

# Auger Cast-in-Place Piles

By 2013, auger cast-in-place (ACIP) piles were considered as a mature foundation technology throughout the United States. General guidelines for the design and construction of ACIP piles are available along with numerous references for design in specific North American geologies. In fact, the current generation of contractors and geotechnical practitioners might view ACIP piles as just another deep foundation option to be considered, along with driven piles, drilled shafts and others. This acceptance has developed, however, over a 60-plus year period. India is yet to try and embrace this highly economical piling system.

ACIP or Continuous Flight Auger Piles have large potential as a much cheaper foundation system in the middle and large size infrastructure and heavy industry projects in India. DFI of India is planning trial execution and documentation of this system for the benefit of the foundation industry.



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**DFI of INDIA**

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## Auger Cast-in-Place Piles - The History of Growth

## What is Auger Cast-in-Place pile?

The term, Augured Pressure-Grouted (APG) pile is often used when referring to ACIP piles because the piles emerged out of construction processes at the Intrusion-Prepakt firm in the late 1940s. The company's specialty was pressure grouting and pre-placed aggregate concrete. The grouting was typically accomplished by driving a pipe to a target level and then injecting grout under pressure. In some soil conditions, it was necessary to use an auger to reach the desired grouting depth. In these circumstances, the grout pipe was driven beside the auger and grout was pumped as the auger was withdrawn. The grout pipe was then withdrawn as well. This was the genesis of the APG, or ACIP pile, and many piles were installed using this technique.

## Patent, Licenses

The patent application, "Method for Forming Piles" was filed by Raymond Patterson of Intrusion-Prepakt in 1951, and the patent was granted in 1956. The process was eventually modified when a suitable hollow-stem auger was developed.



Licenses were granted to the Lee Turzillo Contracting Company and Berkel & Company Contractors, Inc. in the late 1950s. Each of the three companies coined their own terms for the piling process: "Pakt-In-Place" for Intrusion-Prepakt, "Auger Pressure-Grouted" for Berkel and "Augercast" for Turzillo. Over time, "Augercast" was frequently used as a generic term for the system. The installation of these piles was, and still is, a highly nuanced process; "contractor dependent" is a term often seen today. Intrusion-Prepakt, Berkel and Turzillo all had personnel who were part of the original group that developed the system and who appreciated the craftsmanship involved in forming sound piles.

Early installation platforms were wagon or truck-mounted, and augers were advanced by relatively low-torque power units of about 15,000 ft-lbs (20.3 kN-m). Leads were mounted on mechanical cranes that made it difficult to retract the auger smoothly, and grout was placed with pneumatic pumps. Masonry sand was used in the grout (to allow the grout to be pumped with the fairly low-power pneumatic powered piston pumps), and grout was batched on site from bagged cement, fly ash and a grouting agent. The use of the

Early installation of ACIP piles

Continued in Page 6

## From the Expert

### DFI of India and Two "I"s

Dr. N.V. Nayak

DFI of India is doing great service in spreading knowledge through length and breadth of India by organising seminars, workshop and through Newsletters.

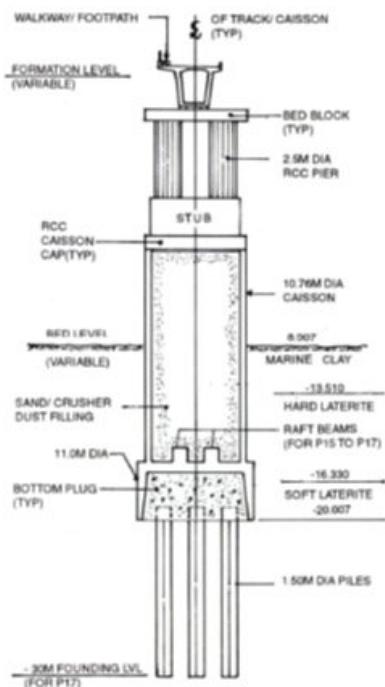
Indians are known for their capabilities for 'Innovations (I)', if duly encouraged. Very recent example is "Mission of Mars." ISRO did it very successfully at the very 1st attempt which no other country could achieve. Further it was done very economically costing roughly Rs.7.5 per km. In general success rate of ISRO is the highest in the world. We, Governments, Managements, Teachers should cultivate & encourage our younger generations for such innovations. This will lead to speedy development of our nation at a relatively low cost. Unfortunately this do not happen often. It is highly disheartening to see that our code on Under-ream Pile (IS2911 Part 3) is still unprofessional in approach which specifies that pile capacity is independent of soil type and characteristics. It is only one such example. Similarly it is highly disheartening to see that Railways in their civil engineering constructions specify even today use of only Ordinary Portland cement whereas blended cement concrete would yield more economical, more durable and more sustainable structures. There are many such examples. Further this is in spite of the fact that concerned officers are aware of limitations of their specifications. This is where second (I) comes in. We not only need to be innovative but need to convert our knowledge & innovations

into practice by "Implementation (I)". We lack badly in timely implementation.

