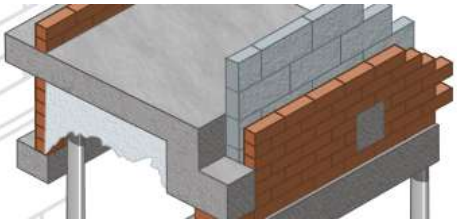


DRIVEN PILING

DESCRIPTION

Driven piling is the formation of a displacement pile typically by driving a steel tube, steel structural section, precast concrete section or other structural element into the ground. The capacity of the pile is determined by driving the pile to a "set". This is usually a function of the penetration of the pile into the ground measured against the number of blows of the driving hammer or the penetration of the pile into the ground during a specified period of time if a pneumatic or hydraulic hammer with a fixed frequency of impact is used. The comments in this document primarily refer to underpinning within existing buildings and limited access and restricted space working conditions although this technique for piling is also applicable to open site works.

TECHNIQUE

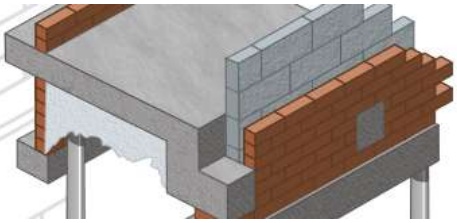
Driven piles are generally used in situations where the founding stratum is granular and the piles are essentially end bearing. Driving a pile to a set in clay is usually very time consuming and not particularly effective. This is due to false sets being achieved as a result of the time it takes for the pore water pressure, which is increased by the driving process, to dissipate. A driven pile can be used in some circumstances to produce a sound pile in clay by driving the pile to a predetermined depth in known ground conditions. A "static design" based on the friction between the pile shaft and the bearing strata plus the end bearing capacity is then carried out in a similar manner to that which would be applied to a bored pile.

For underpinning and restricted access working it is significantly easier to move light weight pile sections to the working area and for this reason the most common type of pile is to drive a thin walled steel tube which is subsequently filled with concrete. This tube may corrode over time in aerobic conditions and is therefore considered sacrificial.

There are two common ways of driving these piles. The first is to use a free falling drop weight which is repeatedly winched a pre-determined distance up the pile tube and then dropped in order to drive the pile. The second is to use a service mole e.g. a Grundomat. This comprises a weight being driven up and down pneumatically inside a steel casing such that if the end of the casing is placed on the bottom of the pile it will drive the pile into the ground.

It is clearly not possible to drive a long pile within an existing building using a single pile section. The light weight steel tubes commonly used for driven piles in an underpinning situation are delivered to site in sections which are the maximum length that can be practically installed taking into account the available headroom with the chosen driving equipment and the difficulties of transporting them to the working area. Clearly the use of pile driving equipment contained within the pile tube helps in dealing with working areas where headroom is limited. The first pile section (starter) usually has a crimped point and a short swaged section at the other end such that the second length (follower) can slide into it. The permanent connection can be made by welding. All subsequent followers are swaged at one end and joined to previous pile sections in the same way.

The sequence of work is therefore to drive the starter into the ground until only the swage is showing. The first follower is welded into position and driving is recommenced until only the swage is showing. This process is repeated until a set is achieved. The pile reinforcement required by the design is then introduced and the piles filled with concrete or grout of the appropriate strength.



DRIVEN PILING

Piles driven from the bottom are driven on a “plug” which is a dry concrete mix. This is compacted within the bottom of the pile casing with a thickness of approximately 500mm.

