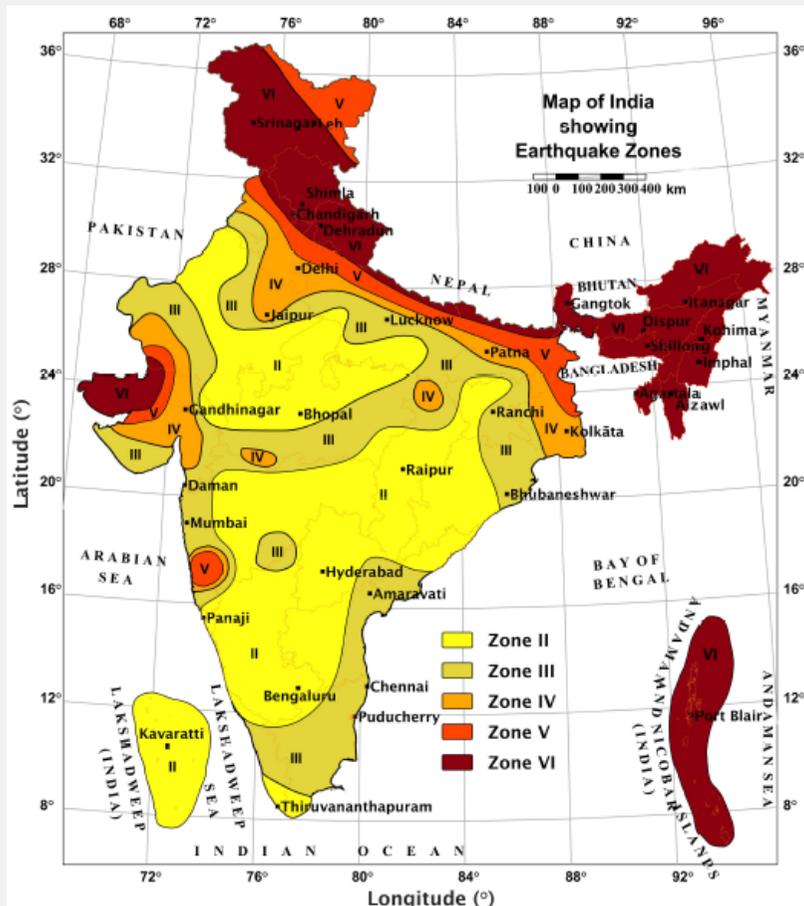


UNDERSTANDING THE PROCEDURE TO EVALUATE LIQUEFACTION SUSCEPTIBILITY - IS 1893 (PART 1): 2025

IS 1893 (Part 1): 2025 introduces an improved framework for assessing soil liquefaction under seismic loading. It evaluates earthquake demand, soil resistance and post-liquefaction settlement using Cyclic Stress Ratio (CSR) and Cyclic Resistance Ratio (CRR). Compared to the 2016 edition, the code expands testing methods, refines correction factors, updates CRR formulations, includes plastic soils and introduces a three-tier safety classification with mandatory settlement checks. Read more on [page 3](#).



*Picture Courtesy: IS 1893: 2025



Volume 12 Book 1, January 2026

DFI INDIA News

- 2 DFI of India Team 2025-26
- 3 Understanding the Procedure to Evaluate Liquefaction Susceptibility - IS 1893 (Part 1): 2025
- 5 Sustainability Corner
- 9 DFI President Message - *Mr. James Johnson*
- 11 Mitigation of Earthquake Induced Soil Liquefaction Risk by Induced Partial Saturation (IPS)
- 14 DFI of India Technical Committee Members 2025-26
- 18 DFII Technical Committee News & Reports
- 20 What Can DFI Do for You?

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

DFI of India Board and Core Committee

Dr. Sunil S Basarkar, Director, Chair, DFI of India
 Mr. Ravikiran Vaidya, Vice Chair, DFI of India
 Mr. Mohan Ramanathan, Director, Immediate Past Chair, DFI of India
 Mr. Anirudhan I V, Director, Past Chair, DFI of India
 Dr. K S Rama Krishna, Director, Past Chair, DFI of India

DFI of India Executive Committee (2025-2026)

Mr. K Bikshapathi, NAC, Hyderabad
 Mr. V K Panwar, Engineers India
 Dr. Anil Joseph, IGS President, GeoStructurals
 Mrs. Annapoorni Iyer, Engosym Consultants
 Mr. Ramadas Veluri V S, Keller Ground Engg. India
 Mr. Mohan Gupta, Delhi Metro Rail Corporation (DMRC)
 Dr. C R Parthasarathy, Sarathy Geotech & Engg. Services
 Prof. A Murali Krishna, Indian Institute of Technology Tirupati
 Dr. R P Singh, National High-Speed Rail Corporation
 Mr. Sanjay Gupta, Cengrs Geotechnica
 Mr. Gagan Goswami, Heritage Infraspace India
 Mr. M Kumaran, L&T GeoStructure
 Mr. Viral Patel, Associated Engineers
 Mr. Aminul Islam, Cemindia Projects

DFI USA

Executive Director	President
Mrs. Theresa Engler	Mr. James O Johnson
Director of Technical Activities	Vice President
Mr. Matthew Glisson	Dr. J Erik Loehr
Treasurer	Immediate Past President
Mrs. Lori Simpson	Mr. Gianfranco Di Cicco
Secretary	
Mr. Morgan NeSmith	

DFI of India Support Committee

Mr. Satyajit Vaidya, LANGAN
 Mrs. Srilakshmi Nagarajan, Geocomp - GeoTesting Express
 Mr. Gianfranco Di Cicco, GD Consulting

DFI of India Office Team

Mr. T S Mahendran, Manager - Accounts & Administration
 Mr. Pranav Jha, Manager - Operations
 Ms. P Sai Sindhu, Senior Technical Coordinator
 Mr. Aswin V Hari, Technical Coordinator

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

Understanding the Procedure to Evaluate Liquefaction Susceptibility - IS 1893 (Part 1): 2025

Cover Story

- Prof. Subhadeep Banerjee, Indian Institute of Technology Madras, subhadeep@civil.iitm.ac.in

WHAT DOES THE CODE SAY?

