



**Client:** Haven van Antwerpen  
**Main contractor:** Smet-Tunnelling nv  
**Machine:** CBC  
**Pipes:** reinforced concrete  
**ID-OD:** 2.500—2.960 mm  
**Length:** 1.205 m  
**Execution:** 1998-1999

The tunnel by means of pipe jacking executed by Smet-Tunnelling was part of a design and construction project conducted by Smet-Boring to improve the quay wall stability of this terminal. After finishing the pipe jacking, Smet- G.W.T. placed drains starting from the tunnel. This makes it possible to control the groundwater level without any impact on container traffic above.

### Pipe Jacking

The complete tunnel, executed at a depth of 18 m, has a length of 1,205 m and an internal diameter of 2.5 m. The departure shaft was executed as sheet piling inside one of the existing caissons which is part of the quay wall. A steel plate was to be integrated and anchored into the wall of the caisson. Onto this plate, a seal was welded to prevent water and sand entering the shaft during the pipe jacking. A watertight grouting block at the other side of the steel plate made it possible to start the pipe jacking in a safe manner. Grouting was executed by Smet-F&C. By creating an annular space between excavated soil and jacking pipes, the injection of bentonite was possible. By doing so, the friction forces are reduced, which results in longer jacking lengths and fewer intermediate jacking stations.

### Lubrication

Special efforts had been made in order to enhance jacking forces. This was done by means of a fully automated lubrication system. Injection flow and pressure were programmed and PLC controlled. The use of reducing additives together with bentonite reduced friction forces down to less than 1 kN/m. Friction reducing polymers were used according to health and safety regulation standards.



### Jacking pipes

The reinforced concrete jacking pipes had an internal diameter of 2,500 mm and an external diameter of 2,960 mm. The applicable jacking forces were limited to 1,280 ton. Each pipe was 2.50 m long and fitted with 3 injection holes. In total, 7 intermediate stations were installed, of which only 6 were used.



### Shield and equipment

Smet-Tunnelling owns a big number of TBM's, most of which are manufactured by Smet-Boring. The CBC shield used weighs 57 tonnes, measures app. 6.80 m and has 155 kW power installed. On the surface, a control unit, gantry crane 20 ton and a de-sanding unit were installed.

### Arrival procedure

An arrival shaft, similar to the departure shaft, was created. By the use of a grouting block and a temporary lowering of the groundwater level, the TBM could be jacked into this shaft and lifted. Thanks to the adequate engineering preparation, the total execution time needed for the 1,205 m was limited to 4 months.