

## GOING BLUE\* [INFRASTRUCTURE]

The impressive Hong Kong-Zhuhai-Macau fixed-link project includes an immersed tunnel with a record-breaking length of almost seven kilometers.

TEXT: JAN HÖKERBERG PHOTOS: GETTY IMAGES, ARUP

*\* Going Blue reflects Trelleborg's aspiration to offer solutions with an added sustainability, in this case reducing energy used in transportation.*

# THE WORLD'S LONGEST IMMERSED TUNNEL

**T**he 8,850-kilometer (5,500 mile) Great Wall of China, started during the Qin dynasty 2,200 years ago, is one of the wonders of the world. But infrastructure construction in China today is booming as never before.

In 2009, construction began on a project to link Hong Kong with Macau and the mainland Chinese city of Zhuhai. The link will be one of the region's most technically complex engineering projects ever. It includes a 30-kilometer (19-mile) dual three-lane carriageway with a 23-kilometer (14-mile) bridge, an almost seven-kilometer (4.5 mile) tunnel and two artificial islands. The tunnel will be the world's longest deepwater immersed tunnel for road traffic.

Originally proposed by prominent Hong Kong businessman Gordon Wu in 1983, the Hong Kong-Zhuhai-



The new link will reduce travel time from Hong Kong to Macau or Zhuhai from three hours to half an hour.

Macau fixed link when completed in 2016 will enhance deeper economic integration between Hong Kong and the Pearl River Delta region in southern China.

In October 2011, Trelleborg signed a contract with China Communications Construction Co. Ltd. (CCCC) for the tunnel's

sealing system. The seals were chosen for their innovative design that will ensure water-tightness even in the event of seismic activity. The joints will be sealed with a Trelleborg sealing system consisting of Gina gaskets, Omega seals and waterstops as well as other seal designs.

Given the size of the project and its huge engineering challenges, CCCC stressed that it wanted the highest possible quality.

"We were able to offer a total sealing system, which none of our competitors could do," says Ruud Bokhout, Business Development Director at Trelleborg's manufacturing facility for tunnel seals in the Netherlands. "We could also show a good reference list that included many big tunnel projects in China, and we have been able to support CCCC with our outstanding engineering knowledge."

### WORLD LEADER IN GASKETS AND SEALS

Trelleborg is the world's leading manufacturer of gaskets and seals. In tunnels, Trelleborg's Gina gaskets are used as primary seals, while its Omega seals are secondary seals. These are used mainly for backup to ensure everything is 100 percent watertight.

The Hong Kong-Zhuhai-Macau tunnel project will contain 34 Gina gaskets with circumferences of around 90 meters (300 feet). The gaskets are produced in a mold and weigh nine metric tons (about 10 U.S. tons), and must be transported in a 12-meter (40-foot) open-top container.

There will also be 34 large and 219 smaller Omega seals as well as rubber waterstops with vulcanized steel strips to make the concrete sections watertight.



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..... TUNNEL



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*Ruud Bokhout,  
Trelleborg*

**Over the past decades,** Trelleborg has supplied gaskets and seals for numerous tunnels in China – in Ningbo, Shanghai, Guangzhou and Tianjin as well as in Hong Kong.

An immersed tunnel consists of several large, long concrete elements that are constructed onshore. Seals are used between the sections to keep the water out of the tunnel. Each element is towed by barges to its final position and then immersed in the water.

“The bigger seals will be manufactured in the Netherlands, while the smaller seals and waterstops will be produced in Trelleborg’s plant in Qingdao, China,” says Bokhout.

A major challenge in the project is the water depth of more than 40 meters (130 feet). The tunnel will be constructed on a soft seabed requiring soil improvement to prevent the elements from settling, in rough open waters beneath navigation channels trafficked by the world’s largest ships.

The geographical area bears many similarities to the Busan-Geoje fixed link in South Korea, which opened in 2010 and for which Trelleborg was the supplier of Omega seals. The tunnel design also has to address the risk of earthquakes. The seals between the tunnel elements must be extremely resilient and stay watertight when exposed to seismic ground movements.

With 33 large elements submerged at depths of more than 40 meters (130 feet) below the surface, the project pushes the boundaries of what is technically possible.

“Safety is of paramount importance, and our products are critical, especially as it is virtually impossible to make repairs once the tunnel is in place,” says Bokhout. “The choice of Trelleborg as supplier further strengthens our leading position in the market for immersed tunnels globally, and demonstrates our capacity for innovation as well as our commitment to protecting people, the environment and infrastructural investments.” ■