

INTERNATIONAL

Realtà Mapei



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**TO LEAD THE EUROPEAN
CHEMICAL INDUSTRY**



Photo 1. View of the Marina Bay Sands Resort. In the middle one can see the three hotel towers (n. 1) with the Sands SkyPark (2) on the top. At their bottom from left on: the ArtScience Museum (3), the theatres (4), the casino (5), the two Crystal Pavilions (6), the event plaza (7), the Expo and Convention Centre (8) and the shopping and dining area (9).



Marina Bay Sands Resort

An innovative project changed Singapore's skyline

Singapore is a South-Eastern Asian country off the southern tip of the Malay Peninsula including 63 islands. It is the world's fourth leading financial centre and a cosmopolitan city, playing a key role in international trade and finance. Its port is one of the five busiest ports in the world.

In 2006, the Singapore government announced its decision to build two integrated resorts after much public deliberation and controversy over integrating casinos inside them. In the past, Singapore's law did not allow casinos within the country. The change in the government's decision, based on the underlying notion to boost the country's economy and tourism sector, resulted in amendments of the law.

The decision to build two mammoth resorts in such a grandeur scale became the highlight of Singapore and that of Asia.

Following that, a highly competitive bidding process was cast out. In 27 May 2006, Las Vegas Sands Corporation (USA) was appointed to build the second of the two resorts, which was later known as Marina Bay Sands. This architectural wonder, said to be inspired by a deck of cards, was designed by the internationally renowned architect Moshe Safdie.

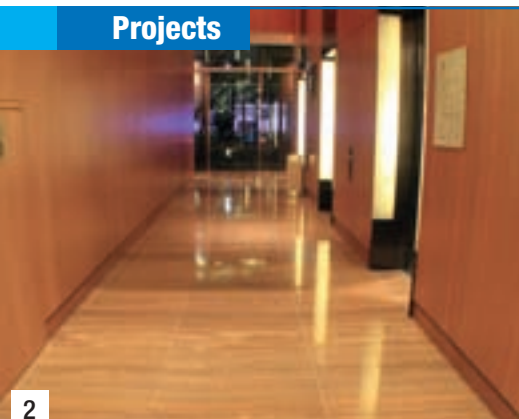
Three 55-storey hotel towers are crowned by the majestic SkyPark,

a 1 hectare skypark floating 200 m above the sea level. From the deck, visitors are offered a panoramic view of the city skyline. The SkyPark accommodates a public observatory, landscaped gardens, a 151-metre infinity outdoor swimming pool, restaurants and jogging paths. The hotel towers have sloping and straight legs and are connected at level 23 to form a single building.

The complex also includes an Expo and Convention Centre; a shopping and dining area with luxury retailers and signature restaurants; a casino with 669 gaming tables and 1,500 slot machines; a 5,000 m² plaza meant for local and international live performances; two floating Crystal Pavilions on water housing shops and night clubs; parking facilities for 4,000 cars.

Mapei's Contribution

The Marina Bay Sands Resort's construction was an enormous and extremely demanding project. Besides having to meet a tight schedule, the structure had to be of the finest condition, not just the finishes, but also right down to its underlying structure. Mapei, which is well known in the Far Eastern countries through its subsidiaries based in Singapore, Malaysia, China and Vietnam, has been extensively involved. Since it has already contributed to com-



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plete prestigious building projects in these countries, it could not but take part in the Marina Bay Sands' construction by supplying cutting-edge products and technologies. Mapei solutions were used in the three hotel towers, SkyPark, hotel atrium, casino and retail mall.

Installation of Ceramics and Stone Materials in the Towers

KERAFLEX MAXI high performance cementitious adhesive with no vertical slip was used for laying porcelain tiles and natural marble slabs (sizes: 600x300x10 mm and 300x300x20 mm) on the floors of back-of-house for towers 1 and 3 and all 742 bathrooms' floors and guestrooms' foyer floors in tower 2. KERAFLEX MAXI has been superseded on several markets by KERAFLEX MAXI S1 featuring Low Dust technology.

800x800x20 mm natural marble slabs were bonded onto raised plywood floors in the lifts, lift lobbies as well as in the lobby area in tower 3 by using ELASTORAPID two-component, highly flexible, high performance, quick setting and quick hydration cementitious adhesive.

KERAPOXY high performance two-component acid-resistant adhesive with no vertical slip was used to install 1800x2200x30 mm

Photos 2 and 3. For laying marble slabs and porcelain tiles on the floors and walls of the towers' toilets KERAFLEX MAXI, KERAPOXY and KERACOLOR SF were used.

Photo 4. The marble floorings in the tower 3's lifts and lift lobbies were bonded with ELASTORAPID.

Photo 5. Marble floors were laid in the atrium with GRANIRAPID.

