, but also totally new materials were conceived, as well as new ways of using traditional materials.
Even the appearance of the materials could be innovative, with very new chromatic possibilities and shiny and reflecting surfaces.
In many cases the building heritage of the Modern Movement can appear to be characterized by a sort of fragility, which is cultural in origin. In Italy, it can be difficult for some buildings to gain public acceptance – they are rejected because of their traditional association with the period of fascist rule. One effective distinguishing feature of our activities relates to the type and quantity of information we possess for most of the buildings of the Modern Movement. Moreover it should be remembered that some of the architects are still alive and that many of us knew them and may even have worked with them or with their direct associates.
The projects and building works are well documented: there are often drawings "as built" for Modern Movement projects. In these buildings, knowledge or documentation of new contributions or of variations to the original situation is all too often evident and discordant - at times so much so as to lead to their "removal".
Obviously all this is said taking account of all the "nuances" and making the due distinctions.

What is the reason for this preamble (which as I said may appear obvious)?
In effect, the outcome of important work concluded recently on Modern Movement buildings has confirmed a trend that is now well enough established to constitute a distinctive mark, a "cipher". In other words, even if decisions about work to be done are tackled based on the problems rather than on preconceptions, projects are nevertheless strongly oriented towards "restoring the original state" as far as materials are concerned, eliminating products found to have been selected incorrectly and therefore unsuitable for use.
Experience tells us that, in this framework more than in others, an alternative option is hotly debated. In this case a "procedure" associated with rediscovery of the

most significant individual form of the monument or of its original arrangement, as ascertained by retracing its historical vicissitudes, is compared with a different "procedure" which envisages recomposing it in the form of an image associated with the accumulation of the various documented historical layers.
Nevertheless, the final choice always remains with the project director who, acting with cultural and professional autonomy and in compliance with the relevant forms of protection, reads and interprets the monument itself as the principal document.
It is effectively a question of interpretation: in recomposing the image a balance must be achieved between respect for the historical intention and the values associated with what exists materially.
Nor is it possible to ignore any symbolic value which the monument, or part of it, may have, by exalting or diminishing it.
Therefore, whatever the entrenched attitudes of certain planners may be, a problem-based approach to the theme would appear preferable, as it allows for solutions directed towards maintaining what corresponds to various recognizable historical "presents" or towards the study and interpretation of what makes the monument valuable, whether it be a building, an urban complex, a piece of urban-rural fabric or an area of land.
If, however, we focus our attention on alterations to Modern Movement architectural works, we frequently find that common experiences, and exchanges of opinion and of results - insofar as we know about them – show that it is easier and perhaps less problematic to opt for re-composing the original image by seeking to return to the "pristine state".
Again the decision can only be made by the project director who must act responsibly, supported by everything that may emerge from the original project documentation, technical inspections of the monument, historical knowledge, disciplinary frameworks, knowledge of the relevant construction techniques, and from knowledge of the culture in which the work was designed and built. At the same time he will be supported by his own culture, in the broadest sense of the term.
In the end he will make project decisions which are his alone, related to his own tastes and his own interpretative procedures regarding the monument in question.
In effect, we have seen how in the framework of the Modern Movement many indications can guide the project director towards reconstructing the original state, within the bounds of possibility.
If we then examine buildings with "decorative facings" – in our case decorative facings in stone materials – we cannot overlook the fact that we are talking about the particular, and about situations where the image (in many cases at least) is provided by the stone materials chosen. These may be brightly coloured or treated in quite special ways, for example placing a polished finish in contact with other materials, which are also of stone and may be finished using techniques such as chiselling or bush-hammering, or different degrees of dressing. In this way it is possible to play with the contrasts between one material and another, and between the surfaces of these materials and the "background" surfaces, in a very decisive way, transferring to the exterior chromatic ideas traditionally used only for interiors.
Finally, it should not be forgotten that the singular and specific nature of some types of machining can enhance the reflection, diffusion and absorption of sunlight and also the artificial "grazing" light characteristic of the so-called self-lighting buildings typical of the Modern Movement.
Inevitably the presence of alterations in the stone materials and elements will lead to deterioration in appearance which can immediately distort the image of the building or monument and eventually cause fractures, cracks, and even dangerous detachments.
Thus it may be that the restoration choices are not quite so free.
Moreover, in cases where the alterations are patently irreversible, the alternatives and options become even more clear-cut.
The range of possible alternatives can include first, restoring the original appearance, the original colourings or patinas; then, preserving or replacing the original materials; replacement with new materials the same as or similar to the original, or replacement with materials comparable with the original in appearance but having greater durability.
Another possible alternative is whether to treat the component elements on site or remove them and re-install them after treatment elsewhere.
It may also be necessary to introduce changes to some construction details in order to keep in place materials and elements which, following the repair, will be protected from further damage.
It may be useful to mention several "case studies", also widely illustrated elsewhere[1], selected from those dealing with alterations of the irreversible type – alterations related to improper use and laying techniques or associated with the use of materials unsuitable for stresses deriving from the outside environment.
In these cases the options must inevitably be aimed largely at "replacement" and must therefore be fine-tuned case by case.

There can be no doubt that "recoverability" situations, on the other hand, offer decidedly more nuanced possibilities for choice and action.

By extrapolating comments from Vittorio Gregotti's preface of the reissue of Semper's *Der Stil*, our working approach can be put forward not only as a means to free us from the alterations to the material and the technical limitations, but also as a way of returning to the values historically and scientifically identified in the object.
In architectural terms, our approach to stone materials used in facing is not simply a recovery of chromatic values; it can and must become a fascinating search for the values inherent in colours such as surface luminescence, surface texture, and the "warmth-colour" components of the surface of the monument itself – which, as A. Cavallari Murat has pointed out, are all closely linked to the laying techniques.
Because our aim is to reconstitute the physical consistency of the facing – meaning the stone material and associated support structure – or to recover the surface texture or the original "polychromy", we must also be aware, particularly with the stone elements of Modern Movement buildings, that extensive use of protective agents, sealants and metallic-mechanical elements with anchoring and protective functions is indispensable. We must also accept that these in turn can bring about new emphases, new visible signs, and new lights and shadows.
In studying and respecting the original quality of both the individual elements and the building in its entirety, the knowledge and cultural heritage of those involved in the planning and those doing the work must be balanced correctly and skillfully between art, craftsmanship and technology.
The materials typical of Modern Movement architecture need to be "revisited" today. They particularly merit investigation now that it has become possible to discuss not only the outcome of important restoration projects, but especially the problems and cultural pressures that assail every planner at the point where he understands and senses the problems and prepares to solve them with personal proposals.
We have addressed these observations specifically to stone façade facings, but of course we cannot separate the part from the whole, from that entirety which cannot be treated as a simple summation or aggregation of elements.
It is true however that the situation may be specific to work on Modern Movement buildings in which stone is used extensively as decorative facing, and these in turn can be separated at least technically from other systems and functional parts of the building.

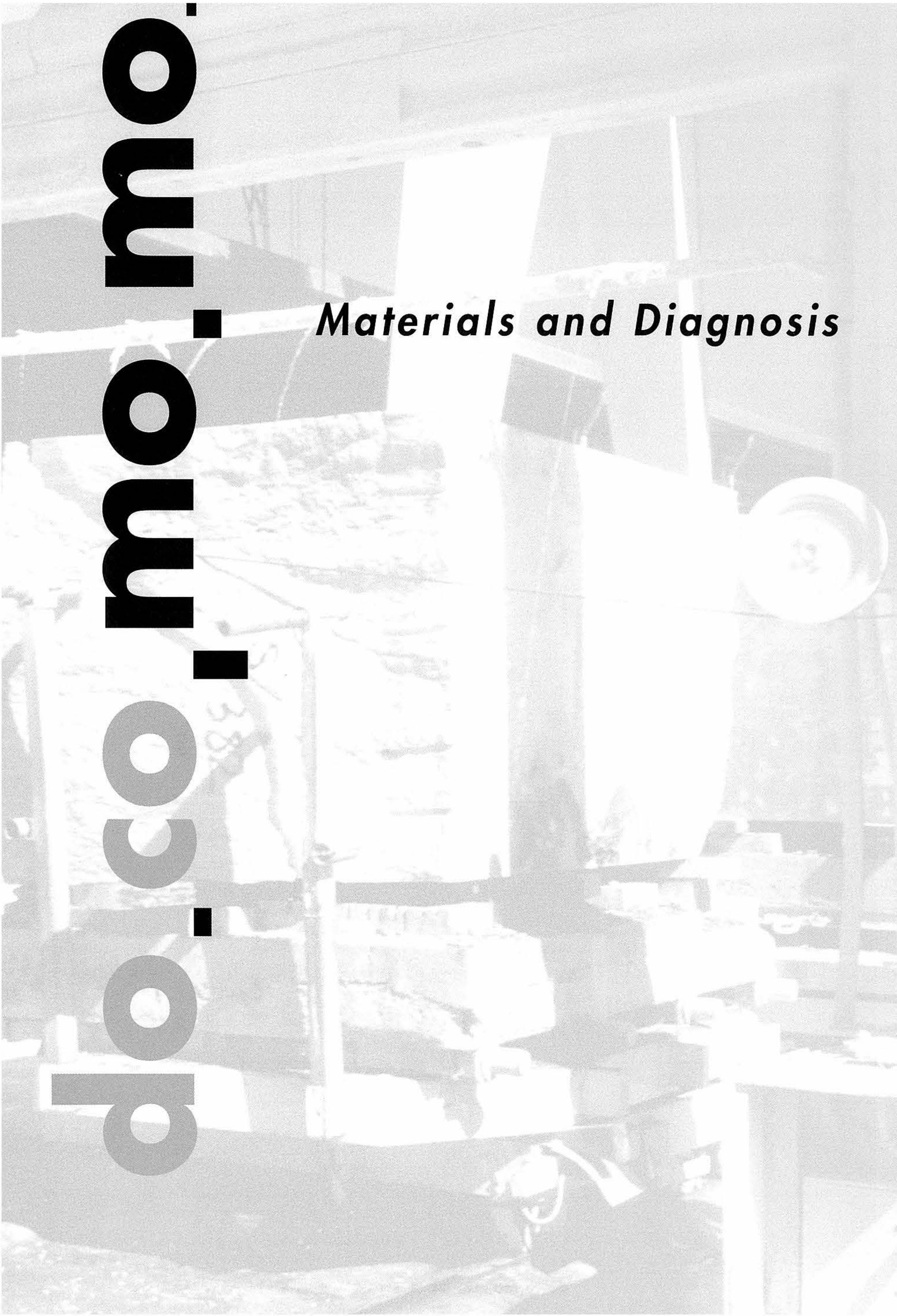
Given the progress and depth of the studies and restoration work, a problem-based framework appears correct here, even if today it is becoming possible to provide an initial set of answers not just at a technical level, but also through the experience of completed projects and thanks to broader inferences, still connected to operational experience on site, where "site" means a sort of medical clinic for experimenting on "unhealthy bodies".
There can be no doubt that by assembling these considerations, these responses derived from experience with projects and on site, we can enrich the "culture of modern building" with some very useful contributions, as long as effective documentation procedures can be established and the documentation itself is not limited to the drawings "as built" – useful though these are – but becomes a true and complete illustration of the project and a clear and exhaustive "site chronicle".

Notes

1. Some of these case studies will be illustrated in specific papers by A. Frisa Morandini and by P.G. Bardelli, C. Mele and M. Gomez.

do.co.mo.mo.

Materials and Diagnosis



Stone Facing Techniques in Twentieth-Century Handbooks

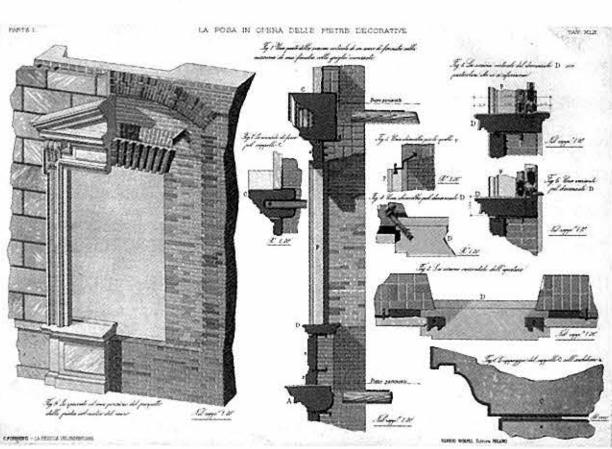
The evolution of techniques for applying and fixing stone facing quickened its pace in twentieth-century Italy. The question of a correct and stable connection between load-bearing masonry supports and facing was discussed at the beginning of the century and some important handbooks were produced. But in the 1930s, when framework systems came into common use and experiments were conducted on thin facing, cases began to emerge of degradation and collapse in stone facing slabs.
The long process of reformulating the technical knowledge consolidated up to that time, according to the evidence in magazines and handbooks, is in this sense interesting not only in itself but as witness to a more general slow technical progression in the building cycle.

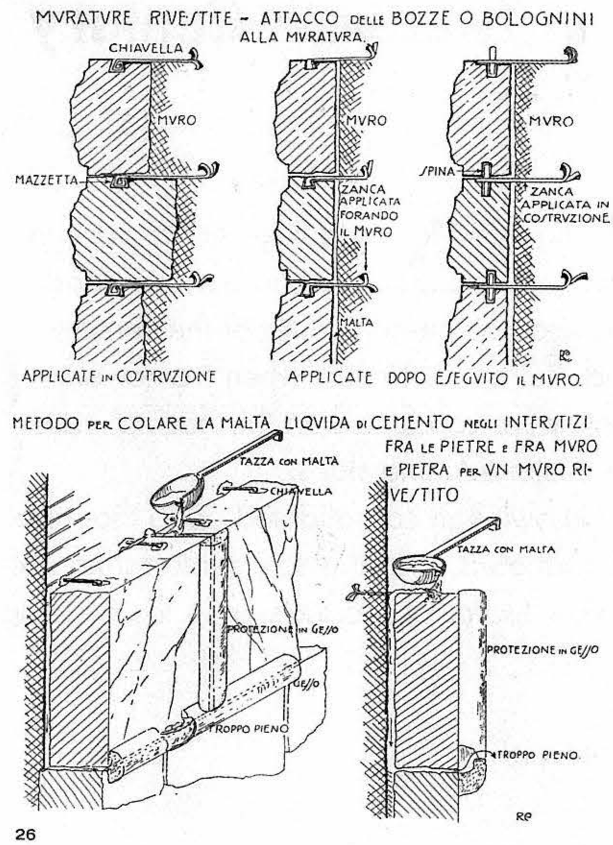
Maria Luisa Barelli, Maurizio Lucat, Silvia Mantovani

The whole subject of the evolution of techniques in laying and fixing stone cladding in Italy during the twentieth-century appears to be marked by what a Turin architect, Gino Levi Montalcini, described in a 1964 magazine devoted to the use of marble as "a certain apprehension more or less relegated to the background of technical awareness"[1].
For the period we are looking at, from the end of the 19th century to the 1960s, the analysis of handbooks and technical literature in general is a helpful tool for re-reading some of the stages in the evolutionary process of stone cladding techniques, and for understanding the reasons for the concern expressed by Levi Montalcini, linked in a technical perspective to the question of the correct secure connection between wall structure and facing.
This question, posed in the 1930s when some young Italian architects began experimenting with the thin sheathing of reinforced concrete buildings, by the end of the following decade had already led some authors to deal in a significant way not only with issues related to the correct design of stone facings, but also with saving them.
Cases of deterioration and collapse of cladding slabs which occurred following the start of this experimentation in fact suddenly and quite unexpectedly turned the capacity of marble and stone to generate questions of quality and durability in architecture upside down.

Stone cladding techniques: convention and prescription
Stone cladding, considered an intrinsic element of masonry work, is mentioned in the handbooks published in the nineteenth and twentieth centuries in the context of discussion about different types of masonry. Thus "clad walls" according to C. Formenti (1893) "are masonry structures which present a cortex or facing made of thin stone towards the outer face, linked to the larger inner wall structure"[2].
The solutions proposed for making this link, as defined in the handbooks, described two approaches to the facing, in many ways contradictory. If scarfing was involved between the cladding stone and the elements of the wall fabric behind, with the use of cramps as

Laying decorative cladding. From: C. Formenti, *La pratica del fabbricare*, Milan 1893, plate XLII



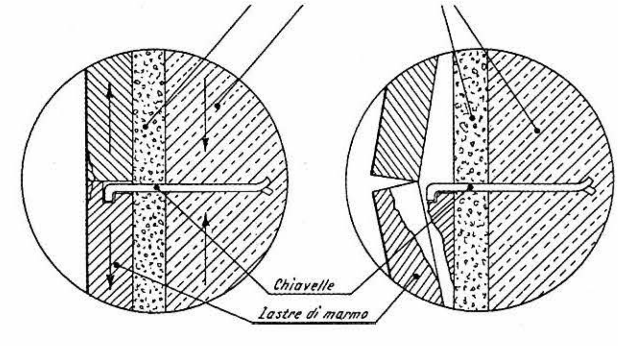


Stone cladding fixing systems. From: C. Formenti, 1933

well to help make the connection firmer, the cladding became an actual part of the wall, imitating an ashlar appearance on the surface. Alternatively, as suggested in the case of thinner slabs, if the connection was made simply by fitting the slabs to the wall, filling with mortar and using retainer cramps, it took on the significance of an independent layer, which could be used in innovative ways in the construction. In the latter case, the handbooks even in those days cautiously suggested distributing the load of the slabs on each floor using solid stringcourses fixed in the wall fabric.
Starting from these distinctions all the handbooks[3] gave substantially similar indications, though with differing emphases, concerning the thickness of the facings, types of metal cramps and times and concepts to be adopted during the work, revealing a series of *conventions* and rules of workmanship able to give a concrete representation of site operations and guarantee the durability that was considered a fundamental aspect of building.
However, certain precise cautions were issued about this durability. In fact one problematic issue in building claddings which we know was already being discussed during the Renaissance[4] concerned the possibility of the wall mass actually coming apart due to shrinkage differences in the mortar joints in the case of scarfing between cladding stones and the wall structure, or detachment of parts of the facing in the case of a less solid connection relying only on mortar and metal cramps.
To overcome this problem, if the cladding was to proceed at the same time as the building of the wall, the advisability of minimising the thickness of the beds of mortar and suspending work every now and then to allow the mortar layers to set and the structure to become compact was emphasised. Alternatively, especially if thinner slabs were to be used, it was suggested that the cladding be done later, when the masonry work had fully settled.

We find the indications still substantially unchanged in the new editions published in the 1930s of the major nineteenth century handbooks, such as the third "renewed, updated, partly remade" edition by R. Cortelletti of C. Formenti's *La Pratica del Fabbricare* (1933), which provided a summary of stone facing technologies accompanied by an effective illustration of site operations.
On the other hand "modern" handbooks offered very meagre indications – if they were included at all[5] - which only minimally reflected the evolving innovation process in thin stone cladding for buildings with a reinforced concrete skeleton[6]: a process which would not immediately have found its way into the handbooks in any case, given the general atmosphere of uncertainty it created.
In fact it was the technical and architectural magazines which documented and discussed the problems that quickly came to light as a consequence of the experiments. As Poretti's thorough studies show, the *prescription* adopted during the second half of the 1930s – based on this highly innovative facing concept – of large thin marble slabs laid in place with minimised joints, the traditional anchoring left to mortar and a few cramps, resulted in many cases of disturbance of the facing panels.
A decisive contribution to the debate this had

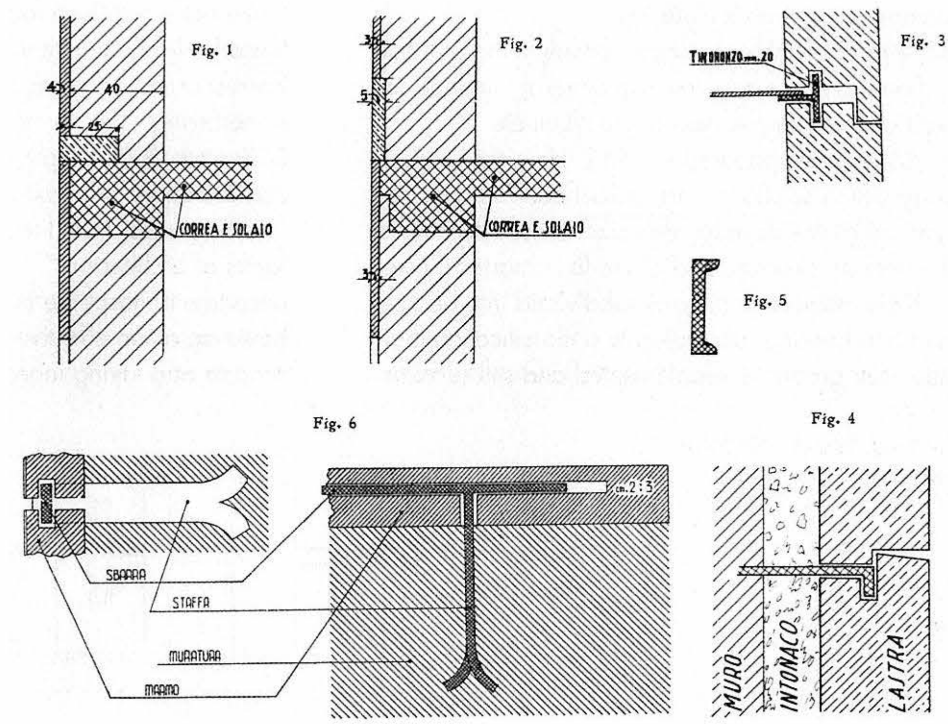
Behaviour of exterior stone cladding to temperature changes. From: A. Consiglio, "La stabilità dei rivestimenti lapidei in lastre", *L'Ingegnere*, 10-15, October 1938



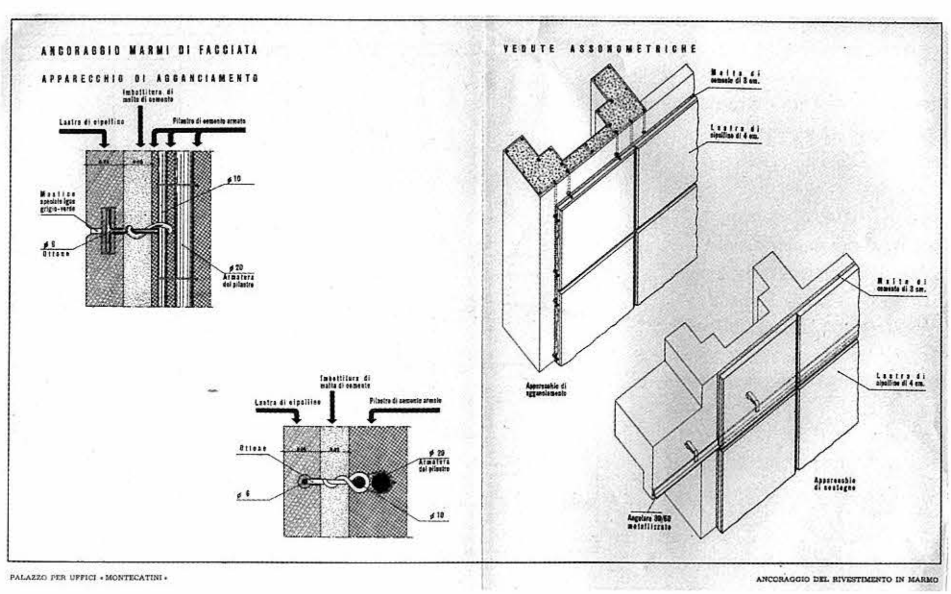
triggered came from Antonio Consiglio, an engineer who from that time on was to play a leading role in the process of formulating more reliable indications for anchorage. Reaping the results of the professional experience he had acquired while running the marble quarries at Lasa (Bolzano)[7], he reached the conclusion that the causes of detachment could be related to the differences in thermal expansion between the reinforced concrete structure, the filler mortar and the stone cladding. If the joints were too thin, these differences caused heavy strain where the metal anchors were attached to the slabs and the wall, which in some cases actually caused parts of the cladding to become detached. The problem therefore had to be solved using bearing cramps to ensure the holding of the slab regardless of the adherence of the filler mortar, and leaving an appropriate clearance space between the panels so each could act as a small expansion joint[8].

Towards a new coding

Once the causes of the instability were understood, new fixing solutions[9] could be identified – from the simplest, like those derived from the traditional ones which involved resting thicker bearing slabs on each reinforced concrete floor, through solutions aimed at taking the cladding anchorage back to within broad margins of safety using more reliable cramping systems like the bearing cramping with long segments patented by A. Consiglio, to the more elaborate solutions like the one designed by the engineer P. G. Bosisio for facing the Montecatini building in Milan



Stone cladding fixing systems. From: G. Bellia, "La posa dei rivestimenti lapidei", *Rassegna di Architettura*, 3, March 1939



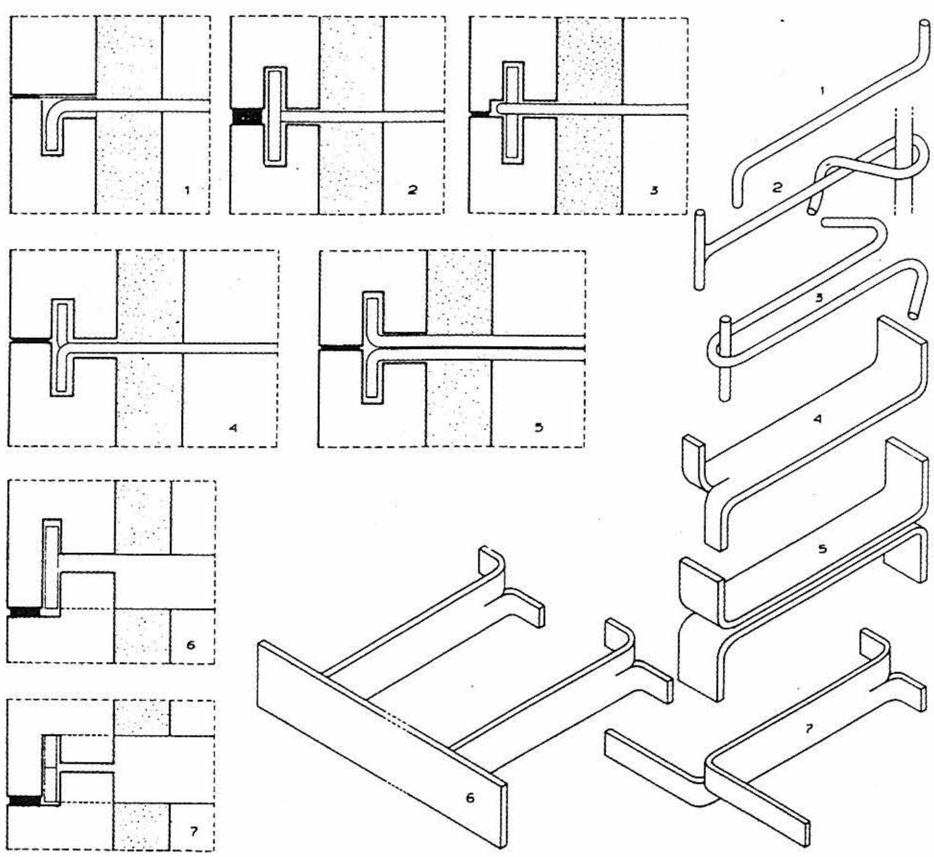
The system devised by P.G. Bosisio for cladding Montecatini Building in Milan by Giò Ponti (1937-38). From: *Il Palazzo per uffici Montecatini*, Milan 1938

designed by Giò Ponti (1937-38). This last solution in particular provided for the use of brass cramps (8 or 10 for each panel) connected to vertical steel bars, which were inserted in the concrete structure but were completely independent of the reinforcement[10].
All the solutions were in any case ready to be taken up and presented in the handbooks for broader and more general use. In the slow process of recoding technical knowledge[11], the *Manuale dell'Architetto* by Mario Ridolfi (1946), for example, gave a list of the main causes of breakage and detachment of the slabs together with some suggestions for anchoring them. A broader discussion of the topic was presented at the end of the 1940s in a text devoted entirely to the use of marble[12], in which the author, Consiglio, gave not only instructions for correct laying and fixing techniques but also some suggestions for strengthening unsafe cladding.
But a more reliable systematic presentation of these techniques in a manual with a general tone had to wait until the new edition of the *Manuale dell'Architetto* appeared in 1962. Here the construction solutions were described in relation to types of materials used, slab sizes, characteristics of the bearing structure and of the filler mortar if used, with the anchorage systems subdivided into bearing and non-bearing, according to a classification that has been gradually supplemented and still survives today.
During the same period, in an article published in *Marmo Tecnica Architettura* following newspaper reports of new cases of facing slabs falling, Consiglio recalled the facts relating to the use of stone sheathing from the 1930s on[13], and reinforced the suggestions proposed in Italy by comparing them with the laying and anchoring procedures adopted in other European countries and in the United States. This survey, a prelude to the publication of a technical guide[14], represented a significant arrival point just at the time when questions about possible innovative uses of marble and stone were being asked in the same magazine.

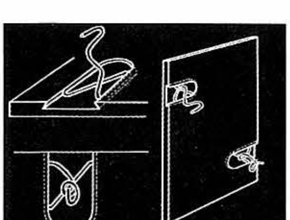
Technique and language of architecture: new points for discussion

In the early 1960s in fact, *Marmo Tecnica Architettura* hosted a lively debate which highlighted the renewed interest of industrialists, technicians and designers in stone facing.
D. Tassotti, for example, took up some of these considerations in a text about marble aimed at "starting a technical literature in correlation with the forms of architecture"[15], emphasising the relatively uncertain atmosphere in the sector. Above all however, as an effective antidote against the ageing process and laying inaccuracies, he used the occasion

Cladding. Exterior walls with marble and stone slabs From: *Manuale dell'Architetto*, 1962



"Le Revêtement Pelliculaire" en dalles de pierre naturelle, procédé Dervillé, système J. Portail.
From: G. Levi Montalcini, "Impiego dei marmi e delle pietre nella architettura contemporanea", *Marmo Tecnica Architettura*, 4, August 1964



to underline the *necessity* of turning to surface and border works which could make the thin slab regain "the effectiveness and vitality of the rocky nature of the block" and conceal the small protuberances in the joints resulting from construction defects. In his opinion these were inevitable, and he therefore advised against placing the panels next to one another on a perfect plane[16].

However, if these positions showed appreciation of the traditional ways of using marble, the overall debate presented by the magazine was mostly focussed on discussing the possibilities opened up by industrialisation and prefabrication in the building industry. The questions the industrialists, technicians and designers were asking themselves concerned the actual possibility of using stone materials in the construction of prefabricated buildings considering their cost and weight, the doubts and associated concerns about assembling different materials and components, and the need to start research and experimentation in these areas to identify suitable devices for anchorage, holding and cladding.

Particularly significant in this area are the papers by architect Gino Levi Montalcini, who was very interested in questions of technological innovation and the way in which these come into play in architecture and its languages. Quite apart from the rhetoric of industrialisation, Levi Montalcini took the discussion about the use of marble and stone in contemporary architecture back to the natural but complex evolution of "expressive and formal interests"[17] that occurs following the introduction onto the market of new materials, products or ways of working. From this perspective the analysis of some recent uses of stone materials in exterior covering led him to express concern about the true reliability of the fixing systems used in multi-storeyed buildings with bearing frames, and about the ways of disclosing those systems in a convincing language.

The "apprehension more or less relegated to the background of technical awareness" mentioned at the beginning of this paper led Levi Montalcini to hope for the adoption of appropriate systems, "guides, or crosspieces, or studs, or key heads or anything else necessary" to guarantee safety, just at the time when the technological problem as posed in the 1930s seemed to have found a solution and systematic expression in the handbooks as well.

On the other hand that same concern, symbolic even before it was technical, made him hope for experimentation with the new technologies for stone cladding. Starting with an exploration of the applications in Italy and abroad, the discussion of these technologies was taking a path that would soon to lead to expanding the range of possible options and further fragmenting the apparatus of technical learning up to the early twentieth century which, in the context of a unitary and homogeneous body of knowledge, was still represented by handbooks on the art of building.

Notes:

1. G. Levi Montalcini, "Impiego dei marmi e delle pietre nella architettura contemporanea", in *Marmo Tecnica Architettura*, 4, August 1964, p. 57.
2. C. Formenti, *La pratica del fabbricare*, Section One, "Il rustico delle fabbriche", Milan 1893.
3. See also C. Formenti, cit.; see D. Donghi, *Manuale dell'Architetto*, Turin 1905; G. Chevalley, *Elementi di tecnica dell'architettura*, Turin 1924.
4. See S. Serlio, *Regole generali di architettura sopra le cinque maniere degli edifici*, Venice 1537.
5. See E. A. Griffini, *Costruzione razionale della casa*, Milan 1933, in which no mention whatsoever was made of natural stone cladding, evidence of the widespread ostracism of traditional materials which distinguished modern Italian architecture in its early stages.
6. See L. Zorzi, *Intonachi pavimenti rivestimenti nella moderna edilizia*, Bologna 1935.
7. See *I marmi italiani*, Roma 1939; A. Consiglio is also the author of the handbook *Nozioni di tecnica del marmo per gli addetti all'industria marmifera*, Bolzano 1934, a collection of seminars organised in Lasa by the Institute for Small Industries and Handicrafts of Alto Adige for workers in the marble industry.
8. See A. Consiglio, "La stabilità dei rivestimenti lapidei in lastre", in *L'Ingegnere*, 10-15, October 1938.
9. G. Bellia, "La posa dei rivestimenti lapidei", in *Rassegna di Architettura*, 3, March 1939.
10. *Il Palazzo per uffici Montecatini*, Milan 1938.
11. In reality already in the early 1940s some texts had started to deal specifically with the topic of thin slab facings and their stability. See G. Arosio, *Enciclopedia del costruttore edile*, Milan 1941.
12. A. Consiglio, *Il marmo*, Pisa 1949.
13. Pointing out that the first cases of instability were appearing as early as 1935, he said "It is helpful here to recall ... that since 1940 one or two firms that are specialists in "franking" (to use a Milanese term) marble facades have been operating in Milan. Which is, in itself, an indication of the widespread extent of the phenomenon". See A. Consiglio, "La posa in opera dei rivestimenti esterni in Europa", in *Marmo Tecnica Architettura*, 5, October 1965, p. 29.
14. A. Consiglio, *Guida tecnica per l'impiego razionale del marmo*, Milan 1972.
15. D. Tassotti, *Aspetti e tecnica del marmo*, Genoa 1963.
16. Id., "Caratteristiche tecnologiche di impiego dei marmi", in *Marmo Tecnica Architettura*, 4, August 1964, pp. 29-38.
17. See G. Levi Montalcini, cit., p. 55.

