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IGS News

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Geotechnical Calendar

- Asian Regional Conference on Geosynthetics (GEOASIA 2004), South Korea, June 21 - 23, 2004.
- Geo-Environment 2004: International Conference on Monitoring, Simulation and Remediation of the Geological Environment, Segovia, Spain, July 5 - 7, 2004
- National Symposium on Advances in Geotechnical Engineering (NSAGE 2004), Karnataka Geotechnical Centre, Department of Civil Engineering, Indian Institute of Science, Bangalore, July 22 - 23, 2004
- Joint Speciality Conference on Probabilistic Mechanics and Structural Reliability, Sandia National Laboratories, Albuquerque, New Mexico, July 26 - 28, 2004.
- The Seventh International Conference on the Application of Stress Wave Theory to Piles - Malaysia - August 8-10, 2004 sec@iem.po.my
- International Symposium on Lowland Technology, International Association of Lowland Technology and Faculty of Engineering, Kasestart University, Bangkok, Thailand, Prof. N Miura, Email fengwnl@ku.ac.th; http://enve.eng.ku.ac.th, Sept. 1-3, 2004
- International Conference on Site Characterisation, Lisbon, Portugal, Sept. 20 - 22, 2004
- International workshop on Risk Management in Site Characterisation and Geotechnical Design (GEORISK), department of Civil Engineering, Indian Institute of Science, Bangalore, November 26 - 27, 2004.
- Indian Geotechnical Conference - 2004, Ground Engineering - Emerging Techniques GREET, IGS Warangal and Kakinada Chapters, Dec. 17 - 19, 2004, email igswgl@yahoo.com
- Geo-Frontiers 2005, Geo-Institute of ASCE and Geosynthetic Materials Association, Austin, Texas, USA, January 24-26, 2005.
- Indian Geotechnical Conference - 2005, Indian Geotechnical Society, Ahmedabad Chapter, Ahmedabad, December 2005.

From the Editor's Desk ... Issues On Piling

Pile foundations are now extensively used for high-rise buildings, bridges and offshore structures. Many field engineers have expressed their deep concern over the fact that a holistic approach is not taken over the three aspects of design, construction and performance evaluation of pile foundations. The most common approach is to take care of the immediate problem at hand.

When piles extending to great depths to support small structures, the concept of optimization is clearly missing. It is evident that there is lack of confidence in the design procedures, in the soil data provided and in the construction methods.

Adoption of proper boring procedures in the construction of bored cast-in-situ piles, scientific methods of establishing pile termination criterion in the cases of both bored piles and driven piles, proper concreting standards, etc. are not given their due attention by the pile construction agencies. Advent of ready-mix concrete into the piling construction is also of great concern, because of inadequate quality control measures adopted at the site. The test cubes prepared at piling sites are often substandard and not representative of the actual quality of the concrete. Half trained masons prepare these test cubes without any supervision and the cubes may not be tested in many cases. Many engineers avoid supervision of preparation of test cubes and checking of slump. In many cases when the test reports indicate the poor strength of concrete, those are ignored on the assumption that the cubes were not prepared properly.

Panel Discussion On Lateral Load Test On Piles

For a specified lateral load the displacement at the pile head, which is fixed by a pile cap or the grade beams will be smaller than the displacement of a pile not restrained at its head. If such fixity is provided by the surrounding soil it will also reduce the displacement of pile head under lateral load. It is to be noted that most of the design approaches for evaluating the design lateral capacity are based on prescribed limiting displacement.

A number of methods are available for analysing the free headed and fixed headed piles. But achieving a fixed head condition when individual piles are tested in the field for their lateral capacity poses a lot of difficulties. Hence it has been a general practice (IS Code 2911) to assume that the lateral capacity of a fixed headed pile is equal to that of a free-headed pile determined from a field test. This prompted Dr. N. Kumar Pitchumani, L&T Ramboll, Chennai, to express a view that the capacity to resist lateral load is uneconomically underestimated for fixed headed piles by adopting the same displacement limits to the load-displacement data obtained from a field test under free head condition. (Dr. N Kumar Pitchumani, 'Lateral Load test on Piles - Theory, Codal Requirements and Practice' IGS News, New Delhi, Volume 34,

Bentonite that is used in the preparation of drilling mud is generally of poor quality. Very wide range in the quality and price of this major constituent in the construction of bored piles often results in poor quality construction.

