TECHNICAL SPECIFICATIONS

PILE LOAD TESTING

1. Introduction

The piling work on this site will require one or more pile maintained load tests. These tests can be of two types or as specified:

• **Preliminary Test**: This is a test carried out on an expendable pile in advance of the main piling work. The pile is usually tested until it fails and the results are used to refine the design of the subsequent working piles.

• **Working (or Proof) Test**: This is a test carried out on a working pile and the test load is usually limited to 50% over the design load to avoid overstressing the pile or the ground. This test is to check that the piles are capable of bearing the loads imposed on them. The test piles (and reaction piles/anchorages, if any) will be installed by the piling contractor. The loading test will be carried out by a specialist testing contractor. After installation, any concrete cast-in-situ piles are left for a minimum period of 7 days or until the concrete has gained sufficient strength.

2. Testing and Specification for Dynamic Load Test

Pile Load Test

In high strain dynamic and rapid load tests, although the force is comparable in magnitude to a static test, it is applied over a much shorter period than in a static load test. Careful consideration is therefore needed in the interpretation of the dynamic effects in order to derive static load capacities.

The Dynamic Load test and its application are summarized below. More details of dynamic testing methods are included in Point No 4 'Load Testing Methods'.

Instrumentation may be built into preliminary test piles to investigate the load transfer mechanism during the test. Piles may be equipped with strain gauges, push rods, load cells and other devices to enable the designer to isolate key pieces of information and improve the analysis of the test result and confirm or refine the design approach. This type of equipment is normally of a specialist kind and requires careful selection, installation and additional monitoring. It is preferable to have specialist advice on the installation, monitoring and testing of any instrumentation.

2.1 Dynamic Load Test

These methods are based on monitoring the response of a pile subjected to hammer blows applied at the pile head. The measured response parameters are subsequently analyzed to give predictions of the soil resistance that would be mobilized by the pile under static load conditions, based on stress wave theory.

The analytical models of the pile /soil interaction is developed to provide prediction of the load/settlement performance of the tested pile. Dynamic load testing of cast in place piles is used to predict the static soil resistance and the load/settlement behavior. The test method is similar to that used on driven piles with the monitoring of hammer blows and subsequently analyzing the pile response to the stress wave propagation. A separate hammer or drop weight is usually brought to site to allow the dynamic load to be applied to a cast in place pile.

Due to the very high rate of applied loading, dynamic load testing cannot take into account time-related effects such as consolidation, relaxation or creep; consequently care should be exercised in reviewing the results of tests carried out in soils which may exhibit these features. However, the use of dynamic testing after calibration within a particular

geological profile will allow more comprehensive testing at low cost in comparison to static testing.

Typically a dynamic test will take about 15 minutes to perform on a precast concrete pile using the piling rig hammer to 30 minutes on a bored cast in place pile requiring the use of a separate drop weight.

2.6 Summary

S.No.	Test Type	Reaction System	Maximum Test Load	Advantages
1	Dynamic	Piling hammer or separate drop weight	3MN (generally, but can be greater) Hammer weight should be in the range 1 to 2% of load to be proved.	Fast and Relatively inexpensive. Suitable for both driven and bored piles. Correlation with static tests on bored piles generally good.

3. Specification

3.1 Test Procedure

All load tests should be carried out in accordance with the ICE Specification for Piling and Embedded Retaining Walls.

3.2 Maximum Test Load

Load tests on preliminary or non-working test piles, in advance of or during the early stages of the piling works, are normally carried out to DVL plus 1.0 or 1.5 times the specified working load (SWL). DVL is the working load plus allowances for soil induced forces such as down drag or heave, and any other particular conditions of the test such as a variation of pile head casting level.

Load tests on working piles are normally taken up to a maximum load of DVL plus 0.5 times the specified working load. This is sufficient to verify the load settlement characteristics of the piles under service conditions.

3.3 Concrete and Reinforcement

The strength of the concrete in the pile must be considered in all cases where a load test is to be carried out, in order to ensure that the concrete is not over-stressed during testing. This is particularly important with preliminary test piles where the stresses in the concrete may be very high. Preliminary test piles are often loaded to between two and three times their normal specified working load and this may call for higher grades of concrete than those to be used in the works. Enhanced reinforcement may also be required in preliminary piles to prevent structural failure under such loading conditions.

For working pile tests, the test should not proceed until compressive tests on works cubes have confirmed that the concrete strength is at least twice the concrete stress in the pile at the maximum specified test load. It is also necessary to ensure that the

trimmed head of the pile is in intimate contact with the pile cap with a horizontal, clean and well formed joint.