Characteristics of Stone and the Choice of Quarry

Technical solutions and details and the most common abnormalities of stone cladding are analysed here. The buildings that are the focus of the essay were built in Turin in the second quarter of the twentieth-century. The analysis examines the quarry, selection of the stone, fastening and cladding alternatives and the design of technical details.

Pier Giovanni Bardelli (P.G.B.), Caterina Mele (C.M.), Maurizio Gomez Serito (M.G.S.)

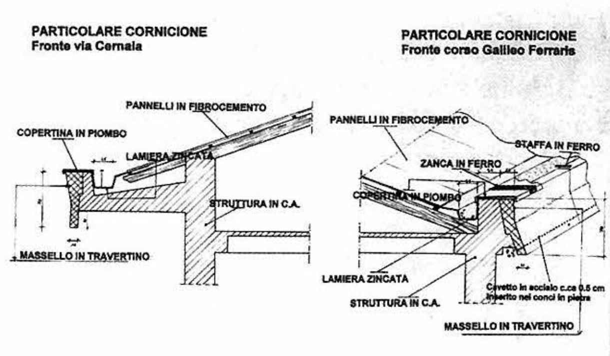
Methodological aspects in the conservation of modern and contemporary works of architecture (P.G.B.)
The debate on methods and techniques for carrying out work on Modern Movement and contemporary buildings is still open and lively.
Some operations on modern buildings have been completed recently, while quite a few others are in progress. The outcome of these will be a useful test of the methodological and operative approaches that underpin them.
If we tackle the problem of further work on a monument, it is indispensable for us to know the socio-cultural climate in which it was constructed and the profile of its creator or creators working together, along with the techniques applied and their relative limits.
We may note, while not rendering it explicit, that many solutions are of great interest to the history of architecture, and the decision to conserve them as documents seems beyond dispute. However the materials used, the artifacts, the technological solutions themselves and the construction details have not been the subject of sufficient experimentation for this particular purpose.
In effect, we frequently tend to work in such a way as to return the building to its "pristine state" while using materials and techniques that have evolved in the intervening period. This attitude is probably linked to the fact that the design and construction dates are close to us in time, or to the impossibility of making qualitatively acceptable additions which can be considered testimony to "historical presents" (to use Cesare Brandi's concept). It is still relatively simple, for example, to put a window mechanism back into operation or recover the original elements of a floor or facing, etc.; many identical pieces can be found in buildings of the same era. There is therefore nothing to prevent "restoring" the original configurations and combinations. This method of restoration would be rejected today for historic buildings, but is recurrent in work on modern and contemporary buildings.
Today, knowledge of possible alterations is well advanced and the materials and techniques for the repair and replacement of the whole or even of parts are completely reliable.
We cannot however ignore two other aspects. On the one hand architecture is an art form in which it is necessary to adapt to the evolution of the functions carried out in a building, but on the other hand what we do on a work of architecture is very often far from being reversible.
The idea of reversibility can inform our approach, however it does not in itself provide an unambiguous interpretation or guarantee a certain result. Every operation we perform, or if you like every interpretation we adopt, passes the buildings on to the future in a new form which may be faithful to the original in varying degrees, or may not be faithful at all.
In music for example, a piece can be interpreted innumerable times in innumerable different ways and accepted as a new work; but stricter rereadings and reinterpretations of the original text still remain possible. In architecture on the other hand we need to

INAIL Office Building in Turin, 1955-56. The main façade.

be aware that in many cases our reworking of the architectural reality can make a rereading of its present state, or of the original state as permitted today, more difficult or perhaps impossible. So only after all the analyses have been carried out and all attribution and classification criteria applied can we allow the buildings to be approached, tactfully and with sensitivity and a deeper knowledge of the architecture.

Compositional and technological aspects of the case study (C.M.)

This section deals with the INAIL [Workers' Compensation Insurance Administration] office building in Turin, built in 1955-56 by the contractors Marega and Bennati to plans drawn up by the INAIL Central Engineering Office.
The building is located in the centre of the city and surrounded by buildings of considerable distinction; it faces the site occupied by the Donjon Citadel, part of a sixteenth-century fortress designed by the military architect Francesco Paciotto.
The INAIL building is an example of so-called minor architecture, with certain noteworthy features such as the extensive use of different types of stone cladding on the façades, the valuable marbles used in the interior (the main staircase in the entry, for example, consists entirely of large violet and white marble slabs laid in symmetrical patterns according to the vein), and a number of creditable solutions in the design detail.
As one of the many buildings belonging to a major public organisation, the INAIL offices in Turin can provide an excellent basis for developing an investigation method for use in managing and maintaining large public and private real estate holdings.
INAIL owns extensive property in Italy. Some of the buildings are of considerable historical and artistic value (the Rome offices in Via IV Novembre for instance are well known for their design by Brasini, while Villa Lemmi in Florence is an interesting example of a Tuscan villa built around a fourteenth-century core). Several of the buildings belonging to the organisation feature in handbooks of contemporary architecture. Examples include the Venice offices (1952) designed by Giuseppe Samonà and Egle Trincanato, and the headquarters in Piazzale Pastore, Rome, rebuilt in 1991 following the original plans by Gino Valle. Giuseppe Samonà also designed the Messina offices which were built in the Palazzata complex in the 1930s, the same period that saw the construction of the Lecco offices designed by Piero Bottoni.



Details of travertine cornice facing slab retention.

These buildings were all completed between the 1930s and the 1950s and share a number of common features. They are austere, monumental constructions with the first floor generally laid out in a ring shape with outpatient facilities and examining rooms, while the upper floors contain offices reached via a large lobby. The floors above the offices were rented out as apartments, which over the years have often been taken over to provide more space for the institution's needs.

This pattern is reflected in the Turin complex, though with some variations. The complex actually consists of a series of buildings of varying heights occupying an entire city block. The main façade has seven storeys above ground level and is flanked by a five-storey structure giving onto a side street and a four-storey structure giving onto another side street.
The façades are largely covered with stone cladding, while some bays and the loggias on the top floors feature high quality plaster and small areas of stone mosaic work.
Analysis of the condition of the building's facing materials showed a high degree of deterioration, some natural, in other words the result of normal aging, and some abnormal.
The materials used on the three elevations analysed are Tuscan travertine, ophicalcite (Verde Issorie), and white granite (Montorfano). The areas finished with stone mosaic work are in Apuan cipolin.
Investigations were conducted in increasing levels of detail in order to:

- Identify and classify the stones used
- Determine the original properties of each
- Investigate and where possible reconstruct the installation process and the means by which the various materials are held in place
- Investigate types of support and retention.

The following methods were adopted:

- Inspection using mobile scaffolding.
- Inspection from balconies, loggias and roofs.

- Inspection from inside the building, which involved demolishing limited portions of hollow tile walls to reach the exterior cladding.
- Inspection of cornices, front panels on balconies and the tops of façade projections. Where necessary to facilitate inspection, sections of the lead roofing were removed after freeing them from the restraints securing them to the structure.

After identifying the materials and determining their state of degradation, it was essential to achieve a better understanding of each stone used and subsequently identify the forms of alternation that were evident in situ.

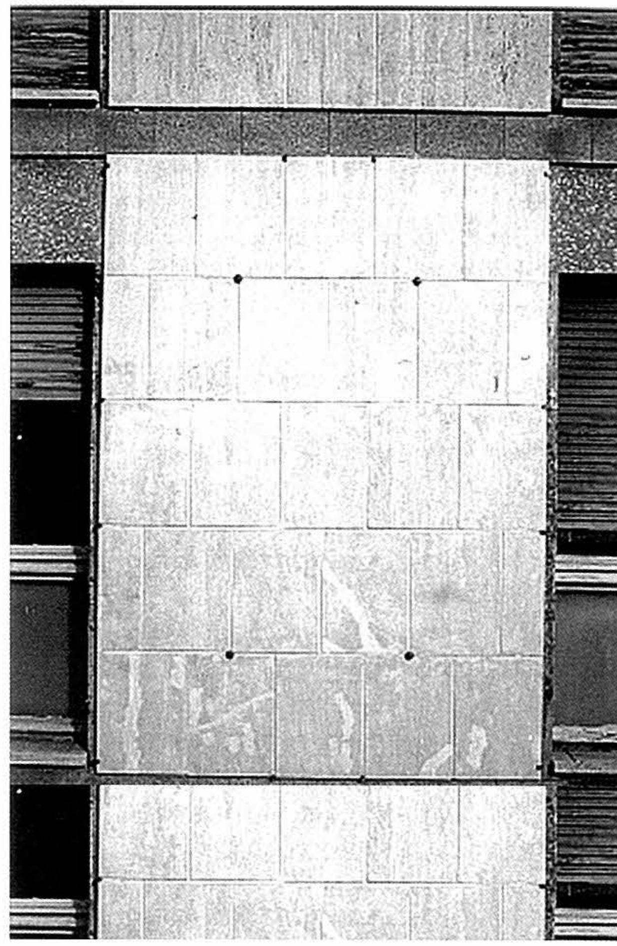
Travertine is used for three types of elements: cladding slabs, door sills, window sills and balcony edging slabs, and large facing slabs carved from solid blocks over the cornices.

The cladding slabs (measuring 64 x 45 cm and 23 x 45 cm) are secured to the masonry support by a method commonly employed at the time of construction, which involved using a thick layer of mortar extending over almost the entire surface of the slab, with one or two round section galvanized steel cramps at the top. One end of each cramp is embedded in the façade masonry, while the other is formed into a hook inserted in a hole in the upper edge of the slab.

The door/window sills and balcony edging slabs (respectively 4 and 8 cm thick) show deterioration resulting from natural aging and insufficient maintenance. This deterioration has caused fragments to become detached, some of considerable size – 10 to 15 cm2 in cross section. This deterioration is accentuated by the fact that the material used was not of particularly high quality, and thick slabs were cut and laid in such a way that the planes along which they were oriented in the bed are positioned vertically and parallel to the plane of the façade.

The large facing slabs over the cornices, though varying in profile to some extent, are provided with a key which engages the carefully plastered reinforced concrete support. This key is large enough to extend along the entire length of the facing slabs.

In addition, flat metal brackets on the outer surface of the facing slabs connect them to the load-bearing concrete structure. The most significant technological feature, however, is the braided metal cable approximately 3 mm in diameter (similar to those used for prestressing in the production of prefabricated reinforced concrete beams) located in a slot a few centimetres deep and protected by plaster which is almost invariably in excellent repair. This measure has ensured that the cornice facing slabs are compact, free from cracks and in good condition.



Panel of rectangular Tuscan travertine slabs. The string course slabs consist of white Montorfano granite.

Ophicalcite is chiefly used for two elements: the solid vertical jambs alongside each of the doors and windows, and the cladding on the ground floor pilasters.

Almost all the jambs have deteriorated virtually beyond repair, in terms of both colour and loss of cohesion in the stone itself, which has led to the detachment of large fragments.

Montorfano granite is also used for two elements: the slabs covering the string courses and all the large cladding slabs used on the projecting bay on the building's main front. This granite is in the best condition of all the materials used in the building, though its appearance has suffered from accumulated dust and smog.

Petrographic identification and physical-mechanical features of the stones used in the building (M.G.S.)

As indicated earlier, three different stones are used on the building's façades: travertine, ophicalcite and granite.

The Travertine is characterised by a warm off-white colour marked with many macro-pores. From its

general appearance, it can be identified as light Tuscan travertine from Rapolano (Siena). Its first documented use in Turin was in the 1930s, when it was employed in constructing the new Via Roma. In the case in question it covers most of the façade surfaces, where it is mounted in panels consisting of large rectangular slabs. It was also used for the cornices, carved to specifications directly from solid blocks of varying lengths, with the resulting sections installed end to end.
It is likely that these elements were originally dressed to a smooth finish. Though slightly whitened, the surfaces do not currently show signs of significant deterioration except in certain limited areas. Grouting was well executed and very little has become detached after 50 years.
The data sheet for Tuscan travertine shows values which are average for Italian travertines, while flexural strength compares favourably with the rest of this category.
The Ophicalcite is an overall cool green with slight white veining and is uniform in appearance. It is a prized variety from the Valle d'Aosta, most likely Verde Issorie. The quarries were opened in the 1920s, and use of this stone in Rationalist buildings in Rome[1] in the subsequent decade is documented.
This stone was used for the solid jambs on all doors and windows, as well as for the large slabs cladding the pilasters and ornamental columns on the ground floor.
The original polished finish has worn off, and the material has undergone profound changes in colour and substance as indicated by a general discolouration. Fragments, some of them quite large, have become detached in the areas most affected by deterioration.
The data sheet for Verde Issorie shows properties that are average for the category, with the exception of compression breaking load after freezing: Verde Issorie is not a frost-proof material. This problem would seem to be responsible for its widespread deterioration on the building, most evident on areas with a northern exposure.
Under close examination the white Granite shows the cold tones characteristic of the Montorfano quarries on Lake Maggiore (VB). This stone was probably first used in Turin in the 20th century.
The colour has been affected by abundant dark deposits, though these can be removed fairly readily. There are no signs of deeper degradation.
The granite is used on all string courses. On the lower section of the building, on the corner of Via Cernaia and Corso Galileo Ferraris, it is also used to provide vertical punctuation on the façades.

Ornamental column clad with slabs of Verde Issorie. The extensive degradation can be clearly seen. The rest of the stone facing consists of Montorfano granite.

Laboratory testing of deteriorated materials

Tests were carried out to determine the properties of the materials as installed in order to compare them with those available from the literature regarding materials that are not affected by degradation. Testing included petrographic analysis and checks on apparent density (mass per unit volume), imbibition coefficient and ultimate tensile strength under indirect traction by bending.Tests were carried out in accordance with UNI 9724.Only the travertine and the green marble were examined, as the granite showed no particular degradation problems.

Results

Verde issorie

The specimen of *Verde issorie* was taken from a 5-cm thick slab on one of the ornamental columns. Seven test pieces measuring 120 x 30 x 20 mm were prepared. At this stage, care was taken to ensure that one of the major faces of the test piece corresponded to the exterior surface of the slab. At the time the specimen was cut, the loss of cohesion in the material was found to be such that it was difficult to prepare test pieces because of frequent fractures. As measured parameters necessarily relate to the portions of the material that remain cohesive, interpretation is thus adversely affected.

VERDE ISSORIE

TEST RESULTS AND COMPARISON WITH VALUES FROM THE LITERATURE

	Apparent density [kg/m³]	Imbibition coefficient [% by mass]	Ultimate tensile strength under indirect traction by bending [Mpa]
Average of 6 test pieces	2.655	0,80	15,03
Data sheet values[2]	2.745	0,59	20,10

Apparent density shows a reduction in the order of 3%. This can be considered high, and indicates an increase in the material's total porosity as a result of intergranular micro-lesions propagating from the exterior surface. The increase in porosity is also confirmed by the higher imbibition coefficient. Ultimate tensile strength is approximately 25% less than that of the material as quarried. All data, and the latter in particular, confirm that the changes in the material are so extensive that it can no longer perform its functions under safe conditions[3].

Light Tuscan Travertine

The test specimen was taken from a 3 cm thick slab on the wall of the third-floor balcony.

At the time the specimen was cut it was found that internal cavities of above-average size were filled with earth and clay deposits showing a certain degree of cohesion[4].

LIGHT TUSCAN TRAVERTINE

TEST RESULTS AND COMPARISON WITH VALUES FROM THE LITERATURE

	Apparent density [kg/m³]	Imbibition coefficient [% by mass]	Ultimate tensile strength under indirect traction by bending [Mpa]
Average of 7 test pieces	2.156	5,15	9,52
Data sheet values[5]	2.380	0,81	13,40

In this case, the approximately 9% reduction in apparent density and the fact that the imbibition coefficient is more than six times higher than that of the material as quarried do not denote degradation. Rather, these values reflect the irregular composition of the test pieces, where the presence of earth, clay and plaster fill falsify measurements because these materials are much more porous than travertine. Likewise, the reduction in ultimate tensile strength (-40%) is certainly not due to changes in the material but to the internal cavities that reduced the effective cross sectional area.

Here then the influence of degradation cannot be determined, as test results are affected by the presence of clay and plaster fill and by an unusual quantity of macro-pores. It can thus be concluded that the travertine used was not a high-grade material.

Notes

1. Post Office Building in via Marmorata, Rome, architect Adalberto Libera (1932-1933); EUR SpA Headquarters, designed by Gaetano Minnucci (1932-1933)
2. Manuale dei Marmi Pietre Graniti, CD Rom, Milano, 1996
3. Visual inspection of this degradation had already prompted the owners to take temporary measures to ensure safety.
4. Similar filled cavities had been observed in areas where fragments had become detached along the outer edges of some sills and slabs.
5. Manuale dei Marmi Pietre Graniti, CD Rom, Milano, 1996

Cladding Technology, from Slab to Precast

Building requirements today impose increasingly rapid construction speeds; building sites have become more assembly areas than manufacturing areas, with benefits not only in economic terms but also in product quality. External stone cladding has followed the same trend, and can respond to requirements that are becoming similar everywhere in the world. The producers of Italian stone are aware of the process, as they are accustomed to supplying stone products to the most advanced markets (USA, Great Britain, Germany, France, Japan, and China in more recent times).

Marco Antonio Ragone

The need to satisfy the requirement for rapid completion of external cladding has led to the creation of new prefabricated products which are certainly a great advance over traditional systems. This is true in not only in terms of the general quality of the building but also in terms of safety and manufacturing precision. There are three main categories of prefabricated stone cladding: precast concrete panels, prefabricated panels with a metal frame and/or curtain wall, and lightweight prefabricated panels.

Prefabricated panels in precast concrete
With this system, the stone slabs are placed at the bottom of a casing with the processed side (polished, dressed or roughened) facing down. On the backs of the slabs there are pairs of holes at 45°, about 1,5 cm deep, containing ivy- or omega-shaped clips or dowels made from stainless steel rods. Once the slabs forming the panel have been placed in the casing, the joints are closed with tape, a sheet of polyethylene is inserted to protect the stone, and metal reinforcements (which must be galvanised to avoid the risk of rust in contact with the stone) are put in place. The concrete is then cast, covering the reinforcement and the clips or dowels to make the entire structure a single unit. The polyethylene insertion helps avoid infiltrations into the stone which might damage the cladding, and also enables the concrete and the stone to move

Grande Arche, Tête Défense in Paris, arch. Otto Spreckelsen, 1988. Photo: Jean Pierre Buffi et Associès

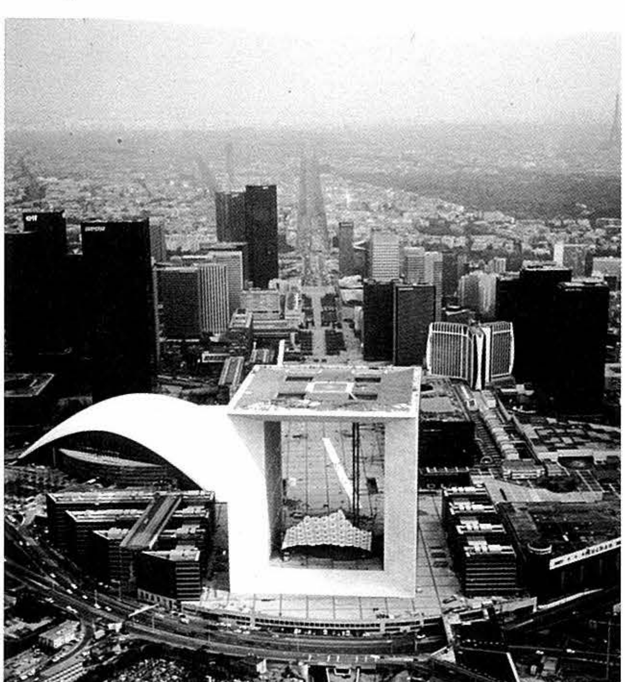
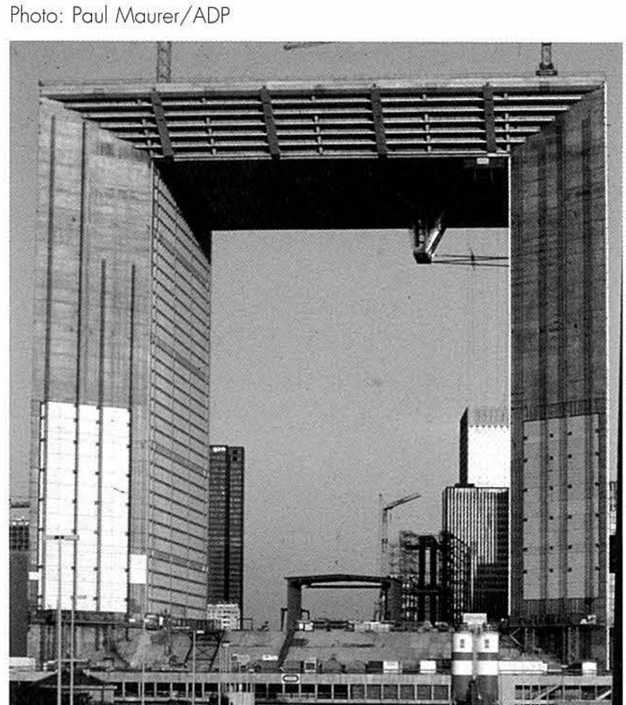


Photo: Paul Maurer/ADP



independently of one another where there are different rates of thermal dilation. As already mentioned, the bond between stone and concrete is ensured by the clips or dowels immersed in the concrete, since the polyethylene prevents the transmission of loads by means of adhesion. The metal rods used for the clips or dowels are 4 or 6 mm in diameter, very closely spaced on the back of the slabs (between 6 and 10 pairs of clips or dowels per square metre of stone). This naturally prevents the stone from separating. The sections of the clips or dowels in contact with the stone should be covered in rubber sheaths to help the metal absorb the dilation differences in the cast and thereby help increase resistance to shear. The precast panels, where the stone slabs can be no more than 2,5 cm thick, compared with the traditional minimum of 3 cm, are particularly suited for use in areas where the risk of seismic shock requires absolutely safe cladding.

Prefabricated panels with metal frame and/or curtain wall

This type of panel basically consists of the stone cladding slabs and a metal frame (made from commercially available tubular or box-section strips welded together) with elements connecting the frame to the slabs (anchors). This prefabricated module can be made either in the factory or, less frequently, on-site using a work area where the individual elements of the panel are assembled. Its main advantages are that it is very light and that it offers considerable resistance to torsion and flexure. It is also able to effectively absorb loads placed upon it, and it simplifies all prefabrication, assembly, transport and installation operations. The stone is fastened to the frame using classic anchoring systems like those used in traditional cladding, or by means of bolts or inserts applied to the cladding slabs and then connected to perforated plates previously welded to the frame. The metal frames may be installed vertically (from floor to floor, with window frames already in place) or horizontally (hooked to the load-bearing floor slab and simultaneously acting as a parapet under the window of that floor as well as a spandrel for the window on the floor below). The lightness of the metal frame facilitates assembly of the cladding, but also means that the building structures can be designed to accommodate lesser loads. Factory prefabrication process also ensures higher levels of quality, since it can be carried out using the proper instruments and an appropriate environment, within a specially organised process. It reduces construction time for the building, which is already prepared for the installation of the cladding once the load-bearing structure has been completed, thus also facilitating the internal finishing work. It helps improve building-site management, because it eliminates the need for scaffolding and storage areas as well as lowering the risk of damage to the materials, and reduces the number of workers required for assembly to the bare minimum. The metal frames can be made of stainless or galvanised steel – the choice, apart from contractual or regulatory requirements, depends on environmental conditions: particularly harsh conditions

Photo: Michele Begali

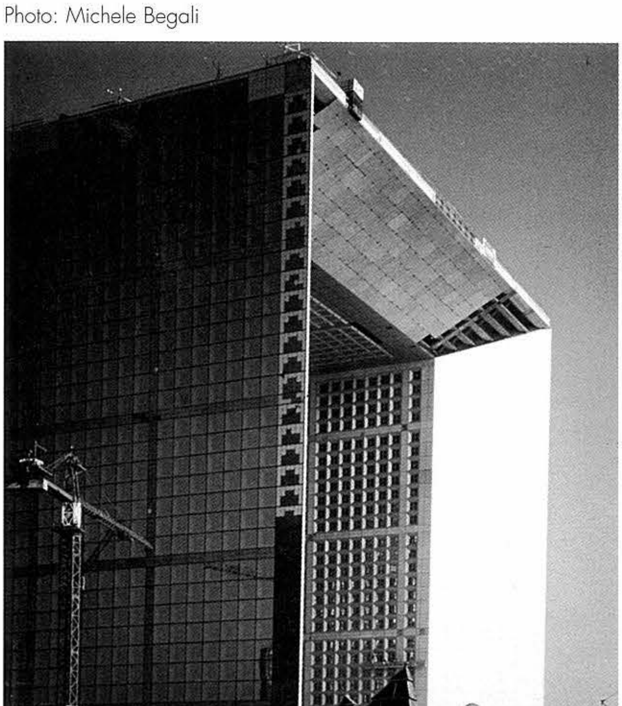


Photo: Paul Maurer/ADP

call for stainless steel. It also depends on economic factors: leaving aside safety issues, cost considerations tend to favour the choice of galvanised steel, since more semi-finished products are available. If a galvanised steel frame is chosen, galvanic separators need to be inserted where contact is made with the brackets – which are always stainless steel – so as to avoid the risk of bimetallic corrosion. Galvanised steel is generally used where environmental conditions are not particularly severe and no humidity is present, while stainless steel is always to be preferred in aggressive environments. The curtain wall is a further step forward from the metal frame, in that it constitutes a complete unit, with door and window frames as well as fittings. This means that once installed it requires no further processing.

Lightweight prefabricated panels

One of the most important innovations in the sector, thin stone (which can be as little as 4 mm thick) is a significant development which opens the way to new applications. Such thin items naturally need to be reinforced with appropriate supports, since the stone on its own would be excessively fragile. Production possibilities these days depend not only on the type of stone but also on the type of support involved: items currently available on the market range in weight from 15 to 25 kg/m^2. This technique thus makes it possible to obtain extremely light semi-finished products while maintaining unaltered, and sometimes even improving, the performance and characteristics of the stone, which is naturally unsuited to flexure. The panels are made by bonding the stone to supports in fibreglass, honeycomb aluminium or sheet steel. The subsequent sanding, polishing and cutting operations are carried out using the same techniques used for normal semi-finished products and make it possible to produce a range of items, as shown in this table.

The new hall at the Fiera of Carrara

The cladding used for the new Carrara hall is a good example of how these new products can be established on the market despite costs being higher than those for traditional cladding methods. In the Carrara hall the structural characteristics of the building required lighter loads than could be obtained with traditional 3 cm slabs. This led to the decision to use thin marble on a honeycomb backing which tests proved to be surprisingly resistant to flexure, even after frost treatment in an aggressive environment. The panel manufactured for cladding consists of 1,25x1,25 m modules anchored to a metal frame totalling 7,70x2,50 m. The panel weighs 436 kg. Installation was carried out by a team of three men with a crane and cage, and the 312 m^2 facade was completed in three working days (from Tuesday to Friday).

Photo: Paul Maurer/ADP

TYPE OF SUPPORT	THICKNESS mm	SIZE cm	MATERIAL
Bonded fibreglass and steel	7	120x270	marble
	7	150x300	granite
	4,5	120x270	granite
Bonded fibreglass	7	120x270	marble and granite
Sheet steel and insulating material	7	60x240	marble
	7	60x270	granite
Honeycomb aluminium and bonded fibreglass	4	120x270	marble and granite

Stone-Faced Precast Panel Technology

Monitoring and Intervention Techniques for Stabilization

Precast panel technology was used to express the International Style of the 1950s in the United States and has required intervention over the past few years. The United Nations Headquarters and Lincoln Centre for the Performing Arts, both in New York City, and the Governor Nelson A. Rockefeller Empire State Plaza in Albany, New York range between thirty and fifty years old. Although these buildings complexes are young, political constituents and historians argue that they are monuments that must be preserved. As a result, engineers, architects, and conservators have been commissioned to document and physically monitor these monuments, beginning with their exterior facades.

Kyle C. Normandin

The technical challenges of preserving stone-faced precast panels not only involve finding aesthetically acceptable repair/replacement materials, but also include addressing the structural characteristics of these types of materials and building systems. Precast panels with marble veneers have been used in a variety of sizes and in the design of unique building forms; they have been used to form curtain walls, window walls, column facings, cantilevers, soffits, and other aesthetic configurations. Structurally, precast panel units are attached to the building frame with various fastening methods and devices, allowing design provisions for expansion and contraction of the panel system. However, in light of these characteristics, how can we address the material and structural failures of these types of composite panel systems? What happens when we cut, drill, pin, patch, and retrofit them? Can we approach the repair of these buildings using similar types of repairs used for traditionally built masonry and concrete structures? While selecting types of mortar patches, dutchman (or indents), and anchor pins may be appropriate for some historical constructions, these types of evident repairs could compromise the architectural expression and technical ingenuity of Twentieth-century curtain wall systems.

The complexes

Three complexes are addressed in this paper: the United Nations Headquarters (UN), New York City, constructed between 1949 and 1953; Lincoln Centre for the Performing Arts (Lincoln Centre), New York City, constructed between 1962 and 1968; and the Nelson A. Rockefeller Empire State Plaza (ESP), Albany, New York, constructed between 1965 and 1979 (Newhouse, 1989). The planning and design of individual buildings within each complex was done by world renowned architects. New York City architect Wallace K. Harrison is listed as the lead architect and was appointed the director of planning at each of the complexes. In total, the three complexes cover an area of over 60 hectares (150 acres) and consist of approximately twenty buildings. The facades of these buildings are finished either with an aluminum and glass curtain wall or a dimensional stone cladding, or a combination thereof.

Identification of curtain wall technology

The architectural conception of buildings of the International Style are defined by the construction of their exterior walls. The facade and the structural elements represent a distinct form that determines the aesthetic character of the building. The curtain wall system comprises the aesthetic and volumetric massing of the building and identification of the exterior cladding system is critical to assessment of the building. If a repair program cannot be implemented or sustained, an intervention may be required to stabilize the curtain wall system. However, if the aesthetic character of curtain wall system is altered, both stabilization and repair measures must maintain the character of the original building. This requirement may impose certain limitations on the potential scope of repairs or treatments, in order to conserve the original material components and maintain the original architectural expression of the building.

Panel System Typology and Classification

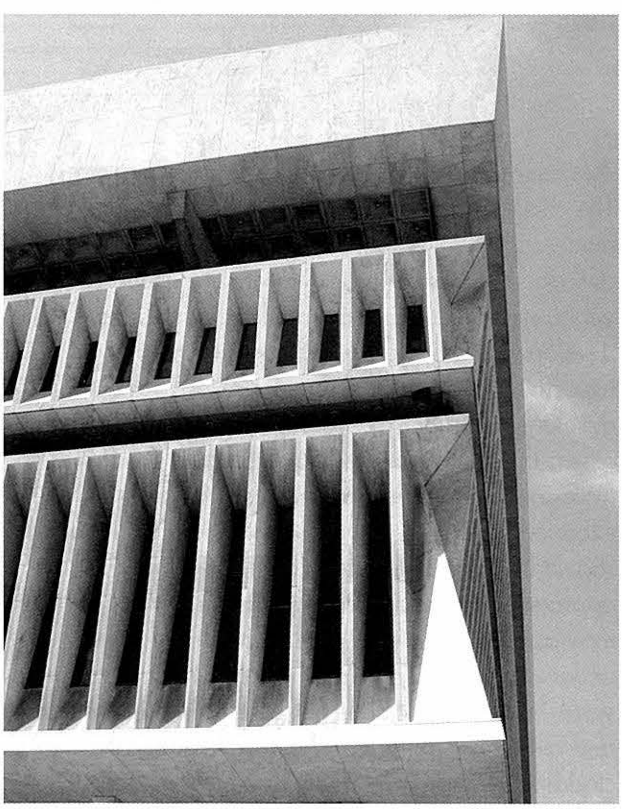
Classification of modern precast panel systems should be defined not only by the building style but also by aesthetic components within a given stone cladding or curtain wall system. The building typology should be defined by (1) the building aesthetic (2) the curtain wall system (3) the cladding material (stone type) and if possible, (4) the specific anchor design. As such, the building typology, building components, and how they perform with the building structure must be understood as a basis for informed recommendations that address structural and aesthetic issues while preserving the original design of the building.

Stone-Faced Precast Panel Systems

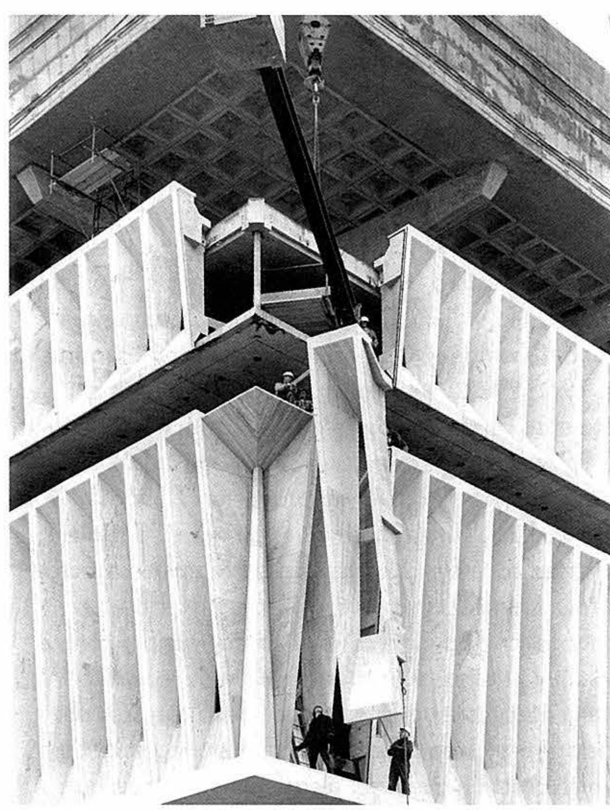
In the early 1960s, stone was successfully used to face precast concrete units. The use of the stone-faced precast concrete panels (concrete panel clad with a thin stone veneer) was popular due to the rapid production and deployment of precast concrete units. Erection of the marble-faced precast elements was a relatively simple process. Prefabricated stone veneer precast panels could be manufactured to meet elaborate design configurations and could be produced rapidly and cost effectively. Both the Juilliard School at Lincoln Centre in New York and the Cultural Education Centre at the Empire State Plaza, were built using large assemblies of stone faced precast concrete panels that were premanufactured and hoisted into place to speed the building erection and reduce construction costs. The *National Association of Marble Producers* listed types of anchorage supports for attaching stone panels to the concrete substrate, for repairs using a sound section of stone to be doweled and epoxied with "hairpin" anchors into place. These precast concrete units faced with marble (2 cm thick at Juilliard School and 2.5 cm thick at Cultural Education Centre) came in various

Cultural Education Center (CEC) at the Empire State Plaza, Albany (N.Y.), W. K. Harrison. Photo: Kyle Normandin

Cultural Education Center: close-up view of stone-faced precast panel system. Photo: Kyle Normandin



Cultural Education Center: typical installation of a vertical marble faced precast panel unit. Photo: New York State Archives

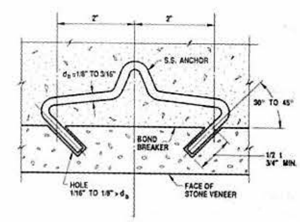


prefabricated sizes to provide an infinite number of marble pattern possibilities; moreover, these units provided various possibilities for overcoming design challenges and erecting 'modular' elements of a particular building.

