

Seminar Title: Ground forum on micro-tunnelling in the urban environment
Organisation: AGS (HK)
Speakers: Mr. Leslie Swann, Mr. Jim Benson, Mr. Alan Thorburn,
Mr. Boyd Merret
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Maunsell Geotechnical Services Ltd. (MGSL)
Dated: 12 May 2004 (6:00pm – 8:00pm)
Venue: The University of Hong Kong

Background

Trenchless techniques offer a means of underground pipe installation without the need for temporary open excavation. As a result, this technique significantly minimises the disturbance to the surrounding areas during construction. Pipe jacking or microtunnelling can be used to bore the required underground alignment using a variety of tunnelling shields. Such techniques are not entirely free from open excavation, with the operation requiring a temporary launch and reception shafts at the two ends of the chosen alignment.

Designer's Consideration on Pipe Jacking / Microtunnelling

Mr. Jim Benson of Mott Connell Limited reviewed some design considerations of pipe jacking/microtunnelling. He emphasised the importance of ground investigations and their interpretation. Mr Benson recommended that designers should gather sufficient information from both desk studies and GI works to generate reliable longitudinal sections along the proposed tunnel alignment. The data should be carefully studied to determine the possible types of soil or rock that may be encountered in the course of the tunnelling operation. The designer should then take into account the effect of material properties, thickness and permeability of each geological stratum, as well as the occurrence of corestones, rockhead levels, rockmass characteristics and groundwater tables. In addition to geological information, archival "As-Built" drawings should also be studied to understand the existing foundation and underground utilities along the proposed alignment.

Examples were provided for different situations:- a tunnel-boring machine (TBM) with earth pressure balanced mode can be selected for clay to medium sand stratum having permeability less than 10^{-7} m/s; for the case of medium sand to rock stratum with permeability more than 10^{-7} m/s, a slurry type of TBM can be used.

Settlement may occur as a result of excavation through pipe jacking. To reduce the sensitivity of the ground to settlement, various types of ground treatment works can be implemented including jet grouting, silica/cement grouting, grouting using tube-a-manchettes, dewatering and ground freezing.

Tunnelling at shallow depth may intersect contaminated ground and this may compromise the safe working environment and lead to spreading of the contamination outside the immediate area.. The Designer should research historical maps, previous ground investigations and "As-Built" drawings to investigate the depth and lateral extent of any contaminated ground.

Contractor's View on Challenges and Solutions with Pipe Jacking and Trenchless Works

Mr. Alan Thorburn of Fine Projects Limited presented challenges faced by a contractor during pipe-jacking and microtunneling construction with reference to projects that his Company had undertaken in Hong Kong. On the construction of pipelines at Gloucester Road and Java Road available working space was limited by traffic, pedestrian access and congested utilities. Challenging ground conditions may also be encountered. It is therefore essential to identify a suitable construction method, an appropriate choice of equipment, carefully chosen location of shafts together with skilled operators and crew.

In the course of this presentation, Mr. Thorburn shared his experience on how reclaimed land has posed significant challenges on projects. In particular, the variability of fill material including the occurrence of boulders, underground voids or old seawalls which may not be identified during desk study or site specific ground investigations. This was further emphasised by the pipe-ramming project below Harcourt Road in Admiralty that experienced four months delay due to the encountering of old timber piles at the former shoreline. A recent project at Gloucester Road, Wanchai involving the use of micro-tunnelling (slurry method) machinery encountered unexpected localized underground causing a substantial loss of slurry into the surrounding soil.

The final case shared by Mr. Thorburn was the installation of a 132kV cable at Ap Lei Chau. This involved the construction of a 420m long twin 1800 diameter cable tunnels and associated trenching works. From the information supplied by the Client/Engineer prior to commencement of the works the local geology was shown to compose of predominately Volcanic Tuff with an average strength of 200MPa.. However, unconfined compressive strengths of up to 300MPa were encountered in several of the tunnel drive sections. An Herrenknecht AVN 1800T micro TBM was adopted which included a purpose built rock cutting head in a slurry shield. Although progress was slow in the very strong ground the correct choice of machine meant that the tunnel could be completed.

Mr Thorburn described how unforeseeable conditions may result in programme and cost overrun on trenchless tunnelling works. It was suggested that the risks presented by the variable nature of the ground and the limited access for ground investigation might best be shared with the Designer and/or Client through some form of partnering.

DSD's Wanchai-North Point Project

Mr. Boyd Merrett of Leighton Asia Limited shared his experience on the construction of Wanchai East to North Point Sewerage Works for DSD. The project involves an extensive network of pipe jacking in variable ground conditions. Owing to the congested environment, a significant section of the new sewers were installed by trenchless techniques that included 3.1km of 1800-diameter sewers, 770m of 1200-diameter sewers and 58m of 600-diameter sewers.

Difficulties encountered during construction have included: complex utility diversions, the presence of unexpected voids behind inserted sheet piles at shaft locations leading to flooding and high face pressures and obstructions to TBMs that have disabled the cutter-head's advancement. To optimise advance rates Leighton employed an automated lubrication system around the pipe to closely monitored the build up of friction and make adjustments to the lubricants where necessary. Interjacks can also be implemented at locations where difficulty in advancement is experienced. Mr Merrett recommended that grouting records be reviewed regularly since any susceptible increase in grout volume can be an indication for underground voids ahead. Site supervision and daily logging is also essential, since the excavation rates in voided areas should also be continuously controlled. TBM operation parameters such as rpm should also be frequently reviewed to ensure the equipment and cutter-head is suitable for advancement.

In conclusion, the Ground Forum provided an excellent opportunity for engineers and other geotechnical professional from various backgrounds to understand the benefits and problems of pipe-jacking and micro-tunnelling methods in the urban environment.

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