



## Pile Cropping - A Review of Current Practice

### Introduction

Construction of concrete piled foundations includes the requirement to construct or crop the piles to the correct level to allow the subsequent construction of pile caps or capping beams. Traditionally, this work has been carried out by operatives using jackhammers. This results in exposure to vibration injury if it is inadequately controlled. HSE's Construction Sector has, as part of its health priority programme, been campaigning for the preferred use of mechanical pile breaking in order to reduce incidence of hand-arm vibration syndrome (HAVS).



This *inspector information sheet* has been prepared to present the findings of a small study to identify the various options available to the piling industry when selecting methods to crop piles to the correct level. In some cases, the selection of the method is entirely at the discretion of the contractor. However, in certain circumstances the designer has an important early role to play to ensure that the design and detailing of the piles will not prejudice the use of particular pile cropping methods.

### Pile Construction Process

Concrete piles fall into two main categories:

- *Cast insitu* (e.g. traditional augered piles, continuous flight augered piles, secant piled walls and diaphragm walls); and
- *Precast driven piles*.

Cast insitu piles have the potential to be cast to the correct level, but the details of the construction sequence or access arrangements do not always make this a practicable option. Frequently, piles have to be driven or cast up to a piling platform level much higher than the formation level for the pilecaps or ground beams. After excavation, this results in piles having to be cropped to formation level. Diaphragm

and secant piled walls, similarly, are often cast above their final level.

From a technical point of view, it is desirable to cast piles higher than the final level because laitance (impurities which have migrated to the top of the pile) and poorly compacted concrete can then be removed to leave well compacted, high quality concrete over the full length of the pile.

Precast piles are driven to a 'set'. The level of the toe of the pile required to reach the design set is variable. The final levels of the tops of the driven piles will vary and will not necessarily be at the correct level for the construction of pile caps or ground beams. Cropping of these piles to the correct level will therefore be required.

Reinforcement provided in piles varies according to the design requirements. Vertically loaded driven piles frequently have only a single reinforcing bar. Cast insitu piles are usually designed to have a cage of reinforcing bars comprising longitudinal bars (minimum of 4 with a maximum to comply with Standards) tied together with links (either individual or spiral formation).

### Pile Cropping Process

The pile cropping process is required to remove all concrete to the specified level, while leaving reinforcing bars protruding to the designed length to allow adequate lap and/or anchorage into subsequent construction. As most reinforcement is now high yield steel, significant, abrupt and repeated deformation is unacceptable, as these processes modify the yield characteristics of the reinforcing bar.

Removal of the concrete to the correct level must not introduce damage to the pile concrete below the cut off level, as this will affect the load carrying capacity of the pile.

The process must remove all damaged or poorly compacted concrete and laitance.

The resulting surface must be reasonably level to allow fixing of reinforcing bar in the pilecaps and leave an exposed aggregate finish to give a suitable construction joint.

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## **Review of Pile Cropping Methods**

The following review of methods is based on information gathered from:

- suppliers'/manufacturers' brochures;
- site visits; and
- meetings with contractors.

**The review is intended to be factual and does not seek to recommend one method in preference to any other. It is for the designer and contractor carrying out the work to select the most appropriate method for their circumstances.**

However, some observations and limitations are noted for information.

Only methods or products which could be traced in the short time available are reviewed. There may be other methods or products available which have not been reviewed and which may have merit. These need to be considered in the light of the design and construction of the particular project.

It should be noted that there is no single method or product which would necessarily suit all designs and conditions. The selection of the method must be made in respect of the circumstances relating to each project.

The pile cropping methods reviewed are as follows:

- Elliott Method;
- Receptieux Method;
- Mr Cropper Methods (five methods using similar technology); and
- Skanska Cementation Method.

*NOTE: The Skanska Cementation Method is not a pile cropping method, but a construction method for secant and contiguous piled walls which eliminates the need to crop.*

**It should be noted that there may be other methods or processes available which have not been reviewed, and which may be viable as a pile cropping method.**

### **Elliott Method**

#### Developer

Elliott Europe Ltd., Slade Park Farm, Pensilva, Liskeard, Cornwall, PL14 5NA.

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#### Process

The process is suitable for use on cast insitu piles.

The piles are formed in the normal way, using a traditional shell and auger or CFA rig.

The reinforcing cage is prepared by placing polyurethane foam sleeves over each reinforcing bar. The level of the bottom of the sleeve is predetermined to line up with the required cut off level. Links or spiral reinforcements are fixed to stop just below the cut off level.

The reinforcing cage is pushed into the fresh concrete, as normal, to the correct predetermined level so that the sleeves are at the correct level for cut off.

When the concrete has cured for a minimum of about 7-days, cropping work can proceed.

Cropping is carried out by drilling a hole into the side of the pile, at cut off level, and using a split tube and wedge (either hydraulically powered on larger piles or hand driven on smaller piles to split the concrete).

The surplus concrete is removed by lifting with a crane or excavator as a single piece.

The system appears to be effective, leaving a good surface for subsequent construction without damage to the concrete below the cut level. There is generally no requirement for hand trimming.

Risks identified during a site visit:

- drilling subjects worker to noise and vibration (but short duration);
- lifting requires equipment of appropriate capacity to prevent overturning;
- control of the preparation process is required to ensure that the sleeves are re-fixed down to, or just below, cut off level and links stopped below cut off level to ensure that release of surplus concrete is achieved;
- bending of any reinforcement protruding from the pile will prevent the surplus concrete from being lifted off;
- any condition which prevents the concrete from being lifted off will result in more traditional jack hammering method being adopted to break up the surplus concrete.