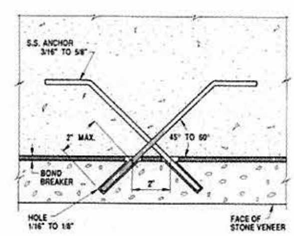
Monolithic Stone Walls

Common to most of the buildings at all three complexes is the idea of the "slab" wall construction. The massive stone wall or monolithic stone wall configuration was a signature architectural element of the International Style. Throughout the 1940s, a "Corporate Internationalism" had taken shape in the U.S. with the Equitable Life Assurance Building in Portland, Oregon, designed by Pietro Belluschi, and with complexes such as the United Nations Complex, led by a design team of Wallace Harrison, Le Corbusier, and others in New York City in 1950. By 1968, Pietro Belluschi had transformed the graceful, aluminum-framed, marble-clad building type represented by the Equitable Building into an equally elegant rectangular building that combined the demanding program requirements of the performing arts school with the restrained contextual requirements of the Lincoln Centre complex, which included the use of travertine as a stone cladding. Combining methods of prefabrication and mass production, Belluschi used an engineered system of stone veneer panels adhered to precast concrete panels on four facades of the Julliard, designing within the idiom of the International Style. Belluschi's seamless design created a continuous appearance of single monolithic load-bearing masonry stone walls remniscient of antiquity, certainly recognized as one of the finest buildings constructed at Lincoln Centre.

The monolithic stone wall was transformed by Wallace Harrison's design of the Cultural Education Centre (CEC) at Empire State Plaza in Albany, New York. Partially inspired by Le Corbusier's Unité d' Habitation constructed in 1953 and later by the Armstrong Rubber Company Corporate Headquarters constructed in 1965 by Marcel Breuer, Harrison designed an immense concrete block raised up on a colossal sculptural *pilotis*, giving rise to a megastructure that occupies over 126,670 square meters (1,363,500 square feet). Parallel to the design of Le Corbusier's inverted concrete columns and cast in place concrete forms, Harrison shaped the building over a vast orthogonal grid plan of inverted trapezoidal concrete columns. The facades are draped with repetitive elements consisting of patterned deep recesses of factory-produced precast concrete standardized units, which create a lively yet elegant unity across the facade of the building. Harrison utilized composite panels composed of 2.5 cm (1") thick Georgia Cherokee white marble veneer over precast concrete backing that were shop formed into large window like marble frames that hung from the cantilevered building structure. Marble-faced precast panels ranged in thickness from a minimum of 2 cm (7/8") to approximately 5 cm (2"). Stainless steel preformed toe-in spring clip (hairpin) anchors were typically inserted from the back side of the marble to one-half the thickness from the face of the veneer and embedded 7 cm (3") to approximately 18 cm (7") into the concrete backing, while the composite framed sections were connected to the building structural frame using cast in place slotted anchor bolts. These composite framed sections ranged in height from one to three stories and measured an average 122 cm (4'-0") in width by 975 cm (32'-0") in height. The bolt connections were typically located at the top and bottom sides along the vertical edges of the composite framed sections.



Stainless Steel "Hairpin" stone veneer anchors.
Drawing: Wiss, Janney, Elstner Associated, Inc.



Stainless Steel stone veneer dowell anchors.
Drawing: Wiss, Janney, Elstner Associated, Inc.

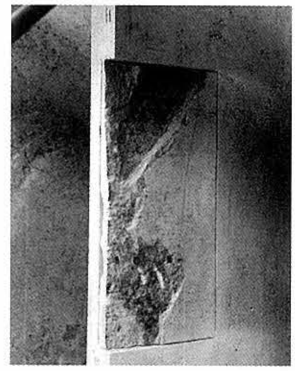
Assessment of ongoing repair program

The challenges of stone cladding stabilization are numerous and their assessment cannot be fully described in this paper. However, over the last fifty years, stone-faced precast concrete panels have developed considerably and continue to change, especially in regard to the methodology for developing a repair program. In order to properly assess the condition of composite panel systems, a materials testing program including petrographic examination and compositional analysis of materials should be undertaken to gather information for a appropriate stabilization program. Structural analysis may also be required. A stabilization program underway at Lincoln Centre for the Performing Arts since 1986 also includes periodic on-site inspection and ongoing monitoring of the travertine stone cladding. Although many types of repairs can be implemented for thin dimension stone veneers and cladding, the examples of repair types used on this project and described here are in sound condition after more than a decade of performance and maintain the aesthetic integrity of modern stone construction.

Full Panel Replacement

A full panel replacement requires installation of a new stone veneer, dimensioned and cut to match the original stone to be removed. Typically, a new panel replacement is recommended when a significant distress condition is identified in the original stone veneer. A full panel replacement (rather than localized repair) may also be a desirable solution in order to maintain the original design intent and modern aesthetic of the building. Examples of significant distress conditions include delamination between stone veneer and concrete substrate at locations of multidirectional cracking that jeopardize the structural integrity of the stone-faced precast concrete panel. Lateral anchorage between the travertine faced precast concrete panel is achieved with stainless steel pre-formed hairpin anchors epoxied into the travertine veneer. A full panel replacement requires removal of the existing stone veneer and any existing clips or dowels. Holes are drilled into the concrete panel substrate and backside of the new stone veneer and new stainless steel double head expansion bolt anchors are positioned into the concrete panel prior to setting of the new travertine veneer. A field test of a sample panel replacement is required in order to test the integrity and aesthetic effectiveness of the repair.

Through the development of a stabilization repair program for the Julliard School, concerns arose out of the use of a dutchman (indent) or patch repair versus a full panel replacement. Under both instances, recommendations were made to replace the entire panel for both structural and aesthetic reasons: (1) structurally, the full replacement of a panel with new stainless steel anchor connectors is a more appropriate long term repair, and (2) aesthetically, the full replacement of a stone panel maintains the original design intent of the travertine-faced precast stone panel system. In most cases, the textural and porous appearance characteristic of the travertine stone cladding permitted the repair stabilization to eventually blend in well with the original surrounding stone veneer panels. Equally challenging will be to develop a comprehensive repair program for the Georgia Cherokee marble veneer precast concrete panels at Empire State Plaza.




Repair Assessment:
- dutchman repair at marble fin;
- and a 'Stitch' repair in progress with 'U' clamps at each end of crack. Photo: K. J. Beasley

Conclusion

In considering measures appropriate to repair and stabilization of modern buildings constructed within the International Style, there remain many challenges in delineating the range of repairs appropriate for stone clad buildings such as Lincoln Centre, the Empire State Plaza, and the U.N. Headquarters. The opportunity to implement and monitor repair programs at Lincoln Centre for the Performing Arts and provides relevant experience for repairs to the travertine stone cladding on other buildings and for the development of repairs to other stone cladding. Although modern buildings clearly will require intervention to stabilize the stone cladding systems, the question to be answered for each building remains, what types of repairs will be most effective with the minimal amount of intervention?

References

American Society for Testing and Materials, *Standard Terminology Relating to Dimension Stone*, West Conshohocken (PA), 2000, C 119 – 00b

Beasley, Kimball J., "Use and Misuse of Exterior Travertine Cladding", *Journal of Performance of Constructed Facilities*, 4, New York (NY), 1988

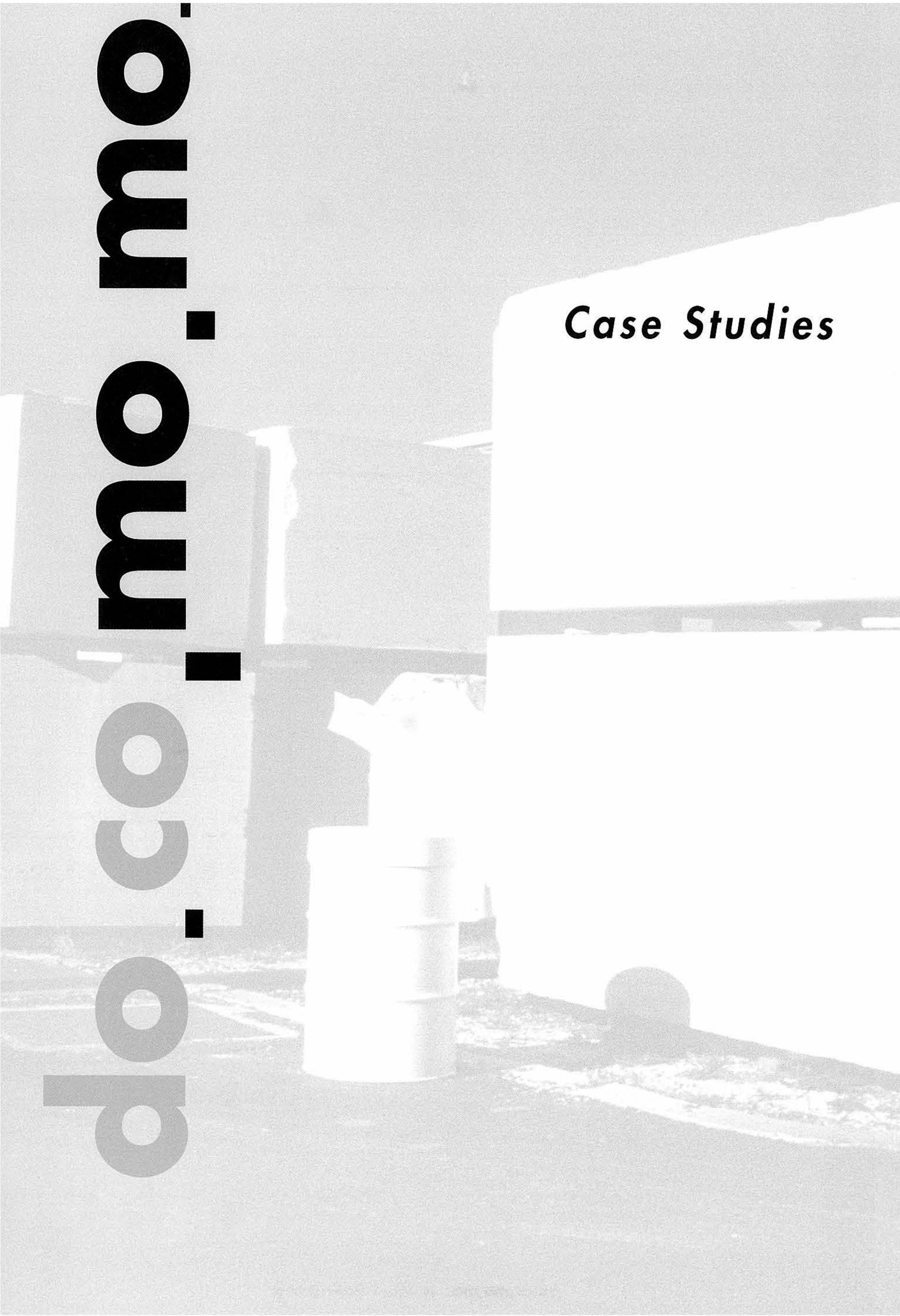
National Association of Marble Producers, *Marble-Faced Precast Panels*, IIT Research Institute, Chicago (Illinois), 1962

Newhouse, Victoria, *Wallace K. Harrison*, Architect, Rizzoli, New York (NY), 1989

Precast / Prestressed Concrete Institute, *PCI Design Handbook*, Fourth Edition, Chicago (IL), 1992

Acknowledgments: *The writer wishes to acknowledge the assistance of Kimball J. Beasley, Principal of the New York office, and Deborah Slaton, Consultant of the Northbrook Illinois Headquarters, for their technical contributions to this paper.*

This paper has been presented at the Seventh International DOCOMOMO Conference in Paris, September 2002.



Case Studies

Palazzo della Civiltà Italiana, Rome

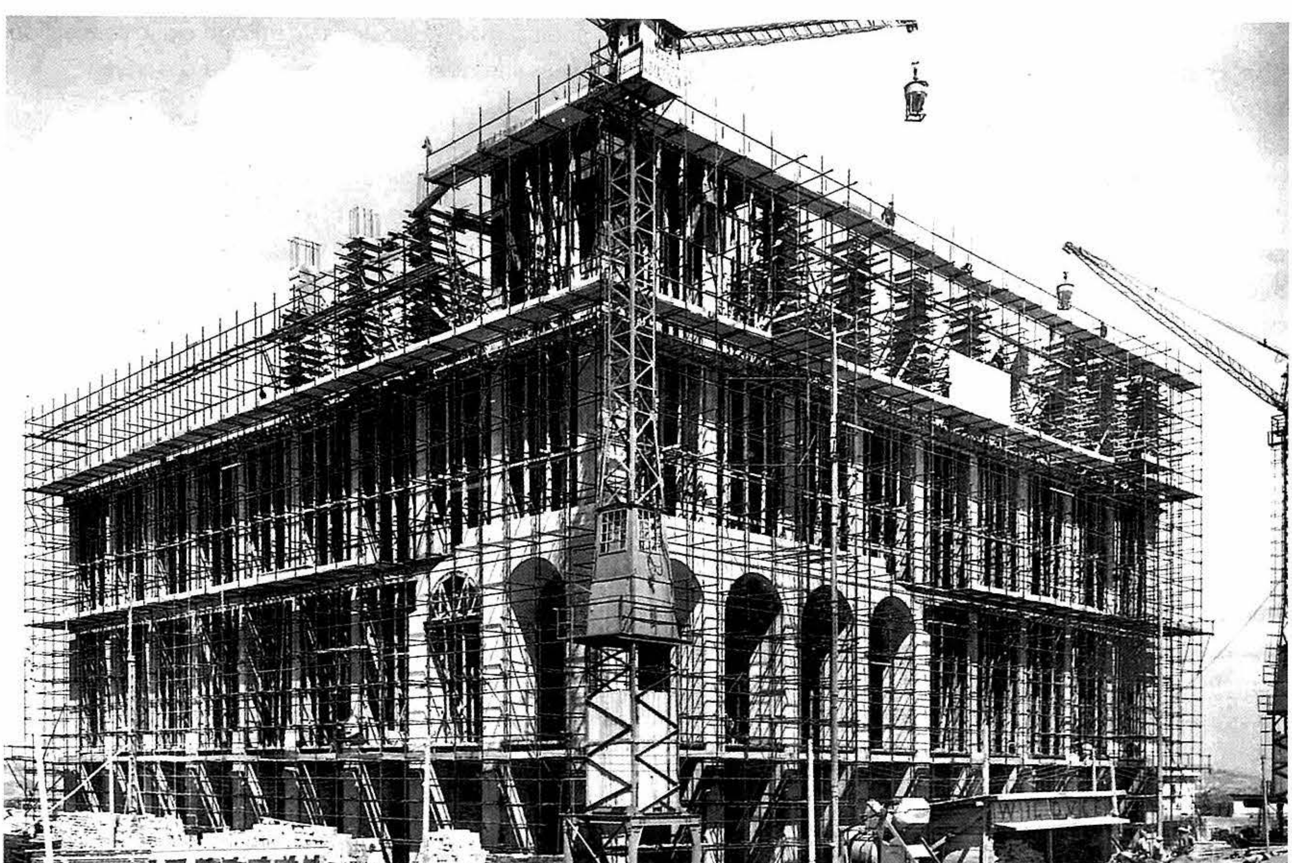
Giovanni Guerrini, Ernesto Lapadula, Mario Romano (1938-1943)

Built to house the Museum of Italian Civilization at the E42 international exhibition, this is one of the most significant buildings of the late 1930s. The load-bearing structure in reinforced concrete meant that some preliminary steps were necessary during the laying of the travertine facing slabs.

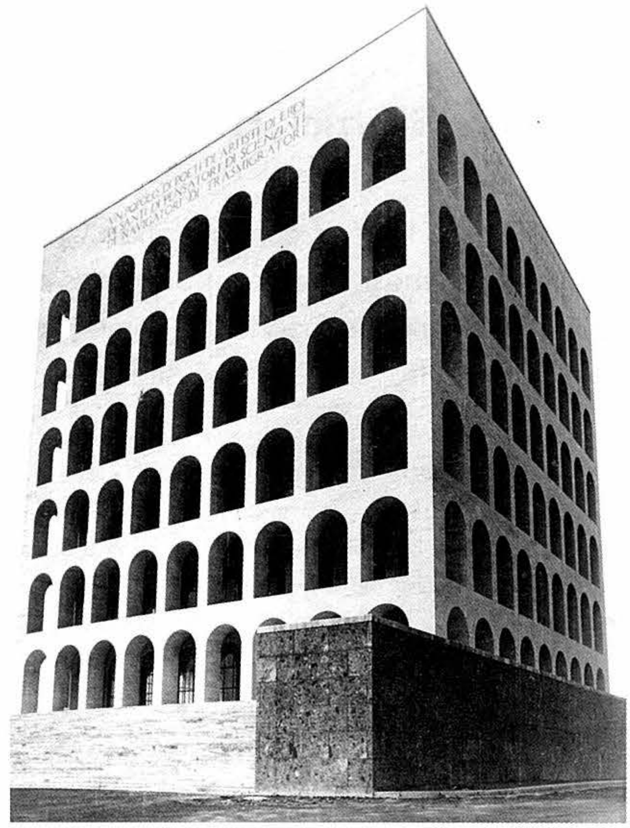
Rinaldo Capomolla

The Palazzo was built between 1938 and 1943 as a permanent home for the Universal Exhibition, which was to be held in 1942 to celebrate 20 years of Fascism.
The E42 exhibition district was to be an eloquent expression of the way Italian architects were coming together to create a grandiose style demonstrating the supremacy of Italian architectural culture.
The architectural project – with a final revision done by Marcello Piacentini, Superintendent of the E42 Architecture Service - was the work of G. Guerrini, E. Lapadula and M. Romano, who decided to give the Palazzo "the majesty of a vertical mass, a solemnity of grandiose proportions, and a clearly Roman Italianness". The building project, however, was then taken up by the Service's engineers, whose director, Gaetano Minnucci, had not only power of approval, but also the authority to modify of his own accord the solutions put forward by the designers. As for the cladding, the Project Development Office of the Architecture Service decided on the arrangement of the travertine slabs and designed the anchoring

The travertine cladding during construction, 1939. Photo: Ufficio Documentazione, EUR SpA



system together with the building contractor.
The Palazzo is a large parallelepiped with a square base of 51.60 m per side, which rises up on a pedestal (the "stylobate"). With a height of 57.75m, the facades were possibly the tallest fully stone-clad facades ever been built in Italy up to that time.
The dominant theme of the four identical facades is an open gallery with no fewer than 216 arches, again all identical. The rhythm of the arches follows the sequence of reinforced concrete frames in the load-bearing structure. And yet the stone cladding is not simply a superstructure suspended from the skeleton, for it is an integral part of a free-standing brick and stone wall which envelopes the pillars and girders. Even so, the reinforced concrete skeleton retains the important function of absorbing the thrust of the arches and vaults of the open galleries, channelling the weight down to the foundations. Without this skeleton, "the building would collapse like a house of cards" (G. Minnucci). As a whole, the ring of the open galleries is more like a 19th-century reinforced masonry structure than a modern skeleton of reinforced concrete with light infills.
This means that the arcades are not just symbolic-figurative elements in a sort of stone "mask", but retain part of the same structural value they have in traditional masonry construction. In other words, the architects did not intend the Palazzo to look as if it were "clad" in stone, but as if it were actually "made" of stone.



The building upon completion of construction work, 1942.
Photo: Ufficio Documentazione, EUR SpA

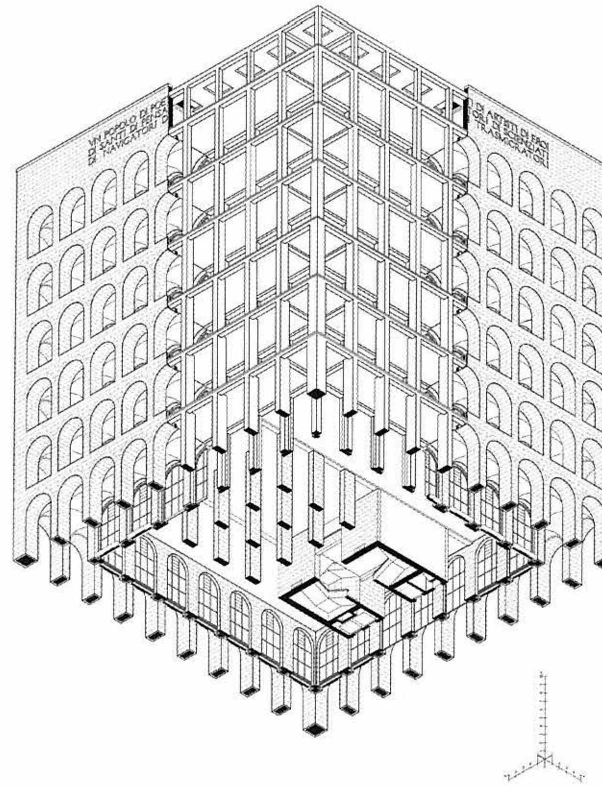
The construction and static properties of the travertine cladding

Let us see how this cladding – consisting of grit-blasted slabs of Roman travertine resting one on the other – was made. The slabs are between 55 and 85 cm in height, up to 210 cm wide, and generally 5 cm thick. There are however some thicker slabs, up to 20 cm deep, especially on the lower floors. The decision to adopt different thicknesses was not designed to achieve particular static qualities – the thicknesses do not increase gradually, and the thicker slabs are always alternated with thinner ones – but to give a monumental appearance to the stone surface even from a close distance when looking upwards: it is no mere chance that the thicker slabs are the only ones whose sides are visible[1]. Moreover, the gradual reduction in the thickness of the slabs on the upper floors helps to accentuate the height of the building when seen from below. This effect is also enhanced by a very slight inward inclination of the façades (about 3cm for each floor): this inclination helps to correct the optical aberration which would otherwise give the impression that the building is falling forwards[2].

During construction, the first problem to solve was that of finding a suitable geometrical and static connection between the slabs and the reinforced concrete pilasters.
The pillars maintain a constant width of 120 cm on all the floors, while their thickness varies between 210 and 193 cm. On the other hand, the reinforced concrete pilasters on the inside taper upwards from 80x165 cm on the first floor to 70x70 cm on the sixth: there is thus a gap of between 5 and 95 cm separating the pilasters from the cladding. This space is filled in with masonry which was originally to have been made of solid bricks, but eventually perforated bricks were used in order to reduce the load on the foundations[3]. The variable thickness of the slabs (from 5 to 20cm, as we have seen) meant it was not possible to make the perforated brick filling first and then add the travertine cladding: on the contrary, it was necessary to make the two parts simultaneously, one layer at a time. The slabs thus rested one on the other although, since the thin and thick slabs alternated, the latter also needed to rest on the brickwork below[4]. This means the pilasters are surrounded by a mixed load-bearing wall consisting of interpenetrating stone slabs and brickwork.

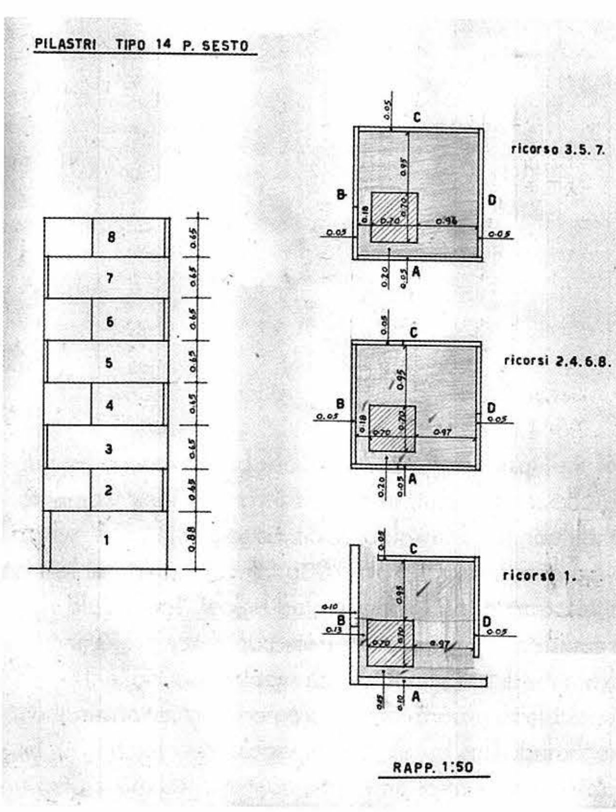
The limited thickness of the slabs means it was not possible to achieve efficient bonding between the stone and the bricks: each slab thus had to be anchored to the masonry with two rod-iron clamps. This construction method means the anchoring is very solid since it is not done in the normal way – by drilling the housing sockets for the clamps into the freshly made wall – but by leaving a slot which is then filled with cement mortar before the layers of brick and stone are applied above it.

Once the pilasters were completed it was necessary to build the arches. The springer slabs (10 to 20 cm, depending on which floor they are on) were then positioned and anchored to the pilasters with sturdy iron clamps. Timber supports were then put into position to hold up the arch during construction: the intrados slabs are 17cm thick and curved, while the front keystone slabs are flat and wedge-shaped, of alternating thicknesses. The arch slabs are held up by mutual opposition, but for safety purposes they are also suspended from the overhead floor slabs by iron tie rods. The stone arch is, however, a true load-bearing arch since it bears not only its own weight, but also two perforated brick supports, two walls closing the space between the arch and the floor slab above, the infill wall behind the front-facing slabs

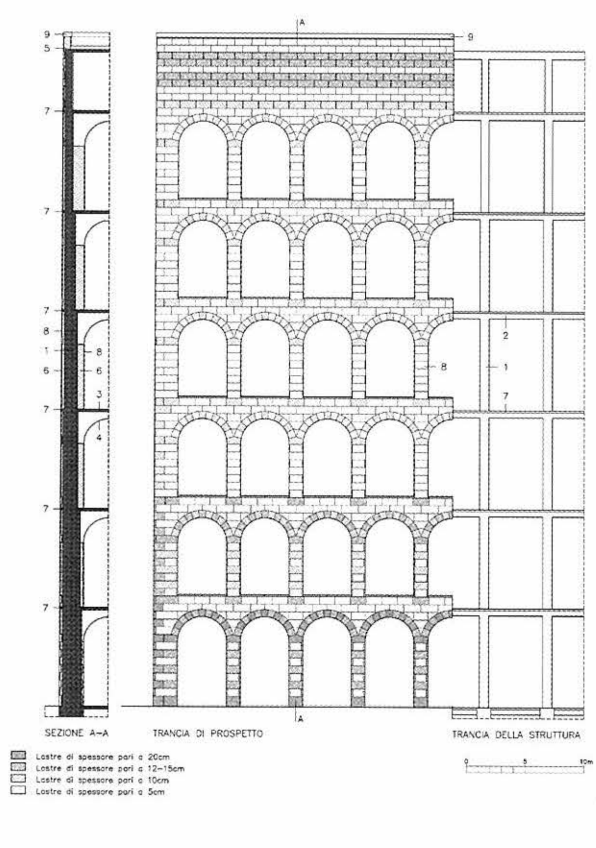


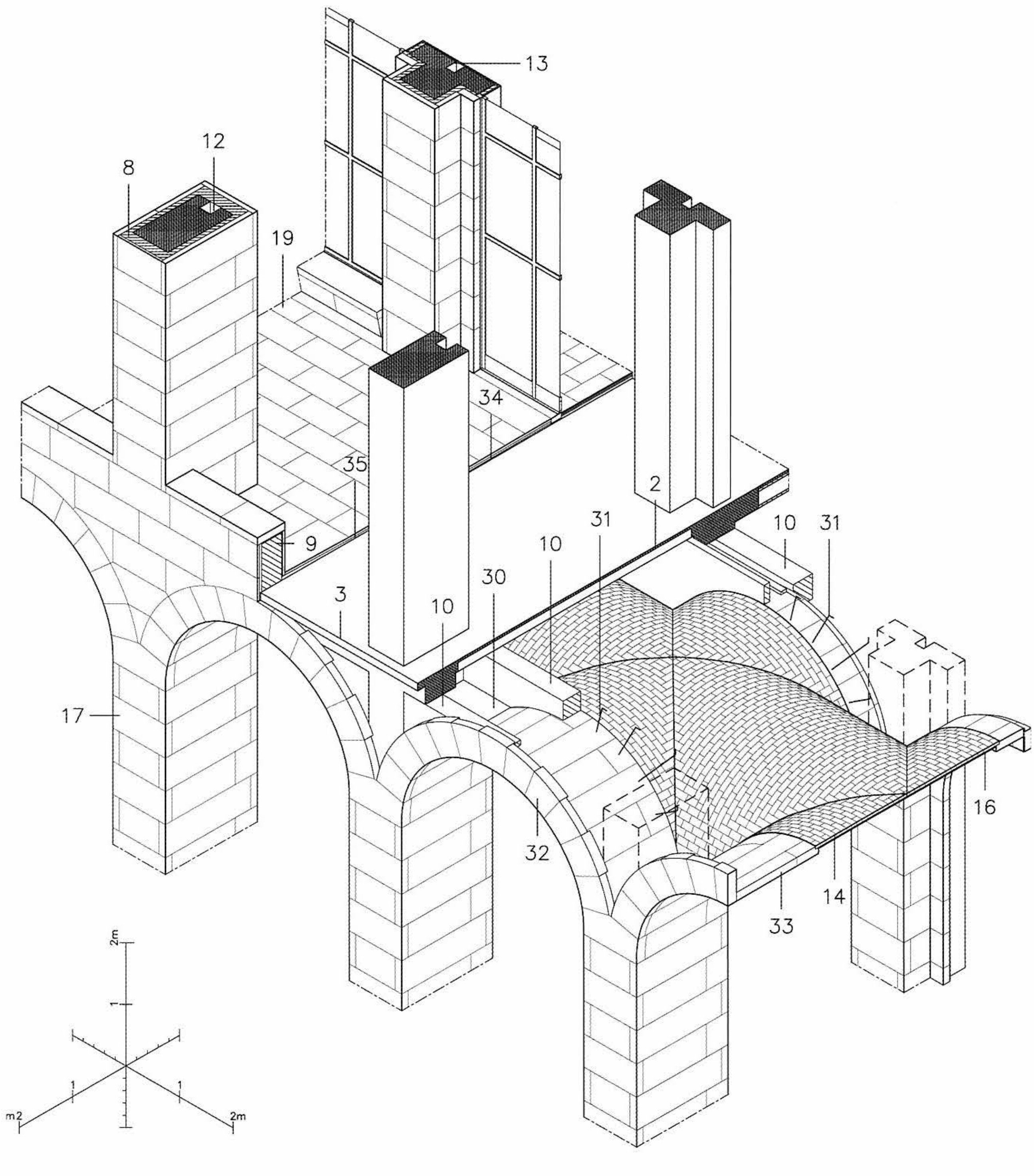
The load-bearing reinforced concrete structure and the arcades clad with travertine. Drawing: D. Floccia

A sixth-floor corner pillar and the contained reinforced concrete pilaster. From: Archivio Centrale dello Stato, Rome



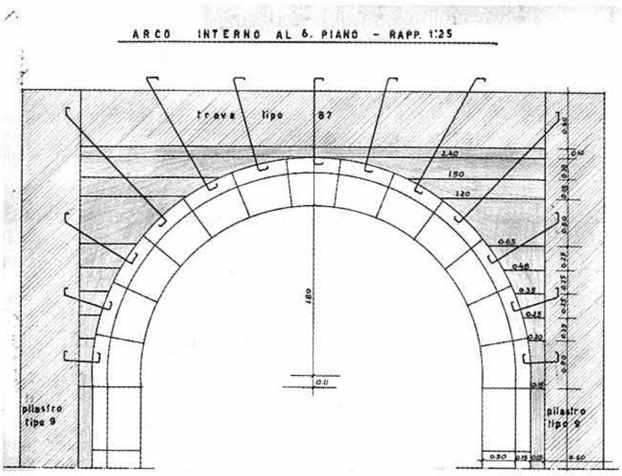
The travertine cladding slabs. Drawing: R. Capomolla



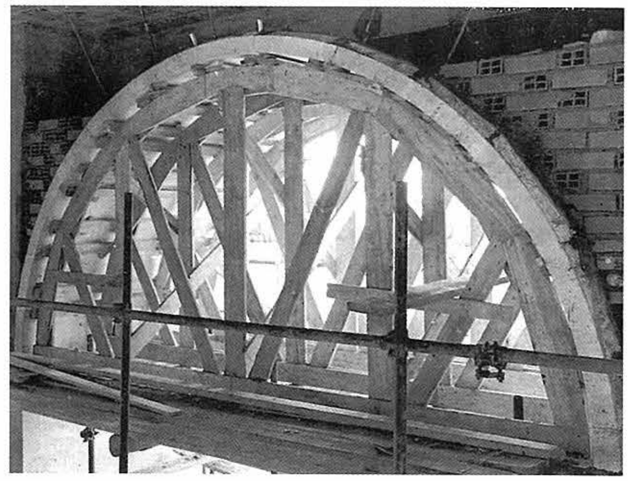


Axonometric section of the loggiato. Drawing: T. Iori

and, via the keystone slabs, the weight of the cladding on the parapet of the upper arches. These loads, together with the weight of the brick ceilings of the galleries, are then transferred down to the stone and brick wall around the reinforced concrete pilasters. The mechanical structure and behaviour of the arches shows that the stone is not used as a face, but as a structural element crucial for the stability of the entire complex.
Once the arches were built and the front-facing slabs of the upper parapet laid, work began on the row of arches above. But, in order to transfer their weight to the floor, the front slab of the base of the pillar, which varies in thickness from 10 to 15 cm, could not rest on the facing already constructed below. This would require a continuous concrete cantilever projecting from the edge beam, which would also make it possible to ensure there were no interruptions in the cladding. This break, which would also have absorbed thermal and settlement-related movements in



Intrados cladding of an arch.
From: Archivio Centrale dello Stato, Rome



An arch under construction. From: R. Mariani, *E42 un progetto per l'"Ordine Nuovo"*, Comunità, Milan, 1987

the load-bearing structure, was never constructed, since it would not have been acceptable to show the cladding broken up into sections corresponding with the number of floors in the building. The base slab of each pillar was thus made to rest not only on the cantilever, but also on the slabs of the arcade below. In any case, the cantilever has a negligible load-bearing function since the weight of the front-facing slabs of the generic order was in any case transferred to the floor slabs. This was achieved by the special arrangement of the slabs cladding the pillars, using staggered joints. This expedient means that, in alternate rows, the front-facing slabs can transfer their own weight onto the slabs below, but it also means the ends of the slabs can rest on those of the intrados. These rest directly on the floor slabs and are themselves able to support the front-facing slabs of each floor, thus making the cantilevers redundant.

