





*Hong Kong-Macao-PRC*

# THE HONG KONG ZHUHAI-MACAO BRIDGE

THE ONLY INFRASTRUCTURE OF ITS KIND IN THE WORLD  
AND ONE OF THE BIGGEST PROJECTS EVER COMPLETED



On the 23<sup>rd</sup> of October this year, in the presence of President Xi Jinping of the People's Republic of China, the longest bridge-tunnel sea crossing in the world connecting Hong Kong, Zhuhai and Macao, was inaugurated. This futuristic structure, with a total length of 55 km is part of a large-scale technological and economic development plan to promote the Greater Bay area integrating 11 cities in the South of China. The bridge was constructed to meet the demand for passenger and goods traffic between Hong Kong, mainland of China and Macao, to improve economic development and stimulate growth in tourism.

#### A FUTURISTIC DESIGN

Work started in 2009 and was completed in February 2018, two years behind

schedule, and cost a total of around 20 billion Euros. With its two three-lane carriageways, the bridge stretches over a large river system in the South China Sea called the Pearl River Delta. This large viaduct is an engineering structure of the highest order which was designed to counter winds and tides. The structure was built to withstand earthquakes up to magnitude 8, typhoons and the impact of a cargo ship weighing around 300,000 tonnes. The bridge was also designed to last 120 years while most large bridges crossing the sea have been designed to last 100 years as observed from historic figures.

The main bridge is a 29.6 km long bridge-cum-tunnel system supported by three cable-stayed spans from 280 to 460 m high. Construction of the bridge required

400,000 tonnes of steel, the equivalent of sixty Eiffel towers, 420,000 million m<sup>3</sup> of concrete, a workforce of 14,000 and a fleet of 100 ships to transport the materials.

The Pearl River Delta is one of the busiest shipping areas in the world, with 4,000 vessels between passenger ferries and gigantic cargo ships passing through every day. Around three quarters of the way along the bridge, a 6.7 km subsea tunnel had to be constructed because it was not feasible to interrupt their passage. The tunnel is at maximum up to 45 m below the seabed and has two artificial islands running alongside it to accompany the transition between the submerged part and the elevated part towards Hong Kong on one side and towards Macao/Zhuhai on the other side.



## PROJECT FIGURES



Construction period:  
**2009-2018**

Overall length: **55 km**

Length of subsea tunnel: **6.7 km at 45 m below** the seabed

Cost: **20 billion Euros**

**400,000** tonnes of steel

**420,000** million m<sup>3</sup> of concrete

**14,000** total workforce

**625 m and 100,000 m<sup>2</sup>:**  
length and surface area of the  
two artificial islands

### A KEY INFRASTRUCTURE

Thanks to the new bridge it is now possible to travel from Zhuhai and Macao to Hong Kong and vice-versa in less than one hour, while previously it took 4 hours to drive all the way around the Pearl River Delta to Zhuhai or around an hour on high-speed ferry to Macao. Experts estimate that around 290,000 cars and heavy goods vehicles will cross the bridge every day.

The structure is intended to help form an integrated economic hub that, apart from the two former English and Portuguese colonies, also includes nine cities in the province of Guangdong, amongst which there are Guangzhou and Shenzhen. 68 million people live in the region and there are numerous businesses and companies operating in the area, including the financial centre of Hong Kong, the Shenzhen technological hub and the Dongguan industrial hub, which produce around one eighth of the total Chinese GDP. In Hong Kong there is also one of the most important container ports in the world and an air-cargo hub on a global scale.

According to experts, reducing travelling times will double the volume of goods transported between Hong Kong and the mainland, that is, the western part of the Pearl River Delta and the provinces of Guangdong and Guangxi. These areas are the home of various logistics companies that were in need of the space that Hong Kong could no longer offer, and vehicles had to reach the port or airport by using the Humen Bridge, a long and particularly congested route.

### MAPEI INTERVENTION

Mapei Technical Services provided site assistance for the main contractor working on three different sections of the project: in 2011 on the section between Scenic Hill and the Hong Kong Boundary Crossing Facilities, in 2012 directly on the subsea tunnel in the Tuen Mun-Chek Lap Kok Link area and in 2013 during construction of the toll area.

*Intervention between Scenic Hill and the Hong Kong Boundary Crossing.* Initially, Mapei Technical Services have collaborated with the contractor on the stretch that connects the Hong Kong Link Road between the main Hong Kong-Zhuhai-Macao Bridge and the Hong Kong Boundary Crossing Facilities. The Hong Kong Link Road includes a section of viaduct around 9 km long that runs from the border of Hong Kong SAR (Special Administrative Region) to Scenic Hill, which is on the island where the airport is located. The project included land reclamation and the construction of tunnels and link roads.

