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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 19.0 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 pipe-lines throughout continents.

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

The Herrenknecht Group employs almost 2,500 people and includes 49 subsidiaries and associated companies working in related fields, e.g. in logistic solutions or deep drilling systems.



**NEW MILESTONE: BIG SUCCESS IN SHANGHAI.
THE WORLD'S LARGEST TUNNEL BORING MACHINES
CROSSED BENEATH THE YANGTZE RIVER.**

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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. The planned eco-city will be built according to the strictest environmental standards. Dongtan 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 SIIIC 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, running from Changxing Island to Pudong district, need to be opened to traffic in time for the World Expo 2010 that will be hosted by the Chinese mega city. 600,000 Changxing Island inhabitants desire faster access to Pudong District, since the ferry ride takes approximately 1 hour. Together with these two tunnels, a bridge from Changxing Island to Chongming Island will complete the connection in the Yangtze delta, as part of the planned "Hu Chong Su Traffic Line"

The largest Tunnel Boring Machines worldwide. Herrenknecht provided two 15.43 meter diameter Mixshields to excavate two 7.47 kilometer-long parallel tunnels, which cross beneath China's largest river, the Yangtze. The Yangtze River is one of the country's busiest waterways. To avoid impediments to vessel traffic, mechanized tunnelling was preferred over an immersed tunnel or bridge construction in the very busy south channel of the Yangtze River. The twin tunnels are located at a depth of up to 65 meters in groundwater-bearing sand, clay and broken rock formations. The multi-functional tunnels will have two levels: the upper deck will be used as 3-lane road tunnel. The lower deck will serve as service and rescue tunnel. The long-term objective is to also use the lower deck for metro traffic by integrating the Shanghai Rail Transit Line 9.

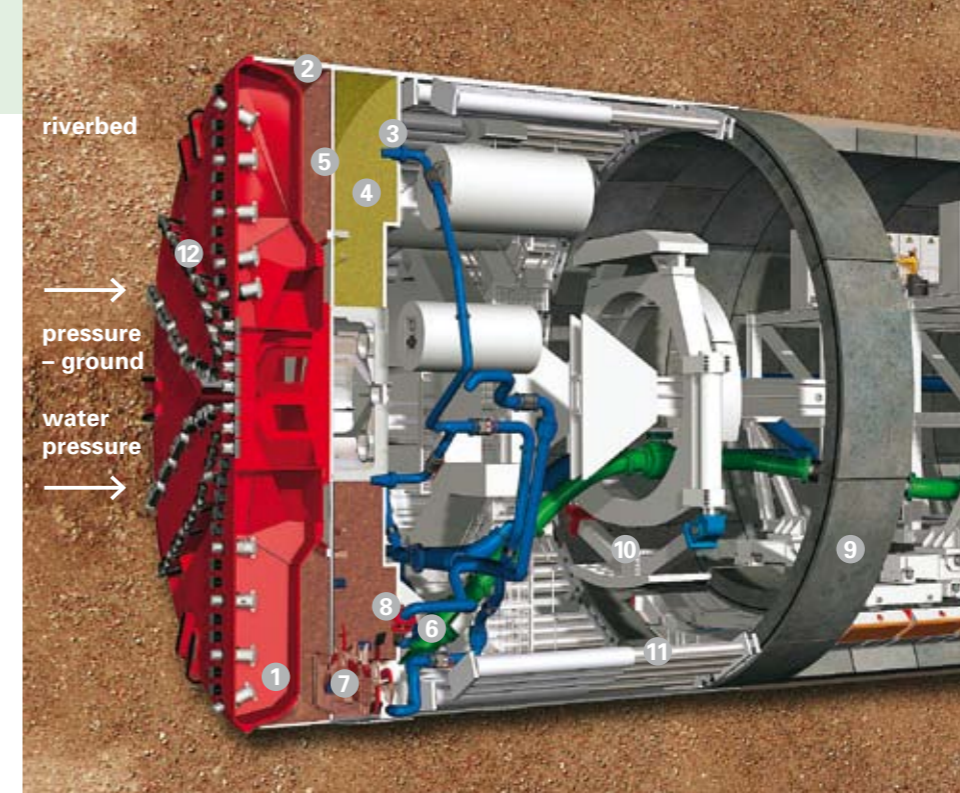


DIAMETER 15.43 METERS: THE LARGEST TUNNEL BORING MACHINES IN THE WORLD. FOR THE LARGEST CITY IN CHINA.

