COMPRESSION LOAD TESTS FOR HIGH CAPACITY PILES

In the recent times, the size and capacity of piles increased manifold making the conventional reaction platform systems insufficient to perform the pile loading tests. Testing of large capacity piles requires large reaction loads well beyond the capacity of a loaded platform (kentledge). Read more about it in the Cover Story on Page 3.

Picture Courtesy: GEO DYNAMICS

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Quarterly Newsletter from
Deep Foundations Institute of India
www.dfi-india.org

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Cover Story

Compression Load Tests for High-Capacity piles

Introduction

Loading a pile two to three time its design load is the best way to ensure the desired performance during its lifetime. Two types of tests namely initial and routine tests, for each type of loading viz. vertical, horizontal (lateral), pull out, are performed on piles. While the initial pile loading test ensure the desired performance, the routine tests provide certain assurance that all the piles under a structure are behaving as expected.

Initial testing shall be performed for a test load of two to three times the design load. Static loading tests are generally regarded as the most accurate method of determining the pile bearing capacity.

Figure 1: Typical loading platform for Kentledge test.

In a static compression loading test setup, a large reaction load provided by a kentledge platform is often used. Incremental loads to the test pile are transferred from the reaction load using hydraulic jacks. The requirements are: 1) enough reaction load is available to apply the maximum test load, 2) the reaction load is concentric to the pile axis, 3) the whole system is stable during the load transfer, and 4) the engineer has access to make the measurements. The pile is loaded at its head during the test.

In recent times, the size and capacity of piles increased manifold making the conventional reaction platform systems insufficient to perform the pile loading tests. Inadequate ground support, instability, large time duration for the setup, and large working area akin to the conventional reaction platform set up are the main reasons for its inadequacy.

Pile Sizes and Capacities

1200 mm to 3000 mm diameter piles are commonly used for infrastructure projects offering large compression capacities in the range of 15000 kN to 50000 kN.

Present Day Testing Methods for Large Capacity Piles

Testing of large capacity piles requires large reaction loads well beyond the capacity of a loaded platform (kentledge). Long piles having large tension (uplift) capacities or high-capacity soil or rock anchors are being used to offer large reaction loads. The piles are loaded at the head. Bi-directional tests, in which the test pile split into two at a suitable depth so that the skin friction from the top portion offer reaction while pushing the bottom portion using a suitable remotely operating hydraulic jacking system. In this case, the pile is loaded at a point close to the base.

Reaction Pile system

The reaction pile system comprises anchor piles located around the test pile, a bearing platform, and a reaction beam. The load is applied to the pile in discrete increments through hydraulic jack placed between the reaction beam and the pile. Several such designs are available these

Contd.

days. The major requirements for reaction pile system are 1) the reaction piles are located equidistant from the test pile and in a symmetry, 2) the reaction piles have somewhat uniform uplift capacity, the sum of which is grater than the test load, 3) the reaction platform is allowing the uplift load through the vertical axis of reaction piles, 4) the load transferred on to the test pile is purely vertical and through the axis of the test pile, and

Figure 2: Typical Reaction system setup;
Picture Courtesy: KELLER

5) the reaction piles and the reaction pile are subjected to the minimum vertical displacement during the test.

The test can be performed without elaborate instrumentation along the pile shaft. The capacities achieved so far by Reaction piles as per the available information is 53600 kN in Indian scenario.

Rock or Soil Anchors

Sites where rock or very dense soil stratum is present at reasonable depths, the reaction can be drawn from rock or soil anchors installed vertically or at an inclination. Anchors with inclination away from the test pile allow independent actions by the test pile and the reaction piles while loading test. Efficiency of the anchors can be improved by suitable grouting procedures and by selecting the right grout mix.

