TECHNICAL NOTE 006

Steel Sheet Piling in Difficult Subsoil Conditions in Tuen Mun Area

Keywords
In-situ tuff, SPT-N value, silent piler, water-jetting, cost/time comparisons

Synopsis
A stratum of in-situ tuff has been encountered in Tuen Mun area during the installation of steel sheet piles (SSP). This layer of clayey materials, having SPT-N values of more than 100, is approximately at 10m below the existing ground, posing substantial challenges to the installation of SSP using traditional method. This technical note presents the SSP installation method adopted – Silent Piler with Jet System – to overcome this clayey layer. Comparisons with traditional and hybrid SSP installation methods in terms of time and cost are presented. When carrying out excavation work in Tuen Mun or other areas having similar subsoil conditions, attention should be given to the time and cost implications described in this note.

1.0 Introduction

Construction Project DC/2009/11 in Tuen Mun entails some deep excavation works. In tender stage, sheet pile walls were proposed as the temporary retaining wall system. In construction phase, different wall types have been further explored to identify a more economic solution.

In consideration of cost, SSP has been selected to form the temporary walls. After some trial installation, it became apparent that some kind of pre-drilling is required to loosen the clayey materials such that the SSP could be installed to the required toe levels.

NB – Traditional SSP installation method using heavy vibratory hammer has been tried. Some SSP were driven to declutching under some 'hard-driving', and yet these clayey materials could not be penetrated through.

2.0 Methods of Installation

The following hybrid SSP installation methods had been tried on site:

i) Aided by GI Rig – A ground investigation (GI) rig had been used to bore holes behind SSP for ease of installation. This method only works sometime, and the outcome was not very predictable. In any situations, this method was terribly slow, giving no programme surety.

ii) Aided by Down-the-Hole Hammer – Holes behind SSP had been sunk using down-the-hole hammer in order to loosen the clayey materials. The result was similar to that of method described in (i).

iii) Aided by Augering – Augering behind SSP had also been tried, and it works only if this was done for all SSPs. The production rate was thus very slow (see table on Page 2).

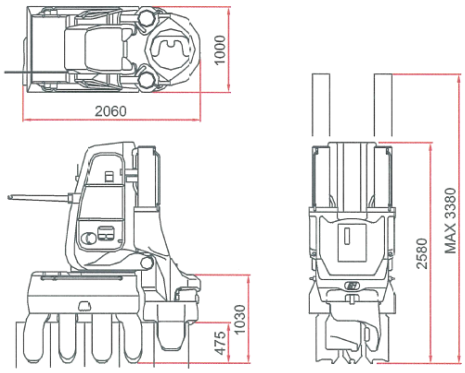
Given the above, the project team at one point had to re-assess the cost implication of using pipe piles as envisaged in the early tender stage since this method appeared to be the only feasible way to get through this clayey layer.

3.0 Silent Piler + Water Jetting

In the midst of re-assessment, the project team had further explored an SSP installation method entailing the use of a piling machine integrated with a water jetting system.

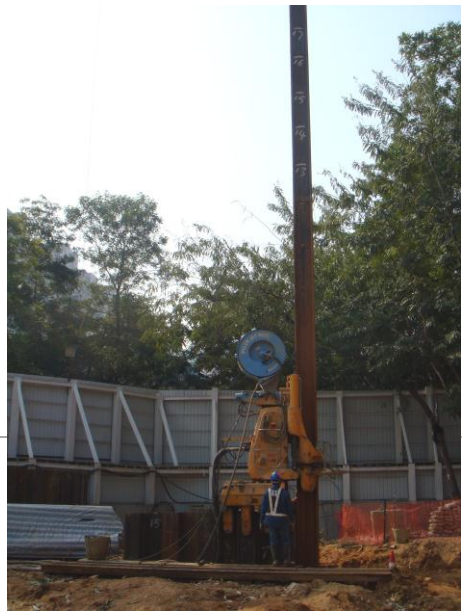
In principle, the SSPs are installed using a 'press-in' machine made by GIKEN (see figure on left). This machine, known generally as Silent Piler, is integrated with a water jetting system.

Upon activation, the high water pressure jetting (see figure below) reduces the pressure bulb at the toe of the pile by temporarily and locally softening the clayey materials (or loosening granular soils as the case may be).



Overall dimensions of Silent Piler

Silent Piler used in DC/2009/11 Project with water jetting system atop (blue)



At the same time, the returning water lubricates the SSP surfaces and the interior of the SSP interlocking. These combined effects reduce the friction and hence enhance the productivity of SSP installation substantially.


A jet lock pre-welded to the toe of SSP for engagement of water nozzle


A high pressure flexible hose and water nozzle engaged in the jet lock

Details of the piling operation are not described in here. It suffices to mention that water pressure can be adjusted to meet operation needs, and the soil parameters disturbed locally by the water jet quickly return to their normal state, which is evident by the adequate reaction force available for pressing-in the subsequent SSPs.

The set up comprises an Engine Unit (diesel engine & hydraulic pump) and a Piler Jet Unit (jet pump and water tank) which take up certain site area. Also, it is desirable to splice the SSP to full length before installation, meaning a fabrication yard might be required.


Silent Piler Engine unit (yellow) and Piler Jet Unit (blue)


Fabrication yard for splicing of SSP

4.0 Cost / Time Comparisons

The actual cost of the piling operation is not disclosed in this technical note. The cost comparison below is thus a relative comparison such that a generic cost picture can be formed. The benchmark cost of steel sheet pile (SSP) walls (Tender Scheme) is set as **'1.0'** for ease of comparison.

The production rate is based on the time (Days) required to install a unit plan length (1m) of temporary retaining wall (20m deep) to the required toe levels in this particular subsoil condition.

Installation Methods	Cost	Production Rate
SSP	**1.0**	See Section 1.0
SSPs with GI Rig	2.5	8 days / m
SSPs with D-T-H Hammer	2.5	4 days / m
SSPs with Augering	4.2	2 days / m
SSPs with Silent Piler+Water Jet	2.2	0.4 day / m

Upon request, the project team would be pleased to discuss more on the information relating to cost, programme and piling operation.

NB – The Slient Piler + Water Jetting system described in this note cannot penetrate Grade IV or better rock. In dealing with this subsoil conditions, another form of penetration assistance called 'Integral Augering' could be of use. Details can be found on website www.giken.com.

Acknowledgement
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