

# OUR BROAD (TUNNEL) VISION

Immersed tunnel execution brings Boskalis' fields of expertise together.

Construction is technically complex and involves an extreme degree of accuracy. Design of the elements is governed by temporary phases, meaning that the early involvement of an experienced contractor is crucial to producing optimal solutions.

Boskalis combines both operational and engineering capabilities and is able to handle the entire installation process, from feasibility studies to completion.

Immersed tunnel execution involves our core activities of dredging, rock placing, inland infrastructure and towage. Our fleet of specially developed marine equipment enables us to execute them safely and with the required precision.

## OUR SOLUTIONS

1. Construction of building dock and water management
2. Dredging the tunnel trench
3. Laying the gravel or sand-flow foundation
4. Towage
5. Transportation overseas

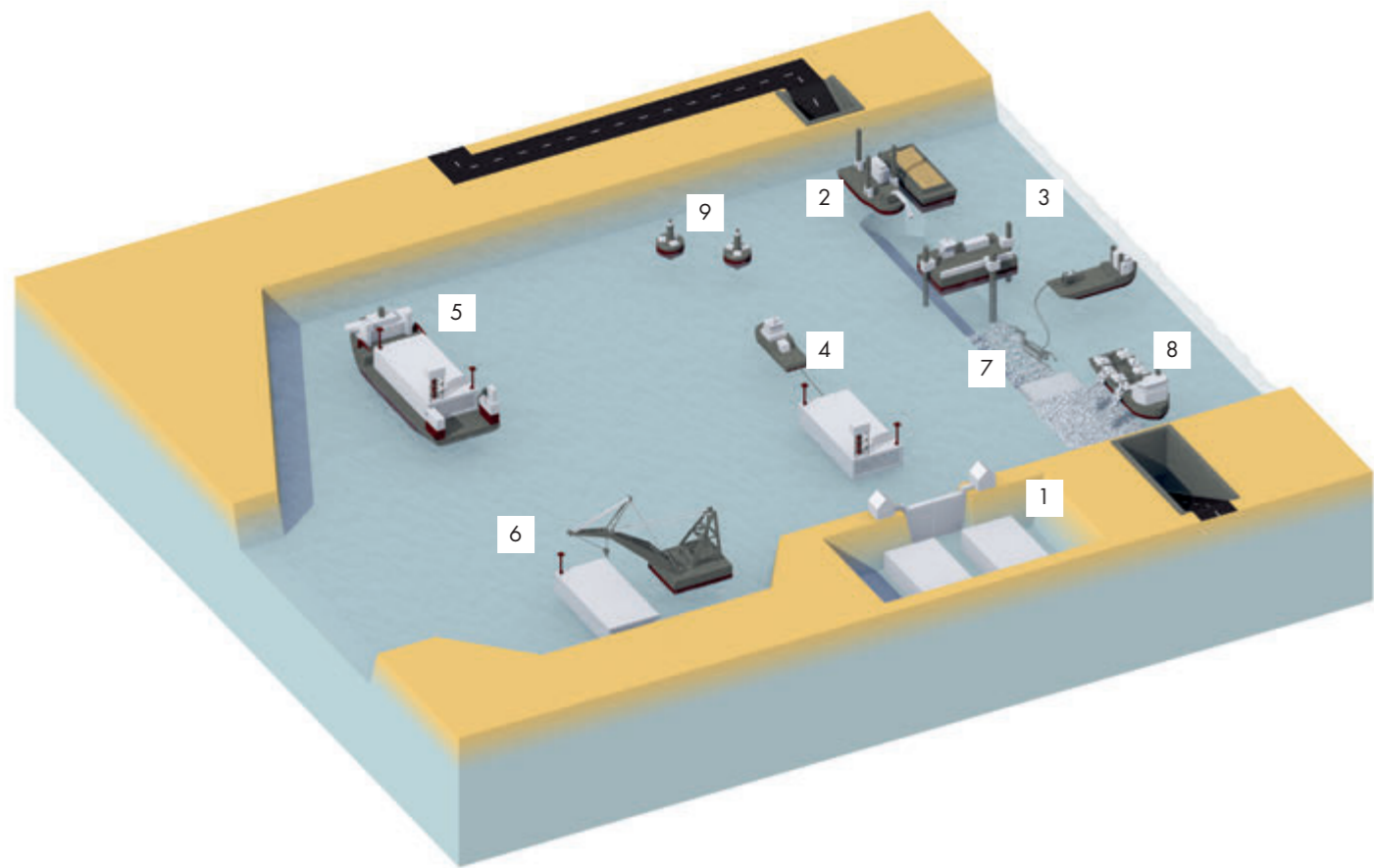
Our in-house experts are from a broad range of disciplines that span the capabilities necessary for immersed tunnel activities, including:

- Geotechnics
- Hydraulic Processes
- Maritime Engineering
- Environmental Management

They work in close cooperation with structural design partners and combine insight about the design process with a thorough understanding of the practicalities of works, which often leads to opportunities for clients.