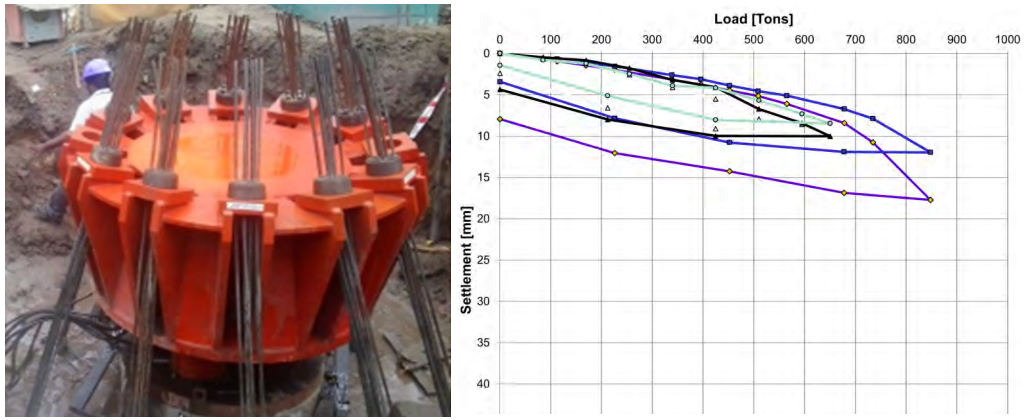


Figure 3: Crown system setup of rock anchors (left) Typical load v/s displacement curve for top-down testing of pile (right)
Picture Courtesy: KELLER

The major requirements described form reaction piles system are applicable for the anchors as well. The test can be performed without elaborate instrumentation along the pile shaft.

The max. load capacity achieved using this method in India is estimated to be around 3000 tons as per available information.

Bi-Directional Static Load Test (BDSLT)

The 'top-down testing' has been used for many years and has become a 'standard' test worldwide. The method, although well developed, cannot be used under certain circumstances where the magnitude of load and the working area being particular issues. Bi-Directional Static Load Test seeks to overcome all the associated

Contd. on Page 15

Message from DFII Chair

Dear Readers,

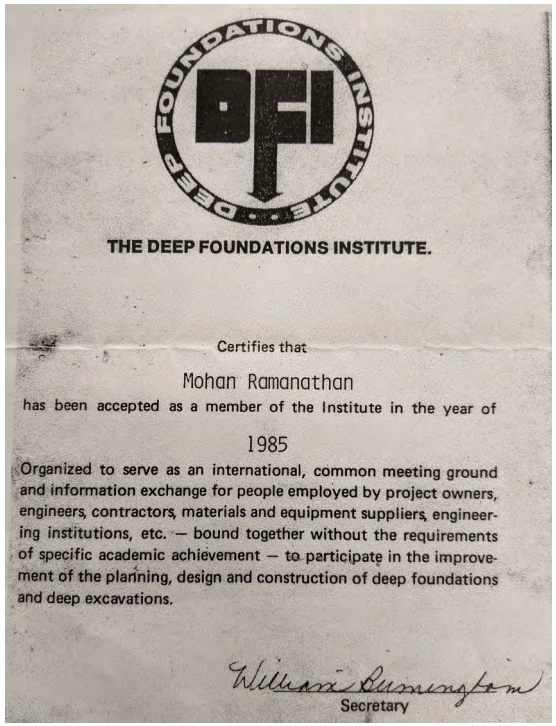
I have been associated with DFI since 1980s. I became a member of DFI(USA) after my graduation in 1979 from University of Illinois, - Champaign, USA. I found the DFI platform very unique and a rewarding experience. It is the only forum where all stake holders meet, greet and network.

I was thrilled to be part of DFI of India when I was invited by the founder of Indian chapter, Dr. K.S. Ramakrishna to become a member. As Vice Chairman of DFII, I had the responsibility to guide the organisation during the pandemic years. I owe all my learning to Sri. I V. Anirudhan who was the Chair and took his guidance in various aspects of running the office. The 2022 DFII conference in Tirupati was a grand success, mainly due to his immaculate planning and execution.

Indian foundation industry has coming of age and its contribution to India's growth in the next ten years or so will be very critical. The wealth of knowledge available with the parent organisation, DFI USA can help solve the complex problems that arise in India with such diverse geology and soil strata.

As the new Chair of this prestigious body, I will endeavour to do my best for the industry. With my contacts in the industry, I plan to increase membership and awareness amongst the new entrants.

The upcoming Annual Conference in Vadodara will be test of my leadership. I seek the support of the Executive Committee and veterans to perform my duties effectively and efficiently. We have wonderful people in DFII office and my best wishes to them.



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Secretary

Lastly, the readers of this newsletter should benefit from reading the technical articles we intend to publish in the coming months. Any feedback is welcome.

Jai Hind

Er. Mohan Ramanathan
Chairman, DFI of India

The executive committee members of DFI of India represent all the stakeholders in the foundation research, design and construction . The members will express their views about the role of DFI and other similar organizations in the development and transfer of modern technology for infrastructure development of India.

DFII Training Program on Support Fluids for Foundation Construction - Registrations Open!!

