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Special Contribution

Current practice of piling works in Bangkok subsoils 1) Design and practice

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1. INTRODUCTION

The foundation in Thailand, especially in Bangkok Clay, is the pile foundation. The soil condition consists of thick soft to medium clay and encountered with stiff to very stiff clay before reaching the first dense silty sand layer. The hard clay is encountered below the first silty sand and followed by the second very dense silty sand layer. The piling work consists of driven pile and jack-in pile for low rise buildings with pile tip penetrated in the first dense sand layer. The high-rise buildings in Bangkok and elevated expressways, elevated train and MRT subway stations normally use long and large bored pile as well as barrette piles with the tip penetrated in the second dense silty sand layer. This paper presents the current practice of all piling work using in Bangkok.

2. SOIL CONDITION

The Bangkok subsoils consists of 13-16 m. thick of soft to medium clay and followed by a stiff clay layer to about 21-28 m. deep. The first dense silty sand layer is encountered below stiff to hard silty clay. The very stiff silty clay is alternated with the second dense silty sand layer at about 45-55 m. deep. Generally, pile foundations of superstructure are penetrated in this second very dense sand layer. The piezometric level or phreatic surface of Bangkok aquifer is drawdown from -23.0 m. below ground surface in 1995 and increased to -13.0 m. in 2016. Figure 1 presents the geological condition of Bangkok subsoils.

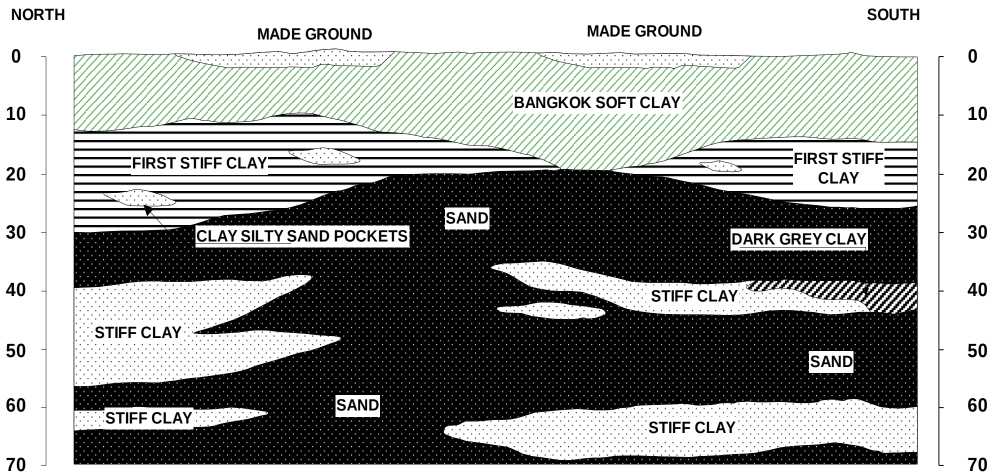

Fig. 1. Bangkok geological condition

3. SHAFT FRICTION AND END BEARING BEHAVIOR OF PILE FOUNDATION

The ultimate pile capacity (Q_{ult}) generally consists of ultimate shaft capacity (Q_f) and ultimate end bearing (Q_b) as follows:

$$Q_{ult} = Q_f + Q_b$$
$$= \Sigma f_s \Delta L P + q_b A_x$$

where
- f_s = Unit pile shaft friction (kN/m^2)
- ΔL = Thickness of soil layer (m)
- P = Pile perimeter (m)
- q_b = Unit end bearing (kN/m^2)
- A_x = Cross section area of pile (m^2)

The unit skin friction (f_s) can be estimated from the following equations

$$f_s = \alpha\, S_u \text{ (for clay layer) and } f_s = \beta\, \sigma'_v \text{ (for sand layer)}$$

where	f_s	=	Unit pile shaft friction (kN/m^2)
	S_u	=	Undrained shear strength of clay (kN/m^2)
	σ'_v	=	Effective overburden pressure in drawdown condition (kN/m^2)
	α	=	Adhesion factor for clay
	β	=	Friction factor for sand

The α and β values can be determined from load transfer curve derived from instrumented test piles.