In spite of this, fortunately some of our Geotechnical and Foundation Engineers have developed and implemented several innovations, many may look very simple but will have significant cost reduction, time saving and improved durability. Some other of innovations are Path breaking. To cite only three cases, we may refer to removal of green concrete above Pile cut off (Fig.1, looks simple), caisson resting on piles (Fig.2, Path breaking innovation) and use of blended cement concrete in piles with high permissible percentage of GGBS in industrially polluted areas where in piles with "OPC" alone failed miserably (Fig.3, Path breaking innovation).

I sincerely believe that DFI of India will arrange Workshops / Seminars, all over India on "Innovations and Implementations" on Foundation Engineering, in addition to interacting with codal authorities and other government authorities to change their approach and specifications for sustainable development in India.

In addition to above two "I"s, we have to learn to be keen "observer" and "disciplined" engineers to ensure speedy growth of our Nation. We also know that geotechnical engineering development is from "Field" to "Theory / Design Office", a practice followed by "Father of our Soil Mechanics." Let us follow this "Mantra" for success and development.





**Next Event****DFI-India 2017 at IIT Madras**

DFI-India 2017, 7<sup>th</sup> Conference on Deep Foundation Technologies for Infrastructure Development in India

October 05, 2017 - October 07, 2017

IIT Madras, Chennai, India

DFI-India will hold its 7<sup>th</sup> Annual Conference back in Chennai in collaboration with IIT Madras and the Chennai Chapter of the Indian Geotechnical Society, the site of their 2012 conference. This two day conference will focus on emerging technology developments and case histories on deep foundations, deep excavations and ground improvement featuring presentations of practical importance showcasing latest technologies in the areas of geotechnical investigation, analysis and design including seismic aspects, treated soil properties, computer software, tele-networking, instrumentation, testing, monitoring, installation/construction equipment and methods, with supporting data on improvement of quality, productivity, safety and sustainability. A one-day workshop will precede the conference on October 5<sup>th</sup>. The event 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.

Visit for more details

<http://www.dfi.org/dfieventlp.asp?13295>

Registration details on Page No: 15

**DFI-IGC2016 PRE-CONFERENCE WORKSHOP 14 DEC 2016**

Pre-conference workshops on topics of relevance to the region were part of these annual conferences. During the last two years, workshop are being organized in every quarter of the year, the third quarter workshop being a part of the annual conference.

Indian Geotechnical Conference, IGC, is a prestigious annual event of Indian Geotechnical Society affiliated to International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE). IGC 2016 was held in Indian Institute of Technology Madras, Chennai during December 2016. DFI of India was invited to conduct the pre-conferences workshop in association with IGC 2016 on 14 December 2016. DFI of India selected 'Deep Foundations in Liquefiable Soils and Deep Excavation Experiences' as the topic for this workshop.

With the recent trend in increased intensity and frequency of earthquakes and the need to understand the tools to effectively deal with liquefaction issues related to the performance of deep foundation. Deep excavations have become more common in recent years in various projects in India namely, metros, basements for tall buildings, and bulk material handling projects, etc. This topic is of significance for design engineers as well as construction engineers. The workshop was designed as two sessions. The morning session was on 'Design and performance of deep foundation under liquefied soil conditions' and the post lunch session was on 'Experiences in the design and execution of deep excavation'.

The workshop was held at IC & SR seminar hall of IIT Madras on 14 December 2016 with an attendance of more than 80 delegates from all over India. The workshop was declared open by the president of Indian Geotechnical Society, Prof. A Srirama Rao. Dr. K.S. Ramakrishna showcased DFI of India to the delegates and gave a brief outline of the workshop.

The morning session on Deep Foundations in Liquefiable Soils offered four presentations and the afternoon session on Deep Excavation Experiences was enriched by three presentations. Each presentation was of 40 minute's duration. The presentations details are as below.

Interaction between deep foundations and liquefied soil: case history and guidelines:

Prof. Jonathan P. Stewart, University of California, Los Angeles.

Downdrag and drag load behavior of piles based on blast liquefaction testing:

Prof. Kyle Rollins, Brigham Young University

Behaviour of combined pile-raft foundation and piles in liquefiable soils during earthquake:

Prof. Deepankar Choudhury, Professor, IIT Bombay, Mumbai, India

Pile design in Seismic Areas: Theory and Code Deficiencies:

Prof. Subhamoy Bhattacharya (Suby), University of Surrey (UK)

What caused the collapse of the Nicoll Highway, Singapore?