DFI of India is organizing this training program with assistance from DFI and its collaboration with the European Federation of Foundation Contractors. The program is scheduled for two days on **28th and 29th April'23 between 03:00pm to 06:00pm IST**.

Overview of the Training Program:

Drilling Support fluids are widely used for the construction of bored piles and diaphragm walls to temporarily stabilize the excavation prior to concrete placement. The choice of support fluid depends on the soil type and construction technique. There is no universal fluid for all projects and selection of the right product has to be made after considering all the parameters for cost-efficient construction. Hence, it requires detail understanding of the behavior of different types of support fluids including their advantages and limitations.

Speakers

For more information and registration, visit: https://www.india.dfi.org/support-fluids-training

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Event	SuperPile 2023	S3 2023	DFI-India 2023	DFI48
Date	June 7-9, 2023	Aug 8-10, 2023	Oct 05-07, 2023	Oct 31 - Nov 3, 2023
Venue	Atlanta, Georgia	Boston, Massachu-	Vadodara, Gujarat	Seattle, Washington

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Deep Foundations Institute of India is regularly conducting workshops and conferences in association with other organizations with similar interests

India, a place not to miss by any Geotechnical Stakeholder

A new World Bank report estimates that India will need to invest $840 billion over the next 15 years—or an average of $55 billion per annum—into urban infrastructure if it is to effectively meet the needs of its fast-growing urban population. The huge amount, only signifying the unbelievable scope of work to be carried out in this time frame, will not only need international investments and private participation to support the needs. The realization of these mega projects within a short time frame even coming close to 15 years requires unbelievable resources and capacities in the construction industry. It is a well known fact that particularly for infrastructure projects the most difficult part lies in the foundation. Ground conditions are the least predictable and anticipated conditions of the works. Programmes and cost are often overrun by a large scale because of adverse ground conditions.

This combined with the logistical problems arising out of the congestion in traffic overloaded Cities and environmental constraints, ask for the use of sophisticated construction methods and equipment which currently may not be at all, or frequently available in India.

Such Methods and resources need to be introduced and proven to be suitable and acceptable to Employers and Engineers. The approval and acceptance process from experience takes time.

Considering the sustainability of the Indian Infrastructure, Building, Mining, Oil + Gas, Manufacturing, Logistic, Defence and other Areas, all requiring construction, it is an invitation to major Foundation Contractors and Foundation Equipment / Material Manufacturers and Suppliers to not overlook the unique opportunities in India.

India has a wide range of difficult ground conditions from soft soils to hard rocks. Conventional construction products and methods, resources readily available in India by far will not suffice to deliver in time and budget the foundations needed for the ambitious infrastructure development plan of India. Value Engineering approaches are needed.

It surely is worth and must be on the focus of the entire international geotechnical private and public sectors to be part of this huge technical and economical development. A development which in all likelihood be like or exceed as what was seen in China with the difference that India is a democratic country.

Thomas Domanski,
Senior Consultant,
TDA Geotechnical Services

From my experience working in India as a foreign Contractor and working with both, local and foreign contractors in India, it is my advice to find reliable Indian partners and develop a business based on partnership, trust and integration. The market in India has seen many foreign Contractors failing either technically or commercially. Many foreign Contractors therefore are cautious and fearful to enter the market. The failure and fear are based on the lack of understanding the diverse culture, relationships and fast changing complex business rules and behaviour in India from State to State.

The partnership must be based on respect and allocate the roles and responsibility of the Partners in its appropriate strength. For methods, equipment, products not widely available in India the experience must come from overseas. The local knowledge and input inclusive business

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networking, sourcing, employing local resources and implementing the works in India the knowledge of the local partner is needed to successfully obtain approvals and execute the works economically. Flexibility and adjustment in behaviour will be required from the partners in such ventures.

The huge backlog of long-term occupancy of equipment and modern proven methods in the foundation industry justifies investment of expensive specialised equipment and the sometimes-difficult process in obtaining approval and acceptance of new methods and construction products.

I am thinking of CFA Piles which are known but not yet vastly used and accepted in India. In the right ground conditions CFA Piles are perfect technical solutions offering huge time and cost savings. Using appropriate borehole stabilization techniques and materials will accelerate production of Bored Piles and Diaphragm Walls by allowing short casings, lighter cranes and avoidance of heavy vibrators disturbing ground and environment. In soft soils, ground improvement systems like Deep Soil Mixing, Full Displacement Columns using various different equipment depending on logistic and soil conditions. Rock Drilling Methods must be developed to cut time and cost for producing the required sockets. The use of Mono Piles with diameters up to 4.0 m for urban viaducts will ease the logistical difficulties, reduce the space requirement and eliminate the excavation for pile caps in the middle of busy roads.