The unit end bearing capacity of pile (q_b) with pile tip penetrated in the silty sand layer is generally derived from the same approach as follows;

$$q_b = N_q\, \sigma'_v$$

where	q_b	=	Unit end bearing (kN/m^2)
	Nq	=	End bearing coefficient
	σ'_v	=	Effective overburden pressure in drawdown condition (kN/m^2)

The parameters for estimation of pile capacity are α-value, β-value and Nq parameter. These three parameters are depended on pile type and pile length as well as construction method.

4. PILING WORK IN BANGKOK SUBSOILS

Piling work or pile type used in Bangkok subsoils or in Thailand are generally divided into 3 groups as follows;

- Driven Pile
- Bored Pile and Barrette Pile
- Jack-in Pile

4.1. Driven Pile

The driven pile can be divided into 3 subtypes depended on the construction method as follows;

4.1.1 Pure drive.
This is the pile driven by hammer from the beginning until pile tip penetrated or driven into the first dense silty sand layer at the depth between 23-28 m. depended on depth of sand layer.

4.1.2 Auger press with final drive.
This pile is applied to the spun pile with technique of auger and press technique until the pile tip penetrated in the very stiff silty clay layer and stop above the first silty sand layer. The pile is finally driven with hammer until the tip of driven pile penetrated into the first dense silty sand layer as the same layer as pure drive technique.

4.1.3 Auger press with base grouting.
The technique is the same as auger press with final drive state in 4.1.2. but the pile is auger press until the pile tip penetrated into the first dense silty sand layer. The excess pore pressure in the sand layer would increase and rebound. Therefore, base grouting is applied to increase the end bearing capacity. Photo 1 presents the photograph of augering in sand layer. The schematic concept of these all driven piles is presented in Fig. 2.

Photo 1. Photo of augering in sand layer

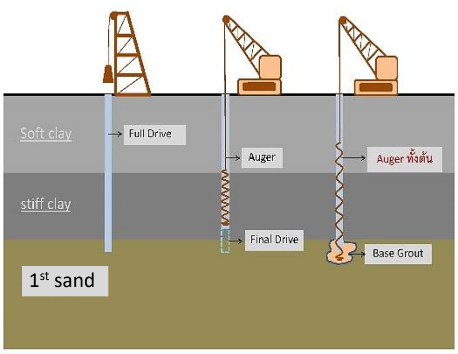

Fig. 2. Schematic concept of all driven piles

4.2. Bored Pile and Barrette Pile

The bored pile is divided into 2 types as wet process bored pile (large and long pile) as well as barrette pile and dry process bored pile (short pile).

4.2.1. Wet process bored pile and barrette pile

Wet process bored pile is the large and long bored pile constructed with polymer base slurry. The construction sequence starts with driving the steel casing to prevent collapse of soft clay. The pile is bored with auger in soft to medium clay until stiff clay layer where bucket technique with polymer base slurry is used as shown in Photo 2. Fig. 3 shows schematic illustration of wet process bored pile. This type of pile is normally used for high-rise building, elevated expressway, elevated train and MRT station.

The barrette pile is the rectangular shape of wet process bored pile which is constructed by excavating grab with bentonite slurry as shown in Photo 3. The capacity of barrette pile is normally larger than the wet process bored pile because of larger size. The research on wet process bored pile and barrette pile is very advanced in order to gain larger pile capacity.