Work on the cladding was completed in February 1940, less than a year after it had started. According to a report dated 11 April 1940, the work ended with "cleaning [...] by means of emery grinding with two grades of abrasion in order to achieve a perfectly smooth, uniformly coloured surface, followed by washing [...] copiously with water and [...] final coating with essence of nicotine diluted in water."

Both the lack of expansion joints and the nature of the final cleaning show that the intention was to make a uniform surface like that of a monolith, without any enhancement of the texture of the slabs. Furthermore, in order to give prominence to the arcade, no ornamentation was applied. The arcade thus became a symbol of wall construction and a clear expression of the autarkic building culture of the Fascists.

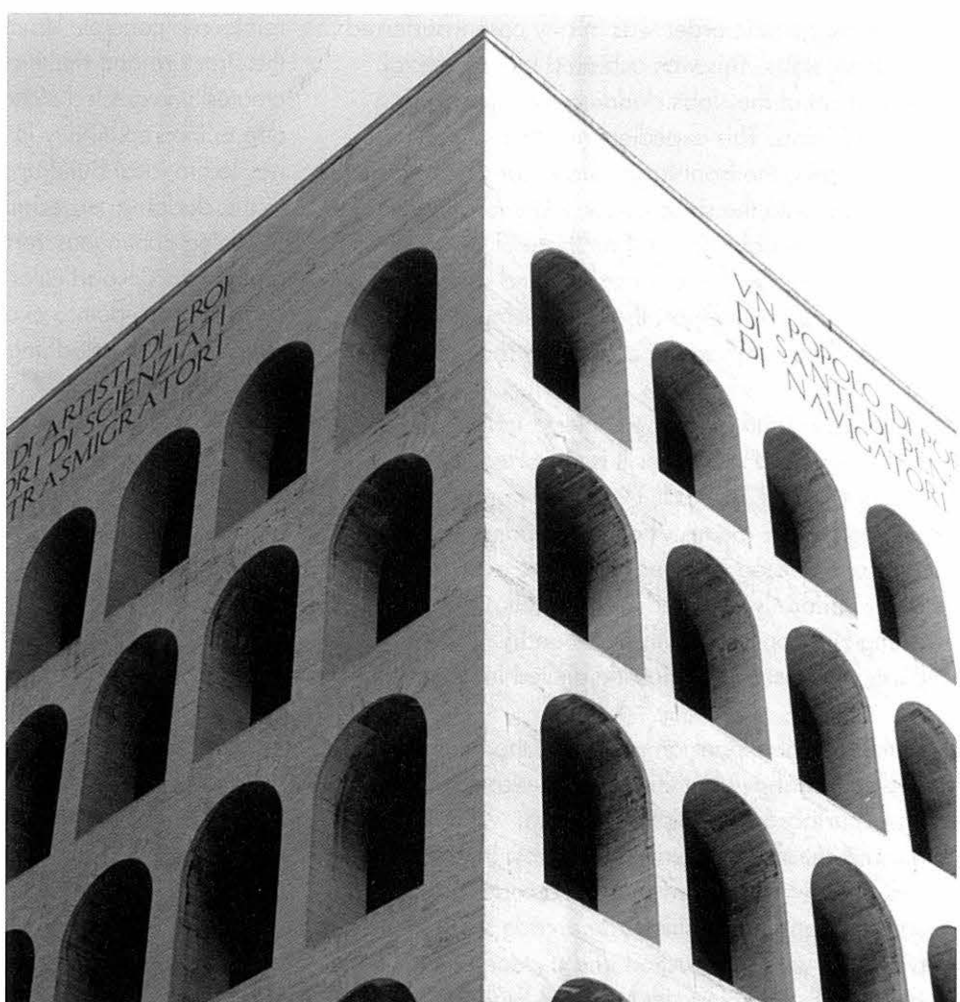
The state of conservation

A number of factors combine to maintain the stability of the cladding, some more effective than others. They include the interpenetration of wall fabric and cladding, the arrangement of the slabs, the anchoring clamps, and the inclination of the facades, although the contribution of each has changed over time due to thermal variations and elasto-plastic settlement of the reinforced concrete structure. The close link between the structure and the thick masonry of the arcades has created unexpected static problems for the cladding, due to incompatibility in the rates of deformation. This has led to local build-ups of tension causing damage to the cladding, especially on the lower floors, including continuous vertical lesions up the sides of many pillars – particularly those on the corners – and broken edges due to excessive pressure[5]. On the lower floors the cladding consists of very thick slabs and so has fortunately been able to pass the test of time without suffering too much damage.
The cladding also reveals damage caused by oxidation of the anchoring clamps. The signs of this are typical: lesions, the ejection of fragments, and the dislocation of slabs no longer anchored. The most conspicuous breaks can be seen in the Southwest corner pillar on the fourth floor. After being fastened to the support with clamps, bolts and filling, the slabs were caged in unsightly iron reinforcement rings. Other damage can be attributed to human actions, especially when slabs needed to be replaced in order to carry out technical surveys of the pillars or to replace sections damaged by the cast-iron leaders they contain[6]. In these cases, the results have proved unsatisfactory, mainly because the absolute uniformity of the stone surfaces means that slabs with any variation in colour and texture cannot be used as

replacements.
When work starts on consolidating and protecting the cladding, it would be advisable to adopt solutions which do not jeopardise the integrity of the building's original appearance or interfere more than is strictly necessary with the complex and consolidated system of mechanical relationships between the cladding and the load-bearing structure.

Notes:
On behalf of EUR S.p.A., a DOCOMOMO Italia workgroup coordinated by Sergio Poretti and Maristella Casciato has carried out a study of the Palazzo, examining architectural and constructional aspects as well as the current state of conservation. In this study particular attention was paid to the travertine stone cladding of the facades, both in order to understand the method used and to establish the state of conservation and obtain information which might be useful when drawing up strategies for possible restoration operations. This report briefly illustrates the results of the investigation. Further details can be found in R. Capomolla, "La tecnica dei rivestimenti lapidei negli anni Trenta: il caso del Palazzo della Civiltà Italiana all'E42", in *Costruire l'architettura: i materiali, i componenti, le tecniche*, 2 vol., Luciano Editore, Naples 2001, II vol., pp. 1147-58.

1. This observation was also confirmed by examining the cladding of the pillars inside the open galleries: the weight of the cladding is supported by the various floor slabs, and yet the thickness of the sides that are visible is 15 cm on the first floor, 10 on the second, and 5 on the others.
2. The same optical correction is used in the corner pillars: they are thicker than the others, not just to demarcate the facades more clearly, but also because, standing out against the sky, they would otherwise be perceived as more slender than the intermediate ones.
3. It should also be borne in mind that an alteration made in the early months of 1938 added an extra floor, bringing the number of floors from 6 to 7.
4. This means that, in the case of a first-floor pillar, for example, a 5 cm-thick front-facing slab has 20 cm of filling behind it. The upper, 20 cm-thick slab, which has 5 cm of filling, has to rest both on the slab below and on the brickwork.
5. These breakages take the form of minute flaking or crumbling. The damage was repaired with cement lime mortar infills, wire staples and synthetic resin sealing.
6. Damage to the leaders and the leakage of large quantities of water is one of the principal causes of corrosion in the reinforcement of the pilasters and the slab-retaining clamps.



The state of conservation, 2001. Photo: M. Biuzzi

Århus Town Hall

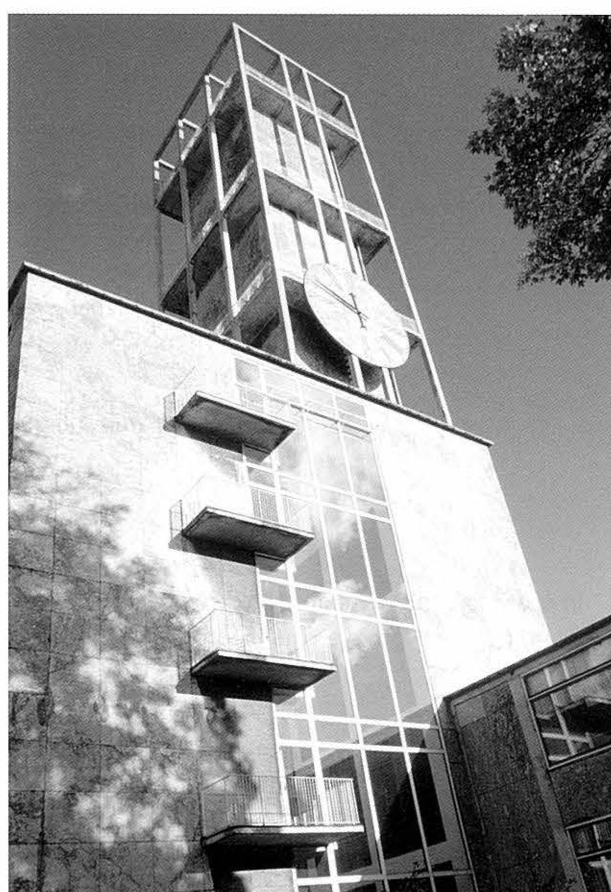
Arne Jacobsen and Erik Møller (1938-1940)

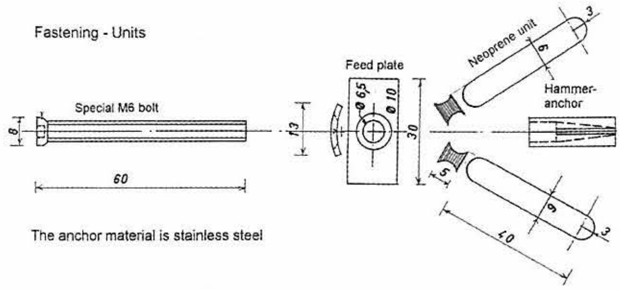
Århus Town Hall is a major work of the Modern Movement in Denmark. For the restoration of the marble façade the engineer, Søren Abrahamsen, developed a tool and a method which made it possible to re-anchor the marble slabs without taking them down and with no visible changes.

Søren Abrahamsen

After winning first prize in an architectural competition held by the Municipality of Århus in 1937, Danish architect Arne Jacobsen built the Århus Town Hall during the years 1938 to 1940. The load-bearing structure consists of reinforced concrete and the exterior cladding is made from Norwegian Porsgrunn marble. From an architectural point of view the buildings are beautifully proportioned and the impression is one of great thoroughness.
After 60 years of service the quality of the engineering is still evident and the design is world-renowned. However, at the beginning of the 1970s problems appeared in the fastening of the marble slabs onto the concrete wall.
At the time the Town Hall was planned and designed, marble cladding was often used on public buildings in Denmark. The technology of the time in this field later proved inadequate, and after some years renovation of the exterior cladding became necessary.
By the mid-seventies a preliminary refastening of the tower cladding was required, and as slabs began falling off the main building facade the need to find an efficient method of fastening them became urgent. The areas affected by falling slabs were roped off, while efforts to find appropriate fixing methods were intensified and thorough studies were carried out on the cladding itself.
The investigations showed that almost all the cladding slabs had become detached from the mortar layer on which they had been mounted. This loosening was caused by temperature-dependent movements of the 1-square-metre slabs and resulted in a cavity forming between the slab and the plaster.
From the investigations it was concluded that all the cladding slabs should be secured using a new fastening method.
At the time, different methods had been adopted on other buildings in Denmark to fasten loose marble slabs, in most cases using visible anchors through holes in the slabs. At the Søllerod Town Hall, also designed by Arne Jakobsen, the slabs were removed and the plaster cut away, and the slabs were remounted in new bearings.
This does not change the facade design, but the method is expensive.
In most cases the method of fastening was to use visible anchors through holes in the slabs. However, inspections of buildings where cladding was done this

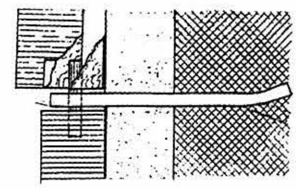
View of the Town Hall tower





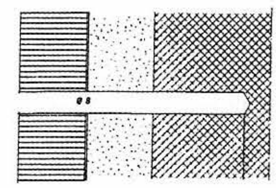
way revealed the presence of shadows and the formation of rust marks beneath the bolts.
Because of the elegant architecture of the Århus Town Hall with the contrasting detail on the facades, methods leaving visible traces could not be used; so the expensive process of removing and reinstalling the slabs could not go ahead until all possibilities of finding alternative solutions had been exhausted.

The original fastening

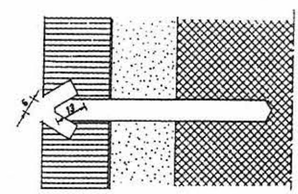


This cross-section of the supporting anchor for the marble slab can serve as an illustration of the original fastening. It can be seen that the rear edge of the slabs has broken off due to the ice pressure in the cavity between the slab and the plaster. As a result the slabs could move further away from the wall and possibly fall off. The serious consequences of this will be evident from this illustration showing a slab which had moved more than 10 mm away from the wall. It was still resting on its supporting anchor, but a new pressure anchor had to be inserted in order to prevent the slab from falling off completely.

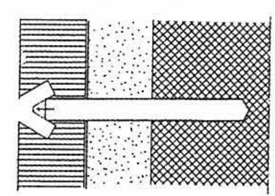
The supporting anchor system step by step



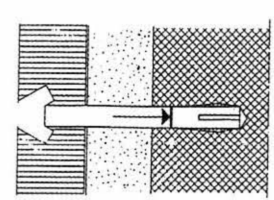
First, an 8 mm hole is drilled through the mortar joint into the concrete.



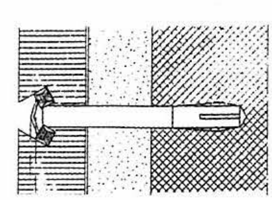
Inclined grooves 40 mm long are then ground into the edges of the marble slabs.



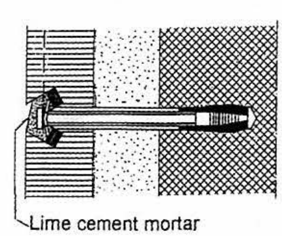
The arris between the grooves is removed in order to create room for a feed plate.



Impact anchors with a hammering cone inserted are used.

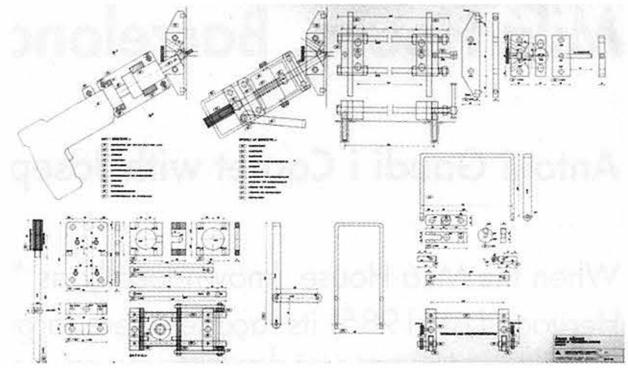


In order to achieve flexible hold on the edge, a neoprene insert is placed in each groove. The feed plate is edged into place on the neoprene units.



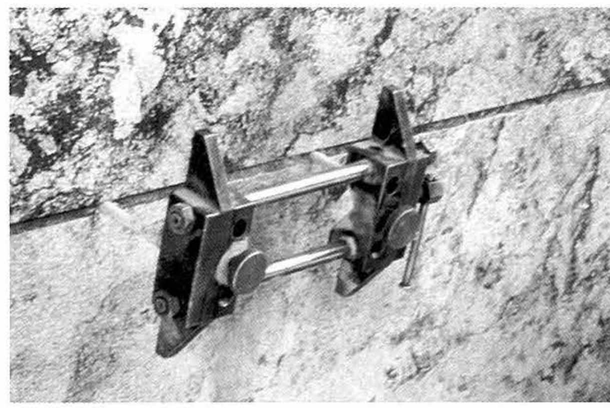
The anchor bolt is inserted through the hole in the feed plate and is fastened to the hammering anchor using a torque wrench. The joint and arbor holes are then filled with lime-cement mortar.

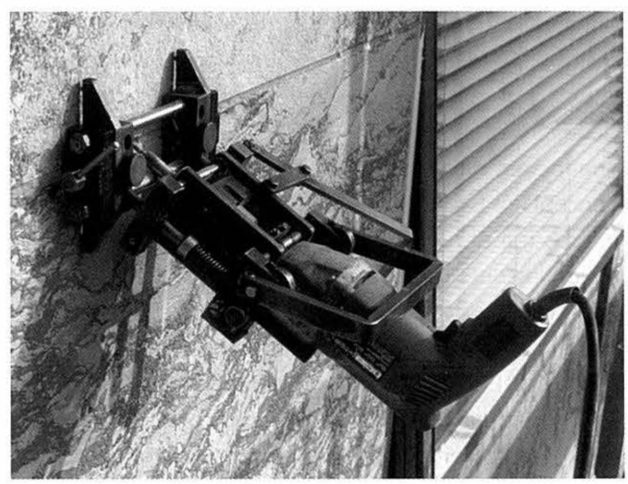
Detailed drawing of the installation tool



Special installation tool

In order to produce the inclined grooves consistently a special tool had to be developed.
After a number of tests a tool was manufactured to work with a specially-made Joran Wolfram 6 mm milling iron, and was successfully tested on 150 anchoring units.
The milling iron is inserted in a cartridge with a rigid guide bearing.
The cartridge is connected to an electric drill suspended in a slide, which can be moved both horizontally and vertically in relation to the milling groove by means of two handles.
The slide glides on a frame, which is supported by two steering columns in the same plane as the milling iron.
The columns are placed in a steering frame, which is fixed with two arbors into holes in the joint between the plates.





Conclusion

In the summer of 1983 all the marble slabs of the Århus Town Hall were fastened using the method described.
Altogether 9,200 anchors were installed. Today, all those anchors remain intact with no visible traces of the fastening process.
Finally I would mention that a marble expert submitted a tender for removing and reinstalling the slabs on the Århus Town Hall using the same method as was adopted for the Søllerød Town Hall.
The total amount of the tender was 18 million Danish kroner. The figure for fastening by the method described was 500,000 kroner. So by using this method the municipality of Århus saved approximately 17 million kroner.

The marble slabs after the fastening process

All drawings and photos by Søren Abrahamsen

Milá House, Barcelona

Antoni Gaudí i Cornet with Josep Maria Jujol (1905-1910)

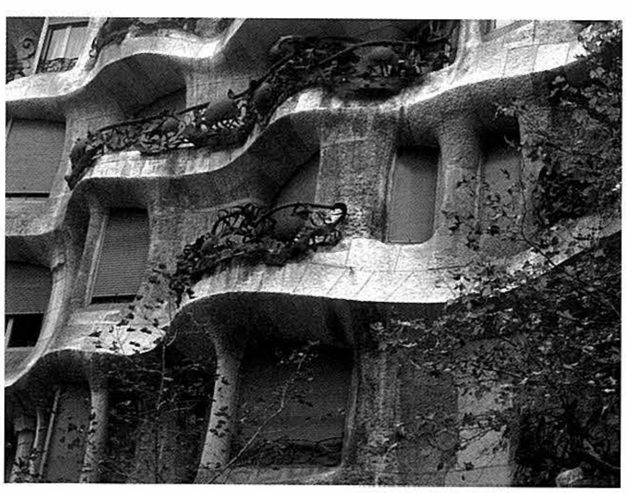
When the Milá House, known locally as "La Pedrera", was included in the World Heritage List (1985) its façades were largely deteriorated with stones' displacement and other damages of the surfaces caused by atmospheric agents. After an experimental phase of cleaning of some portions in 1986, the house went through an extended restoration project, which included both structural and decorative elements.

Josep Emili Hernández-Cros

The building is a complex bay work of stone columns, bricks, girders and metal supports which replace the traditional loading walls. The result is a free plan which subsequently Gaudí utilized in all apartments each showing peculiar differences from any other. Similarly the façade is disjoint from the plan distribution, like a dividing wall which allows for the shaping of an unprecedented facade and of the geometry of interiors.
The façade develops one of the most preoccupying concepts of Gaudí's work which conveys the impression of a constant movement and weightlessness by the use of a hard and very heavy material: the stone.
The materials used on the façade come from different sources. At ground floor and at mezzanine level is used limestone coming from the Garraf Mountains; on the balconies and upper floors are sandstones from the Vilafranca area. The stone used in the façade is hung and cantilevered. The blocks are secured with iron anchors fixed in each block, tied with iron braces that are soldered to external wrought iron girders. Typology offers a range of novelties as compared to the residential rental housing which was being built at the time. For example: the elimination of the staircases leaves the lift as the only to access to the apartments; a ramp leads to the basement where stables and carriages are located; elements of lesser importance like chimneys, are used to transform the roof top into a forest of phantasmagorical shapes.

General view in the second half of 1910s. From: C. Martinell y Brunet, *Gaudì su vida, su teoria, su obra*, Barcelona 1967

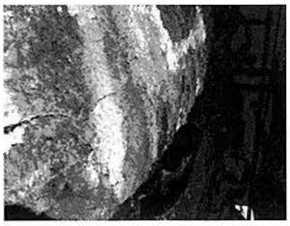
Partial view of the main façade. Photo: C. Marcosano Dell'Erba



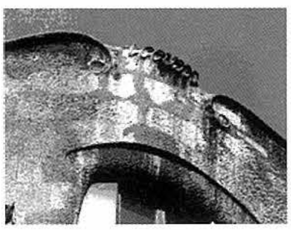
Interior views

Symptoms

- Numerous cracks and gaps all over the façade.



- Patches of cement cover up basic networks of wires that were set in place to control the cracks during a 1970s restoration. These mesh-works are generally rusted and broken.



- Fillings of mortar and reflecting cement (Electroland[1]) and inclusions of pieces of solid bricks envelop the Ø12, round, iron rods placed during the 1970's restoration. The iron was much rusted.

- Wide-angle iron sections of the original anchoring system protrude out of the stone surface, possibly belonging to previous works and the situation was left to Gaudi's decision to "carve" the stone of the façade to accomplish the shape he wanted.

- Parts of the facade covered with applications of solid brick laid with cement.

- Overall dirt on the facade, with encrusted with atmospheric waste encrustations, moss, lichens and fungus which masked the chromatic range of the diverse stones utilized.
- Oxidation of drains and down pipes as well as of the balustrades on the balconies.
- Decay of external timber carpentry and of timber shutters which in some case had been replaced by PVC shutters.

Methodology of intervention

- The iron testing determined that the iron employed is of a grade similar to the Acero A-42b2.
- Tests on masonry revealed that very different qualities of stones were employed. The high porosity of sandstone caused a sponge-effect, which in turn caused the oxidation of the encased iron anchors, fungus growth and sediment build up.
  Different treatments to achieve complete clean up were planned on the basis of these tests.
  Vaporized, non-compressed air, application of chemical fillings in the areas more resistant to the clean up and to salts removal. For what concerns the employment of strengtheners, the analysis suggested the employment of ethyl silicates in a controlled manner and the application of silicon-type hydro-insulators (water/humidity).
  The stone high porosity ked to think that the water used for the clean -up could seep into the apartments, so it was decided to resort to propel blunt glass fine particles at low pressure.

Execution of the works (1988-1989)

• Masonry joints: after analyzing the original mortar, fillings of similar compositions were employed.

• Masonry restoration. The following situations were assessed: mortar re-integrators were used after replacement of entire stone blocks; an investigation was carried out to assess replacement potential and find some of the quarries were the stones were mined, which had been closed down for many years. The decision was to re-open one of them and extract the necessary quantity of stone.

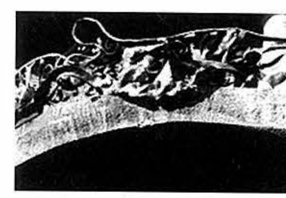
• Mortar re-integrators: to apply them it was necessary to hollow the fractures and establish a range of colours to use in every instance, avoiding resorting to a superficial layer of painting as a patch-up job.

• Injection system: tests on resins were carried out to seal the fine cracks caused by internal iron oxidation, adopting the low-pressure, epoxy-type resins injection system.

• Stone strengthening: following specialized laboratory advice, it was decided to apply ethyl-silicate esters where required.

• Finishes: the areas restored with new stone or with mortar integrators were worked upon with tools and techniques similar to the original ones.

• Balconies handrails: they were dressed with granulated metal, treated with minium (anti oxidant) coatings and finished off with metallic paints.



• Carpentry: shutters were replaced by lacquered aluminium dulled by a special colour and window frames and balconies as well as their iron works were restored. An assortment of green paint hues were chosen, ranging from a greenish-beige for the jambs, a much lighter tone for flat shutters and a darker tone for the new shutters.

Notes

1. The Electroland cement, produced by Cementos Molins Industrial, S.A., is calcium aluminate cement obtained in a reverberation oven from limestone and bauxite. A ground clinker containing no additives is obtained. Cementos Molinos, SA. Production and marketing of ready made cement, luminous (Electroland) cement, Portland cements and related products. Operations comprise a Portland cement factory, a luminous cement factory and a manufacturing plant in Palleja as.
2. Acero: The main component is a vertical shaft located in the middle of the staircase. It is built in Acero A-42b. In many cases it consists of a 140 mm diameter tube, but it is also common to find concentric rings as an alternative.

All photos by Josep Emili Hernández-Cros

Shell House, Berlin

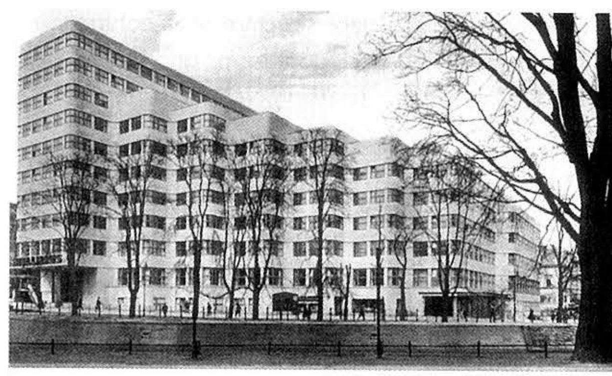
Emil Fahrenkamp (1930-32)

The Shell House is an icon of modern architecture in Berlin. The restoration was begun in the 1980s and completed recently. The main problem for the Office of Preservation was to maintain the natural stone cladding on the street façades. During the renewal many technical problems arose, including the conflict between old and new building regulations. In order to solve the technical problems the designers were forced to build a curtain wall.

Sibylle Schulz

The building was designed by the architect Emil Fahrenkamp and built in 1930-32 under the direction of the Rhenania Ossag Mineralólwerke AG.
Emil Fahrenkamp (Aachen 1885 - Dusseldorf 1966) worked as architect for the Rhein-Stahl AG, designing industrial buildings. He achieved world recognition as a teacher at the Kunstgewerbeschule in Dusseldorf. From 1933 he worked on government buildings, and after WWII he directed plans for the Karstadt department store in Herne, for example.
When the plans for Shell House were implemented the name of Fahrenkamp was already known in Berlin. His first project to reach physical completion was the Administration-Residential-Trade building at Dieselstrasse 37, constructed in the years 1920-23. But the unique achievement of his architectural career is Shell House at the Landwehrimal.
Fahrenkamp was obviously familiar with the plans for the skyscrapers in Friedrichstrasse from the legendary competition of 1920-21, in which popular names such as Paul Mebes, Paul Emmerich and Alfred Grenander participated, and he also knew the architectural visions of Mies van der Rohe and Erich Mendelsohn.

The first skyscrapers in Berlin were built at the end of the 1920s. The main design issue was to place emphasis on the arrangement of buildings on city corners. An early example of a multi-storey commercial building was the one built in 1928-29 at Kurfurstenstasse 87, designed in 1925 by Heinrich Straumer. Another example is the Loeser & Wolf cigar factory (1929) at Potsdamerstrasse 58, designed by Alfred Biebendt.
The characteristic features of these examples and of Shell House are the choice of noble metals – thin



Main façade on the Landwehrkanal. From: V. M. Lampugnani, *Dizionario dell'architettura del Novecento*, Milan 2000

profiles in combination with natural stone. This combination is used to decorate the outside façades and the main interior rooms. The formal solution used shows the influence of the time. In Berlin traffic and industry were growing rapidly: multi-storey buildings reflected modern times and expressed the new artistic imagination.

Fahrenkamp's task was to build Shell House on an irregular corner lot in an area of houses and villas. The plot was located between a road connecting with the city and the new district: of Berlin. On one side there is the Landwehrkanal and on the other a narrow alley. The design brief was for an administrative office building with modern facilities, such as a petrol station and a garage. The car was becoming more important in everyday life and beginning to have an effect on city planning and architecture.
Since the competition for the Friedrichstrasse there had been a trend towards building skyscrapers, however the building code in Berlin was not able to

adjust quickly to this. Changing the regulations for tall buildings and new forms of ground plans were a big problem, and Shell House is a clear example of this conflict. In the end only one part of the planned building complex (the one on the connection street) was completed as a multi-storey building. It has ten floors and three basements. It is 38 metres high, but to guarantee light to the neighbouring buildings the third part of Shell House is at their level.
The ten-storey building dominates the wing on the Landwehrkanal and resembles a bridgehead. The façade is designed following a horizontal arrangement, formed by natural stone breasts of fine white Roman travertine and ferrous windows. The whole façade is curved, with the curves following the form of the Landwehrkanal. Bay windows flow around the corner. The result is a fascinating piece of architecture.
Fahrenkamp shaped the building like a sculpture with a dynamic form. The clear structure on a flat façade together with the finest elegant forms and details make a picturesque impression, with the complete façades reflected in the water of the canal.
Contemporary descriptions emphasised the technical features rather than the architecture. Some of the technical peculiarities in this case were: the foundation in the form of a pool of reinforced concrete, so that excavations and other disruptions in the street cannot reach or affect the construction; the steel skeleton bolted together; the filler walls consisting of large aerated concrete blocks; the panels of ferrous windows and stone cladding.
During WW II the façade was hardly damaged, and the building could be repaired some years later. But the travertine slabs and the iron windows could not be kept in place. The reason for this was the corrosion of ferrous dowels and anchors, and also the old mortar bed for the travertine. Over time, the use of these materials together caused many problems because of thermal stress between the different materials.
The thickness of the overlaid travertine slabs is only 3 cm, and the surface has corroded. The windows have also deteriorated and are corroded and leaking, and the old façade failed to meet the new standards of soundproofing and heat insulation.
Problems similar to those of the stone cladding on Shell House are seen in the tile claddings of some 1950s buildings, for instance Luciano Baldessari's building in the Hansaviertel, and in Karl-Marx-Allee. A separate rehabilitation and modernisation technology has to be created for each building.
The owners of Shell House, REWAG, wanted a building corresponding to modern standards and with a weather-resistant façade. They planned new stone

The façade before restoration, 1991.
Photo: C. Marcosano Dell'Erba

cladding, for example a curtain wall, ventilated and heat insulated. This would give the façade a new deeper sculptured profile with stronger shadows.
At the end of the 1980s a major conflict was revealed between the interests of the owner and the Office for the Preservation of Historical Monuments in Berlin. The aim for our office was to substantially retain the original characteristic image of the façade. My colleague Frank Pasche had to fight for this project for more than ten years, until finally a good solution was found.
To begin with the architects, Fischer and Fischer, designed new modern stone cladding. We hoped to lose only the windows and to retain some old areas of the façade including the filler wall and the column lining. A prototype façade area was constructed, including test windows of steel, aluminium and bronze. The result showed the problems of these technologies, including:

- large gaps, and also a conflict in the installation of the windows because the façade level changes;
- expensive rehabilitation of external walls and iron girders;
- considerable loss of façade material;

- it was possible to achieve only a few of the required building standards;
- many special details were necessary;
- the work of re-building and supervision would be difficult.

One positive achievement was finding some fine new windows resembling the originals. The bronze windows closely matched the original image, and the architects constructed a new box window for the façade with the internal seal tighter than the external one. Thus there is no condensation problem.
In the curved areas they constructed insulating glass windows instead of the original simple windows. In the end the technology was costly, with many technical deficiencies and uncertainties. Walls conforming to modern standards had to be constructed and the structural steel work thoroughly rehabilitated. The stone slab was reconstructed from the old stone quarry. The new walls have retained the original geometry.

The compromise between Fahrenkamp's design and the new plan is evident in a number of differences.

- The original walls have travertine fixed by ferrous dowels and anchors, mortar bed, steel skeleton and a filler wall of aerated concrete blocks.
- The new walls are faced with travertine fixed to the original steel skeleton by non-corroding steel dowels and anchors, mineral fibre insulation and lightweight concrete. On the façade there are 4mm ventilation joints instead of the old butt joints.
- The original window hardware was installed on the new windows.
- The architects constructed a new rebated window frame which guarantees the required technical, thermal and physical standards.

This way we were able to preserve the original character of Fahrenkamp's façades.

Last year this project was awarded the special German natural stone prize from the German Natural Stone Association and the Union of German Architects. Since the beginning of 2000 BEWAG and GASAG have been housed in this fine building.

