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| **Federation of Piling Specialists**  **Testing Datasheet No. 1** |  |

**Guidance for the Principal Contractor**

[www.fps.org.uk](http://www.fps.org.uk) March 2008

It is an essential requirement that the specialist testing contractor is allowed to work in a safe way and fully in accordance with their own procedures.

**1. Static Load Testing of Piles**

**Introduction**

Applies a direct load to the pile head by jacking against an external resistance (Kentledge or Reaction Piles) and movement of the pile head is measured using deflection transducers. The method simulates the pile performance in its working condition and at some specified additional load.

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

* **Preliminary Test**: This is a test carried out on an expendable (non-permanent) pile in advance of the main piling work. The pile is usually tested until it fails and the results are used to validate and possibly optimise 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 verify the settlement performance of the pile(s) at their working (or service) loading.

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.

**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 prestressing 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. A repeat test will severely disrupt your program!

**Testing**

The testing contractor will need road access from the public highway to the test location for the lorries containing reaction system and associated ancillaries plus plant for dead load or larger reaction frame systems.

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

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

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.

**Overnight Working Attendance**

The Engineer’s Specification for the load testing normally requires the load to be maintained and measurements made continuously from the commencement to the completion of the test over a period of about 20 hours. There is no requirement for Overnight Working Attendance as the load test shall be capable of remote monitoring with critical in built safety features, activated should unusual occurrences emerge. However, the Principal Contractor will need to make the following provision outside of normal working hours;

* General site illumination.
* Access and egress will need to be maintained and security provided where appropriate.
* An emergency contact number should be provided to the test operative.

**2. Dynamic and Rapid Load Testing of Piles**

**Introduction**

Examines the performance of a pile under the impact of a heavy falling weight (e.g. Piling Hammer). The inputted force and motion of the pile are measured *indirectly* by re-usable strain and acceleration transducers attached to the pile wall. The test does not require reaction piles/anchorages.

The test pile will be installed by the piling contractor.

The measurements under impact 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.

**Pile Protection between Installation and Testing**

Between installation and testing, the test pile must be protected from damage and interference.

**Testing**

If testing performed without a pile installation hammer on site, the testing contractor will need road access from the public highway to the test location for the lorries which contain the testing equipment. The lorries will also need to be able to park a safe distance from the test area. Craneage/drop weight systems or piling rigs will also need safe access to the test location.

The area around the test must be made suitable for the technician to safely work, i.e. levelled, 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.

During the test, no work that could cause vibration should be carried out adjacent to the test.

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.

**3. Integrity Testing of Piles**

**3a. Low Strain Integrity Testing (Sonic Echo / Transient Dynamic Response)**

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This test method covers the procedure for determining the integrity of individual vertical piles by measur­ing and analyzing the velocity (required) and force (optional) response of the pile induced by a hand held hammer impact device applied axially and perpen­dicularly to the pile head surface. This test method is the most widely used and is applicable to structural elements that are receptive to low strain impact testing.

It is normal practice to carry out an assessment on the integrity of the piles after they have been trimmed to cut-­off level. Low Strain Integrity Testing is a comparative test method and therefore more than one pile shall be made available for assessment on the initial visit to enable evaluation to be meaningful.

The method works best on solid concrete sections, and has limited application to unfilled steel pipe piles, H piles, or steel sheet piles. These data assist evaluation of the pile cross-sectional area and length, the pile integrity and continuity, as well as consistency of the pile material, although evaluation is relative and approximate. This test method will not provide information regarding the pile bearing capacity

To enable this technique to be carried out, the Principal Contractor should note that:

* The pile(s) need to be trimmed down to sound material and free from standing water.
* A safe access will be provided for the test technician to gain access to ALL the pile head.
* The pile cap or ground beam reinforcement must not be in place.
* Although a thin layer of blinding can be in place around the pile, it must neither cover the pile nor be greater than 75mm thick.

