

NEW DIMENSIONS FOR SHANGHAI: THE WORLD'S LARGEST TUNNEL BORING MACHINES CROSS UNDER THE YANGTZE RIVER.

HERRENKNECHT
Tunnelling Systems

SHANGHAI GROWS: UPWARDS, OUTWARDS – AND DOWNWARDS.

Dongtan – the first planned eco-city. The world's first eco-city is to be created in the middle of the Yangtze River delta. This pilot project for Chinese environmental policy will be realized on the island of Chongming off Shanghai in the coming years. Here, a city is planned which is to be built according to the strictest environmental criteria. Dongtan, as this eco-city is called, will have the most up-to-date environmentally-friendly technology. From waste recycling and water treatment – still far from standard in China – to supplying heating and electricity from renewable energy sources. However, the planners are going a couple of steps further; they want to restrict car traffic to the periphery of the residential areas, which is why their transport planning is oriented towards pedestrians and cyclists. They plan to locate working and living close enough to each other to make energy-consuming commuter traffic unnecessary. The residential blocks are planned with no more than 8 stories, including their greened rooftops. The ambitious plan of the British engineering studio Arup and the Shanghai Development Company SIIC is to complete the initial phase in time for the World Expo 2010. Some 80,000 people from various social backgrounds are expected to live in Dongtan by the year 2020.



The People's Republic of China is one of the most dynamic economic regions in the world. With its unprecedented growth, the country has already become the fourth largest economic power in the world. China has consistently promoted urbanization since the 1980s and it is one of the most important engines for growth on the Chinese market, along with the extension of infrastructure that goes with it.

With its 20 million inhabitants, Shanghai is now the biggest city in China and one of the largest cities worldwide. This mega city continues to grow and is permanently seeking more space – even beyond the natural borders of the Yangtze River delta. 500 new vehicles are registered each day, although the city can hardly cope with the level of road traffic even now.

Two tunnels to prevent traffic jams. Two gigantic tunnels are to be opened to traffic in time for the World Expo 2010, which is to be hosted by this Chinese mega city. They will bring Changxing river island closer to Pudong, connecting 600,000 island inhabitants with the Shanghai mainland. A bridge from Changxing to the large island of Chongming completes the connection to the Yangtze delta with the newly planned "Hu Chong Su Traffic Line".

The largest mechanized tunnels worldwide, with a diameter of 15.43 meters, cross under China's largest river, the Yangtze, at a depth of up to 65 meters. The ground which must be excavated for the 2 tunnels is a mixture of sand, clay, broken rock and groundwater – with water pressures of up to 6.5 bar. Each tunnel stretches over a length of 7.47 kilometers and accommodates two levels: a three-lane highway will run on the upper level, the lower level has space for service and safety facilities and a metro line which may be built later. Since the Yangtze River is one of the country's busiest waterways, it is important that inland traffic should not be restricted by the construction work. Therefore the mechanized tunnelling technique was chosen rather than an immersed tunnel or a bridge construction for the very busy south channel of the Yangtze River.





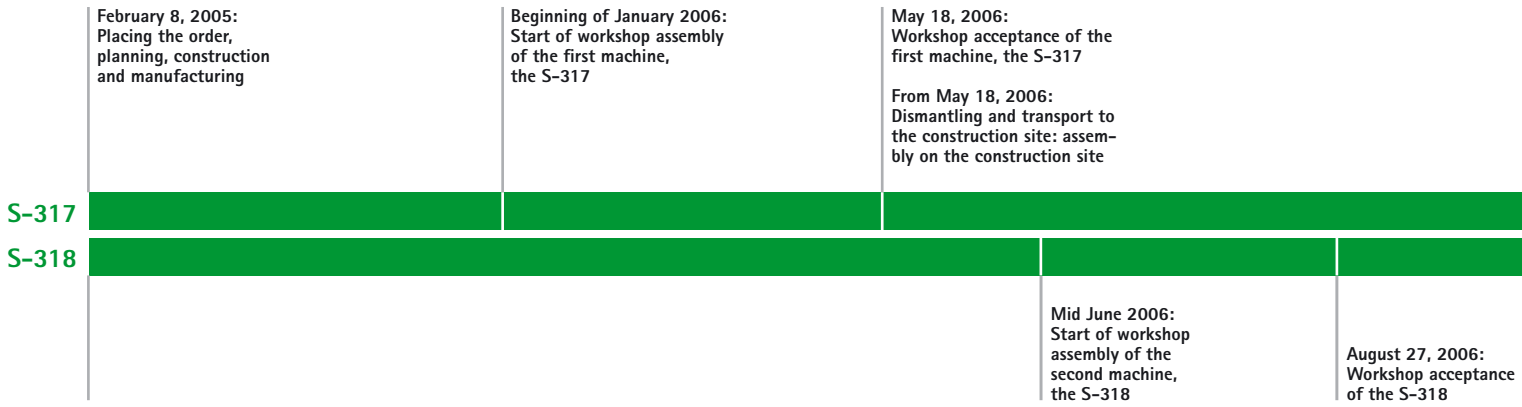




DIAMETER 15.43 METERS: THE LARGEST TUNNEL BORING MACHINES IN THE WORLD. FOR THE LARGEST CITY IN CHINA.