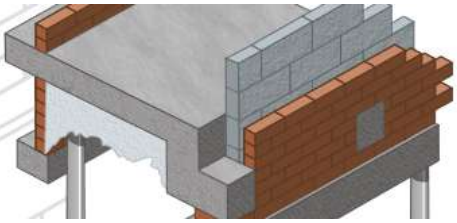
During the driving process the rate of penetration is observed and when the required set is approached an accurate measure will be made to record the rate of penetration per blow of the drop weight or the rate of penetration e.g. 10mm in 10 seconds for a service mole. When a set equal to or better than that required by the pile design calculation is achieved the driving of the pile is complete and the construction of the pile can be finished by introducing necessary reinforcement and concrete or grout. There are circumstances e.g. driving piles into chalk that it may be appropriate to come back to a pile after a period of time and check the set.

Driven piles are sometimes installed in an underpinning situation by top driving. This is usually done when ‘pin piling’ an existing floor slab using a pneumatic hammer with an appropriate adaption to drive a dolly machined to an exact fit in the pile tube. The pile is subsequently both driven below slab level and to a set. Top driving of solid pile sections in an underpinning situation is not a usual method of work as there is rarely sufficient headroom for the hammer to be positioned on top of the pile casing.

As driven piles usually generate the majority of their capacity from end bearing and a lesser proportion from shaft friction, their ability to sustain tension loads may be limited and the justification for any tension load applied might need to be made on a static calculation.

A driven pile is by its nature individually tested. Each pile is driven to a set; any worsening of ground conditions will result in piles achieving a set at a greater depth or not achieving a set at all at which time the obvious problem can be addressed and dealt with appropriately. It is therefore generally accepted that a factor of safety of 2.5 for piles without any load testing is acceptable. For the majority of underpinning jobs the cost of installation and testing of preliminary piles will not save sufficient money, by reducing the factor of safety to 2, to justify the time and cost of the test.

The driving of piles will inevitably result in vibration. A free falling drop weight will use a high energy blow with a gap of several seconds between each blow and might possibly cause more significant vibration than a service mole which will use impacts of relatively high frequency but low intensity. Vibration problems are notoriously difficult to anticipate. It has been known in the past, for example, to not affect the subject property or the one next door but to affect a property further down the street. It would be fair to say that the amount of energy used in driving piles appropriate to most underpinning situations is relatively low and does not often cause vibration problems. Obvious care should be taken if ground conditions dictate the use of a driven pile in connection with works to a property which is obviously very old or in very poor condition or where the upper strata are very soft.



DRIVEN PILING

ADVANTAGES AND DISADVANTAGES

The question of advantages and disadvantages of using driven piles does not really apply as the choice of pile type is mainly dictated by ground conditions. There are rare situations when a driven pile might be used where a bored pile would be the obvious first choice for example:

- The upper strata are extremely unstable and/or wet and where it would be difficult to guarantee the integrity of the shaft of a bored pile.
- The upper strata are seriously contaminated and the use of a driven pile will avoid any contaminated material being discharged onto the site surface as pile spoil.

HEALTH AND SAFETY

Briefly, the main health and safety considerations are:

- The use of a free falling drop weight will require the use of a relatively large piling rig and a heavy drop weight in restricted working access conditions. Operatives will require correct training and qualifications.
- The use of a service mole, especially the larger sizes, will require the use of a winch to remove the hammer from the completed pile and the use of powerful compressed air powered equipment. Operatives will require correct training and qualifications.
- Pile tubes are often joined by a welding for which appropriate hot work permits, fire precautions, flash screens and operative qualifications will be required.
- In particular difficult access conditions, cranage and hoisting of piling equipment may be required which will require proper planning and risk assessments and method statements.
- Proper investigation of existing services must be carried out and permits to dig obtained from main contractors.
- Notwithstanding the apparent adequacy of site investigation there is always the possibility of encountering unforeseen ground conditions and in failure of the pile to achieve the set generally in accordance with the detailed design would indicate a variation in ground conditions. Work must stop while proper engineering solutions are developed.
- Any excessive adverse reaction of the subject building or adjoining structures to vibration should result in work stopping while a proper assessment of the potential problem is made.

For detailed Health and Safety information, see ASUCplus ‘Guidelines on safe and efficient underpinning and mini-piling operations’