There is scope for improving the testing procedures adopted to confirm that the performance will be satisfactory. Even the initial test pile driven and tested before the construction of routine piles is used only to 'confirm' the 'design' capacity and not for redefining the capacity even if there is a very wide difference in the prediction and performance. The cry for more allowable displacement in the performance criterion has no meaning, when there is no mechanism to adapt to the situations.

One of the issues related to the performance study by load test is interpretation of results from a lateral load test conducted under free-headed condition. The issue is significant because of the common perception that lateral load testing under fixed-head condition is not very easy in the field. Dr. N. Kumar Pitchumani of L&T Ramboll, Chennai, raised this point in an article published in IGS News Letter, New Delhi. He suggested simple arithmetical correction for estimating the allowable lateral load on a fixed-headed pile by using test data for a free-headed pile.

IGS Chennai Chapter organized a panel discussion on the issue and the responses were very interesting. The major outcome of the discussion is that the issue is not simple enough to allow such mathematical corrections. A final document that can give insight to the problem of interpretation of the results from lateral load test on pile is expected out of this discussion. The proceedings of the discussions are published elsewhere in this issue. ●

No: 4, Jan - March 2002).

IGS Chennai Chapter organised a panel discussion on the subject on January 31, 2004. Summary of this discussion is included in detail in this issue. ●



Delegates discussing through lunch

Personal Column

- 1 Dr. S.R.Gandhi, (LM-13), IIT, Madras, presented a paper titled 'Foundation Difficulties in and around Cochin', First Cusat National Conference on 'Recent Advances in Civil Engineering RACE 2004, Mar. 25-27, 2004
- 2 Mr. Reji Zachariah, (LM-138), S&R Consultants, Cochin, developed very user friendly windows based software integrating Geotechnical-Frame Analysis - Design (RCC & Steel) - Estimation + AutoCAD Pre/Post connectivity. Design modules for Footing, Pile, Retaining Wall, Combined Footing, Frame Analysis, Estimation, Slab, Beam, Column, Prestress, T Beam etc. Can offer 50% discount to IGS members. email - modstr@vsnl.com, Web - www.sandrconsultants.com
- 3 Dr. V.K. Stalin, (LM-252), Anna University, presented two papers, "A study on Soil Contamination Using GIS Approach", and 'Utilisation of Silica Fume and Tannery Sludge in the Improvement of Problematic Soils' in the International Conference on Geo-environmental Engineering held at Singapore, Dec. 8-10, 2003.

Delivered a lecture on 'Shrinkage Behaviour of Expansive Clays' at National Seminar on Problems in Expansive Soil and Remedial Measures, Basavarwar Engineering College, Bhagalkot, Karnataka, Mar. 19-20, 2004.
- 4 Dr. D.Thirunakkarasu, (LM-117), Dy. Director (Retired), Highways Research Station, assumed charge as Principal, Vel Sri Rangarajan Sakunthala College of Multimedia Engineering, Avadi, Chennai.
- 5 Er. Ayothiraman R. (LM-569), IIT Madras, attended and presented the research paper "Effect of shear modulus of soil on dynamic bending behaviour of single piles in clay" at 11th International Conference on Soil Dynamics and Earthquake Engineering & 3rd International Conference on Earthquake Geotechnical Engineering held at University of California Berkeley, USA, January 7-9, 2004. He later visited Soft Ground Engineering Research Laboratory at National University of Singapore.
- 6 Dr. Boominathan A, (LM-20) IIT Madras, attended and presented the paper "Experimental studies on the liquefaction resistance of sand using cement columns" (Co-author Mr. K. Sudhir) at 11th International Conference on Soil Dynamics and Earthquake Engineering & 3rd International Conference on Earthquake Geotechnical Engineering held at University of California Berkeley, USA, January 7-9, 2004. Prof. Boominathan visited University of California Los Angeles, USA during January 11-13, 2004.

Members are requested to write to the society about their activities and other personal achievements. Members may please send their email ID for better communication. ●

Welcome New Life Members

819	Rama Rao M.
820	Jeeja T.R.
821	Senthil R
822	Murugesan S.
823	Makarand G. Khare
824	Ganeswade Udaya
825	Ravi N.
826	Murukesan R.
827	Sathi Devi
828	Durai M

Lateral Load test on Piles - Summary of Discussion

The discussions were held under the following headings to achieve coherence and clarity.