The 2025 code uses a *simplified procedure* to evaluate the liquefaction susceptibility of the ground during earthquakes. This is essentially a combination of the estimations of three quantities: a. *Demand* (how hard the earthquake shakes the ground), b. *Capacity* (how well the soil can resist that shaking) and c. *Settlement* (how much the ground settles).

A) Cyclic Stress Ratio - Calculating the Demand

The code first looks at the *Cyclic Stress Ratio (CSR)*, which represents the earthquake's demand on the soil. This calculation takes the *Peak Ground Acceleration (PGA)*, the strongest shaking expected at the site, and adjusts it based on the total weight of the soil above and the hydrostatic pressure at that depth. It also uses a *stress reduction coefficient* to account for the fact that soil is not a rigid block; the shaking energy changes as it travels deeper into the ground.

B) Cyclic Resistance Ratio - Determining Soil Capacity

Next, the *Cyclic Resistance Ratio (CRR)* is calculated to find the strength of soils. This is based on conventional field tests like standard penetration tests, cone penetration tests, dilatometer tests and geophysical tests. This simplified procedure is standardised for a generic earthquake of 7.5 magnitude; the code applies a *Magnitude Scaling Factor (MSF)* to adjust the capacity for the actual earthquake magnitude expected in your specific zone. It also applies an *Overburden Stress Correction Factor* to account for how soil becomes more resistant under the overburden pressure of the deep layers.

C) Settlement - Assessing Safety and Serviceability

Once the *Demand* and the *Capacity* are determined, the factor of safety will be obtained by dividing the Capacity by the Demand.

If the value is below 1.2, the site is labelled as unsafe, meaning the soil is highly likely to liquefy.

If the value is between 1.2 and 1.4, the code says that while the soil might not fully liquefy, it could still settle or sink significantly. In this case, engineers must use the code's volumetric strain charts, which depend on the relative density of the soil layer to calculate exactly how much the ground might sink and whether the structure can handle it.

Only when the factor of safety is above 1.4, the soil is considered to be safe.

HOW DIFFERENT IS IT FROM THE 2016 VERSION?

While the primary objective remains the same, the 2025 edition introduces an additional *safety net* by incorporating several technical refinements and a relatively more comprehensive methodology compared to the 2016 version. Some of the salient changes are as follows:

Expanded Testing Methods: While the 2016 code primarily focused on standard penetration test (SPT), cone penetration test (CPT) and shear wave velocity (V_s) measurements using geophysical tests, the 2025 code introduces the *Dilatometer Test (DMT)* as a recognised method for estimating CRR.

Continued

The Cover story in each issue of the newsletter showcases a technology/work practice that is not very popular in India, but has tremendous potential for India's infrastructure development. Readers may contribute to the cover story.

Detailed Magnitude Mapping: In the 2016 code, the MSF depends only on the *Magnitude* of the earthquake zone, whereas in the revised 2025 code, it depends on the SPT blow count and CPT resistance along with the magnitude of the earthquake.

Refined Stress Reduction Factor (r_d): The 2025 code uses a modified expression for *Stress Reduction Factor* (r_d) that accounts for both depth and earthquake magnitude, whereas the 2016 code used simpler linear depth-based equations.

Updating $CRR_{7.5}$ in SPT and CPT: In the 2025 version, the formulations for q_{c1Ncs} and $(N_1)_{60cs}$ have been revised by incorporating additional incremental correction terms, namely Δq_{c1N} and $\Delta(N_1)_{60}$.

Treatment of Plastic Soils: The 2025 code includes specific empirical methods and formulas for assessing the CRR of clay and plastic silt, which was not accounted for in the previous version.

Categorization of Soil Safety: The 2016 code considered soil safe if the Factor of Safety (FS) is generally ≥ 1.2 . The 2025 code provides a more specific 3-tier safety assessment:

Unsafe: $FS_{liq} < 1.2$

Verify Settlement: $1.2 \leq FS_{liq} \leq 1.4$ (requires checking ground settlement)

Safe: $FS_{liq} > 1.4$

Settlement Calculation: The 2025 code includes settlement of soil layer from the post liquefaction volumetric strain ($\epsilon_v = \frac{\Delta H}{H}$) where ΔH = Settlement of the soil layer and

H = Height of the soil layer

HAVE YOU RENEWED YOUR DFI MEMBERSHIP YET?



Renew it now if not done already. DFI offers multiple benefits to its members for their technical as well as professional development.
Learn, Network and Grow with DFI.

Check DFI membership categories, benefits, fees and renew here: dfi.org/members/

Hurry up!!! Join DFI of India today and connect with a network of geotechnical professionals driving innovation in deep foundations



Unearth More than 145,000 Technical Papers - At No Cost



You should be taking advantage of DFI's Most Valuable Membership Resources

DFI members have free, unlimited access to more than 145,000 technical papers at OneMine.org the Global Digital Research Library for the mining, tunneling and deep foundations construction communities

- Download DFI's archived documents including conference proceedings, technical manuals, reference documents, magazine articles and journal papers
- Download documents from related industry organizations
- Search by keyword, title, author or participating society
- Sign in as DFI member at www.dfi.org and be automatically logged in to OneMine.org

Two insightful articles contributed by the DFI of India Sustainability Committee are featured in this section from pages 5-8.

