TAMBEW (Pty) Ltd

INTERNALLY JACKED PILE TESTS

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1 Introduction

This test is to determine the load-carrying capacity of a foundation pile. Instead of applying a load to the head of the pile, which requires the provision of a reaction to generate the load, a jack is incorporated into the pile shaft. The jack applies force simultaneously to the length of the pile shaft above it and to the length of shaft plus the toe of the pile below it. This removes the necessity for the provision of an external reaction, which can make the test simpler and cheaper to do.

This document describes the planning, technical implementation and interpretation of an internally-jacked pile test. Site operations are described in one of the following documents:

1. INTERNALLY JACKED PILE TESTS, METHOD STATEMENT OF SITE OPERATIONS, SYSTEM 1 - NO PILE REINFORCEMENT, MANUAL WINCH.
2. INTERNALLY JACKED PILE TESTS, SPECIAL METHOD STATEMENT FOR [job name].

2 Choice of jack position

The objective of the jack position choice is to see as much movement as possible of the lengths of the pile both above and below the jack. To achieve this, the maximum load capacities of the upper and lower lengths should be equal. For example, if the pile is to bear onto rock, the capacity of which is clearly greater than the shaft above it, then the jack must be as low down as possible. However if the end bearing capacity is less than the total from the shaft, then the jack must be somewhere higher up from the base. A careful examination of the available geotechnical information about the site is needed, and its interpretation into pile performance prediction.

3. Pile installation

NOTE. The following brief description in this section is relevant only to the case when a reinforcement cage is not being installed and Tambew’s hand operated equipment is being used. For other cases refer to the Special Method Statement for the particular site or pile test, as mentioned in Section 1 above. It is included to encourage the use of the beneficial practice of testing without pile reinforcement and with centrally located strain rods.

The pile is bored to the required depth and the piling machine moves away. Either while the boring is taking place or immediately afterwards a set of six access-scaffold frames are erected and a beam with pulley-wheels attached is placed on the top. If the set of frames is erected before the hole is finished, then it is lifted by one man at each of its four corners and carried into position over the hole.

Depending on the groundwater inflow to the hole, the first concrete is poured at a stage to minimise the risk of getting excess water in the hole and to minimise the standing time of the concrete truck.

On one of the lower scaffold frames a hand-operated winch is already attached. From this winch a wire rope is passed over the two pulleys and a double-ring centraliser attached and lowered a short distance into the hole. A device to ascertain whether the wire rope is vertical is attached to the rope and with one man at each end of the beam at the top of the scaffold, the beam's position is adjusted until the wire rope is vertical. The beam is then clamped to the top frames.

The jack is then attached to the wire rope, with a centraliser (and perhaps also a strain gauged rod if strain measurements are to be made during the test), and lowered into the hole, attaching the jack's hydraulic hose(s) to the wire rope as it descends. If strain gauged rods are included, then their wires are also attached to the wire rope. If the pile is specially installed as a test pile (i.e. not a working pile), then only one hydraulic hose to the jack is required. If it is a working pile then two hoses are needed so that the jack can be filled with epoxy grout after the test of the pile is complete.

As the jack is lowered, more centralisers and strain rods may be attached, depending on the measurement requirements of the particular test pile. When the jack reaches the top of the concrete already in the hole, it is held there by the winch, and concrete is poured on top of it up to the required level. The equipment is left in this condition until the concrete has set sufficiently for the jack's weight to be taken off the winch. This is usually the following morning, when the scaffolding can also then be removed.

The hydraulic hose(s) from the jack (and the wires from the strain rods if included) are put into a suitable protective enclosure, which may be buried to prevent them being seen by vandals.

4 Testing of the pile

A beam approximately 6m long (i.e. an extended aluminium ladder) is supported to span over the pile by two steel pins driven into the ground. Instruments are suspended from this beam to measure the movement of the head of the pile. The total movement (up plus down) at the jack is measured by electronic devices incorporated in the jack. (Note that the upward movement at the jack will be found as the sum of the pile head movement and the shaft compression above the jack. The shaft compression will be found from either measured or calculated strains in it. The downward movement at the jack is then the total movement minus the upward movement.) The wires from all instruments are connected to a data-logging computer. 220V electricity is required, and is usually supplied by a portable generator with battery back-up.

Hydraulic oil is pumped into the jack within the pile, causing it to load the pile, and both electronic and visual measurements are made.