The decay of the travertine cladding and the iron windows. Photo: C. Marcosano Dell'Erba

Post Office Building, Naples

Giuseppe Vaccaro, Gino Franzi (1928-36)

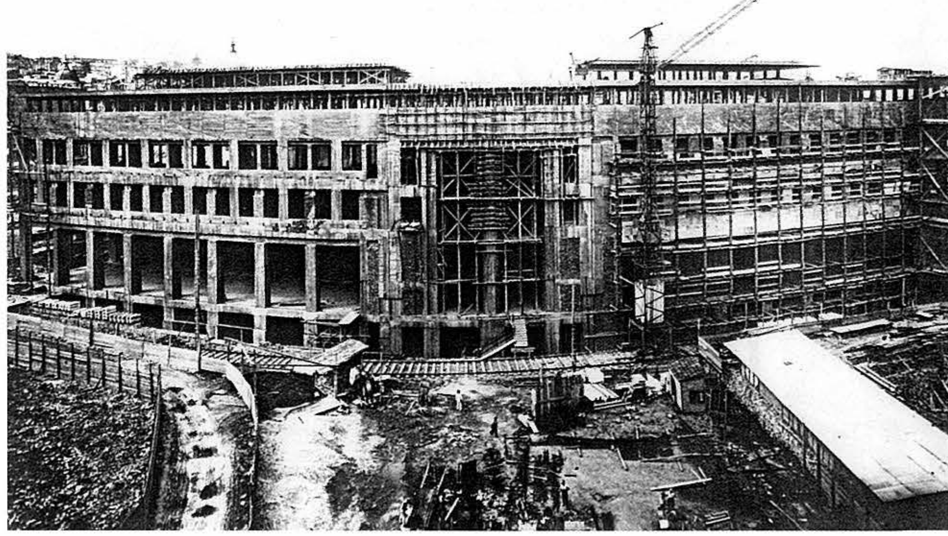
The building had a key role in the passage from traditional to modern architecture in Italy at the beginning of the 1930s. It appears to have been experimental in formal and functional conception as well as in its construction techniques. It is one of the first buildings where the integral facing of marble slabs is applied to an edifice with a supporting skeleton in reinforced concrete.

Tullia Iori

This essay examines the complex story of the marble cladding of the building, highlighting the difficulties faced by the architect Giuseppe Vaccaro and his colleague Gino Franzi in obtaining approval for a solution which was highly innovative from the figurative and constructional point of view.
The archive documents, retrieved by Sergio Poretti many years ago, and recent restoration work (2001) have clarified some interesting aspects concerning the way the cladding material was laid.

The project
The history of the building began with the first round of the competition in 1928, and it came to a close only in mid-1936. The day of inauguration thus came only after eight long years, many of which were spent arguing first about the architectural characteristics of the building and then about the choice of materials. Meanwhile, no first prize was awarded in the two rounds of the competition. Vaccaro, who won the second prize with Franzi, was entrusted in 1938 with the design of the building, quite independently from the outcome of the competition. As Poretti[1] has already pointed out in his reconstruction of the issue, Vaccaro completely revised the competition project on a number of occasions: the building lost its traditional decorative structure and acquired a decidedly more modern configuration. This was mainly the result of his decision to clad the façades with a thin layer of highly polished marble, pierced only by the windows and the main entrance.
However, the new version of the project, which reflected the modified cultural climate which had come into being after the first MIAR exhibition, met with fierce opposition from local bureaucrats. In January 1932, Vaccaro was obliged to ask Mussolini to voice

The building under construction. From: Archivio G. Vaccaro, Rome

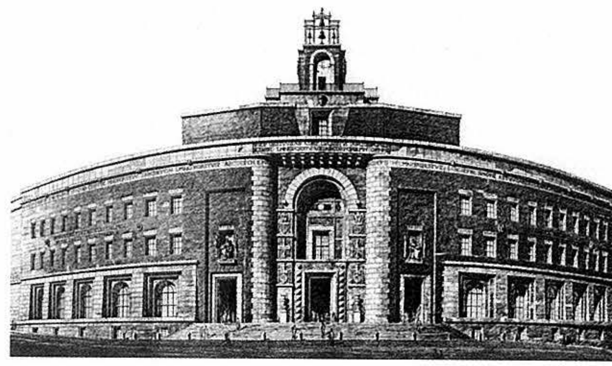


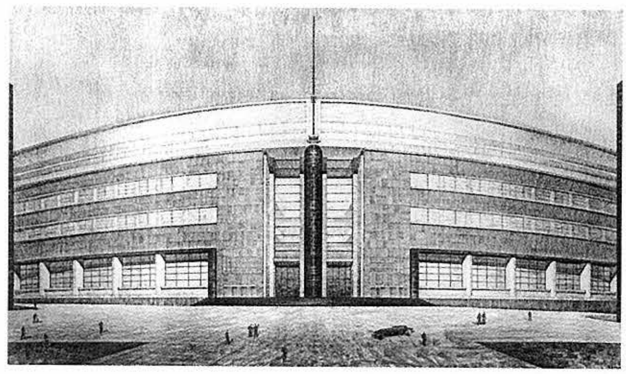
his opinion, and indeed in April he finally approved the project.
But this approval from on high was only the first victory in Vaccaro's war against the bureaucrats. The architect was soon forced to fight another, even longer and more tiring battle over the choice of marble, against the Servizio Lavori e Costruzioni (the public works and construction service of the Ministry of Communications in Rome) and the Sezione Lavori in Naples.

Valle Strona and Diorite

Right from the first versions of the project after receiving the commission, Vaccaro had decided to use two particularly precious materials for the façades: speckled grey "Valle Strona" marble and black "Diorite" stone.
In this new use of integral cladding, in which all trace of traditional decoration was abolished, the type of marble, its chromatic qualities, the cut, and the pattern of its veining played a very important role in the architectural expression of the building.
In the case of the Naples building, Vaccaro gave importance to the excellence of the materials, conferring nobility and elegance upon his project, which was now becoming increasingly simplified in its architectural lines.
The key role attributed to the precious cladding can be seen in the obstinacy with which he approached the attempts to dissuade him and the many more economic alternatives put forward by the Servizio Lavori.

As early as the end of 1931, the Servizio Lavori approved the gradation in the colours of the marble, even though expressing perplexity about the choice of Valle Strona which - extracted from a single quarry in Piedmont - was one of the most expensive types of marble available in Italy at that time.
The beauty of Valle Strona was undeniable and, in terms of its technical qualities as well, it was unrivalled. Even though the deposit had been exposed to the weather for centuries, the marble appeared "healthy and strong and in no way brittle or friable" to the geologist Maddalena who was sent to inspect the quarry in April 1932. Furthermore, its high flexural strength, which enabled the thickness of the slabs to be reduced, and its high specific weight, which pointed to considerable compactness, made the marble particularly suitable for external cladding.
The quality of the material did not, however affect the cost-related objections put forward by the offices in Rome and Naples.
Thus, while the main works were starting on the





Simplification of the façade:
the project for the second round of the competition;
the sixth versions of the execution plan.
From: Archivio delle Ferrovie dello Stato, Ministero delle Comunicazioni, Rome

The building just after its inauguration. From: Archivio G. Vaccaro, Rome

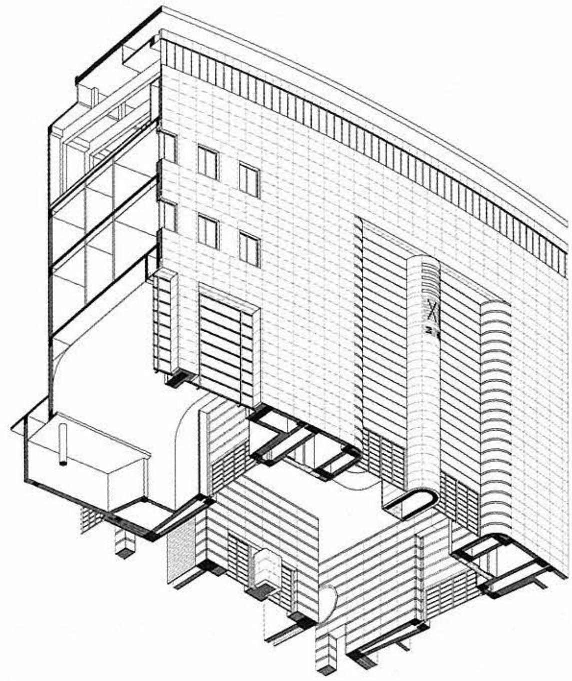
building, the Servizio Lavori in Rome started up a long study of "alternative" types of marble of the colour chosen by the architect. After contacting dozens of companies and asking them all for estimates, in January 1933 several samples were shown to the Minister of Communications, Ciano, who however approved the Valle Strona without too much ado. But the Servizio Lavori did not give in and managed to get Vaccaro to accept tendering for a contract, which took place in 1933. Five types of marble and one stone which, in the view of the Servizio, "could compete with the Valle Strona", were

admitted. Once the tenders had been assessed, only the marble of Musso, which cost half as much as that of Valle Strona, could reasonably be submitted to Vaccaro for his judgment. However, he refused it categorically because of its "excessive uniformity of colour and lack of liveliness".
Finally, after a year of efforts, the Servizio Lavori technicians gave in. Once the problem of the Valle Strona contract had been solved, it was the turn of the Diorite. This, however, was concluded much more rapidly.

Later on, this obstinacy about the choice of such precious marble led Vaccaro to some harsh self-criticism.
In his presentation in *Architettura*[2], he later said: "while the splendour of the materials chosen undoubtedly confers nobility upon the simple architectural volumes, comparative considerations may regard it as somewhat excessive." The "comparative considerations" probably referred to his visit to the Casa del Fascio in Como: as quoted by Poretti[3] Vaccaro was surprised by the "modern and, at the same time, unfeigned classic harmony which Terragni was able to create" with much less prized, strictly plain-coloured, and certainly less lively Botticino limestone. He commented: "I'll have to remake everything in my mind!".
Actually, Vaccaro's insistence today appears to have been far more shrewd: while Terragni's Botticino has considerably deteriorated over the years, the "limpid veneer of precious briar" on the Naples building has remained virtually intact, thanks to the superior quality of Valle Strona, as well to the skillful and astute way in which it was mounted.

The characteristics of the cladding

The fact that the building was designed in the most crucial phase of the shift from traditional to modern architecture in Italy can be seen in the singular dualism in the solutions devised for assembling the marble.
On the one hand, the new approach to cladding required the surface of the façades to be perfectly smooth, without any relief. In this manner, the connections between the marble and the brickwork and reinforced concrete structure behind it had to be completely invisible in order to highlight the purely figurative function of the exterior surface.
On the other hand, the pattern of the slabs and the differences in size and thickness of the special pieces was still traditionally linked to the structure of the building - unlike what later emerged in the works of young Italian architects. In the latter, the thin skin of

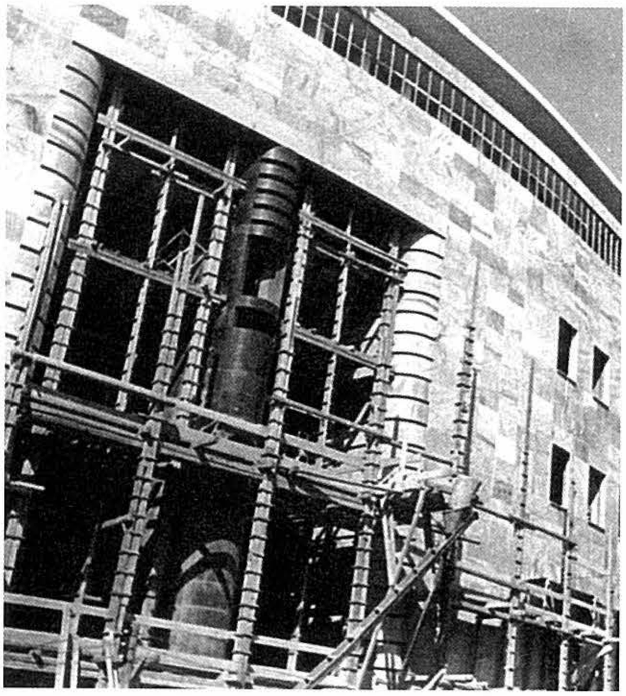


Axonometric section of the entrance hall of the building.
Drawing: T. Iori

marble appears as a sort of precious plasterwork which covers the skeleton, the walls and the smallest details of the façades uniformly and in an undifferentiated manner.

Traditional methods were used to lay the slabs. The 5 cm Diorite and 3 cm Valle Strona slabs were laid one upon the other and fastened to the wall at the top and sides by galvanised iron bolts and cement filling in order to prevent tipping.
Here again, some contrivances were taken from consolidated traditional techniques and, considering the thinness of the cladding, they proved to be very effective. First of all, slim strips of lead were placed between the slabs to attenuate the risk of overloading while compensating in part for thermal deformation. Furthermore, even in the interiors the thin cladding was interrupted at regular intervals by blocks toothed into the masonry. As well as providing stronger support for the slabs above, they also reduced the height of the self-supporting areas.
Although from one project the next the cladding gradually ceased to imitate an alternate ashlar texture and acquired a simplified pattern "a sorelle", the separation of the slabs was intentionally stressed. So while Terragni was doing all he could to make the joints invisible in the Casa del Fascio, Vaccaro decided to make the edges of the Diorite slabs more visible by bordering them with white stucco.

However, it is the use of special blocks which point



The double window above the main entrance during construction. From: Archivio G. Vaccaro, Rome

most clearly to the transitional nature of the Neapolitan building. The thin slabs do not envelop all the elements indiscriminately, for the architraves and jambs consist of very thick blocks, which are noticeable for the way they break up the regular rhythm of the thin slabs.
In order to make the joints between the special elements and the structure invisible, late-19th century reinforced masonry construction techniques were used as a model.
The platbands of the large window openings on the ground floor, consisting of four blocks of Valle Strona marble, were thus reinforced with double-T iron girders recessed into the specially prepared blocks. Only the two enormous architraves of the twin entrance appear not to have metal reinforcements but simply cramps fastening them to the concrete beam behind. The two 7.2-metre Valle Strona monoliths were so large that they were not even available in the quarry, which had to be explored in a number of areas in the hope of finding pieces of the size required.
Further confirmation of the transitional role of the building can be seen in the jambs of the twin entrance. In a number of alterations to the original project during construction, Vaccaro perfected the peculiar band design in which 30 cm parabolic-shaped blocks of Valle Strona are alternated with thin strips of Diorite. The effect is that of a highly modern bugnato which, even though it recalls traditional solutions, helps reinforce the essentiality of the façade.

The restoration

To conclude, a brief word about the recent restoration work. Even though the cladding had performed perfectly over the years, in a few places some slabs showed signs of detachment and were at risk of falling.
The restoration work only involved the application of stay cramps from the exterior on both slabs and blocks, without dismantling the cladding. This means that the devices which Vaccaro had studied so carefully to make the attachments totally invisible have been annulled by a fastening process now commonly used in Italy. Although it is well camouflaged today, it will inevitably become visible as the stuccowork ages. Furthermore, the joints between the slabs and the blocks of Diorite have been edged with black stucco, thus cancelling the slendering effect of the base, of the pilaster and of the central pillar which Vaccaro had obtained by using white edging. The restoration work, which was unfortunately only partial and not part of an overall conservation project, was funded by Poste Italiane and supervised by the Naples Soprintendenza, since the building is subject to preservation restrictions.

Notes

1. S. Poretti, "La facciata del Palazzo delle Poste di Napoli e la questione dei rivestimenti lapidei nell'architettura italiana degli anni trenta", *Rassegna di Architettura e Urbanistica*, 84-85, 1994-1995, pp. 28-37.
2. G. Vaccaro, "Edificio per le Poste e Telegrafi di Napoli. Architetti Giuseppe Vaccaro e Gino Franzi", *Architettura*, fasc. VIII, August 1936, pp. 353-394.
3. S. Poretti, "La facciata del Palazzo delle Poste di Napoli", cit.

Corner view of the building after restoration. Photo: T. Iori

Finlandia Hall, Helsinki

Alvar Aalto (1967-71)

The restoration of the marble façade of this building is a case study as well as part of an international research project to develop knowledge of the physical and chemical reactions of marble as a façade cladding material.

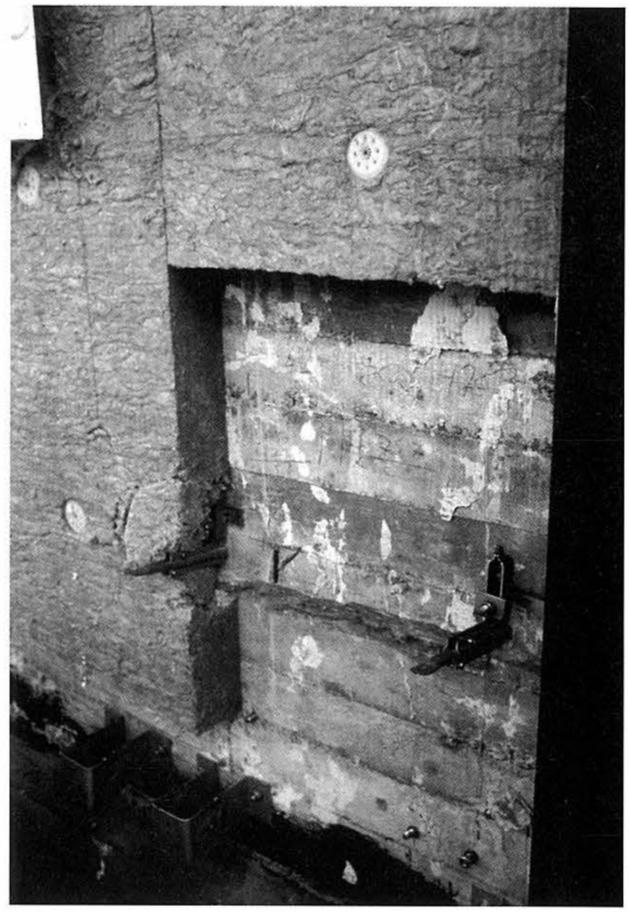
Martti Jokinen

Finlandia Hall was built between 1967 and 1971. The congress wing was added between 1973 and 1975. Alvar Aalto's idea of using white marble as a symbol of humanism and Mediterranean culture was first seen in Jyväskylä University, where the upper part of the professors' dining hall was done in marble. The Technical University of Helsinki (1964), designed by Aalto, is similar. The southern facade of the architecture department was cladded in Carrara marble, while other department buildings were of red brick.

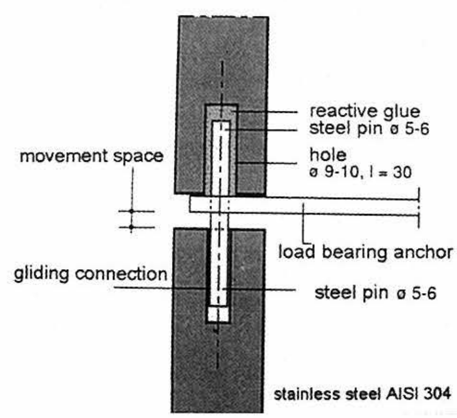
The protection of Finlandia Hall by law
In 1990 the City of Helsinki was given permission to use both Tolga White and Bethel White in the renovation of Finlandia Hall's marble facades. Later,

Detail of the façade, early 1980s. From: *A+U*, May 1983

Mount Airy was accepted as well (all these are granites). Subsequently however, the National Board of Antiquities (NBA) accepted none of them.
In 1992 the Association of Finnish Architects (SAFA), together with the Museum of Architecture and the Architectural Society, put forward a proposal for the protection of Finlandia Hall by law. This was the second such proposal, the first having been discarded in 1991 by the provincial government. The proposal was accepted by the Finnish Government on 6 May 1993. The first part of the decision says: "In the facades of the building the appearance corresponding to the originality of the materials, colours and design must be preserved".
The NBA, which was responsible for drafting this order, had stated clearly that only marble was acceptable. This was modified later in the process when the provincial government changed the wording and added instead of marble, "corresponding to the originality...".
Many problems arose from those words "corresponding to the originality". The City of Helsinki continued to search for light-coloured hard stones and finally had a new proposal for aplite from China, which is light coloured but has a slight red tone to it. The pressure to give up marble was immense, because for a few years very negative views on marble were aired weekly in newspapers and on TV and relatively few people understood the use of marble. On 2 June 1977, after many long, angry discussions and meetings, the City of Helsinki finally reached a decision to use Carrara marble.



Detail of the cladding



Panels' anchor. Detail

Original marble cladding

The maximum size of the original panels was 140 cm, and they were 3 cm thick. Each panel was fixed by four pins, two on each vertical side, and connected to the panel alongside it. The pins were inserted 35 cm in from the edges. Thus each panel was connected to four panels, overlapping at half the panel height. This connection method made changing a panel in the middle of a facade very difficult.

The problems with the original marble facade were:
- deterioration of the marble, surface deterioration, cracking, safety problems and appearance;
- bending of panels;
- the too-rigid fixing system did not allow the panels to move with changes in temperature;
- lack of ventilation;
- poor insulation.

Renovation plan

The City of Helsinki asked permission from the NBA to reduce the size of the slabs. After studying the original drawings we estimated that reduction in size was possible, the maximum amount of the reduction being 20%. However, after the NBA had put this in writing, we realised Alvar Aalto had already done this reduction. Now the City of Helsinki had our paper and wanted to reduce the size of the existing panels by a further 20%. Architects studied this proposal carefully and we accepted it, because we all knew that this marble facade was temporary and would be renovated again. This was seen as a kind of study to gather new knowledge for the next renovation and to give it a longer service life.

Demands for new marble facade:

- the (flexural) strength of the marble should be more than 9 Mpa/mm^2;
- the appearance of the marble should resemble the original, including even the pattern of the veins rising diagonally from the left;
- the fixing system should be flexible and allow movement and easy changing of panels;
- ventilation gap;
- better insulation.

Assumptions concerning the properties of marble:

- there is a correlation between strength and bending - the stronger marble the less bending there will be;
- there is also a correlation between colour and strength - the darker the marble the stronger it will be - an argument against our aim for white marble.

Execution

In 1997 Helsinki selected a finish contractor who was subsequently revealed to be quite inexperienced. Unfortunately it also turned out that the Italian partner in the contract was unreliable, and that the aesthetic appearance of the marble was so poor and the colour so dark that half of it had to be rejected. This caused problems and delay in the schedule, and finally in the autumn of 1997 the work had to be stopped and a new contractor engaged. At that point the insulation material had been applied in some parts and just a few slabs of stone were installed on the walls of the eastern side of the concert hall tower. The building was left as it was to wait for the following spring.
This time the City of Helsinki was very careful in choosing both the contractor and the Italian stone supplier. In the summer of 1998 we went to Carrara to look at two marble factories and their models. We asked both producers to make mock-ups for the wall of Finlandia Hall, and it was clear which one met our demands. The main reason was the appearance, but also the company's attitude and capacity. Savema was chosen and this decision appeared to be very good. They kept their promises, the quality of marble was good and they were on schedule. After accepting the mock-ups we signed both sample slabs and the second was sent to Finland as a reference.
In order to secure the desired quality in both the marble and the installation work a special control system was created, with every piece of marble being allocated a code number indicating the place it was taken from. This number was written on the blocks at the quarry and on the slabs at the processing plant. At the building site a map was created showing the code for each slab, and if a particular piece of marble did not fulfill the requirements according to laboratory tests it was rejected and changed, along with all the other slabs originating from the same block.
The amount of marble used in Finlandia Hall was 7,000 m^2 - approximately 80 blocks.
Completion of the work was celebrated in May 1999. In autumn 2001 when it was realised that panels were bending again, articles began appearing in the newspapers asking who was responsible for making the same mistake yet again.

The MARA project[1]

The Public Works Department of the City of Helsinki, with support from the European Union (Raphael program), launched a research project "Developing long-term durability of marble facades" known as the MARA project. It took two years and was completed in 2001.
Helsinki was responsible for the project management. Other participants in Finland were the National Board of Antiquities, Stonecon Oy, the Technical Research Centre of Finland (VTT) and Helsinki University of Technology; the Italian participants were Parma University, Internazionale Marmi e Macchine (IMM), Henraux S.p.A. and Savema S.p.A.; in Portugal Cevalor was involved. A number of other companies producing marble also took part in the project.

The main goal of the project was to find out the reasons for the characteristic behaviour of marble panels in outdoor uses. This information can be used in finding better solutions for building a more durable marble facade or in restoring the existing facades and monuments comprising the European cultural heritage. One of the goals was to create an active network of European stone companies, experts and research institutes and a model plan for the continual development of work within this network. The project also contributes to transferring technologies developed outside Europe which deal with research in and use of marble, although its research concentrated only on Italian marbles quarried in the Carrara, Massa and Lucca areas. The behaviour of marble is strongly defined by its microstructure. Three different structures were chosen to represent the relevant qualities: one homoblastic texture, one xenoblastic texture and two intermediate textures.
Xenoblastic marble structure is characterised by the interlacing of irregular grains that are closely fitted to

each other along the wavy contours. Regular-shaped grains with straight or gently curving boundaries define homoblastic structure. In general xenoblastic marbles present greater flexural strength, lower water absorption, smaller coefficient of thermal dilatation, and higher elastic modulus than the homoblastic marbles. The Carrara marble used in this renovation was intermediate, showing both xenoblastic and homoblastic features.

Field tests

The behaviour of marble structures consisting of thin stone panels was examined in practice in the facade above the roof terrace of Finlandia Hall. Items studied were the impact of the marble panel thickness, stone panel size and initial stone strength on the durability of the marble and coating structure. Also the bowing and changes in colour were measured. Different types of marble-coated structures were selected for the research as well as different qualities of Carrara Bianco. Three granites were added for comparison. Each sample occupies roughly 10m^2 of the research wall, the total area of which is 140m^2. The prevailing climate conditions i.e. humidity, temperature and the composition of the air by the wall were followed very closely. One of the most important factors was the cycle of freezing and thawing.

Research program

The main objective of the MARA research was to develop more durable solutions for a facade cladding of white Carrara marble (Carrara Bianco) in order to achieve a longer service life. Practical research was focused primarily on the durability properties of marbles.

In order to achieve the main objective, the MARA project was divided into the following areas:

- the main causes of marble deterioration in facade claddings;
- the main influencing factors and the failure mechanism;
- the method of testing the suitability of a given marble;
- technical specifications for the maintenance of a marble facade.

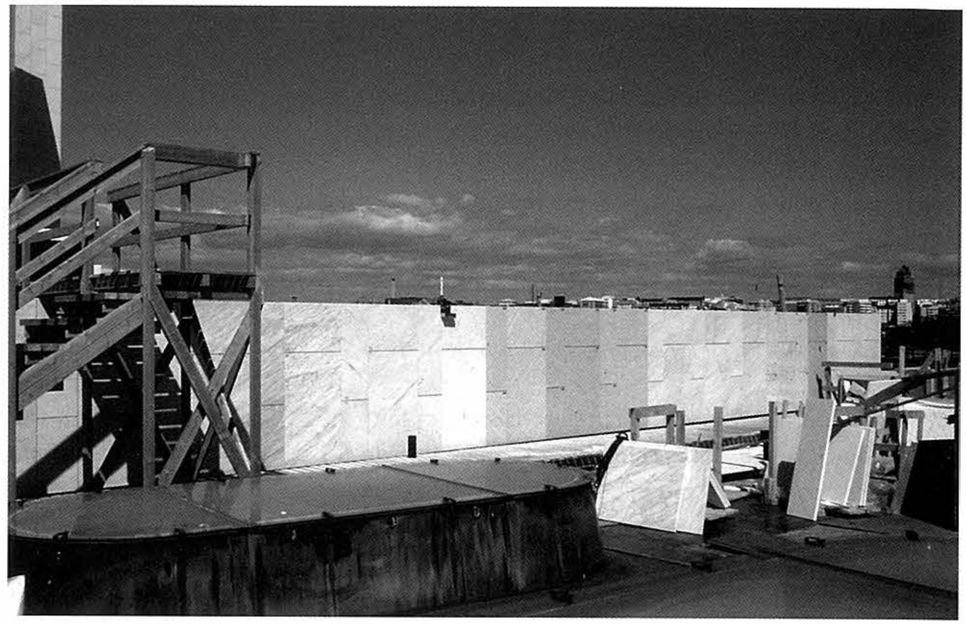
Finlandia Hall was used as the main reference. Previous experiences obtained from Finlandia Hall as well as the ongoing tests at the actual facade provided a valuable contribution to research activities.

BASIC PROPERTIES OF CARRARA BIANCO MARBLES A, D, E AND K (MARA RESEARCH PROJECT)

TYPE A ("LORANO PRADETTO") WAS USED IN FINLANDIA HALL IN THIS RECENT RENOVATION.

	A	D	E	K
microstructural characterisation	homo/ xenoblastic	homoblastic	xenoblastic	homo/ xenoblastic
appearance	white veined	white veined clear contours	white slightly veined	light grey slightly veined
strength	medium or high	low	high	high
porosity	low	low	low	low
typical uses	all purposes	mainly interior	all purposes	all purposes
earlier experiences regarding suitability	considered to be among the best quality in the region	known to have durability problems when used outdoors	known to be durable	known to be durable
rough geographic location	Carrara	Carrara	Lucca	Massa

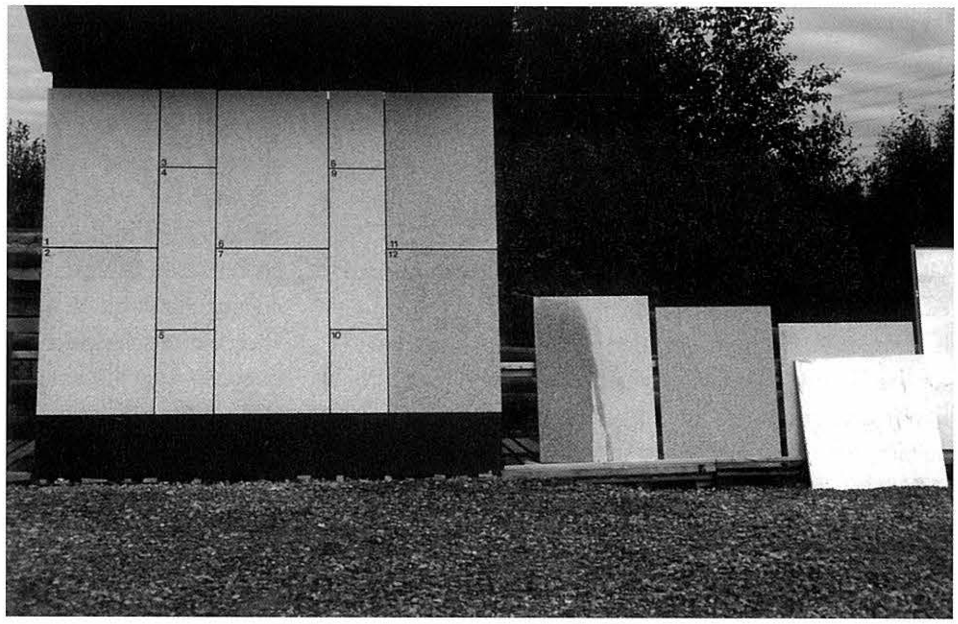
MARA project.
Different qualities of Carrara Bianco Marble



Three types of light-coloured granites were included in the research. Permission was given during the long preparation period for the recent renovation for all of these granites to be used in the Finlandia Hall facades.
Panel sizes were according to the architectural design, panel thickness 30, 40 and 50mm. Surfaces were honed as in Finlandia Hall at 600, which gives Carrara Bianco a smooth shining appearance.
Finishing was both asymmetric (front face 600/back diamond-sawn) and symmetric (both faces 600)

The MARA project conclusions
The main cause of the degradation of Carrara white marble in cold climates is essentially the anisotropic thermal expansion of the constituent calcite granules. It is not due to the acidity of air or rain. A temperature increase of a few degrees is sufficient to produce a significant self-equilibrated state of the various stresses within the material because the thermal anisotropy directions of the various granules are randomly oriented in marbles. Moreover, a major parameter in the material characterisation should be represented by the microstructural mosaic texture of the constituent grains. Marbles formed by round-shaped grains with gently curved boundaries (homoblastic textures) should show poorer properties than those formed by grains with wiggly contours (xenoblastic textures), because of the greater degree of intergranular connection of the latter.
Before this research the estimated number of freeze/thaw-cycles was about 20 in a year, but in reality it is between 60 and 70. The number of freeze/thaw-cycles seemed a little lower on the inner surface of the marble slab than on the outer surface, with a difference of about 10%. As this causes a higher strain on the outer than on the inner surface it could be one of the factors contributing to the bowing. Daily variations were bigger on the southern walls than on the northern ones. Very low temperatures (-20 degrees or more) seem to be more damaging, even without a frost effect. But also temperatures from +30 degrees to +50 degrees cause permanent changes in the microstructure of some marbles. These kinds of temperatures can easily exist in a Nordic climate.
The strain caused by freezing and thawing may have an accelerating effect on the deterioration process once has started and enough cracks have been formed. The very first cycles can have the most significant influence. The number of the cycles after the first five does not have any significant influence. After that the deterioration process slows down and the properties of marble will stay more or less the same. But in order to predict the behaviour of marble for any longer periods of time a longer monitoring of the marble properties would also be required.
Temperature cycling has a strong effect on both the porosity and the capillary water absorption coefficient.
This study indicates that the greatest reduction of the marble quality due to the thermal cycling is in marble E (from Lucca) which has the best original quality. So the thermal cycling seems to equalise the differences in pore characteristics between the marble types.
The measurements show that the renovated walls of Finlandia Hall have already deteriorated. The reduction in the strength of the marble since the slabs were installed is 20-30%. Panels installed in autumn 1998 are bowed more than those installed in the following spring. The reason for this must be the very cold winter in Finland in 1998-99.
The reason marble qualities behave differently is to be

MARA project.
Additional granites for comparison with Bianco Carrara Marble



found in the microscopic arrangement of the crystals. Any marble is composed of more than 99% pure calcite, whereas the other accessory components have practically no influence on the mechanical properties. Granular decohesion is certainly more favoured in homoblastic than in xenoblastic marbles because there are more imbrications. Therefore this study suggests that the grain texture may be a major qualifying characteristic for selecting marbles able to endure over the years.

Physical building design principles
The following design principles should be applied for natural stone cladding:
- stone cladding should be jointed by mastic to prevent rain penetration and to allow small deformations of structural elements without the risk of internal strains;
- humidity in the wall structure should be let out using a ventilation gap placed behind the stone cladding; proper functioning of the ventilation gap is ensured by using sufficient openings for both air going in and air coming out;
- connections between panels should be elastic to allow for deformations due to thermal stress
- internal stresses, due to fixings and deformations between structural elements, should be eliminated by proper design of the fixings;
- protective agents can be considered if there is a need to protect the cladding against environmental impurities.