**3b. Crosshole Sonic Logging Integrity Testing**

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This test method covers procedures for checking the homogeneity and integrity of concrete in deep foundation such as bored piles, diaphragm walls, barrettes etc.

**To enable this technique to be carried out, the Principal Contractor should note that:**

* Proper installation of the access ducts is essential for effective testing and interpretation.
* For crosshole tests, the access ducts should preferably be made of steel to prevent debonding of the access duct from the concrete resulting in an anomaly.
* If the access duct diameter is too large it influences the precision of arrival time and relative concrete wave speed. Access ducts typically have an internal diameter from 38 to 50 mm.
* The access ducts shall be installed such that their bottom is as close as possible to the bottom of the concrete deep foundation element so that the bottom condition can be tested. The access ducts shall have a minimum concrete cover of one tube diameter.
* Access tubes shall be secured to the inside of the main axial reinforcement of the steel cage at frequent and regular intervals along their length to maintain the tube alignment during cage lifting, lowering and subsequent concreting of the deep foundation element.
* Access ducts shall preferably be filled with water prior to, or within one hour of, concrete placement to assure good bonding of the concrete to the tube after the concrete cools.
* The method does not give the exact type of flaw (for example, inclusion, honeycombing, lack of cement particles, etc.) but rather only that a flaw exists.

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| Typical Access Duct Configurations |

**Pile Protection between Installation and Testing**

Between installation and testing, the access tubes protruding above the pile head must be protected from damage, crushing and interference. They must be sealed to stop ingress of unwanted material entering the tubes.

**Grouting after Completion of Testing**

The water filled access tubes usually require grouting for structural or aquifer protection reasons. The tubes should only be grouted after confirmation of acceptable test results and that no re-testing or tomography testing is required.

**3c. Thermal Integrity Profiling**

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This test method covers procedures for measuring the temperature profile within a deep foundation element constructed using cast-in-place concrete, such as bored piles and diaphragm walls, barrettes, etc. The thermal profile induced by the curing concrete can be used to evaluate the homogeneity and integrity of the concrete mass within the deep foundation element.

To enable this technique to be carried out, the Principal Contractor should note that:

* Thermal sensors shall be at­tached to the reinforcing cage and aligned with the longitudinal reinforcement of the foundation element corresponding to a given measurement location.
* Requires reinforcement cage(s) delivered to site in advance of installation to allow time for fixing the appropriate number of wires.
* Proper installation of thermal sensors is necessary for effective testing and interpreta­tion.
* The method is limited primarily to testing the concrete during the early curing process.

**Pile Protection After Installation and during Monitoring**

During the hydration process, the pile head and data acquisition units must be protected from damage, crushing, infilling and excavation. A substantial exclusion or protective barrier system shall be employed. The optimal thermal test time occurs when the core tempera­ture reaches a peak and provides the maximum contrast to the surrounding material, which depends on the foundation cross-sectional area and the concrete mix. For cylindrical foundations, a minimum wait of 36 to 48 hours is common.

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| **Federation of Piling Specialists**  **Testing Datasheet No. 2** |  |

**Pile Testing – Interpretation**

**Pile Load Testing**

Normally the specialist testing contractor undertakes the load test, takes measurements and then reports the factual data.

The pile designer (whether piling contractor, Engineer, or another party) then interprets the factual data within the context of the design as they should have full knowledge of all the relevant information. This note is applicable to those interpreting all types of pile load test (including static, dynamic and rapid tests).

Competence requirement for persons interpreting a Pile Load Test

There are no formal academic qualifications available for interpreting the results from a static pile load test, but recognised dynamic testing specialists can be found at [www.pdaproficiencytest.com](http://www.pdaproficiencytest.com) . As a minimum, the following attributes should be demonstrable by any person carrying out such an interpretation;

1. The person must be able to demonstrate competence in the testing method and an understanding of the limitations of the method in relation to the intended use of any results obtained.
2. The person must be able to evaluate the results within the context of the design.
3. The person must be able to communicate findings obtained from the test to a third party who is possibly not competent in pile testing.

