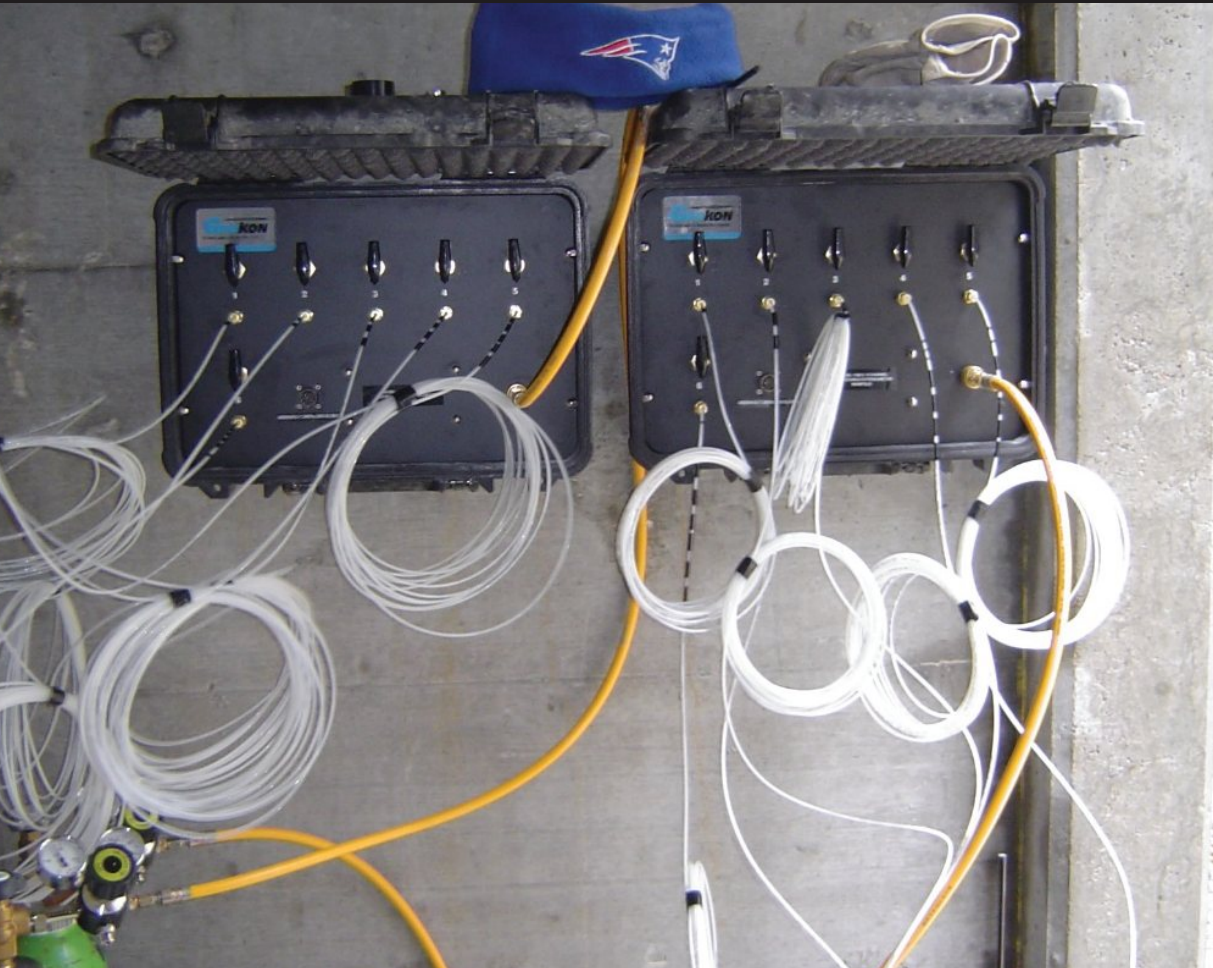


# Measuring Deformation in Concrete Piles



**Retrievable Extensometer** is a novel device designed to monitor loads and displacements along the shafts and at the toes of bored cast-in-place piles. A series of anchors are expanded inside an embedded pipe. Between each anchor is a vibrating wire displacement transducer which measures any change in the distance between the anchors.



Volume 2, Book 2, July 2016

## DFI of INDIA *News*



- 2 Cover Picture - Retrievable Extensometer
- 3 Excerpt from DFI of India Regional Report in April 2016 DFI Magazine - Dr. K.S. Ramakrishna, DFI of India Chair
- 4 Technology as a Driver for India's Foundation Industry - Dr. Sunil Basarkar, ITD Cementation & EC Member, DFI of India
- 5 Company Profile - L&T GeoStructure
- 6 Forthcoming Events - DFI India-2016, Kolkata
- 7 Early Applications of DMT in Arabian Gulf Area – One Case Study- Sharif, Emad, e.construct
- 13 Report of one day Workshop at Guntur
- 13 DFI of India Members 2016
- 14 DFI World Activities - 2016-2017
- 16 Obituary Note - Mr. K.P. Pradeep, Master Builder
- 16 What Can DFI Do For You?

Quarterly e-Newsletter from  
Deep Foundations Institute of India  
[www.dfi-india.org](http://www.dfi-india.org)

## DFI of India Executive Committee 2015-2017

Chairman

Dr. K S Ramakrishna, Geotechnical & Project Consultant, Chennai

Vice Chairman

Mr. Anirudhan IV, Geotechnical Solutions, Chennai

Members

Prof A Srirama Rao, President, IGS, New Delhi

Mr. Aravind Shrivastava, NPCIL, Mumbai

Dr. V Balakumar, Simplex Infrastructure, Chennai

Prof. BVS Viswanadham, IIT Bombay, Mumbai

Mr. Jagpal Singh Lotay, Bauer Maschinen, Mumbai

Mr. Jeyson J Samuel, L&T Geo-structure, Chennai

Mr. Harikrishna Yandamuri, Keller Ground Engineering P Ltd, Chennai

Dr. Kumar Pitchumani, AECOM, Chennai

Er. Laxmi Kanta Tripathy, Hony Secretary, IGS, Bhubaneswar Chapter

Prof. Manoj Datta, IIT Delhi, New Delhi

Mr. Mohan Ramanathan, Advance Construction Technologies, Chennai

Dr. Niranjana Swarup, CIDC, New Delhi

Mr. Ravikiran Vaidya, Geo Dynamics, Vadodara

Prof. Shailesh R Gandhi, IIT Madras, Chennai

Dr. Sunil S Basarkar, ITD Cementation India Ltd, Mumbai

Mr. Surajit Mukherjee, Sure Tech Infrastructure P Ltd, Mumbai

## DFI USA

Executive Director - Theresa Engler

President - John R Wolosick

Vice President - Dan Brown

Treasurer - Mathew Janes

Past President - Robert B Bittner

## DEEP FOUNDATIONS INSTITUTE OF INDIA

Non profit company registered under Ministry of Company Affairs,

Government of India (Regn No: U91900TN2013NPL091176)

C/o I. V. Anirudhan, 44/17 'BHASKARA', 19 Usha St.,

Dr. Seethapathy Nagar, Velachery, Chennai, Tamil Nadu, India

www.dfi-india.org – Email dfiindiaoffice@gmail.com

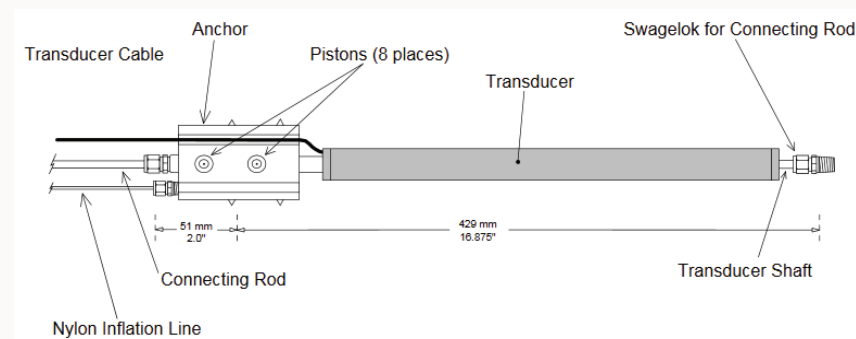
## The Cover Picture

## Measuring Deformation in Concrete Piles

Retrievable Extensometer is a novel device designed to monitor loads and displacements along the shafts and at the toes of bored cast-in-place piles

A series of anchors are expanded inside an embedded pipe. Between each anchor is a vibrating wire displacement transducer which measures any change in the distance between the anchors. The whole system is designed so that, on completion of the load test, the anchors may be deflated and the system recovered for repeated use.