Photo 6. The bamboo mosaic flooring of the Rise restaurant was bonded with GRANIRAPID. Joints were grouted with KERACOLOR SF.

Photo 7. In the Rise restaurant the floor substrates of the open kitchen were waterproofed with MAPELASTIC before laying marble slabs with ELASTORAPID.



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and 2500x1500x30 mm natural marble slabs with aluminium honeycomb base on the guestrooms' bathrooms walls and floors and on the guestrooms' foyer floors.

The joints of all the above-mentioned wall and floor coverings were grouted with KERACOLOR SF high performance, white superfine cementitious grout for joints up to 4 mm.

Photo 8. From the Sands SkyPark terraces one can enjoy a breathtaking way on Singapore city.

Photos 9 and 10. In the shopping area the marble, slate and granite floorings were installed with GRANIRAPID.

Atrium and Lift Lobby: Installation of Marble, Slate and Bamboo Floorings

In the atrium linking the three towers and in the lift lobbies Jura marble, bamboo mosaic and slate floorings were bonded with GRANIRAPID high performance, deformable, two-component cementitious adhesive.

KERACOLOR SF was again used to grout the joints.

was subsequently applied after the first layer has set.

ELASTORAPID was then applied to bond the 600x600x20 mm natural marble slabs on the raised plywood floor. Joints were again grouted with KERACOLOR SF.

Laying Ceramic and Marble Floorings in the Sands SkyPark

For laying porcelain tiles on floors



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Rise Restaurant: Waterproofing with Mapelastic

The Rise restaurant features an open kitchen which allows customers to watch the food's preparation. Before laying the marble floor, a first layer of MAPELASTIC two-component flexible cementitious mortar was applied on the plywood of the raised floor to waterproof the substrate. Then the alkali-resistant FIBREGLASS MESH (N.B the product has been superseded on several markets by MAPENET 150) was embedded for reinforcement.

The second layer of MAPELASTIC

and walls in the SkyPark toilettes and lift lobbies KERAFLEX MAXI was used.

KERACRETE and KERABOND + ISOLASTIC adhesive systems were chosen for bonding marble slabs on the restaurants' walls and floors.

All joints were grouted with KERACOLOR SF, except for joints of the porcelain tile floors in the toilettes where KERACOLOR FF high performance, polymer-modified, water-repellent, cementitious grout with DropEffect® technology was used.



11

Installation of Floor and Wall Coverings in the Retail Mall and Casino

Natural marble, slate, granite floors were laid on three levels in the retail mall with GRANIRAPID. GRANIRAPID was also used to bond the natural marble floors of the casino's VIP private rooms. KERAFLEX MAXI was chosen to lay the porcelain tiles on the casino's toilette walls. KERAFLEX was used to install natural marble slabs in the casino entrance. Joints of all the above-mentioned wall and floor coverings were grouted with KERACOLOR SF.

Structural Strengthening: Dry Cracks

Several areas in the three hotel towers and basements needed repair works. Mapei was called upon for expertise and reliable solutions for cracks and concrete repairs and complete Mapei systems were adopted. Dry cracks along the walls and ceilings of the building were discovered. ADESILEX PG2 SP

Photo 11. In the casino entrance KERAFLEX was used to bond marble floorings.

Photo 12. ADESILEX PG2 SP was used to grout dry cracks on ceilings and walls before applying EPOJET LV epoxy resin.

Photos 13 and 14. EPOJET LV was injected into packers to seal the microcracks.

Photos 15 and 16. Some concrete surfaces featured wet cracks which were treated with RESFOAM 1 KM to remove moisture, before applying ADESILEX PG2 SP and EPOJET LV.

epoxy adhesive was recommended to seal the cracks. Its special formulation was developed for the Singaporean market.

Where microcracks were present, injection packers were inserted into the walls and ceilings. Next, EPOJET LV, an epoxy resin with very low viscosity, was injected into the packers to seal the microcracks.

After the application of EPOJET LV, a water ponding test was conducted in which a curb was formed above the repaired ceilings. The curb was filled with shallow water to test the success of application. After 3-5 days, there was no water leakage from the cracks, proving that the application was perfectly done.

After both ADESILEX PG2 SP and EPOJET LV have dried up, the next step was to remove the packers and grind the surface to ensure a smooth finish.

Structural Strengthening: Wet Cracks

Besides dry cracks, wet cracks, that is cracks with water leakage, were also found on walls and



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ceilings. This situation required the use of RESFOAM 1 KM, an ultra fluid, one-component polyurethane injection resin for waterproofing concrete or masonry structures, grounds and rocks. RESFOAM 1 KM was injected into the preinstalled packers attached to the ceiling.

Due to its high fluidity, this product is able to penetrate and seal micro cracks, hence preventing water leakage. A yellow excess is formed as RESFOAM 1 KM reacts with moisture present in the concrete, thus removing moisture in the structure.