Boskalis has the skills, resources and experience to engineer and execute all marine activities involved in any immersed tunnel project, anywhere.

6. Outfitting
7. Immersion management and survey (including closure joint)
8. Locking fill, trench backfill and rock protection
9. Environmental monitoring

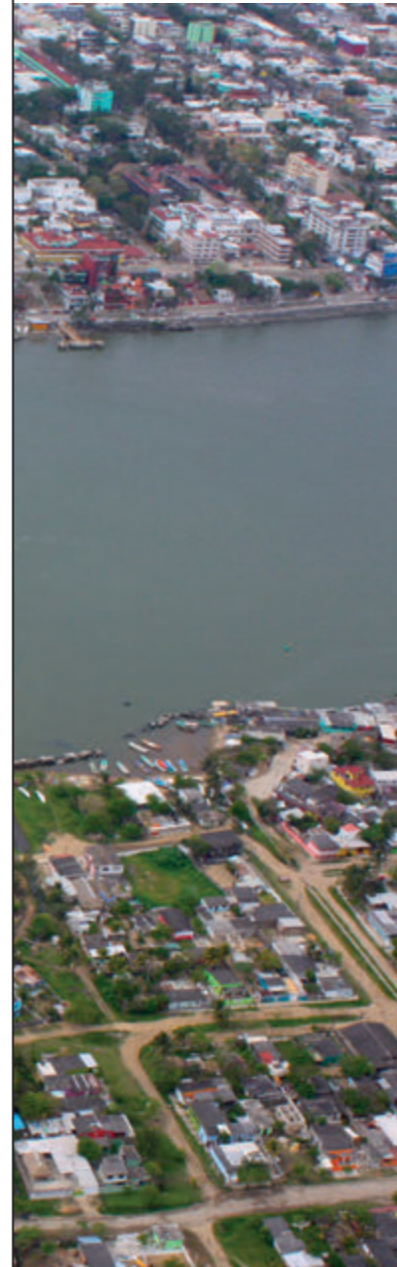


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# IMMERSED TUNNELS



# COMPETITIVE SOLUTIONS

Immersed tunnels are an engineering solution for water crossings, whereby prefabricated elements are floated to the location, immersed into a dredged trench, ballasted and protected with sand and rock.

Tunnels are an answer to changing mobility and transportation needs. They are an ideal solution to connect people and places, as well as facilitating traffic and the transport of freight. They can accommodate different infrastructure including:

- Highways
- Railways
- Urban mobility systems
- Utility systems (water supply, electricity cables)

Immersed tunnels are often a competitive alternative to other crossing solutions such as bridges or bored tunnels (drilled underground) and should always be considered during the early stages of the design process. They offer the following advantages:

- Shortest crossing  
Construction is typically just below the water bed, making the immersed tunnel the shortest overall crossing route (including access ramps). It is also the solution with the lowest gradients.

- Economical, flexible shape  
Cross-section design is highly flexible and not limited to a circular shape. A large variety of demands can be accommodated.

- Low environmental impact  
Proven work methods, limited soil residues and possibilities to reuse the excavated soil (mitigation measures).  
Virtually no impact during operation.

- Limited visual impact
- Unlimited air draught clearance for shipping
- Minimal disruption to waterways and roads
- Applicable in most ground conditions, including soft alluvial deposits of river estuaries
- Good seismic behavior
- Top quality elements (pre-cast)
- High levels of safety



## (1) COATZACOALCOS, MEXICO

Removal of the dyke around the dry dock where the elements of the first immersed tunnel in Central America were built.

- Construction: 2011-2012
- Length: 700m (5 elements)
- Function: road



## (2) ØRESUND, DENMARK-SWEDEN

Simultaneous construction of two tunnel segments on weather proofed production lines for one of the longest immersed tunnels in the world.

- Construction: 1995-2000
- Length: 3520m (20 elements)
- Function: road-rail link



## (3) ROSTOCK, GERMANY

Submerging a tunnel element into a dredged trench at a depth of 22 meters below the water level of the River Warnow.

- Construction: 2000-2003
- Length: 720m (6 elements)
- Function: motorway ring road



## (4) TUAS, SINGAPORE

Outfitting of the tunnel elements, designed to accommodate high voltage power supply cables across Tuas Bay.