On your marks, get set, go! Following workshop acceptance by the client, STEC and Herrenknecht dismantled the S-317 in the shortest time possible and prepared it for excavation at the construction site. The necessary power to drive the 2,300 tonne, 135 meter shield through the ground is provided by the 3,500 kilowatt main drive, which itself weighs 170 tonnes alone. It drives the cutting wheel with its 6 cutting wheel arms, which can be accessed via the rear area of the shield under atmospheric conditions. This means that the excavating tools can be replaced on site even under extreme conditions – maintaining the highest safety standards for the team. Time and cost intensive diving operations can be reduced to a minimum.

The second machine, the Herrenknecht Mixshield S-318 is excavating the second tunnel tube with a distance of 23 meters between center axes. The mission will be over at the beginning of 2009, when the TBMs finally arrive on the Changxing river island. Or even earlier, if everything runs smoothly. We are working on this – with our 30 years of experience, with 7,000 kilowatt overall power and the most modern Mixshield technology.





REQUIREMENTS

SHANGHAI CHANGJIANG UNDER RIVER TUNNEL

2 traffic tunnels for 3 traffic lanes each, service and safety facilities and a potential subway line

Lengths: 7,470m each

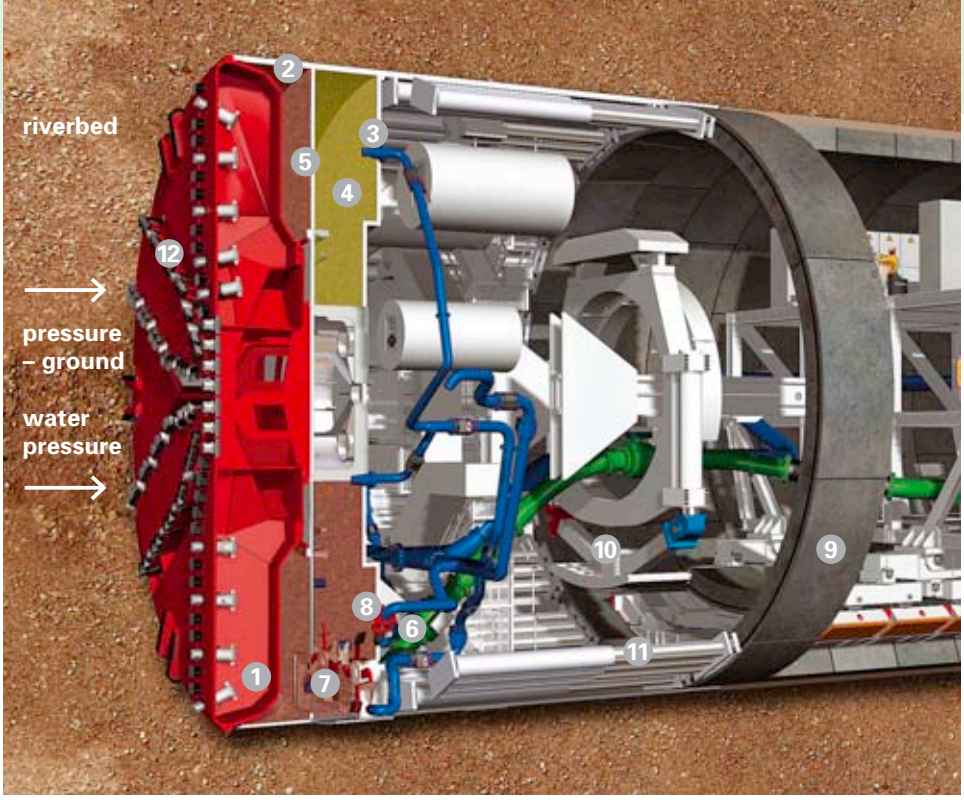
Interior diameter: 13,700mm each

Geology: sand, clay, quarrystones, groundwater

Maximum overburden above the tunnel axis: 65m

Maximum water pressure: 6.5bar

Client: Shanghai Changjiang Tunnel & Bridge Construction Development Co., Ltd.