- A The conditions at which the pile is to be treated as free headed, partially fixed headed and fully fixed headed.
- B Validity of the procedure for estimating lateral capacities given in Amendment 3 of the present IS Code 2911.
- C Procedure for lateral load test on single free-headed pile
- D Procedure for lateral load test under fixed head condition
- E Validity of the analytical procedure suggested by Dr. Kumar Pitchumani

Dr. S.V. Ramaswamy moderated discussions assisted by Dr. K. Ilamparuthi and Er. I.V. Anirudhan.

Issue A: The conditions for fixity

Mr. V. Balakumar, Consultant, Chennai - If the pile is having a rigid pile cap with pile reinforcement embedded into the pile cap concrete the pile head can be treated as fully fixed, even if the pile cap is above the ground provided the pile-caps are restrained in at least two directions.

Dr. G. Narayanan, Chief Engineer, Railways, Chennai, The issue of fixity is purely a structural design issue and the condition used in the design shall be used in the analysis. In the case of bridges, there is no allowance for rotation at the pile head. Hence the piles are to be designed as fixed headed and the safe lateral capacity shall be suitably arrived at. However translation at pile head level is allowed in the case of bridges.

Mr. P.G. Venkatram, Chief Consultant, L&T Ramboll, Chennai, Theoretical analysis suggests large difference in the behaviour of free and fixed head conditions and this shall be taken into account in the design. In most of the cases, the piles are restrained from rotation by structural property of pile and pile cap and other components of the structure.

Dr. N. Lakshmanan, Director, SERC, Chennai, Large group of piles under a large raft cannot be considered fully fixed because of the flexible nature of the raft acting as the cap. Pile -raft system shall be designed as flat slab to make it fixed headed. Under-reamed piles are generally short and cannot be considered short even though the piles are connected by grade beams.

Dr. S.R.Gandhi, IIT, Chennai, Piles in a large group need not be fully fixed, especially in the case of pile groups supporting large storage tanks, etc. In bridges, where rotation is not allowed at the pile-cap level piles can be considered fixed.

Dr. S. Thyagarajan, Fichtner Consulting Engineers, Chennai, Most of the analysis for pile cap designs assumes unit rotation and unit displacement and the values are adjusted so that the moment, vertical load and lateral load combinations are causing a push and pull effect (in group of piles). The moment transfer on to the pile head is usually very negligible indirectly implying no real fixity at pile head.

Dr. A. Boominathan, IIT Chennai, Pile embedded in cap may not be fixed in all cases.

Issue B: Validity of the procedure for estimating lateral capacities given in Amendment 3 of the present IS Code 2911.

Mr. Shankar Guha, Technical Director, Simplex Concrete Piles, Chennai, The provisions in the present code are in practice for some time now and a complete review of the code is concluded only a couple of years back. The new code is expected to be available any time. This issue was never under discussion during complete review, and it will be very difficult to incorporate

Activities - January - March 2004

LECTURES

Prof. A. Varadarajan, Visiting Professor, Anna University, Chennai delivered a lecture on "Finite Methods in Geotechnical Engineering – Some Experience" on January 12, 2004.

Mr. V. Chellappan, Chief Engineer, Chennai Port Trust, delivered a lecture on "Marine Structures - Some Experience" on February 24, 2004

OTHER ACTIVITIES

PANEL DISCUSSION ON LATERAL LOAD TEST ON PILES was held on January 31, 2004 at IIT, Chennai. More than 20 members actively participated in the discussions while forty members attended the programme.

EC meeting of IGS Chennai Chapter was convened on March 31, 2004 and decided to put forward a request for IGC 2006 in Chennai. EC Members pointed out that Chennai has all the necessary infrastructure for holding such event at the backdrop of successful conduct of IGC 2006. ●

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anything in the present revision. However, if a genuine serious outcome is possible from this discussion, a request can be made to provide it as an amendment. The procedure for bringing in an amendment is relatively simple.

Er. V. Balakumar, Lateral capacity shall be determined for the permissible deflection only. Allowable deflection is a parameter to be decided by the end user and the designer has no discretion in this issue. In the absence of such requirement from the end user, 5 mm deflection criterion suggested in the code is justifiable. The major issue here is the difficulties in arriving at the most desirable values for the modulus n_h or k_1 .

Dr. K. Ilamparuthi, Anna University, Chennai, Since lateral capacity of pile is decided by its deflection, some criterion on allowable deflection is needed for designing the lateral capacity of pile. 5 mm criteria suggested in IS code cannot be amended until unless we have another such figure available from practical studies.