Prof. Andrew J. Whittle, Massachusetts Institute of Technology

Risks and design challenges of deep excavation in urban settings:

Dr. K.N. Gunalan, AECOM, USA

Construction systems for deep excavations in modern India:

Er. Vetriselvan, L&T Geostructures



Prof. G. L. Sivakumar Babu, President Elect, IGS, chaired the morning sessions and Prof. K. Ilamparuthi, College of Engineering Guindy, Anna University, Chennai, chaired the post lunch sessions. Researchers Balu George and Sona Gokuldas of IIT Madras coordinated the workshop. Er. I.V. Anirudhan, Vice Chairman, DFI of India concluded the session with formal vote of thanks. The delegates gave very positive feedback on the workshop.



## FIRST QUARTER WORKSHOP 2017 AT NAGPUR- Report

## A Message from DFI

ONE DAY NATIONAL SEMINAR ON

**PILE FOUNDATIONS: WITH SPECIAL CONTEXT TO METRO RAIL WORKS**

15<sup>th</sup> April 2017

DFI of India in association with The Institution of Engineers (India), Nagpur Local Centre organized One Day National Seminar on Pile Foundations – With Special Context to Metro Works at The Institution of Engineers (India), Nagpur Local Centre, Dokras Hall at Nagpur on 15<sup>th</sup> April 2017 – an event intended to create awareness and dissemination of the state of art knowledge in the field of pile foundations applied to Metro works. This objective was realized by inviting experts from the field to deliver presentations.

Following topics were covered:

- Geotechnical Characterization of the Metro Alignment at Nagpur (Presented by Dr. AR Katti, MD, NYSS, Airolia)
  - Bored and Socketed piles – Design, load displacement behavior, Methodologies & Case Studies (Presented by Dr. Dasaka Murty, Professor, IIT Bombay)
  - A Case Study of Mumbai Monorail Project (by Mahendra Shukla & Sandip Ghumde, General Consultants to Nagpur Metro)
  - Deep Excavations – Problems & Solutions in Urban Scenario (Presented by Mr. Rambabu, Director, Ultraco, Hyderabad)
  - Large Diameter Bored Piles, Case Studies & Special Applications Abroad (Presented by Er. Milind Bhuwad, GM Bauer Equipment, Mumbai)
  - QA/QC Methods for Pile Foundations at Nagpur Metro & Case Studies (Presented by Ravikiran Vaidya, Principal Engineer, Geo Dynamics, Vadodara)
  - International Practices of Monitoring & Instrumentations (by Er Hans Jakob Becker; (presented by Dr. Sunil S. Basarkar, Afcons, Mumbai)
- . This slot also took advantages of show casing the DFI activities in India and the advantages of being a DFI member.



Workshop drew revenue from the delegate fees and sponsorship as under:

1. Gold sponsorship of Rs. 50000/- from M/s Geo Systems Research & Consultancy pvt. Ltd., Nagpur;
2. Silver Sponsorships of Rs. 30,000.00 each from M/s HBL Power Systems Pvt. Ltd, Hyderabad; GEO – Ground Engineering Operations India Pvt. Ltd., Noida, Bauer Equipments India Limited, STEWOLS INDIA (P) LTD., Nagpur, and
3. Support Sponsorship of Rs. 10,000.00 each from M/s Itasca India Consulting Pvt. Ltd., Nagpur & SKW Soil & Surveys Pvt. Ltd., Mumbai.

Continued in Page 6

A Letter from the DFI President to DFI of India

We are eager and interested to hear of the progress of the DFI of India and our prospects to contribute to the advancement of our industry in India. Many exciting developments are under way, with the establishment of a permanent headquarters for DFI of India and the addition of paid staff to support the work of the many enthusiastic volunteers. We had an excellent report from Dr. Sunil Basarkar at our recent winter planning meeting in San Antonio, Texas, USA on the prospects for growth in India resulting from the push for economic and tax reforms there. It seems that the timing for growth of DFI of India is well matched to a potential growth in the Indian construction markets. There is a worldwide need for investments in infrastructure and India certainly appears to be poised to make those investments as well. Most respected economic forecasts project the Indian economy to grow by more than 7% for the next couple of years, making it the fastest growing major economy in the world.



The DFI Trustees and Executive Committee have been notably impressed with the hard work and dedication of the members of the DFI of India, and the leadership of Chairman Dr. K.S. Rama Krishna. The dedication of our Indian colleagues to improve our industry is reflected in the vigorous program of activities including workshops, seminars and the well-attended DFI-India Annual Conference. It is exciting that DFI of India has just been awarded a grant from the DFI Committee Project Funds to support a project to implement the development of Continuous Flight Auger (CFA) piles in India and improve the quality, reliability, and safety of this technology. We strongly encourage local industry to contribute to this project and help make a difference in the advancement of piling technology in India.

So, it's an exciting time for DFI of India and I am greatly encouraged by the many things that are happening there. I congratulate all of you for the great work you are doing and I'm looking forward to an opportunity to visit personally.