**Pile Integrity Testing**

Normally the specialist testing contractor undertakes the test, records the measurements and then reports the factual data with an assessment of the pile’s integrity. The specialist testing contractor will not pass judgment within the context of the pile design and in terms of performance under load or durability.

The piling contractor should also carry out an assessment of the results and act upon any anomalies.

This note is applicable to those interpreting all types of pile integrity test (including sonic echo, transient dynamic response, cross hole ultrasonic logging and Thermal Integrity Profiling).

Competence requirement for persons interpreting a Pile Integrity Test

There are no formal academic qualifications available for interpreting the results from a pile integrity test, but freely available courses, ran by specialists in this field provide competency certificates. As a minimum, the following attributes should be demonstrable by any person carrying out such an interpretation;

1. The person must be able to demonstrate competence in the testing method and an understanding of the limitations of the method in relation to the intended use of any results obtained.
2. The person must able to demonstrate an understanding of their own company procedures.
3. The person must be able to evaluate the results within the context of the design.
4. The person must be able to communicate findings obtained from the test to a third party who is possibly not competent in pile testing.

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| **Federation of Piling Specialists**  **Testing Datasheet No. 3** |  |

**Training Programme for Pile Testing Operatives**

Any company undertaking pile testing should have a training scheme in place in a form similar to that below. This is to be substantiated by company training records.

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| **Trainee Pile Testing Technician**  **Name:**  **Training Programme** | **Person responsible  for arrangements** |
| **Induction** |  |
| Company Policies & Procedures |  |
| Company - General Site Rules |  |
| Company Reporting Routes |  |
| Roles and Responsibilities |  |
| Environmental Awareness Training |  |
| Spill Kit & Fire Extinguisher Training |  |
|  |  |
| 1 Day Construction Site Safety Awareness Training |  |
| CSCS Touch Screen Awareness Study |  |
| CSCS Touch Screen Test |  |
| Safe use and wearing of PPE & Safety Harnesses |  |
| Slinger / Signaller |  |
| Manual Handling |  |
| Safe Use of Equipment Briefing / Familiarisation |  |
|  |  |
| **Site Experience** |  |
| Accompanied Pile Testing |  |
| Pile Testing unaccompanied |  |
|  |  |
| **Reviews / Reports** |  |
| Initial |  |
| Interim |  |
| Issue of company competence card |  |
|  |  |
| **Records** |  |
| Log book |  |

Note: not all of these are applicable for every type of pile test

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| **Federation of Piling Specialists**  **Testing Datasheet No. 4** |  |

**Static Pile Load Testing**

**Minimum Requirement for an Automated Remote Control System**

To add and encourage safety to all involved an appropriate remote control system shall be employed to help prevent accidents to those directly and indirectly involved in the testing process. The Main Contractor and Pile Designer shall ensure the remote system is intrinsically safe, including additional instrumentation.

As a minimum, the system shall possess;

* Ability to monitor reaction frame stability
* Detect, and react to excessive reaction frame movement as a result of a failing anchor(s) or in the case of a kentledge stack, some form of potential toppling.
* Control systems that are autonomous and able to stop excessive parameters being breached without manual input
* Detect, and react to an excessive hydraulic pressure difference, above or below that to be expected as calculated from the load measured. (detection of hydraulic system failure)
* Detect, and react to excessive pile cap rotation.
* Detect, and react to excessive Pile Displacement or an inability to comply with Specification parameters.
* Detect, and react to an excessive time to achieve a load stage.
* Communication Links
* Alert by text/email as to the state, should any of the above be instigated.
* A Web based update available to both the specialist testing company and piling contractor.
* Backup data both off and on site.