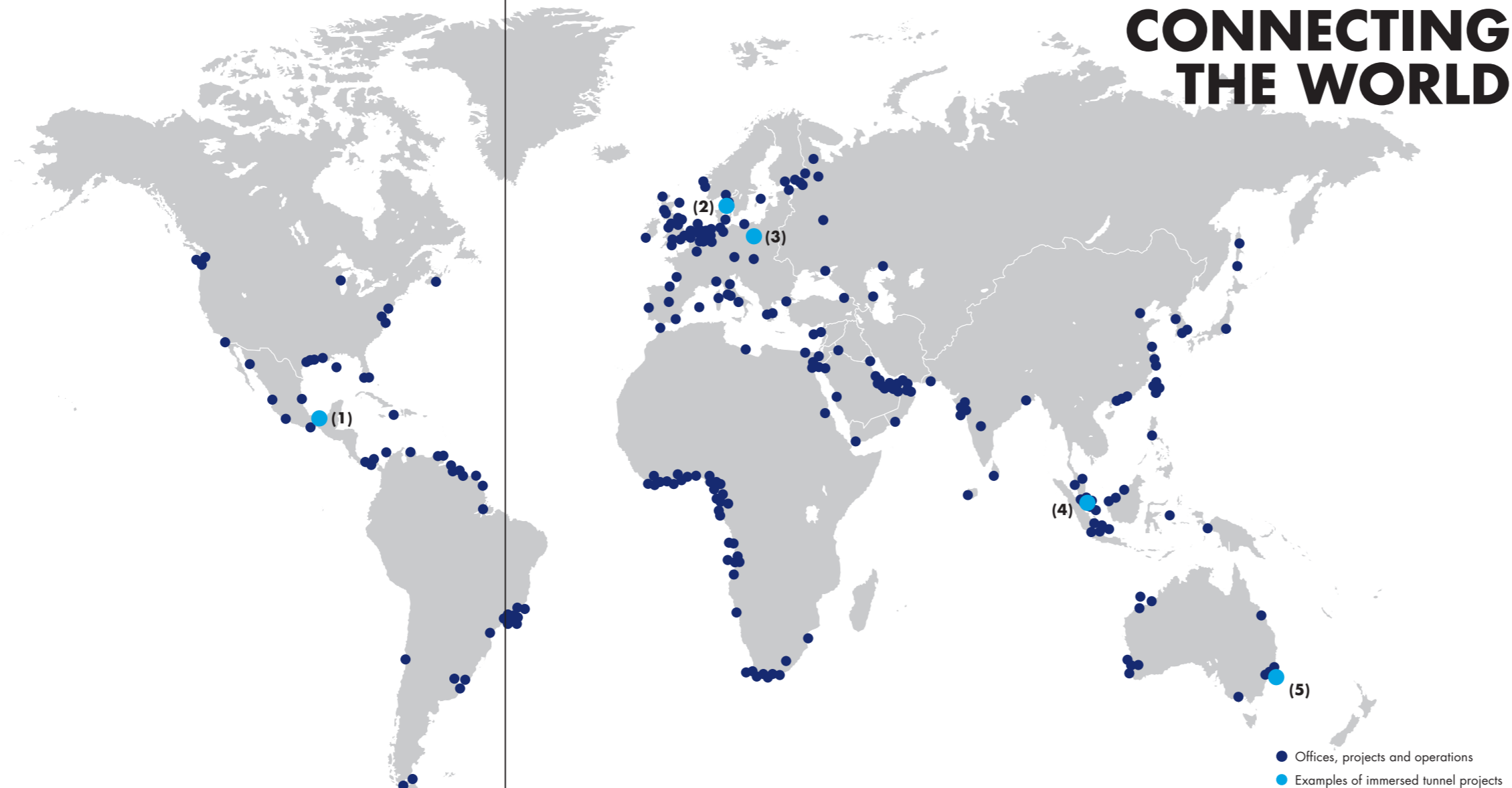
- Construction: 1997
- Length: 2000m (21 elements)
- Function: utility systems



## (5) SYDNEY HARBOUR, AUSTRALIA

Dredging close to Sydney's Circular Quay. Tunnel elements were towed from the casting basin over 100 kilometers away.

- Construction: 1987-1991
- Length: 960m (8 elements)
- Function: road



- Offices, projects and operations
- Examples of immersed tunnel projects

# CONNECTING THE WORLD

# PROVEN TECHNOLOGY

Immersed tunnels have been in use for more than 100 years. With more than 30 of these tunnels, The Netherlands has historically been a leading country in their construction.

Over the last decades there have been significant developments in dredging and tunneling technologies. These include larger cross sections, longer prefabricated concrete or steel elements, and possibilities to install the tunnels at greater depths.

There is currently an increase in demand and in the scale of tunnel projects worldwide, particularly in congested areas where mobility needs are challenging.

Boskalis continues to be part of the history of their development.

## SPECIAL TOOLS

Tunnel projects call for specialized tools. Our diverse fleet and capability to develop project-specific equipment is a major advantage when creating efficient tunneling solutions.

