Evening Talk on "Reclamation for the Tanjung Bin Power Plant"

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Figure 1: A bird's-eye view of the project site as of January 2005

This talk was given by Engr. Tony Barry and Engr. Sridhar Krishnan at The Institution of Engineers, Malaysia on September 28, 2005. It focused on three key geotechnical aspects of the US$ 1.5 billion coal-fired power plant project in southern Johor: the reclamation and soil improvement works; the offshore and onshore piling works; and the deep excavations. The Tanjung Bin Power Plant, owned by Malakoff Berhad's subsidiary, Tanjung Bin Power Sdn. Bhd., is the largest Independent Power Producer Coal-Fired Power Plant in Asia with an installed power capacity of 2100MW. The engineering, procurement and construction contract for the plant was awarded in July 2003 to a consortium of the Sumitomo Corporation and Zelan Construction Sdn. Bhd. Work began in September 2003 and is on schedule for phased completion between mid-2006 and mid-2007.

The reclamation and soil improvement works were awarded in February 2003 to Van Oord on a design/build basis. It was gathered from material presented at the talk that the scope of these works included:

- Design and detailed engineering, to achieve specified Performance Objectives at specified Guaranteed Final Acceptance Dates. The key performance objective was to ensure that 9 0 % of final primary consolidation s e t t l e m e n t s occurred at loads attributable to sand fill platform at specified elevations.
- Dredging, transporting and placing of approximately 7 million cubic meters of sand, in order to reclaim approximately 80 hectares of land. The sand was dredged by trailing suction hopper dredgers from an offshore borrow area located approximately 75 nautical miles from the project site and placed through floating and shored-based pipelines. The average rate of sand filling was 300,000 cubic meters per week.
- Installation of approximately 22 million linear meters of prefabricated vertical drains, spaced 1 meter apart on a triangular grid. Three types of vertical drains were installed in a world record time of 102 days using a mixture of static and hydraulic rigs. At an average installation rate of 30,000 linear meters per day per rig, the hydraulic rigs outperformed the static rigs by a factor of between 3 and 4.
- Installation and monitoring of soil instruments, including inclinometers, settlement gauges, deep datum magnetic extensometers, pneumatic piezometers and open standpipes.
- Performing soil investigations, including trial pits, Piezocone Tests, Vane Shear Tests, deep boreholes, undisturbed (piston and tube) sampling and laboratory tests.
- Dredging, transporting and disposal of 2.3 million cubic meters of soft clay, to provide a berthing basin and approach access for Capemax-size coal carriers.

An especially interesting part of the talk focused on the limitations of Asaoka's observational procedure for settlement prediction, which was the procedure specified for assessment of compliance with the performance objective for settlements. Two important limitations arised from the time-varying surcharge loading that occured as a result of settlement of the fill below the static groundwater level and drawdown of transiently elevated water levels within the sand fill; and the concurrent occurrence of secondary consolidation settlements with primary consolidation settlements. It was therefore necessary to assess the ability of Asaoka's observational procedure to reliably predict final primary consolidation settlements under the applied surcharge loading through an extensive validation study using methods that ranged from the basic Terzaghi One-Dimensional Consolidation Theory and Barron Theory through to the more sophisticated Koppejan Incremental Model and PLAXIS Finite Element Code. Those interested in learning more were encouraged to read the paper "Reclamation for a Power Plant in Johor, Malaysia" by Barry *e.t.al* published in the proceedings of the 15th Southeast Asian Geotechnical Conference, 2004.

It was learnt that the project piling works included the installation of:

- Over 14,000 raked and vertical pretensioned high strength spun concrete piles of diameters ranging from 400 to 1,000mm;
- Bored cast-in-place piles of up to 1,200mm diameter to support heavily-loaded, settlement-sensitive and dynamically-sensitive structures such as the turbine generators, boilers, bunkers and chimney;
- Raked and vertical high strength steel pipe piles of 914mm diameter to support the coal-unloading jetty; and
- Micropiles up to 250mm diameter to support lightly-loaded structures such as pipe racks and cable trays and also where access restrictions and vibration issues were concerns.

The design and installation criteria for piles were determined based on a comprehensive pre-production pile load testing programme that included high-strain dynamic testing and static axial and lateral load testing. These criteria were regularly reviewed to ensure continued applicability by means of extensive high-strain dynamic testing and limited static load testing on production piles.

Another interesting aspect of the project was the opportunity to monitor ground movements of three deep sheeted and strutted excavations that were nearly identical in geometry (60m x 15m x 10m), soil profile, water pressure profile and surcharge loading. Lessons learnt from each excavation were used to refine and revise construction methods to minimize ground movements and limit detrimental movements to adjacent structures.

The talk was followed by a lively hour-long question-and-answer session, with active and enthusiastic participation from the audience that numbered over a hundred. The questions ran the gamut from the form of contract for the reclamation and soil improvement works, quality control of fill material, further settlement of the reclaimed land and finite element modeling through to the magnitude of drag loads on piles and the connection of steel pipe piles to the jetty deck. Such was the interest in the talk that members of the audience were seen talking to the speakers long after the close of the question-and-answer session and even beyond the vote of thanks and memento presentation events that marked the formal end of the session.

It was indeed heartening to note the exceptional turnout at the talk and, if this trend continues, IEM will soon need to consider moving these evening talks to a bigger conference hall! ■

Figure 2: An artist's impression of the 2.100MW Coal-fired Tanjung Bin Power Plant