



# MAPEI AND THE TEATRO ALLA SCALA THE ART OF WORK

7<sup>th</sup> December, 2004

**the Teatro alla Scala reopens after 912 days of work  
renovated and restored**

It may seem an etymological contradiction in terms to associate art with work. Art means talent, the ability and masterly skill which exalt the quality of man's application. It would not appear to have anything to do with the real sense of the word "work", whose meaning often implies fatigue, effort, breathlessness. However, the capacity of conjugating these two concepts, which on the surface would appear quite distant, is the mission that Mapei has always pursued and which has decreed their success all around the globe.

A work of art is born out of the effort and fatigue to render an idea well-known, to turn a dream into concrete reality. Command of technical know-how is the premise when constructing a company.

Striving for ever more advanced solutions makes it possible to explicate creative actions.

So, as a true artist would say that art can not be without hard work, Mapei has always been strongly convinced that

work may never be separated from art.

This strongly enrooted conviction has been expressed over the years with constant attention and increasingly masterful skill, towards the needs of "places of art". Whether we are talking about working in one of the great museums or simply rendering a medieval basilica more stable, the skill and technology, which is the fruit of Mapei's research, have contributed in making some of the most important arts and cultural centres more alive and long lasting, both at home and abroad. Activity at an international level which, nonetheless, has never allowed Mapei to distance itself from the special attention it pays towards the territory which has witnessed its growth: Milan. The rebuilding and renovation work of the Teatro alla Scala is the most recent and most prestigious example in which the entirety of Mapei's skill, technology and research have been put into practice. And the company's great love of the Arts.



## Birth and Rebirth

On the 25<sup>th</sup> of February, 1776 a blaze destroyed the Teatro Regio Ducale in Milan, which at that time was the historical site for opera performances in the city. Giuseppe Piermarini, Royal Imperial Architect for works and factories for the entire Lombardy region, took just 40 days to design the theatre that would be built, at the express wishes of Empress Maria Teresa of Austria, on the site of an old church instituted by Regina della Scala, the wife of Bernabò Visconti.

And thus the Teatro alla Scala was born.

Yesterday, just like today, the hard work and generosity of the inhabitants of Milan, and of all those who have spiritually adopted Milan, represent the deep lying roots of the Teatro alla Scala. In the case of the Teatro Regio Ducale, the building costs were initially met by the box holders, just as a large part of the cost of today's renovation, which has turned the theatre into a jewel in the crown of world music, has been met by the Milan inhabitants of the new millennium, and by the cosmopolitan melting pot of lovers of music and art. Amongst which, citizens, Institutions and companies, such as Mapei, which were firm believers in this project. On the 3rd of August, 1778, after little more than two years of hard work, the new theatre was inaugurated with a rendition of Antonio Salieri's "L'Europa riconosciuta," with an accompanying libretto by Mattia Verazi. Just as now, in the new millennium, little more than two years were enough to bring the theatre back to its original splendour and to give it a new life.

This year, on the 7<sup>th</sup> of December, the Scala was inaugurated again, with the same opera by Salieri.

## The Evolution of a Masterpiece

Foscolo was the first to exalt the correct form of the stalls in the show arena, to optimise the sonority, to take great care in the spectator's view and the comfort of the boxes, with intelligent positioning and layout of the corridors, the halls, the entrances and the service areas.

With the passage of time, the Scala has become not only the most important opera house in the world, but also the very symbol of the city of Milan, the irremovable driving force around which the city has grown and developed.

Rome, Paris, Florence, London, Vienna, Budapest.....the most important and most beautiful cities in Europe have a grand river which flows through their hearts. The waterways, which work their way through the houses and monuments of these cities, make them more alive, as if the incessant flow of the water were also purifying the actions and work of the people who inhabit them.

Milan does not have a river running through it, and even the Navigli, a series of artificial waterways which up until a few years ago enlivened the city, have been all but completely covered over. But only Milan has the Scala. Depriving the city of its waterway has been compensated for by an invisible, yet equally noble, fluidity: of music. And the Scala is the precious jewellery box from which flow the notes and harmony which dictate the rhythm of the city.

From the 31<sup>st</sup> of December, 2001 until the 7<sup>th</sup> of December of this year, Milan has not been able to reap



the benefits of this positive energy, which once flowed out from its most famous theatre.

The enforced closure, which lasted a total of 912 days, was essential in order to carry out a complete restoration and renovation of the theatre and to redesign the layout.

The poor environmental conditions of the theatre had already been highlighted in 1991, when the then Superintendent for Cultural Resources, Lionello Costanza Fattori, had advised upon the necessity to create new spaces "which meet today's new technical and structural requirements" and declared that he was "on the whole, in favour" of a restoration operation. To put it into more technical terms, the Scala was no longer "up to modern standards". The level of safety was no longer acceptable, after more than a decade of postponements which were only too tolerant and accommodating.

The glamour and fame of the theatre were simply no longer enough to permit the safety of its employers and spectators being put to risk.

The life of the theatre was at a crossroads, with a choice of two directions. The first one, theoretical and unacceptable, was to close the theatre and turn it into a museum dedicated to itself: a noble, yet sterile and sad monument to the history of the theatre and to the glory of Milan. As the Mayor of Milan, **Gabriele Albertini**, so eloquently put it, it would have been like "committing cultural euthanasia".

