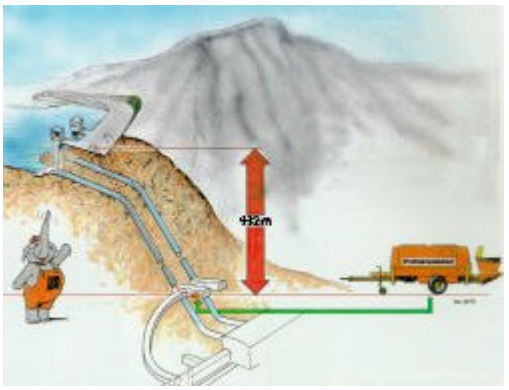
Site Report

432 m highrise concrete pumping in "Estangente-Sallente"



With 432 m pumping height the old Putzmeister world record of 340 m set in 1978 in the Gotthard Tunnel was exceeded by nearly 100 m. In the meantime Putzmeister concrete pumps have achieved over 300 m at several sites. The machine technique first applied in 1977 during Frankfurt world record has proven itself again and again. Lon stroke pumps with the largest possible stroke volume have proven to be very reliable and economical. Fewer piston change-overs at 80-100 bar delivery pressure reduce the wear on all parts, especially on delivery line fixtures. Up to now Putzmeisters' highest achievements have not yet been beaten.

The World Record Pump BSA 2105

With the new generation of Putzmeister high pressure pumps, Putzmeister had set themselves a new record challenge. At the power station Estangento Sallente, in the Spanish Pyrenees, concrete had to be pumped up to a height of 432 m. The standard concrete pump BSA 2105 which was used had a delivery cylinder diameter of 180 mm in combination with 140 mm bore hydraulic cylinders, fed from the bottom side. This resulted in a pressure ratio of i=1.7, i.e. with 350 bar oil pressure, an effective concrete pressure of over 200 bar was achieved in conjunction with the largest stroke volume which has ever been effectively used in high pressure concrete pumps. Of special importance is the fact that Putzmeister machines so easily generate the required pressure in the delivery line. This is possible due to the well proven high pressure transfer tube and the special hydraulic control developed by PM, which prevents pressure peaks and produces extremely rapid piston changeovers, thus keeping the gaps in the material flow to a minimum. It also achieves a fantastic volumetric efficiency of 90% (actual figures) at effective delivery pressures of 130-170 bar. These values, which up to now were believed not to be possible, have been achieved and documented for the first time.

Why was this Record set in the Pyrenees?

Originally it was planned to pump the concrete down to the two pressure points of the pump storage power station Estangento Sallente from a height of 2200 m. However, in order to save costs and avoid having to use the cable car - as material and machines would have had to be taken up to a height of 200 m - the site management decided to pump the concrete from below. Initially a 4 year old BRA 2108, which was owned by the company Dragados, was used. This machine was not built for high pressure pumping. However an astonishing height of 340 m at effective concrete pressures of 100 bar was achieved. Putzmeister then made available the new BSA 2100 with S-tube in order to test the performance of this system.

The Delivery Line System to go with the Pump

A 125 mm dia. Putzmeister ZF-high pressure delivery line was used which was carefully laid by the responsible engineers. A hydraulic PM gate valve was installed directly after the pump. For cleaning purposes the outlet connection could be coupled to a cleaning line and then swivelled over the truckmixer hopper. After finishing work, the concrete was forced back from the top with compressed air and could thus be collected and taken away very quickly.

The Importance of careful Concrete Preparation

The available aggregates were crushed granite, granite sand and washed out sharp fine river sand. The concrete had to have a certain flow behaviour and stability so that it could satisfactorily fill every cavity without vibrating after it had been filled into the top cirular areas of the 47° sloping pressure shaft. It had to flow freely and without bleeding down the inclined surface. This special flow behaviour was first tested on a similar sloping ground and then adjusted accordingly. In the pan positive action mixer at the central station, 0.7% Sika Plastiment E 90 was added (in relation to the cement), which resulted in a slump of approx. 14 cm. This was tested from every truckmixer. The mix design of the concrete per m³ was as follows:
506 kg granite, 12-25 mm
362 kg granite, 5-12 mm
655 kg granite sand, 0-5 mm
350 kg river sand 0-3 mm
211 kg cement
90 kg fly ash
183 litre water total

The slump of concrete without Plastiment was 8 cm. A strength of 200 kg per cm² was reached after 28 days. High strength was not required. During the high-rise pumping the concrete lost approx. 4 cm slump, i.e. was stiffer at the top end of the delivery line and its temperature increased by approx. 2° C. The pumping stages ranged from 70-120 m³ at outputs of 20-30 m³/h. The pressure during continuos operation was approx. 130 bar. When the concrete was pumped to the height of 432 m, a delivery pressure of 150 bar was measured in the delivery line 1 m after the pump. The static pressure was 105 bar and hydraulic pressure 280 bar. With the engine running at full capacity the output was still 21 m³/h. Trials were carried out after the pump had pumped consistently and without any problems and all the concreting work was finished with higher pressures and without super plastisizer. Then the concrete had only a slump of 14 cm (45 cm spread) and the delivery pressure rose to 170 bar with an oil pressure of 300 bar. Despite this fact, the machine worked consistently and there were no problems with the delivery line. The pump had not yet reached its pressure limit, but the engine was working with full capacity. As there were no other possibilities to pump higher and the shutterings were already full the high-rise pumping was finally successfully completed.

The pump has proven that high pressure pumping can be astonishingly easy. The correct choice of pump and delivery system and strict application of the PM site experience is therefore crucial.

The decision to concrete the delivery line into the space between wall and shutters was correct and proved to be very economical.
For safety reasons, two climbing delivery lines, one as a standby, were installed next to each other. In fact the second was only used as a feed line for compressed air and sold later to the contractor for an additional cable duct.

All the above has contributed to the new record in high-rise pumping. The old record which had lasted for 10 years was by far exceeded. It now stands at 432 m height with a total delivery line length of 630 m, 125 mm dia. The incredible achievement of the Putzmeister BSA has created enormous interest not only amongst the participating work team but also amongst the many concreting experts in Spain.