When strain measurements are being made, to get sufficient points on the graphs that will be plotted, the testing of the pile is done in at least six stages of increasing load, and the load is held constant until the rate of movement at the jack is less than the rate specified. In the case of SANS 1200 Part F 1983, this is 0,2 mm/hour. This can take a long time in clay soils, causing the whole pile test to sometimes extend over many days. If the test may extend past sunset, lights are made available to be powered from the generator.

When strain measurements are not being made, the normal intervals of load increase as specified by SANS 1200 will be used.

In either case, when required by the responsible supervising engineer, the load can be held constant for 24 hour periods as described by SANS 1200 Part F.

5 Grouting up of jack in the case of a working pile

When the pile being tested has been specially installed for test purposes, then when the test is finished, all equipment is removed from the site, and when the results have been checked to be sufficient, the wires and hose may be cut off at the top of the pile. It is often desirable to have the test pile between the working piles so that: a) it is in the same ground conditions; b) it can contribute to the support to the structure; and c) it will not interfere with anything else by its presence.

When the pile is a working pile, the axial capacity of the pile through the jack is maintained by grouting up the inside of the jack with an epoxy that is specially formulated with low viscosity and slow set for grouting purposes. Although this grouting will not provide tensile, and hence moment, resistance continuity of the pile past the jack when external loads come onto the pile, this is not likely to be a problem because the jack is always positioned low down the pile where the moments in the pile have become small, being mainly dissipated into the ground at high levels in the pile.

6 Processing of measurements

6.1 No strain instrumentation

In this case, the result from the test is a compilation into the head load v. head displacement relationship for the pile. It is obtained by simply plotting graphs of jack load v. displacement for the upper and lower lengths of the pile, and for corresponding values of displacement, adding the jack loads together. This can only be done over the range of displacement given by that part of the pile which moved the lesser amount, hence the need to position the jack so as to balance the ultimate load capacities of the lengths of the pile above and below it.

6.2 With strain instrumentation

6.2.1 Determine the factor to convert strain in the shaft to force in the shaft

For each of the load increments, plot the distribution of measured strains along the length of the pile. Extrapolate the graph lines to the level of the jack. If there are two lengths of shaft, take the mean of the extrapolated values at the jack level.

Plot a graph of jack load v. strains at the level of the jack. The slope of this line is the conversion factor in (say) kN per microstrain.

6.2.2 Determine the distribution of shear stress along the shaft

Using the conversion factor from 6.2.1 calculate the forces in the shaft at the points where strain was measured. The average shear stress between any two of these points is then the difference in the two forces divided by the area of the shaft between them. Graphs showing the distribution of shear stress along the length of the shaft can then be plotted, assuming the average shear stress is correct for the point midway between the force measurement points.

6.2.3 Determine shear stress v. movement graphs for points along the shaft

Using the measurements of movement, together with the measured strains, the movements at the points on the shaft where shear stresses have been calculated can be determined for all load stages. Graphs of shear stress v. relative movement between pile and soil can be plotted for these points, i.e. for the different soil strata down the pile shaft.

6.2.4 Determine end bearing stress v. movement graph

In similar manner to that described in 6.2.1, extrapolate the graphs of strain distribution along the shaft, at each load increment, to the toe of the pile. These extrapolated strains are converted to forces at the toe using the conversion factor from 6.2.1.

Movements at the toe at each of the load increments can be calculated from any of the movement measurements, together with the strain measurements, just as for points along the shaft described in 6.2.3.

A graph of toe force v. toe displacement can therefore be drawn.

6.2.5 Compilation of head load v. head displacement graph

When strain measurements have enabled shear stress v. movement and end bearing stress v. movement graphs to be obtained, the head load v. head displacement graph can be derived using the “load transfer” method. This will give a slightly more accurate result than that described in section 6.1 here, but for piles with a length:diameter ratio of less than 25, the difference is small.

The major value from the strain measurements is that it enables refinements of the pile design to be done (on diameter and depth) to improve economy and reliability.

7 Bibliography

Fellenius, BH 2001 “The O-cell - an innovative engineering tool” *Geotechnical News Magazine* V19, No 2, pp32-37.

Luker, I 1988 "Prediction of the load-settlement characteristics of bored piles" *Deep Foundations on Bored and Auger Piles* pp 229-237 Balkema, Rotterdam

Osterberg, JO 1998 "The Osterberg load test method for drilled shafts and driven piles - the first ten years" *Proc 7th Int'al Conf on Piling and deep Foundations* Vienna, Austria.

Note: Click here to back to the website: http://tambew.com/internally-jacked-test/