Warm regards,

-Dan

One page is allotted for the Corporate Members of DFI of India to showcase its capability in the field.

Please contact DFI of India at [dfiindiaoffice@gmail.com](mailto:dfiindiaoffice@gmail.com) for including your company profile. This is more than an advertisement since it carries your mission statement.



## Auger Cast-in-Place Piles

Continued from Page 2



4. Registration fees from Delegates which was Rs. 1200.00 for Non-members; Rs. 750.00 for DFI/IEI/IGS members and Rs. 200/- for students.

**Seminar Responders**

This seminar evoked an overwhelming response with more than 150 participants coming from MMRL, NMRL, GCs, Metro main contractors like Afcons, NCC, ILFS, ITD Cementation, Government departments, private consultants and service providers; Equipment suppliers; academicians and including post graduate engineering students.

The participants hailed from Amravati, Jalgaon, Mumbai and Ahmedabad, covering a radius of about 600kms.

This seminar had very inspiring standards and was curtain raiser for the existing and novel practices in piling and deep excavation support systems. Each of the speakers had in store various cases of Indian and global practices, untapped technologies with various case studies.

Mr. Mahesh Kumar Agrawal, Director projects, MMRL was the Chief Guest. The Inauguration ceremony was compered by a professional Mr. Sanjay Tatwavadi. The seminar kit contained the Seminar CD, brochures from sponsors; a writing pad, pen, Programme schedule, badge.

Posted by Dr. Sunil Basarkar, AFCONS, Mumbai, the programme co-ordinator

fine masonry sand limited the achievable compressive strength to typically about 3,000 psi (20.7 MPa). The construction of 400 to 500 linear ft (122 to 152.5 m) of piling in a single day was considered quite an accomplishment. The piles were generally 12 in to 16 in (0.3 m to 0.4 m) diameter with short lengths and of relatively low capacity. The contractors installing ACIP piles worked continuously to address these issues through the development of improved equipment and processes.

**1970s and 1980s: Transitional Period**

The level of ACIP piling activity increased steadily in the early 1970s, although they were still being used primarily where loads were fairly modest or where substantial uplift resistance was required. This time was also a transitional period for the ACIP industry. Equipment with increasingly higher torque was becoming available. Gear boxes with 30,000 ft-lbs (40.7 kN-m) of torque were now common. The installation process was also being refined. Ready mix companies were now routinely supplying grout, and mixes with concrete sand could be used thanks to more powerful and efficient pumping equipment.

Additionally, the original patent for ACIP piles expired in the mid-1970s, and the number of companies offering the system grew. This led to a greater exposure of the system in the market. However, it also diluted the pool of those with a deep appreciation of the nuances of the process. The installation looks simple, and most of the major equipment needed can be rented; however, seemingly minor

**ACIP pile installation at Hindu Temple****One construction site in Hawaii (cover)**



## Auger Cast-in-Place Piles

## The Cover Story

changes in materials or procedures typically have a large impact on the finished product.

As installers were making significant advances in equipment, materials and installation processes, market forces were also at work that would provide more opportunities for ACIP piles. In many markets where ACIP piles were beginning to gain some acceptance, driven piles and drilled shafts were more traditional and widespread. Raymond Step-Taper piles were a staple in many of these markets. Additionally, inexpensive oil-field pipe, suitable for piling, had become available and driven systems tended to dominate the market. Drilled shafts were also typically used where loading and subsurface conditions were appropriate.

In the 1980s, as the price of steel increased and the oil field pipe that had been so plentiful (and cheap) was beginning to dry up, ACIP piles moved into the void that was being created in the driven pile market. At the same time, the ACIP piling industry developed more powerful equipment capable of producing in excess of 40,000 ft-lbs (54.2 kN-m) of torque; tooling capable of penetrating more resistant materials; and more powerful, more reliable and higher capacity grout pumps. Projects that exemplify the advances in the system were the World Congress Center in Atlanta where piles were extended into partially weathered rock and the Miami Rapid Transit System with piles penetrating into soft limestone. These projects solidified the position of ACIP piles in their respective areas (which were both experiencing rapid growth) and provided a template for the introduction of the system in other major metropolitan areas.

### Growing Knowledge Base

Another significant factor in the growth of ACIP piles during this time was a substantial increase in the knowledge base in the geotechnical engineering community and an increasing level of confidence in ACIP quality control processes. References for static capacity analysis and quality control began to appear more frequently, and standard specifications became a part of the deep foundation literature. In 1990, the Deep Foundation Institute (DFI) published the ACIP Pile Manual. This was the first industry-based document that provided a detailed, comprehensive guide for installing ACIP piles (the manual was updated in 2003). DFI has also published a model specification and Inspector's Guide to ACIP Piles.