Photo 2. Photo of wet process bored pile

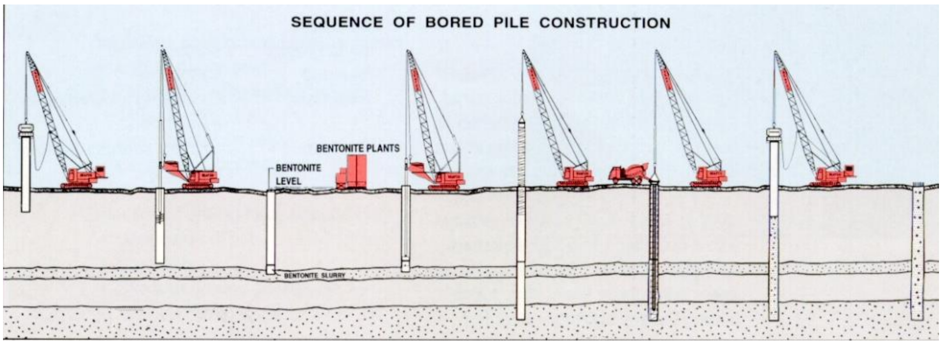

Fig. 3. Schematic illustration of wet process bored pile

Photo 3. Photo during constructing barrette

Photo 4. The schematic technique of dry process bored pile (continued)

Photo 4. The schematic technique of dry process bored pile

4.2.2. Dry process Bored Pile

The dry process bored pile is the small size pile up to 0.60 m. in diameter. The pile tip must stop above the first silty sand layer. The pile length normally varies between 17-20 m. depth. The schematic technique of dry process bored pile is presented in Photo 4. The dry process bored pile is excavated by bucket method.

4.3 <u>Jack-in Pile</u>

Jack-in pile is the pile using pressed in pile technique by pressing the pile with hydraulic jack. This is one of the non-vibrating piling impacts. It can be applied to various pile sizes up to 600 mm. in diameter. It can be penetrated into the first dense sand layer. Photo 5 shows the photograph of jack-in pile machine.

Apart from the above-mentioned driven pile and bored pile, recently, a small type of driven pile (diameter 0.20-0.25 m.) with small driven hammer so-called “micro spun pile” is widely used for remedial work. The driven rig and hammer is small and can be driven in the narrow area with little clearance. Micro spun pile is normally driven every 1-1.5 m. long and is connected with steel collar. Photo 6 shows the photograph of micro spun pile

Photo 5. Photo of jack-in pile machine

Photo 6. Piling work of micro spun pile

5. ADHESION AND FRICTION FACTOR FOR PILE CAPACITY ESTIMATION

The research on wet process large bored pile is very advance and there are many factors to be concerned. The following factors are the example of pile parameters. The adhesion factor for estimating wet process bored pile in Bangkok clay is presented in Fig. 4 (Teparaksa, 2000; Teparaksa, 2008). The friction factor for estimating shaft friction in sand layer with bentonite and polymer slurry is presented in Fig. 5 (Teparaksa, 2015).

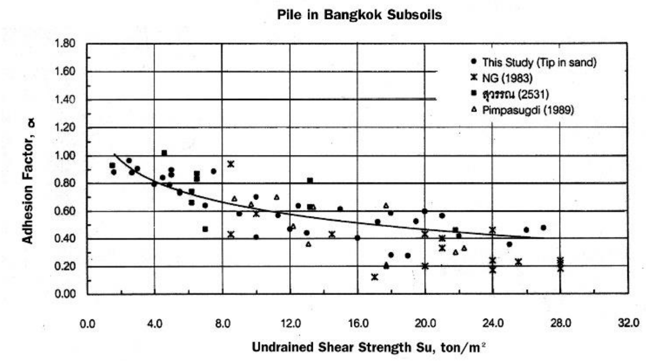

Fig. 4. The adhesion factor for estimating wet process bored pile in Bangkok clay

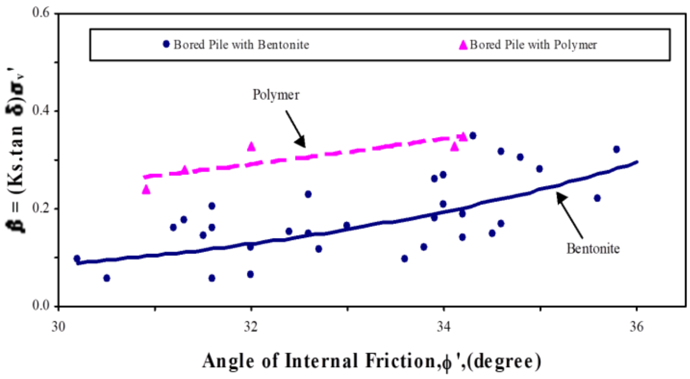

Fig. 5. The friction factor for estimating shaft friction in sand layer with bentonite and polymer slurry