Sustainability Corner

Keller's Carbon Reduction Journey

- Dr. Venu Raju, venu.raju@keller.com; Sai Kumar S, saikumar.suggula@keller.com, Team Planet Keller.

The United Nations' 17 Sustainable Development Goals (SDGs) address environmental, social and governance aspects of sustainability. Keller has adopted the most relevant SDGs and developed its 4P model (Planet, People, Principles and Profitable Projects) to guide future actions. While sustainability is a comprehensive topic, this article particularly focuses on Keller's net-zero journey, aligning with SDG 13, Climate Action.

The global 2015 Paris Agreement set a global target to limit warming to well below 2°C, encouraging nations and businesses to pursue net zero by 2050. In 2022, Keller took 2019's Scope 1 & 2 emissions as baseline emissions and set target of achieving Scope 2 (electricity emissions) net zero by 2030 (achieving 10% YOY reduction), Scope 1 (fuel emissions) net zero by 2040 (achieving 5% YOY reduction) and overall net zero by 2050.

Keller adopted the carbon reduction hierarchy (eliminate, reduce, substitute and compensate) as a strategy to achieve its net zero target across all three scopes.

Keller's approach to Scope 2 reduction follows a clear hierarchy: eliminating redundant electrical appliances, improving efficiency in usage and equipment, substitute grid power with renewable energy and offset any remaining emissions. Keller India started by conducting energy audits to identify and eliminate inefficiencies, before installing solar power plants with a total capacity of 55 kW for yard operations. Additionally, Keller India transitioned its Mumbai and Chennai offices to green energy. Through these kinds of measures, Keller group has successfully reduced Scope 2 emissions by more than 70% as of 2025 from its 2019 baseline.

For Scope 1, Keller prioritizes efficiency through right-sizing equipment, optimization and anti-idling practices. Keller Australia recently adopted Battery Energy Storage Systems (BESS), reducing diesel generator size for the same peak load. The next step involves substituting diesel with alternative fuels such as grid power and biofuels, which Keller is trialing across markets. Finally, Keller is introducing alternative equipment, including its first in-house manufactured electric drill rig launched in 2023. Since over 90% of Scope 1 emissions come from diesel consumption, progress depends on the availability of low-carbon biofuels and electric equipment infrastructure in respective markets.

Scope 3 emissions present the greatest opportunity for reduction, accounting for nearly 80% of total emissions. A significant share comes from

Continued

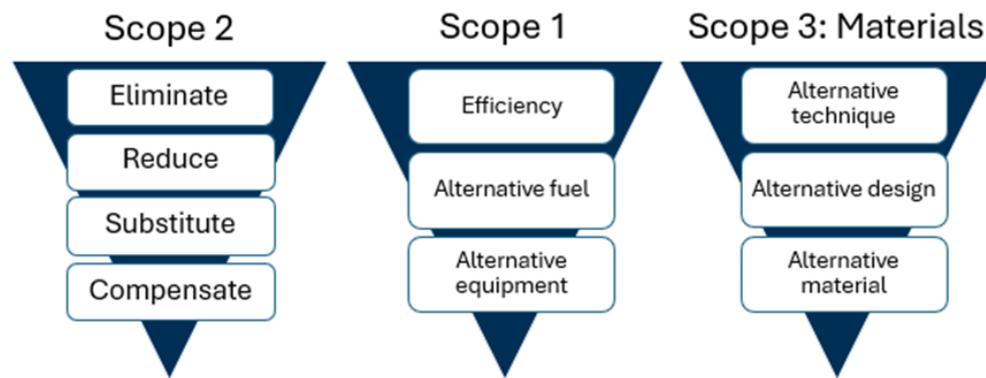


Fig. 1: Strategy for scope 1, 2 & 3

purchased goods such as steel and cement. Keller's low-carbon ground improvement solutions eliminate/reduce the need for these materials, bringing down the overall project emissions by up to 80% compared to conventional heavy foundation methods. Even for projects requiring heavy



Fig. 2: BESS with Diesel generator at Keller Australia

foundations, optimized design and the use of low-carbon or recycled materials can cut emissions by more than 50%. For instance, in a project for a steel manufacturing company in Ludhiana, Keller redesigned the original piling solution by integrating ground improvement techniques. This approach reduced emissions by about 50%. Further optimization through low-carbon materials and equipment brought the total reduction to 60% compared to the initial design.

Data collection and emission estimation

Existing financial systems are used to collect data on resource consumption and fuel use for the estimation of Scope 1, Scope 2 and Scope 3 greenhouse gas emissions. While the calculation of Scope 1 and Scope 2 emissions is relatively straightforward due to the availability of direct consumption data, estimating Scope 3 emissions remains more complex. At present, Keller applies a spend-based methodology to estimate Scope 3 emissions, leveraging financial expenditure data where activity-based information is not yet available.

Driving engagement across the organisation

Sustainability is actively embedded at all levels of the organization through a structured governance model that combines both top-down and bottom-up approaches.

From a top-down perspective, Keller has established a Group-level Sustainability Committee comprising Executive Committee members and divisional presidents. This committee defines the overall sustainability vision, strategy and key guiding principles.

From a bottom-up perspective, *Team Planet*—a network of members from diverse functions operates at divisional and business unit levels. These teams play a pivotal role in, sharing ideas and best practices, uncovering local opportunities and implementing guidance from the Group-level committee.

Roadmap and outlook

Keller is focused on piloting and scaling resilient and sustainable technologies, materials and fuels that are available across its respective markets worldwide. Keller group actively fosters research both at global and regional level by supporting with guidance & funds for innovation.

