

PILE CAPACITY USING THE PILE DRIVING ANALYZER

1. INTRODUCTION

This Technical Note provides information on the testing of piles using the Pile Driving Analyzer (PDA) and outlines the benefits of the assessment of pile capacity and pile integrity and the performance of the pile driving equipment. PDA testing may be used to assess both driven and cast-in-place piles. It is applicable to all pile types, including steel, concrete and wood.

VicRoads introduced PDA testing into Australia in 1982, and has since been using and specifying PDA testing to assess pile capacities of driven and cast-in-place piles.

It should be noted that VicRoads Standard Specification for Roadworks and Bridgeworks, Section 605 – Driven Piles, and VicRoads Design Technical Note 96/001 – Design Parameters for Driven Piles, details the requirements for PDA testing of piles to confirm the design pile capacity.



Figure 1. Pile with Strain Gauge and Accelerometer

2. PDA TESTING

PDA testing involves the instrumentation and monitoring of piles during initial driving, or on restrike testing. The instrumentation generally consists of two strain gauges and two accelerometers, which are attached to the upper section of the pile. (Refer Figure 1.) In some circumstances a total of four of each gauge type may be used. These gauges are monitored using the pile driving analyzer. (Refer Figure 2.)



Figure 2. Pile Driving Analyzer

The strain gauges measure the compression in the pile shaft during, and immediately after an impact from the pile driving hammer. The pile compression is directly related to the stress, or force in the pile. The accelerometers measure the accelerations of the head of the pile, which can then be related back to the velocity of the head of the pile during and immediately after an impact from the pile driving hammer.

During PDA testing, each blow from the hammer can be recorded on the pile driving analyzer, and checked in the field to ensure that the response from the gauges is correct.

The field check of the data will also indicate:

- if the pile driving system is operating correctly;
- if the pile has suffered damage during driving or construction (i.e. bored piles);
- an approximate ultimate pile capacity.

To complete the PDA test the field data is taken back to the office and analyzed using a special computer program. GeoPave uses the full wave equation analyses program called **CAPWAP (CAse Pile Wave Analysis Program)**. Other similar programs, such as TNOWAVE, are also acceptable.

3. ADVANTAGES OF USING PDA TESTING

PDA testing offers the following advantages:

- significant cost and time savings can be achieved,
- improved construction quality,
- provides approximate pile capacity in the field immediately after each blow of the hammer,
- provides measured transfer energy in the field
- verification of pile structural integrity in the field,
- can be used to monitor induced pile compressive and tensile stresses during pile driving,
- provides a high level of certainty on the computed ultimate load capacity of the pile,
- provides a load-displacement curve as well as the ultimate capacity, (empirical capacity methods, such as Hiley, provide ultimate pile capacity only).
- provides resistance distribution along the pile shaft, after CAPWAP analysis,
- can provide a continuous record of pile resistance with embedment depth.
- test piling programs to determine design founding levels and allowable pile capacities prior to tendering, can result in considerable cost savings, where large numbers of piles, or high design loads are required.

4. DATA COLLECTION CONSIDERATIONS

In order to ensure correct results from the PDA test, the following is required:

- correct hammer size to mobilise the pile during the test;
- proper alignment of hammer and pile;
- uniform impact of hammer and pile;
- correctly calibrated accelerometers and transducers;
- correct attachment of accelerometers and transducers to the pile;
- full and correct details of the pile, including length below the position of the gauges, cross sectional area and pile modulus;
- an experienced PDA operator.

5. PDA TEST INTERPRETATION

The field data obtained from the PDA test is generally analysed, using the CAPWAP computer program, by an experienced geotechnical engineer. The analyses program attempts to model the pile soil system, using various soil and pile properties, and compares the model with the measured force or velocity response of the pile, after impact by the pile driving hammer, over a set period of time. The program requires many parameters to be established, and may carry out several hundred iterations for each variable.

Once the pile model has been established, the program compares the actual field test response with a computed response using the model, and assigns a match quality ranking (MQ). The MQ will indicate the degree of confidence in the analysis.

6. REFERENCES

CAPWAP Manual, GRL, Cleveland Ohio, 1993, Stresswave '96, Fifth International Conference on the Application of Stress-Wave Theory to Piles, September 11-13, 1996, Orlando, Florida, edited by F.C. Townsend, Mohamed Hussein and M.C. McVay.

VicRoads Standard Specification for Roadworks and Bridgeworks, Section 605 – Driven Piles.

VicRoads Design Technical Note 96/001 – Design Parameters for Driven Piles.

AS 2159 Piling - Design and Installation.

7. CONTACT OFFICERS

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