

Conservation of a masterpiece of modern architecture: Mapei systems for renovating and restoring the exterior of the Guggenheim Museum in New York with a LEED-certified project

Photograph by David Heald® - Solomon R. Guggenheim Foundation, New York

The Guggenheim... re



The Solomon R. Guggenheim Museum, located along 5th Avenue in New York, is aimed at promoting an understanding and appreciation of contemporary art. It is one of the three museums (together with the Peggy Guggenheim Collection on the Canal Grande in Venice and the Guggenheim Hermitage Museum in Las Vegas) belonging to the Solomon R. Guggenheim Foundation, which was set up in 1937 for the purpose of collecting, conserving and studying modern-day art. In actual fact, the building holding the New York museum designed by the American architect Frank Lloyd Wright and completed in 1959 a year after his death, may be considered a work of art in its own right. Wright was an architectural “visionary”, who attempted to explore the unexplored, distancing himself from traditional design methods and pushing engineering to its limits. He created a circular structure for the Guggenheim Museum in New York, made entirely of concrete and designed as a spiralling ramp rising up over six levels to a two-storey glass skylight at the top. The spiralling form, inclined at an angle of 3%, allows visitors who have taken the lift up to the seventh floor to walk down the ramp while admiring the works set on the various levels until they find themselves back at the exit at the end of their visit.

An Unconventional Design

The building holding the Solomon R. Guggenheim Museum was constructed using unconventional methods, quite different from those commonly used at the time or even today. The structure was made of shotcrete, positioning plywood formworks outside the building. After installing the reinforcement rods and T-bars, the entire structure was built by spraying concrete with a low water/cement ratio from the inside. The shotcrete was specially formulated to be highly resistant to compression, with controlled shrinkage and, hence, high durability. In view of the 50th anniversary of the building, which will be commemorated this year, and bearing in mind the “advanced age” of the construction (meaning it badly required renovation and restoration work), the Guggenheim Foundation commissioned various experts, including architects and engineers, to carry out an initial diagnosis of the causes of its degradation and decay and to

study various operating techniques and methods prior to drawing up a final renovation proposal.

It was vital that the methods used allow the building to maintain its most distinctive features and traits, such as the pattern of formworks and certain irregularities (such as the rusty surfaces) caused by problems which arose during the initial spraying operations and which are now part of the building's most distinctive features.

A Global Company Offering Local Solutions

After the American research institute ICR (Integrated Conservation Resources) carried out a careful search for firms qualified to take on a restoration/renovation operation of this scale and after performing very careful laboratory tests on individual materials, Mapei was chosen to come up with a conservative restoration solution which would be ideal for this prestigious building. The system proposed (and guaranteed by the Company for 10 years) then underwent further laboratory testing before it was approved. This system was developed thanks to constant and highly successful cooperation and exchange of information between Mapei SpA, the Group's mother company, and its American subsidiary, Mapei Corporation, and also between the Research & Development Laboratories in Milan and those in Deerfield Beach, Florida.

Solutions to Artistic and Technical Challenges

Due to the particularly innovative construction method, which included a total lack of expansion joints in the building holding the Guggenheim Museum, right from the very beginning cracks began to appear. Down the years, oxygen, together with water and aggressive agents, penetrated into the cracks and brought about a gradual corroding of the reinforcement rods. This, in turn, led to rust forming on the ironwork and, consequently, the iron surface deteriorating and damaging the overall structure.

After the company commissioned to carry out the work removed the various layers of finishing that had been applied to the outside surfaces of the building over many years, ICR technicians and structural engineers drew up a map of the cracks present, making a distinction between those subject to movements (and which subsequently



Photo 1.
2007: renovation works begins at the Guggenheim Museum.

Photo 2.
2007: analyses of the damaged areas and cracks in the outside surfaces of the building.

Photo 3.
2007: reinforcement rods protected using MAPEFER 1K.

Photo 4.
2007-2008: repairing of certain sections of the Museum's circular outside facade using PLANITOP XS mortar.



developed into expansion joints) and those caused by shrinkage of the concrete. It was obvious that the different types of cracks had to be treated using different operating methods. More generally speaking, Mapei was asked to deal with the building's structural problems.

Mapei Solutions

Mapei developed its own very concrete solutions for this project, based on all the experience it has gained over the last 20 years restoring prestigious works around the world.

1st Phase:

Mechanical demolition and cleaning of the surfaces using systems designed to respect their original appearance.

Solution:

Pneumatic stone hammers were used for the mechanical removal, after locating the operating area and completely uncovering the reinforcement rods using diamond-edged discs. The surfaces were then cleaned using the innovative "sponjet" system, which does not cut deep down into the sur-

faces and leaves them looking as they originally did. The system uses an aluminium oxide dust coated with polyurethane foam, which makes the material less abrasive despite its hardness.

2nd Phase:

Localised repair work on the demolished sections of reinforcement rods using a system which ensures effective protection against further decay.