ACIP piles being installed at the Revel Casino in Atlantic City, NJ



## The Cover Story

## Auger Cast-in-Place Piles

From the earliest installation of cast-in-place piles, the question of, "How do you know what you have here?" has been asked. The issues of whether or not the piles being formed were sound, continuous and of the proper diameter were of high concern, as installation was very operator-sensitive. Early basic inspection guides included monitoring the drill depths and the grout pumps were calibrated for their output. From this, a pumping procedure in terms of the number of strokes-per-foot could be established for given diameters in varying soil conditions.

This same basic process is used today, but the methods of gathering information have changed radically. There are numerous monitoring systems on the market to electronically measure tool depth, torque, grout placement and a variety of other parameters during ACIP pile construction. The first modern automated monitoring system in North America was the Pile Installation Recorder (PIR), developed by Pile Dynamics, Inc. working with Berkel & Company on its development and implementation in 1995. Since that time numerous other automated monitoring systems have become available.

An example of the market penetration of ACIP piles in the 1990s was the preparation for the 1996 Olympic Games in Atlanta, where the system was selected for the majority of construction where deep foundations were needed. The most visible symbol of the Olympics, the Olympic Stadium (later to be transformed into Turner Field, home of the Atlanta Braves), saw the installation of more than 123,000 ft (37,490 m) of piling that ranged from 35 ft to 85 ft (10.7 m to 25.9 m) in length.

The project included 16 in (0.4 m) diameter piles with a design compressive load of 150 tons (1,335 kN), requiring a grout compressive strength of 6,000 psi (41.4 MPa). This, in contrast with the struggle to produce 3,000 psi (20.7 MPa) grout 30 years earlier is an example of how one component of the ACIP piling system has advanced, and all aspects of the process have advanced similarly. Clearly, the major thrust in the use of ACIP piles has been in development of equipment, materials and processes to go "bigger and deeper," and the increase in design loads reflects that emphasis. Certainly, increases in capacity of conventional ACIP piles will occur with development of more powerful equipment; however, new processes seem to be the likely source of significant changes in the cast-in-place pile industry.

During the 1990s, European systems based on fixed mast installation platforms entered the U.S. market. In contrast to the historical emphasis on the casting process seen in conventional ACIP piles, the European drilled displacement (DD) and Continuous Flight Auger (CFA) piles evolved with an emphasis on control of the drilling process, and these systems brought with them a broad base of related data acquisition technology.

### Technology Tour

In 2002, representatives of AASHTO and FHWA embarked on a technology scan tour of Europe. The purpose of the trip was to see if there were construction techniques in place in Europe that would be of value in accelerating FHWA projects. Several processes found to be of interest were documented in two papers by Ali Porbaha, Dan Brown, Alan McNab and Richard Short. Both papers were presented at the

DFI Annual Conference on Deep Foundations in San Diego in October of 2002.

A major element of the tour was an interest in the European method of installing cast-in-place piles, and that interest developed into an initiative to produce FHWA Geotechnical Engineering Circular (GEC) No. 8, Design and Construction of Continuous Flight Auger Piles, which was published in July, 2007. The implementation of the European systems and the fusion of European and conventional U.S. systems continue today.

Over the past 60-plus years, the ACIP pile industry, and the application of the system have changed dramatically. Today, APG piles of over 42 in (1.1 m) diameter and 150 ft (45.7 m) in depth are not uncommon. Where ACIP piles were once used to support relatively modest loads, they are routinely installed in geologies today where the load limits are structural (from code limits relating the allowable load of the grout or concrete used) rather than geotechnical. For example, 24 in (0.6 m) diameter APG piles have been installed to support 400 ton (3,559 kN), or greater, single-pile compressive loads on multiple projects in the past few years.

### Conclusion

Contractors working in the ACIP pile arena have recognized the need to develop higher-capacity equipment, refine installation and quality control procedures, and to develop materials and equipment to provide ever increasing capacities in a broader range of subsurface conditions. Material suppliers have developed grout additives that make it possible to cast piles with increasingly reliable high capacities and to insert reinforcing steel to greater depths. Just as important, many in the geotechnical community have responded with a willingness to evolve technically, and the result has been application of ACIP piles over a broad range of construction types in an increasing variety of geologic settings.

*Contributors: Willie M. NeSmith, P.E. (retired); Alan Roach, President, and W. Morgan NeSmith, P.E., Chief Geotechnical Engineer, Berkel & Co. Contractors, Inc.*



## Technical Presentation

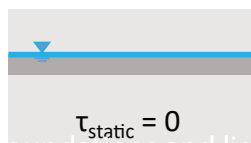
### Interaction between deep foundations and liquefied soil: case history and guidelines:

Jonathan P. Stewart, University of California, Los Angeles [jstewart@seas.ucla.edu](mailto:jstewart@seas.ucla.edu)