Structural design principles
In conclusion the following structural principles are recommended for natural stone cladding:
- panels are fixed independently to the frame of the building using load-bearing and restraint anchors of stainless steel or aluminum;
- anchors are placed in the joints between stone panels and fixed to the edges of the stone panels with stainless steel pins;
- load-bearing anchors, placed in the lower part of each panel, carry the weight of the stone panels and part of the wind forces;
- restraint anchors, placed in the upper part of each panel, take only wind forces.

Is Carrara marble still a possibility?
Marble seems to be prone to bend when it is used in thin panels on facades. One possibility is to choose xenoblastic marble, which bows less than the others do. The MARA project also shows that it is possible to find white marble of better quality than that used now or previously. But still the main problem - bending - remains. The City of Helsinki will continue its research into marble cladding alone after the MARA project, because there are so many unanswered questions. New kinds of solutions can be created: some of them have in fact been tested in practice for years. In Karjaa, west of Helsinki, there is an office building about the same age as Finlandia Hall, with its facades made from Carrara marble. There is no problem with bowing at all, because the structure is composite: the marble is only 1cm thick and is used with 3cm concrete behind it. Because concrete usually shrinks when drying, the marble slab is prebowed by sandblasting the back of it until there is 4mm of bowing. Then as the concrete dries the slab will be straightened.
In the centre of Helsinki there is an office building with a marble cladding. It looks like Carrara marble and its slabs are straight. There is no bowing at all. We

might guess that this building was constructed following Finlandia Hall, which would make it about 25 years old, because after the bending of marble became commonly known nobody wanted to use it any more. The slabs in this case seem to be 3cm thick. Why this is possible?

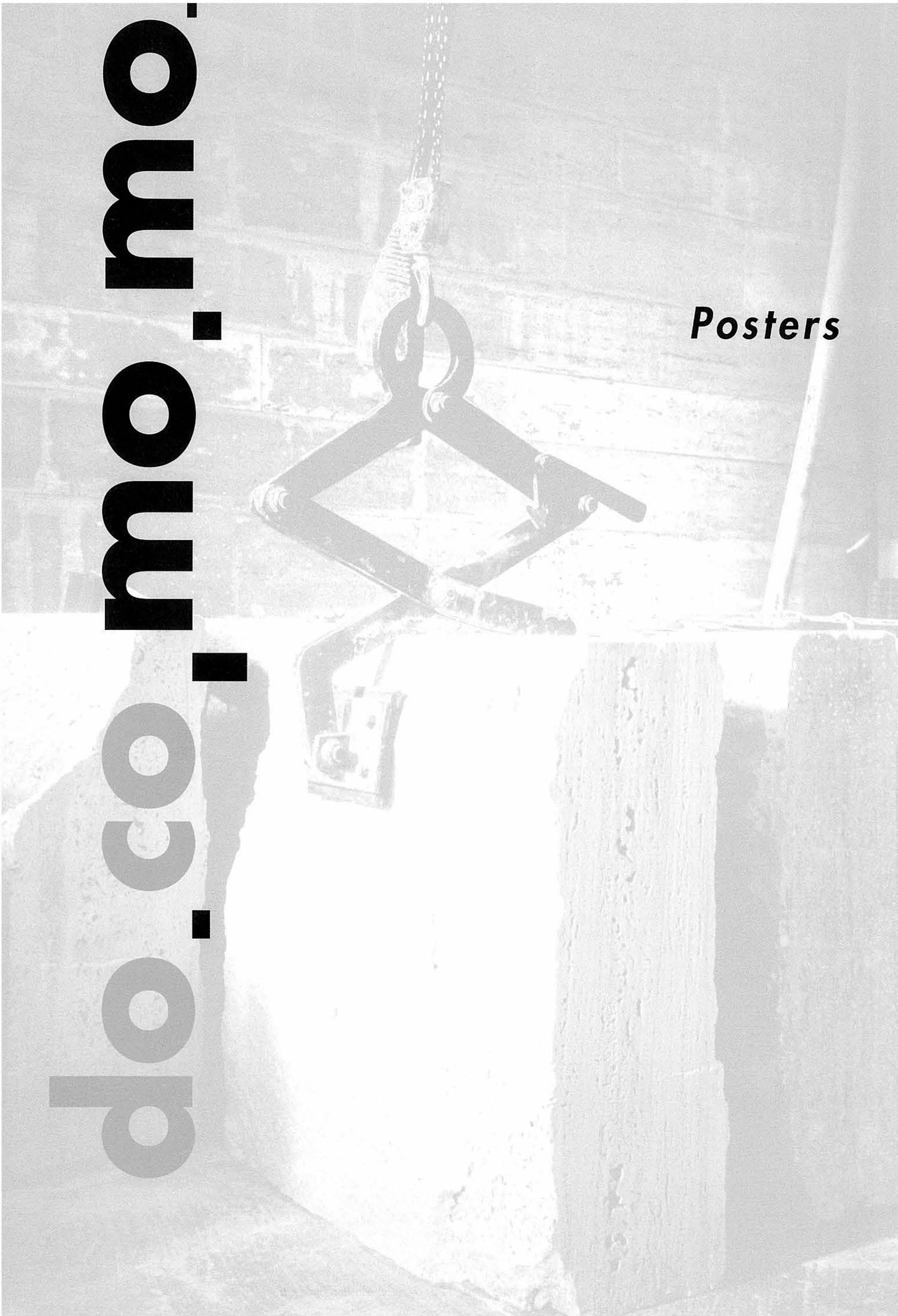
What about the change of stone and colour of Finlandia Hall?

It is not quite clear whose idea it was to use marble for the Finlandia Hall. Alvar Aalto favoured it and for him it was an important link with Mediterranean culture, which he wanted to introduce into Finland[2]. But his assistant the architect Jaakko Kontio recounts that when he was planning the church in Seinäjoki (1955-1960), Alvar Aalto wanted to make both the church and bell tower of black granite[3]. However this was too expensive and Aalto selected the cheapest alternative: red brick with white lime wash. Jaakko Kontio also says that Aalto in the beginning suggested black granite for Finlandia Hall, but the mayor of city preferred a white building. In fact granite could be a solution even though it takes a lot of courage to use it. A change of colour trying to imitate the original Carrara marble facade is doomed to fail. This way Finlandia Hall would lose its significant character. If a change of stone is implemented the difference between the original cladding and the new one would be so visible and clear that it could no longer claim to be an Aalto design. It is our duty to preserve the cultural heritage of Alvar Aalto for future generations. The cost of renewing the marble will not be so high because now the only thing to change will be the marble panels; fixing or insulation, which accounted for the major part of expenses in the last renovation, can stay due to the new construction of the facade.

Notes

1. MARA Project, Final report 30.4.2001, unpublished
2. *Finlandia Talo/Finlandia Hall*, Alvar Aalto Foundation, Helsinki 2000
3. *Alvar Aalto ja Helsinki*, Porvoo 1998

All drawings and photos by Martii Jokinen



Posters

Techniques and Experiments in Fixing Stone Cladding

Daniela Bosia

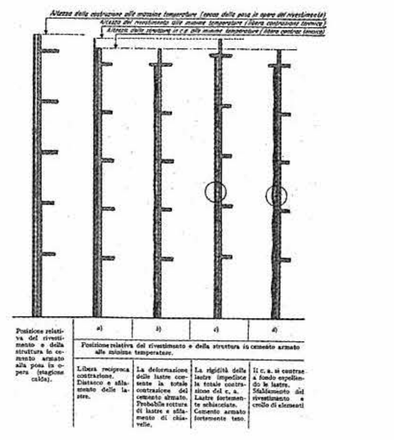
"MODERN" SYSTEMS FOR FIXING STONE CLADDING: TECHNIQUES AND EXPERIMENTS

Daniela Bosia - Politecnico di Torino - Facoltà di Architettura 2 - DINSE

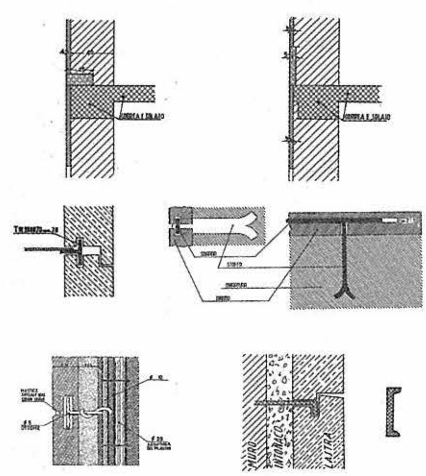
THE "MODERN" ANCHORAGE SYSTEMS FOR STONE CLADDING

Stone cladding are quite a familiar feature of the Italian building tradition and they characterize many modern buildings throughout the country. Local marble became autarchic as a sort of "elegant and durable plaster". However, it is considered "a practical need, a solved problem" more than a decorative attribute of buildings. The use of thin but very large slabs required the study of suitable anchoring systems, sometimes specific ones for given projects. Some of these systems, tested on various buildings, have been listed in the Manuale dell'Architetto

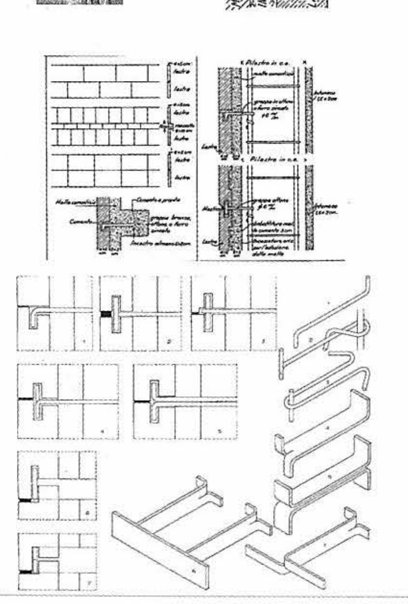
THE EARLY STUDIES



ANCHORAGE SYSTEMS LIST



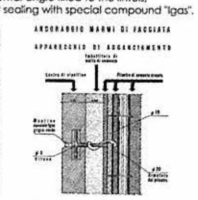
ANCHORAGE SYSTEMS FROM THE "MANUALE DELL'ARCHITETTO"

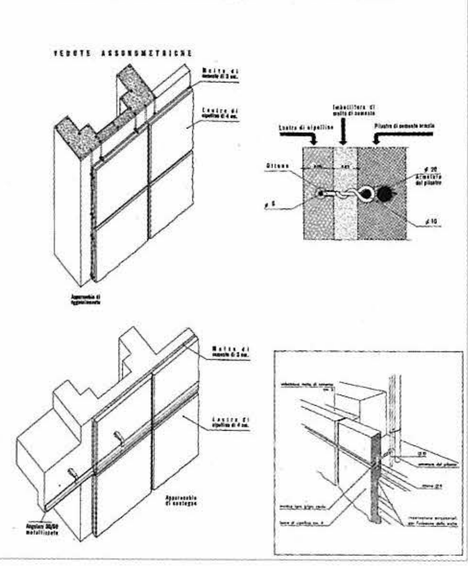


"PALAZZO PER UFFICI MONTECATINI": A STONE CLADDING BUILDING IN MILAN

Palazzo per Uffici Montecatini - Milano
Gio Ponti, Antonio Fornaroli, Eugenio Soncini
1935-38

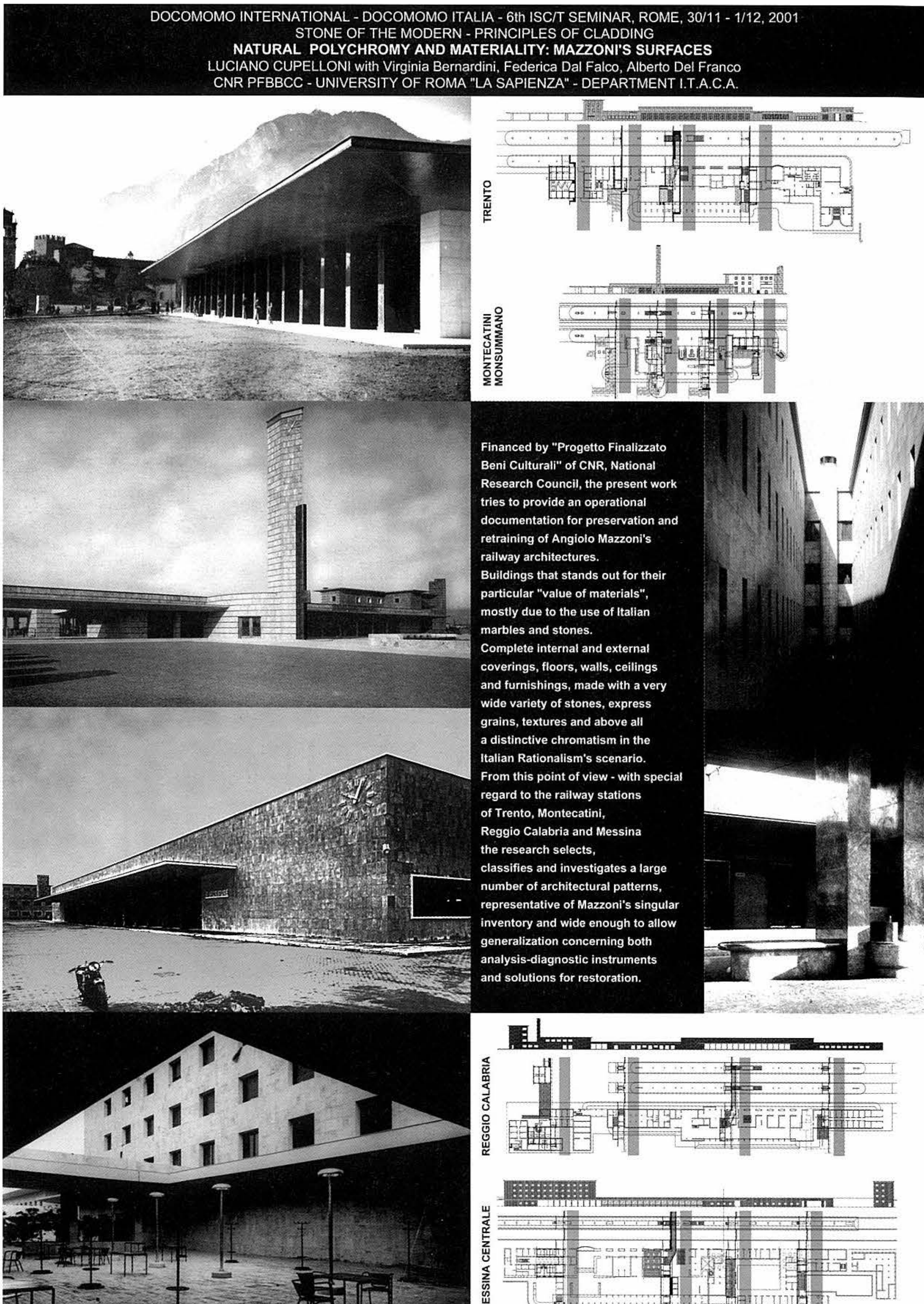
The external cladding - in all about 6200 mq - are in "cipollino apuano" slabs. The rectangular top size 210 x 90 cm slabs are 4 cm in tickness. The slab edge are chamfered with a clean-cut separation between the marble slabs.
The marble slabs anchorage system is designed by ing. P.G.Bosisio:
- every marble slabs is anchored to the rinforced-concrete structure by eight or ten supprting soft brass clamps. At the external side, the clamps are T-shaped and fixed into fitting seats maide in the tickness of the marble slabs. On the other side, the clamps are twisted around special rods in the concrete seated;
- use of 3 cm cement mortar between wall and slabs;
- every single cladding floor is supported by horizontal angle fixed to the lintels;
- joint sealing with special compound "Igas".





Natural Polychromy and Materiality in Angiolo Mazzoni's Buildings

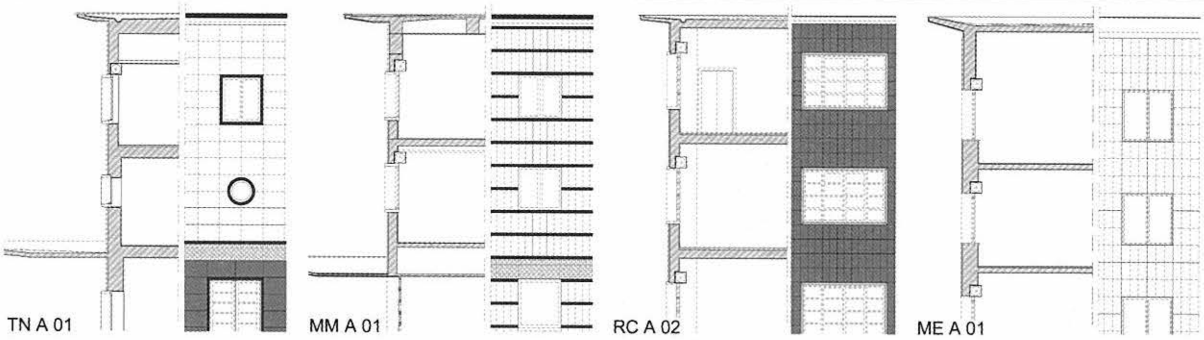
Luciano Cupelloni con Virginia Bernardini, Federica Dal Falco, Alberto Del Franco



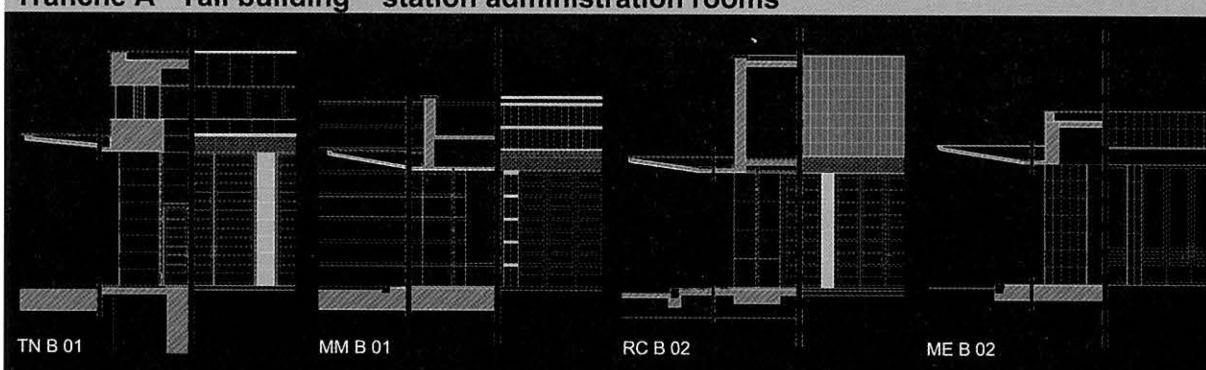
DOCOMOMO INTERNATIONAL - DOCOMOMO ITALIA - 6th ISC/T SEMINAR, ROME, 30/11 - 1/12, 2001
STONE OF THE MODERN - PRINCIPLES OF CLADDING

NATURAL POLYCHROMY AND MATERIALITY: MAZZONI'S SURFACES

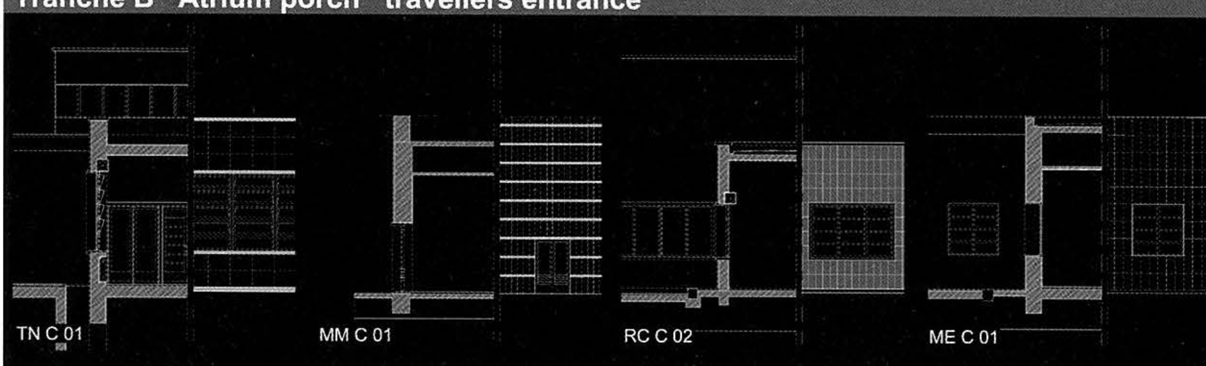
LUCIANO CUPELLONI with Virginia Bernardini, Federica Dal Falco, Alberto del Franco
CNR PFBBCC - UNIVERSITY OF ROMA "LA SAPIENZA" - DEPARTMENT I.T.A.C.A.



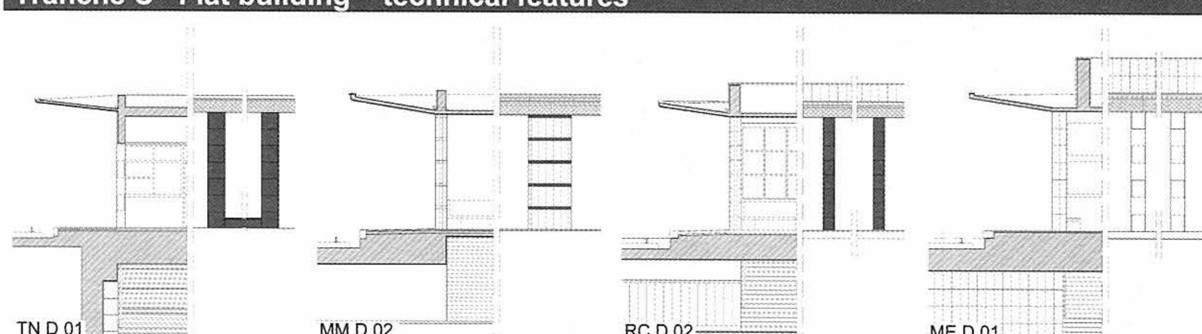
Tranche A Tall building station administration rooms



Tranche B Atrium porch travellers entrance



Tranche C Flat building technical features

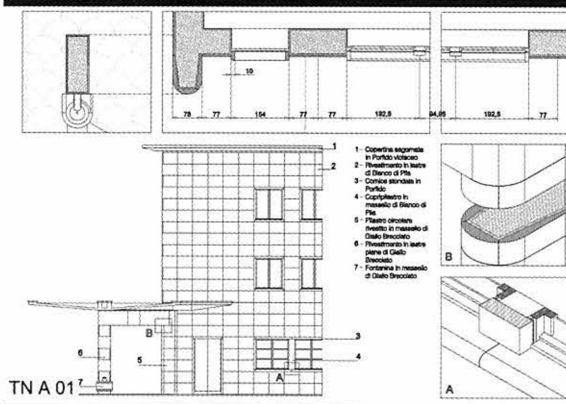


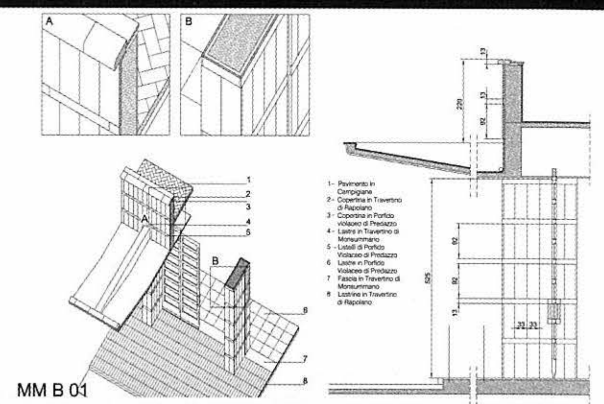
Tranche D Platform roof train waiting area

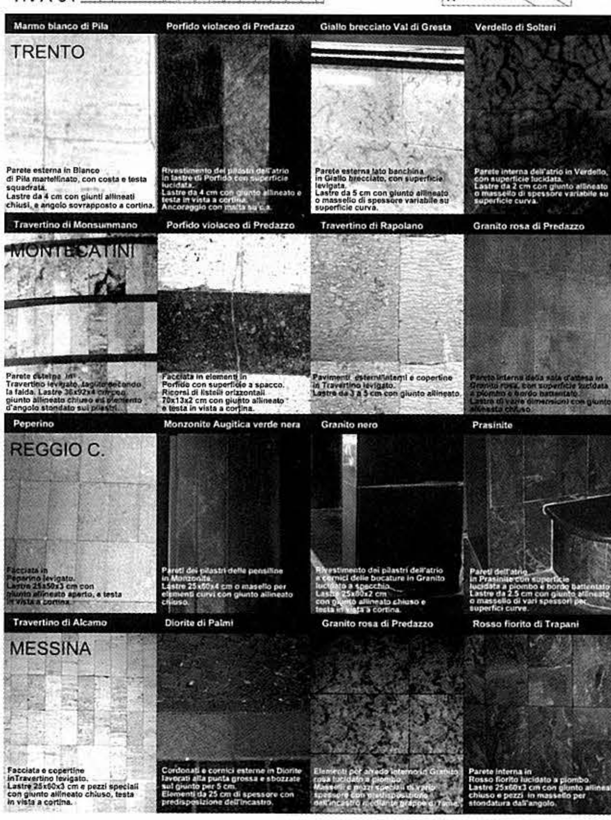
DOCOMOMO INTERNATIONAL - DOCOMOMO ITALIA - 6th ISC/T SEMINAR, ROME, 30/11 - 1/12, 2001
STONE OF THE MODERN - PRINCIPLES OF CLADDING

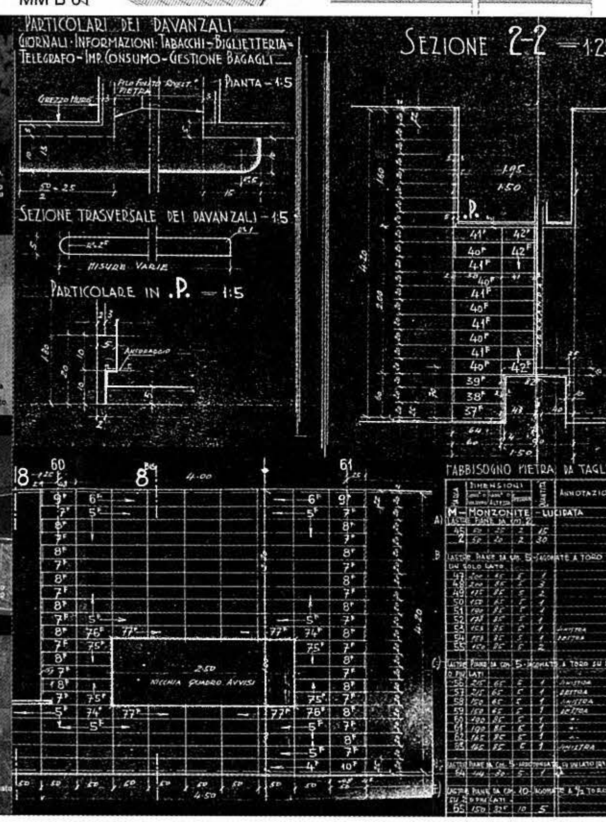
NATURAL POLYCHROMY AND MATERIALITY: MAZZONI'S SURFACES

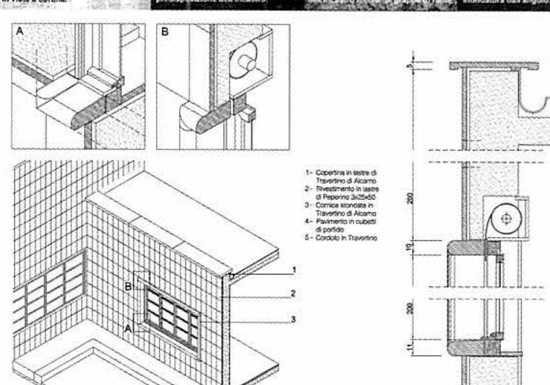
LUCIANO CUPELLONI with Virginia Bernardini, Federica Dal Falco, Alberto Del Franco
CNR PFBBCC - UNIVERSITY OF ROMA "LA SAPIENZA" - DEPARTMENT I.T.A.C.A..

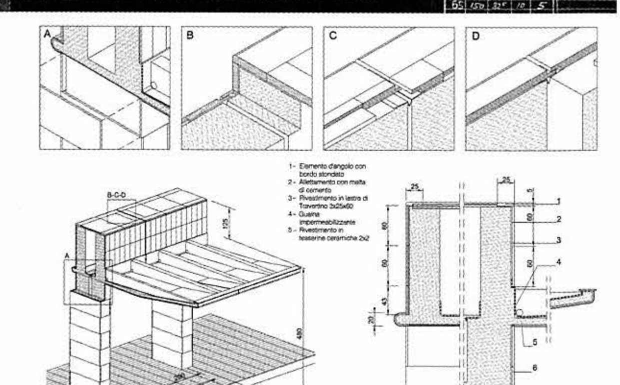












The Marble Facing of Marconi's Obelisk at EUR, Rome

Maria Grazia D'Amelio

DOCOMOMO INTERNATIONAL - DOCOMOMO ITALIA
SIXTH SEMINAR ISC/T, Rome 30.11 - 1.12.2001
STONE OF THE MODERN
LA PIETRA NELLA COSTRUZIONE DEL MODERNO

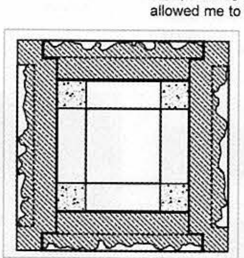
The Marble Facing of the Guglielmo Marconi Obelisk in EUR, Rome (1939-59)

M.G. D'Amelio
Department of Civil Engineering, University of Rome, Tor Vergata

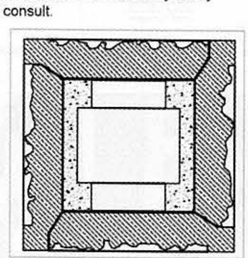
Competition regulations for projects submitted at the E42 encouraged the use of local materials and a limited use of iron. Yet the Guglielmo Marconi obelisk, in the middle of what used to be called Piazza Imperiale[1], which because of its monolithic shape could easily have been made of a single block of material, ignored these specifications. It was designed as a reinforced concrete structure, with its four sides covered by 32 panels of Carrara marble, carved with figures in high relief by Arturo Dazzi (1881-1966)[2].
The monument has been described critically as "too narrow", "needle-thin", "squat" and visually feeble. This is partly because its final height was reduced from the original 54.70 metres planned by Dazzi to less than 45 metres, but also because the background of the scenes portrayed on the marble facing changes abruptly. In the lower orders, the scenes are hemmed in by geometric patterns, while in the upper levels they extend outwards towards the corners of the obelisk[3].
The preliminary project (March 1939) offered two solutions for building the obelisk's reinforced concrete structure. The first proposal was to create a framework of pilasters connected by girders with a shelf-like edge, which would hold the marble blocks and offload their weight on the supporting structure. The blocks would also to be anchored down in the middle by other girders. The second proposal was to join the pilasters with vertical concrete slabs, which would follow the inclination of the obelisk's truncated pyramid shape. This surface would then support the marble blocks.
The solution which was eventually implemented was a compromise between these two proposals. Four pilasters are connected by external girders with a shelf-like edge and by vertical concrete slabs. The marble blocks are attached to the slabs and are an average of 80cm thick (the carved areas have to be at least 35cm deep) and weigh up to ten tons. Their weight is such that it was necessary to use reinforced tubular scaffolding, which could bear a 1000-kilogram load, and four supports were needed for the pulleys[4]. An analysis of the panel's abacus reveals that the blocks are the same height along the whole shaft of the obelisk. However, they are doubly tapered, which consequently effects their thickness, so that the sculptural relief is half as deep at the top of the monument than it is at the base.
The work specifications (ACS, Ente Eur, Busta 655) clearly define the high artistic quality to be achieved by the sculptural work and the need for perfect joining when laying the marble blocks. The blocks had to be connected by copper cramps and anchored to the structure with a cement mixture and iron clamps (f 12 and 40 cm long) that were partly chromium plated. The joining had to be done with white Durablo cement, which was pigmented when used for the coloured marble of the crypt in the obelisk's base. Because of the obelisk's specific characteristics, great care was taken to ensure that the marble facing was not damaged at any stage. Reading between the lines, the documents reveal that a titanic enterprise was set in motion, which covered transporting the carved pieces from the artist's studio near Massa Carrara to Rome as well as every phase of storing, raising and anchoring the blocks.

[1] The square later became piazza Italia and now is named for Guglielmo Marconi. See: *Concorso per il progetto della piazza Imperiale*, "Architettura", XVII, December 1938, 865-871; *L'esposizione Universale 1942 fulcro dell'espansione di Roma al mare, stato dei lavori- nuovi progetti approvati*, "Architettura", XVIII, December 1939, 38-48.
[2] For the sculpture work on the obelisk, see: A. Dazzi, *Il monumento a Guglielmo Marconi*, edited by A. Pisani, M. Venutelli, Carrara 1959; *Arturo Dazzi e il monumento a Guglielmo Marconi*, Carrara, 1959; see also the entry by D. De Dominicis, M. De Luca, *Stele a Guglielmo Marconi*, in *E42. Scenario di un regime. Urbanistica, architettura, arte e decorazione*, edited by M. Calvesi, E. Guidoni, S. Lux, Venice, II, p. 374.
[3] In drawings done by the Moretti, Quaroni, Fariello and Muratori group, the high relief scenes always look as if they are framed, an effect achieved by the anchoring system used for the blocks, which are wedged between angle bars that are individually clamped to the frame. "Horrible", "coarse" and "ugly" are terms used by Ludovico Quadroni, see: *Gli obelischi, le piazze, gli artisti: conversazione con Ludovico Quaroni*, edited by A. Greco, in *E42*, op. cit., 283-287.
[4] The first two orders were supposed to be installed by the E42, while the other high relief decorations up to the top of the obelisk were to be substituted by reinforced gesso panels. A substantial corpus of drawings and documents related to finishing the obelisk can be found in the archives of Ingegnere Ugo Bernieri, which his family kindly allowed me to consult.

