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Title: A PILE TEST APPARATUS

Abstract: Apparatus for testing, in situ, the static load capacity of a pile comprises a jack (20) supported by the pile (21) and a reaction beam (13) supported by blocks or trestles (24), the jack is raised to come into contact with the reaction beam (13) via a spherical seating (22) and a spreader plate (23). The reaction force from the jack is counteracted by an anchor arrangement at each end of the reaction beam (13) via secondary beams (15) themselves anchored down to anchor piles (25) via threaded steel tendons or bars (14). The reaction beam (13) is made up a number of constituent parts (10, 11, 12) which bolt together to make one reaction beam (13), the weight and size of each constituent part enable this apparatus to be erected in restricted access without the need for craneage.
A PILE TEST APPARATUS

Field of the Invention

The present invention relates to an apparatus and method for testing the static load bearing capacity of pile foundations.

Background to the Invention

Piles either of concrete or steel are used to transfer applied loads from buildings and other structures to deeper strata, where it is deemed the shallow strata is insufficiently capable of supporting the loads at shallow depths. Piles derive their capacity from skin friction along their shafts and/or from end bearing at their bases. It is usually a requirement of a contract that piles are load tested to validate their design.

Static load testing is usually carried out by applying a load to the pile by means of a jack. The force of the jack is resisted by a beam which itself is anchored to the ground at either end via anchor piles installed for that purpose.

This arrangement is heavy and requires the use of a crane to erect the beams which are usually made of steel. The beams are also of a substantial size so that their use in an area with restricted access is not possible. Piles for use in these situations are usually designed with a higher factor of safety as their design cannot be validated by static load testing methods as described.
Where significant numbers of piles are to be installed the effects of the increase in the factor of safety means that the piles installed are often longer than they otherwise would have been if they were able to be validated by one or more static load tests. The use of longer piles can prove expensive as piles in areas of restricted access are usually comparatively slow to construct.

Furthermore, a contract may insist upon the piles being validated in some way. In areas of restricted access, the dynamic pile test is often specified, whereby the measurement of the response of the pile to a hammer blow is used to derive an estimate of the ultimate bearing capacity of the pile. This is often considered to be inferior to the result from a static load test.

A conventional two anchor pile testing apparatus for conducting a static load test is shown in Figure 1. The apparatus comprises a test reaction beam (1), initially supported on blocks or trestles (2) above a test pile (3). A jack (4) is seated on the test pile (3) and supports a spherical seating (5) which is coaxial with the jack (4). The test reaction beam (1) is anchored by means of a pair of threaded tendon bars (6) cast into anchor piles (7) at each end of the reaction beam (1). Each pair of tendon bars (6) straddles the reaction beam (1) at its front and back and passes through apertures in a respective small cross beam (8) located above and perpendicular to the reaction beam (1). Each tendon bar (6) is secured by a retaining nut (9).

In use, a force is applied by the jack (4) to the pile (3), using the test reaction beam (1) to provide a
reaction to that force. The reaction beam (1) is held vertically in place against the upwardly directed jacking force by the cross beams (8) and the tendon bars (6). The reaction force thus acts on the reaction beam (1) where the cross beams (8) contact the reaction beam (1).

The apparatus described is necessarily heavy and large and does not lend itself to use in restricted areas, where crane access is not possible. Also since each pair of tendon bars (6) may need to be splayed apart to enable them to encompass the reaction beam (1), they may become unbalanced during the test and thus allow the reaction beam to tilt about its longitudinal axis. Furthermore, application of force by the jack (4) upwardly through the spherical seating (5) serves to exaggerate the tilting motion. The whole assembly may become critically unstable when the reaction beam (1) tilts far enough away to allow the jack (4) to be ejected with the force which it had been applying to the test pile (3).

It is an aim of the present invention to overcome at least one problem associated with the prior whether referred to herein or otherwise.

Summary of the Invention

According to the present invention there is provided an apparatus and method as set forth in the appended claims. Preferred features of the invention will be apparent from the dependent claims, and the description which follows.
According to the invention the apparatus comprises a jack supported by the pile and a beam made up from separate parts to make a constituent whole supported by blocks or trestles. The jack may be raised to come into contact with the beam via a spherical seating. The reaction force from the jack may be counteracted by an anchor arrangement at each end of the beam via further secondary beams. The further secondary beams may be anchored down to anchor piles via steel bars. In this form each of the beam constituent parts are sufficiently small and light enough to be manoeuvred by hand.

The beam may be generally elongate and its constituent parts are made from H sections of steel girder. Each of the beam sections may bolt together to form a single beam section. Preferably, two beams are used parallel to each other. However, one beam could be used where light loads are specified.

