

CHANNEL TUNNEL SPECIAL UNDERGROUND WORKS



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TML had to build, either manually, either with roadheaders and front-end loaders, some 700 structures (almost 10 km) connecting the 3 TBM-excavated tunnels.

Undersea crossovers

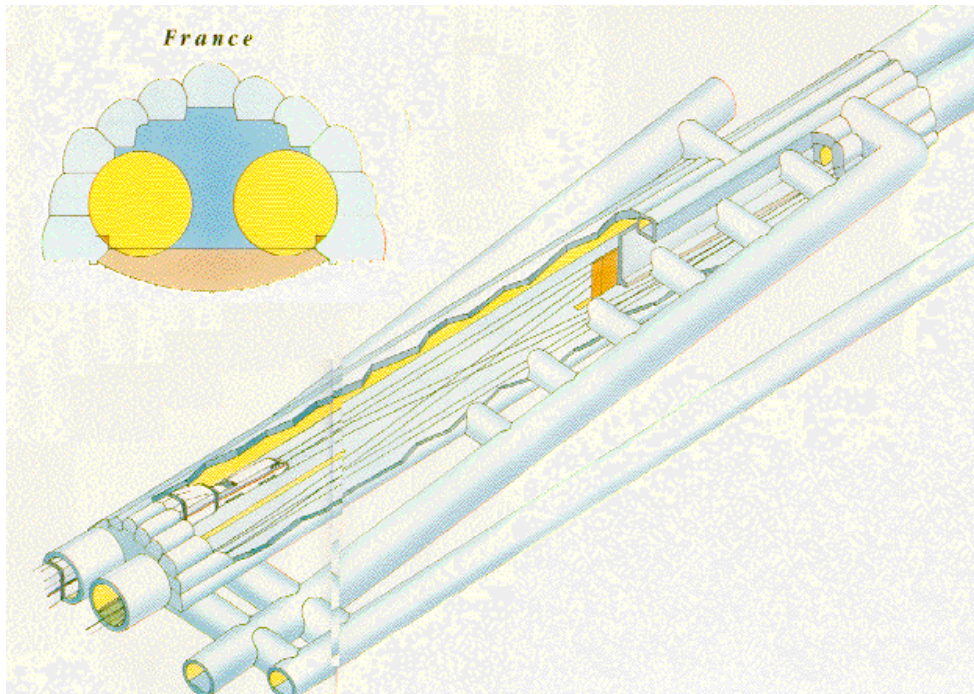
The Crossovers enable shuttles to cross from one tunnel to the other in order to ease tunnel maintenance. They also house many fixed equipments in large technical rooms. The French crossover is located 12.5 km from Sangatte. The UK crossover is 7.0 km away from Shakespeare Cliff. Both crossovers divide the tunnels into three sections of just about equal length.

During normal operation of the Fixed Link, tracks in the crossovers are separated by fire-resistant sliding doors (2x33.5 m long, 6.85 m high, weigh 2x92 T, opening time 3 minutes). These doors are designed to withstand aerodynamic effects of trains movements (over 1 T/m²).

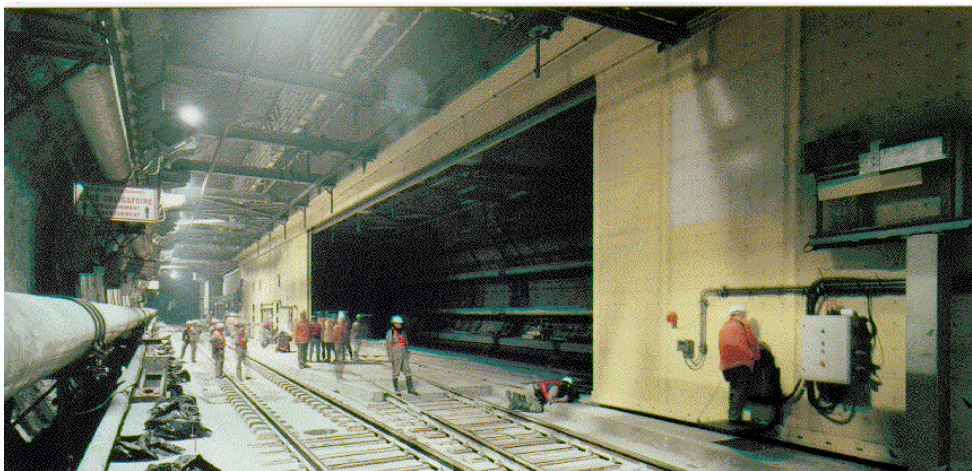
The French and UK caverns are about the same size, but have been built by entirely different construction methods. The British cavern was built before the running tunnels reached it (due to the earliest advance of Service Tunnel on UK side), and the French cavern was built around the excavated running tunnels.