Many more of products and methods could be mentioned. All of these methods and products have been used and implemented successfully outside of India. It is time to establish this modern technology into India where it is needed. Invested time and money certainly will pay back.

More, India has an excellent hard working labour force. India has an excellent University System with producing high quality Engineers. India is in a spirit of ambition and drive of improving, learning and developing new methods and products by themselves. People are eager to improve and grow. An attitude forming the fundamental basis in implementing these enormous undertakings and progressing the country.

I found in the DFI India an organization gathering the most excellent Indian geotechnical professionals of all sectors in the industry. The DFI India is a board facilitating contacts with international geotechnical organizations, authorities and Universities. The DFI promotes, supports and contributes through programmes the education of excellent Indian geotechnical Engineers. The DFI India is a platform which can ideally be used as a stepping stone into India and a reliable knowledgeable partner during the implementation and integration process. The DFI India is driven by the desire to develop the Indian Foundation Industry to the highest technical and quality standard, respecting safety and environment.

India is a fertile ground for the future which cannot be missed by any serious player in the geotechnical and foundation industry. It is the opportunity and chance in decades to be part of a growing country which unavoidable will have a strong economical position in this world. For any support, the DFI India is highly recommended as an extremely helpful organization for any Indian Contractor / Employer to select the right technique, find a foreign partner, and, for international Contractors / Equipment Suppliers / Professionals to seek assistance in finding a successful path into India.

DFII Technical Committee News & Reports

DFII Committee for Geotechnical Characterisation for Foundations

After conducting three training programs in 2022-23, DCGCF committee is planning to conduct its first 5-days training program for working Geotech lab technicians for the year 2023-24 at National Academy of Construction Hyderabad during May'23 . The program will be jointly organised by DFII and NAC. More training programs are planned in different regions of India. An online bi-monthly webinar series is also planned by the Committee to emphasize proper geotechnical investigation and good work/tender practices from May-June'23.

DFII Training Committee on Foundation Technologies

DFII Training committee has scheduled an online training program on 'Support Fluids for Foundation Construction' with the assistance of DFI US on 28-29 April'23. It will be the third training program overall and first in 2023. More training programs are planned in 2023 on topics like Working Platform, Tool Management for Construction Equipment, Tremie Concrete, etc.

DFII Student Outreach Committee—Groundwork

DFII Groundwork committee successfully conducted two webinars for the months February and March 2023, with the first webinar being an interactive panel discussion program on the topic 'Bridging the Expectations – Career Prospects in Geotechnical Engineering Industry'. The expert panel consisted of Mr. Prakash Bansod, Afcons and Mr. Manash Bhattacharya, Keller India. The discussion was moderated by Er. Annapoorni Iyer, Engosym Consultants.

Second session was a technical presentation by Dr. Sebastian Lobo-Guerrero, Geotechnical Project Manager/ Laboratory Manager AGES Inc. on 'A review of Ground Anchors - Design and Construction'. The session was moderated by Mr. Govind Raj, and was attended by more than 130 participants from all over the world.

Third webinar, a technical presentation, scheduled on 20 April,23 on the topic 'Deep Foundation Construction for Modern Bridges', will be delivered by Er. Ekhlaq A Khan, Chief Engineering Manager, L&T Construction, Mumbai.

CFA Pile Technology Implementation Committee

For the year 2023-24, the DFII CFA Pile Committee is planning to conduct few technology promotional webinar programs for different stakeholders. The Committee is also working for the implementation of CFA piling in at least two of the Indian sites by December 2023 and completion of draft BIS Guideline for CFA piling under CED 43 committee. DFII is hopeful that the BIS Guidelines will help consultants, contractors, and owners, to adopt the CFA piling technology in India

WiDF India Group

WiDF India team is back with online webinar programs on different topics relevant to women and young engineers in the industry. First webinar will be conducted in May'23 with national and international panelists. The team is also working on developing a session during DFI-India 2023 annual conference in Vadodara during 05—07 Oct'23. More details will be rolled out soon.

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problems of large scale and restrictive area "top-down testing", utilizing static load testing techniques.

Figure 4: BDSLT setup; Picture Courtesy: GEO DYNAMICS

In comparison to traditional methods of load testing, BDSLT is safer, faster, and often provides more accurate data. However, large scale instrumentation of the pile along the pile shaft and pile bottom is necessary for the test. The procedure is often the only solution for restricted access or low headroom situations.