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**Choice of the Pile Integrity Assessment**

To encourage an appropriate strategy for pile integrity testing it is recommended that the pile designer informs the pile contractor the type and purpose of the specified pile integrity test. None of the options provide information regarding the pile bearing capacity. The options could be one or more of the following;

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* Low Strain Impact Integrity Assessment (Sonic Echo or Transient Dynamic Response)

Most applicable to, cast in place concrete piles of diameters ranging between 250mm and 1000mm. For meaningful interpretation, length/diameter ratios less than 30 is applicable. Not suitable for mini piles (below 250mm), steel pipe piles, H section or sheet piles. Has limited application on precast concrete segmental piles.

The data assists evaluation of the pile cross-sectional area and length, the pile integrity and continuity, as well as consistency of the pile material, although evaluation is relative and approximate.

Low Strain testing may not identify all imperfections, but it can be a useful tool in identifying major defects within the effective length.

Preferable to plan for 100% of piles to be assessed as it is commonly known that mechanical imperfections from site activities can damage small diameter/lightly reinforced piles.

* Crosshole UltraSonic Logging

Most applicable to cast in place piles of diameters in excess of 750mm and large length/diameter ratios, as the method is not depth dependent. Access tubes (recommendation: one per 300mm of diameter) must be inserted to the full depth of the pile shaft.

Test programme should start with high percentage of testing to establish installation technique is successful, reducing for the remaining installations based on verified results.

* Thermal Integrity Profiling

Most applicable to cast in place piles which contain a full length skeleton/reinforcement cage. Sensors shall be placed within 150 mm of the bottom of the foundation element to provide information concerning the pile base. As with crosshole logging, is not depth dependent. Recommendation: one wire per 300mm of diameter and ideally even numbers to simplify interpretation.

Test programme should start with high percentage of testing to establish installation technique is successful, reducing for the remaining installations based on verified results.

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**Testing Datasheet No. 6**

**Pile Load Testing**

**What each test type should realistically achieve.**

**Static**

1. The test is carried out to a specified method of applying a static load incrementally to the test pile head and measuring the pile head deflection under the applied load.
2. Static load testing will give information about the deflection versus time and load versus deflection characteristics of the pile.
3. The test results should be presented graphically in the form of load and deflection versus time and load versus deflection. The results should also be presented in tabular form.
4. The load versus deflection curve will provide the pile designer with data to assess the suitability of the pile to support the structure.
5. If the pile fails to meet the specified performance criteria during the test the data can be analysed to indicate the mode of failure.

**Dynamic**

1. The test is carried out to a specified method of applying a dynamic load to the head of the pile using a pile hammer or drop weight. The resulting pile head forces and displacements are measured (or derived from other parameters) versus time and this data is subsequently analysed.
2. If carried out on a driven pile during driving the test will provide information on pile hammer performance, pile driving stresses and the bearing characteristics of the pile during and at the end of driving.
3. If carried out on a driven pile by re-striking the pile, at some time after initial driving or on a cast in place pile, the test will give information about expected pile performance under static load.
4. The test results should include the measured (or derived) force and velocity versus time graph, the computed static load versus deflection (and if required the load distribution along the pile shaft and pile end bearing). All test results should be presented graphically and numerically.
5. Depending upon site factors the test can be used on its own or in conjunction with static load testing to assess the suitability of the pile to support the structure for which it was designed.
6. The test also provides information that can be used to interpret pile integrity.

**Rapid**

1. The rapid load test is carried out to a specified method of applying a load to the pile head utilizing a reaction system and a rapid-burning fuel. The resulting pile head forces and displacements are measured versus time and are subsequently analysed using computer software.
2. The test results should include the measured force and velocity versus time graph, and if required the computed static load versus deflection. All test results should be presented graphically and numerically.