In the coming years, Keller plans to further standardise guidelines for data management and performance measurement. This initiative will strengthen the company's ability to accurately estimate Scope 3 emissions with activity-based information.

Keller remains committed to achieving net zero carbon by 2050, supported by its design excellence, continuous product innovation, employing newer technology and proactive collaboration with suppliers to procure low-carbon materials.

Keller is a corporate member of DFI. We invite all the corporate members of DFI to publish their sustainability journey in the upcoming newsletters. To get in touch contact technical@dfi-india.org

Paving the Way to Sustainability: Geocomposite Drainage Layers as a Low-Carbon Alternative to Conventional GSB

- *Dr. Lakshmana Rao Mantri (Engineering & Design), Afcons Infrastructure, lakshmana.mantri@afcons.com*

Flexible pavements are widely adopted due to the excellent riding surface they provide. The granular sub-base (GSB) layer, located between the granular base and the subgrade, is primarily designed to serve as a sub-surface drainage layer. However, the long-term performance of conventional GSB has been compromised by the ingress and generation of fines, due to heavy vehicular loads and capillary action from the subgrade. This process makes the GSB layer ineffective in the drainage function, resulting in water accumulation within the pavement layers. The presence of accumulated water in this, as well as other layers, ultimately leads to premature rutting failure. To mitigate this condition, it was determined that a sustainable and efficient sub-surface drainage option is urgently required.

Comprehensive investigations have been carried out such as design optimization, economic evaluation and environmental impact assessment of flexible pavement systems. However, the aim of this section is to present a systematic environmental impact assessment (EIA) for flexible pavements with conventional GSB as against the proposed geocomposite drainage layers (GCDL) as drainage layers of a flexible pavement of two-lane roads, with a focus on sustainability and carbon footprint calculations.

The analysis is presented here based on consideration of 1km road length and the study investigates various traffic loading scenarios, ranging from 5 million standard axles (MSA) to 50 MSA, forming a robust framework to evaluate long-term viability under different levels of use and stress. All necessary emission factors for materials and equipment are derived from reliable databases and established industry codes to ensure the validity and robustness of the results.

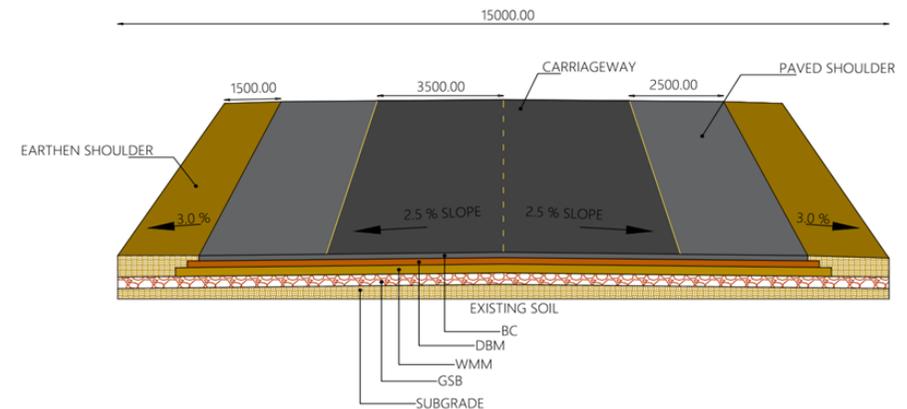


Fig. 1: Typical Cross Section of 2 Lane Pavement with Conventional GSB

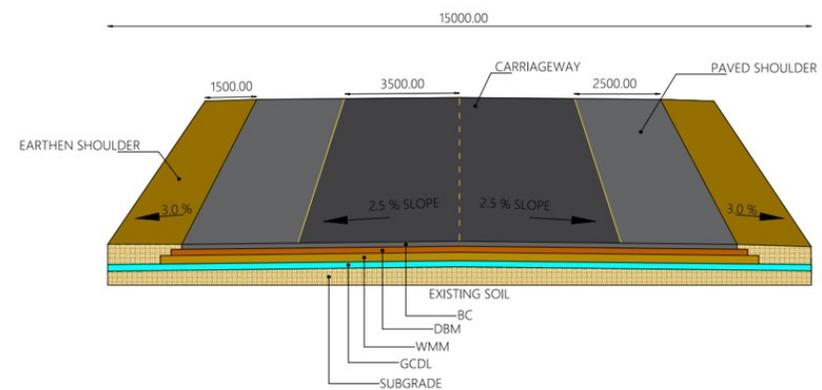


Fig. 2: Typical Cross Section of 2 Lane Pavement with GCDL

Continued

The ultimate objective of this comprehensive EIA is to identify the most ecologically sound and sustainable pavement design, thereby supporting prudent and responsible infrastructure choices that preserve environmental integrity.

The EIA utilizes a comprehensive life cycle assessment (LCA) approach, quantifying carbon dioxide (CO₂) emissions for every component of the pavement structure. This evaluation extends beyond the pavement's operational cycle to include emissions generated during material manufacturing, transportation, construction and end-of-life disposal or recycling.

The carbon emissions CO₂ equivalent for both pavement alternatives was calculated based on a complete LCA. Key emission sources evaluated include:

- Emissions generated during the extraction, processing and manufacturing of materials (including the geosynthetics for GCDL).
- Emissions quantified based on the haul distance and mode of transport for materials used in each design.
- Emissions resulting from on-site equipment usage and construction activities.

The results indicate that GCDL-based pavements dramatically reduce carbon footprint, emitting less than 1% of the CO₂ equivalent compared to traditional GSB pavements across all traffic scenarios. This significant reduction is attributed to decreased material extraction and transportation needs, as well as efficient construction processes. The study underscores the environmental sustainability of the GCDL system, supporting its adoption as a greener, cost-effective solution aligned with evolving infrastructure policies aimed at minimizing ecological impact.