The second and most courageous choice, and the one which was finally taken and



put into practice, was, as again described by the Mayor, to bring the Scala back to being "a grand structure, but alive and up-to-date, a modern churning pot of art and beauty".

The project foresaw a conservative restoration of the monument area and rebuilding of the stage tower, the stage service facilities and of the offices. Two new structures were also created: the ellipsoid dome, decorated with Botticino marble, which houses a series of dressing rooms and rehearsal rooms, and a new, large scenery area, a technologically avant-garde facility.

The scenery apparatus is housed backstage and is the real heart of the new Scala. The structure is the only one of its kind in the world, and allows for both horizontal and vertical movements of the scenery and, therefore, a number of shows and changes of scenery may be catered for at the same time.

Piermarini, who excelled in the study of mechanics and astronomy before becoming the most renowned architect of his time, would certainly be surprised if he could only see his theatre as it is today, with all the innovative solutions which, without completely revolutionising his original structure, have restored to the world a theatre which is even more beautiful and attractive than before.

And for those who so wish, it is through the Scala that one may understand that subtle bond which joins the three sciences so loved by Piermarini and which here is applied to music: mechanics, architecture and astronomy. A place which has been born to display the Sublime.

## Mapei on Site

Mapei's technology, experience and products have been employed both in the monument area and for the new constructions. For example, a number of samples of the theatre's gold-leaf decor were analysed in Mapei's research laboratories, so that the restoration of these priceless ornaments could be carried out as faithfully as possible.

As **Elisabetta Fabbri**, the architect who coordinated the work carried out in the monument area, is quoted as saying: "even the characterisation of the gold (in the hall) was carried out by careful laboratory analysis, which helped us define the characteristics of the gold still in use, and therefore to suggest the most appropriate techniques for the operation".

The result of such an incredibly detailed operation means that: "restoration of the gold-leaf, and the repair and renewal of missing patches of gold, are the operations which have brought the hall back to its antique splendour". However, the fronts on which Mapei demonstrated their experience were numerous and, in the following pages, a synthetic yet exhaustive technical report will be given. The whole undertaking may be considered to be of epic proportions, and the entire staff of Mapei's experts are overwhelmed with emotion when they remember the grandiosity and complexity of the work carried out. The phrase which was most widely used when they came back into the company was: "you've got absolutely no idea of the magnitude of what is being carried out". This concept was expressed in more technical terms by **Antonio**

**Acerbo**, Works Director and Safety Coordinator during the operations, when he stated: "It is particularly credit-worthy the short amount of time required to demolish the existing stage tower and service facilities (80,000 m<sup>3</sup>) and to rebuild the new structure (180,000 m<sup>3</sup>), not to mention the awkward on-site logistics, which meant that all the materials had to be evacuated and brought in day by day, working 24 hours a day on a three shift basis". Every day, new problems were encountered and solutions found, thanks also to the support of the Mapei team. An extremely complex range of activities, which also involved **Mario Botta**, the architect in charge of operations: "without a shadow of a doubt, it was an exceptional site. ....with, quite frankly, extremely difficult working conditions. ....and complex technical-functional situations which required the presence of a vast array of craftsmen and experts whose combined effort was quite out of the ordinary. Craftsmen and technicians who performed in the most extraordinary way, working on the same wave-length as a team, confronting the challenge in a way that left no margin for improvisation or for error. I would like to finish off by pointing out the symbolic value of the theatre. Putting ones hands on a city's symbol, even for the most experienced architect, inevitably leads to a number of sleepless nights". And Mapei's team also had more than a few sleepless nights, well aware of the fact that art is worth a hard day's work. Today, the scintillating music pours out of the Scala yet again, limpid like the waters of a sparkling river.

*We would like to express most sincere thanks to the Botta Studio of Architecture for supplying the project drawings. Photographs by Gianni Dal Magro.*

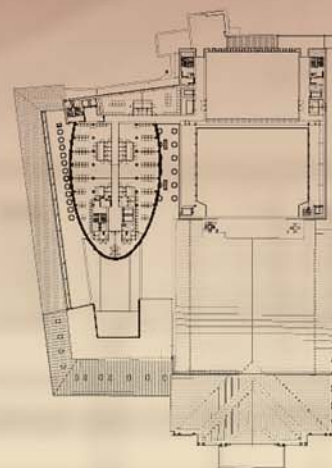
## TECHNOLOGY AND MATERIALS

In rebuilding and upgrading the Teatro alla Scala, Technology meets Music. Mapei has contributed with their systems, innovative products and expert assistance, which represent the fruit of their commitment to research and innovation.

