Cementation

SKANSKA

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CTRL Stratford Box Contract 230

Largest ever UK diaphragm wall station box with plunged columns

Client
Union Rail

Main Contractor
Skanska UK

Engineer
Rail Link Engineering (RLE)

Stratford International Station will become the major international station interchange in the east of London. Trains arriving there from continental Europe will eventually be able to choose between the London terminus at St Pancras or a direct onward journey to the Midlands, the North and Scotland. The massive international station is also seen as the trigger for a huge regeneration of this semi-derelict industrial wasteland.

Owners Union Rail awarded the contract to build the gigantic, 1075m long and 24m deep, underground station to Skanska Construction with partners Cementation Skanska - the engineering design being provided by Rail Link Engineering. The construction package was let under the new Engineering Construction Contract (ECC) - with the project a model for the partnering approach to construction.

At £30 million, the foundations package is the largest yet awarded in the UK, and as such represented one of the more demanding challenges taken on by UK foundations and ground engineering specialist Cementation Skanska.

Cementation was able not only to mobilise its Rickmansworth Head Office expertise, but also its long-established and widely experienced manufacturing and plant base in Doncaster, Yorkshire.

The main element of the package was a 65,000m² in situ reinforced concrete diaphragm wall - forming the retaining walls for the underground box housing the new Station - which was excavated up to 24m below ground level.

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The diaphragm wall was between 25m and 31m deep, 1.2m and 1.5m thick, and was constructed as a series of panels 2.8m to 7.5m in plan length, to form a continuous water-tight structural wall. The panels were carefully aligned to avoid steps or 'joggles' in the wall using steel 'stop-end' formers - which were designed to facilitate the positioning of a full depth (ie. 25m to 31m) rubber water-bar at each construction joint.

Ground conditions at Stratford were variable - the sequence could be simplified as essentially soft clays and silts overlying the very dense abrasive Thanet Sands. In diaphragm walling terms these are two very different soils requiring very different digging techniques. For the softer upper strata, Cementation opted for the use of rope-suspended and hydraulic grabs mounted on modern hydraulic Liebherr base units. Grabbing, as the name implies, removed the ground in large 1.5m³ bites of the grab jaws and deposited the spoil in the attendant dump truck for removal to the on-site Land Raise operations. Bentonite mud (a suspension of sodium montmorillonite in water) was supplied to the trench to replace the excavated material and provided support to the side walls of the excavation.

Thanet Sands are altogether different; difficult to penetrate by grab, Cementation opted to mobilise 3nr reverse-circulation hydraulic Bauer hydromills which milled their way through the ground, using two powerful revolving wheels bristling with tungsten carbide cutting teeth. The excavated material was 'thrown' into suspension in the bentonite mud, pumped to the surface and into a 350m³ per hour Bauer de-sanding/ de-silting bentonite cleaning unit - which removed the silt and sand, and supplied 'clean mud' back to the excavation. Logistics planning in moving machines around efficiently - using both digging techniques for each and every panel - became an essential ingredient to the successful delivery of the project.

The 12,500 tonnes of reinforcing steel was being supplied by Express Reinforcements; cages for the

diaphragm wall were fabricated on horizontal 'beds' adjacent to the line of the wall. At steel densities of up to 200kg/m³, individual cage weights were as high as 50 tonnes. Lifting these cages from the horizontal to the vertical, to allow the cage to be lowered carefully into the excavated panel trench, required 2nr 135/165 tonne crawler cranes lifting in tandem - under the command of an experienced Crane Coordinator.

With a predominance of 50mm reinforcing bars, lead-in order times are critical. Ancon CCL Bartec couplers were used extensively to connect the main reinforcement. This avoided what would have been unacceptable steel densities at lap positions.

With such high steel densities, concrete flow through the reinforcement during casting of the diaphragm wall could have been a cause for concern. A self-compacting high slump 40MN/m² strength diaphragm walling concrete was therefore specified by Cementation, with a 600mm-700mm flow table range. Readymix Concrete expert Tarmac Topmix supplied the 85,000m³ of CIIIB (p/hsb - slag replacement) concrete with a minimum cementitious content of 380kg/m³, from 2nr 'wet-batch' pan mixers. The main supply was a site-based 110m³/hour, 2.5m³ batch Elba unit, with back up from the existing plant at Bow. All loads were slumped at the panel, prior to placing, to meet Quality Control requirements.

Innovation is a leading driver in the Cementation philosophy; the design of the station box called for 20nr water-tight movement joints - providing for movement in all three planes, over a target design life of 120 years. Cementation delivered the design and manufacture of pre-stressed steel/rubber composite joints, which could readily be inserted into the diaphragm wall panel during construction.

Other challenges included adapting diaphragm walling techniques to construct 30m deep panels in 12.5m headroom below high-voltage power supply cables, and for working next to live railways.

Cementation Skanska also installed 100nr 1.5m diameter, low cut-off, plunge-column, base-grouted, bored piles - drilled under bentonite, using an innovative adaptation of its patented 'Cemloc' system for accurate positioning of plunge columns for top-down construction techniques.

Safety and the management of safety is a major ingredient for a successful project; Cementation worked alongside Main Contractor Skanska and Engineer RLE in improving site behaviour and safety awareness.

Cementation achieved over 250,000 man hours without a reportable accident on site. At the same time, a rigorous Self-Certification system was employed to manage quality issues. Construction of the diaphragm wall commenced in July 2001, at the two ends of the station box. These were completed first to provide the launch chambers for the tunnelling machines for the two adjacent contracts.

The diaphragm wall was completed in October 2002 and the finished station followed in 2004.

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