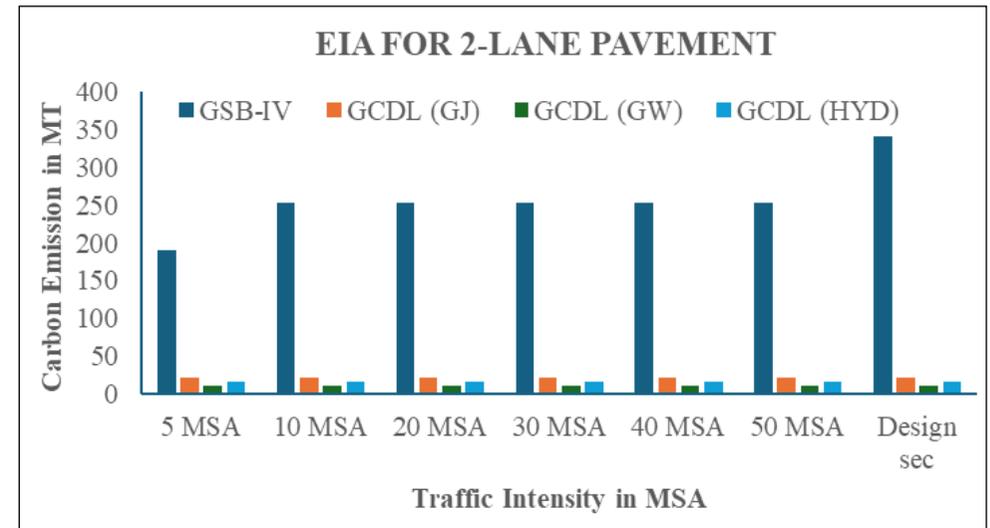


Fig. 3: EIA of 2 Lane Pavement with Conventional GSB and GCDL

Conclusions

The EIA shows that the GSB layer produced approximately 190 metric tonnes of CO₂ equivalent emissions per kilometre of a two-lane road, while the GCDL resulted in lower emissions of CO₂ equivalent per kilometre of a two-lane road which is less than 1% of the CO₂ equivalent compared to traditional GSB pavements across all traffic scenarios. The study concludes that the GCDL is a sustainable, cost-effective alternative to conventional GSB layers, offering benefits in terms of enhanced drainage efficiency and structural performance, with minimal environmental impact.

Afcons is a corporate member of DFI. We invite all the corporate members of DFI to publish their sustainability journey in the upcoming newsletters. To get in touch contact technical@dfi-india.org

A dedicated page is allotted for a nominal fee of Rs 10,000 per issue for the profile of a reputed company involved in the deep foundation industry to showcase its capability in the field. Please contact DFI of India at dfiindiaoffice@gmail.com.



James Johnson
*Condon-Johnson &
 Associates
 President, DFI*

As the new year begins—and with it my second term as DFI President—I am honored that our DFI of India chapter has invited me to share a message for this quarterly newsletter. Over the past year, I've written messages for *Deep Foundations* magazine, each one inspired by a popular song. I can't be sure which songs resonate most widely with our colleagues in India, but I hope this classic will feel familiar.

Queen's 'We Are the Champions' is an anthem of triumph, resilience and perseverance—qualities that define our industry. Every day, we confront geotechnical challenges that demand ingenuity and collaboration. And as DFI celebrates its 50th anniversary, the song's spirit feels especially fitting. For five decades, DFI has been the

gathering place for geoprofessionals involved in deep foundations, excavations and tunneling, united by a commitment to finding common ground. Our inclusivity is our strength: each member contributes to the essential work beneath our world's infrastructure and through shared knowledge we elevate our ability to solve complex geotechnical problems so that, together, every project succeeds.

That mission has remained constant since our founders established the Institute and it continues today—from headquarters to the initiatives led by this chapter and those in Europe and the Middle East. DFI provides a forum for meaningful dialogue through conferences, courses, webinars and committee-developed consensus documents. We examine lessons learned, celebrate innovation and support one another in continuous improvement.

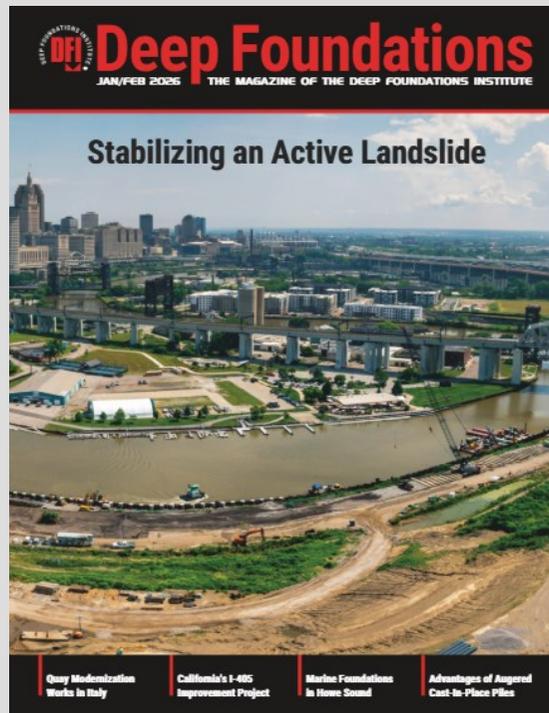
DFI President Message - Mr. James Johnson

As DFI looks ahead to its next 50 years—and ultimately toward a century of service—we are focused on strategies that ensure our relevance, sustainability and readiness for the innovations our field will require. One major effort this year is our themed annual conference in Orlando this November 2-5, where we will address the global design and construction challenges posed by sea level change. We are convening experts not only from geotechnical engineering but also from planning, public policy, insurance, finance and research—continuing our commitment to inclusivity and shared problem-solving. Our goal is clear: to collaborate on actionable solutions to one of the most pressing issues of our time. As the professionals who are first on the project and foundational to its success, we aim to champion early-stage dialogue that leads to economical, safe and resilient outcomes.

