

## Site report

# Tunnel pipes securely anchored

**Putzmeister**

An impressive tunnel building project in Spain's capital, Madrid, is to run the southern section of the heavily used M30 urban motorway under the earth's surface.

A number of Putzmeister pumps have been used here for placing concrete and for backfilling the tubing with special mortar. Pumping distances of 600 m, high air humidity and harsh continuous operation were on the agenda at this mammoth construction site.

The tunnels are being built by a consortium consisting of the Spanish construction firms FCC and Dragados. The planned construction time is 30 months. At the start of work, build costs were estimated at 740 million Euro.

Driving of the two tunnels by machine (3,650 m in the northern bore, 3,550 m in the southern) has now been completed. The consortium has used two of the largest tunnelling machines in the world, built by Herrenknecht and Mitsubishi. Advancing with an EPB shield, the tunnelling machines, weighing over 4,000 tons with up to 160 m of trailing machinery, have bored through Madrid's clay and gypsum subsoil in a boring cross-section of over 180 m<sup>2</sup>. Two-metre wide tubing rings each comprising nine elements and a keystone were set as progress was made.

### 10 fine concrete pumps integrated into the tunnelling machine

While the southern bore was being advanced, six KOV DUO 550 PM pumps with ball valves were used to fill the annular gap between the tunnelling face (15.20 m diameter) and the external radius of the concrete rings (14.65 m diameter). Four further ball valve pumps



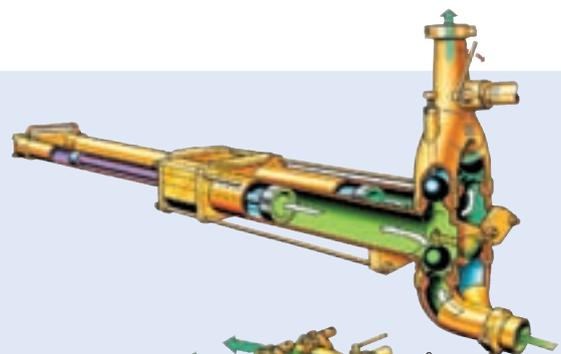
The tunnelling machines for the M30 motorway tunnel have a diameter of over 15 m. Pictured is the tunnelling machine supplied by Mitsubishi Heavy Industries (Photo: MHI / Duro Felguera)

(KOV 1050) were used to transport the mortar material from silos. All ten Putzmeister pumps were integrated on the backup for this purpose. Thus, as the site was working a three-shift system, the

PM ball valve pumps were in use 24 hours a day, seven days a week in 95 % air humidity. The delivery systems ran in a fully automated mode as the tunnel was driven from the centre control room of the EPB.

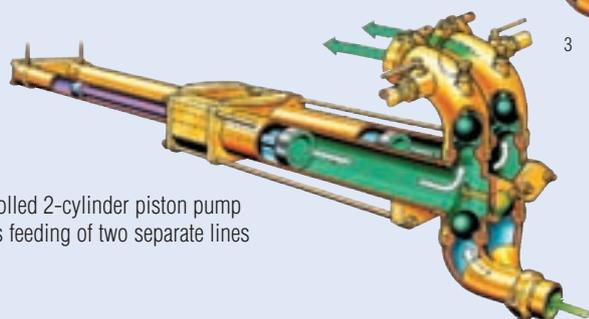
#### KOV

Ball-valve-controlled 2-cylinder piston pump for pumping in a shared line



#### KOV DUO

Ball-valve-controlled 2-cylinder piston pump for simultaneous feeding of two separate lines



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KOV DUO pumps delivered the injection mortar behind the concrete preform

5



Mortar injection pumps ergonomically positioned on the trailing axle of the tunnelling machine

6



Four KOV 1050s were used to transport the mortar from these reservoirs to the actual injection pumps

The KOV DUO double piston pumps each loaded one injection line with each of its delivery pistons to backfill the M30 tunnel pipes. The special silicate-sand mortar (maximum particle size 4 mm) backfilling material was supplied to the KOV DUOs by four similarly constructed KOV 1050s, which drew the backfilling mortar down continuously from two mortar storage tanks. However, on these KOVs the two pistons alternately fed a pump line. The material was delivered 50 m horizontally and 15 m vertically. The delivery pressures of both the KOV 1050 transport pumps and the KOV DUO 550 injection pumps were limited by Putzmeister service engineers because of the low delivery distances to 40 bar and 48 bar respectively. Pressure sensors were also used to ensure that a maximum injection pressure was not exceeded as the annular gap was backfilled.

### Concrete pumps for long distances

The consortium leased a Putzmeister truck-mounted concrete pump with a 42-metre boom from a local pumping service, Ibérica de Bombeos Especiales, for the numerous concreting jobs in the

tunnel. The machine was set up on the surface immediately adjacent to one of the shafts so that it was possible to deliver concrete vertically downwards through the placing boom. The concrete was then supplied through the end hose on the boom tip to a BSA 2109 stationary concrete pump located in the tunnel and also provided by Ibérica de Bombeos Especiales. This ran as a kind of relay station and delivered the concrete up to 600 m through a connected SK pump line. The truck-mounted concrete pump and stationary concrete pump set-up with its pipeline was used a number of times during the construction work.

The two tunnel bores, with an internal diameter of 13.45 m, are sized so that on completion they can accept a carriageway bed with three lanes and two strips at the side. The carriageway bed consists of 60 cm thick pre-stressed concrete prefabricated components which then lie on brackets concreted into the inside of the tubing. The entire ventilation system is accommodated in the roof of the tunnel while there is a service and rescue route beneath the carriageway bed. Cross tunnels connect the two bores every 200 m.

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The long-range concrete pumping was performed by a BSA 2109, supplied by a truck-mounted concrete pump situated outside the tunnel

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The concrete was pumped over a horizontal range of up to 600 m

### The Putzmeister Group

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