GEO DYNAMICS

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Quarterly Newsletter No.5 – August 2012

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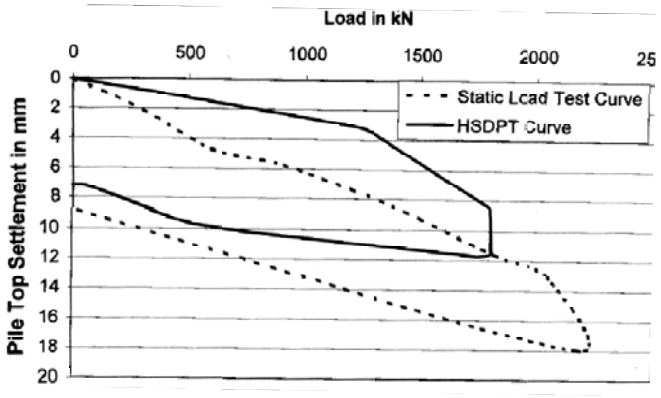
RELIABILITY STUDY FOR ROCK SOCKETED PILES IN MUMBAI

High Strain Dynamic Pile Testing (HSDPT) is now routinely used in Mumbai where buildings, flyovers are mostly founded on pile foundations. Construction of cast-in-place and pre-cast prebored piles is very common in Mumbai. Most of the piles are cast-in-place concrete bored piles with diameter ranging from 400mm to 1500mm. In some cases where chloride or sulphate content in soil is high, prebored and pre-cast piles are also used. The type of strata where the piles are embedded is mostly rock that could be breccia or basalt and maybe weathered or sound. Pile foundations are hence designed as toe bearing piles with capacity contributed by toe bearing or by combination of rock socket friction and toe bearing. High strain dynamic pile testing is now accepted in Mumbai as many reliability studies with conventional static tests have been done for various flyover projects and published literature available. Following are few case studies for the rock socketed piles on which HSDPT was performed.

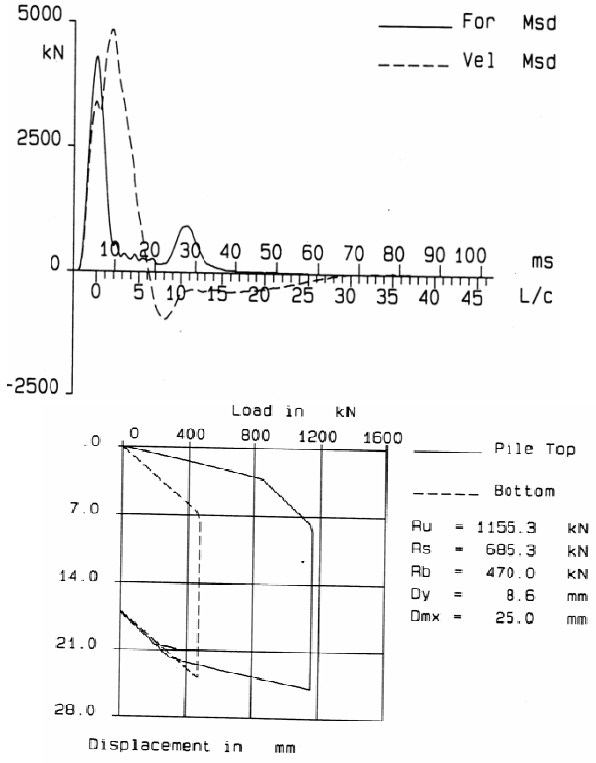
Case Study : 1 For a multi-storey tower in Mumbai 500 mm pre-cast and prebored piles were used as a foundation. Approximately 200 such piles were installed at the project site. The piles were 8.5 m – 9.5 m deep and terminated into highly weathered grayish black basalt rock. The piles were designed for a test load of 3000 kN (design load was 1500 kN).

