

**MASTERLY PERFORMANCE IN MADRID:
KEEPING THINGS MOVING ON THE M-30 HIGHWAY.**

3,650 METERS IN LESS THAN 30 MONTHS.

Spain's traffic successfully goes underground. People in Spain recognized early that only efficient transport systems can lead to a mobile and successful future. That's why Spain has been renewing its infrastructure consistently for years. The transport system is undergoing an unparalleled and comprehensive modernization process. That goes for trans-regional rail lines as well as inner-city subway lines and highways. The best example: the M-30 city highway in Madrid.

Requirement: better quality of life. The Spanish capital is experiencing the largest infrastructure project in its history. Some 8 billion euros are being invested to prevent imminent transport collapse. One of the main focuses in this project is the M-30 inner-city highway. Day after day this artery sees kilometers of jams which block traffic in the city.

The ambitious solution to this bottleneck problem: a highway tunnel with a length of 3,650 meters in the center of the city. This is the only way to avoid constructing a new bridge and an extra highway intersection. And it is the only way to relieve the highly built-up areas of traffic noise and exhaust pollution; and it is also the only way to achieve a better quality of life for the local residents.

The solution: a record-breaking tunnel. Planners have created dimensions which break all previous records: three traffic lanes per tunnel tube, with integrated pedestrian sidewalks on both sides. The developers Acciona Infraestructuras S.A. and Ferrovial Agroman S.A. commissioned Herrenknecht with the construction of an EPB Shield with a diameter of 15.20m – the world's largest tunnel boring machine to date. 30 months were scheduled from the receipt of the order to the completion of the tunnel. Herrenknecht developed and constructed the required machine within 12 months. The TBM titan achieved breakthrough in Madrid well ahead of schedule – after just 25.5 months. A true record-breaking performance: never before had a Herrenknecht EPB Shield of this size completed such a route so rapidly.





Madrid: Demographic growth from 5.2 to 5.8 million within 4 years.

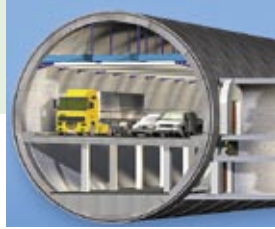
Realization: a huge challenge. The project posed many difficulties. The high-friction ground with layers of clay and solid gypsum required powerful forces. The distance of the planned tunnel tubes to the subway and railway routes is no more than 6.5 meters in some places. Gradients of 5 percent, overburdens of up to 75 meters and pressures up to 6 bar demand the utmost from man and machine. The logistics also set the highest demands: the removal of the excavated material from the ever growing tunnel tube, the organization of the entire construction site infrastructure, including transport – everything had to match the enormous tunnelling performance. But the safety of all workers involved, as well as transport safety and the safety of all people on the sometimes densely built-up area is always given the highest priority.

Conclusion: together we are strong. Madrid's M-30 highway tunnel has been realized ahead of schedule, and there were good reasons for that:

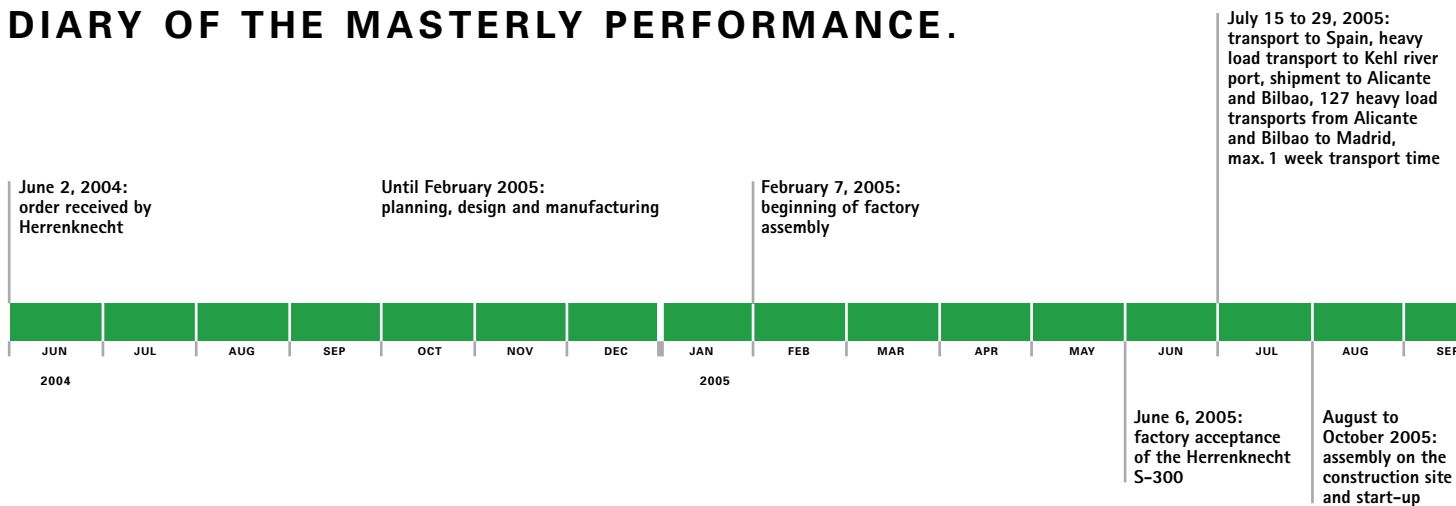
- professional project management with experienced personnel throughout all project phases
- cooperative collaboration with experienced partners in production and transport logistics
- close, partnership-based cooperation with the client and final customer