The system consists of pneumatically actuated anchors with spring loaded transducers that are connected to one another in series by a single connecting rod. When installed, the anchors are fixed in place and the transducers measure the deformation between the anchor positions. The connecting rods are held in tension to eliminate errors due to bowing and friction. The standard system is designed to be used in a nominal 2" ID pipe; either plastic or steel



The string of sensors is assembled with variable lengths of connecting rods to enable positioning of the anchors at the required depths.

When used as a substitute for strain gages the extensometer integrates the strains over a larger and more representative sample than that obtained using conventional strain gages.

The system is designed for a maximum of eight segments.

Each anchor contains eight pistons, which are pneumatically actuated to force against the sides of the borehole, and also to automatically retract when pressure is removed.

A manifold, connects to the anchor inflation lines, and allows each to be actuated in turn, it also maintains the pressure during the monitoring.

Gas pressure comes from a pressurized nitrogen tank.

*Geokon Inc., Lebanon, NH, 03766, USA, [www.geokon.com](http://www.geokon.com)*

## From the Chair



### Excerpt from DFI of India Regional Report in April 2016 DFI Magazine

#### Dr. K.S. Ramakrishna, DFI of India Chair

After a series of successful programs, starting from the year 2011, DFI of India had conducted this year's first quarter one-day national workshop on "Deep Foundations Technologies for Infrastructure Development of Andhra Pradesh" at Acharya Nagarjuna University(ANU) Campus, Guntur. Twin cities, Vijayawada and Guntur, form part of the new Capital Region, Amaravati, of the recently carved out state of Andhra Pradesh. The Government of Andhra Pradesh has developed a master plan to make the Amaravati as a world class city. It is expected that this region will be the hub of civil engineering activity for at least the next 50 years. Several projects of highways, roads, high rise buildings, flyovers, metros, bridges across river Krishna and its many canals, riverside development, etc. would be taken up. DFI of India felt it appropriate and timely to conduct the workshop in this region. The event was conducted in association with the Indian Geotechnical Society(IGS)- Guntur Chapter and the Department of Civil Engineering-Acharya Nagarjuna University College of Engineering, Guntur. Thanks to the overwhelming support received from the University authorities. Sincere thanks are due to Prof.Muvvala Ramarao, Honorary Secretary of The IGS-Guntur Chapter and his team, Dr. T.V.S.Varalakshmi, Head of the Department of Civil Engineering, ANU, and her colleagues, Mr. T. Satyamurthy, Managing Director of Singa Engineering and Trading for their sincere and enthusiastic support. The program covered various technologies of interest to the Capital Region ranging from driven precast piles, large diameter drilled piles, diaphragm walls and dam cutoff walls, marine foundations, and ground improvement. Lectures delivered by domain experts from the industry in India and abroad were well received by around 300 delegates. DFI More such workshops are planned in each of the following quarters of this year at various regions of India to address the local needs.

DFI of India, in collaboration with the Indian Institute of Engineering Science and Technology (IIST) Shibpur, Jadavpur University and the Indian Geotechnical Society (IGS) Kolkata Chapter, is hosting DFI-India 2016: 6th Conference on Deep Foundations Technologies for Infrastructure Development in India, September 9-10, 2016, at IIST Shibpur in Howrah, Kolkata, India. This two-day conference focuses on technology developments and case histories on drilled and driven piling systems, ground improvement, deep excavation systems and soft soil engineering in underground space applications. A one-day workshop precedes the conference on September 8. The event attracts contractors, developers, local and government representatives, designers, consultants and educators involved in geotechnical design and construction. equipment, material and instrumentation suppliers, contractors and other vendors are presenting their products and services in the exhibit hall. For more information or to register visit [www.dfi-india2016.org](http://www.dfi-india2016.org).

Recognizing the fact that DFI of India and its programs are gaining acceptance and appreciation throughout the length and breadth of the country, DFI of India made a proposal to the board of DFI at the Winter Planning Meeting (WPM), 2016 in Orlando, Florida, USA, to establish a permanent office with staff employed to work full time to carry on with the mission goals. The Trustee Board of DFI had in principle agreed to this proposal and assured every support that DFI of India would need. Thanks to the DFI Board, especially to the President, Mr.John Wolosick, for his appreciation and encouraging words about the activities of DFI of India. In this connection I am grateful to the DFI board and its staff, to all the active executive members of DFI of India and others for their active support and sincere efforts in making every program of DFI of India a resounding success.

I appeal to the geotechnical consultancy firms, specialist foundation contractors, foundation equipment manufacturers, foundation technology providers, special material manufacturers, testing agencies, etc. from all over the world to look at the Indian Deep Foundations industry as a long term and far reaching opportunity and to explore possibilities of setting up local offices and/or joint ventures with local firms. They can use the DFI of India platform to effectively reach out to all the stake holders of the Indian deep foundations industry by becoming corporate members and also by actively participating in many of its initiatives such as seminars, regional workshops, annual conferences, technology implementation exercises, skill development programs, etc. all of which are aimed at disseminating knowledge of latest foundations technologies, design, construction and testing practices.

#### REGRET

We regret that we could not bring out the April 2016 of the E-News due to various reasons



### Next Event of DFI of India in 2016

NATIONAL INSTITUTE OF TECHNOLOGY  
RAIPUR & DEEP FOUNDATIONS INSTITUTE  
OF INDIA

Organizes  
One day National Seminar on  
Recent Trends in Pile Foundations &  
Importance of Soil Investigation.

Saturday, 30<sup>th</sup> July, 2016

Venue  
E-Hall,  
National Institute of Technology, Raipur.

Contact details:

Dr. L.K Yadu,  
Asst. Prof, Civil Dept. NIT Raipur  
<lkyadu@gmail.com>

Mr. Arun Bhawe  
Marshal Geo Test Laboratory, Raipur  
<atbhawe@gmail.com>



### Technology as a Driver for India's Foundations Industry

India is witnessing one of the most interesting phases in the history of its infrastructure development. A dream of realization of infrastructural growth would demand fast track foundation practices hitherto not seen in the past. Demand for rapid foundation construction with reassuring quality and safety can only be supported through fresh lease of technologies.

With above lines, it will be worth noting that India sprung into habitual use of hydraulic rigs during late-nineties. Past decade and a half have given fillip in applied ground improvement techniques; use of trench cutters, instances of integrated rigs, energy efficient hydraulic hammers, manufacturing and application of spun piles, use of polymer slurries to name some. Even while having adopted these technologies, a very wide gap exists vis-a-vis international practices in the field of equipment applications, design practices, quality control, monitoring and testing techniques, availability of process and training manuals, up-to-date codal guidelines, and foremost of all, availability of accredited training facilities for our forward looking ground staff.

Many of the technological forays of the foundations industry in India had been driven by project demands – be it peculiar sub-surface conditions or the progress requirements. The principal clients, design consultants, specialist contractors, equipment manufacturers and suppliers had always played a key role in bringing and applying new technologies under Indian conditions. Clearly the time is ripe to take the foundation practices in this promising country to a higher level.

Large diameter monopoles, diaphragm walling in weathered rock and CFA piles are a few examples of technologies that can address to respective problems of urban space constraints, deep basements and rapid piling requirements which current situation demands. Examples are limitless. The mega projects are expected to throw a series of foundation engineering challenges, and it is here that new foundation technologies would render optimal solution.

Envisioning such a scenario, DFI of India has been striving for enhancing the deep foundations practices in India by encouraging new technologies and promoting awareness events and training programmes. In a short span of six years DFI of India organized five international conferences across India that included four pre-conference workshops; and in addition, four workshops addressing the local issues to spread awareness on modern deep foundations practices.

DFI of India, apart from above enumerated basic objectives, is striving and intends

- to homogenize Industry and Academia so that the research and the field practices can go hand in hand,
- to reach out to remote areas to spread awareness, and disseminate applicable foundation technologies,
- to create a certified course and training curriculum for ground staff, supervisors and operators,
- to create a platform for regular sharing, dissemination and publications on case studies and applications by field and academic professionals alike.

To realize a dream of taking the Indian foundations industry to a greater height and at par with the best in the world, my sincere appeal to students, professionals, and corporates is to join hands through membership, active participations and support to the DFI of India activities.

Together we can make it happen!

*Dr. Sunil Basarkar, GM Technical Services, ITD Cementation and Member, Executive Committee, Deep Foundations Institute of India*



## L&T GeoStructure

L&T GeoStructure is a part of L&T Construction – the construction arm of Larsen & Toubro Limited, India's largest technology, engineering, construction and manufacturing company. L&T GeoStructure is a unique entity, formed to focus on foundation and ground improvement-related business. We are a strong and professional foundation specialist team with the knowledge of design, equipment and methods to execute and supervise sophisticated foundation works.