The presence of Mapei on the "Teatro alla Scala" site was divided into three areas of activity:

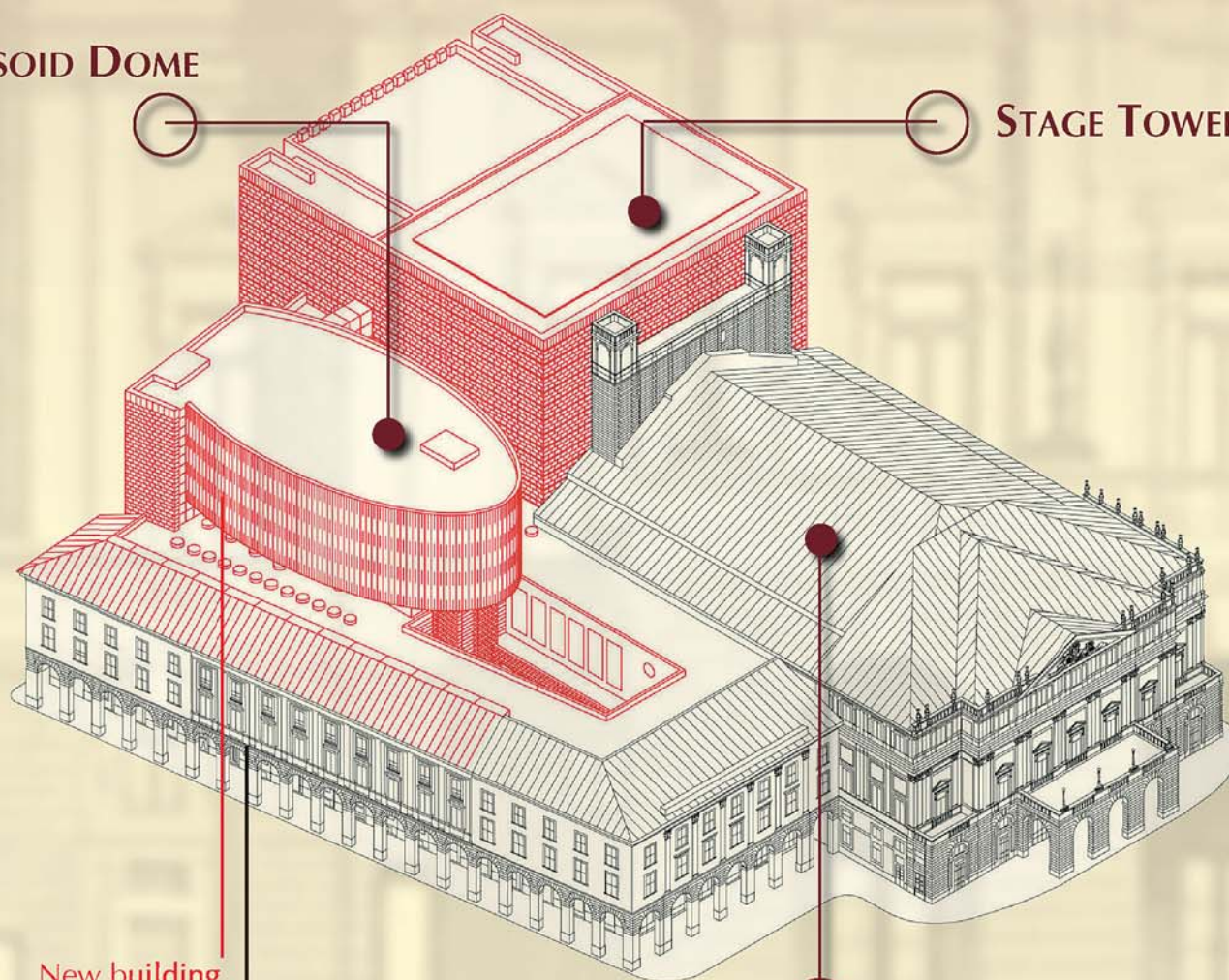
- diagnosis of the materials, taking and analysing samples of plaster, render and gold-leaf frieze decors, in order to identify the most suitable type of renovation work;
- on-going technical assistance during the work, to recommend the most suitable technical solutions to solve the various on-site problems;
- technical support regarding the use and correct application of the products during the various application and installation phases.

Approximately 40 Mapei solutions were employed on this prestigious site: from the range of systems for the building industry, to those used for constructing screeds, self-levelling products and smoothing compounds; various types of adhesive for laying ceramics, natural stone, terracotta, PVC and wood, up to systems for protecting the decorative finishes on the walls and epoxy resin systems for floors.



### ELLIPSOID DOME

### STAGE TOWER



New building

Monument area

MONUMENT AREA  
Conservative restoration



The complex nature of the renovation and restoration work of the Teatro alla Scala, and the large number of people, companies and institutions involved, meant that for the first time the editorial team of the "Realtà Mapei" company journal was unable to produce the usual Technical Data sheet.

In the following pages, and for each single area of intervention, the various types of operation performed by Mapei and the products used in each case are highlighted. Recommended reading is the marvellous volume published by Marsilio, along with the contribution of Mapei, entitled "The new Scala - the site, restoration work and architecture", which covers all

technical and in-depth descriptive issues regarding this grandiose operation.