High Strain Dynamic Pile Tests were conducted on 30 piles at the project site. The tests were conducted using a 22 kN hammer falling from 1 m to 3 m drop height. These piles showed capacity ranging from 750 kN to 2000 kN only. Most of the piles showed very high permanent settlement ranging from 10 mm to 200 mm during repetitive blows of the hammer and this was significantly higher than the permissible values. Static testing was also done on a pile adjoining to one of the piles that were dynamically tested. The purpose of selecting an adjoining pile was to ensure that the geotechnical parameters remain the same. Figure presented below shows the reliability study between static and HSDPT results. It can be inferred that both the tests show similar load bearing capacity and high net settlement.



Reliability Study

It was concluded that this was primarily due to two reasons. a) The grout was not injected under adequate pressure and this resulted in grout or debris remaining below the pile, also described as soft toe condition. This caused excessive net settlement. b) The rock socket was inadequate and hence these piles could not reach the respective test loads. Refer to PDA data in Figure presented below which show that either of these findings is a possibility.



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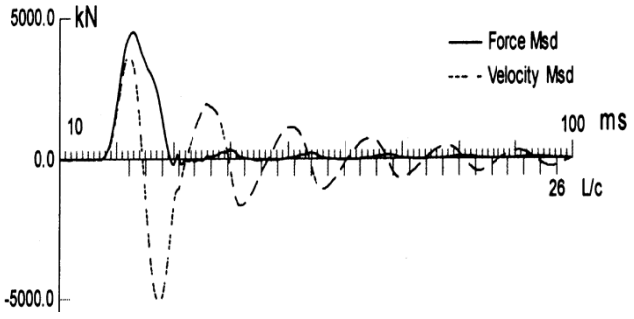
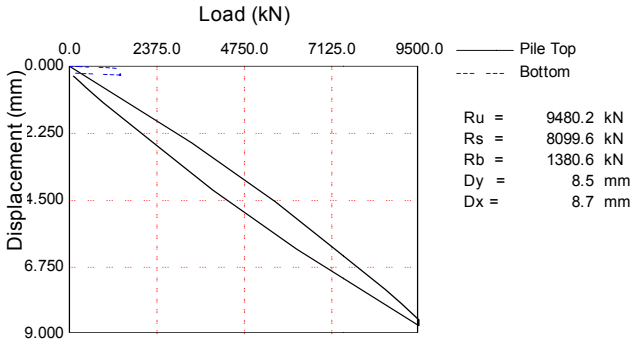
Eventually all the piles were rejected and it was then decided to install new cast-in-place reinforced concrete bored piles with permanent liners. The piles were 600 mm diameter with a depth of 11.5 m – 13.0 m and the expected test load was 6300 kN (design load of 4200 kN). These piles were installed in fresh grayish black basalt and they were socketed for a depth of 2 m into the stratum. This was at least 3 m more than the previous piles. These piles were tested using a 38 kN hammer falling from a height of up to 3.5 m. All the piles achieved the required test load and there was hardly any net settlement recorded by the piles.

The pile integrity was found to be acceptable and there was no sign of crushing of pile toe in the records. The maximum compressive stress at the pile head and at the pile toe never exceeded 35 MPa. Thus the tests demonstrate that toe bearing piles installed into hard stratum or with rock socket can be tested by HSDPT.

Since the pile shows negligible net settlement due to being installed in hard stratum, it was inferred that it may achieve ultimate capacity only due to maximum stress in concrete.

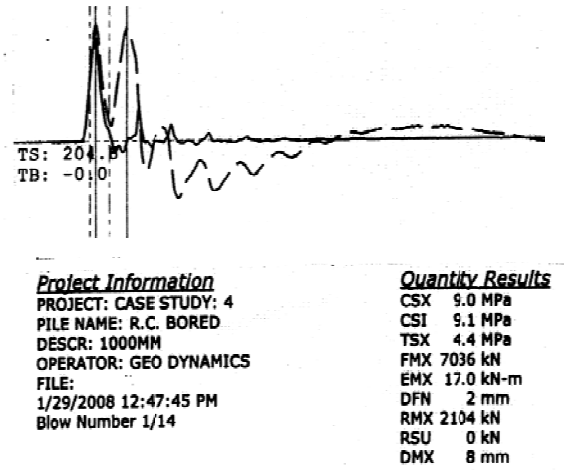
As only a 38 kN hammer was used to test the pile up to 6300 kN (hammer weight is 0.6% of test load), it can be said that lighter hammer can be used to measure heavier loads for rock socketed piles. A hammer weight of 1% - 2% of the test load may not be required all the times. However, this depends on experience in the region and should be used with precaution. Following figure presents the field data and simulated load test curve after CAPWAP analysis for one such pile.