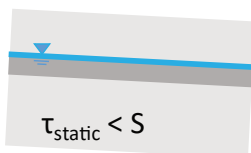
## Lateral Ground Displacements

Level ground: no lateral spreading

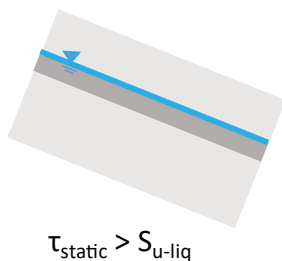


Post-liquefaction undrained shear strength:  $S_{u-liq}$

Gentle slope: cyclic mobility, lateral spreading



Relatively steep slope: flow failure



Lateral spreading and flow failure apply displacement demands to deep foundations



Showa Bridge, 1964 Nigata EQ, Japan  
[vis.eng.uci.edu](http://vis.eng.uci.edu)



Nishihomiya Bridge, 1995 Kobe EQ, Japan  
[geerassociation.org](http://geerassociation.org)



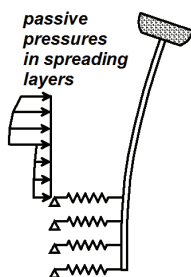
2010 Maule, Chile EQ  
USDOT FHWA Report FHWA-HRT-11-030

## Technical Presentation

## Response Analysis

## ESA Guidelines Documents

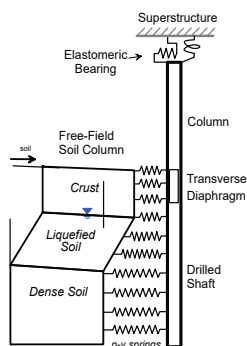
Limit pressure approach: applied in spreading layers



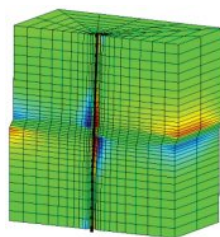
JRA, 1996

too simple

Equivalent-static analysis (ESA)



Continuum model: dynamic analysis



McGann et al. PEER Rpt. 2012/05

→ complex, displacements suspect

- MCEER/ATC-49: Used in AASHTO LRFD Bridge Design Specifications
- Ashford et al. (2011): Basis for Caltrans design guidelines (2013)

## Existing design guidelines:

- Limit pressure approach
  - E.g., Japanese Roadway Association<sup>1</sup> (2002)— *not recommended*
- Equivalent-static analysis (**ESA**) using BNWF:
  - MCEER/ATC-49— prescriptive guidelines incorporated into AASHTO LRFD Bridge Design Specifications
  - Ashford et al.<sup>2</sup> (2011) PEER Report—

<sup>1</sup>JRA (2002). Specifications for highway bridges, Public Works Research Institute and Civil Engineering Research Laboratory, Tokyo.

<sup>2</sup>Ashford, SA, Boulanger, RW, and Brandenberg, SJ (2011). Recommended design practice for pile foundations in laterally spreading ground, PEER Report 2011/04.

<sup>3</sup>[http://www.dot.ca.gov/research/structures/peer\\_lifeline\\_program/](http://www.dot.ca.gov/research/structures/peer_lifeline_program/)



## Technical Presentation



### PACIFIC EARTHQUAKE ENGINEERING RESEARCH CENTER

#### Recommended Design Practice for Pile Foundations in Laterally Spreading Ground

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**ABSTRACT:** The Pacific Earthquake Engineering Research Center and the California Department of Transportation have recently developed design guidelines for computing foundation demands during lateral spreading using equivalent static analysis (ESA) procedures. In this study, ESA procedures are applied to two parallel bridges that were damaged during the 2010 M 7.2 El Mayor-Cuicah earthquake in Baja California, Mexico. The bridges are both located approximately 15 km from the surface rupture of the fault on soft alluvial soil site conditions. Estimated median ground motions in the area in the absence of liquefaction triggering are peak ground accelerations = 0.27g and peak ground velocity = 38 cm/sec (RotD50 components). The bridges are structurally similar and both are supported on deep foundations, yet they performed differently during the earthquake. A span of the pile-supported railroad bridge collapsed, whereas the drilled-shaft-supported highway bridge suffered only moderate damage and remained in service following the earthquake. The ESA procedures applied to the structures using a consistent and repeatable framework for developing input parameters captured both the collapse of the railroad bridge and the performance of the highway bridge. Discussion is provided on selection of the geotechnical and structural modeling parameters as well as combining inertial demands with kinematic demands from lateral spreading.





**Technical Presentation**

The Pacific Earthquake Engineering Research Center (PEER) is a multi-institutional research and education center with headquarters at the University of California, Berkeley. Investigators from over 20 universities, several consulting companies, and researchers at various state and federal government agencies contribute to research programs focused on performance-based earthquake engineering. These research programs aim to identify and reduce the risks from major earthquakes to life safety and to the economy by including research in a wide variety of disciplines including structural and geotechnical engineering, geology/seismology, lifelines, transportation, architecture, economics, risk management, and public policy. PEER is supported by federal, state, local, and regional agencies, together with industry partners.