Madrid can breath easily. The new section of the highway is due to be opened at the end of March 2007. The tunnel and the six-lane extension of the M-30 highway have created completely new dimensions for traffic connections to downtown Madrid. Reducing traffic jams, noise pollution and exhaust fumes while creating more mobility and a higher quality of life for millions of people.





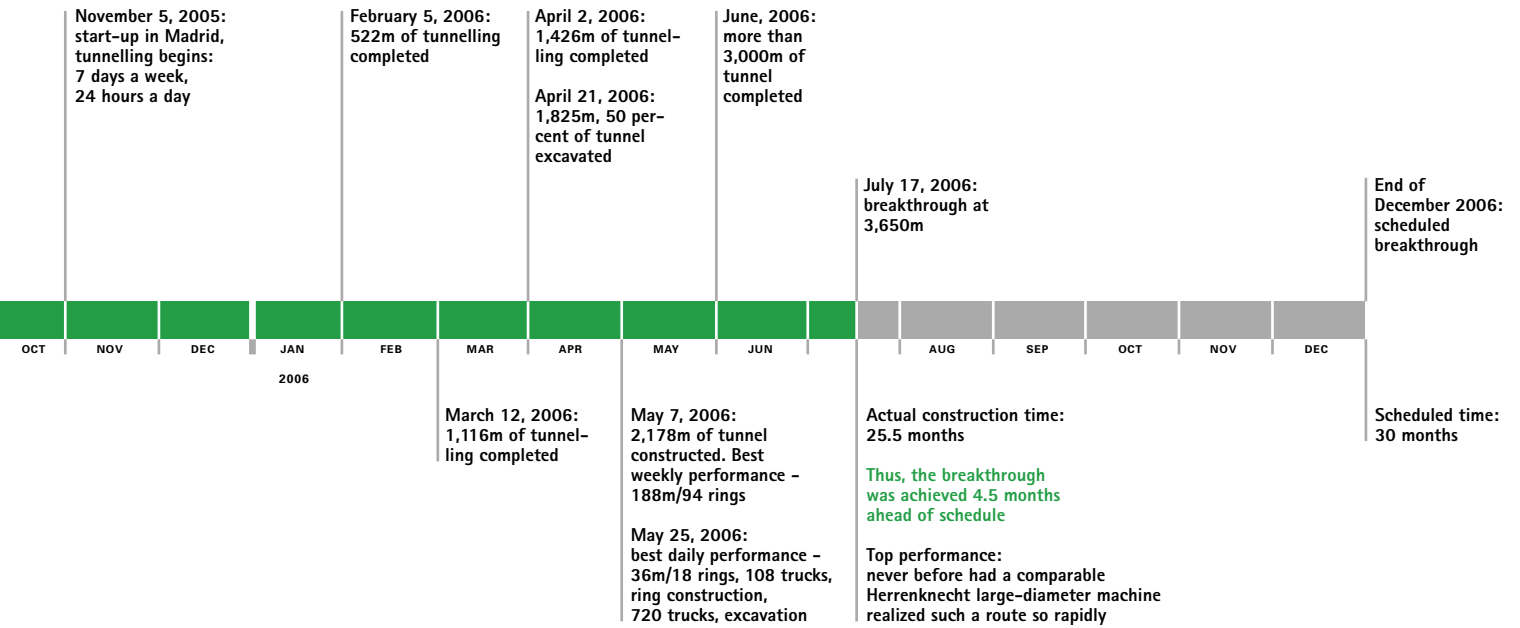
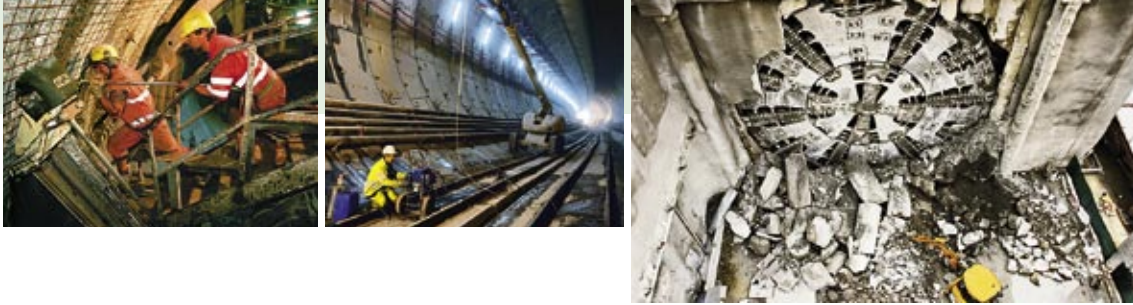
DIARY OF THE MASTERLY PERFORMANCE.