Mr. P.G. Venkatram, Since larger deflection does not cause failure of soil in the case of laterally loaded piles, 5 mm deflection criteria is very conservative. Piles are to be structurally designed for larger deflections wherever permitted and

er capacity for economy.

Dr. S.R.Gandhi, IS 2911 (Part 4) does not specify 5 mm settlement as a rigid criterion. It allows the use any suitable settlement that the designer considers relevant with respect to the structure. Piles in jetty structures are allowed large deflections and piles used to support sensitive machines are not allowed even 5 mm displacement. Lateral capacity corresponding to desirable displacement with respect to the structure can be used.

Er. I.V.Anirudhan, Geotechnical Solutions, Chennai, The procedure given in IS 2911 (Part 1) is only for long elastic piles, which can be achieved when the pile length is 15 to 25D depending on the type of soil around and the fixity conditions at the pile head.

Code should address this issue as most of the large diameter piles are short and rigid. Socket length into the rock of sufficient quality may be defined to ensure elastic behaviour when piles are designed for lateral load.

Dr. K. Muthukrishniah, Geotechnical Consultant, Chennai, The limiting displacement and settlements for foundations is evolved from FPS system in which half inch, 1 inch, one and half inch, etc. were prescribed. These, when translated into metric, became 12 mm, 25 mm and 40 mm. In this sense, 6 mm should have been specified instead of 5 mm. Duration of each incremental load in the case of lateral load test need not be as stipulated for vertical load test as the displacement is elastic

in nature. Group effect shall be incorporated.

Issue C: Procedure for lateral load test on free headed piles

Dr. S.R.Gandhi, Initial load test for vertical compression capacity may not truly represent the actual conditions of the working piles as the piling agency takes extra care in making the test pile. Lateral load test is not generally affected by this problem.

Lateral load test may not however represent the true condition of the working pile for other various reasons as below.

- The absence of vertical load on the pile
- Lack of fixity at pile head during test
- Densification of cohesionless soil in the case of driven piles may make the routine piles different from the test pile in the case of lateral capacity also.
- In the case of large pile groups where the overburden around the pile is completely removed may behave differently from a test pile subjected to lateral load without removing the soil up to cutoff level for a large area (in the case of cohesionless soil)
- Contribution from pile cap, passive resistance from soil around the pile cap and the base resistance is not accounted for when the pile is tested under free head condition without a cap

Lateral load tests may not be feasible when the exposed length of the pile is very large. Behaviour of piles installed over a sloping ground differs under lateral loaded condition.

Because of these reasons, there is a need for instrumentation of test piles in the case of relatively large sites so as to confirm the parameters used in the design of laterally loaded piles. Testing of a pile-group with two or three piles shall be done to have some idea about the group effect. Group efficiency factor shall be incorporated for large pile groups with spacing smaller than 6 times the pile diameter.

Mr. Shankar Guha, IS 2911 is mainly aimed at buildings. Guidelines given in relevant IRC code shall be used in the case of bridges. If specific provisions are not available in IRC, it shall be incorporated by amendments. Structural designer shall have to decide the limiting deflection.

Er. Murali Iyengar, EIL (retd.), Effect of compaction / densification of soil around the pile for a small depth below the pile cap level can substantially improve the lateral capacity. Passive resistance is improved in the case of piles driven in groups.

Dr. K.S. Ramakrishna, Vasudhaika, Chennai, Instrumentation shall be mandatory for lateral load tests for better understanding of the behaviour. Base resistance from the pile cap may not be fully available because of loss of contact. Such loss of contact shall be considered while allowing for base resistance.

Dr. G. Narayanan, Lateral load test with vertical load will be the true representative. Time lag between formation of pile and load testing is very important in the case of lateral load tests. Large traction load can be applied by high speed moving vehicle with heavy load and the piles complete with superstructure can be tested under such traction load ((by instrumentation).

Er. I.V. Anirudhan, The use of two dial gauges shall be made mandatory to measure displacement and rotation. Even though IS Code stipulates the procedure with two dial gauges (only if the dial gauge cannot be fixed just opposite to the loading point), often the lateral load tests are done with single dial gauge. The load-deflection-slope data corresponding to loading point shall be used to arrive at the stiffness factor T or R and to re-estimate the safe capacity for any desired deflection.

Er. V. Balakumar, The major issue here is the difficulties in arriving at the most desirable values for the modulus n_h or k_1 . Hence the lateral load test shall be aimed at confirming these vital design parameters and a back analysis is appropriate.