Benefits are gained if the method planned early in the construction process. Site arrangements to protect the top of the piles during curing, accurately setting the cut off level, avoiding changes to the cut off level after casting piles and planning the sequencing of work are essential to the efficiency of the process. Overall, the contractor reported time and cost savings over the traditional method of using a jackhammer to break down piles. The Elliott Method takes approximately 10 to 15 minutes per pile.

### **Receptieux Method**

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## Developer

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## Process

Formation of the pile shaft is by either the traditional shell and auger or by CFA rig.

The reinforcement cage is prepared by placing polyurethane sleeves over the reinforcement down to the cut off level. Links and spiral reinforcement should stop below the cut of level to ensure easy removal of the surplus concrete.

An arrangement of purpose designed plastic flasks are fixed to the reinforcing cage with their bases at the desired cut off level. Filler tubes are also attached to the flasks and fixed so that they will protrude from the top of the completed pile. The number of flasks required depends on the size of the pile. Generally, one flask is used in piles up to 300 mm dia., four flasks in piles up to 750 mm dia., and twelve flasks in piles up to 1500 mm dia..

The completed cage is introduced into the fresh concrete in the conventional way. The cage is pushed down to a predetermined level, which will ensure that the bottom of the flasks are at the required cut off level.

After the concrete has cured the flasks are filled with a predetermined quantity of expanding grout (which is supplied with the flasks as a kit). The state of curing of the pile concrete is determined by measuring the core temperature of the concrete, in accordance with the system method statement. The grout is then left to cure and, in the process, cracks the pile at the cut off level.

Surplus concrete is then removed. On the site visited this was done using mini excavators, fitted with hydraulically powered breakers. The contractor was then using hand tools to finally trim to level (the crack).

The manufacturer's literature suggests that the surplus concrete could be removed as one piece by sliding it over the reinforcement. There appears to be no reason why this could not be done.

Potentially, this method could be adapted for use on contiguous pile walls. Separation of the wall into discrete sections would be required.

The method appears to give a suitable level surface ready for placing reinforcement for subsequent construction.

Risks identified during a site visit:

- lifting requires equipment of appropriate capacity to prevent overturning;
- control of the preparation process is required to ensure that the sleeves are re-fixed down to, or just below, cut off level and links stopped below cut off level to ensure that release of surplus concrete is achieved;
- bending of any reinforcement protruding from the pile will prevent the surplus concrete from being lifted off;
- any condition which prevents the concrete from being lifted off will result in more traditional jack hammering method being adopted to break up the surplus concrete;
- there is possible exposure to harmful materials. Appropriate controls are required.

Benefits are gained if the method is planned early in the construction process. Site arrangements to protect the top of the piles during curing, accurately setting the cut off level, avoiding changes to the cut off level after casting piles and planning the sequencing of work are essential to the efficiency of the process.

Overall, the contractor reported time and cost savings over the traditional method of using a jackhammer to break down piles even though he was still using plant to break up the surplus concrete and not removing the concrete in one piece.

## **Mr Cropper Equipment**

### Developer and Manufacturer

Mr Cropper Ltd., PO Box 5688, Derby, DE21 2YW

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## Process

The Mr Cropper Equipment is, essentially, all of the same type. It is hydraulically operated and suspended from the dipper arm of an excavator. The equipment works by crushing the surplus concrete in the pile in sections down to the required cut off. There are currently five items of equipment for different applications.

These are as follows:

- *the pile cropper* - suitable for cutting square precast, single reinforcement bar piles;
- *the power cropper* - suitable for rapid excess pile reduction with subsequent trimming;
- *the multi-bar cropper* - suitable for cutting square multi-bar precast piles;
- *the CFA cropper* - suitable for circular cast insitu concrete piles from 200 mm upwards;
- *the contiguous pile cropper* - suitable for cast insitu contiguous pile walls.

The only equipment seen on site was the CFA cropper. This appeared to work well, cutting down piles without damage to reinforcement. In this case the piles were pre cut round the perimeter with a stihl saw. This was used to give a cutting level and also formed a stress raiser to form a crack during the crushing process.

Concrete remaining within the reinforced section of the pile was removed by a small amount of breaking with a CP9. This hand held equipment was also used for any final trimming required, however this was found to be minimal.

The contractor reported considerable time savings using this equipment (2 minutes per pile using this equipment compared with 45 minutes per pile using CP9, or similar).

No pre-knowledge of the required cut off level is necessary, thus the equipment provides flexibility. Some benefit in concrete removal would be gained if links or spirals could be omitted above the cut off level. This would reduce the further use of hand held equipment.

## **Skanska Cementation Method**

### Developer

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### Process

This is, technically, not a pile cropping method. The method allows the construction of contiguous or seccant pile wall without the need to crop excess concrete from the top of the wall. To this extent, use of the method would eliminate exposure to hand-arm vibration.

The method uses a system of precast concrete sections which are purpose designed for the project. The sections are placed accurately on site to line and level. They form a template for drilling the pile shafts and for placing concrete to the correct level for placing reinforcement and formation of the capping beam.

The system has been developed to form the shutter for the construction of the capping beam and a further development to use the precast units as the capping beam structure is under consideration.

The system has cost and time benefits on site and eliminates the need to break out concrete.



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This Inspector Information Leaflet, and the advice it contains, is current at 8/02. It is intended, primarily, for internal circulation and should not be used as an endorsement of any method.