### Business areas:

We have expertise in the areas of large diameter piling, piling, diaphragm walls, cut-off walls, secant pile walls, sheet piles, marine and riverfront structures, intake structures, deep foundation-supported bridges, ground improvement, soil investigation, hard-rock boring, microtunneling and water retaining structures.

### Why L&T GeoStructure?

- One-stop solution provider
- Design & Build expertise
- Extensive experience
- Focussed approach to safety
- Exceptional quality
- Reliable partnership

6000 nos of BCIS piling at  
1x525 MW power plant in  
Tuticorin



### What differentiates us?

**Large diameter piling** – A first in India! L&T GeoStructure successfully executed piles of diameter 2500mm and depth about 33m in very hard rock strata at Chennai CMRL site. These large diameter piles contribute significantly to time and cost savings, thereby creating value for the customer.

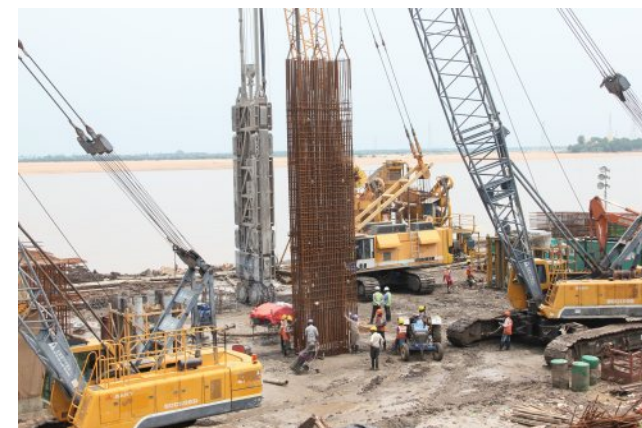
**Diaphragm walls using trench cutters** – L&T GeoStructure successfully completed diaphragm wall panels using trench cutters for depths varying from 25 – 30m at metro and commercial projects across India. With this technology, we created value for the customer.

**Top-down construction method** – We are one of the pioneers of the top-down construction method. This has the advantage of simultaneous working both above and below ground, thus resulting in significant time savings.

**Ground improvement** – L&T GeoStructure has established its presence in the market by successfully executing ground improvement solutions on 'design and build' basis for various high-rise structures across India. We offer a combination of piles and stone columns to avoid liquefaction.

**Hard rock boring** – L&T GeoStructure has the expertise and equipment to drill in very hard strata where uniaxial compressive strength is greater than 100 MPa. This exploration in challenging geotechnical strata, creates value for the customer.

## Company Profile



First-of-its-kind multi-cellular intake structure for river linking at Pattisam, Andhra Pradesh



Sheet pile work for laying under-sea LNG pipeline at 5m below ground level at ONGC, Hazira

### CONTACT US:

L&T GeoStructure  
Mount Poonamallee Road,  
Manapakkam, Chennai 600 089, India.  
Ph: +91 44 2270 4306, Email: geost@Intecc.com  
Website: www.Intecc.com

## Forthcoming Events

### DFI-India 2016: 6<sup>th</sup> Conference on Deep Foundations Technologies for Infrastructure Development in India

September 8-10, 2016 • IEST Shibpur, Howrah, Kolkata, India

#### Event Description

Deep Foundations Institute of India (DFI of India), in collaboration with the Indian Institute of Engineering Science and Technology, Shibpur Jadavpur University, Kolkata and Indian Geotechnical Society, Kolkata Chapter, will host DFI-India 2016: 6<sup>th</sup> Conference on Deep Foundations Technologies for Infrastructure Development in India on September 9-10, 2016 at the IEST Shibpur, Howrah, Kolkata, India. This two-day conference follows previous successful DFI of India annual conferences since 2011 and will focus on technology developments and case histories on the following topics:

1. Drilled Piling Systems (viz., bored piles-land and marine, drilled displacement piles, continuous flight auger piles, micro piles)
2. Driven Piling Systems (driven cast-in- situ piles, precast piles, marine piles)
3. Ground Improvement (mass stabilization, deep soil mixing, jet grouting, densification, grouting technologies, reinforcement, liquefaction mitigation)
4. Deep Excavation Systems (slurry/diaphragm walls, sheet piles, earth retention, contiguous and secant pile walls, soil nailing, soil and rock anchors)
5. Soft Soil Engineering in Underground Space Applications (tunnel support, ground water control, etc.)

Papers of practical importance showcasing latest technologies in the areas of geotechnical investigation, analysis and design including seismic aspects, computer software, tele-networking, instrumentation, testing, monitoring, tremie concreting, geo-materials, installation/construction equipment and methods, with supporting data on improvement of quality, productivity, safety and sustainability will be presented. The conference will be of particular interest to contractors, developers, local and government representatives, designers, consultants and educators involved in geotechnical design and construction. Equipment, material and instrumentation suppliers, contractors and other vendors will present their products and services in the Exhibit Hall. The conference will be preceded by a one-day workshop on September 8, 2016 on Soft Soil Engineering in Underground Space Utilization, including topics related to ground improvement, consolidation, preparation of soft soils for tunneling and other underground applications. Updated details on the event as plans evolve can be found at [www.dfi-india2016.org](http://www.dfi-india2016.org).

## DFI of India Conference DFI-India 2016

September 8-10, 2016 | IEST Shibpur, Howrah, Kolkata, India



### DFI-India 2016: 6<sup>th</sup> Conference on Deep Foundation Technologies for Infrastructure Development in India & Soft Soil Engineering Workshop

#### Registration Fees

##### Two-day Conference Only

	INR*	USD
DFI Member	6,500	200
IGS Member	7,000	250
Non-Member		
(includes DFI membership thru 31 Dec. 2017)	8,700	300
Students	3,000	50

##### Two-day Conference plus Workshop

DFI Member	8,000	300
IGS Member	9,000	350
Non-Member		
(includes DFI membership thru 31 Dec. 2017)	10,000	400
Students	4,500	75

Registration includes session attendance, exhibit attendance, poster attendance, refreshments, tea breaks, lunches, banquet dinner, conference bag containing registration materials and handouts, and access to the online proceedings including technical papers and presentation files.

#### Contact Information

Prof. Ambarish Ghosh, Organizing Secretary, DFI-India 2016

Conference email: [2016dfi@gmail.com](mailto:2016dfi@gmail.com) | Ph: +91 91 7621 1967

Website: [www.dfi-india2016.org](http://www.dfi-india2016.org) | Email: [dfiindiaoffice@gmail.com](mailto:dfiindiaoffice@gmail.com)



## Early Applications of DMT in Arabian Gulf Area – A Case Study

Sharif, Emad, B.Sc, M.Sc, Geotechnical Engineer, e.construct – Geotechnical Engineering Director (Dubai),  
emad.sharif@econstruct.ae

## Technical Paper

**ABSTRACT:** DMT was used for three main applications in famous projects in Dubai, UAE and in Duqm Port in Sultanate of Oman in the Arabian Gulf. The 1st two applications were conducted in man-made sandy earthfill embankments formed by dredging from the sea bed and stabilized by deep ground improvement. The recent correlations of S. Marchetti to incorporate the DMT stress history parameter KD for CPT-based CRR was used to confirm post CPT-based liquefaction analysis in the Duqm Site, whereas DMT was used in Dubai site to confirm the over consolidated nature of upper sandy fill soil that was previously Vibro-Compacted (8-10 years). On the other hand, the design of large diameter flexible steel oil storage tanks is based on controlled & strict, edge settlement requirements. Without DMT, the estimates of soil modulus are made based on Nspt or CPT tests resulting in conservative estimates, and suggesting the need for deep ground densification/improvement. Site specific correlation was developed for a large site between DMT based M and CPT tip resistance ( $q_c$ ) indicating at least 50% increase over the CPT based M.

### I. INTRODUCTION

DMT was only recently introduced for practical use in Dubai and the Gulf Area in General. This paper describes three main early applications of DMT in main projects. The several man-made islands in Dubai and other places, present a convenient area of application of DMT and SDMT for both assessment of the deep man made earth fill, design and control of deep ground improvement procedures and assessment of liquefaction potential. Further, the construction of large diameter oil storage flexible steel tanks presents another important area where DMT can provide valuable information to accurately assess the settlement of tanks.

This paper presents some of the recent applications of DMT in this area.

### II. MAN-MADE ISLANDS / EMBANKMENTS

Construction on artificial islands or embankments by dredging and filling is very common in the Arabian Gulf region for different purposes.

#### A. Background on Man-made Islands & Embankments Construction and Stabilization

Several Man-made Islands were constructed along the shore line of Dubai. The first was Palm Jumeira Island having an approximate diameter of 8 Kms.



Fig. 1. Typical shapes of man-made islands

The following photos show part of the Commercial berth site in Duqm Port in Oman, proposed to accommodate several industrial facilities for the port.