RAPID TUNNELLING: THE M-30 HIGHWAY TUNNEL IN MADRID.

Top performances day after day, around the clock. That is where this 4,364t TBM colossus made in Schwanau began its tunnelling journey on November 5, 2005. The experienced team never had to push the envelope of what was technically possible. The amply dimensioned driving power was enough to drive through Madrid's "underworld" with an impressive degree of constancy.

The deciding factor was its impressive final leg. In just 8 weeks – i.e. a quarter of the construction time – the EPB giant accomplished 1,162 meters, which accounts for a third of the entire route. An average of 100 lining segments were installed every day, i.e. 10 complete rings or more. The minimum weekly performance in this period was 148 meters (74 rings), the maximum weekly performance was 188 meters (94 rings). And every day an average of 60 trucks transported the lining segments and mortar required for the ring installation to the construction site. More than 400 trucks transported the excavated material from the construction site every day to the dumps outside Madrid. The opening of the new, three-lane road tunnel at the end of March 2007 will mean residents along the new M-30 will be able to breathe easily.



REQUIREMENT

M-30 BY-PASS SUR TÚNEL NORTE

Road tunnels for 3 lanes and sidewalk

- Length: 3,650m
- Interior diameter: 13,450mm
- Max. gradient: 5%
- Geology: clay, clay and gypsum, solid gypsum
- Max. overburden over the tunnel axis: 75m
- Minimum distance to next building: 6.5m (subway/railroad route)
- Max. pressure: 6bar
- Contractor: Acciona Infraestructuras S.A., Ferrovial Agroman S.A.

SOLUTION

EPB SHIELD S-300

- Max. excavation diameter: 15,200mm
- Pioneering technology: two independent cutting wheels, three screw conveyors
- Driving power: outer cutting wheel 12,000kW/ inner cutting wheel 2,000kW
- Shield weight: 2,610t
- Total weight: 4,115t
- Total length: 114m
- Jacking station power: 315,880kN at 400bar
- Max. torque: 125,268kNm

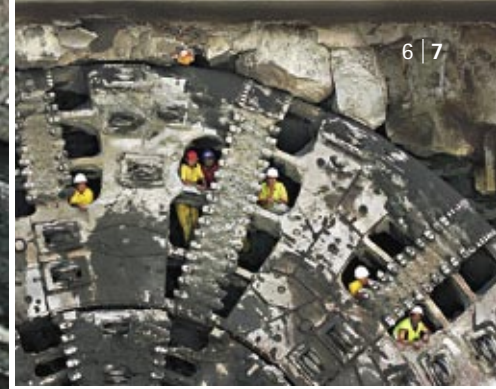




CUTTING EDGE TECHNOLOGY AT WORK: TWO CUTTING WHEELS, THREE SCREW CONVEYORS.