I am proud to see DFI of India carrying forward the same spirit that shaped DFI's beginnings in the United States. Through annual conferences, this newsletter, collaboration with peer societies and the formation of technical committees focused on regionally relevant methods, techniques and applications, the chapter has become a vital force. Since its incorporation 13 years ago under the leadership of Dr. K.S. Rama Krishna—a DFI Distinguished Service Award honoree and Lifetime Contribution Awardee. DFI of India has grown significantly in membership and influence. I am pleased to welcome Dr. Sunil Basarkar as he takes the helm this year, following the strong leadership of Anirudhan I.V. and Mohan Ramanathan.

Continued

Let us continue to be champions of continual improvement in the planning, design and construction of deep foundations, excavations and tunneling. We are the champions because of the many dedicated professionals who contribute to our association and support one another in delivering solutions. And if you're not familiar with the song, you can listen to it here: www.youtube.com/watch?v=d5GkgVhFeZY



The latest issue of *Deep Foundations* magazine for Jan-Feb 2026 is out.

Read it here: bit.ly/DF-JanFeb-26

My Experience at DFI50, Nashville, USA

- Mr. Ravikiran Vaidya, Vice Chair, DFI of India

It gives me great pleasure to write this article about my experiences of attending the 50th Annual Deep Foundations Institute Conference held from 20th to 23rd October 2025 at Nashville, USA. The conference is similar to DFI-India conferences but on a much bigger and grander scale. The number of participants exceeded 1300 and there were more than 100 booths. The conference was an excellent mix of contractors, consultants, owner organizations like FHWA, DOT etc., testing companies, academicians and students too.



I was fortunate to make a presentation about DFI of India activities for the year as well as future plans and these were definitely well received as per feedback and acknowledgements. The first day of the conference is normally the committee meetings. DFI has 28 committees and working groups. I attended five committee meetings like drilled shafts, foundation reuse, driven piles, testing and evaluation. It was definitely an exhausting day but was then followed by the Women in Deep Foundation networking dinner which was refreshing.

The conference was a fantastic event with high quality lectures showing innovation, application and new developments in the field of deep foundations. As I take over the post of Vice Chair of DFI of India, I look forward to contributing to the DFI activities through my term with all your support and wishes. **Read the full article in the next newsletter.**

MITIGATION OF EARTHQUAKE-INDUCED SOIL LIQUEFACTION RISK BY INDUCED PARTIAL SATURATION (IPS)

- Rima Das, manika.dasnit@gmail.com; Dr. K Muthukumar, kmk@nitt.edu, National Institute of Technology, Tiruchirappalli

Introduction

Earthquake-induced liquefaction occurs in saturated, loose, granular soils due to the rapid buildup of excess pore water pressure under cyclic loading, leading to a significant reduction in shear strength (Kramer, 1996). Liquefaction during moderate to strong earthquakes can cause severe damage, including slope failures, loss of bearing capacity and deformation of soil-retaining structures (Seed et al., 1989; Bird and Bommer, 2004; Huang and Yu, 2013). Conventional mitigation techniques such as dynamic compaction, deep soil mixing, grouting and groundwater lowering are effective but often constrained by high cost, environmental concerns and potential disturbance to existing infrastructure (Cooke and Mitchell, 1999; Bayat et al., 2013). Recent research has therefore focused on non-disruptive ground improvement approaches, including bio-mediated methods and soil desaturation techniques. In particular, controlled desaturation has emerged as a promising, cost-effective and environmentally sustainable strategy for enhancing liquefaction resistance, even beneath existing structures.

Experimental and empirical studies indicate that reducing the degree of saturation from 100% to approximately 98% can increase liquefaction

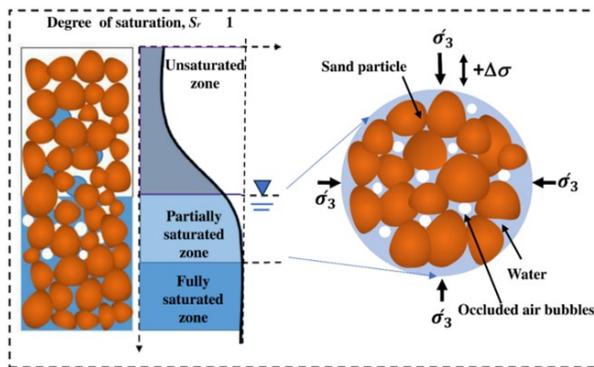


Fig. 1: Schematic illustration showing the distribution of saturation states: fully saturated, partially saturated and unsaturated zones

resistance by up to 30% (Okamura and Yasumasa, 2006; Mele and Flora, 2019; Tsukamoto, 2019). Partial saturation can be induced through air injection, electrolysis, chemical treatment and biogenic gas generation. The presence of entrapped air or gas bubbles increases pore fluid compressibility, reduces excess pore pressure accumulation during cyclic loading and consequently improves liquefaction resistance (Ishihara et al., 2003; Okamura and Yasumasa, 2006) (Fig. 1).