The beam may be anchored in the region of its ends, preferably by threaded anchor bars themselves cast into adjacent anchor piles. The load may be transferred into the anchor bars via a secondary beam arrangement perpendicular and at each end of the beam.

**Brief Description of the Drawings**

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings in which:
Figure 1 is a front view of a conventional test beam apparatus;

Figure 2 is a front view of a pile test beam according to a preferred embodiment of the invention;

Figure 3 is a plan view of the embodiment of Figure 2; and

Figure 4 is a side view of the embodiment of Figure 2.

**Description of the preferred embodiments**

An apparatus for testing the load capacity of piles according to the invention is shown in Figure 2-4. It is similar to the apparatus shown in Figure 1, with the important difference that the reaction beam (13) is made up of three constituent sections (10, 11, 12). The beam comprises two lower H sections (10, 11) forming the bottom of the reaction beam (13) and one upper H section (12) forming the top of the reaction beam (13). The reaction beam (13) is assembled by means of a bolted connection, which bolts the lower and upper sections (10, 11, 12) together to form a single section (13). This bolted connection is formed at the centre of the assembled reaction beam (13) where the forces in the connecting flanges are minimal.

The embodiment shown in Figures 2-4 shows an apparatus having two reaction beams. However, the apparatus could also be adapted for use with a single reaction beam. As most clearly shown in Figure 3, two anchor arrangements are provided for anchoring the two reaction beams (13),
one at each end. Each anchor arrangement comprises two secondary cross beams (15) which are anchored down to anchor piles (25) via a threaded steel tendon bar (14). Each tendon bar (14) passes through the respective secondary cross beams (15) located above and perpendicular to the reaction beam (13). Each tendon bar (14) is secured by a retaining nut (30).

Below the reaction beams (13) at each end are two further secondary cross beams (17). The further secondary cross beams (17) are seated on a plate (18) secured in place by a retaining nut (19). By turning the retaining nut (19), the beams (13) can be easily adjusted for height. In addition, the beams (13) can be clamped between the further secondary cross beams (17) and the secondary cross beams (15) located above the reaction beams (13), thereby preventing longitudinal twisting at the supports towards the ends of the reaction beams (13).

In use, a force is applied by the jack (20) to the pile (21), via a spherical seating (22) and spreader plate (23) using the reaction beams (13) to provide a reaction to that force. The reaction beams (13) are held vertically in place against the upwardly directed jacking force by the secondary cross beams (15) and tendon bars (14). The reaction force thus acts on the reaction beams (13) where the secondary cross beams (15) touch the reaction beam (13).

The increased portability of the apparatus in terms of the weight and size of each constituent part is of major benefit for testing piles in areas with restricted access. In turn, this means such piles can either be designed with
a lower factor of safety or greater confidence can be realised for the proposed design.

An alternative to the dynamic pile test in restricted access is also offered by this apparatus. There is a potential cost saving where piles can be reduced in length by using a lower factor of safety or by maintaining the same factor of safety increased confidence is realisable for the installed piles.

Furthermore, compared with the conventional pile testing apparatus of Figure 1, there is increased stability of the apparatus gained from the clamping action from the secondary cross beams, which is a major benefit for safety in terms of a greatly reduced risk of causing the jack to eject itself from between the reaction beam or beams and a pile to be tested.

Attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.
Each feature disclosed in this specification (including any accompanying claims, abstract and drawings) may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated otherwise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.
CLAIMS

1. A pile test apparatus for testing, in situ, the static load bearing capacity of a pile, comprising:

- a force application means for applying a force to the pile;

- at least one reaction beam adapted to be supported on the force application means; and

- an anchor arrangement for anchoring the reaction beam;

wherein the or each reaction beam comprises a plurality of beam sections which are adapted to be connected together in use.

2. The pile test apparatus of claim 1, wherein the or each reaction beam has three beam sections.

3. The pile test apparatus of claim 2, wherein the or each reaction beam has two lower beam sections connected together by means of an upper beam section.

4. The pile test apparatus of claim 3, wherein the two lower beam sections abut end to end.

5. The pile test apparatus of any preceding claim, wherein the beam sections forming the or each reaction beam are connected together by means of one or more bolts.

6. The pile test apparatus of any preceding claim, wherein the force application means is a jack.
7. The pile test apparatus of claim 6, wherein in use the jack is adapted to be raised to support the or each reaction beam.

8. The pile test apparatus of claim 7, wherein a spherical seating is provided between the jack and the or each reaction beam.

9. The pile test apparatus of any preceding claim, wherein the beam sections are of H shape cross section.

10. The pile test apparatus of any preceding claim, wherein the beam sections are steel girders.

11. The pile test apparatus of any preceding claim, wherein the anchor arrangement comprises anchor means located towards each end of the or each reaction beam.