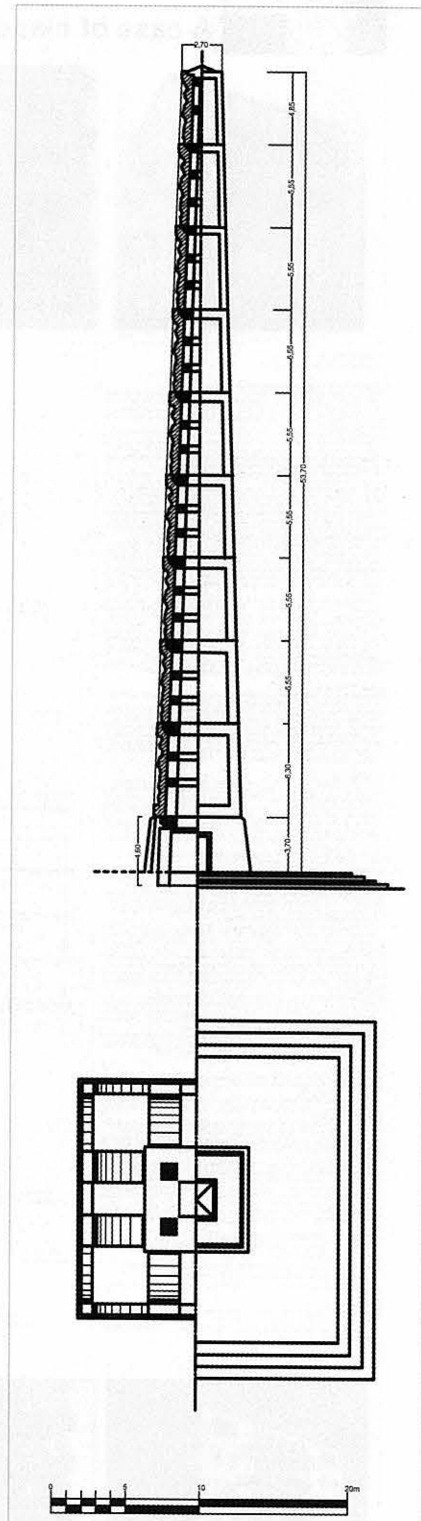
The Obelisk



Preliminary project (March 1939): cross-section of the marble blocks (proposal A).
The frame in reinforced concrete consists of pilasters connected by girders.



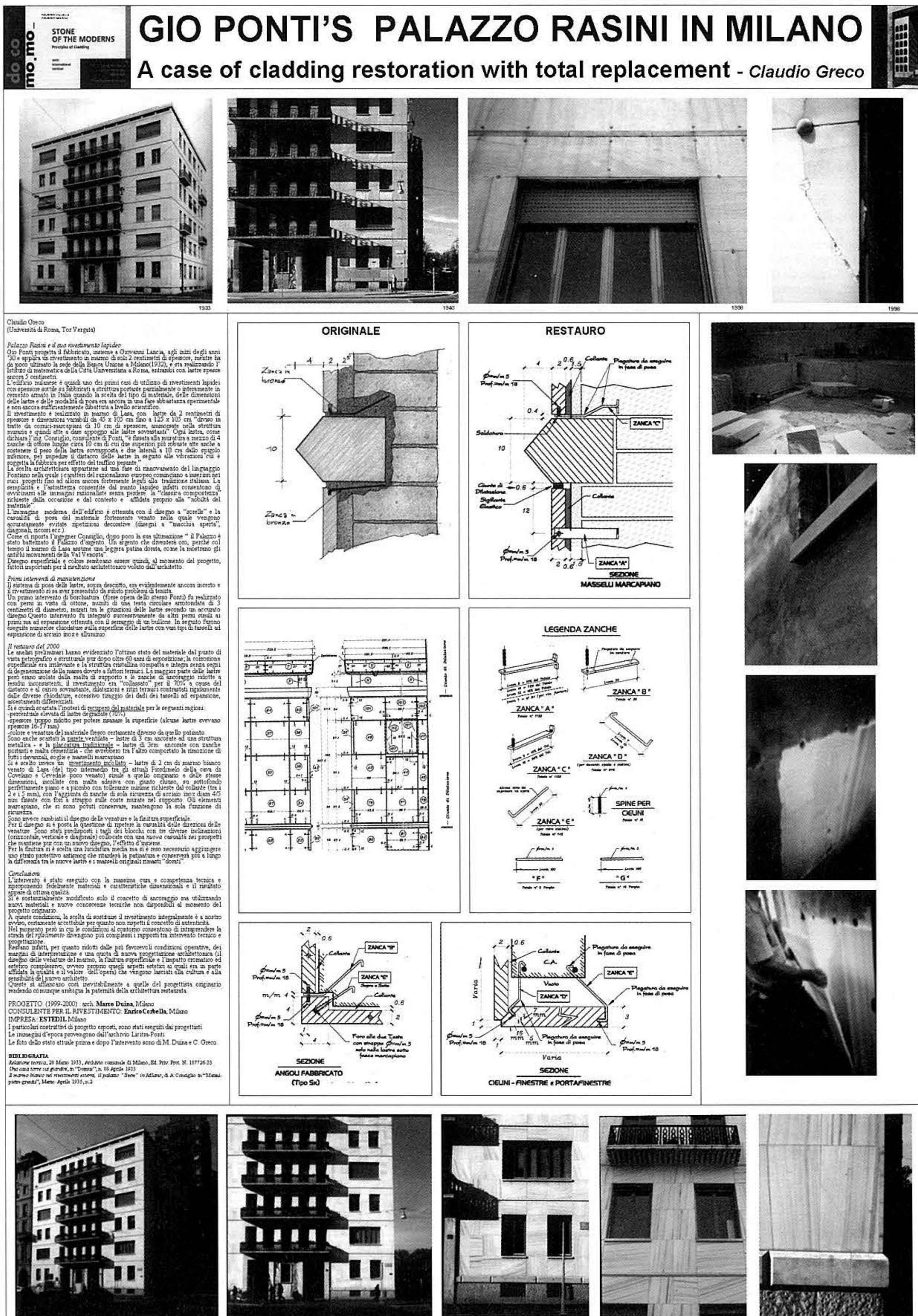
Preliminary project (March 1939): cross-section of the marble blocks (proposal B). The reinforced concrete frame in this case is made of vertical concrete slabs and girders connected to the pilasters.



The construction system used for the Obelisk (re-worked drawings by M.G. D'Amelio), from the Progetto di massima per il monumento a Gugliemo Marconi, June 1939, Archivio Stato Roma, Ente Autonomo Esposizione Universale di Roma, Busta 655.

Gio Ponti's Palazzo Rasini in Milano

Claudio Greco



Between Autarky and Innovation: Spatrisano's House for the Disabled

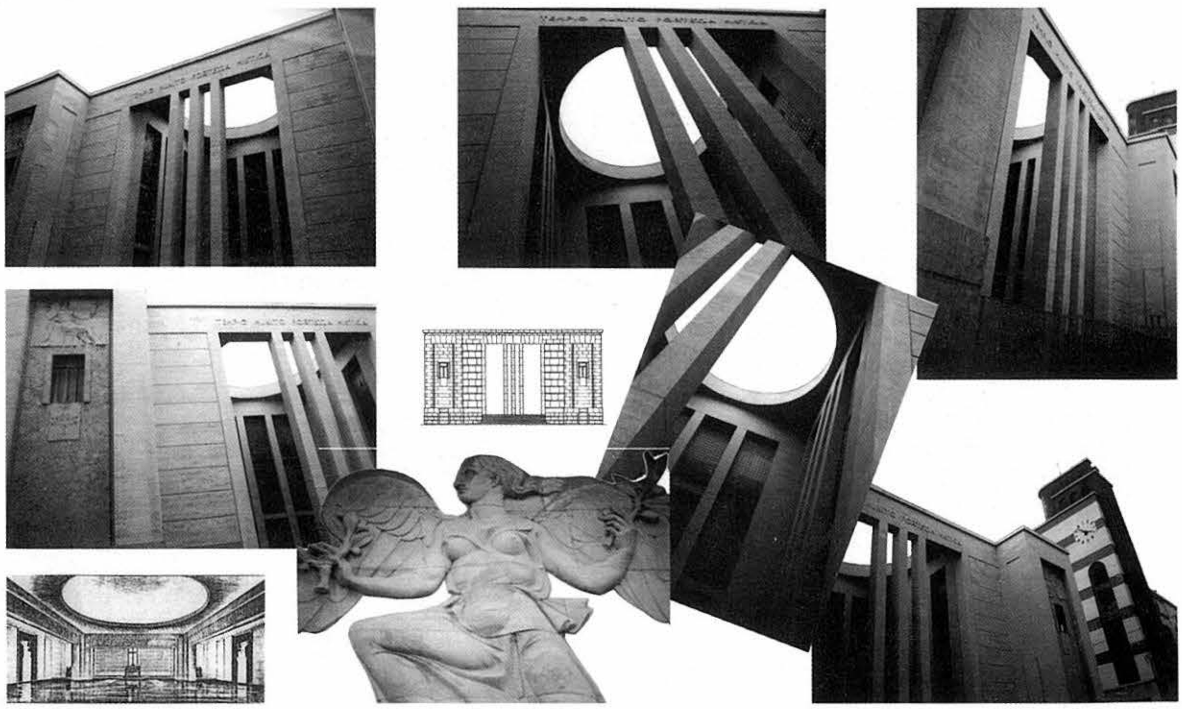
Maurizio Oddo

DOCOMOMO INTERNATIONAL - DOCOMOMO ITALIA
6° SEMINARIO INTERNAZIONALE ISCT/T, Roma, 30.11 - 1.12. 2001
STONE OF THE MODERNS / LA PIETRA NELLA COSTRUZIONE DEL MODERNO

Between autarky and innovation:
the House for Disabled People by Giuseppe Spatrisano

Tra autarchia e innovazione: la Casa del Mutilato di Giuseppe Spartisano

Maurizio Oddo
Università di Catania,Facoltà di Siracusa



GIUSEPPE SPATRISANO E
LA CASA DEL MUTILATO
A PALERMO (1936-1939)

Laureatosi a Roma, nel 1930, presso la Scuola Superiore di architettura diretta da Gustavo Giovannoni, Giuseppe Spatrisano è un importante esponente della storia dell'architettura siciliana del Novecento, sia per la sua attività professionale che per i risultati ottenuti nell'ambito della ricerca storica.

La sua Casa del Mutilato, un'opera di alto valore rappresentativo, interpreta, con evidenti intenzionalità classiciste, il *carattere rivoluzionario* dell'Italia fascista, espresso attraverso un'architettura monumentale e per certi aspetti retorica.

L'aderenza alla realizzabilità del progetto, caratteristica fondamentale degli elaborati delle opere di Spatrisano di questi anni, è una costante presenza derivata dall'attaccamento alla fisicità dell'architettura, attraverso un operare che trova la sua più alta realizzazione nella pratica costruttiva del mestiere.

L'opera che segna l'acme della sua esperienza professionale è la Casa del Mutilato che si inserisce nel filone, inaugurato dal regime fascista, degli edifici commemorativi destinati ad onorare i caduti della guerra e a custodire e potenziare il valore ideale della *Vittoria*.

Giuseppe Spatrisano, vincitore del concorso, viene invitato a perfezionare il progetto in funzione alle esigenze dell'associazione, volte soprattutto a conferire all'erigenda Casa del Mutilato maggiore carattere di monumentalità; in particolar modo, viene suggerita la possibilità di rivestire in marmo di Billiemi la parte basamentale e tutti gli aggetti del prospetto dei piani superiori.

Un'architettura che si concentra sui valori comunicativi ed ideologici della forma architettonica alla cui coerenza generale sono strettamente subordinati motivi linguistici particolari attraverso un rigore basato su un'operazione di semplificazione del linguaggio classico.

Il tema da sviluppare spinse Spatrisano a confrontarsi, fin dall'inizio, con quello più generale dell'edificio pubblico, così come dimostra una serie di studi preliminari. D'altro canto, la sua architettura non si muove sulla creazione tutta intellettuale del *tipo* come categoria di problemi simili, non conosce l'estendibilità culturale che un simile approccio comporta all'architettura. Al contrario, attraverso la sua opera offre differenti risposte concrete, attraverso l'uso del progetto come strumento che interviene a raccogliere e a spiegare le strategie d'intervento.

Ispirata al Danteum di Terragni ma con un linguaggio che risente delle architetture della retorica Roma piacentiniana, la configurazione dell'edificio appare come il risultato di un sottile dosaggio di suggestioni diverse: la dimensione architettonica dell'atrio è filtrata nell'atmosfera rarefatta della ricerca metafisica; i muri, i rivestimenti e i bassorilievi si collegano alla tradizione romana, sul piano astratto della geometria, epurata da ogni connotazione realistica.

Pur se realizzata con caratteri più modesti del previsto, senza per questo perdere il suo carattere monumentale, la Casa realizza, attorno al vuoto centrale dell'atrio, uno spazio caratterizzato da un

movimento ascensionale che sottolinea il significato del martirio.

Grande cura delle tecniche costruttive e nell'uso dei materiali viene rivolta dallo Spatrisano a conferma delle ricerche condotte in quegli anni in campo architettonico: la struttura portante dell'edificio è realizzata in cemento armato, mentre il tompagnamento è stato eseguito in pietra d'Aspra e mattoni. Le pareti dell'atrio sono caratterizzate da superfici di vetrocemento.

Sia l'atrio che parte del prospetto principale e le finestre del piano elevato sui fronti laterali sono rivestite con lastre di travertino mentre le restanti superfici e tutto il prospetto posteriore sono rifiniti con intonaco.

Fondamentale il ruolo assunto dalla rifinitura dell'involucro, sovrapposta alla struttura attraverso un materiale di rivestimento; diffuso è l'impiego di lastre sottili in marmo e in generale di finiture realizzate in materiale lapideo, soluzioni sotto il profilo espressivo e figurativo suggerite, o forse più spesso imposte, dalla politica autarchica di regime, specie nella realizzazione delle opere pubbliche, ma anche preferite dai progettisti per configurare una architettura dal carattere certamente più monumentale e aulico rispetto alle soluzioni ad intonaco tipiche del razionalismo; ciò anche in funzione del fatto che le tradizioni costruttive locali, nell'isola, erano legate ad aspetti di impronta tipicamente artigianale.

Tutta la parte basamentale è rivestita di lastre di calcare compatto e lucidato a piombo.

Gli intonaci esterni dei prospetti secondari, perfettamente impermeabili, sono stati realizzati col sistema ad impasto a corpo ad imitazione della pietra naturale. I pavimenti in quadrelli di cemento a scaglia.

L'edificio è studiato in funzione del reticolo stradale ma l'impossibilità di creare una zona di rispetto, antistante al Monumento, utile per le celebrazioni e le adunanze assai numerose dell'epoca, conduce il progettista alla adozione di una pianta a cortile aperto e all'arretramento del corpo centrale del prospetto principale che risulta fortemente dilatato rispetto alle due testate laterali da cui emerge, inatteso ed imponente, l'alto tamburo dell'atrio la cui definizione presenta un trattamento astratto, spogliato di ogni declinazione in senso stilistico.

La Casa, infatti, è stata concepita come organismo simmetrico disposto intorno al grande atrio d'ingresso con la scala in posizione assiale che porta al centro dell'*ipotetico* spazio cilindrico.

Tale composizione centrale assume, inoltre, un significato *spirituale* che è affidato principalmente agli stessi elementi architettonici, a differenza delle fronti dei due corpi laterali che hanno un prevalente carattere illustrativo, per le opere scultoree che ne fanno parte, rappresentanti l'assistenza ai mutilati e il fante che addita al giovane fascista il sentiero del sacrificio; elementi che assolvono alla funzione celebrativa insieme alle iscrizioni poste a coronamento dell'edificio.

Si tratta di un aggiornamento del concetto tradizionale del monumento allegorico, frutto di una rielaborazione formale del frammento classico, con quegli accenti di plasticità e solidità di forma, di esaltazione dell'italianità e romanità che ben si addicono ai nuovi orientamenti del linguaggio figurativo.

Forme architettoniche che sono rapportabili ad una immagine caratterizzata da un forte potere evocativo. Forme che, nella loro caratteristica di archetipi, paiono mostrare contemporaneamente il contenuto e le intenzionalità dell'uomo, proprio come accadeva nella architettura romana più significativa. L'uso del repertorio classico, semplificato e rielaborato, infatti, ricorrente nel linguaggio piacentiniano della capitale, raggiunge all'esterno accenti di severa monumentalità.

Ma il martirio è atto di purificazione, così come è dimostrato dagli apparati decorativi che vi sono collocati, secondo i dettami della mistica fascista.

Il salone delle cerimonie, posto nella zona centrale dell'edificio, in relazione ideale con la corona che sovrasta l'atrio stesso, è illuminato attraverso ampi lucernari in vetrocemento.

Il centro della composizione, vero e proprio cuore della Casa, centro dell'atrio circolare e quindi centro degli assi di simmetria della pianta è rafforzato dall'inserimento dell' altare per le cerimonie pubbliche.

Anche la decorazione degli spazi, a partire dalle campiture del pavimento per arrivare al posizionamento del pannello centrale, scaturisce dallo stesso principio compositivo e dallo stesso criterio di figurazione che fanno della Casa del Mutilato una architettura monumentale ma nello stesso tempo una grande scultura a scala urbana.

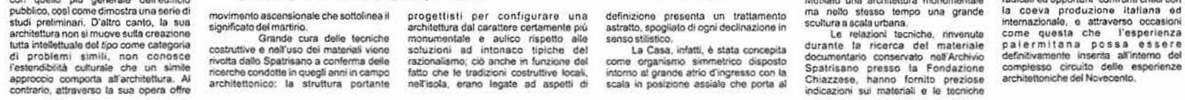
Le relazioni tecniche, rinvenute durante la ricerca del materiale documentario conservato nell'Archivio Spatrisano presso la Fondazione Chiazzese, hanno fornito preziose indicazioni sui materiali e le tecniche esecutive impiegate alle varie scale d'intervento, dalla struttura alla decorazione.

In accordo con le teorie del Giovannoni e attraverso la rielaborazione delle conclusioni di E. Persico degli anni Trenta, Spatrisano argomenta che lo stile di un architetto non è una scuola di pensiero o una tecnica a cui attingere di volta in volta forme e concetti, ma è un bagaglio, un microcosmo interiore in continua evoluzione, che ognuno possiede e che interviene nel momento della scelta in campo progettuale.

Pur senza la pretesa di tracciare bilanci esaustivi, preme sottolineare che alla fine degli anni trenta, la cultura architettonica siciliana si dissolve fagocitata nel novecentismo e nell'arte di regime che sovente si identificano con la conseguenza del ripristino di una figurazione ancora legata a moduli espressivi ottocenteschi o, in taluni casi, a reminiscenze deco, con la conseguenza di un irrigidimento e di una frammentazione dei percorsi individuali; ed è proprio la dimensione più appartata ed intimista dei temi, sebbene affrontati con un linguaggio omogeneo alla maggior parte della contemporanea produzione italiana, a sottolineare lo scacco del moderno in Sicilia, la sua

rinuncia a confrontarsi con una concezione più problematica, ampia e conflittuale.

E' auspicabile, infine, attraverso radicali ed opportuni confronti critici con la coeva produzione italiana ed internazionale, e attraverso occasioni come questa che l'esperienza palermitana possa essere definitivamente inserita all'interno del complesso circuito delle esperienze architettoniche del Novecento.



The Role of Stone Cladding in Modern Italian Architecture

Giovanni Picco, Elena Filippi, Emilia Garda

do.co.mo.mo_

DOCOMOMO INTERNATIONAL - DOCOMOMO ITALIA
6° SEMINARIO INTERNAZIONALE ISC/T,
Roma, 30.11 1.12.2001
STONE OF THE MODERN/LA PIETRA NELLA COSTRUZIONE DEL MODERNO

FACING AND HISTORY

Guarino Guarini, Sindone Chapel inside Turin Cathedral

Cortazzone, San Secondo (first middle of XII century): particular of the façade

Sant'Andrea Abbey, Vercelli: particular of the façade

Angelo Ceresa, building in Messena street, Turin, 1911: particular of the façade

Giovan Battista Alloati, Maffei building, Turin, 1904: particular of the façade

FACING AND PUBLICITY

Advertising image in *Il Marmo*, March-April 1935

Advertising image in *L'Architettura Italiana*, September 1939

Advertising image in *Il Marmo*, March-April 1938

Advertising image in *Il Marmo*, May- June 1942

Advertising image in *Il Marmo*, January-February 1936

(REPRODUCTION L. GUARRERA)

Elena Filippi, Emilia Garda, Giovanni Picco
Politecnico di Torino - Dipartimento
di Ingegneria dei Sistemi Edilizi e Territoriali

THE ROLE OF STONE CLADDING IN TWENTIETH CENTURY ITALIAN ARCHITECTURE

The paradox of cladding's return to prominence at the dawning of the 21st century, more as a sort of jacket than as a technological contribution to tectonics, calls for a critical rereading of its role.
Such testimonials to this role as "the outer surface of a building is where design communicates its meaning and its identity; as carriers and catalysts for information, claddings contribute to the meanings implicit in a cultural and a place" have been made by the creators of some of the most technologically advanced expressions of today's architecture.
Italy, with its excellent quarries, has offered outstanding examples of stone claddings that have contributed to the advancement of architectural language.
In architecture, stone cladding has never been simply a cover-up; never an attempt at mystification or a mere veneer that detracts from the building's essential dignity. Indeed, stone cladding has always brought improvements, adding connotations and messages that enhance architectural or functional qualities.
However varied it may be in its colors, types, workmanship and so forth, stone invariable retains a character and a significance that prevent it from being relegated to secondary roles, and have shown interesting developments even in limited geographical areas.
In Piedmont, cladding techniques were already used in the period when a building's stylistic features received more attention than construction techniques.
Thus, the practice of covering humble materials and undistinguished masonry work with cladding arose during the transition between Romanesque and Gothic. Involving dissimilar materials and, consequently, such means of retention as ties, cramps and mortising, cladding thus began to diversify, developing distinct forms for different structural parts of the building.
Stone and brick were quick to stake different claims, each occupying a specific area of application and, with its use of color and pattern, its own place in the architectural vocabulary.
Each material thus developed its own authentic identity with respect to the role assigned it by the designer's creativity.
Masonry, with its greater vulnerability to wear and appearance problems, is the component involving the greatest need to mask dubiously

THE ROLE OF STONE CLADDING IN ITALY IN THE TWENTIETH CENTURY

ELENA FILIPPI, EMILIA GARDA, GIOVANNI PICCO

POLITECNICO DI TORINO
Dipartimento di Ingegneria dei Sistemi Edilizi e Territoriali

FACING AND AUTARCHY

Marble railing "Tipo Apuania" introduced at the "Autarchic railings exposition of Milan", 1940, in *Il Marmo*, November-

Marble railing "Tipo Littoria" introduced at "Autarchic railings exposition of Milan", 1940, in *Il Marmo*, November-Dicember 1940

Marble facing calls "Sistema Ferrero" in *Il Marmo*, March-April 1936

Entrance pavilion at the "Italian mineral autarchic exposition", in *Il Marmo*, September-October 1939

(REPRODUCTION L. GUARRERA)

attractive structural systems such as half timbering, herringbone work, and rubble work. Clear ideas began to take shape concerning the structural components which not only call for their own particular type of morphological treatment, but also require that each form be correspondingly and consistently translated into a specific material.
Stone was the best material then known: until metals came into use, its fundamental position in construction was summed up by the idea of the "corner stone".
From this period onwards, building forms and their meanings assume increasingly sharp dialectical outlines.
Not only is the organization of stylistic features less rigid, but the freer and more creative approach to spatial organization takes on an importance that begins to prevail over the excellence of materials, pushing that conceptual authenticity of architectural components which can enhance the primary values of tectonics into second place.
With its use of stone cladding, the transition between Gothic and the Renaissance introduces the age of imitation of classical architecture: a masonry creation made up of perfect shells. The imitation of classical structures is transposed or at times restricted to the more stately or load bearing portions of the building, such as facades, pulpits and apses.
In the Renaissance, stone cladding contributes to the rigorous definition of architectural space and perspective: thus, its linear and chromatic divisions, with subtly juxtaposed marbles, are essential to producing that "rarefied atmosphere of perfection" that critics have not hesitated to regard as a "secularization" of the then-prevailing metaphysical culture.
With the Baroque and its shift from a single focus to multiple points of view, when the perception of architectural space is no longer rigorously centered on the eloquence of a frontally arranged recession, stone cladding finds a new role in supporting the expressive play of light that establishes continuity between interior and exterior space.
In the 19th century, new materials such as iron and cement draw the prevailing attention onto the materials themselves. With this newfound concern for tectonic eloquence, primacy goes to modular language, serial production and the articulation of a framework that goes beyond the building's physical dimension.
With Eclecticism, attention shifts once again, moving to the figurative and decorative scale where the "grain" of materials comes into view. Spatial relationships on this more intimate scale exalt the material qualities of the built space. Structural space and figurative space merge, finding common ground in configurative contexts other than the strictly architectural, be they naturalistic, anthropomorphic, etc.
This is the foreshadowing of the greater attention to plastic values, where deconstruction supports representation, and dilatation

do.co.mo.mo_

DOCOMOMO INTERNATIONAL - DOCOMOMO ITALIA
6° SEMINARIO INTERNAZIONALE ISC/T,
Roma, 30.11 1.12.2001
STONE OF THE MODERN/LA PIETRA NELLA COSTRUZIONE DEL MODERNO

FACING AND TOWN

(REPRODUCTION L. GUARRERA)

Roma Nuova street in Turin in *Il Marmo*, March-April 1939

Block of Sant'Emanuele in Turin, in *Il Marmo*, November 1937

Gallery San Federico in Turin, in *Il Marmo*, November 1937

(PHOTO C. OSTORERO)

Armando Melisi de Villa e Giovani Bernocco, Seat of the "Reale Mutua Assicurazioni" in Turin, in *L'Architettura Italiana*, July 1934

Domenico Morelli, Tasusso house, in *L'Architettura Italiana*, June 1942

Arrigo Tedesco Rocca, house in Corso Galileo Ferraris, Turin, in *L'Architettura Italiana*, 1934

Ferruccio Grassi, working-class housing in Borgo Dora, Turin, in *L'Architettura Italiana*, Novembre 1939

(REPRODUCTION L. GUARRERA)

Ottorino Aloisio, Verona house, in *La Casa bella*, October 1931

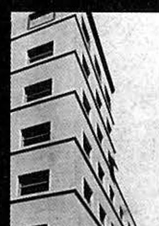
accentuates the plastic merit of architectural objects.
The message conveyed by Purism and de Stijl, with the rearrangement of architectural pace and the poetics of the dividing wall, brings the roles of perfect materiality, contours, edges and lines back into prominence, giving cladding a specific identity and purpose in supporting these roles.

It is no accident that stone cladding is heavily used in monumental public building such as the *case del fascio* and town halls. In residential construction, where we find the most interesting innovations from both the typological and technological standpoints, the use of stone is limited to socles, window sills or string courses, where it is often replaced with artificial stone in accordance with a hierarchical view of materials, where the noble grades away into the less noble as we move upward on the building or from its main to secondary fronts.

Occasionally, as is often the case in the historical evolution of construction technologies and techniques, the new technology first appears in disguised form, without reaching its full expressive potential. An example is the Reale Mutua building in Torino by Melis and Bernocco, constructed with a fabricated metal framework which is unexpectedly "masked" by masonry and by a decorative apparatus in ornamental stone whose richness, complexity and elegance gives it all the appearance of an ashlar construction.
As for the question of "strict adherence to function" and its direct corollary, the "negation of all decorative aspirations", it is precisely in the area of cladding that we see the most obvious contradictions.
In analyzing designs and buildings from these years, it is clear that however strong the urge to achieve an architecture based exclusively on functional needs may have been, the concept of decoration was never eliminated: indeed, we find decoration cropping up again and again, though no longer as a mere adjunct or overlay but as a synchronic and consubstantial part of design. Programmatically banished from the Rationalist ethos, decoration returns clandestinely, and, no longer able to root itself in forms that had been distilled into pure geometry, delegates all aesthetic responsibilities to cladding. In other words, it is the material itself that, in the majority of cases, fulfils decorative function. Hence the predilection for glossy, mirror-bright materials that with their perfection and clarity enhance the geometry of the forms and the bold and unusual color combinations featuring intense, pure and decisive tones with varying shades and contrasts.

Modernism and Rationalism will make extensive use of stone cladding as part of a delicate balance between tradition and innovation. In Italian Rationalist architecture in

Armando Melisi de Villa, Seat of the Reale Mutua Assicurazioni in Turin, in *L'Architettura Italiana*, July 1934



Gino Levi Montalcini, Giuseppe Pagano, Pogatschinig, Gualino building in Turin, in *Domus*, June 1930

Dead's charnel-house inside the Gran Madre di Dio church, Turin, in *Il Marmo*, November 1937

(REPRODUCTION L. GUARRERA)

Ottorino Aloisio, Ideal cinema in Turin, 1938-1939

(G. MONTANARI, *INTERVENTI URBANI E ARCHITETTURE PUBBLICHE NEGLI ANNI TRENTA: IL CASO PIEMONTE*, 1992)

Municipal technical offices in Biella, Lictoral tower, 1933

Francesco Peducci, building of Post Office in Alessandria, 1931-1941

Angiolo Mazzoni, building of Postal and Telegraph service in Novara, 1932-1935

Augusto Momo, Lictoral house (at this moment used for the financial offices and land registry) in Aosta, 1939

Giuseppe Wittich, building of Postal and Telegraph service in Aosta, 1937-1945

(PHOTO G. MONTANARI)

Fabris, Workering Confederation of industry (at this moment used for the seat of "ASL" office) in Vercelli, 1936

particular, stone cladding occupies an ambiguous position in the ideological and constructional break with tradition brought about by the culture of the Modern Movement. On the one hand, it maintains links and a conceptual continuity with traditional construction methods, while on the other hand it is involved in the experimental decisions made with a view to achieving the durability that using stone cladding together with other materials and construction techniques that had not yet stood the test of time would not always prove capable of ensuring.
The theoretical discourse of those years, and the debate in architectural journals which it fueled, revolved chiefly around the idea of modernity.
This idea, a recurrent one in the history of architectural, took on a particular ideological charge in the Italy of the day. Behind the use of new materials lies a desire for global renewal which is not limited to the world of design, but extends to the political and social fronts.
Likewise, behind this choice of "new materials", or rather, behind the attempts to find a "modern use" for these materials, we can make out, as Giuseppe Pagano observed in his celebrated article of 1929, a unswerving faith in the rationalization of production processes and methods, combined with an immense confidence in progress and hence in the myth of the machine and that artificial universe that was so dear to the Futurists.
"The new architecture is the architecture of cold calculation, of reckless daring and of simplicity ... just as the ancients drew on nature to inspire their art, we materially and spiritually artificial - must find our inspiration in the elements of the sparkling new mechanical world of our own creation, of which architecture must be the finest expression, the fullest synthesis and the most effective artistic integration" (Antonio Sant'Elia, Manifesto of Futurist Architecture, 1914).

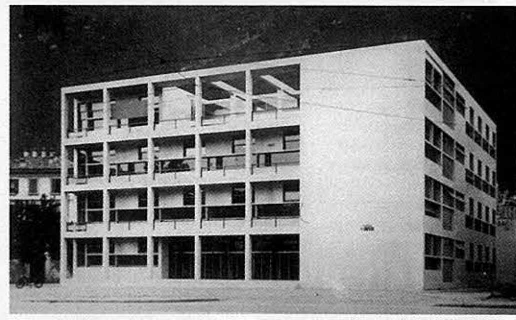
But this "modern use of material" or, as the Rationalists saw it, a use embodying "truth of expression" and "strict adherence to function", interpreted as the negation of all decorative aspirations, is not always achieved in the use of stone cladding, which perhaps more than other construction techniques of the time, has unequivocal links with history and with the idea of "ennoblement" that is so foreign to the spirit of the Modern Movement.

Giuseppe Terragni's Casa del Fascio in Como

Sergio Poretti, Rinaldo Capomolla, Tullia Iori, Stefania Mornati, Rosalia Vittorini

DOCOMOMO INTERNATIONAL - DOCOMOMO ITALIA
SIXTH SEMINAR ISC/T, Rome 30.11 - 1.12.2001

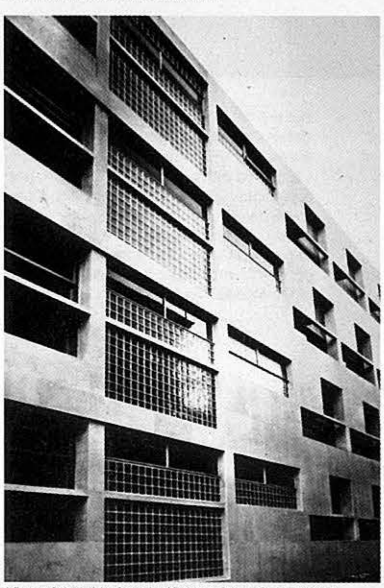
STONE OF THE MODERN
LA PIETRA NELLA COSTRUZIONE DEL MODERNO



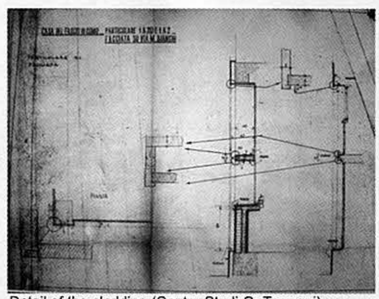
Casa del Fascio di Como (1928-1936)
Il rivestimento delle facciate in calcare di Botticino

S. Poretti, R. Capomolla , T. Iori , S. Mornati , R. Vittorini
Dipartimento di Ingegneria Civile, Università di Roma Tor Vergata

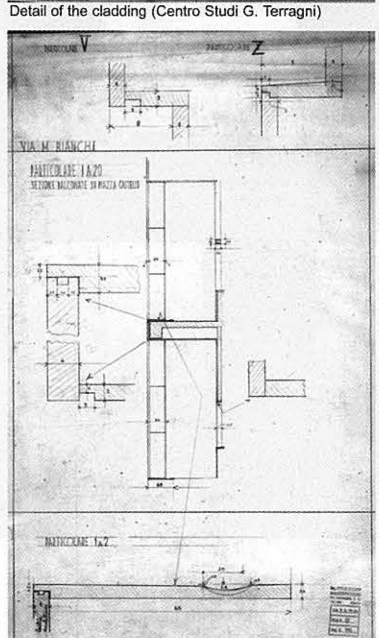
The decision to clad the façades in stone in order to enhance the monumentality of the building and adhere to the autarky policy for the promotion of Italian marble, was taken in March 1934. This took place when suggestions that the facing should be of plaster had been dismissed, seven months after the works had begun, The initial plan had been to clad only three façades but, during the course of the works, the rear was also included.
Once Musso and Carrara marble had been rejected, Terragni chose Botticino limestone for its plain tone. The idea was to obtain a uniform and compact plating, concealing the pattern created by the slabs. In order to obtain this "excellent and elegant plastering", Terragni called for complex and sophisticated processing techniques almost as though it were carpentry work. In order not to alter, but rather emphasise the abstract geometrical configuration of the Casa, the slabs needed to be thin and very large in order to reduce the number of joints. Lesenes, architraves and sills were to be monolithic, vertical and horizontal edges were to be perfect, and there were to be no projections or overhanging parts.
The slabs were fastened to the structure using traditional methods for stone cladding: each row rested on the one below and the slabs were fastened to the wall with metal bolts.
This modification during construction, which required the cladding to be adapted to the reinforced concrete already erected, led to arguments between Terragni and his principals, with long controversy and disputes with the supplier companies leading to considerable difficulties and delays in construction.