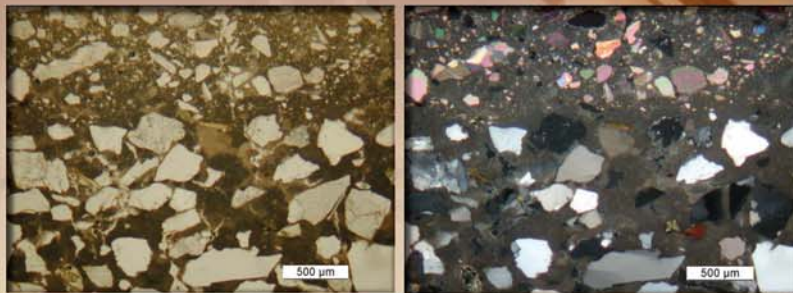
The volume is on sale in all the most important Italian bookshops.



## DIAGNOSTIC WORK



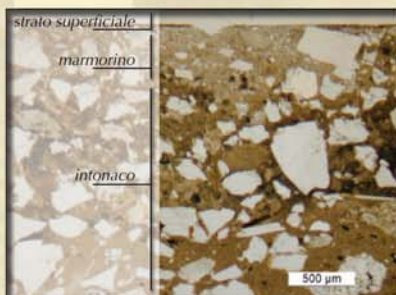
The main objective of the Conservative Renovation of the Teatro alla Scala's existing building, which derives from the original Theatre designed by Giuseppe Piermarini, and subsequently modified over the course of its two centuries of history to bring it up to required standards due to normal usage, was to leave the theatre's original spaces intact from a characteristic point of view, while also conserving their most recent layers wherever they were considered to be of value and did not markedly clash with the original design by Piermarini. In order to reach this objective, therefore, it was initially necessary to gather all the information possible regarding its history and the materials and construction techniques used, by using a "critical relief" process which would later be used to orientate the conservative renovation operation. A fundamental step during this phase was the series of chemical-physical analyses carried out in the Central Analysis Laboratory, one of the "pride and joys" of Mapei, the real driving force behind the Research and Development activities of our Company. The laboratory is equipped with the most sophisticated and innovative equipment available, which makes it one of the most advanced Research Centres in the world, and is constantly at the service of our clientele to solve the most complex problems in the sector involving the restoration of historical monuments. Particularly noteworthy is the support activity during the Conservative Restoration work on the Walls of Jericho, the vaulted roof in the Basilica of San Francesco at Assisi and, more recently, the



The sectional radiographic analysis of the plaster and of the underlying layer of render, observed at 1 Nicol, shows how the interface between the plaster (on the left) and the render (on the right) is indicated by the different grain size of the aggregates (larger in the render) and by the different colour of the matrix. In the second section, observed at 2 Nicols, the interface between the plaster and the render is indicated by the variation in the nature of the aggregates, which are mainly carbonated (calcites) in the plaster and silicates in the render (quartz).

renovation work carried out on the Oratorio della Passione in the Basilica of Sant'Ambrogio in Milan. In the particular case of the Conservative Restoration work carried out on the Teatro alla Scala, and the gathering of important information about the materials and construction techniques regarding the stratification which took place over the course of two centuries of history of the Theatre, the following were considered:

- the analysis of the stratification of the floors in the boxes area, which helped define the materials and technology required to recover the original flooring in terracotta tiles, the last remaining reminder of the material chosen by Piermarini;
- a survey of the finishes and renders used on the walls of the corridors and boxes, which helped to determine the nature of the most recent and poorer quality dressing materials, and thus to define the most suitable techniques to remove them and to uncover the precious plaster renders previously described in 1865 in the book "A guide for the visitor to that grandiose, theatrical building";
- an analysis of the gold-leaf on the decorative elements around the boxes, which led to them being dated and, thus, to distinguish between the most antique ones from the more recent repaired areas, to help in choosing the most suitable conservative restoration techniques.



Sectional radiographic analysis of sample 1-01 (IN): the notes to the side indicate the 3 layers (surface layer, plaster and render) which make up the sample. This image allows the particle size and form of the aggregates which make up the render and plaster to be assessed, as well as the thickness of the layers.



Position of where sample 1-01 was taken.



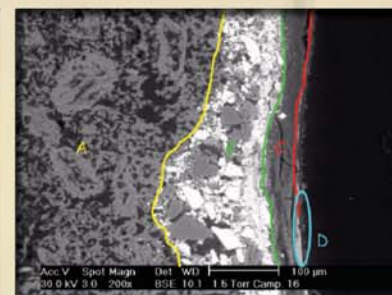
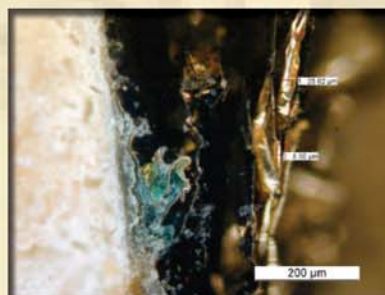
Sample 19 was taken in a point where the decorations were probably the original ones from the start of the 19<sup>th</sup> century.



