



IN SITU DYNAMIC TESTING OF FOUNDATION PILES

5 The present invention relates to the in situ dynamic testing of foundation piles, particularly in situ cast concrete piles, and to a rig for such testing of foundation piles.

10 After a foundation pile has been installed, it is usual, and in many countries mandatory, to subject it to dynamic testing prior to use to ensure that it has the necessary structural integrity and load-bearing capacity. This is conventionally effected by applying impact loads of known magnitude to it, typically by dropping a weight onto its upper end, and measuring the strain and acceleration induced in the pile at one or more positions by means of strain transducers and accelerometers. The data produced by the transducers and accelerometers is
15 then analysed to produce values for the integrity and load-bearing capacity of the pile. This testing method is well known per se and is described in detail in ASTM D4945-89.

20 The conventional method of dynamic testing of foundation piles presents no problem in connection with conventional driven piles because the pile driving hammer that was used to drive the piles is also used to apply impact loads to it in the dynamic testing process. However, use is increasingly being made of so-called bored or concrete piles which are made by boring a hole into the ground, optionally lining at least the upper portion of the hole with a metallic liner to
25 prevent it collapsing, inserting metallic reinforcement into the hole and then filling the remainder of the hole with grouting material, typically concrete or the like. A pile driving hammer is not inherently readily available in order to apply

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impact loads to such concrete piles for the purpose of dynamic testing. It is therefore usual after having made a number of such concrete piles to have to bring a crane and an impact weight onto the site. After the necessary strain transducers and accelerometers have been connected to a pile, the impact weight is raised to a predetermined height and then dropped onto the top of the pile.

However, the known method described above of in situ dynamic testing of in situ cast concrete piles is very unsatisfactory for a number of reasons. Thus it is difficult and time-consuming to ensure that when the impact weight is in its elevated position prior to being dropped onto the top of the pile it is indeed precisely above the pile. It will be appreciated that any significant misalignment of impact weight and the top of the pile could result in damage to the pile and in significant danger to personnel in the vicinity of the pile. If the weight is physically disconnected from the lifting tackle of the crane there is of course considerable danger associated with dropping it from a substantial height because its final resting position is somewhat unpredictable. If movement of the impact weight is restrained by not physically disconnecting it from the lifting tackle of the crane but merely by allowing the hoisting winches and the like of the crane to freewheel, the lifting cable and lifting gear of the crane constitute a substantial brake on the downward movement of the impact weight which means that it does not achieve its theoretical freefall velocity and thus that the precise magnitude of the impact applied to the pile when it is contacted by the weight is not known. This renders the result of the test unreliable. There is also the significant problem that if a substantial weight is lifted to a great height by a crane and then suddenly released, the sudden deloading to which the crane is subjected imparts significant shock loads to it and to its lifting gear

which can not only cause damage to it but can in extreme cases cause it to topple over.

Accordingly, it is the object of the present invention to provide a method and a
5 rig for in situ dynamic testing of foundation piles, particularly in situ cast concrete piles, which avoids or substantially reduces the problems referred to above.

According to the present invention a method of in situ testing of a foundation
10 pile includes positioning a support frame over the pile, positioning an impact weight on the support frame, lifting the impact weight to an elevated position above the top of the pile, securing the impact weight in its elevated position to the support frame, releasing the impact weight and allowing it to fall into contact with, and thus to apply an impact load to, the top of the pile and
15 measuring the strain and acceleration induced by the impact load at one or more predetermined positions on the pile.

Thus in accordance with the present invention, the impact weight is lifted on a support frame and secured to it in an elevated position. Accordingly, when it
20 falls down into contact with the pile the shock loads resulting from the release of the weight are not applied to a crane or the like, which is susceptible to damage, but to the support frame or rig which may be readily constructed to resist such loads. The fact that the impact weight may be dropped freely means that the magnitude of the impact to which the pile is subjected may be known
25 very precisely.

Whilst this method may be used in connection with any type of pile, it is

particularly advantageous with in situ cast concrete piles.

It is preferred that the impact weight and the support frame have cooperating guide means which guide the fall of the impact weight. The fact that the impact weight is laterally constrained with respect to the support frame means that there is no risk of it falling off the pile after the impact and potentially endangering personnel in the vicinity of the pile.