6. REFERENCES

1. Teparaksa, W. (2000): Estimating ultimate capacity of deep bored pile in Bangkok subsoils in line with global research trend. Proceedings of Annual Conference of the Engineering Institute of Thailand, pp. 41-56.
2. Teparaksa W. (2008): Polymer base bored pile in Bangkok subsoils, Key Note Lecture, National Conference of Korean Geotechnical Society, October, Daejeon, Korea.
3. Teparaksa W. (2015): Deep Barrette Pile Capacity with Aging Effect, Journal of Geotechnical Engineering, Journal of the SEAGS and AGSSEA, Vol. 46, No. 2, June.

2) Application examples of Press-in Piling

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Photo 1 Vibro hammer technique

Nowadays, Thailand has being planned to construct many infrastructure development projects especially in the capital city, Bangkok. Bangkok city is located in the lower region of the central part and close to the Gulf of Thailand. The city is covered with thick soft clay deposit (Bangkok soft clay) and it has low bearing capacity. The soft to very soft clay layer is underlain by the medium and stiff clay layer. The first sand layer is located under the above series of clay layers. The bearing capacity of the foundation, the stability of the excavation work and excessive settlement of the earth structure are the problems caused by thick and soft of Bangkok clay.

In urban area, there are inevitable interactions between existing structures and new construction in a congested space. The working space, vibration and pollution become concerned issues to be considered during construction. Sheet pile has been used as retaining wall for underground construction. Vibro hammer technique (Photo 1) is very famous to install sheet pile in Thailand due to budget and quick mobilization. However, this conventional method creates vibration and loud noise. The adverse effect can be minimized by applying press-in technology. Altemtech is one of the frontline companies where it has experience in many projects using Silent Piler.

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Saranrom palace project

One of interesting projects to show the great advantage of press-in technology is renovation of old palace, Saranrom palace. Saranrom palace (Photo 3) is more than 120 years old and it is located on Bangkok soft clay. The palace is a two-storey brick building. The condition of construction site is very sensitive to vibration and noise. In addition, the working area is very narrow where it could not be applied by conventional technique. The narrowest distance between sheet pile alignment and existing palace's wall is 80 cm. (Photo 4). Top of sheet pile needed to be elevated due to existing footing which could not be demolished.

Photo 2 Sheet pile was driven around existing palace

Photo 3 Saranrom Palace after renovation

Photo 4 Silent Piler (AT90 model) and existing of Saranrom palace wall

Aira one project (New building next to infrastructure and neighborhood area)

There is a high rise building where it is located in the central part of Bangkok. This building is called Aira One and it has 27 floors with two basements. The sky-train (BTS Rajthevi station) and Muslim community are located next to the construction site (Fig. 1). Contractor needs to provide space for evacuation from sky-train station. As a result, the sheet pile wall alignment will be very close to the construction fence (Photo 5). In addition, Muslim community has many old buildings with bricks and concrete. The area is concerned with the vibration and loud noise. Press-in machine is suitable with this situation. A tentative sketch building is shown in Fig. 2 and it will start operation in 2019.