*The sample of a fragment of surface gold-leaf showed that there was also an older layer.*

In particular, thanks to the application of sophisticated analysis techniques, such as with an environmental scanning electron microscope (ESEM-FEG), spectrophotometry and thermogravimetric analysis together with differential scanning calorimetry (TG-DSC), it was possible to identify the nature of the levelling layers applied on top of the original terracotta tiles, together with the more recent layer of linoleum floor covering. The analyses highlighted the presence of two distinctively different levelling layers, the upper one with a base of Portland cement and the lower one, in contact with the terracotta tiles, with a base of gypsum. The results of the analyses permitted the best technique for removing these layers to be defined, with the most suitable option being to mechanically remove the cementitious-based materials, due to their being more rigid and compact, and a light chemical treatment to eliminate the mechanically weaker layer made up of gypsum-based smoothing compound, and to avoid damaging the existing terracotta. Also, the analysis of the dressings materials on the walls in the corridors leading to the boxes allowed the type of paintwork used in more recent times to be identified, and was found to be made up basically of acrylic-based paint. Similarly, the analysis in this case permitted the best technique for removing this low-quality dressing to be suggested, based on a light chemical "swab" technique to avoid altering the underlying, antique plaster render, which dates back to the end of the 19th century. The analysis also showed that the render was made up of a roughing base layer on which a plaster render had been laid using an aerated lime-based product. The presence of this binder was confirmed in the area where the plaster had a typical waxy finish which, by stopping air entering, partially impeded the carbonation process, which also demonstrated the presence of the calcium hydroxide used as the original binder.

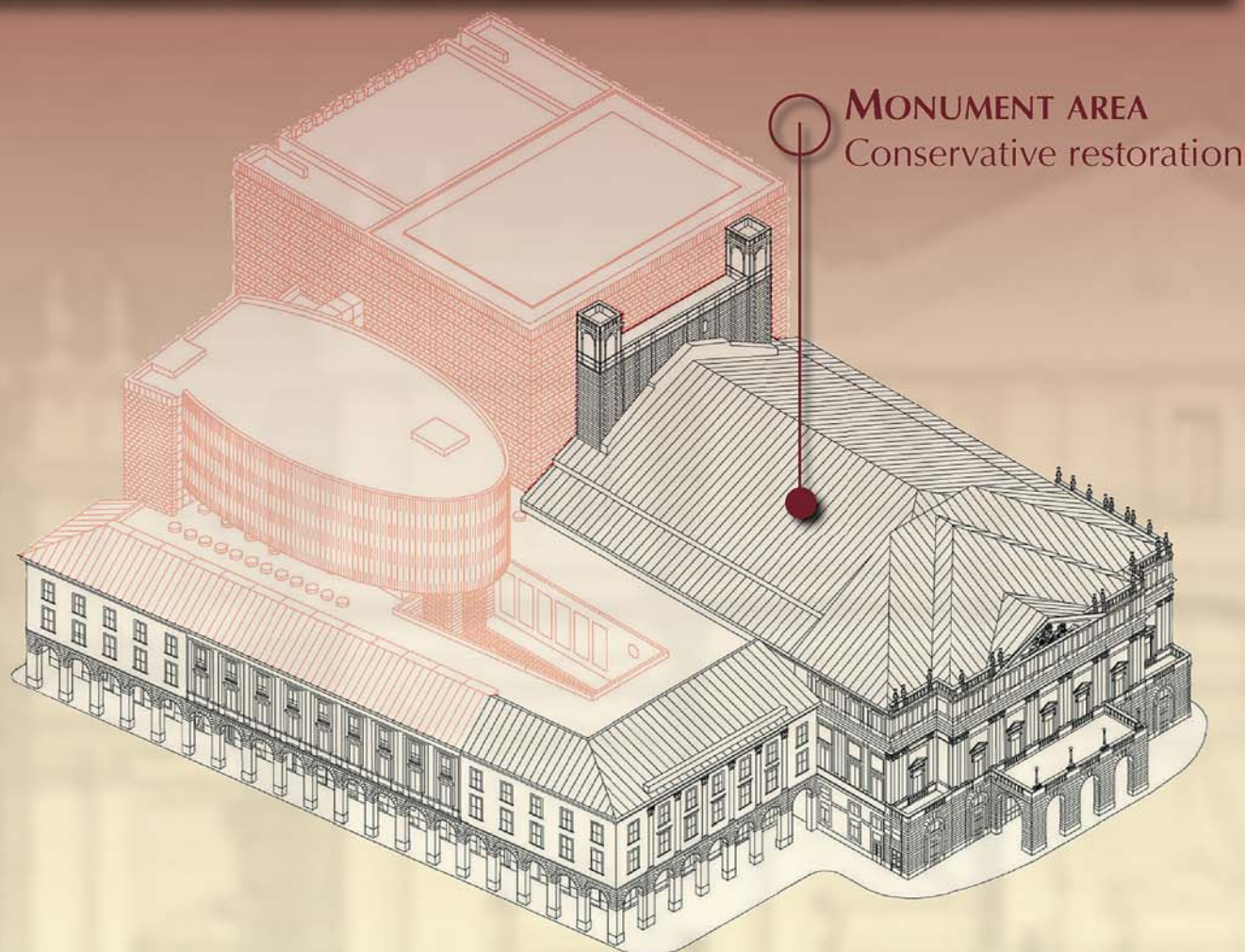
The information deduced regarding the nature of the binders, powders and other aggregates used, supplied useful indications for the restoration team in order to define the composition of the mixes to use for renewing the render in those areas where the structure was severely compromised. Finally, the survey was used to gather detailed information on the gold-leaf decoration of the boxes.