Despite advances in induced partial saturation (IPS), critical gaps persist in understanding monotonic behavior, pore pressure evolution, environmental controls on gas stability, optimal air injection parameters under seismic loading and long-term, large-scale field performance. This study systematically evaluates microbially induced partial saturation (MIPS) and air injection to address these gaps and quantify their effectiveness in improving liquefaction resistance of sandy soils.

Materials and methodology

poorly-graded liquefiable sand collected from Chidambaram, Tamil Nadu, was used in this study. Microbial desaturation was achieved using *Pseudomonas stutzeri* (MTCC 863), a denitrifying bacterium cultured in a nitrate-rich nutrient medium to induce biogenic nitrogen gas generation (Fig. 2).



Fig. 2: A portion of biogas bubbles is shown in the picture

Continued

Undrained static and cyclic triaxial tests were performed on sand specimens at relative densities of 30–60% and effective confining pressures of 50–100 kPa. Fully-saturated specimens ($B \geq 0.98$) were desaturated to target saturation levels ($S_r = 75\text{--}95\%$) using either microbial denitrification or controlled air injection. Static tests assessed shear strength, strain behavior and pore pressure response, while cyclic tests evaluated cyclic resistance under stress-controlled loading ($CSR = 0.2\text{--}0.4, 1\text{ Hz}$).

Air injection efficiency was evaluated through calibrated injection pressures ($\leq 1.7\text{ kPa}$) to achieve uniform desaturation without inducing soil cracking. The relationship between injection pressure, B-value and degree of saturation was established. Numerical simulations using FLAC 3D with the Finn model reproduced pore pressure generation and strain response under cyclic loading, with bulk modulus adjustments accounting for partial saturation.

Gas sustainability and migration were examined using vertical and horizontal flow setups under hydrostatic and gradient conditions, demonstrating stable air/biogas retention over extended durations. A large-scale plexiglass chamber and 1-g shaking table tests validated liquefaction resistance under controlled desaturation. Finally, a prototype automated air–water injection system integrating microcontrollers and real-time feedback was developed to demonstrate scalable, in-situ IPS implementation.

Results and discussion

MIPS static triaxial tests showed that untreated loose and medium-dense sands exhibited strain-softening with near-complete pore pressure buildup ($r_u > 0.98$), whereas MIPS-treated loose sands displayed strain-hardening, $\sim 1.4\times$ higher peak strength and reduced r_u (0.30–0.46). Dense sands showed minor strength reduction due to dilation effects. Microbial desaturation shifted the instability line toward the critical state and reduced the liquefaction potential index (LPI) from 0.55 to 0.05. Biogenic gas generation was strongly influenced by nitrate concentration and temperature, with optimal activity at 37–47 °C.

Under cyclic loading, MIPS-treated specimens showed a marked increase in cyclic resistance with decreasing saturation, particularly for $S_r < 85\%$. At $S_r = 85\%$, the maximum r_u was limited to 0.05, indicating non-liquefaction behavior. Excess pore pressure evolution, stress–strain response and failure modes differed significantly between treated and untreated sands across saturation levels ($S_r = 99\text{--}91\%$), with consistent improvements observed at higher relative densities and confining pressures (Fig. 3).

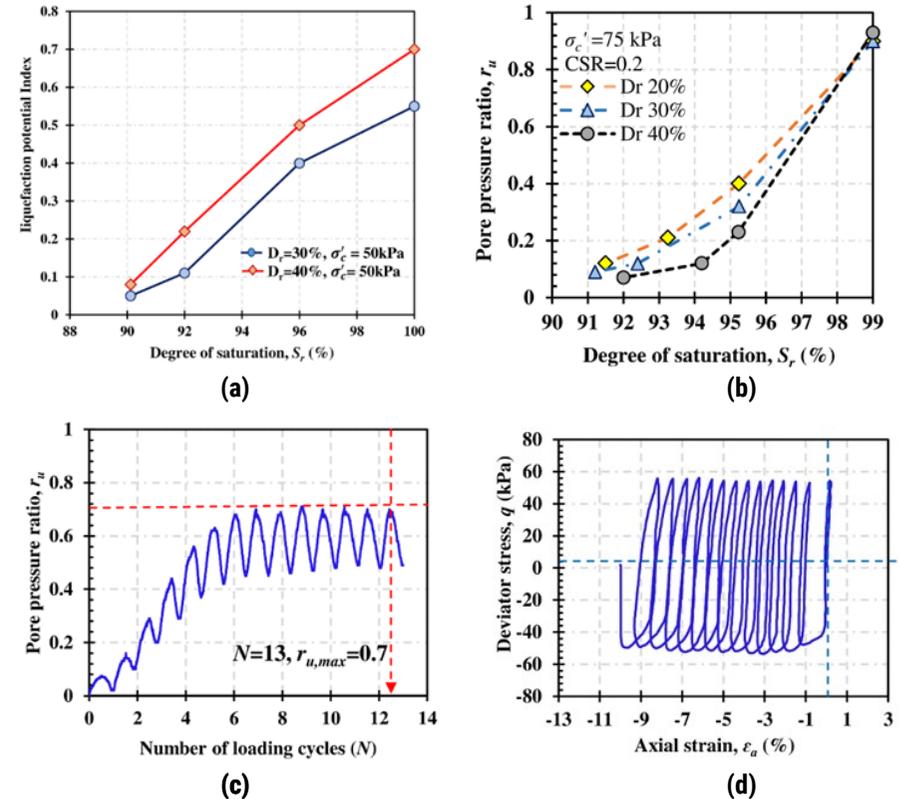


Fig.3 (a) Variation of LPI with degree of saturation (b) Variations of the excess pore pressure ratio with degree of saturation (c) excess pore pressure response (d) stress strain curve in MIPS treated sand

Continued

Direct air injection effectively reduced saturation and enhanced liquefaction resistance across all densities. Desaturated specimens exhibited increased stiffness, reduced r_u and higher CSR, with $S_r \approx 75\%$ producing the most significant gains (Fig.4). Even minor reductions in S_r increased the factor of safety against liquefaction ($FOS_L > 1$) under earthquake loadings ($PGA = 0.08 - 0.36 g$). Optimal target saturations were identified as 75% for $D_r = 20\%$ and 80% for $D_r = 30-40\%$, accompanied by increased shear modulus and reduced damping.