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**Testing Datasheet No. 7**

**Pile Load Testing**

**Minimum information provided to the Testing Contractor**

**General**

Full site address, including Project Name

Site location map

Contract identification number

Principal contractor name

Engineer’s name

Client/Employer’s name

Number of pile tests

Type of pile test, including additional monitoring, e.g anchors

Testing specification

Any particular site restrictions and site specific safety rules

Details of site induction(s)

Piling contractor’s office and site contact details, including email address for factual report

24 hour piling contractor’s contact details

**Pile Information**

Identification (number and location)

Pile diameter or width

Piling technique

Cast date

Ground conditions

Specified Working Load (SWL)

Design Verification Load (DVL)

Unfactored Negative Shaft Friction Load (NSF)

Peak Test Load

Design Factor of Safety

Platform level at pile position

Pile cut-off-level

Test pile head level

Vertical test pile or raking, tested in compression, tension, or laterally

Pile length in ground

Level of pile toe

Dimensions of any permanent casing or cast-in steel members

Whether test pile incorporates any instrumentation

Details of reaction arrangement

Bar size provided in any reaction piles

Test pile cap details, including cast date

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| **Federation of Piling Specialists**  **Testing Datasheet No. 8** |  |

**Pile Load Testing – Test Cap**

General

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 be made available to the Principal Contractor or Engineer upon request.

For cast in situ preliminary test piles where test loading can be significant, consideration should be given to installing steel casing for the upper few metres of pile length. This will make determining the centre of the pile easier and avoid undesirable eccentric loading and structural failure of the top of the pile.

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.

Dynamic Testing (Cast In-Place Piles only)

The test cap shall be formed at the same time as the installation of the pile, to ensure the concrete properties of the shaft are the same as the sacrificial cap. The cap shall be of similar diameter as the shaft, built up above ground in a thin walled liner and capable of withstanding the impact of a heavy falling weight.

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| **Federation of Piling Specialists**  **Testing Datasheet No. 9** |  |

**Pile Load Testing – Working Platform**

**Why it is important to adequately maintain the working platform until the end of all piling activities**



* The working platform provides access for all piling plant, labour and testing activities
* The working platform must be designed, constructed, maintained and repaired so as to always provide the safe access for all piling plant, labour and testing equipment
* The working platform must have a specified design life, which is to begin before the piling contractor starts work on site, and must not end at least until all piling works (including pile construction, load testing, investigation of any non-conformances and the repair or replacement of any piling works) are completed
* The FPS Working Platform Certificate, or similar, is to be used
* If the working platform is to be constructed or removed in phases whilst any piling works are still ongoing, then the extent of these works shall be clearly described to, and agreed with, the piling contractor
* Note that pile load testing will require safe access to the test pile position for lorries, craneage and labour, both for erection of the test and for the dismantling of the test afterwards.

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| **Federation of Piling Specialists**  **Testing Datasheet No. 10** |  |

**Pile Integrity Assessments - A Good Practice Guide**

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1 Pile integrity assessments are normally carried out after the piling contractor has left site. It is important therefore that the piling contractor provides the Principal Contractor with a specified contact person who will arrange for testing to be carried out when requested.

2 The contract documentation will normally specify how many visits to site are

allowed to carry out the integrity testing or the minimum number of piles to be tested at each visit. This aspect can be usefully addressed during the pre-start or subsequent progress meetings.

3 It is good practice for the Principal Contractor to be provided with guidance on

the preparation of piles for testing, specifically that:

* The pile needs to be trimmed down to sound concrete.
* Safe access needs to be provided for the test technician to gain access to the head of each pile.
* The pile cap/ground beam excavations must be clear of any standing water.
* The pile cap or ground beam reinforcement must **not** be in place.
* Although a thin layer of blinding can be in place around the pile, it must neither cover the pile nor be greater than 75mm thick.

4 Where the integrity test results indicate there is an anomaly in the pile, the Principal Contractor should be advised at the earliest opportunity so that potential problems can be promptly addressed. It should be noted that anomalies identified at the time of testing may be re-evaluated after processing of the data. Hence, sufficient time in the Principal Contractor’s programme should be allowed for dealing with any potential anomalies.

