

Aiming high with pumping solutions

Pumping concrete is an established and important method of placing concrete, often in locations deemed virtually inaccessible such as the upper floors of high-rise buildings. But it requires careful preparation, the correct equipment and a mix design with special properties says Jasen Gauld of Hanson Concrete.

Hanson Concrete supplied the lightweight concrete for Heron Tower, Bishopsgate.

For long-distance pumping – both horizontal and vertical – the concrete design must complement the correct pump and the suitable diameter of steel pipeline being used. Specialist concretes, such as lightweight concrete, will need a particularly robust design to produce a consistent material that will flow under pressure for the required distance.

There are numerous advantages to pumping concrete. Large volumes can be delivered successfully to a variety of points over a wide area that would take much longer to place by alternative methods (for example crane and skip) or prove inaccessible for direct discharge from a truck mixer. As a result, a large proportion of ready-mixed concrete for high-rise construction is pumped.

A concrete pump consists of a receiving hopper, a pumping chamber and a discharge point to the pipeline. The receiving hopper is covered with a grille, which shields the agitator and a non-return valve mechanism. The concrete passes through the grille and is directed from the receiving hopper to the pipeline by reciprocating rubber pistons, powered by hydraulic rams inside two parallel delivery systems. A swinging pipe arrangement will bring the concrete to each cylinder in turn, avoiding loss of pressure and reducing back pressure.

The pipeline consists of a number of steel pipe sections at 125mm or 100mm diameter that lead to a flexible hose to dispense the concrete. Pumps are available with varying piston diameter, stroke length and hydraulic systems giving different pressure capabilities and outputs.

Assessment

A pumpable concrete must be homogeneous with the correct consistence or flow class. For certain specialist concretes an assessment might be determined by slump flow, based on a local and site-specific test arrangement.

Concretes that pump very well are those that generate less friction against the pipeline and pump at reduced pressures. The concrete must be able to receive and transmit the applied pumping pressure to overcome resistances in the pipeline. Of all the constituents in concrete only water is pumpable in its natural state, so it is water that transmits the pressures to the other components, making its controlled and uniform presence essential to the overall design.

Fundamentally, the pressure at which the segregation of the concrete occurs must be greater than the pressure needed to pump it. To prevent segregation, the void spacing between the successive aggregate sizes needs to be tight and consistent with the required proportion of the finer constituents. The void spacing in the concrete needs to be small enough to ensure that the





Pumping to the 41st floor of Heron Tower.



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cohesion within the design overcomes the resistance of the pipeline. The appropriate free water content must be retained under pressure and cannot be driven or locked away into a material (such as sintered fly ash) and so prevent the transmission of the exerted pumping pressure. Conversely, if the proportion of finer constituents is too high, the frictional resistance of the concrete (through adhering to the inside surfaces of the pump and pipeline) can become greater than the pressure being exerted by the pump piston through the water phase. Where the pump pressure is not sufficient to move the mass of concrete, the concrete will get stuck in the line, until either a greater pressure from the pump piston can be exerted or the frictional resistance of the concrete is lowered subject to the specified mix design constraints.

Lightweight high-rise pumping solution

Over 6000m³ of an LC35/38 lightweight concrete has been successfully pumped at Heron Tower, 110 Bishopsgate, London EC2. The concrete was supplied from Hanson's Kings Cross plant, backed up by Victoria

Deep, Blackwall. Heron Tower will be a state-of-the-art concept building, reaching 46 storeys and 202m, providing office and retail accommodation along with a restaurant and sky bar. On completion in 2011 it will be the tallest building in the City of London, reaching 230m with mast.

The lightweight aggregate used is a sintered fly ash (Lyttag), which has an extensive and proven track record. The aggregate pellets can absorb water during pumping, resulting in a potentially dangerous loss in consistency. At both Kings Cross and Victoria Deep, Hanson has taken steps to avoid this problem through prolonged soaking and storage of the Lytag up to the point of batching. This means pumping distances using this type of aggregate are far extended.

The mix design has also benefited through using admixture technologies provided by BASF built on the 'synthesis of key performance and yield'. The chemical admixtures provide added control to the viscosity and the homogeneity of the material and impart structure to the liquid phase of the concrete, preventing bleeding and segregation. The admixtures also aid the fluidity of the concrete.

The material also benefits from the use of a superplasticiser that maximises dispersion of the cementitious particles. The particular superplasticiser also delays the absorption of its molecular structure onto the cement particles, allowing them to be dispersed more efficiently over a longer period and to leave space on the cement grain surface to allow for the later rapid hydration, which results in early strength development.

Quick and easy delivery

A large proportion of ready-mixed concrete is transported on site by pump each year in the UK. This method allows large volumes to be delivered quickly and easily, provided the concrete design complements the correct pump, appropriate operating technique and pipeline. Hanson's considerable experience in producing both conventional and specialist concrete mixes suitable for long-distance pumping is well recognised and has helped to reinforce its proven track record for providing concrete solutions for a range of difficult environments. ●

A Hanson truck mixer at Heron Tower. The operator awaits site instruction to discharge lightweight concrete.