On your mark, get set, go! From workshop assembly to acceptance, from dismantling to jobsite commissioning, everything went rapidly and smoothly – just as scheduled. The two machines started tunnelling between Pudong and Changxing Island in September and December 2006.

The necessary power to drive the TBM with a weight of 2,300 tonnes and a length of 135 meters through the ground was provided by a 3,500 kilowatt main drive, which weighed 170 tonnes alone. The cutterhead with its 6 cutting wheel arms can be accessed via the rear of the shield under atmospheric conditions – allowing for cutter changes under extreme conditions and ensuring the highest possible safety standards on the machine.

The Herrenknecht Mixshields excavated two tunnels with a distance of 23 meters – measured between center axes – and operated at a pressure of 6.5 bar. The TBM achieved top performances of 26 meters per day, 142 meters per week and 556 meters per month. The tunnel boring machines each drove a 7,472 meter long tunnel beneath the Yangtze river, underpassing dikes and a residential area with low overburden, with downtimes of maximally 6 hours. The first machine broke through a year earlier than scheduled after a construction period of 20 months. The second machine reached its target 10 months ahead of schedule. The tunnels have a vertical deviation of less than 2 centimeters and a horizontal deviation of less than 2.7 centimeters.

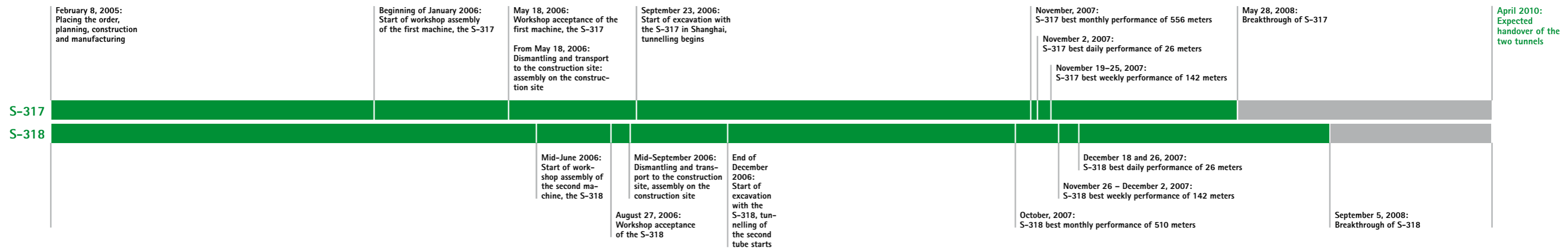


The tunnelling principle: ① Behind the cutting wheel with its soft ground cutting tools, there is a steel tube, the shield ②. It offers protection during tunnelling. The space in front of the bulkhead ③ is filled with a bentonite suspension which seals the soil ahead. The excess pressure necessary to 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.

To move forward, the machine pushes against the last installed tunnel ring produced, using 57 hydraulic thrust cylinders ⑪. The gap between the lining segment and the ground is continuously filled with grout. All activities are controlled from the control panel located on the backup. To change the cutting tools, the cutting knives can be accessed via the accessible cutting wheel arms ⑫.



The cutter exchange is carried out from the rear via accessible cutting wheel arms.



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



REQUIREMENTS

SHANGHAI CHANGJIANG UNDER RIVER TUNNEL

- 2 traffic tunnels for 3 traffic lanes each, service and safety facilities and a subway line
- Lengths: 7,470m each
- Interior diameter: 13,700mm each
- Geology: sand, clay, quarystone, groundwater
- Maximum overburden above the tunnel axis: 65m
- Maximum water pressure: 6.5bar
- Client: Shanghai Changjiang Tunnel & Bridge Construction Development Co., Ltd.



SOLUTION

S-317, S-318, 2x MIXSHIELDS

- Maximum excavation diameter: 15,430mm
- Pioneering technology: 6 cutting wheel arms accessible from the rear under atmospheric pressure.
- Installed power: 3,500kw
- Total weight: 2,300t
- Total length: 135m
- Total thrust force: 203,066kN
- Maximum torque: 39,945kNm



Tunnelling work of the S-317.



Constructed Yangtze river tunnels.



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 Mixshields 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 kilometers 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 soil 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 hydrosshield 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 tailskin, the tunnel is then seamlessly lined with specially manufactured, reinforced concrete elements (lining segments).

The project: Shanghai Changjiang Under River Tunnel. Two superlative tunnel boring machines have completed the world's largest mechanized twin tunnels with a team of 1,500 staff members. A total of 7,472 segment rings have been built in the two tubes, with an outside 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 have been excavated and removed during tunnelling.