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## DFI-World Activities 2017-2018

**Dr. Sunil Basarkar, AFCONS India and DFI of India Executive Committee Member at Winter Planning Meeting of DFI at San Antonio, Texas, US, February 22-24, 2017**

The 2017 DFI Winter Planning Meeting (WPM) provided a forum for trustees of the DFI and DFI Educational Trust Boards, chairs of the technical committees and working groups, as well as other invited guests to meet and discuss the events of 2016 and to plan for 2017 and beyond. This year's WPM was held at the Westin Riverwalk hotel in San Antonio, Texas, from February 22-24.

Sunil S. Basarkar, Ph.D., executive committee member of DFI of India, made a long journey to the U.S. to attend the WPM, where he provided an extensive report on the chapter's activities. Dr. Basarkar provided a brief state of the economy in India, which is projected to grow between 7 and 8 percent in both 2017 and 2018. He reported that DFI of India is actively involved with improving quality and safety in construction practices by spreading awareness of the latest foundation technologies in India through quarterly seminars and workshops in various regions and annual conferences at premier institutions. In 2016, a technical conference was held in Shibpur, Kolkata, and four workshops were held in Guntur, Raipur, Kolkata and Delhi. Another technical conference is scheduled for October 6-7, 2017, at IIT Madras, Chennai. Four workshops are also planned for 2017 on different topics and in different parts of the country. However, Dr. Basarkar indicated that more training and technology implementation efforts still need to be done throughout India. DFI of India also hosts monthly meetings, distributes a quarterly newsletter, and is developing a program for operator training.



### DFI to Host Helical Piles and Tiebacks Specialty Seminar on September 18-19 in Montreal

Deep Foundations Institute's (DFI) Helical Piles and Tiebacks Committee is hosting a one-day seminar on the detailed design, application and installation of helical piles and tiebacks for new construction and rehabilitation. The seminar is being held on September 18-19, in Montreal, Quebec, Canada.

Topics include axial, lateral, uplift, seismic, cyclic and dynamic loading; settlement analyses; and materials, construction and testing procedures for helical projects. The seminar features presentations on current technologies, design concepts, research and case histories for helical piles and tiebacks applications. Equipment, material and instrumentation suppliers; contractors; engineers; and other vendors will exhibit innovative products and services during the seminar.

The seminar features two keynote speakers. Dr. Hesham El Naggar, P.Eng., professor of geotechnical engineering and associate dean of engineering at University of Western Ontario, Canada, has 30 years of experience in analysis and design of foundations and soil-structure interaction. Dr. Amy Cerato, P.E., professor in the School of Civil Engineering and Environmental Science at the University of Oklahoma, is a geotechnical engineer whose research includes predicting expansive soil behavior using microscale properties and foundation design for alternative energy. Dr. Yasser Abdelghany of the British Columbia Ministry of Transportation and Infrastructure is the chair for this event.

The DFI Helical Piles and Tiebacks Committee is meeting before the seminar on September 18, and encourages participation from seminar attendees and industry professionals in Quebec. The committee includes manufacturers, engineers, academics, suppliers and experienced contractors who constitute a forum for advancing the applications, understanding and use of helical pile and tieback foundation elements. Following the committee meeting, the seminar will kick-off with a welcome networking reception in the exhibit area.

For more information or to register, visit <http://www.dfi.org/helical17>.

### DFI-EFFC Partner to Host the International Conference on Deep Foundations and Ground Improvement: June 6-8, 2018, in Rome

Abstracts Being Accepted Until July 17, 2017

The Call for Abstracts is open for the DFI-EFFC International Conference on Deep Foundations and Ground Improvement at Sapienza University in Rome on June 6-8, 2018. The theme of the conference is Urbanization and Infrastructure Development: Future Challenges.

International public and private clients are invited to present their upcoming programs for development of new infrastructure. Researchers and designers are invited to contribute and debate design and modeling criteria for new and innovative technologies. Presentations related to variations in national and international codes (including Eurocode), new investigation methods, Project Management Information System (PMIS) and Building



## DFI-World Activities 2017-2018

Information Modeling (BIM) implementation, are strongly encouraged.

Contractors are invited to discuss case histories that highlight how these procedures impact contractual rules, construction risk, execution procedures, quality control and final acceptance criteria. Geotechnical equipment and material manufacturers as well as technology providers are invited to present advancements and trends in capabilities, safety, sustainability and environmental compliance. Young researchers are encouraged to submit for consideration summaries of their Ph.D. and M.Sc. final reports that are related to the conference theme.

Abstracts for technical papers and panel sessions can be submitted at [www.dfi-effc2018.org](http://www.dfi-effc2018.org). The deadline is Monday, July 17, 2017.