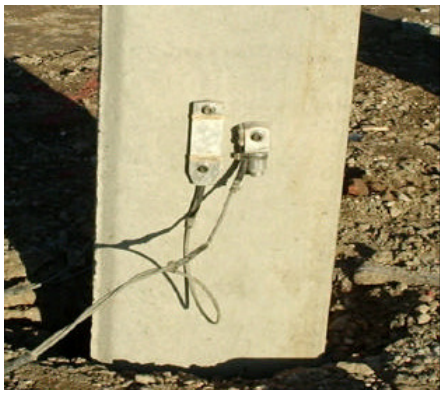
Pile head preparation of bored/CFA piles undergoing dynamic load testing is critical. Unless the pile has a permanent liner, the pile shaft must be built up 2 to 3 pile diameters above ground level at the pile position within a thin-walled liner, suitably reinforced and finished with a smooth flat surface normal to the pile axis. A pair of diametrically opposed windows, 200mm square, must be cut into the liner to reveal smooth concrete surface to which the gauges can be attached. CFA piles subject to dynamic load tests will require the main reinforcement to extend to the pile toe. The heads of piles undergoing rapid load tests will require similar pile head preparation to that necessary for static load tests.

4. Load Testing Method

4.1 Dynamic Load Testing

In order to carry out this method of testing an impact hammer is required. The hammer should ideally be sufficiently large to fully mobilize and therefore characterize the dynamic pile capacity without damaging the pile, and in the case of driven piling will usually be the same hammer as used to install the pile (see side Picture).

Dynamic load testing of bored cast-in-place or CFA piles will generally require the use of a separate hammer or drop weight (see Picture below).



As Dependent upon the method employed, electronic gauges are attached to the pile as illustrated in side picture. The gauges measure the acceleration of the pile (and therefore (indirectly) velocity with a knowledge of the pile properties) and strain within the pile just below the head as the hammer strikes the pile. The information is then recorded in the associated site computer. A variation of the method involves deflection measurement directly by laser theodolite.

In addition to access for the piling hammer/drop weight only minimal access is required to attach the gauges, provided that the pile shaft protrudes at least 2 to 3 pile widths/diameters above ground level; this safeguards the gauges and allows the propagation of a uniform stress wave.

A large number of piles can be tested in the course of one day using dynamic load testing methods.

Analysis of data

Once the data has been recorded, it can then be analyzed by suitably experienced personnel using associated programs to provide the information on mobilized soil resistance, pile integrity and hammer performance.

5. Pile Protection between Installation and Testing

Between installation and testing, the test pile and reaction piles/anchorages must be protected from damage and interference, specifically:

- Reaction piles are normally reinforced with pre-stressing bars which protrude from the piles to allow connection to the test beams. The bars are formed from high grade steel which can be damaged by heat or bending. The test area must therefore be **barriered off** from plant movement and no hot work allowed in the vicinity. In the unfortunate event of a bar being bent, it must never be straightened, but the piling contractor should be informed so that they can re-end the bar. This may require the breaking down of the pile.

- No excavations must take place around reaction piles/anchorages as these have been designed assuming ground level remains undisturbed. Excavations or loosening of the ground can cause these to pull out, stopping the test.

6. Pile Load Testing – Test Cap

Dimensions for the test cap should be agreed with the testing contractor prior to its construction. The test cap must be designed and constructed so that it:

- Is concentric with the centre of pile (with a stated allowable tolerance)

- Is able to safely transfer all the vertical and any other induced forces from the cap into the pile

- Comprises a continuous uniform section without any inclusions.

The design and/or the method statement should made be available to the Principal Contractor or Engineer upon request.

If not constructed integral with the pile then the ICE Specification for Piling and Embedded Retaining Walls requires concrete test cubes to be taken from the concrete used to cast the cap.

7. Testing

The testing contractor will need road access from the public highway to the test location for the lorries which contain test beams and the data-logging cabin. The lorries will need to be able to park adjacent to the test pile to enable the data cables to run from the data

cabin to the test assembly without interference. The lorries will also need to be able to park a safe distance from the test area.

The area around the test must be made suitable for the technician to safely work, i.e. leveled, hard-cored and without trip hazards or excavations.

An exclusion zone will need to be established around the area of the test, clearly marked and signed. This zone then becomes a **restricted** area.

8. Guidance for the Principal Contractor

During the test, no work that could cause vibration should be carried out adjacent to the test as the measurements being made may be affected.

The Principal Contractor can usually mitigate the disruptive effects of complying with the above requirements by careful selection of the location of the pile(s) to be tested.