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After the water seepage problem was curbed, ADESILEX PG2 SP and EPOJET LV were then applied onto as in the case of dry cracks.

Injecting Cementitious Mortars by Pressure Grouting

To repair damaged concrete in other areas a different Mapei product system was used.



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Rusting reinforcing rods needed to be treated since rusting formations on rods would have lead to concrete damage. MAPEFER corrosion-inhibiting cement mortar was chosen to prevent corrosion and rusting and to restore alkalinity. Before application, the rods had to be cleaned; thereafter, two coats of MAPEFER were applied with a brush.

To restore the concrete structures Mapei Technical Service Department recommended the use of MAPEFILL SP, a super flow non-shrink cementitious grout suitable for grouting concrete structures. MAPEFILL SP, whose formulation has been especially developed for the Far Eastern countries, has excellent adhesion to concrete, elasticity and waterproofing. These properties make it the appropriate choice for sturdy and long-lasting concrete structures.

MAPEFILL SP can be applied both by pressure grouting and by pouring. Both methods were used in the works at Marina Bay Sands. The pressure grouting method was used for most of the damaged areas; the pouring method was used for the most urgent cases and only when the site conditions allowed for room for pouring. In the case of pressure grouting, only water was mixed with MAPEFILL SP to form a homog-

Photo 17.

MAPEFER was applied on the reinforcing rods to prevent corrosion and damage of the concrete.

Photo 18.

A formwork was set up on the damaged concrete structure.

Photo 19.

Applying MAPEFILL SP by pressure grouting through the preinstalled hoses sticking out of the formwork.

Photo 20.

Where the surface area to be repaired included substantial cavities, a prepack formwork was formed which comprises of aggregates and reinforcing rods bounded with a mesh. MAPEFILL SP was then applied by pressure grouting.

Photo 21.

Where the application was particularly urgent, water and chippings were added and mixed with MAPEFILL SP, which was then applied by gravity pouring.

Photo 22.

The concrete structure after completion of the works.

enous fluid. MAPEFILL SP was then pumped through the preinstalled hoses sticking out of the formwork which had been prepared in advance.

Where the surface area to be repaired included substantial cavities, the damaged concrete sections were removed. The reinforcing rods were cleaned and treated with MAPEFER. A prepack formwork was formed which comprises of aggregates and reinforcing rods bounded with a mesh. MAPEFILL SP was then applied by pressure grouting.

In the case of the gravity pouring method, water and chippings were



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Photos 23 and 24.

To repair damaged concrete in some areas a Mapei product system was used including MAPEFER, PLANICRETE SP and MAPEGROUT THIXOTROPIC.

Photo 25.

In the hotel lobby marble floorings were installed with GRANIRAPID.

added and mixed with MAPEFILL SP until a homogenous fluid was formed, which was then applied by gravity pouring.

Repairing with Cementitious Mortars

Other concrete surfaces within the Marina Bay Sands Resort were repaired with a system made up of MAPEFER, PLANICRETE SP and MAPEGROUT THIXOTROPIC.

First, MAPEFER was applied onto the reinforcing bars.

Subsequently, PLANICRETE SP synthetic-rubber latex for cementitious mortar (whose formulation has been specially developed for the Far Eastern market) was mixed with cement and applied onto the partially finished concrete. PLANICRETE SP acted as a bonding slurry between the concrete and MAPEGROUT THIXOTROPIC

shrinkage-compensated fibre-reinforced thixotropic mortar, which was then applied on top of the PLANICRETE SP layer. Lastly, MAPEGROUT THIXOTROPIC was used to make the concrete smooth and uniform. The products recommended by Mapei Technical Service Department ensured that installation and repair works were completed in a fast and satisfying way. Mapei also supplied similar solutions for the ongoing construction of the ArtScience Museum and Theatres which will be opened in early 2011. Just like it was the case with the Venetian Macao and City of Dreams complexes (see *Realtà Mapei International* n. 26 and 32), one more prestigious structure symbolising contemporary Asia was completed in Far East with the contribution of Mapei.





TECHNICAL DATA

Marina Bay Sands Integrated Resort, Singapore

Project: Moshe Safdie & Associates

Period of Construction: 2008 - June 2010

Period of the Intervention: January 2008 - December 2010

Intervention by Mapei: supplying products for waterproofing the substrates, laying ceramic and stone material floor and wall coverings in the three towers hotel, in the casino, retail mall and restaurant area, as well as for structural repair operations on walls and ceilings in several areas of the towers and in the basements

Client: Marina Bay Sands Pte Ltd (Singapore) - Las Vegas Sands Corporation (USA)

Contractor: SsangYong Engineering & Construction Co. Ltd (Singapore)