Solution:

MAPEFER 1K, a one-component, corrosion-inhibiting, cementitious mortar

was applied to the reinforcement rods after they had been cleaned, to ensure a re-alkalising protection and prevent dust formation.

MAPEFER 1K has proven to be an extremely beneficial product for installers, because it is extremely easy to work and apply by brush.

This highly innovative product, which is resistant to chlorides and aggressive agents found in the air, conforms to the DIN 50021 regulation (relative to the resistance to saline-fog test) and also passed the B117 test (for the same property) set by the ASTM (American Society for Testing and Materials).

After the MAPEFER 1K had dried, numerous sections of damaged concrete were repaired using PLANITOP XS, a special normal-setting, one-component, thixotropic mortar manufactured in Mapei Corporation's plants and marketed in the Americas by the Mapei Group's North-America subsidiary.

PLANITOP XS one-component mortar is super versatile and has shown it is ideal for all kinds of repairs: at surface level or in depth, on small, large, vertical, horizontal or raised surfaces, etc.



At the building site: from left, Giorgio Squinzi, Amanda Thomas-Trienens (ICR), Norman Weiss (Columbia University) and Bruce Burton (Mapei Corp.).

Unlike conventional mortars used for repairing concrete structures, PLANITOP XS can be used in thicknesses of 0-10 cm per layer, without having to apply several different layers, thereby saving on application time. This product offers high workability and extended open time. These features allowed the restorers to easily recreate the original forms of the building with great success and reshape any imperfections in the substrate, as suggested by the designers.

3rd Phase:

Work on cracks subject to movements using an elastic sealant, which may be painted over.

Solution:

Cracks caused by a lack of joints could not be sealed using rigid systems without then reappearing in neighbouring areas.

To choose the right product a survey was carried out, which recorded and identified movements in the cracks



Photo 5.
2008: spraying
ELASTOCOLOR.



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Mapelastix used worldwide

The Guggenheim Museum in New York is one of a long list of international projects of the highest profile, which have made effective use of Mapelastix industrially for the long-term waterproofing and protection of concrete structures.

This unrivalled success is due to Mapelastix's being:

- a flexible, two-component, cementitious membrane
- may be sprayed on or applied with a trowel
- ideal for protecting concrete structures against aggressive chemical agents and for waterproofing balconies, terraces, dams and swimming pools
- used for over 20 years around the world for waterproofing and repairing concrete

over the course of a year.

In the end MAPEFLEX AC4, a one-component acrylic sealant, was chosen.

The MAPEFLEX AC4 was applied to the cracks after first widening them and inserting a MAPEFOAM polyethylene foam cord in the bottom of the joint.

In some cases cracks subject to smaller movements were sealed using ELASTOCOLOR RASANTE SF, a fibre-reinforced elastomeric undercoat with high filling properties and admixed with fine sand.



The Technical team that worked on the restoration of the Guggenheim Museum. From left: Paolo Banfo, Pasquale Zaffaroni, Paolo Sala, Alessandro Presotto (all belonging to Mapei SpA), Bruce Burton and Todd Miller (Mapei Corp.).

4th Phase:

Protection for all the building's outside surfaces using a flexible mortar.

Solution:

The work was carried out using MAPELASTIC, one of Mapei's biggest selling products worldwide and used successfully for about 20 years all over the world. This two-component cementitious mortar is impermeable to water and carbon dioxide, flexible and capable of bridging cracks subject to movements of up to 0.6 mm in width. Developed to be as flexible as possible, MAPELASTIC is ideal for concrete structures which, like the Guggenheim, are subject to movements due to severe heat fluctuations or vibrations. The product was sprayed on in this project, using a special lance designed for smoothing agents, so that any imperfections caused by the formworks were deliberately left visible. In certain parts of the building subject to notable wear-and-tear, MAPELASTIC was reinforced using MAPETEX SEL, a macro-holed polypropylene fabric increasing the product's tensile strength.

5th Phase:

Applying an elastomeric coating in the original colour.

Solution:

Considering all the movements the Guggenheim Museum is subject to, as previously determined in the case of protection, the finish coating also had to be flexible.

For this reason it was decided to use ELASTOCOLOR RASANTE, a fibre reinforced filling undercoat applied using an airless spray. After drying, ELASTOCOLOR RASANTE forms a smooth coating, which, thanks partly to the fiber content, follows any expansion substrate without cracking.

6th Phase:

Protecting surfaces at street level using an elastic paint and anti-graffiti system.