Photo 5 Sheet pile alignment and site fence

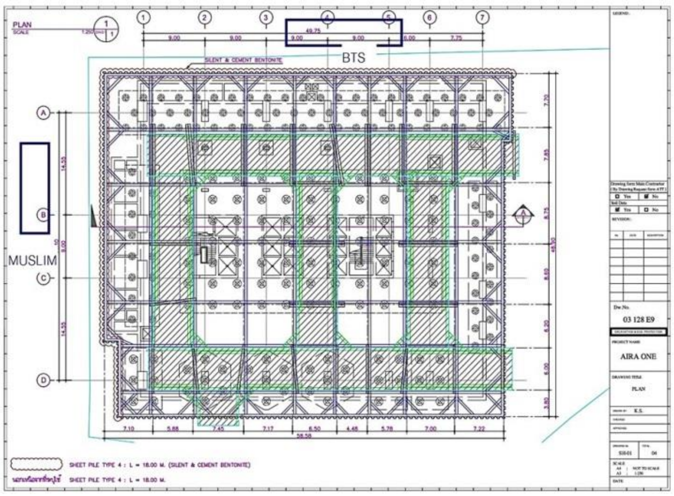

Fig. 1. Sheet pile plan for Aira One project

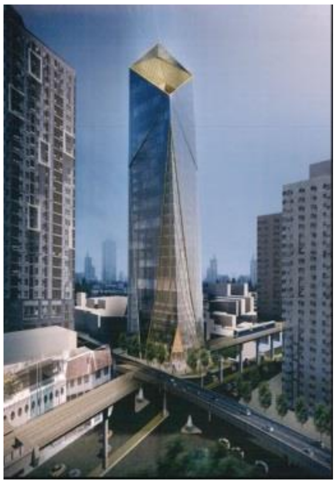

Fig. 2. A tentative sketch of Aira One building

Pathum Thani brewery flood protection project

In 2011, severe flooding occurred in Thailand. The floods spreaded through the provinces from northern to central part of Thailand along the Mekong and Chao Phraya river basins. 46.5 US billion has been estimated in economic damages and losses due to flooding. Pathum Thani brewery is one of the manufacturing facilities that was inundated during that time. As a result, flood protection wall has been proposed to construct around the factory. Total distance of sheet pile wall is 1,125 m (Fig. 3). The working area is very limited and close to many existing structures (Photo 6). It was very difficult and time consuming if conventional method was selected to install sheet pile wall. In addition, the manufacturing process can be continued during construction.

In summary, Press-in technology has been successfully introduced to construction society in Thailand since it could be applied in difficult conditions in urban area. This technique will be an alternative solution in underground construction.

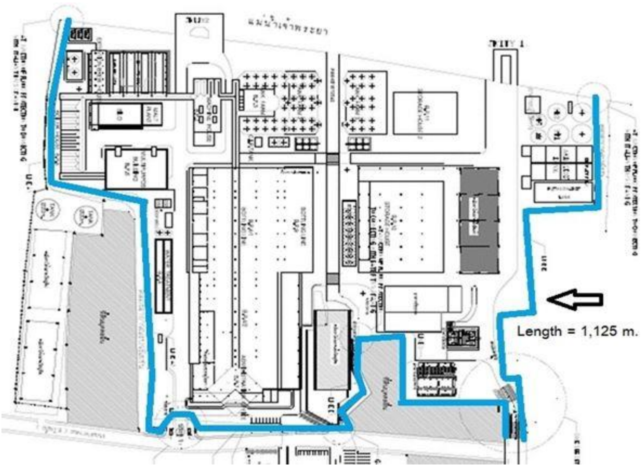

Fig. 3. Flood wall protection plan or Pathum Thani brewery project

Photo 6 Available working space

A brief CV of Dr. Wanchai Teparaksa

Dr. Wanchai Teparaksa is an Associate Professor of Chulalongkorn University. He graduated from Kasetsart University with Bachelor in Civil Engineering 1st Class Hons. Degree in 1979 and obtained his master degree from Asian Institute of Technology in 1981 and PhD degree from Kyoto University in 1987. He is the former director of Geotechnical group and committee at Civil Engineering Department of Chulalongkorn University. His research area is FEM, Instrumentation and Tunnel.

A brief CV of Mr. Visanu Vivatanaprasert

Mr. Visanu Vivatanaprasert is the managing director of Altemtech Co., Ltd. He graduated from Chulalongkorn University with Bachelor in Civil Engineering. His company is an expert in Press-in technology and he has a lot of experience in underground construction with Press-in machine. Altemtech combines the best knowledge and practice of one of the most well-established local contractors in the industry, with the team building and quality assurance approach of professional management.