UK Crossover:

The cavern is 163.8 m long, 15.4 m high and 21.2 m wide. The structure was built in 3 stages using the flexible NATM technique. Excavation was made by roadheaders. Shotcrete together with up to 8 m long rockbolts was then used to stabilize



Above: structures of the French crossover cavern, 160 m long, 180 m² cross-section.
Below, left: inside, during construction. Right: while commissioning the 184T-sliding door, opening in 3 minutes.



temporarily the structure, constantly monitored with 200 instruments taking 120 measurements daily. Once the excavation completed, permanent lining was installed, including waterproof seal and in-situ concrete designed for the full overburden.

The crossover was excavated in 22 months. The TBMs went through it and continued tunnelling until they met with their French counterparts.

French Crossover:

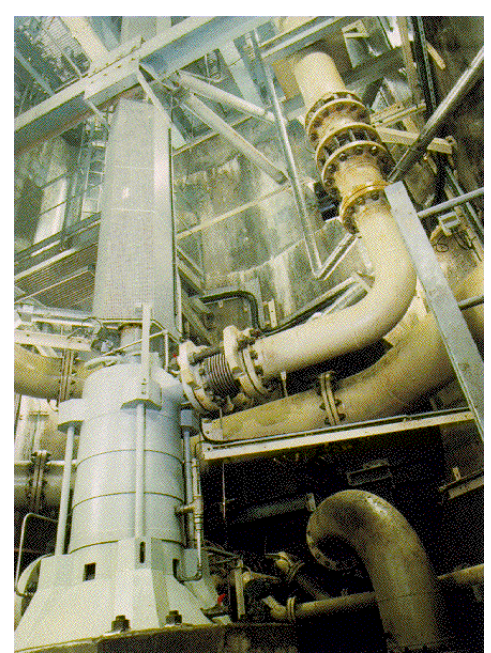
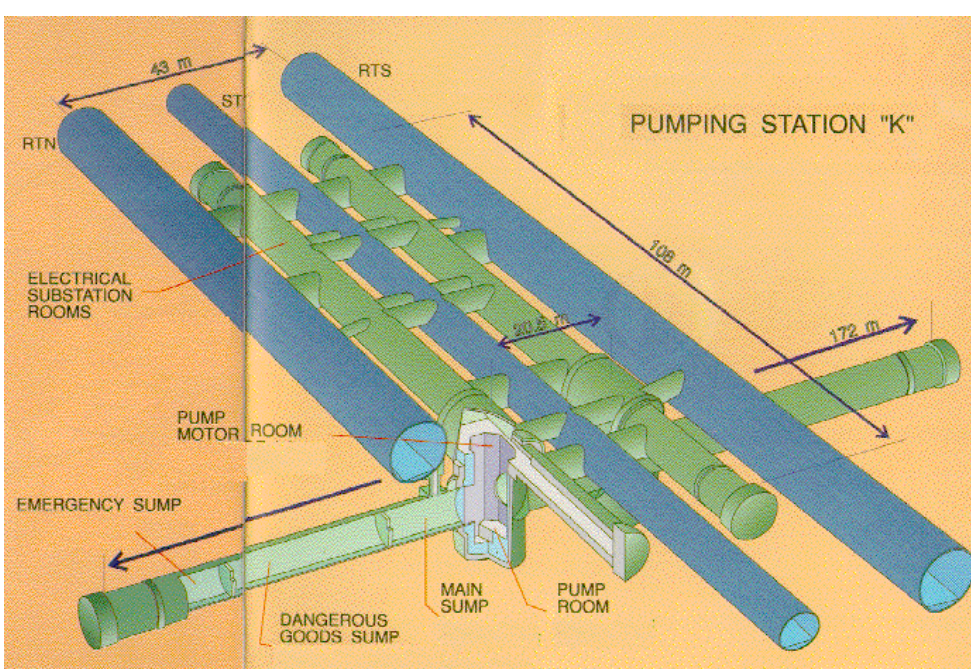
The excavation was completed in only 15 months. Extensive preparatory studies allowed to avoid any interference with TBMs.