Fig. 2. Commercial Berth – Duqm New Port

The islands / embankments were constructed with silty sands dredged from adjacent sea bed and laid by hydraulic filling with heights ranging between 12 - 18m above original sea level.

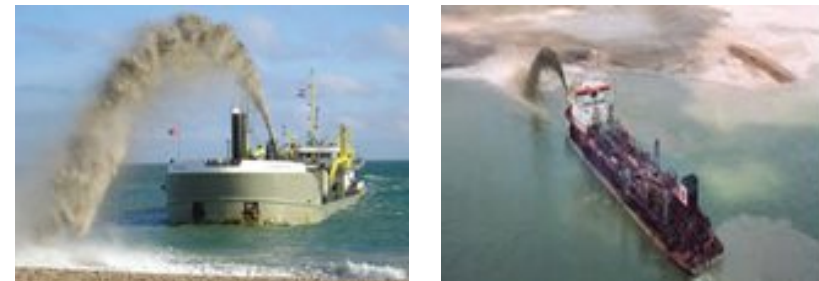


Fig. 3: Typical photos of sand dredging operations

### B. Ground Densification and Verifications

Stabilization and densification of the upper sandy fill is essential to improve its Engineering performance and mitigate such hazards as liquefaction and high differential settlements and long term creep movements. Common Methods used are Vibro Compaction/ Replacement and Dynamic Compaction/RIC for shallow sand depths. Vibro Compaction is most widely and commonly used method although other methods were also used. Verification of VC works is typically based on Pre and post CPT measurements and zone loading tests in some cases. The use of Robertson CPT-based Profiling (SBT) is very effective to establish the localities of high silt content / high friction ratio which are not likely compactable.

### C. Actual Performance

Several roads, buildings on shallow and deep foundations exist since more than 8-10 years by today and performing very well.

## Technical Paper

### Early Applications of DMT contd.



Fig. 4: Typical light weight and heavy structures in PJ

No published data exists about actual performance of the foundation, however the observed evidence indicates very well and satisfactory performance of the compacted earth fill. Testing showed remarkable stiffness and strength increase with aging. Fills tested after several years of laying are stiffer than young fills.

### III. CASE 1: CONFIRMING CPT-BASED LIQUEFACTION ANALYSIS IN PORT OF DUQM IN OMAN

The Duqm area lies along the coasts of the Indian Ocean, about 600 Km SW of Muscat, the Capital City of The Sultanate of Oman.

The area is intended to accommodate one of the largest Oil Ports in the Middle East with all associated facilities as sea port, airport, dry dock, oil refinery, Storage Terminals, infra-structures like roads, rail way, bridges, buildings and residential villas etc. that are under construction or on the anvil.

#### A. Description of DMT/CPT Application

A main component of the port facilities is the Commercial Berth which is made up of thick reclaimed sandy fill by dredging from the sea bed and hydraulic filling. The berth is >250m meters in width and more than 1500 m in length extending from the coastal line into the sea. The typical soil profile indicates a thick (typically 12-18m), slightly to silty fined sand (reclaimed soil) on top of a thin sea bed layer of silt/clay soil that is underlain by bedrock of very to extremely weak claystone (Figure 6).

The use of shallow foundations to support the many proposed light to moderately heavy structures within the area of the Commercial Berth requires satisfaction of both liquefaction mitigation and acceptable settlement performance criteria, including control of potential differential settlement.

The Berth was investigated with large number of widely spaced boreholes with Nspt testing conducted at 1 to 1.5m intervals in each borehole as part of technical feasibility and initial risk assessment and planning of the port. Later, a more detailed investigation was conducted within the site of a typical project that lies within the mid-zone of the Commercial Berth and which is proposed for cement silos and concrete mixing plant.

The subsurface conditions are indicated in the below generalized subsurface profile indicating the upper sandy fill of about 15m depth, underlain by thin sea bed layer of clayey soil followed by bedrock of claystone.

The Nspt tests results obtained within 5 test borings, has indicated large stiffness variations and presence of weak zones. This is clearly indicated by the graphical plot of Nspt vs elevation presented in Figure 7.

The obtained Nspt results, suggested that deep ground improvement is necessary. Vibro compaction was found to be technically feasible, time and cost effective method to achieve the necessary targets. Pre compaction – CPT tests were conducted and used to assess the liquefaction potential and plan the VC works. The results showed the site is liquefiable and weak, and therefore VC works were conducted. 1st round VC: The typical layout of triangular grid of VC points is shown below.

Verification included post CPTU tests at three locations as indicated in the above layout. At each location, 2 pair of post CPT tests were conducted, at 1/3rd spacing from the poker point and at centre of spacing of a typical triangular grid. Typical

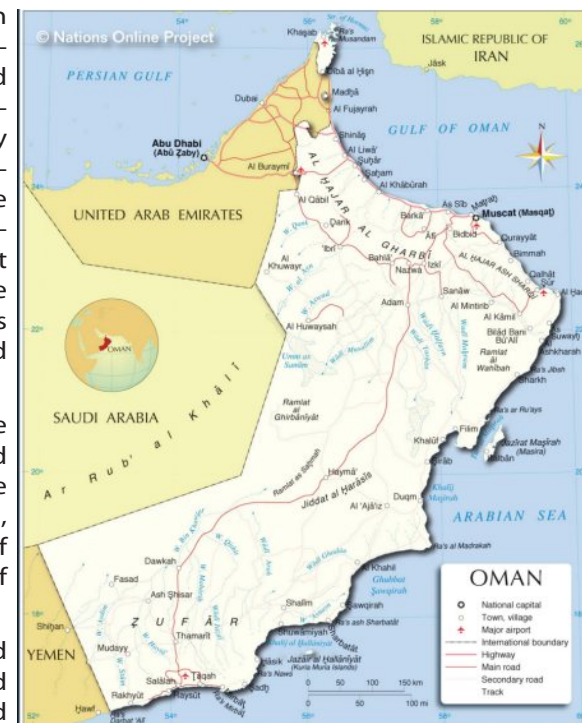


Fig. 5: Map of Oman showing location of Duqm



## Technical Paper

### Early Applications of SMT contd.

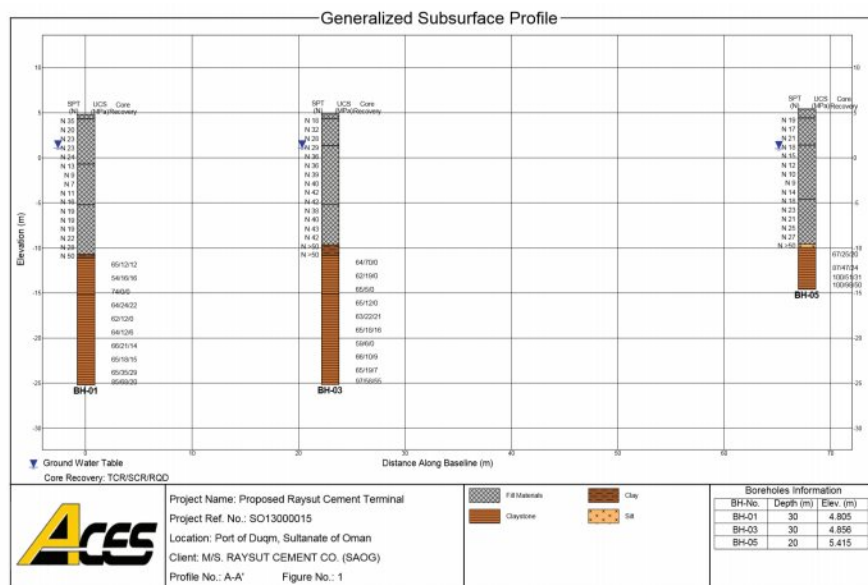


Fig. 6: Generalized Subsurface Profile – Duqm Site

post CPT and CPT – based liquefaction analysis are presented below. Typical post CPT result & CPT-Based liquefaction analysis are shown below.

Later, 3 post DMT tests were conducted, each at the centre of the test areas of post CPTs, to assess KD effects on the CPT-Based liquefaction potential, and also for settlement performance of circular raft foundations proposed for the cement silos. The following presents typical DMT result.

In his recent paper (9), Prof. S. Marchetti described a method to incorporate the stress history parameter (KD) of DMT into the Liquefaction Correlations. The final recommended relationship that shows the new correlation is shown below.