In the preferred embodiment, the method includes using a lifting beam which has guide means, which cooperate with the guide means on the support frame, and releasable fastening means, the method including the steps of attaching the impact weight to the lifting beam by means of the fastening means, lifting the lifting beam and thus the impact weight, securing the lifting beam to the support frame at an elevated position and releasing the fastening means, thereby permitting the impact weight to fall into contact with the top of the pile. The use of a lifting beam between the weight and the lifting means greatly simplifies the procedure. It will be appreciated that the weight and/or the lifting beam may be lifted by a variety of means, for instance hydraulic rams built into the support frame. It is, however, preferred that the lifting beam is lifted by means of a crane.

The present invention also embraces a rig for carrying out this method and thus according to a further aspect of the present invention a rig for in situ testing a foundation pile includes a support frame for positioning over the pile, the support frame having first guide means, a lifting beam having second guide means, which are adapted to cooperate with the first guide means such that, in use, the lifting beam is guided to move vertically with respect to the support

frame, and releasable fastening means for attachment of an impact weight thereto and means for securing the lifting beam in an elevated position with respect to the support frame.

- 5 In the preferred embodiment the lifting beam has a safety catch which is selectively movable between an operative and an inoperative position, the fastening means only being releasable when the safety catch is in the inoperative position. This feature ensures that there is no possibility of inadvertent release of the impact weight at a time other than that when it is
10 desired.

The preferred embodiment also includes an impact weight which is releasably connectable to the lifting beam by means of the fastening means and has third guide means adapted to cooperate with the first guide means such as that, in
15 use, the weight is guided to move vertically with respect to the support frame.

Further features and details of the invention will be apparent from the following description of one specific embodiment of an in situ cast concrete pile dynamic testing rig which is given by way of example only with reference to the
20 accompanying diagrammatic drawings, in which:

Figure 1 is a side view of the testing rig showing the upper end of the concrete pile to be tested and the associated lifting crane;

25 Figure 2 is a side view on an enlarged scale of the impact weight; and

Figure 3 is a side view on an enlarged scale of the lifting beam.

The upper end of an in situ cast concrete pile is indicated by the numeral 2. It projects slightly above ground level and a shallow excavation 4 is made around its upper end to facilitate access. When dynamic testing is to begin, a number of pairs of sensors 6, comprising a strain gauge and an accelerometer, are attached to the surface of the pile. The test rig is then erected above the upper end of the pile. The rig comprises an annular base 8 of e.g. rectangular or circular shape which is positioned symmetrically around the upper end of the pile. Connected to two opposite sides of the base are respective upstanding towers 10 of e.g. metal girders, profiles or the like. The two towers are connected together at their top by a tie bar 12. Their stability in the other direction is ensured by the provision of two opposed struts 14, inclined at e.g. 60°, connected to the base and each tower 10. On the two opposed sides of the towers 10 they carry a respective channel guide 48 consisting of two spaced tubular pipes, the purpose of which will be described below.

The testing rig includes a lifting beam which is shown in more detail in Figure 3. it comprises a beam 16 which extends between the two towers 10 and has a centrally disposed lifting hook 18 above it for connection to a crane. The beam 16 carries two relatively movable jaws 20 which are movable between the closed position shown in Figure 3, in which they define a small opening 22 for accommodation of a lifting cable, and an open position in which there is a space between them. The jaws 20 are movable between their two positions by a hydraulic cylinder 24. The cylinder 24 is connected to a hydraulic pump 26 by means of a trailing hose 28. Associated with the hydraulic cylinder 24 is a safety catch 30 which is movable between an operative position, in which it prevents opening movement of the hydraulic cylinder 24, and an inoperative

position, which is shown in Figure 3 and in which the hydraulic cylinder may open the jaws 20. The safety catch 30 is movable between its operative and inoperative positions by any desired means and in this case it simply constitutes a pivoted lever and is movable by means of a hand rope 32, though it will be appreciated that the safety catch may be mechanically operated, e.g. remotely. On its two opposed sides, the lifting beam 16 affords respective guide flanges 34 which are slidably received in the channels of respective guides 48 on the towers 10. In their lower surfaces the flanges 34 have recesses 36 whose purpose will be described below.

At its upper end the two guide channels 48 have one or more cooperating pairs of openings 38 for the accommodation of locking rods, which are not shown.

The impact weight, which is shown in more detail in Figure 2, and comprises a massive body 40 of e.g. steel, has a central lifting eye 42 on its upper surface. Its underside is flat to enable it to deliver a uniform impact to the upper surface of the pile. On two opposed side surfaces it carries respective guide projections 50 which, in use, are again slidably received in the guide channels 16 on the towers 10.