Case Study : 2 In another case, for a multi-storey building in Mumbai, a 1.0 m diameter pile with permanent liner was suspected to have soft toe condition during low strain integrity testing. The pile was installed in fresh rock and socketed to one times the pile diameter. The required test load for the pile was 3600 kN. HSDPT conducted on the pile with a 40 kN hammer and 1.5 m drop showed much lower capacity for the 1st blow at only 2100 kN.

The pile was then subjected to 14 blows to check if weak material beneath the pile can be removed so that more toe bearing can eventually be mobilized. It was observed that the pile permanently settled by 70 mm during the blows and then was able to take the required load. Although, theoretically the pile fails to achieve the required load within permissible settlement values, no further remedial action was required. Refer to PDA field data in the following figure that shows capacity lower than test load.



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Hence, from these case studies it can be concluded that the High Strain Dynamic Testing is applicable for rock socketed piles. For piles in hard rock or socketed very deep into weathered rock and which may not undergo a measurable net displacement, the ultimate capacity will mostly be defined by the permissible stress in concrete.

It is possible to test rock-socketed piles with hammer weights up to 0.7% of the test load considering a drop of 1 m – 3 m and where dead weight of the pile is not a governing criterion. However, this must be used where there is past local experience or soil stratum is reasonably known.

WAVE EQUATION ANALYSIS PROGRAM (WEAP) TRAINING IN VIETNAM

A 3 day training course was conducted by Mr. Sujan Kulkarni for Vietsovpetro in Vietnam. Mr. Kulkarni trained the attendees on the latest version (2010) of WEAP.

The training covered theory, operational procedure as well as solution for the Client's real problem related to offshore driving of raker steel pipe piles. We acknowledge PDI's support which helped us in smooth execution of the training program.

GEO DYNAMICS CELEBRATES THE 1ST ANNIVERSARY OF THE NEWSLETTER

Its already been a year since we have launched newsletter series. Major credit goes to our well wishers and technocrats who always motivated us by appreciating us for publishing useful information. We will try our best to continue in similar fashion and publish more and more interesting case studies to keep construction fraternity up to date.

TECHNICAL LECTURES AND TRAINING SESSIONS

Mr. Vaidya presented lectures on foundation and super structure QA/QC, GPR studies at the following events.

1. IGS Seminar at Vadodara on 23rd, 24th June, 2012
2. Institute of Engineers Seminar at Goa on 29th June, 2012
3. Gayatri Vidya Parishad College of Engineering, Visakhapatnam.

Training Programs were conducted for Gujarat Electricity Board Engineers at GUVNL, Vadodara on new methods for Non Destructive Testing.

Three day training was undertaken for Nigerian engineers on deep foundation testing. Mr. Vaidya also conducted a training program for Al Tariq Engineering Bureau a company based in Iraq.

VISIT GEO DYNAMICS BOOTH AT DEEP FOUNDATION INSTITUTE (DFI) CONFERENCE IN CHENNAI

DFI is arranging a national level conference at IIT Chennai from 17th to 21st September. The program comprises a one-day short course on deep excavation systems, followed by a 2-day main conference as well as exhibition. On the last day, an informative field visit to the landmark Chennai Metro project site is arranged. The conference will be useful to all the Professional Engineers, Contractors, Academicians etc. Geo Dynamics will participate in Exhibition and will put up a stall. Do not forget to visit our stall and to update yourself in the latest technologies in deep foundation and super structure industry.

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