### DFI 42nd Annual Conference on Deep Foundations

October 24, 2017 - October 27, 2017, New Orleans Marriott, New Orleans, LA

Join us for our 42nd Annual Conference on Deep Foundations in the Big Easy where you will network with the largest gathering of practitioners specializing in the deep foundation industry; attend special lectures featuring our world-renowned keynote speakers; learn about innovations in design, construction and delivery of deep foundations; become updated on design, construction, QC/QA and risk assessment/management; hear about DFI's global initiatives and research to promote foundation safety, quality, durability and sustainability. There will also be an Exhibit Hall featuring 120+ companies.

### DFI India 2017 Conference at IIT Madras, October 5-7, 2017

#### Registration fees

	INR*	USD
<b>2-day Conference Only</b>		
DFI Member	6,500	200
IGS Member	7,000	250
Non-Member (includes DFI membership thru Dec. 31, 2018)	8,700	300
Students (limited to 40)	3,500	50
Spouses	2,500	35
Authors (single concession, one author per one paper)	5,500	150
<b>2-day Conference plus Workshop</b>		
DFI Member	8,500	300
IGS Member	9,000	350
Non-Member (includes DFI membership thru Dec. 31, 2018)	10,700	400
Students (limited to 20) 4,500 75 Spouses	2,500	35
Authors (single concession, one author per one paper)	7,500	250

REGISTER NOW FOR DFI-INDIA 2017 [www.regonline.com/dfi-india2017](http://www.regonline.com/dfi-india2017)



## SAVE THE DATE

DFI International Conference on Deep Foundations, Seepage Control and Remediation (42nd Annual Conference on Deep Foundations) - October 24-26, 2017, New Orleans Marriott, New Orleans, LA <http://www.deepfoundations2017.org>

## WHAT CAN DFI DO FOR YOU?

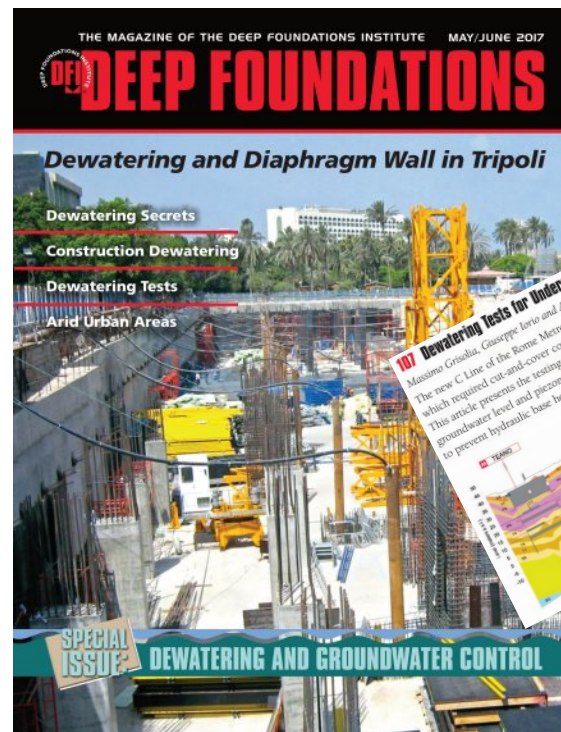
## Overview

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



### 91 Construction Dewatering Challenges in Urban Environments

Rafael A. Rivera

As compared to rural projects, excavations in urban areas face numerous challenges, including accessibility, proximity to adjacent properties or structures, and construction induced deformations to these existing structures. When performing excavations below the existing water table, various areas, concerns, and evidence must be considered to ensure the excavation is safe and viable.



### 107 Dewatering Tests for Underground Stations in Rome

Massimo Grolla, Giuseppe Iorio and Antonio Zecchi

The new C Line of the Rome Metro comprises 30 new stations along 15.5 mi (25 km), which required cut-and-cover construction utilizing multiproped diaphragm walls. This article presents the testing and design for the deep well systems used to lower the groundwater level and piezometric head during excavation to ensure dry conditions and to prevent hydraulic base heave instability.

### 99 Engineering Successful Dewatering in Arid Urban Areas: Abu Dhabi Dewatering Guidelines

M. Melih Demirkan, Juan J. Gutierrez and Raghav Ramanathan

One of the various challenges facing Abu Dhabi is ground settlement caused by poor groundwater control practices. A newly developed geodatabase was used to develop risk maps to identify locations and extents of areas vulnerable to surface subsidence. This article presents guidelines developed to standardize dewatering practices and to support the dewatering permit applications.



## SAVE THE DATE

## DFI-India 2017: 7<sup>th</sup> Conference on Deep Foundations Technologies for Infrastructure Development in India

October 5-7, 2017 • Indian Institute of Technology Madras, Chennai, India

Updated details on the event as plans evolve can be found at [www.dfi-india2017.org](http://www.dfi-india2017.org).

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