In use, after the towers have been erected, a crane 44 is brought into position and connected to the lifting weight 40. It lowers the weight onto the towers from above so that its guide projections 44 engage in the guide channels 48. The weight is then lowered until it rests on the top of the pile. The crane is then disconnected from the weight and connected to the lifting beam which is lifted in a similar manner and then lowered so that its guide flanges 34 also engage in the guide channels 48. The tie bar 12 is detachable and is only positioned after

- the impact weight and lifting beam have been lowered onto the towers. A cable 46 attached to the lifting weight is clamped in the opening 22 defined by the jaws 20 on the lifting beam. The crane then lifts the lifting beam, and thus also the impact weight, until the lifting beam has reached a predetermined elevated position. Retaining bars or rods, not shown, are then inserted, e.g. manually or mechanically, into one of the opposed pairs of holes 38 in the guides 48. The lifting beam is then lowered somewhat until the retaining bolts are received in the recesses 36 in the lifting beam. The crane's lifting cable is then slackened off somewhat so that the entire weight of the lifting beam and the impact weight is carried by the testing rig. During this procedure, the safety catch is in the operative position thereby preventing accidental release of the impact weight. However, the safety catch is now released, in this case by pulling manually or mechanically on the operating rope 32, and the hydraulic motor 26 is then controlled to operate the hydraulic cylinder 24 thereby moving the jaws 20 apart. Once the jaws have opened, the impact weight 40 moves downwardly in freefall, guided by the guides 50 and 48, into contact with the upper end of the pile 2. The values of strain and acceleration detected by the sensors 6 are fed to a computer and analysed in the conventional manner.
- The bolts are then removed from the holes 38 and the lifting beam 16 is then lowered and the cable 46 reconnected to it. The lifting beam and impact weight are then lifted again by the crane and the process is repeated as many times as desired.
- It will be appreciated that the fact that the impact weight is allowed to fall freely means that the magnitude of the impact delivered by it to the pile is known precisely. Due to the fact that the impact weight is guided with respect to the

towers, it cannot fall off the top of the pile and thus endanger life. The entire weight of the impact weight 40 is carried by the towers and not by the crane prior to its release which means that when the impact weight is released no shock loads are applied to the crane which in turn means that there is no risk of damage to or toppling over of the crane.

CLAIMS

1. A method of in situ testing of a foundation pile including positioning a support frame over the pile, positioning an impact weight on the support frame, lifting the impact weight to an elevated position above the top of the pile, securing the impact weight in its elevated position to the support frame, releasing the impact weight and allowing it to fall into contact with, and thus to apply an impact load to, the top of the pile and measuring the strain and acceleration induced by the impact load at one or more predetermined positions on the pile.
2. A method as claimed in Claim 1 in which the pile is of in situ cast type.
3. A method as claimed in Claim 1 or 2, in which the impact weight and the support frame have cooperating guide means which guide the fall of the impact weight.
4. A method as claimed in any one of Claims 1 to 3 which includes the use of a lifting beam which has guide means, which cooperate with the guide means on the support frame, and releasable fastening means, the method including the steps of attaching the impact weight to the lifting beam by means of the fastening means, lifting the lifting beam and thus the impact weight, securing the lifting beam to the support frame at an elevated position and releasing the fastening means, thereby permitting the impact weight to fall into contact with the top of the pile.

5. A method as claimed in Claim 4 which includes lifting the lifting beam to an elevated position by means of a crane.

5 6. A rig for in situ dynamic testing a foundation pile including a support frame for positioning over the pile, the support frame having first guide means, a lifting beam having second guide means, which are adapted to cooperate with the first guide means such that, in use, the lifting beam is guided to move vertically with respect to the support frame, and releasable fastening means for attachment of an impact weight thereto and means for securing the lifting beam
10 in an elevated position with respect to the support frame.

7. A rig as claimed in Claim 6 in which the lifting beam has a safety catch which is selectively movable between an operative and an inoperative position, the fastening means only being releasable when the safety catch is in the
15 inoperative position.

8. A rig as claimed in Claim 6 or 7 further including an impact weight which is releasably connectable to the lifting beam by means of the fastening means and has third guide means adapted to cooperate with the first guide means such as that, in use, the weight is guided to move vertically with respect
20 to the support frame.