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**Pile Integrity Assessments**

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**Minimum information provided to the Testing Contractor**

**General**

Full site address, including Project Name

Site location map

Contract identification number

Principal contractor name

Engineer’s name

Client/Employer’s name

Number of pile tests

Type of pile test

Any particular site restrictions and site specific safety rules

Details of site induction(s)

Piling contractor’s office and site contact details, including email address for factual report

**Pile Information**

Identification (numbers and locations)

Pile diameter or width

Piling technique

Ground conditions

Platform levels

Cut-off levels

As-built pile lengths in ground for every pile to be tested

As-built levels of pile bases

As-built toe levels of pile reinforcement

Dimensions of any permanent casing or cast-in steel members

Details of any flared heads or enlarged pile bases

The following information may be requested after the test;

* Date of installation(s)
* concrete overbreak or undersupply
* records of construction or concreting sequence

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| **Federation of Piling Specialists**  **Testing Datasheet No. 12** |  |

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**Pile Integrity Testing**

**Why it is important to allow enough time   
between pile integrity testing and pile cap construction?**

* Pile integrity testing is an important part of the pile construction process
* There is a small risk that the pile might be damaged after construction, either by the ground itself or by the following site activities
* When pile damage or an anomaly has been identified, it is important that the appropriate measures are then carried out;

1. the integrity test result must be reviewed by a competent person
2. the pile construction record must be reviewed and compared to the pile integrity test result
3. if after data processing there is still doubt regarding the pile quality, an inspection must be made, normally requiring excavating around the pile or coring through the pile
4. if a problem is found to exist, remedial measures will then need to be designed, approved and installed

* Hence, it is important that the site programme is designed to allow the time for reporting the pile test results and for any subsequent checks and remedial actions, if any, to be carried out

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**Federation of Piling Specialists**

**Testing Datasheet No. 13**

**Low Strain Pile Integrity – Evaluation Criteria**

Certain limitations are inherent in low-strain integrity testing. These limitations must be understood and taken into consideration in making the final integrity evaluation.

Integrity evaluation of a pile section below a crack that crosses the entire pile cross-sectional area or a manufactured mechanical joint is not normally possible since the impact wave is likely to be reflected completely at the discontinuity.

Piles with highly variable cross sections or multiple discontinuities may be difficult to evaluate. In some cases, it may be difficult to distinguish the soil response from the pile response.

If the reflection from the pile toe is not evident in the records, the integrity evaluation may not be conclusive and may be limited to a certain unknown depth. This limitation may apply to long or highly variable piles or piles in soils that exhibit relatively high friction.

The test may identify minor imped­ance variations that may not affect the intended use of the pile. For piles having minor impedance variations, the engineer should use judgement as to the acceptability of these piles considering other factors such as load redistribution to adjacent piles, load transfer to the soil above the variation, applied safety factors, and structural load requirements.

Different testing contractors use slightly different terminology for the assessment of piles. Terminology similar to that below is recommended;

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| **Assessment by the testing  contractor** | **Description** | **Site actions required to be  carried out by the main  contractor** |
| OK | Pile acoustically satisfactory | None - proceed |
| Trim and re-test | Anomaly identified at pile head | Trim pile to sound concrete and schedule a new integrity test with the testing contractor |
| Review | Acoustic review needed after  detailed analysis or upon  receipt of further information | Contact piling contractor. Piles to be left alone unless agreed with piling contractor |

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**Crosshole Sonic Logging - Criteria for Evaluating Data**

|  |  |
| --- | --- |
| **Federation of Piling Specialists**  **Testing Datasheet No. 14** |  |

The test measures the propagation time and relative energy of an ultrasonic pulse between parallel access ducts (crosshole) or in a single tube (single hole) installed in the deep foundation element. This method is most applicable when performed in tubes that are installed during construction. This test can assess the integrity of the concrete mainly in the area bounded by the access ducts, which means typically inside the reinforcement cage.