Bi-directional technology employs Osterberg type Load Cell (O-cell). An O-cell is a sacrificial jack like device attached to the pile rebar cage within the pile body. Hydraulic lines and telltales extend from the O-cell to the top of the pile to monitor the movement of the pile base as the O-cell load is applied. The load cell is positioned in such a way to balance the effective friction on the top section of the pile and the friction and end bearing on the bottom portion of the pile. Upon application of load, the pile is separated into two elements and load is applied to both elements simultaneously. The jack assembly simultaneously pushes up against the effective frictional resistance above the jack assembly and pushes down against the effective frictional resistance and the base resistance below the jack assembly location.

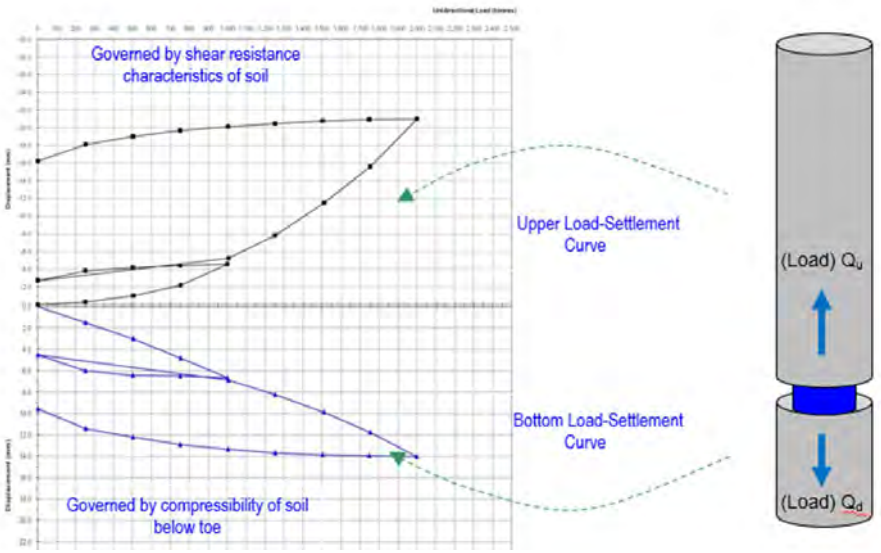

Figure 5: Typical Load v/s Displacement Curve for BDSLT

BDSLT offers distinct assessments of a pile's end-bearing and skin friction along the length of the pile using a combination of hydraulic, high-capacity bi-directional jacks to give the necessary test load.

Based on the two load - settlement curves from testing (separate tests for upper and lower parts of the pile), an equivalent curve that represents pile behavior during standard static load tests can be drawn. A large advantage of this test is that the pile capacity can be assessed without any retaining structure. record (with inputs from Geo Dynamics and Keller Ground Engineering India Team).

WHAT CAN DFI DO FOR YOU?

Overview

DFI is an international association of contractors, engineers, suppliers, academics and owners in the deep foundations industry. For more than 30 years, we have brought together professionals for networking, education, communication and collaboration. As a member, you help create a consensus voice and a common vision for continual advancement in the planning, design and construction of deep foundations and excavations.

Find Common Ground. Become a Member of DFI

- Network with thousands of members and industry professionals worldwide
- Get involved locally through DFI's active presence in Europe, India and the Middle East
- Strengthen your knowledge base and obtain practical information at seminars, short courses, workshops and conferences
- Collaborate with colleagues by joining one of 15 active Technical Committees, Regional Chapters or a DFI group
- Gain visibility with a corporate member listing on the DFI website, which has 20,000 views each month
- Connect and communicate with industry peers through social media such as DFI's LinkedIn Groups
- Access OneMine.org and download up to 130,000 articles, technical papers & books from DFI & organizations all over the world - at no cost

48th Annual Conference on Deep Foundations

Oct 31st - Nov 3rd, 2023

Join us for DFI's 48th Annual Conference on Deep Foundations in Seattle and network with the largest gathering of international practitioners specializing in cutting-edge technologies and risk management for deep foundations, ground improvement, earth retention and excavation support. Attend special lectures featuring world-renowned keynote speakers, share experiences and lessons learned and discuss the advancements and innovations in the state-of-practice, research, materials and equipment.

Registration is open, register now.

For more information, visit https://www.dfi.org/annual2023

This e-newsletter of DFI of India is available at https://www.india.dfi.org/publications/dfi-of-india-newsletters/

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