The relationship is based on  $Q_{cn}$  KD relationship as  $Q_{cn} = 25 \times KD$  given earlier by Robertson, therefore, CRR is evaluated from measured CPT ( $Q_{cn}$ ) and also from  $Q_{cn} = 25 \times KD$ , and the average CRR is then evaluated as: Average CRR =  $[(CRR \text{ from } Q_{cn}) + (CRR \text{ from } KD)] / 0.5$ . CRR is the cyclic soil resistance. The CRR values provided by Fig. 11 can be regarded as the sum of two parts. One part, the bulk of it, is the CRR estimated by the CPT consensus curve. The other part is the KD correction. An advantage of Fig. 11 is that it shows in one graph the whole picture, facilitating the recognition of trends. For instance the graph indicates that for high values of KD and  $Q_{cn}$ , corresponding to seasoned sands, the differences between the curves are higher. This later observation is of importance as the likely improvement effect of KD on the value of soil cyclic resistance CRR can be quickly noticed. Therefore, for low KD of  $<2$ , the effects may be ignored, whereas for higher KD, then the effects are regarded as significant. This is also illustrated in the

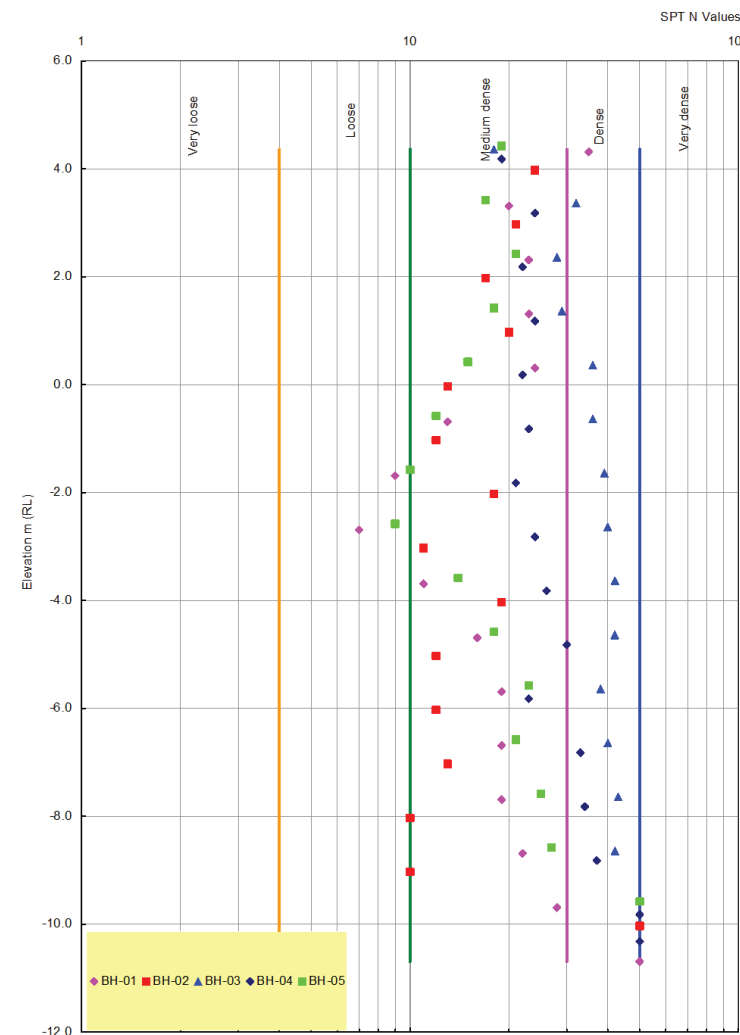


Fig. 7: Nspt vs Elevation – Duqm Site

## Technical Paper

### Early Applications of DMT contd.

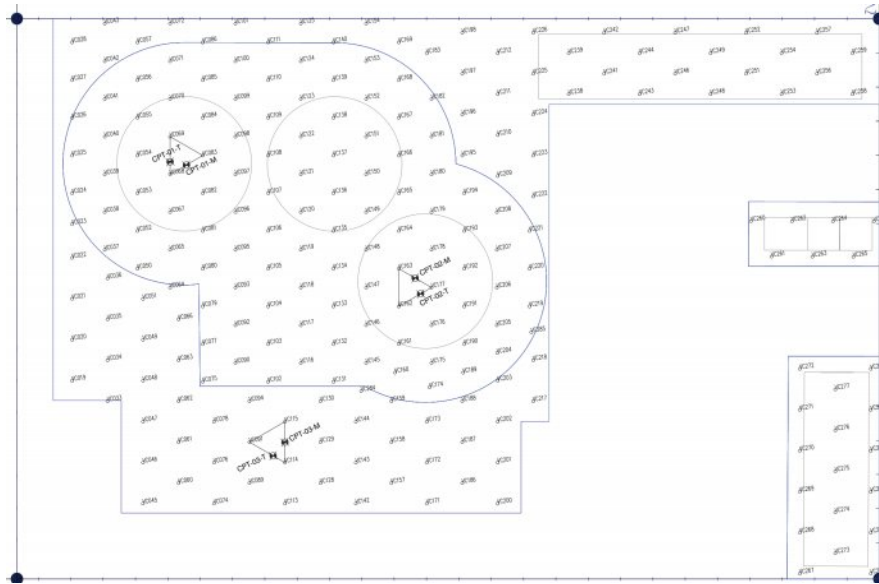


Fig. 8: Layout of VC points & Post CPT Tests Locations – Duqm Site

below graph as given by S. Marchetti (8).

An excel sheet was prepared to conduct the analysis for the above. The 3 DMT tests conducted in the middle of each test triangle has indicated low KD as indicated in the above tests results (from slightly <1 to 1 for tests 1 & 3 and around 2 to 3 for test 2). The conclusion was that KD results did not impose any improvement on CRR, and the site was still classified as liquefiable and further round of VC was specified. The DMT results however has also indicated the spatial variation as indicated by different ranges of KD, which is in close agreement with the post CPT findings.

Following re-compaction works conducted by the contractor, other round of post CPT tests were only conducted that indicated satisfactory performance, as illustrated below.

Liquefaction analysis was found satisfactory and the site was accepted, and the construction commenced.

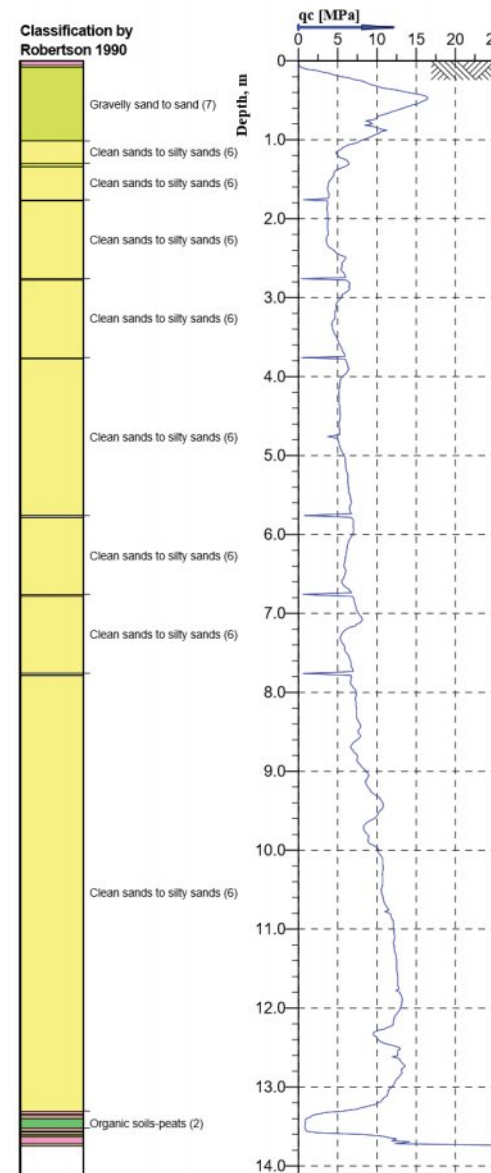


Fig. 9a: Typical post-CPT result & Liquefaction Analysis Duqm Site

### REFERENCES

- [1] API650, 11th Ed., June 2007, "Welded Steel Tanks For Oil Storage".
- [2] C.R.I. Clayton. "The Standard Penetration Test (SPT): Methods and Use". CIRIA Report 143, 1995.
- [3] NYSDOT, "Geotechnical Design Manual". October 3, 2013.
- [4] P.K. Robertson. "Interpretation of Cone penetration Tests – A Unified Approach". MS 08-158, Submitted to Canadian Geotechnical Manual, and accepted for Publication. May 2009.
- [5] R. Williams and D. Penumadu. "Multichannel Analysis of Surface Waves (MASW) at the National Geotechnical Engineering Site at Texas A&M". 2011.
- [6] T. Lunne, P.K. Robertson, and J.J.M Powell. Cone Penetration tests in Geotechnical Practice. 1997.
- [7] The Flat Dilatometer Test (DMT) in Soil Investigation. Report of the ISSMGE, Technical Committee 16 on "Ground Property Characterization from In-Situ Testing". 2001.
- [8] Some 2015 Updates to the TC16 DMT Report 2001, Silvano Marchetti University of L'Aquila, Italy.
- [9] Silvano Marchetti, "Incorporating the Stress History Parameter KD of DMT Into the Liquefaction Correlations", Published in Jnl ASCE, January 09, 2015.
- [10] NCEER Workshop on Evaluation Resistance of Soils, "Technical Report NCEER-97-0022", December 31, 1997.