12. The pile test apparatus of claim 11, wherein each anchor means comprises a tendon bar which is secured to an anchor pile.

13. The pile test apparatus of claim 12, wherein the tendon bar is cast into an anchor pile.

14. The pile test apparatus of claim 12 or 13, wherein the tendon bar is steel.

15. The pile test apparatus of any preceding claim, wherein each anchor means comprises at least one secondary cross beam located above the or each reaction beam.
16. The pile test apparatus of claim 15, wherein the or each secondary cross beam is located perpendicular to the or each reaction beam.

17. The pile test apparatus of any of claims 12-14 or claim 15 or 16 when dependent on claim 12, wherein each tendon bar is threaded to receive a retaining nut for securing the or each secondary cross beam in position on the tendon bar.

18. The pile test apparatus of any preceding claim, wherein each anchor means further comprises one or more further secondary cross beams located directly below the or each reaction beam.

19. The pile test apparatus of claim 18, wherein the vertical position of the or each further secondary beams is adjustable.

20. The pile test apparatus of claim 19 when dependent on claim 12, wherein the or each further secondary cross beams are seated on a plate secured in place on the tendon bar by a retaining nut which is turnable to adjust the height.

21. The pile test apparatus of any preceding claim, wherein the apparatus comprises two said reaction beams parallel to each other.

22. The pile test apparatus of claim 21 when dependent on claims 12 and 15, wherein the anchor means comprises the
tendon bar passing between said two reaction beams and two said secondary cross beams.

23. A pile test beam for use in apparatus for testing, in situ, the static load bearing capacity of a pile, wherein the beam comprises a plurality of beam sections adapted to be secured together in use and adapted to be disconnected when not in use.

24. The pile test beam of claim 23, wherein the or each reaction beam has three beam sections.

25. The pile test beam of claim 24, wherein in use the or each reaction beam has two lower beam sections connected together by means of an upper beam section.

26. The pile test beam of claim 25, wherein the two lower beam sections abut end to end.

27. The pile test beam of any of claims 23-26, wherein the beam sections forming the or each reaction beam are connected together by means of one or more bolts.

28. A pile test apparatus for testing, in situ, the static load bearing capacity of a pile, comprising:

   a force application means for applying a force to the pile;

   at least one reaction beam adapted to be supported on the force application means; and
an anchor arrangement for anchoring the reaction beam to counteract the reaction force of the force application means; and

a stabilising means located towards each end of and below the or each reaction beam to stabilise the pile test apparatus in use.

29. The pile test apparatus of claim 28, wherein each stabilising means comprises at least one further secondary cross beam.

30. The pile test apparatus of claim 29, wherein each anchor arrangement comprises a tendon bar which is secured to an anchor pile, and the or each further secondary cross beams of each stabilising means are anchored to the anchor pile via the tendon bar.

31. The pile test apparatus of claim 29 or 30, wherein the vertical position of the or each further secondary cross beams is adjustable.

32. The pile test apparatus of claim 31 when dependent on claim 30, wherein the or each further secondary cross beams are seated on a plate secured in place on the tendon bar by a retaining nut which is turnable to adjust the height.

33. The pile test apparatus of any of claims 28-32, wherein the apparatus comprises two said reaction beams parallel to each other.
34. The pile test apparatus of claim 33 when dependent on claim 30, wherein the anchor arrangement comprises the tendon bar passing between said two reaction beams and two said secondary cross beams.

35. A pile test apparatus substantially as hereinbefore described with reference to Figures 2 to 4.

36. A pile test beam substantially as hereinbefore described with reference to Figures 2 to 4.
INTERNATIONAL SEARCH REPORT

International application No
PCT/GB2006/004628

A  CLASSIFICATION OF SUBJECT MATTER

INV. G01N3/00

According to International Patent Classification (IPC) and to both national classification and IPC.

B  FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

G01N E02D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched:

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Inter

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<th>Relevant to claim No</th>
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<td>X</td>
<td>GB 2 284 673 A (PRECISION MONITORING &amp; CONTROL [GB]) 14 June 1995 (1995-06-14)</td>
<td>1-3-5-34</td>
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<td></td>
<td>abstract page 1, line 2 - page 6, line 12 page 7, line 1 - page 9, line 16; claims 1-8; figures 1,2</td>
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<td>A</td>
<td>GB 2 401 189 A (ROXBURY LTD [GI]) 3 November 2004 (2004-11-03) whole document</td>
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D. Further documents are listed in the continuation of Box C.

X See patent family annex

* Special categories of cited documents

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure use, exhibition or other means.

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1T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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Date of the actual completion of the international search

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