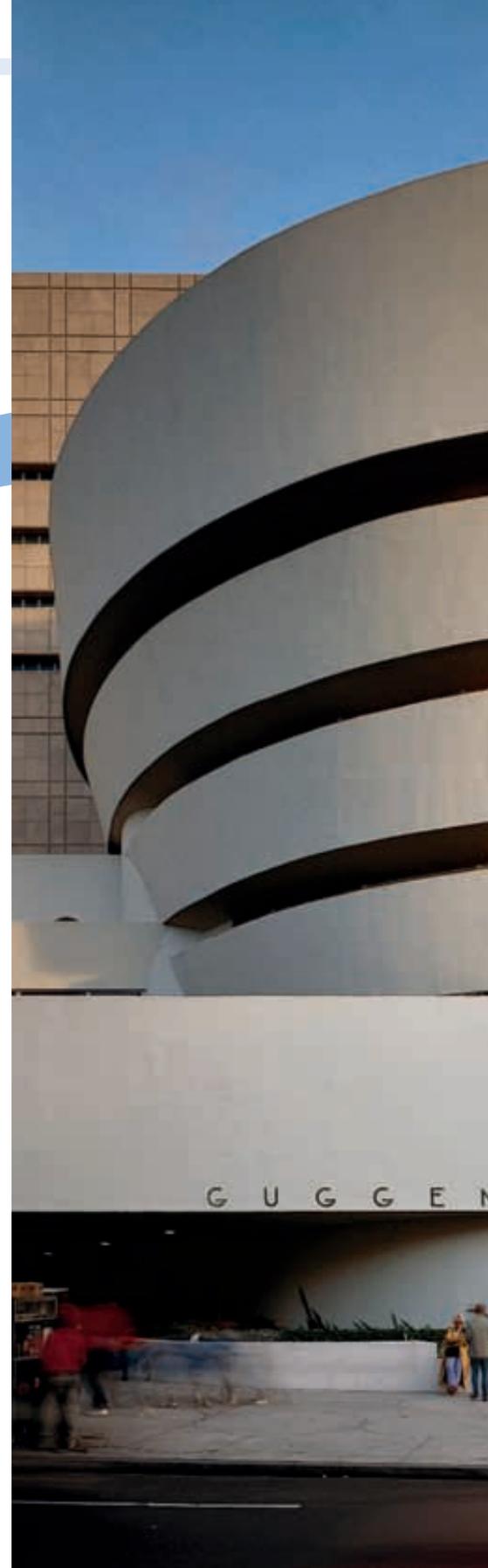
Solution:

ELASTOCOLOR WATERPROOF was applied to the surfaces of the walls surrounding the rotunda at street level. This is an acrylic resin-based paint in water dispersion ideal for permanent, direct contact with water and guaranteeing long-lasting protection. The product is particularly suitable for painting all kinds of waterproof surfaces using MAPELASTIC or MAPELASTIC SMART, as was the case here.

ELASTOCOLOR WATERPROOF ensured the surfaces were protected, making them resistant to all kinds of weather conditions, aggressive attack from smog and sunlight and, at the same time, making them look smooth and seamless.

There are already plans to provide further protection using WALLGARD GRAFFITI BARRIER, a barrier protecting surfaces against graffiti from spray paints, work crayons, markers, etc.

50 years after the Guggenheim was



built, Frank Lloyd Wright's genius is still widely recognized all over the world thanks to this building. Mapei would like to thank the Museum Management Committee for being given the chance to use its technological experience to help restore the exterior of this masterpiece. Working with other partners on the building has enabled the Company



Photograph by David Heald® - Solomon R. Guggenheim Foundation, New York



restoration work now completed. The building, which has now been restored to its original splendour, will continue to enjoy the worldwide admiration it has received for years. 

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Mapei Products: *Elastocolor Rasante, Elastocolor Rasante SF, Elastocolor Waterproof, Mapefer 1K, Mapefoam, Mapelastic, Mapetex Sel, Mapeflex AC4, Planitop XS, Wallgard Graffiti Barrier. These products are manufactured and distributed in America by Mapei Corp. (USA) and Mapei Inc. For further information please see the web site www.mapei.com.*

TECHNICAL DATA

Solomon R. Guggenheim Museum, New York (USA)

Construction Year: 1959

Works Years: 2007-2008

Original Project: Frank Lloyd Wright

Work: repairing reinforcement rods; restoring numerous sections of damaged concrete surface; waterproofing and protecting outside concrete surfaces

Customer: Solomon R. Guggenheim Foundation, New York

Project: Wank Adams Slavin Associates and Robert Silman Associates, New York

Works Management: FJ Sciame, New York

Materials Consultant: Integrated Conservation Resources, New York

Consultant for Concrete Technology: Prof. Norman Weiss, Columbia University, New York

Contractor: Nicholson and Galloway Inc., New York

Mapei Co-ordinators: Bruce Burton (Mapei Corp.), Pasquale Zaffaroni (Mapei SpA) and Paolo Sala (Mapei SpA)

to set up contacts and relations, which may be beneficial in the future for renovating other structures calling for technologically innovative solutions. After completing the renovation work, the scaffolding was finally removed from the Solomon R. Guggenheim Museum on 22nd September 2008, in time to celebrate the 50th anniversary of its construction this year.

On 6th November 2008, the building also hosted a special event (see the article further on) organised by Mapei and mainly devoted to architects, designers, engineers and industry press delegates, who were given a detailed outline of the various stages, results and main "players" involved in the



Our environmental commitment
More than 150 Mapei products help project designers and contractors building innovative projects, which are LEED (Leadership in Energy and Environmental Design) certified by the U.S. Green Building Council