## Technical Paper

### Early Applications of DMT contd.

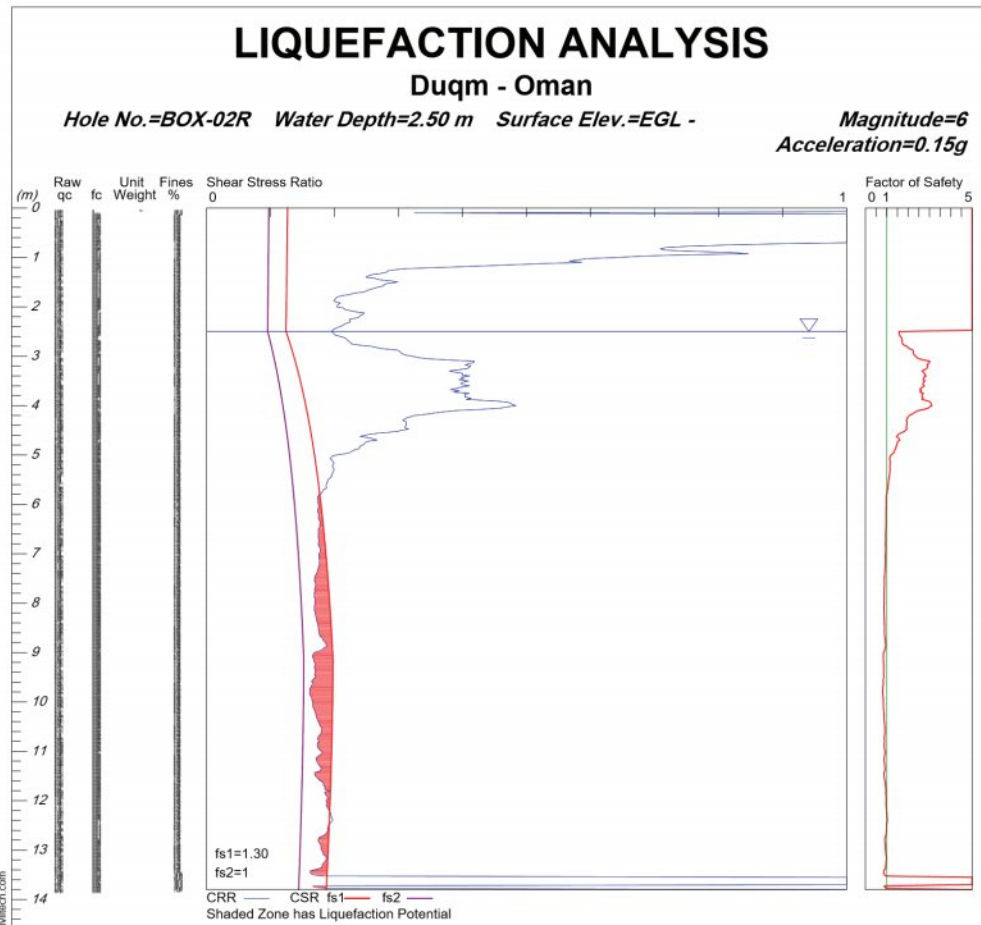


Fig. 9b: Typical post- CPT result & Liquefaction Analysis Duqm Site

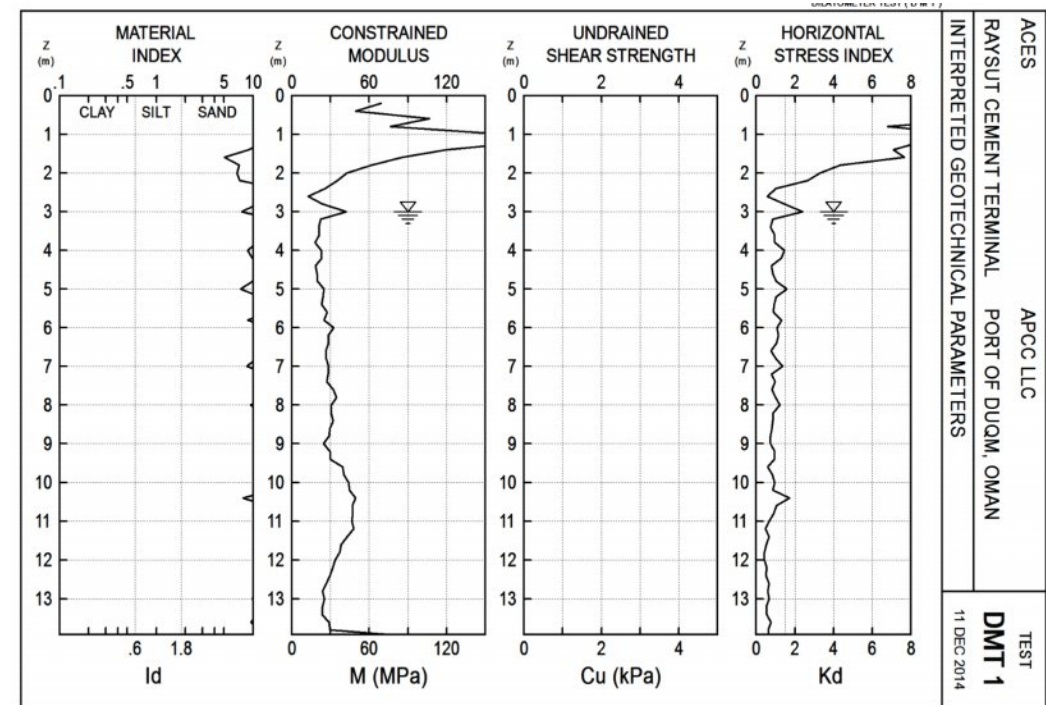


Fig. 10: Post Compaction DMT 1 (typical result) – Duqm Site

## Technical Paper

## Early Applications of DMT contd.

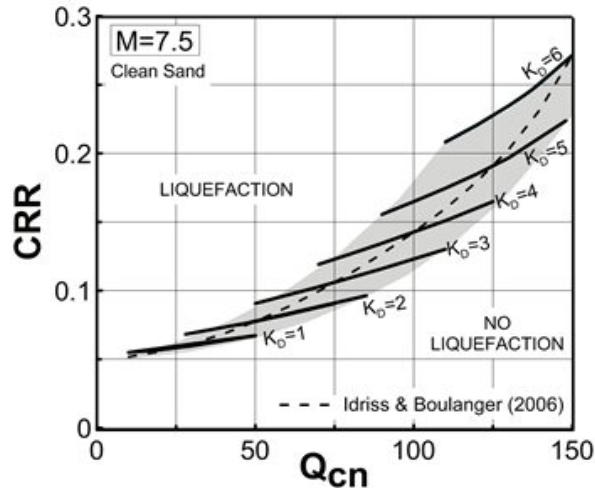


Fig. 11 - Chart for Estimating CRR in Clean Sand Based on  $Q_{cn}$  &  $K_D$  (as given in ref. 9)

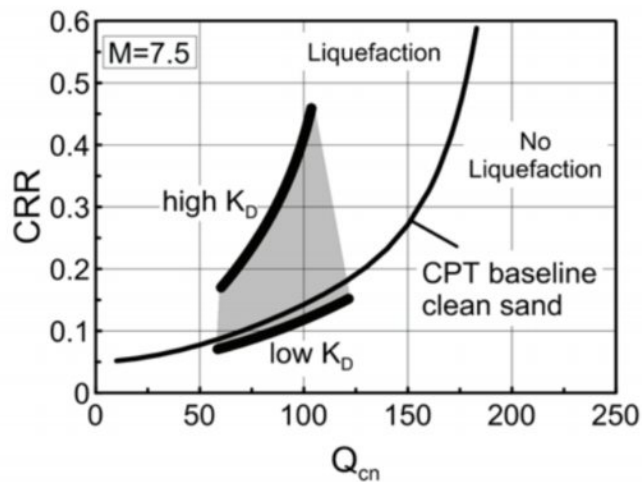


Fig. 12. CRR expressed as a function of  $Q_{cn}$  &  $K_D$ . Qualitative Framework