New dimensions require new ideas. The top performance in Madrid is a triumph of teamwork tunnelling and innovation. Herrenknecht developed a completely new cutting wheel concept to master the excavation diameter in this high-friction ground. The S-300 bores with two cutting wheels at the same time, which can be turned in both directions independently of each other. The inner cutting wheel has a diameter of 7 meters, and the outer cutting wheel, mounted in the same working plane, extends the excavation diameter to 15.20 meters. In this way, the huge torque at the start of TBM operation can be gradually introduced into the soil, beginning with the inner cutting wheel as it "hurries ahead". With 125,268kNm the machine provides the largest torque ever installed in a TBM so far. Thus, it can provide enough power to raise a fully loaded Boeing 747 (410t) with a 30 meter long lever.

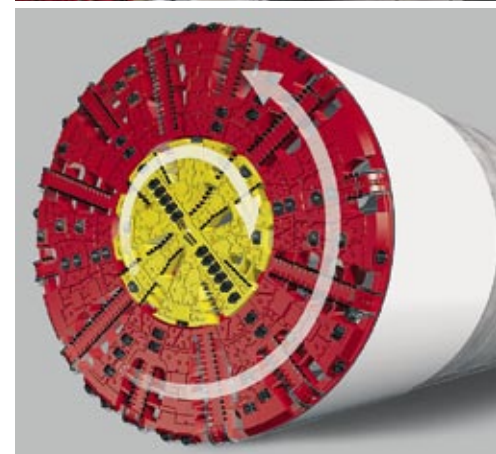
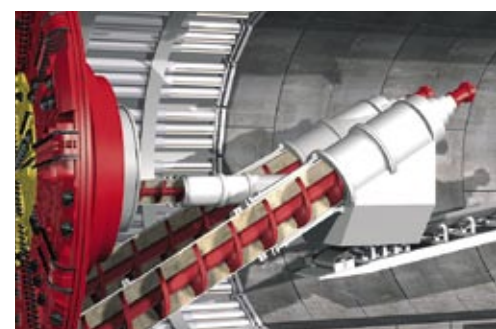
Three screw conveyors set the pace. Three screw conveyors were integrated into the excavation shield to control excavation and to provide safe support for the tunnel face, but also to maintain the high pace of tunnelling. Two large screw conveyors draw the soil excavated by the outer cutting wheel in the lower part of the shield back to the conveyor belt. A somewhat smaller screw conveyor is installed in the lower third of the inner cutting wheel to transport to the back the material excavated there. In this way, with a maximum daily performance of 18 rings, the huge amounts of excavated material can be removed without slowing the pace of tunnelling. This design concept has also proved its great value.



July 17, 2006: breakthrough for the S-300 in Madrid.

Just-in-time logistics. The entire backup organization and ring construction also have to keep up with the pace of excavation. The tunnel conveyor, made by the Herrenknecht subsidiary H+E Logistik GmbH, which was installed in Madrid, transports the excavated material out of the tunnel. Each journey of the tunnel train transports all segments for a complete lining ring into the tunnel. This journey cannot take longer than 30 minutes, including loading and unloading, since in that time the next boring stroke will be completed. In the following 30 minutes the delivered segments are assembled to form a ring. Cycle times of a little more than one hour for one ring with a length of 2 meters have thus made possible top daily performances of 36 meters. For each ring, 5 trucks deliver the segments to the construction site, 1 truck brings the necessary mortar and another 40 trucks transport the excavated material to various dumps.

Legendary right from the start. The Spanish crew named the Herrenknecht Earth Pressure Balance Shield S-300 "Dulcinea" after Don Quixote's imaginary lady-love. Perhaps because they believed this pioneering technology could make the wildest dreams come true? In the end, the construction team and the machine completed their work much more quickly than planned. The champion performances in Madrid once again proved Herrenknecht's competence and efficiency in teamwork with the client. And showed that even the largest diameters can be safely controlled with traffic tunnelling.





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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 36 subsidiaries and associated companies working in related fields, e.g. in logistic solutions or deep drilling systems.

Herrenknecht AG
D-77963 Schwanau
Phone +49 7824 302-0
Fax +49 7824 34 03
pr@herrenknecht.com