View of the side façade (Centro Studi G. Terragni)

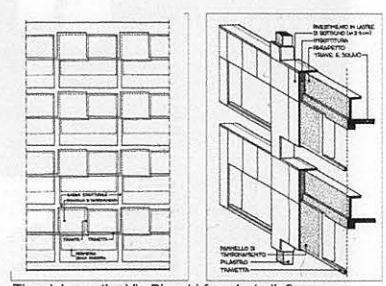


Detail of the cladding (Centro Studi G. Terragni)



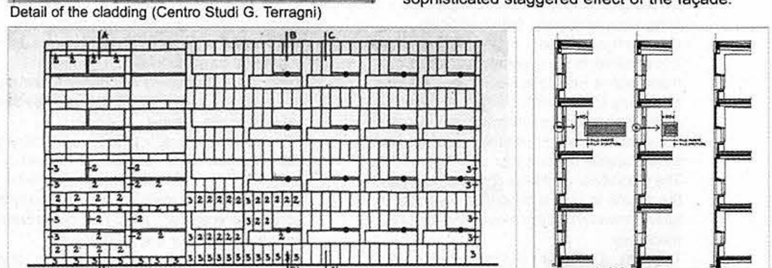
Detail of the cladding (Centro Studi G. Terragni)

In 1998, for the seminar "Storia e conservazione dell'architettura contemporanea: consulto sulla Casa del Fascio di Como di Giuseppe Terragni", a survey was carried out to examine the state of preservation of the work and its structural elements. This included the structure, facings, doors and windows, internal finishing and technical systems.
In particular, direct inspection of the cladding of the façade revealed:
- the thickness of the slabs, ranging from 2 to 5 cm,
- the system used to hang the slabs with iron clamps,
- the presence of shaped rabbets on the heads of the slabs,
- the widespread use of a non-protruding drip channel,
- the use of incautious solutions, such as the covering of slim, highly reinforced girders.



The slabs on the Via Bianchi façade (relief)

For example, the thickness of the slabs on the right-hand side of the building on Via Michele Bianchi varies between 2 and 3 cm. The slabs used for the plinth, the left and right edges, and the pilasters between the L-shaped windows are 3 cm thick while all the others are 2 cm. On this façade and on the one at the rear, an expedient was used to give "depth" to the wall in order to obtain a chiaroscuro effect similar to that of the other façades: the facing is not placed up against the forward plane of the structure, but at a distance of between 10.5 and 12.5 cm. By making use of masonry thicknesses, Terragni obtained a sophisticated staggered effect of the façade.

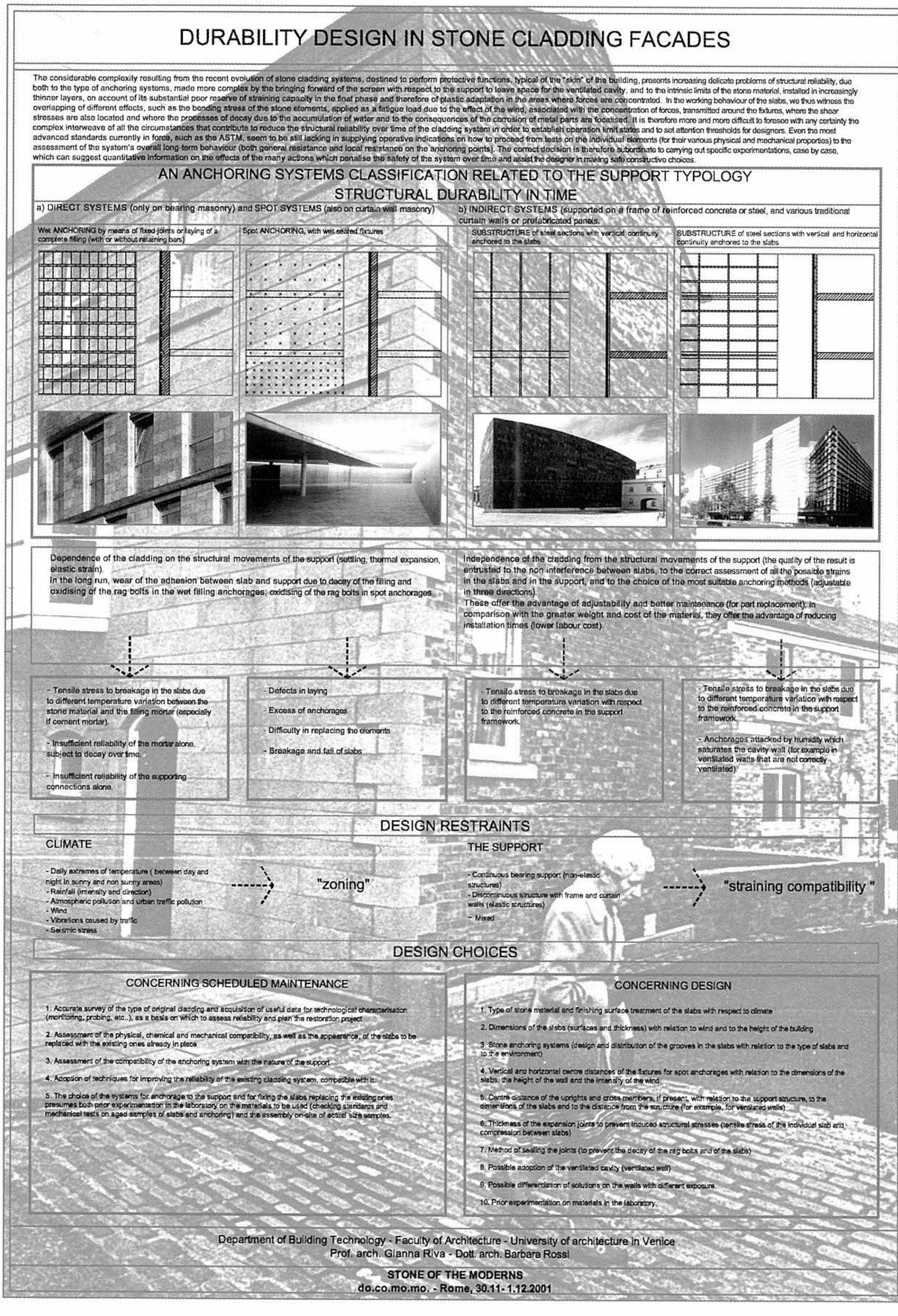


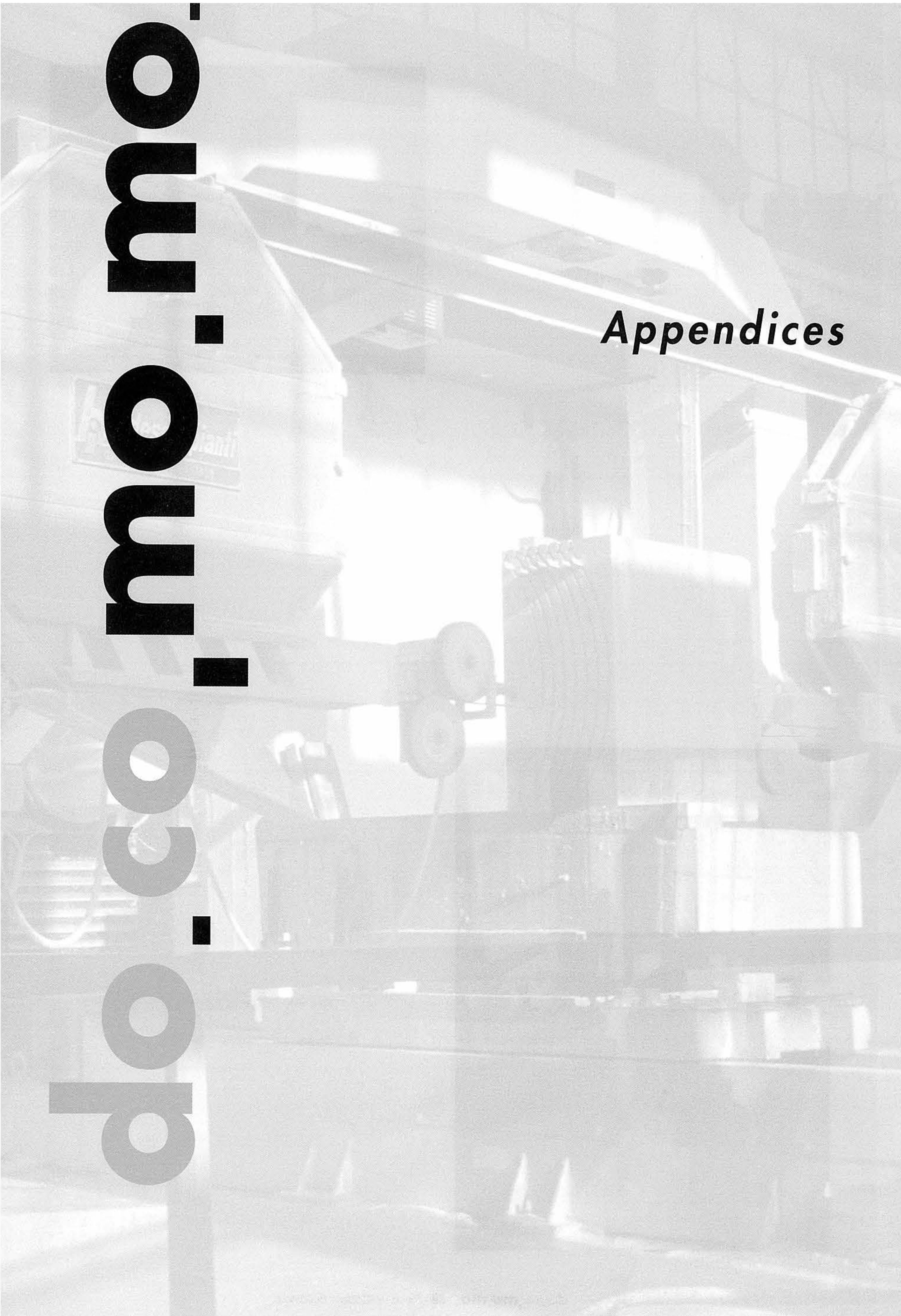
The structure of the wall on Via Bianchi (relief)

Bibliografia:
S. Poretti, La Casa del Fascio di Como, Carocci, Roma 1998
R. Capomolla, I rivestimenti esterni, relazione a "Storia e conservazione dell'architettura contemporanea: consulto sulla Casa del Fascio di Como di Giuseppe Terragni", III Seminario internazionale sul restauro architettonico, a cura del Centro Internazionale di Studi di Architettura Andrea Palladio, Como, 2-5 aprile 1998

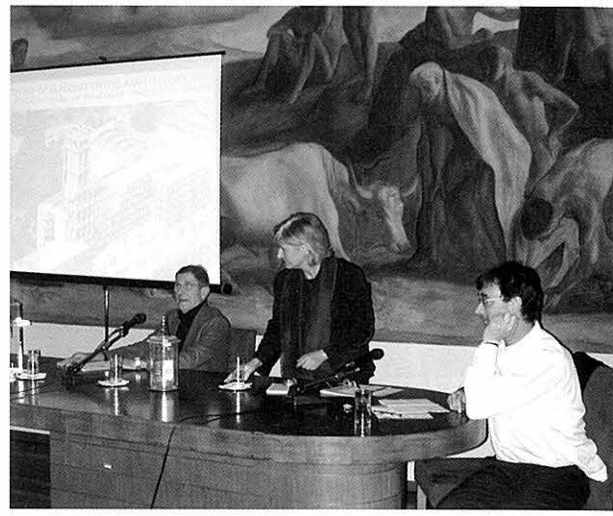
Durability Design in Stone Cladding Facades

Gianna Riva, Barbara Rossi





Appendices



Programme

INTERNATIONAL SEMINAR DAY

November 30, 2001
Sala Quaroni, EUR SpA
Headquarters, Rome, Italy

9.00 **Reception**

Welcoming Address
Paolo Novi

9.30 **MAIN THEMES**
Chair Maristella Casciato

Experiencing Stone, Structure and Cladding
Ola Wedebrunn

Marble Sheeting in Modern Architecture
Sergio Poretti

Prerequisites and Alteration of Materials in the Restoration of Modern Buildings
Pier Giovanni Bardelli

Chemical Processes of Weathering
Angelica Frisa Morandini

Cladding Technology, from Slab to Precast
Marco Antonio Ragone

Coffee

11.30 **CASE STUDIES**

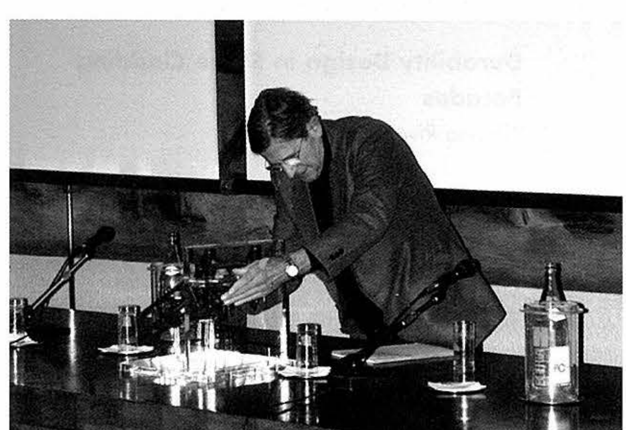
Palazzo della Civiltà Italiana in Rome
Rinaldo Capomolla

Fastening the Cladding on Århus Town Hall
Søren Abrahamsen

Milá House in Barcelona
Josep Emili Hernández-Cros

Stone Facing Techniques in Twentieth-Century Handbooks
Maria Luisa Barelli, Maurizio Lucat, Silvia Mantovani

Lunch



15.00 **PRESENTATION OF THE POSTERS**

Modern Systems for Fixing Stone Cladding
Daniela Bosia

Natural Polychromy and Materiality: Mazzoni's Surfaces
Luciano Cupelloni

Guglielmo Marconi's Obelisk at Eur
Maria Grazia D'Amelio

Modern Turin and Stone Cladding
Angelica Frisa Morandini, Carlo Ostorero, Simone Ortoncelli

Gio Ponti's Palazzo Rasini in Milan
Claudio Greco

Restoring Building with "Artificial Cladding"
Alessandra Lucchesi

The Role of Stone Cladding in the Modern Italian Architecture
Giovanni Picco, Elena Filippi, Emilia Garda

Giuseppe Terragni's Casa del Fascio in Como
Sergio Poretti, Rinaldo Capomolla, Tullia Iori, Stefania Mornati, Rosalia Vittorini

Durability Design in Stone Cladding Facades
Gianna Riva, Barbara Rossi

Between Autarky and Innovation: Spatrisano's House for the Disabled
Maurizio Oddo

Tour of the EUR SpA Headquarters

16.00 **CASE STUDIES**

Emil Fahrenkamp's Shell House in Berlin
Sibylle Schulz

Giuseppe Vaccaro's Post Office in Naples
Tullia Iori

Finlandia Hall by Alvar Aalto in Helsinki
Martti Jokinen

Characteristics of Stone and the Choice of Quarry
Pier Giovanni Bardelli, Caterina Mele, Maurizio Gomez Serito

18.00 **DISCUSSION AND FINAL REMARKS**

EXCURSION DAY

December 1, 2001

9.00 **Post Office Building, via Marmorata, Rome,architect Adalberto Libera (1933-35)**

11.30 **Visit to the Travertine quarries, Mariotti SpA at Tivoli (Rome)**

13.00 **Visit to Villa Adriana at Tivoli (Rome)**

About the authors

Søren Abrahamsen is an engineer who since1955 has been practising as a private consultant in his special field, building archaeology and statics. He is a consultant for the Danish National Forest and the Nature Organisation and the National Museums of Denmark and Greenland. He has also headed the Department of Building Science at the Architecture School in Aarhus.
soerena@post9.tele.dk

Pier Giovanni Bardelli, engineer, is Professor of Design and Restoration Techniques at the Turin Polytechnic and Vice Chancellor for Building Development at the same university. In 1999 he founded DOCOMOMO Piemonte, the first regional chapter of DOCOMOMO Italia onlus.
bardelli@polito.it

Maria Luisa Barelli, architect, has a Ph.D. in Architectural Design. She is an Assistant Professor at the Turin Polytechnic, and has done research in the area of knowledge and recovery of nineteenth and twentieth-century industrial architecture and the restoration of modern buildings.
barelli@archi.polito.it

Daniela Bosia is an architect with a Ph.D. in Building and Environmental Renewal, and an Assistant Professor at the Turin Polytechnic. Her fields of research are mainly the architectural and technological rehabilitation of modern buildings, the conservation of Modern Movement architecture and modern materials.
bosiad@mondovi.polito.it

Rinaldo Capomolla is an engineer and Associate Professor of Technical Architecture at Tor Vergata University of Rome. His research activity focuses on building techniques in Italian architecture in the twentieth century.
capomolla@ing.uniroma2.it

Maristella Casciato is Associate Professor of History of Architecture at the University of Bologna. Her field of research is the history of twentieth-century European architecture. She is Chair of DOCOMOMO International.
cascima@uniroma2.it

Luciano Cupelloni is an architect and Professor of Technology at La Sapienza University of Rome. He has studied the architecture of the Modern Movement and the connections between architectural modernisation and technological innovation.
luciano.cupelloni@tiscali.it

Maria Grazia D'Amelio is an Assistant Professor at Tor Vergata University of Rome. Her research work is devoted to studying the relationship between form and construction in Renaissance, Baroque, and early twentieth century architecture.
damelio@ing.uniroma2.it

Elena Filippi is a practising architect who has a Ph.D. in Construction Engineering. At present she is engaged in research and teaching at the Polytechnic in Turin.
filippie@polito.it

Angelica Frisa Morandini is Associate Professor in the Technical Properties of Raw Materials and also director of the Marble Laboratory at the Turin Polytechnic. She chairs the CEN TC 246 Natural Stones Technical Committee. Her main research interests are technical characterization of ornamental stones, the deterioration and durability of stone in buildings, and the cleaning and conservation of stone in buildings.
marmi@vdiget.polito.it

Emilia Garda is an architect with a Ph.D. in Construction Engineering. She is an Assistant Professor at the Turin Polytechnic. She has worked with the Institut Français d'Architecture on projects for developing countries.
garda@polito.it

Maurizio Gomez Serito is an engineer with a Ph.D. in Environmental Geo-engineering. His research interest is in creating and developing a catalogue of the decorative stones used in Piedmont. He works with the research group co-ordinated by P.G. Bardelli.
serito@polito.it

Claudio Greco, engineer, is an Assistant Professor at Tor Vergata University of Rome. His architectural practice is based in Rome, and his research activities focus on the restoration and maintenance of modern architecture.
greco@ing.uniroma2.it

Josep Emili Hernández-Cros is a practising architect and a Professor at the Escuela de Arquitectura in Barcelona.
hc-arq@hcros.looptele.com

Martti Jokinen, architect and advisor to the Finnish National Board of Antiquities, is involved in a wide range of restoration projects including churches and public buildings.
martii. jokinen@nba.fi

Tullia Iori is an engineer and an Assistant Professor at Tor Vergata University of Rome. She works with the research group coordinated by Sergio Poretti, and her research areas are the history of construction techniques and the restoration of modern architecture.
iori@ing.uniroma2.it

Maurizio Lucat, architect, is an Assistant Professor at the Turin Polytechnic. His scholarly work addresses issues in the recognition and recovery of evidence of technologies used in nineteenth and twentieth century architecture.
lucat@archi.polito.it

Alessandra Lucchesi is an architect whith a Ph.D. in Building Restoration. Her interests focus on architecture and technology and her research work is on modern building restoration with special attention to early twentieth century restorations.
capriallu@libero.it

Silvia Mantovani, architect, is an Assistant Professor at the Turin Polytechnic. Her scientific activities are concentrated on the technological analysis and re-use of historic buildings from the late nineteenth to the twentieth century.
mantovani@archi.polito.it

Caterina Mele is an architect with a Ph.D. in Building Engineering. Her research relates to the different aspects of the design project and restoration. Since 1994 she has been interested in safeguarding buildings of the Modern Movement.
mele@polito.it

Stefania Mornati, architect, is Associate Professor of Architectural Technique at the University of Cosenza. Her research activity focuses on building techniques in Italian architecture in the XX century.
mornati@ing.uniroma2.it

Kyle C. Normandin, architect, specialises in the investigation and restoration of historic buildings and monuments (projects in the U.S. Northeast region and international preservation projects in the former Soviet Baltic States, Eastern Europe, and Asia). He is an active board member in Northeast Chapter of Association for Preservation Technology, US Committee of the International Council on Monuments and Sites, the American Society for Testing and Materials.
KNormandin@wje.com

Maurizio Oddo is an architect and an Assistant Professor at the School of Architecture in Catania. He has a Ph.D. in the history of architecture and a Master's degree in the same field.
maurizio.oddo@tin.it

Giovanni Picco is a practising architect and was previously Professor of Urban Design at the Turin Polytechnic.
piccoarch@libero.it

Sergio Poretti is an engineer and Professor of Architectural Technique at Tor Vergata University of Rome. A scholar of the history of construction and conservation of modern buildings, he is also President of DOCOMOMO Italia onlus.
poretti@ing.uniroma2.it

Marco Antonio Ragone, architect, heads the Promotional Office of Internazionale Marmi e Macchine Carrara spa. He is the coordinator and project manager for special projects and has vast experience in the use of stone materials.
m.ragone@immcarrara.com

Gianna Riva is Associate Professor of Architectural Technology at the School of Architecture in Venice (IUAV). She is engaged in experimental laboratory activities on the properties of building materials and on-site controls of the behaviour of buildings over their lifespan.
riva@iuav.it

Barbara Rossi is an architect who works in the research team supervised by Gianna Riva.
rossi@iuav.it

Sibylle Schulz works as an architect in the Office for the Preservation of Monuments in Berlin, where her tasks include the registering and preservation of historic monuments, stone conservation, and studies of construction. Since 1999 she has been Inspector of Monuments for Berlin's inner city area.

Rosalia Vittorini is an Assistant Professor at Tor Vergata University of Rome. She works with the research group coordinated by Sergio Poretti, and her field of research is mainly the building techniques in Modern Italian architecture.
vittorini@ing.uniroma2.it

Ola Wedebrunn is an architect working as a teacher and research assistant at the Institute of Applied Technology of the Royal Danish Academy in Copenhagen. He is co-author with Torben Dahl (Director of the Institute) of *Modern Buildings. Applied Technology and Murede House* (*Danish Masonry*), a book on Twentieth-century building technology. He chairs the DOCOMOMO International Specialist Committee on Technology and is member of the Executive Committee of DOCOMOMO International.
olaw@sol.dk

List of participants

Søren Abrahamsen, engineer, Højbjerg, Denmark
Francesco Accardi, Direttore Generale Assomarmi, Rome, Italy
Antonello Alici, Università di Ancona, Italy
Paola Ascione, Università di Napoli, Italy
Mario Avagnina, architect, Rome, Italy
Pier Giovanni Bardelli, Politecnico di Torino, Italy
Maria Luisa Barelli, Politecnico di Torino, Italy
Liliana Bazzanella, Politecnico di Torino, Italy
Alessandro Bazzoffia, architect, Perugia, Italy
Virginia Bernardini, architect, Rome, Italy
Carlo Bertilaccio, EUR SpA, Rome, Italy
Daniela Bosia, Politecnico di Torino, Italy
Rinaldo Capomolla, Università di Roma Tor Vergata, Italy
Luciano Cardellicchio, student, Rome, Italy
Maristella Casciato, DOCOMOMO International
Filippo Cerrini, engineer, Rome, Italy
Els Hilda Claessens, ISC/T, Brussels, Belgium
Claudia Conforti, Università di Roma Tor Vergata, Italy
Luciano Cupelloni, Università di Roma La Sapienza, Italy
Torben Dahl, Royal Danish Academy of Fine Arts, School of Architecture, Copenhagen, Denmark
Maria Grazia D'Amelio, Università di Roma Tor Vergata, Italy
Paola David, Ministero dei Beni e delle Attività Culturali, Soprintendenza BB.AA. Rome, Italy
Federica Dal Falco, Università di Roma La Sapienza, Italy
Alberto Del Franco, architect, Rome, Italy
Livia De Andreis, student, Rome, Italy
Wessel De Jonge, DOCOMOMO International
Eliana De Nichilo, Politecnico di Bari, Italy
Daniele De Vincenzi, student, Rome, Italy
Massimo Dringoli, Università di Pisa, Italy
Nike Maria Ferraris, Politecnico di Torino, Italy
Elena Filippi, Politecnico di Torino, Italy
Laura Fiora, Dipartimento Scienze Mineralogiche e Petrologiche Università Torino, Italy
Mette Frederiksen, student, Copenhagen, Denmark
Angela Frisa Morandini, Politecnico di Torino, Italy
Emilia Garda, Politecnico di Torino, Italy
Maurizio Gomez Serito, Politecnico di Torino, Italy
Alessandra Greco, architect, Roma, Italy
Claudio Greco, Università di Roma Tor Vergata, Italy
Margherita Guccione, Ministero dei Beni e delle Attività Culturali, DARC, Italy
Francesco Innamorati, EUR SpA, Rome, Italy
Tullia Iori, Università di Roma Tor Vergata, Italy
Lamberto Ippolito, Università di Firenze, Italy
Eleonoor Jap Sam, DOCOMOMO International
Martti Jokinen, National Board of Antiquities, Helsinki, Finland
Marieke Kuipers, Rijksdienst voor de Monumentenzorg, Zeist, The Netherlands
Rejean Legault, Ecole de Design – UQAM, Montreal, Quebec Canada
Juha Lemstrom, Engel building services Ltd, Finland
Maddalena Libertini, engineer, Rome, Italy
Maurizio Lucat, Politecnico di Torino, Italy
Diego Lucietti, EUR SpA, Rome, Italy
Alessandra Lucchesi, Politecnico di Torino, Italy
Silvia Mantovani, Politecnico di Torino, Italy
Marzia Marandola, engineer, Rome, Italy
Cristiana Marcosano Dell'Erba, architect, DOCOMOMO Italia Executive Committee
Caterina Mele, Politecnico di Torino, Italy
Mette Marciniak Mikkelsen, student, Copenhagen, Denmark
Nicoletta Marconi, Università di Roma Tor Vergata, Italy
Renato Morganti, Politecnico di Torino, Italy
Stefania Mornati, Università della Calabria, Cosenza, Italy
Gaia Novello, student, Latina, Italy
Paola Nicolin, student, Milano, Italy
Paolo Novi, EUR SpA, Rome, Italy
Maurizio Oddo, architect, Trapani, Italy
Simone Ortoncelli, Politecnico di Torino, Italy
Carlo Ostorero, Politecnico di Torino, Italy
Paola Pederiva, EUR SpA, Rome, Italy
Sergio Poretti, Università di Roma Tor Vergata, Italy
Giovanni Picco, Politecnico di Torino, Italy
Mariël Polman, Rijksdienst voor de Monumentenzorg, Zeist, The Netherlands
Marco Antonio Ragone, Imm. Carrara SpA, Marina di Carrara, Italy
Raffaele Ranucci, EUR SpA, Rome, Italy
Maria Caterina Redini, Università di Roma La Sapienza, Italy
Gianna Riva, IUAV, Venice, Italy
Barbara Rossi, architect, Venice, Italy
Carla Saggioro, Università di Roma Tor Vergata, Italy
Alessandra Scena, Ordine degli Architetti Latina, Italy
Sibylle Schultz, Landesdenkmalamt, Berlin, Germany
Maria Margherita Segarra, Università di Roma Tre, Italy
Giuseppe Smeriglio, architect, Messina, Italy
Marina Sommella Grossi, architect, Rome, Italy
Daniela Spiegel, Rome, Italy
Silvano Stucchi, Università di Roma Tor Vergata, Italy
Paolo Verducci, Università di Perugia, Italy
Luca Veresani, architect, DOCOMOMO Italia Executive Committee
Cecilia Vittori, Università di Roma Tor Vergata, Italy
Rosalia Vittorini, Università di Roma Tor Vergata, Italy
Ola Wedebrunn, Royal Danish Academy of Fine Arts, School of Architecture, Copenhagen, Denmark

Order form

☐ I am a member of DOCOMOMO International

☐ I am not a member of DOCOMOMO International

Name ....

Institution ....

Address ....

Postal code ....

City ....

Country ....

Please mail with an invoice:

...... copy (ies) of Curtain Wall Refurbishment (Euro 15,83)

...... copy (ies) of The Fair Face of Concrete (Euro 15,83)

...... copy (ies) of Reframing the Moderns (Euro 15,83)

...... copy (ies) of Wood Structures (Euro 15,83)

...... copy (ies) of Modern Colour Technology (Euro 21,10)

...... copy (ies) of Stone in Modern Buildings (Euro 15,83)

The prices includes French tax on books 5,5%.

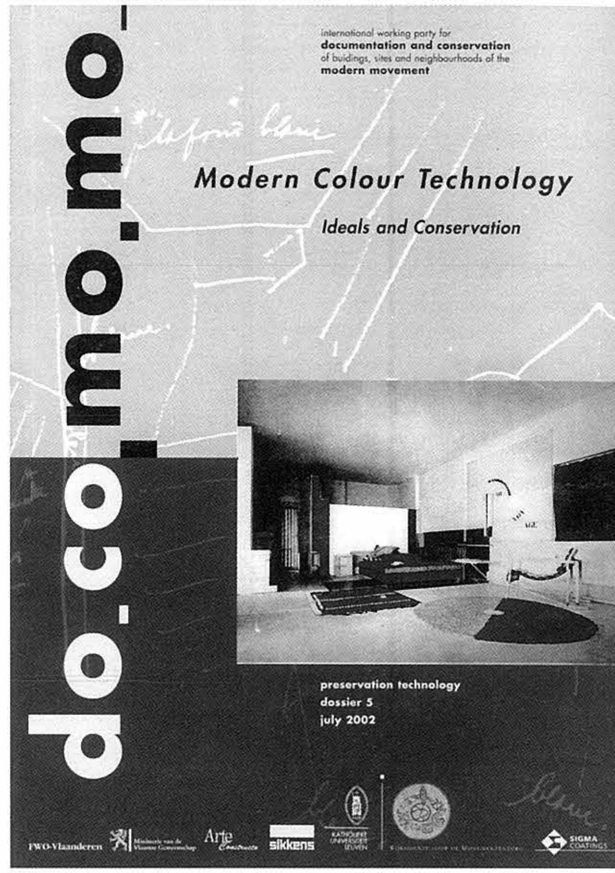
Preferred method of payment:
(no personal cheques accepted)

☐ Mail order (VISA, Eurocard/Mastercard or American Express), no transfer costs

Card number..

Expiry date ....

☐ Transfer to bankaccount (add Euro 13 per transfer)
Bank: CCF PARIS ODEON
Name of account: DOCOMOMO INTERNATIONAL
IBAN: FR 76 30056 0070 00705517590 36



Modern Colour Technology

Ideals and Conservation

Preservation Technology Dossier 5

This publication includes the papers presented at the 2000 seminar "Modern Colour Technology. Ideal and Conservation" held in Leuven-Antwerpen, Belgium. Papers by researchers and designers from Belgium, Denmark, France, Germany, Netherlands, Russia, Switzerland, USA are included. Many of them are case-studies.

The publication includes:
- All lectures presented at the seminar
- Contributions from over 20 authors
- Over 100 pages
- Fully illustrated, including black & white and colour photographs

Please send order to:
DOCOMOMO International Secretariat
Institut Français d'Architecture
6, rue de Tournon
75006 Paris - France
p: +33 (0) 1 46 33 59 76
f: +33 (0) 1 46 33 02 11
e: docomomo@ifa-chaillot.asso.fr
i: www.docomomo.com

"Stone in Modern Buildings", of which this publication is the result, is the Sixth International Seminar promoted by the International Specialist Committee on Technology (ISC/T). The headquarters of EUR SpA in Rome served as venue of the meeting. The building, designed (1937-39) by Gaetano Minnucci, is one of the most well preserved buildings at EUR showing a sophisticated travertine cladding.
The themes under discussion addressed issues related to the deterioration of stone cladding facades in modern buildings. Thirteen papers have been delivered, ranging from general considerations of aesthetic and technical principles, over physical and chemical properties of stone, weathering, anchoring techniques, structure and cladding, to case studies, such as the Palazzo della Civiltà Italiana in Rome, the Århus Town Hall, the Milá House in Barcelona, the Shell House in Berlin, the Post Office in Naples and the Finlandia Hall in Helsinki.
In addition to the papers, a range of posters documenting the restoration of stone cladding have been presented.

Previous seminars of the ISC/T developed the following themes: Restoration of Reinforced Concrete Structures, The Curtain Wall Facades, Wood Structures: Maintenance and Restoration, The Iron Windows, Colours in Modern Architecture and Restoration Demands.

docomomo international secretariat
Institut Français d'Architecture
6, rue de Tournon
75006 Paris
France

p: +33 (0) 1 46 33 59 76
f: +33 (0) 1 46 33 02 11
e: docomomo@ifa-chaillot.asso.fr
i: www.docomomo.com

ISBN: 2-9519819-0-2

ISC/T
International Specialist Committee on Technology

Ola Wedebrunn, chair
Els Claessens, secretary
Wessel de Jonge
Emanuelle Gallo
Tom Jester
Susan MacDonald
Caterina Mele
Mariël Polman
Jadwiga Urbanik
Tony Walker

e: ola.wedebrunn@karch.dk