*A basic chemical analysis of the various layers was carried out using an electron microscope, with the corresponding EDS images obtained in the Mapei R&D laboratory.*

The sectional radiography analysis led to establishing that the most antique and, most likely, the original gold-leaf was carried out using pure gold or using an iron/copper alloy. On the other hand, the most recent repairs were carried out using copper/zinc alloys (brass). Also, the quality of the gold leafing was characterised according to whether the model on which it was applied was one of the original ones from 1830 in papier-maché, or one dating back to a more recent, post-war rebuild based basically on gypsum mouldings. Similarly in this case, the chemical-physical analysis demonstrated that it was of fundamental importance to define the most suitable technique to bring the decorations back to their original splendour.

## MONUMENT AREA



### CONSOLIDATION AND RESTORATION OF THE VAULTED CEILINGS

Consolidation of the brickwork of the vaulted ceilings by injecting EPOJET LV, a two-component epoxy resin with very low viscosity, and repair of the render using MAPE-ANTIQUE MC, a pre-packed, cement-free dehumidifying mortar.



### CONSERVATIVE RESTORATION OF THE FLOORS IN VENETIAN-STYLE INLAY

Laying of a part of the flooring in Venetian-style inlay, ruined when the theatre was renovated on previous occasions, using binder (STABILCEM SCC) and self-levelling smoothing compound (ULTRAPLAN MAXI) with high dimensional stability properties.



### INSTALLATION OF THE SUBSTRATES, THE GALLERY, THE FOYER AND THE STALLS

Preparation of the areas to be laid by installing screeds made using TOPCEM and TOPCEM PRONTO. Correction of the slopes and elimination of differences in the level of the areas to be laid, using FIBERPLAN, a self-levelling fibre reinforced smoothing compound, and STABILCEM controlled-shrinkage binder for cementitious mortar.



### CONSERVATIVE MAINTENANCE OF THE EXISTING TERRACOTTA FLOORS AND LAYING OF THE NEW ONES

The surface of the existing terracotta floors, which had inevitably been ruined by normal use over the years, were brought back to their original splendour by a thorough cleaning process using KERANET. The new terracotta flooring was laid using KERAFLEX high-performance adhesive.



In the monument area in particular, removal of the surface layers of the paintwork in the corridors leading to the boxes, which, after careful analysis, was found to be acrylic-based, was carried out using PULICOL, specially modified in this case to cater for both the poorly-ventilated work environment in which it was used, and to render it sufficiently thixotropic.

The skimming layers which had been applied over the original terracotta tiles, on the other hand, were removed both mechanically and with the use of KERANET, an acid-based product which is particularly suitable for removing traces of cement, lime, efflorescence, residues of cementitious adhesives and grouts. In the areas where the original terracotta tiles were irreparably damaged, new ones were laid using KERAFLEX, a high-performance adhesive which is classified as C2TE according to Standard EN 12004.



In the corridors leading to the boxes, it was also necessary to carry out static consolidation of the arched, brickwork ceilings by injecting EPOJET LV, a low-viscosity epoxy resin. The vaulted ceilings were then rendered using MAPE-ANTIQUE MC pre-packed cement-free mortar. A further operation was carried out in the corridors leading to the boxes, using STABILCEM SCC binder and ULTRAPLAN MAXI self-levelling smoothing compound to repair areas of the Venetian-style floors and to perfectly blend in the original areas with the new, repaired areas. In the foyer, gallery and stalls areas, before laying new parquet flooring, quick-drying screeds with high dimensional stability were installed, using TOPCEM binder and TOPCEM PRONTO pre-blended mortar. Also, where required, the use of FIBERPLAN self-levelling smoothing compound reinforced with polymeric fibres was recommended for correcting the slope of the areas to be laid, in order to reduce the risk of cracking to a minimum.

For this final operation, STABILCEM binder was also used which, mixed with continuously-graded aggregates, helped in the preparation of controlled-shrinkage self-levelling mortar.



## ELLIPSOID DOME



### BINDERS AND PRE-BLENDED MORTAR FOR SCREEDS

Installation of screeds in all the areas, including the canteen and washrooms, using TOPCEM and TOPCEM PRONTO.



### WATERPROOFING SYSTEMS

Waterproofing of the showers and canteen using MAPELASTIC and IDROSILEX PRONTO.



### ADHESIVE AND GROUT FOR LAYING CERAMIC FLOORS

Laying of porcelain and klinker floors and decorative dressing using KERAFLEX MAXI high performance cementitious adhesive and KERACOLOR FF cementitious grout for joints.



