Tunnel construction is one of the most complex civil engineering challenges there is. Engineers study the varying types of ground conditions before commencing excavation underground. These include:

- soft ground
- hard rock
- soft rock
- underwater (immersed) tunnels

In addition, they must examine groundwater conditions, proposed tunnel length, diameter and depth, as well as the construction thickness and shape. They also need to apply appropriate methods for lining the tunnel to counteract compression forces from the surrounding ground and to keep it watertight.

TUNNEL CONSTRUCTION

Five types of tunnel construction are commonly used:

1. Cut and cover tunnels. Constructed in a shallow trench and covered over. Example: Metropolitan railway, 1886
2. Bored tunnels. Made using shields and tunnel boring machines without removing the ground above. Usually circular in shape or horseshoe cross-section. Crossrail, 2018
3. Immersed tube tunnels. These are sunk into a trench on the seabed. Proposed Fehmarn Belt
4. Drill and blast. Explosives are used to blast away sections of hard rock. Sections of the Gotthard Base Tunnel, 2016
5. New Austrian Tunnelling Method. Soft ground. A sprayed concrete lining is applied after face advance is achieved.

KEY TUNNELLING PROJECTS

From London’s Thames Tunnel of 1843 to the 2016 Gotthard Base Tunnel discover our six epoch-making projects:

- **Thames Tunnel**
  - Location: London, UK, 1843
  - The engineering marvel came about due to Marc Brunel’s tunnelling shield invention that was inspired by his observations of the shipworm boring its way through timber. Bricks and extra strong cement lined the tunnel’s exposed parts.

- **Box Tunnel**
  - Location: Wiltshire, UK, 1841
  - Isambard Kingdom Brunel designed and oversaw construction of a 2,940m tunnel cutting through Box Hill to carry the Great Western Railway from London to Bristol. He used gunpowder to blast through the limestone.

- **Mersey Tunnel**
  - Location: Liverpool, UK, 1886
  - This 3,920m road tunnel opened in 1886 and remains the fastest way to cross the Mersey estuary from Birkenhead to Liverpool to this day. Chief engineer, Francis Fox brought in a tunnel boring machine, complete with rotating arm with teeth to rip out chunks of rock that were then carried away on a conveyor belt.

- **Simplon Tunnel**
  - Location: Switzerland - Italy, 1905
  - This 19,800m rail tunnel connected Geneva and Milan via the Alps. Built by Swiss engineers, it was at the time the longest rail tunnel in the world. A system of twin tunnels with cross passages delivered fresh air to the construction workers.

- **Channel Tunnel**
  - A 34km tunnel was bored under the English Channel to create a fixed link between England and mainland Europe. Three tunnel boring machines dug from either side, meeting with great celebration in the middle. There are two main rail tunnels and a smaller service tunnel.

- **Gotthard Base Tunnel**
  - Location: Switzerland, 2016
  - Enabling rapid rail travel between Zurich and Milan, the tunnel runs for 57km. It was built using the latest tunnel boring technology and lots of explosives. Two tunnels were dug with regular crossover points linking platforms for passenger safety.