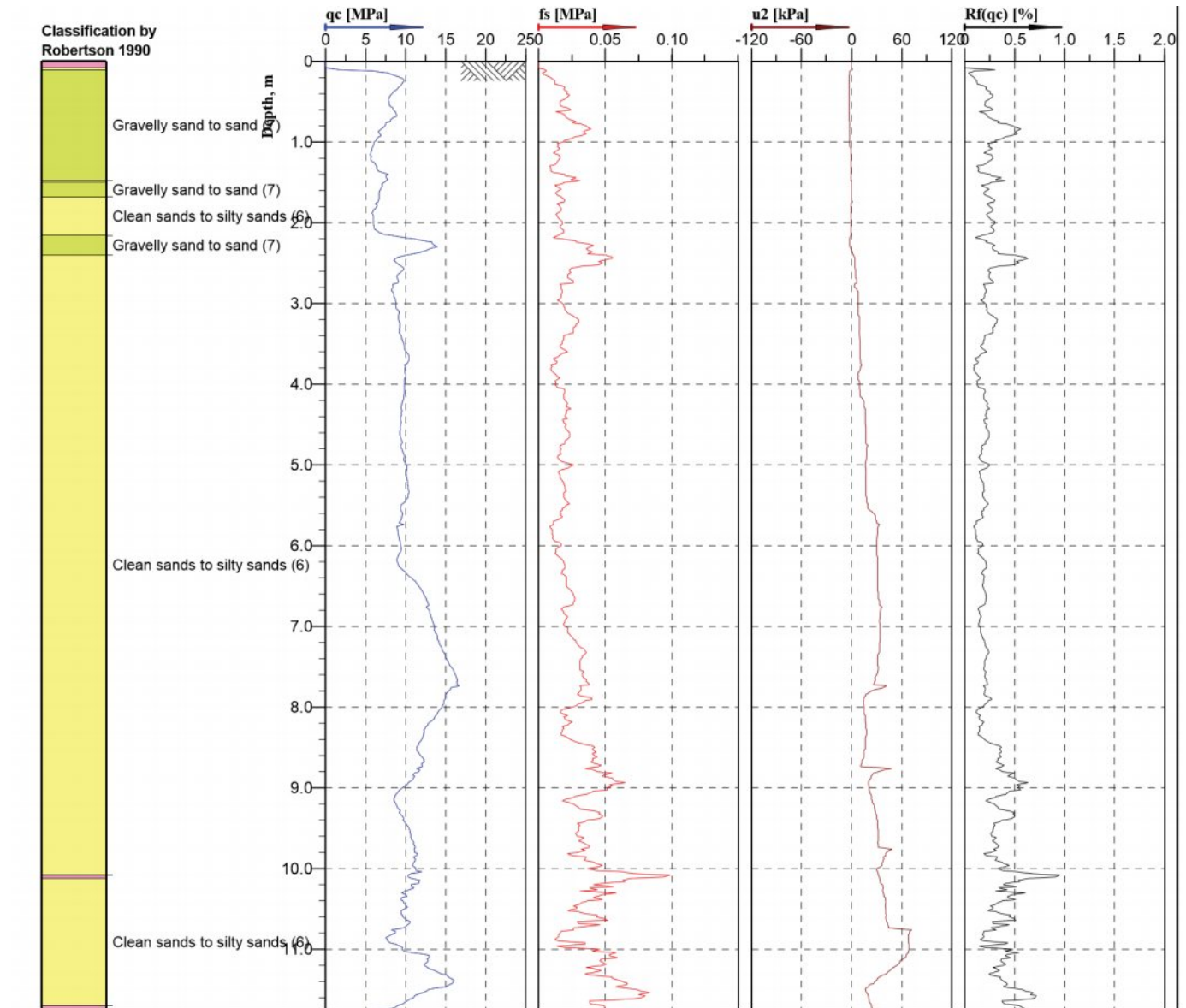


Fig. 13: Typical Post Compaction (2nd Round) CPT – Duqm Site.



## Report on ONE DAY NATIONAL WORKSHOP ON 'Deep Foundations Technologies for Infrastructure Development of Andhra Pradesh'

At Deichman Hall, Acharya Nagarjuna University, Nagarjuna  
Nagar, Guntur - 522510, A.P. India on Saturday, 12th March 2016

Organised by Deep Foundations Institute of India, in association  
with Indian Geotechnical Society, (Guntur Chapter) and  
Department Of Civil Engineering, University College Of Engg. &  
Tech. Acharya Nagarjuna University, Guntur

After a series of successful programs, starting from the year 2011, DFI of India had conducted this year's first quarter one-day national workshop on "Deep Foundation Technologies for Infrastructure Development of Andhra Pradesh" at Acharya Nagarjuna University(ANU) Campus, Guntur. Twin cities, Vijayawada and Guntur, form part of the new Capital Region, Amaravati, of the recently carved out state of Andhra Pradesh. The Government of Andhra Pradesh has developed a master plan to make the Amaravati as a world class city. It is expected that this region will be the hub of civil engineering activity for at least the next 50 years. Several projects, viz., highways, roads, high rise buildings, flyovers, metros, bridges across river Krishna and its many canals, riverside development, etc. would be taken up. DFI of India felt it appropriate and timely to conduct the workshop in this region.

The event was conducted in association with the Indian Geotechnical Society(IGS)- Guntur Chapter and the Department of Civil Engineering-Acharya Nagarjuna University College of Engineering, Guntur. Thanks to the overwhelming support received from the University authorities. Sincere thanks are due to Prof.Muvvala Ramarao, Honorary Secretary of the IGS-Guntur Chapter and his team, Dr.T.V.S. Varalakshmi, Head of the Department of Civil Engineering, ANU, and her colleagues, Mr. T. Satyamurthy, Managing Director of Singa Engineering and Trading for their sincere and enthusiastic support.

The program covered various technologies of interest to the Capital Region ranging from driven precast piles, large diameter drilled piles, diaphragm walls and dam cut-off walls, marine foundations, and ground improvement. Lectures delivered by domain experts from the industry in India and abroad were well received by around 300 delegates. More such workshops are planned by DFI of India in each of the following quarters of this year at various regions of India to address the local needs.

## DFI of India Members - 2016

### Corporate Member s

Larsen & Toubro Ltd - L&T Geostructure, Class IV

Jeyson J. Samuel

M. Kumaran

Kondapalli Bairagi

Sivarama Sarma Bhaskara

Rajan S.N.

Kanappan Subbaiya

Ananthakumar T.S.

Sivaprasad P.

Jasmine Nisha

Jaya Pragash V

Vinusha Karupannan

Chinta B V K Mohan

Praveen Kumar G R

Surath Shilpa

K Venkata Sivannarayana

K Kiran Kumar

Keller Ground Engineering India Pvt. Ltd., Class III

Hari Krishna Yandamuri

Deepak Raj

Ramadas V.V.S.

Madan Kumar Annam

Arunkumar Sekar

Tanwir Wahab Sayed

Sridhar Valluri

Sangeen Naik B.

Saday Mishra

Kanhaiya Lal Meghwal

Panasia Project Consultancy Pvt. Ltd. , Class I

Shyam Chengalath

Pradeep Kumar D.

Geo-Ground Engineering Operations India Pvt Ltd,

Affiliate

Kamlesh Mishra

Corporate Ind. Mem

Vidya Sagar Kongubangaram, L&T Construction

Individual Members - Gov Emp

Kanniappan Ilamparuthi, Anna University

Umesh Kumar, B.S.E.I.D.C. Ltd. Patna

### General Individual Members

A. Sreerama Rao, Indian Geotechnical Society, New Delhi

Mohan Ramanathan, Advanced Construction Technologies Pvt Ltd.

N. Kumar Pitchumani, AECOM

Valiveti Ramamurthy, AFCONS Infrastructure Limited

Prakash Bansod, AFCONS Infrastructure Limited

Asit Thakkar, D. Thakkar Constructions Pvt. Ltd.

Sree Rama Krishna Kalavacharla, Deep Foundations Institute of India

Anirudhan IV, Geotechnical Solutions

J B Ravishankar, Grips India

Ghananeel Molankar, Liebherr India Private Limited

Jayaram Kousik, Maheshwari Mining Pvt. Ltd.

Sreejith G.H., PWD, Govt. of Kerala

Shankar Guha, Simplex Infrastructure Limited

Venkatraman Balakumar, Simplex Infrastructure Limited

Sandeep Talwar, Super Drilling Pvt Ltd

Surajit Mukherjee, Suretech Infrastructure Pvt. Ltd.

Dicky Sinha, Tethys Business & Projects P Limited

B N Krishnaswami, Time Institute for Materials Testing

### Corresponding Members

Ashoka Y

L. Durga Charan Kiran, Atkins India Private Ltd.

Duggirala VVK Rao, Atkins India Private Ltd.