### ADHESIVES FOR LAYING STONE FLOORS

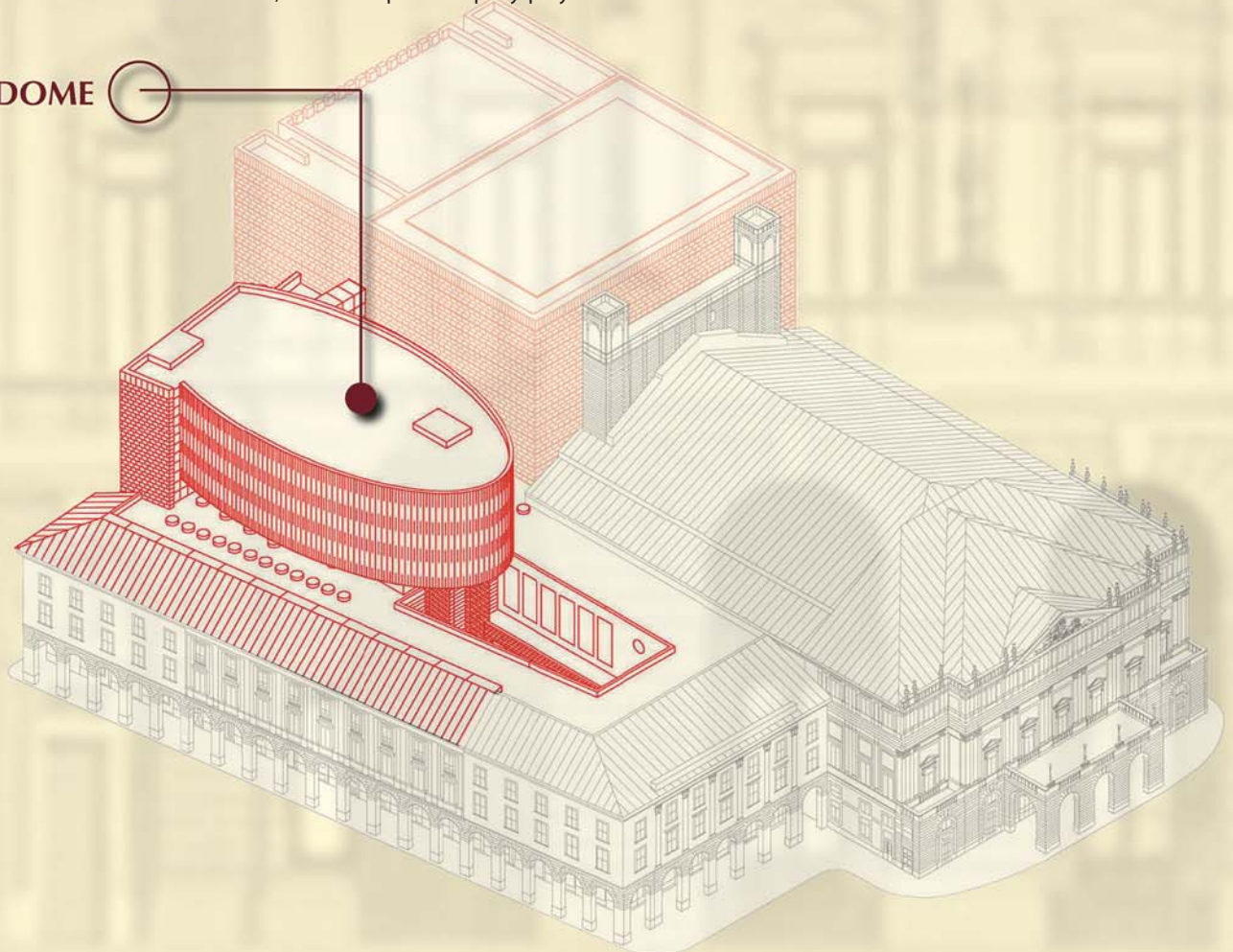
Laying of Botticino di Cava marble using GRANIRAPID, a fast-setting and hydration adhesive.



### LAYING OF PARQUET

Laying of floors using pre-finished wooden slats in the office complex and corridors, using ULTRABOND P902 2K, a two-component epoxy-polyurethane adhesive.

ELLIPSOID DOME





When the new structures of the ellipsoid dome and the stage tower were constructed (designed by the architect Mario Botta), the quality of the conglomerate employed for the foundations and restraining walls proved to be of particular importance. In this phase, Mapei offered their experience to the building company and the concrete manufacturer involved, to optimise the composition of the cement conglomerate. The concrete, prepared using nanostructure admixes from the DYNAMON range, was the solution chosen to meet the customer's requirements regarding waterproofing, durability and the low amount of heat generated.

Mapei's support was also important in the sector involving the finishing of internal surfaces, recommending the most suitable system for waterproofing the canteen and showers by using rigid and flexible protection products (IDROSILEX PRONTO and MAPELASTIC), and also the most suitable adhesives for the various types of floor coverings laid in the ellipsoid dome. High performance, flexible adhesives were used (KERAFLEX MAXI, class C2TE according to Standard EN 12004) for laying the porcelain and klinker floors.

To avoid the onset of both warping and staining, a quick-setting and hydration adhesive (GRANIRAPID, class C2F according to Standard EN 12004) was used for laying the slabs of Botticino marble. Finally, to make sure that the wooden slats were laid correctly and securely, ULTRABOND P902 2K proved to be the most suitable choice.



## STAGE TOWER



### BINDERS AND PRE-BLENDED MORTAR FOR SCREEDS

Installation of screeds in the rehearsal rooms for the dance troupe and for the orchestra using TOPCEM and TOPCEM PRONTO.