Laying Companies: Shanghai Chong Kee Furniture & Construction Pte Ltd, Engareh (S) Pte Ltd, Builders Shop Pte Ltd, Kwang Mooi Renovation Contractor, Sunray Woodcraft Construction Pte Ltd, DDS Contract & Interior Solutions Pte Ltd

Concrete Repair Specialists: Grouteam Pte Ltd, Y.H.H. Engineering Pte Ltd, Technocrete Pte Ltd, Chua Chuan Ho Construction, VSL Singapore Pte Ltd

Laid Materials: natural stone, slate, porcelain tiles, bamboo mosaic

Mapei Coordinators: Chong Lawrence, Heng Rodney and Poon Fabian - Mapei Far East (Singapore)

MAPEI PRODUCTS

The products mentioned in the article belong to the "Products for Ceramic Tiles and Stone Materials" and "Building Speciality Line" ranges. The technical data sheets are available at the web site: www.mapei.com. Mapei's adhesives for ceramics and stone materials conform to EN 12004 and have been awarded the CE mark in compliance with Annex ZA, standard EN 12004. Mapei grouts for ceramics and stone materials conform to EN 13888 standard. Mapei products for the protection and repair of concrete surfaces and structures have been awarded the CE mark in compliance with EN 1504 standard. Mapei levelling and smoothing compounds and pre-blended mortars for screeds conform to EN 13813 standard and have been awarded the CE mark in compliance with annex ZA, standard EN 13813. Almost all the Mapei products for laying floors and walls are also GEV-certified and have been awarded the EMICODE EC1 ("very low emission level of volatile organic compounds") mark, awarded by GEV.

Preparation of substrates

Fibreglass Mesh: alkali-resistant fibreglass mesh. N.B This product has been superseded in several markets by Mapenet 150.

Mapelastix (CE EN 1504-2, coating (C) principles PI, MC and IR, EN 14891): two-component flexible cementitious mortar for waterproofing balconies, terraces and bathrooms.

Installation of ceramic, stone materials, bamboo and slate floor and wall coverings:

Elastorapid (CE EN 12004, C2FTE S2): two-component, highly flexible, high performance, quick setting and quick hydration cementitious adhesive with extended open time and no vertical slip, for ceramic tiles and stone material.

Granirapid (CE EN 12004, C2F S1, EC1): high performance, deformable, two-component cementitious adhesive with rapid setting and hydration for installing ceramic tiles and stone material.

Kerabond (CE EN 12004, C1, becomes C2E S2 if mixed with Isolastic): cementitious adhesive for ceramic tiles.

Keracolor FF (CG2, EC1 R): high performance, polymer-modified, water-repellent, cementitious grout with DropEffect® technology for joints up to 6 mm.

Keracolor SF (CG2, EC1 R): high performance, white superfine cementitious grout for joints up to 4 mm.

Keracrete: synthetic-rubber latex to be mixed with Keracrete Powder (white and grey) or with sand and cement.

Keracrete Powder (CE EN 12004, C2T): ready-to-use mixture of sand and cement to be mixed with KERACRETE latex. This adhesive has high performance, no vertical slip and is suitable for ceramic tiles, glass mosaic and stone material.

Keraflex (CE EN 12004, C2TE, EC1 R): high performance cementitious adhesive, with no vertical slip and with extended open time for ceramic tiles and stone material.

Keraflex Maxi (CE EN 12004, C2TE S1): high performance cementitious adhesive with no vertical slip, extended open time and deformable for ceramic tiles. N.B This product has been superseded in several markets by Keraflex Maxi S1.

Kerapoxy (R2T, CE EN 12004; RG): high performance two-component acid-resistant grout and adhesive with no vertical slip for installing and grouting ceramic tiles and stone material (with joints over 3 mm).

Products for structural repair:

Adesilex PG2 SP (CE EN 1504-4): two-component thixotropic epoxy adhesive with extended open time for structural bonding. N.B. The product is manufactured and distributed on the Far Eastern markets by Mapei Far East, the Group's subsidiary based in Singapore.

Epojet LV (CE EN 1504-5): two-component epoxy resin with very low viscosity for injection.

Mapefer (CE EN 1504-7): two-component corrosion-inhibiting cementitious mortar for reinforcing rods.

Mapefill SP (CE EN 1504-6): super-flow non-shrink cementitious grout for repairing concrete structures. N.B. The product is manufactured and distributed on the Far Eastern markets by Mapei Far East.

Mapegrout Thixotropic (CE EN 1504-3, class R4): shrinkage-compensated fibre-reinforced thixotropic mortar for the repair of concrete

Planicrete SP: synthetic-rubber latex for cementitious mortars. N.B. The product is manufactured and distributed on the Far Eastern markets by Mapei Far East.

Kesfoam 1 KM: ultra fluid, one-component polyurethane injection resin for waterproofing concrete or masonry structures, grounds and rocks.