Precision dredging is required to produce a suitable foundation trench, free of pits, outcrops or sediments.

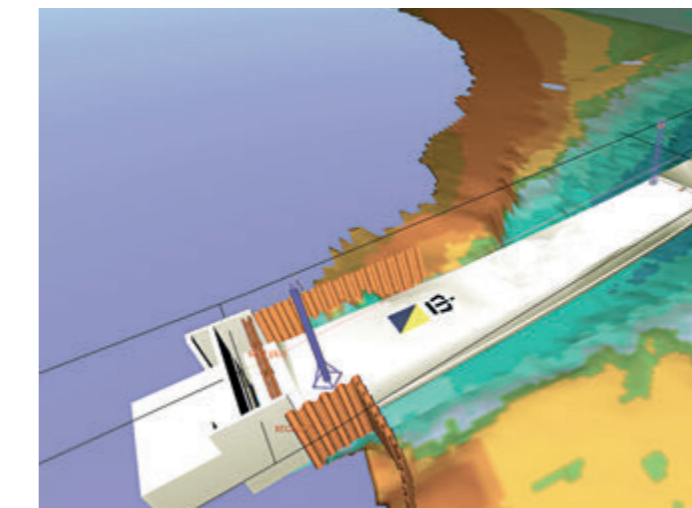
Our fleet of different types of dredgers can excavate various soil types and clean up and maintain trenches.

Through our subsidiary Dockwise, we operate the largest fleet of semi-submersible, heavy transport vessels, which can carry out the dry transportation of tunnel elements.

Using our specially developed multi-purpose pontoon Scradeway® we construct gravel beds with extremely high accuracy. Its automated movable telescopic fall pipe can deposit and level the gravel material at the same time - minimizing losses. The ability to produce a very smooth rock bed results in considerable cost savings in the structural design of the tunnel elements.

Our survey department utilizes customized tools and has developed in-house software to visualize and control the immersion process.

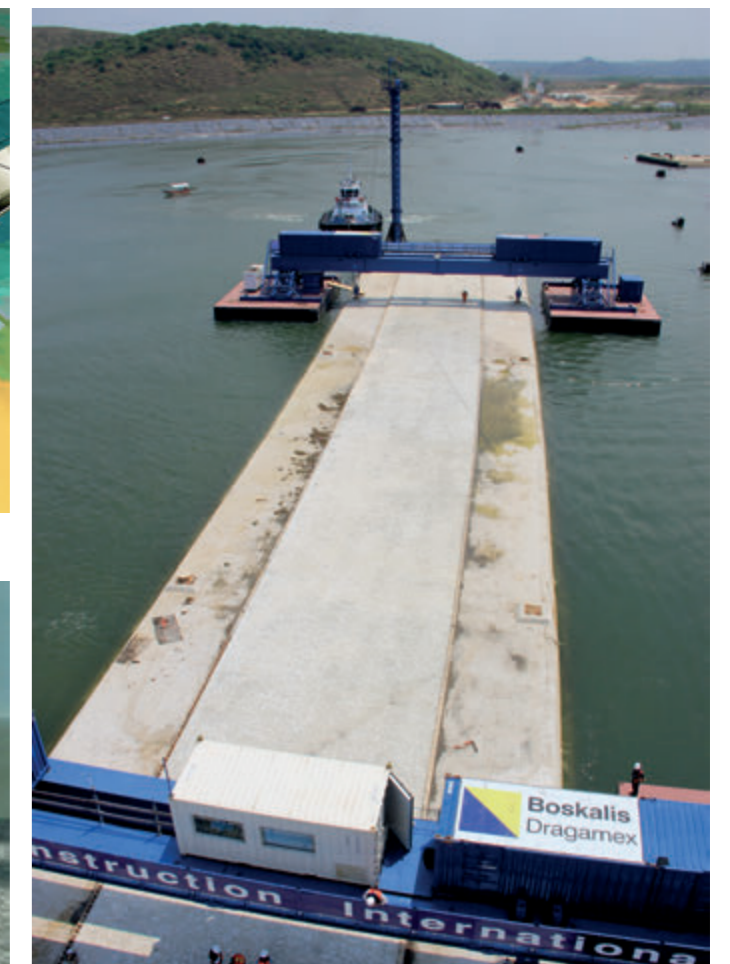
Our dynamically positioned fall pipe vessels are able to deposit stone accurately at great depths and can be deployed to place locking fills and rock protection layers over tunnels.



3D model of the surveyed seabed of the Coatzacoalcos Estuary.



The Scradeway® method produces a smooth rock bed, reducing the costs of the tunnel structure.



In Coatzacoalcos, the elements were taken to the site and submerged using two specially manufactured catamarans.