To waterproof the external area (a surface area of 83,000 m<sup>2</sup>), after priming the surfaces with MAPEFLOOR 1900 two-component, epoxy resin-based binder, Mapei Technical Services recommended treating the surface with PURTOP 400M HK two-component, solvent-free, hybrid polyurea membrane applied in situ using a high-pressure, bi-mixer type pump to form waterproof coatings on bridge decks, cut and cover tunnels and flat roofs. The product, which is distributed locally by Mapei China Ltd based in Hong Kong, has excellent tensile and

**PHOTO 1.** The layout of the Hong Kong-Zhuhai-Macao bridge.

**PHOTO 2.** The area worked on at Scenic Hill.

**PHOTO 3.** Waterproofing work in the Scenic Hill area was carried out with PURTOP 400M HK and POLYFOND KIT DRAIN.

**PHOTO 4.** MAPEPLAN TU S waterproofing membrane was applied to the internal surfaces of the tunnel.

### IN THE SPOTLIGHT MAPEPLAN TU S

It is a single-layer PVC P waterproofing membrane with orange signal layer. It can be applied as a fluid barrier in tunnel and underground structures construction.

It can also be used for drill and blast tunnel waterproofing, as well as for open cut tunnel waterproofing and underground structures waterproofing. MAPEPLAN TU S performs both high mechanical properties and workability and welding characteristics.



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**PHOTO 5.** The largest tunnel boring machine in the world while boring the subsea tunnel section.

**PHOTO 6.** MAPEFILL HS special mortar was used for anchoring the metal elements.

**PHOTO 7.** MAPEFILL HS was also applied in the underground corridors.



tear strengths, high resistance to chemical agents and excellent flexibility.

The intervention was completed by installing POLYFOND KIT DRAIN, a protective and drainage system by Polyglass, a subsidiary of the Mapei Group. The system is made from high-density extruded polyethylene (HDPE) laminated with a polypropylene needle-punched nonwoven. It is particularly effective in protecting and waterproofing below grade structures, also providing excellent drainage capacity.

The connection tunnel (80,000 m<sup>2</sup> of surfaces), which was excavated using the "drill and blast" method, was waterproofed with MAPEPLAN TU S, a single-layer PVC P waterproofing membrane with orange signal layer for waterproofing natural and artificial tunnels and underground structures. Manufactured by Polyglass, MAPEPLAN is a line of synthetic waterproofing membranes made using exclusive "multi-extrusion coating" technology to form high-performance, highly durable PVC-P membranes with

excellent workability and good welding characteristic.

Other products used included MAPEPLAN GEO 500, MAPEPLAN DISKS and MAPEPLAN COLLARS.

*Tuen Mun-Chek Lap Kok Link intervention - Northern Subsea Tunnel Section.*

This two-lane tunnel is 40 m below the seabed and is more than 6 km long and will wind its way between the Northwest New Territories and Hong Kong – Zhuhai – Macao Bridge (HZMB), the airport and North Lantau and also provides an alternative route to the airport. The largest tunnel boring machine in the world, with a bore diameter of 17.6 m, was used to bore the tunnel.

For this operation Mapei supplied MAPEBENT API natural sodium bentonite, MAPEFILL HS high-strength, non-shrink, anchoring grout and MAPEGROUT HI-FLOW SP shrinkage-compensated fibre-reinforced mortar (all products are distributed by Mapei China Ltd.).

*Toll areas.* To gain access to the Tuen Mun-Check Lap Kok Link and drive

across it, a toll needs to be paid and vehicles must have a permit.

To carry out this service, a dedicated area and service areas covering a surface of more than 5 hectares had to be built. Mapei provided solutions to waterproof the area (18,000 m<sup>2</sup>) by supplying MAPEPLAN TU S, MAPEPLAN GEO 1000, MAPEPLAN DISKS, MAPEPLAN ANCHORING and MAPEFIX VE SF.

#### TECHNICAL DATA

**Bridge linking Hong Kong, Macao and Zhuhai,** Hong Kong and PRC

**Period of construction:** 2013-2018

**Period of the intervention:** 2017-2018

**Intervention by Mapei:** supplying products for underground waterproofing

and anchoring

**Client:** Highway Department, HK SAR Government

**Main contractor:** Dragages-Bouygues Joint Venture

**Works direction:** Ove Arup & Partners Hong Kong Ltd

**Mapei coordinator:** Stuart Watt, Mapei China Ltd (Hong Kong)

#### MAPEI PRODUCTS

**Underground waterproofing:** Mapebent API\*, Mapefill HS\*, Mapefix VE SF, Mapegrout Hi-Flow SP\*, Mapeplan Anchoring, Mapeplan Geo 1000, Mapeplan Geo 500, Mapefloor I 900, Purtop 400M HK\*

\*These products are distributed by Mapei China Ltd

#### POLYGLASS PRODUCTS

**Underground waterproofing:** Polyfond Kit Drain, Mapeplan TU S, Mapeplan Disks, Mapeplan Collars

For further information on products visit [www.mapei.com](http://www.mapei.com) and [www.polyglass.com](http://www.polyglass.com)