R Balasubramaniam, Avant-Garde Engrs & Consultants (P) Ltd

Rajesh Gupta, Gauge Geotechniques

Ravikiran Vaidya, Geo Dynamics

Ananth Ramasamy, Independent Consultant

Sunil Basarkar, ITD Cementation India Limited

Krishnendu Mandal, Mythcon

Manohar Pakade, National Highway Division No.14, Nagpur

Subramanian Ramanathan, National Institute of Ocean Technology

Abhijit Patki, Project Management Group

Bhiva Parab, Royal Haskoning Dhv

Narayan Agrawal, RVR Projects Pvt Ltd

Maruthi Nandhitha Shinde, Saipem India Projects Pvt Ltd

Guraja Srinivasa Rao, Saipem India Projects Pvt Ltd

Jogesh Chandra Gogoi, Sanjib Services

Badam Sundara Rao, Sundar Associates

Salim John, Tebodin Consultants & Engineers

Akshay Kumar Sahoo, PWD, Govt. of Odisha

## DFI-World Activities 2016-2017



Theresa Engler  
Executive Director, DFI

I am pleased to be asked to contribute to the quarterly news of our DFI of India Chapter to ensure that our colleagues in India are aware of all of DFI's activities worldwide. Several positive things have already happened this year and many more are planned for the rest of 2016 and beyond. We look forward to having participation on these upcoming events from the deep foundations community in this country. Many of you are probably aware of and have participated in the April 2016 Bauma event in Munich, Germany. I attended on behalf of DFI to connect with current DFI member exhibitors and other industry companies. Bauma is a global driving force behind innovations, an engine for success and a marketplace. The trade fair brings together the construction machinery industry in its entire breadth and depth. This platform presents a high concentration of innovations and DFI's presence was imperative during this trade show. With planning already underway for Bauma 2019, we are looking forward to visiting the show again.

Visit [www.bauma.de](http://www.bauma.de) for more information.



Though I was not in attendance at it, our Middle East Chapter held its third conference during May 11-12, 2016 in Dubai, UAE. The chapter organized the event in collaboration with the American University of Dubai and it was a great success. It provided an opportunity for the region's geotechnical engineering practitioners and academicians to network, exchange information and experience, and present the latest developments in the field of foundations design and construction.

To view photos from the event go to: <http://s1078.photobucket.com/user/DeepFoundationsInstitute/library/2016%20DFI%20Middle%20East%20Conference>

Another successful DFI event this year was our SuperPile'16 Piling Design and Construction Conference held in Chicago, IL, USA with record-breaking attendance of more than 400 attendees and 50 exhibitors. The conference was held June 7-9 and featured 32 technical presentations plus the Osterberg Memorial Lecture, the presentation of the Ben C. Gerwick Award, an exhibition of innovative technologies and services, committee and working group meetings, and networking events. If you would like to access the presentations or view the conference photos, go to [www.dfi-superpile.org](http://www.dfi-superpile.org).

Coming up later this year and in 2017 and 2018 are the following events:

**International Conference on Deep Foundations, Seepage Control and Remediation, (DFI's 41st Annual Conference)**  
New York City, USA

Registration is now open at [www.deepfoundations2016.org](http://www.deepfoundations2016.org) for this not-to-be-missed conference where an anticipated 1000+ geo-professionals are expected to gather to present, discuss, and debate all aspects and current challenges pertaining to the advancement of the deep foundations, earth retention, and seepage control and remediation industries. Almost 200 abstracts were received for consideration by the technical committee by authors from 20 countries. Sessions in the deep foundation technical track will focus on planning and mitigation, design and construction, project delivery, communication and training, incorporation of emerging technology, data management, risk and liability, and industry advancements while the track on seepage control and remediation will focus on foundation challenges, design and construction, case histories, historic performance data, QC/QA and new research and development. The full technical program will be published in August. There is also an exhibit space of over 120 companies to visit who will display their latest innovative products and services.

**DFI-PFSF Conference**  
Melbourne, Australia March 2017

The planning committee for the inaugural joint conference of the Deep Foundations Institute (DFI) and Piling and Foundation Specialists Federation (PFSF) on Piled Foundations & Ground Improvement Technology for the Modern Building and



Infrastructure Sector, being held March 21-22, 2017, in Melbourne, Australia, is now accepting abstract submissions describing the subject matter of their proposed presentation no later than Friday, July 22, 2016.

Presentations on the following topics are welcome:

- Innovation in design methods
- Selection and justification of design and installation parameters
- Interesting or novel solutions to construction problems by design and/or construction techniques
- Testing of foundations
- Case studies
- Retention solutions for basements
- Ground improvement methods associated with retention works and soil improvement
- Equipment developments and performance
- Database systems associated with construction

Interested parties should go to [www.dfisubmissions.org](http://www.dfisubmissions.org) and create an account using the Conference ID PFSF2017. Please note, abstracts should be no more than 300 words.

**13th International Workshop on Micropiles – 2017, Vancouver, Canada**

Industry professionals interested in making a presentation at the 13th International Workshop on Micropiles being held March 29 – April 1, 2017, in Vancouver, Canada, should submit a brief abstract, no more than 300 words, describing the subject matter of their proposed presentation by September 1, 2016, to [ism2017@dfi.org](mailto:ism2017@dfi.org).

Papers are solicited on the following topics within the main theme of the conference, Micropiles: Resisting and Remediating the Effects of Mother Nature:

- Seismic Design
- Foundation Designs – Solar/Wind/Hydro
- Energy Piles
- Challenging Subsoil Conditions (Groundwater/Karst)
- Landslide Prevention/Slope Stabilization
- Climate Change/Rising Sea Levels
- Resisting Structural Thermal Effects
- Flood Prevention and Scour Protection



In addition, the 2nd Micropile World Cup Competition will be held at the Workshop in Vancouver and project proposals are currently being solicited. This international competition of micropile projects, submitted from five regions of the globe, will recognize the project that stands above all others and be awarded the Micropile World Cup.

To enter your project, submit a one-page summary to [ism2017@dfi.org](mailto:ism2017@dfi.org) before December 31, 2016. We strongly encourage submissions from India as our hope is we will have participation in the competition from all regions of the world.

For more information visit <http://www.dfi.org/ISM2017>

**DFI-EFFC International Conference on Piling and Deep Foundations**

**Planned for mid-year 2018 in Rome, Italy**

Planning for the DFI-EFFC International Conference on Piling and Deep Foundations taking place in Rome, Italy in May or June 2018 is underway. This conference will focus on infrastructure and sustainable urbanization, highlighting worldwide mega-projects. The two-day event will include special lectures, technical sessions and interactive panel discussions. Stay tuned to [www.dfi.org](http://www.dfi.org) for details as they become available.

Respectfully submitted by **Theresa Engler, DFI Executive Director**

## SAVE THE DATE

DFI International Conference on Deep Foundations, Seepage Control and Remediation (41st Annual Conference on Deep Foundations) - October 12-15, 2016, Marriott Marquis, New York, NY.  
<http://www.deepfoundations2016.org>

## 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  
 Stay informed through the flagship Deep Foundations magazine and the peer-reviewed DFI Journal  
 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 100,000 articles, technical papers & books from DFI & organizations all over the world - at no cost

Visit [www.dfi-india.org](http://www.dfi-india.org) OR [www.dfi.org](http://www.dfi.org)  
 to know more and to become a member

## OBITUARY



17.04.1961 - 11.06.2016

K.P. Pradeep, Master Builder

Photo courtesy: Master Builder

Mr. Pradeep was a great friend to DFI through his collaboration in assisting us with publicizing our efforts in India. He will be very much missed in the geotechnical and construction industry worldwide.

His dedication to the society and continuous effort in spreading the developments in the construction industry will always be remembered.

## SAVE THE DATE

**DFI-India 2016: 6<sup>th</sup> Conference on Deep Foundations Technologies for Infrastructure Development in India**

September 9-10, 2016 • IEST Shibpur • Howrah, Kolkata, India

Updated details on the event as plans evolve can be found at [www.dfi-india2016.org](http://www.dfi-india2016.org).

DFI of India News, Quarterly e-Newsletter, published by DFI of India, Chennai. Copyright: DFI of India, Chennai

This e-newsletter of DFI of India is available at <http://www.dfi.org/commhome.asp?INDIA>.

Editorial team: Anirudhan I.V, Y. Harikrishna, Ravikiran Vaidya & Dr. Sunil S. Basarkar

All rights reserved. No part of this publication or the information contained herein may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, by photocopying, recording or otherwise, without written prior permission from the publishers. Although all care is taken to ensure integrity and the quality of this publication and the information herein, no responsibility is assumed by the publishers nor the author for any damage to the property or persons as a result of operation or use of this publication and/or the information contained herein. The views expressed in the articles are of the authors and the articles are published after obtaining full consent of the respective authors and based on their confirmation that there are no copyright violations whatsoever.