Introduction

Following the invention of Prestressed High Strength Concrete Piles by Japan in the early 70’s, PHC piles have been used widely in many well-developed countries such as USA, Germany, Italy, as well as our neighbouring regions such as Korea, Singapore, Malaysia, Thailand, Indonesia, Vietnam and also our rapidly developing motherland China. There are over 100 PHC piles concrete pile manufacturers in China, with a total production of over 45,000,000 meters in 2002.

PHC piles have distinct advantage over the other techniques in the following aspects:

1. High loading capacity per pile;
2. A wide range of application;
3. Adaptable to ground condition with varying bearing strata;
4. Ease of transportation and splicing;
5. Rapid construction, high efficiency, short construction period;
6. Easy to maintain a clean and tidy working environment;
7. High strength, good penetration power;
8. Reliable quality, high yield;
9. Ease of inspection and testing;
10. Low construction cost per design load;
11. Adaptable to a wide range of installation methods.

However, there have been some adverse comments from the industry that the general quality of PHC piles does not meet the requirements of foundation work in Hong Kong. Having worked in the piling industry for many years, it is my opinion that these comments are not necessarily valid.

From technical points of view, the prestressed bars used in PHC piles are capable of withstanding more than 1420 MPa with only about 1.5% elastic extension. The compressive strength of PHC piles produced nowadays can reach more than 80 MPa. PHC piles are of high density, good durability, high resistance to frost attack, and high corrosion resistance. In fact, PHC piles produced nowadays are state-of-the-art products that incorporated most of the latest technologies available in the production of high quality concrete.

By comparing with Bored Piles, PHC piles are manufactured in a factory environment under a tight quality control process. In contrast, the concrete for bored piles is cast in-situ so it is always difficult to ensure that the concrete has been compacted and cured properly. It is obvious that the quality of Bored Piles is more human dependent and it is significantly more expensive to use Bore Piles than PHC piles in terms of construction cost for a specified total design load.
H-piles on the other hand are stronger than PHC piles in terms of strength but its corrosion resistance is significantly inferior to PHC piles. H-piles are also more expensive than PHC piles.

A detailed comparison of the merits and demerits of these three piling techniques had been discussed in a technical meeting organized by the HKIE-Materials Division on 10 October 2002. The aim of the current presentation is to introduce a method in which the advantages of PHC piles can be fully utilized while minimizing the possible drawbacks of the piles.

**Installation methods**

PHC piles can be installed utilizing a wide range of methods and each method has its own merits over the others. A simple method of installation is to use diesel, hydraulic or drop hammer but the method is not environmentally friendly and the impulse load that it imposed could damage the piles from time to time. An alternative method that is more environmentally friendly but not commonly available in Hong Kong or most other countries is by static pressing. This method is widely used in Mainland China.

**Static Pressing of PHC piles**

1. No noise pollution problem;
2. No vibration;
3. The load imposed on piles is minimized, and most critically, impulsive loading that is most damaging to the piles is eliminated;
4. Highly automated process with minimal labour work requirement, the load and driving rate imposed can be monitored and recorded throughout the process, i.e., the working condition is traceable.
5. The work can be completed in a very short working period:
   a. larger drive capacity than pile hammer;
   b. 24 hours operation is feasible since the noise generated is insignificant (quieter than a motorcycle);
   c. can operate in adverse weather condition.
6. Applicable to some special ground conditions where pile hammer is not suitable.
7. Effective driving
8. Minimal wastage
9. Easy to maintain pile geometry
10. Reduced overall construction cost

**Limitations of static pressing PHC piles**

1. Subject to influence from neighbouring piles
2. Not suitable for ground condition with underground cavity or underground
3. Very heavy and large equipment, stability of the equipment may be affected on soft ground.

**Equipment**

Nowadays, static pressing equipment utilized hydraulic pressure to drive the piles into the ground. The driving force can be transmitted either though a clamping action on the side face of the piles, or through a jacking action from the top of the piles with a speed of over 1.5 m/min and a stroke of 1.5 meters. To achieve the required driving force, sufficient number of counter weight is placed on the equipment to resist the reaction force resulting from the pile driving action. The piles can also be driven at an angle into the ground by adjusting the hydraulic jack angle when required. Currently, the largest static pressing equipment is capable of exerting 6000 kN to drive piles into ground condition with SPT N-values of 30-55 with individual pile loading capacity of up to 5500 kN.

**Process**

The static pressing is rather simple. The first section is loaded to the hydraulic rack by means of the built-in crane of the equipment. After accurate positioning of the pile, the equipment exerts pressure onto the pile to drive the pile into the ground. Successive sections of piles are welded together until the desired depth is achieved.

**Codes**

Since static pressing of PHC piles is a fairly new-born installation method and the method is mainly used in China, there is no well established codes that could be used as reference. A draft code on the technical requirements for static pressing PHC piles has been worked out recently and it is expected that the final version will be available by mid or end of 2003. A more systematic and regulated approach will be available to the industry to construct reliable foundation work at very low cost but still meeting the growing social demand for quality life and better environment.