The most common criteria for evaluating the data are the First Arrival Time (FAT) and the signal attenuation. The pictorial presentation known as the “waterfall” is also commonly provided. Quantitative evaluation of concrete piles using the limits below may be used for guidance;

|  |  |  |  |
| --- | --- | --- | --- |
| **Evaluation** | **Increase in FAT** |  | **Reduction in signal energy** |
| **Good** | 0 to 10% | and | < 6 dB |
| **Questionable** | 11 to 20% | and | 6 to 9 dB |
| **Flaw** | 21 to 30% | or | 9 to 12 dB |
| **Defect** | > 31% | or | > 12 dB |

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**Thermal Integrity Profiling - Criteria for Evaluating Data**

|  |  |
| --- | --- |
| **Federation of Piling Specialists**  **Testing Datasheet No. 15** |  |

Exothermic chemical processes generate heat as con­crete cures within a cast-in-place deep foundation element. The amount of heat generated and the rate of heat dissipation are strongly influenced by the concrete mix and by the size and shape of the deep foundation element. Therefore, temperature measurements within the deep foundation element provide a thermal profile from which to evaluate the consistency of the concrete and the regularity of its shape. Temperature measured at the reinforcing cage, typically near the perimeter, will be lower than the core temperature due to heat dissipation into the surroundings (for example, soil, rock, water or air). If the cage is not concentric within the foundation element, then the portions of the cage closer to the perimeter will be cooler during those times when elevated temperatures exist. Portions closer to the center will be warmer.

A flaw in the form of a void, a neck, an inclusion, or poor quality concrete will generate less heat than the normal concrete around it, resulting in lower temperature near the flaw. Conversely, a bulge will have more effective concrete cover, resulting in higher temperature near the bulge. Temperature measurements at access locations equally spaced around the circumference of the reinforcement cage and at regular depth intervals allow the user to identify potentially weak zones of concrete, to estimate the effective size of the foundation, and to check concrete cover and cage alignment along the length of the foundation element.

During the initial concrete hydration period of a deep foundation element, heat production exceeds the rate of dissipation into the surrounding material, and thus it dominates the early thermal profile. Analysis also shows that the degree of saturation in the surrounding material has little effect on the early thermal profile. Interpretation of the thermal profile should consider any significant changes in the thermal diffusivity of the environment around the deep foundation element, for example, when it extends above the ground surface through air or water.

Can be used to assess the homogeneity and integrity of concrete both inside and outside the reinforcing cage, as well as placement of the cage relative to the center of the curing concrete.

Potential local defects indicated by locally low temperatures relative to the average temperature at that depth, or average temperatures significantly lower than the average temperatures at other depths, shall be immediately reported to the Engineer.

If a flaw is detected, then the method does not give the exact type of flaw (for example, inclusion, bulge, honeycombing, lack of cement particles, and alike.) but rather only that a flaw exists.

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**Pile Testing - Safety**

|  |  |
| --- | --- |
| **Federation of Piling Specialists**  **Testing Datasheet No. 16** |  |

Main Contractor Site Briefing & Tool Box talks SHALL include for remote load testing and strict adherence to safety parameters re-emphasized. Exclusion Zones shall and will be maintained at all times for all pile testing activities.

Specific hazards for pile testing may include but are not limited to the following;

**1. Load Testing**

* Manual handling of items of test equipment.
* The forces induced in the test equipment during testing can be very large indeed. Thus a clearly marked and signed exclusion zone must be created around the test area and access restricted.
* During the test the following substances may be used: batteries, oxygen free nitrogen, petrol/diesel and hydraulic oil. The appropriate COSHH sheets are to be made available upon request.
* Working at height during erection and dismantling of the test equipment.
* The area around the test must be made suitable for the operative(s) to safely work, i.e. levelled, hard-cored and without trip hazards.
* Safe and maintained access to the test area for lorries and plant.
* Lifting operations.
* Use of Working Platform Certificate for the platform within and around the test area.
* No excavations must take place around the test area.

**2. Integrity Testing**

* A safe access needs to be provided for the test technician to gain access to the head of the pile.
* The pile cap/ground beam excavation must be clear of any standing water.
* The pile cap or ground beam reinforcement must not be in place otherwise there will not be safe access for the technician and protruding tie wire can cause injuries.

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