The tunnelling principle: (1) Behind the cutting wheel with its soft ground cutting tools, there is a steel tube, the shield (2). It offers protection during tunnelling. The space in front of the bulkhead (3) is filled with a bentonite suspension which seals the soil ahead. The excess pressure necessary to support the tunnel face is provided by a compressed air cushion (4) in the excavation chamber, which is divided by a submerged wall (5). The loosened soil is pumped along in the slurry line (green) (6) together with the suspension. The agitator (7) mixes the bentonite-ground mixture for easier removal. The removed suspension is replaced via the feed line (blue) (8). Protected by the shield, the steel reinforced concrete lining segments (9) are positioned by a segment erector (10).

For pre-drilling, the machine pushes off from the last tunnel ring produced, using 57 hydraulic thrust cylinders (11). The gap between the lining segment and the ground is continuously filled with mortar. All activities are controlled from the control panel on the rear backup system. To change the cutter tools, the cutting knives can be reached via the accessible cutting arms (12).



Tool replacement is carried out from the rear via accessible cutting wheel arms.

September 23, 2006:
Start of excavation with the S-317 in Shanghai, tunnelling begins

March 15, 2007:
Tunnel boring with the S-317 at meter 1,326

End of 2008:
Expected breakthrough of the S-317

April 2010:
Expected handover of the two tunnels

Mid September 2006:
Dismantling and transport to the construction site, assembly on the construction site

End of December 2006:
Start of excavation with the S-318, tunnelling of the second tube starts

March 15, 2007:
Tunnel boring with the S-318 at meter 142

Beginning of 2009:
Expected breakthrough of the S-318

Rapid connection via 2 gigantic tunnels with 3 traffic lanes each and comprehensive service and safety facilities.



SOLUTION

S-317, S-318, 2x MIXSHIELDS

Maximum excavation diameter: 15,430mm

Pioneering technology: 6 cutting wheel arms accessible from rear shield under atmospheric pressure.

Installed power: 3,500kW

Total weight: 2,300t

Total length: 135m

Total thrust: 203,066kN

Maximum torque: 39,945kNm



Tunnelling work of the S-317.





Launch shaft of the S-317, S-318 on the banks of the Yangtze river.

GREATNESS TIMES TWO.

The "Shanghai Changjiang Tunnel & Bridge Construction Development Co., Ltd." decided to use high-tech "Made in Germany" to tunnel beneath the Yangtze River and ordered 2 Mix-shields from Herrenknecht. These tunnel boring machines are the largest on the market to date. The machines have been designed in Germany where the main components, such as the cutting wheel, main drive, process technology and hydraulic thrust cylinders are also produced. Following shipment, our joint venture partner "Shanghai Tunnel Engineering Co. Ltd." (STEC) assembled the machines on site at its factory in the Shanghai district of Pudong only 6 kilo-meters from the excavation site.

Mixshield technology to cross the Yangtze River. The two Herrenknecht Mixshields are in their element, working on the 7.47 kilometer-long crossing of the Yangtze. The loose geology and the high water pressure can be kept safely under control with these tunnel boring machines. Mixshield technology is the best solution for long and deep river crossings with large diameters. Their precise controlling of the support pressure avoids subsidence and heave and they forge ahead safely with the tunnel production even with extreme water pressures.



The Mixshield works on the so-called hydroshield principle: an unstable tunnel face is supported by a bentonite suspension – a mixture of clay and water. In this way, ground with high water permeability, mostly sands and gravels, can be driven through quickly and safely, without causing subsidence or heave on the riverbed. At the "stern" of the shield, the so-called shield tail, the tunnel is then seamlessly lined with specially manufactured, reinforced concrete elements (lining segments).

The project: Shanghai Changjiang Under River Tunnel. Two superlative tunnels are currently being excavated. A total of 7,500 segment rings will be built in the two tubes, with an exterior diameter of 15.43 meters each. Each individual ring consists of 10 segments weighing up to 16 tonnes each. 2.7 million cubic meters of ground will be excavated and removed during tunnel boring. One of many challenges for the team of 1,500 people working on the construction site.









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Herrenknecht AG is a technology and market leader in mechanized tunnelling. As the only provider of a full range of services worldwide, Herrenknecht delivers high-tech tunnel boring machines for all ground conditions and with all diameters – ranging from 0.10 to more than 16.0 meters.

Herrenknecht's tailor-made machines create pipeline systems for water and sewage, for gas and oil (Utility Tunnelling) as well as tunnelling systems for car, metro and railway traffic (Traffic Tunnelling) around the world. Our tunnel boring machines are forging ahead with the world's longest railway tunnel and the largest metro lines. They help to cross under water with supreme accuracy and to lay pipelines throughout continents.

Herrenknecht sees itself as a partner in teamwork tunnelling throughout the entire project. Comprehensive services for all aspects of tunnel boring activities complement our range.

The Herrenknecht Group employs more than 1,800 people and has more than 30 subsidiaries and associated companies working in related fields, e.g. in logistic solutions or deep drilling systems.

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