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A Bulletin of Indian Geotechnical Society, Chennai Chapter

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Growth of Geotechnical Wisdom

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Issue D: Procedure for lateral load test under fixed head condition

Mr. S. Boominathan, Geotechnical Consultant, Chennai, Various test procedures suggested and practised for conducting the tests on piles under fixed head conditions as per ASTM - D - 3966-B1 to determine the pile capacity can be adopted (technical note received was presented by Er. Anirudhan)

Dr. G. Narayanan & Mr. P.G. Venkatram, The frame arrangement shown does not ensure adequate fixity at the pile head as the frame can also rotate by deflection (even if the end support does not yield).

Dr. A. Boominathan, Tests on fixed head conditions are being done elsewhere and we should also conduct the tests at fixed head conditions.

Mr. Shankar Guha, Lateral load test without vertical load on the pile is not truly representative.

A number of discussers also expressed practical difficulties in conducting such tests.



Issue D: Validity of the semi-analytical procedure suggested by Dr. Kumar Pitchumani

Er. Murali Iyengar, Such simplistic approach is not acceptable because of various uncertainties. The results of a field test conducted on a free headed pile as described in IS 2911 shall be compared with the load deflection curve derived by p-y curve approach using the initial design parameters. The p-y curve is then refined to match with the actual p-y

curves derived from the test results. These curves can then be used for different conditions of restraints as demanded by actual working condition. This exercise is a must in the case of important projects where lateral loading is critical.

Er. V. Balakumar, Evaluation of n_h under a range of allowable strains can be made and this value can be used for arriving at the lateral capacity using suitable analytical procedures.

Dr. A. Varadarajan, Visiting Professor, Anna University, Chennai, The approach by Broms can be adopted in which the test data shall be used to prepare a non-dimensional curve fitting by trial and error.

Dr. A. Boominathan, Testing under actual condition of working piles should be done and extrapolation / interpolation is not advisable.



We are on the web - www.igschennai.org

Next One Day Seminar, Pile - Raft Interaction

Next Technical Lecture in 1st Week of May 2004 Current Piling Practice By Dr. K.S. Ramakrishna

Mr. S. Boominathan, Values of k or n_h used in the solutions proposed by Broms and others are highly approximate and testing under actual conditions is advisable. Many studies indicate that the k or n_h are influenced by the type of soil, pile stiffness and the loading conditions and the extrapolation procedure is not hence advocated. In the case of heterogeneous soil deposits, the suggested extrapolation coefficient of 2.00 to 2.58 becomes irrelevant.

Dr. N. Lakshmanan, Long piles behave like elastic members and the influence of soil parameters is relatively small. In the case of short rigid piles, the capacity is related to the capacity of soil. While there is difficulty in arriving at the actual status of pile (whether elastic or rigid), testing under actual condition is advisable.

Er. I.V. Anirudhan, Testing of free-headed pile in normal conditions to a large displacement and observation of displacement and inclination will enable the identification of the pile as a rigid or elastic type. Using the modulus derived from relatively large displacement and estimating the capacity for free and fixed head condition will take care of non linearity to some extent.

Dr. S.R. Gandhi, It is not possible to assess whether the pile is fully fixed or partially fixed. It is also difficult to assess the degree of fixity. In such condition it is not advisable to use the test results from a free-headed pile for inferring the capacity of a fixed headed pile. Test of group of two or three piles connected by a rigid pile cap can provide more information.

Dr. B. Ramanathan, United Foundations, Chennai, It is true that the lateral load test on free-headed pile will provide a conservative lateral load carrying capacity in the case of fixed headed piles. In reality, the degree of fixity is far below 100 percent. If the test results from a fully fixed head condition are used in the design, it can lead to unsafe design where fixity is not fully achieved. Hence test results from free-headed pile shall only be used in the design.

Dr. S.V. Ramaswamy, in his concluding remarks, pointed out that though discussions ranging over a wide area were interesting and illuminating, it was difficult to reach any specific conclusions and recommendations. He said that further deliberations are necessary to arrive at suitable recommendations. Then it was decided to form a committee consisting of Dr. K. Ilamparuthi (Chairman), Er. Shankar Guha, Er. Murali Iyengar, Dr. S.R. Gandhi, Dr. Kumar Pitchumani and Er. I.V. Anirudhan (Convener) to peruse the proceedings and draft suitable recommendations to be sent to BIS. ●

Education is the ability to perceive the hidden connections
between phenomena
- Václav Havel