The shell of the structure was based on eleven 14-m² small tunnels immediately

concreted, set out in a half moon with access provided by lateral ramps and adits. Excavation works used "Lynx" roadheaders for access adits and small tunnels. Some 60,000 m³ of material were carried away by conveyors and trains to the Sangatte shaft. Once this completed, the 11 small tunnels, filled with 45,000 m³ of concrete, were part a 170 m-long vault. After removing the material located in the internal space, the linings enclosing the already driven running tunnels were dismantled. Final dimensions are: 156 m long, 10.5 m high and 18.1 m wide.

Pumping Stations

These structures are designed to control seepage and to deal with leakages of water



Above, left: Pumping station « K », one of 3 undersea. Right: inside view of the French Pumping station « W3 ». Below, left: One of the 270 Cross-Passages, with door open. Right: one of the 194 Piston Relief Ducts.

or chemical liquids from running tunnels. Service sumps collect liquids during normal operation. Emergency sumps were also provided to store water in case of partial or total loss of pumping capacity.

The French undersea pumping station is located 100 m below sea level and 8.8 km from Sangatte at the low point of the French Tunnels. It includes two identical equipment passages with associated pits and sumps, one to the north and one to the south. Each side has an emergency sump (capacity 1660 m³) able to isolate dangerous goods and/or to increase water storage capacity. Each of the equipment passages has been built on two levels: tunnel level for electrical equipment, anti-surge tanks and motors and the lower part, 11 m below, to house pipes and pumps.

Each passage houses two 4,200 kg 400 kV pumps, capacity 600 m³/h. Diameters of connecting pipes are from 100 to 400 mm.

Four pumping stations have been built. Due to lower seepage than expected, only 3 have been equipped, undersea, at tunnel low points undersea. The remaining, at Sangatte shaft, is not used.

Piston Relief Ducts

The piston relief ducts (PRD) allow to compensate aerodynamic resistance: The larger the train is relative to the tunnel section, the more it acts as a piston inside a cylinder, and the more power is needed to maintain speed. Through PRD's, the pressure wave ahead of the shuttle is greatly reduced as



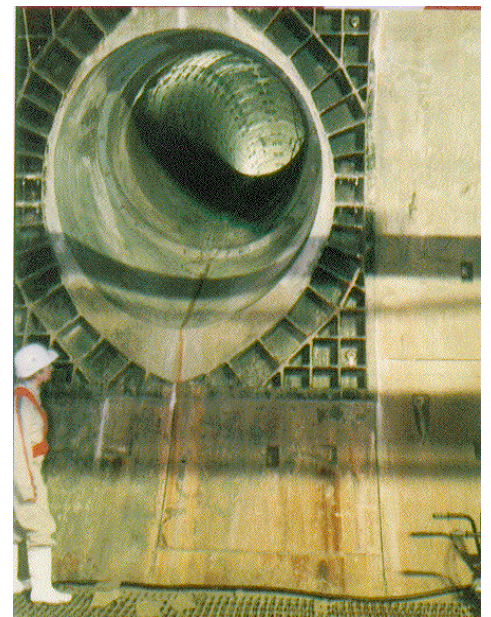
air is pushed into the other tunnel and can pass more easily to the low pressure area at the rear of the train.

194 PRDs, diam.2 m, were excavated using hand tools at 250 m spacing. They are lined and water-proofed, and fitted with a fire-resistant damper in order to separate the running tunnels in case of fire.

Cross Passages

The main functions of the Cross Passages (CPs) between the Service Tunnel and the Running Tunnels are:

- access for passengers in case of evacuation or for maintenance staff.



- house fixed equipments.

270 CPs have been built, every 375 m, excavated using hand-held tools. Internal diameter is 3.3 m. Junctions with tunnels were formed by special concrete/cast iron sets and in-situ concrete. Each CP is fitted with a doors able to resist to 3 T/m².

Technical rooms

210 Technical rooms were built to house electrical or rail signalling equipment. These structures are similar to cross passages, with internal diameter of 3.3 m, but are only accessible from the service tunnel.

TML, THE CHANNEL TUNNEL CONTRACTOR, IS A JOINT VENTURE BETWEEN:

Balfour Beatty constructions LTD, Bouygues S.A., Costain Civil Engineering LTD, Dumez S.A., Société Auxiliaire d'Entreprises S.A., Société Générale d'Entreprises S.A., Spie Batignolles S.A., Tarmac Constructions LTD, Taylor Woodrow construction holdings LTD, Wimpey major projects LTD.