### LAYING OF KLINKER TILES

The klinker tiles in the technical services areas were laid using KERAFLEX MAXI and grouted with KERACOLOR FF.



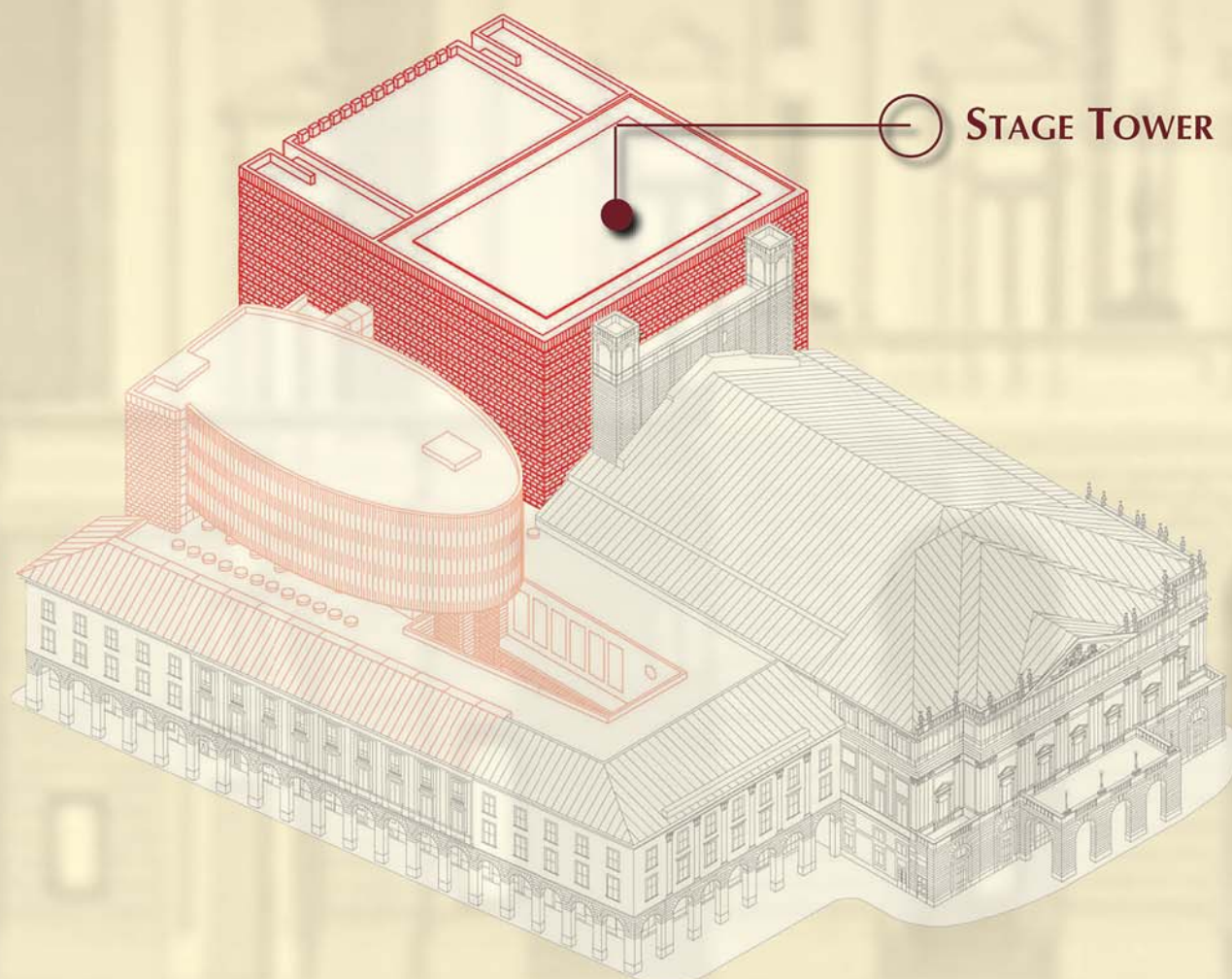
### RESIN FLOOR FINISHES

The finishing coat of the floors in the service corridors and walkways were carried out using the solvent-free, multi-layer epoxy system MAPEFLOOR SYSTEM 31 (including PRIMER SN, 0.5 QUARTZ and MAPEFLOOR I 300 SL).



### LAYING OF PVC FLOORS

The sheets for the PVC flooring in the rehearsal room were bonded in place using ADESILEX V4, an universal acrylic adhesive in water dispersion.





In the Stage Tower area, apart from installing the screeds with the same materials and techniques as those used in the monument area, and laying the klinker floor tiles by using KERAFLEX MAXI (KERACOLOR FF was used for grouting the joints), Mapei's assistance was also required to define the materials and operational techniques for the service corridors and walkways. In these areas, to obtain a floor covering which was particularly resistant to abrasion caused by the rigours of the service loads, the best solution was found to be the solvent-free, multi-layer epoxy system MAPEFLOOR SYSTEM 31. Finally, in the rehearsal rooms, where PVC sheets were to be used, an universal acrylic adhesive in water dispersion, ADESILEX V4, was employed, to guarantee the functionality of the floor throughout its entire period in service. 