Numerical simulations reproduced the experimental liquefaction response of partially saturated sands with high accuracy. At $D_r = 30\%$, fully saturated specimens liquefied ($r_u = 1$), whereas partially saturated specimens ($S_r \leq 85\%$) showed substantially reduced r_u (≤ 0.09). At $D_r = 40\%$, fully saturated specimens liquefied under lower confining pressure, while partially saturated specimens remained stable ($r_u \leq 0.11$).

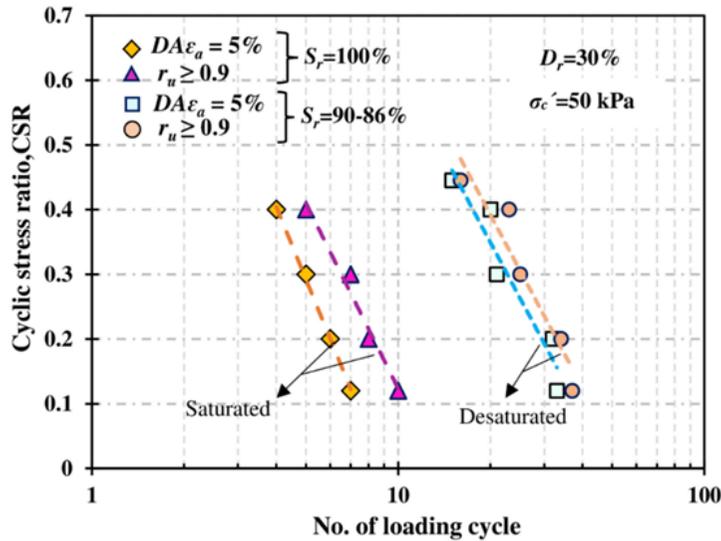


Fig.4: CSR - N under initial effective confining stress for air injected treated and untreated sands

Durability tests demonstrated effective gas retention under flow and hydrostatic conditions. Under horizontal flow, saturation increased by 4% for air injection and 2.5% for MIPS-treated samples, while vertical flow showed smaller increases ($\leq 2.5\%$) (Fig.5). Under hydrostatic conditions, saturation increased by only $\sim 0.5\%$ over 30 days. Saturation remained stable between 25-35 °C and decreased by $\sim 4\%$ at 35-45 °C, indicating enhanced gas stability at elevated temperatures.

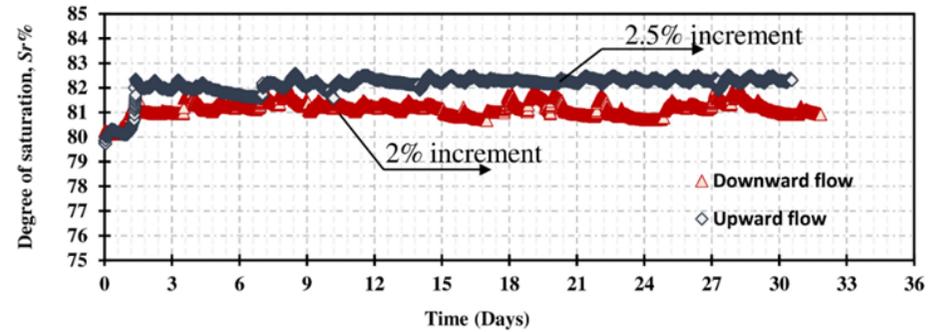


Fig.5: Variation in the degree of saturation under vertical flow conditions for air-injected sand sample

In the prototype air injection system, horizontal injection achieved superior performance with 84% spatial coverage, compared to a limited radial influence in vertical injection. Target saturation levels of $\sim 80\%$ were achieved without soil disturbance. Shaking table tests confirmed reduced excess pore pressure generation ($r_u < 0.5$), lower settlement and mitigated stiffness degradation with decreasing saturation. An automated air-water injection system with real-time sensor feedback was developed to maintain target partial saturation through controlled air-water cycling, demonstrating a scalable and field-adaptable solution for long-term liquefaction mitigation.

The above work was awarded the best PhD Research work in deep foundation engineering under DFI of India Student Awards 2025.

DFI of India Technical Committee Members 2025-26

DFI of India Committee for Geotechnical Characterization for Foundations

- Dr. C R Parthasarathy, Sarathy Geotech and Engg. Services (**Committee Chair**)
- Mr. Sorabh Gupta, Cengrs Geotechnica (**Committee Vice-Chair**)
- Mr. Anirudhan I V, DFI of India
- Dr. Yogini Deshpande, Renuka Consultants
- Mr. Alope Samanta, Fugro Geotech
- Mr. Ravi Sundaram, Cengrs Geotechnica
- Prof. A Murali Krishna, IIT Tirupati
- Dr. Sreevalsa Kolathayar, NIT Surathkal
- Dr. Arindam Dey, IIT Guwahati
- Mr. Gaurav Kumar, SNF

DFI of India Training Committee on Foundation Technologies

- Mr. Ravikiran Vaidya, Geo Dynamics Engineers (**Committee Chair**)
- Mr. Anirudhan I V, DFI of India
- Mr. PVSR Prasad, Keller India
- Mr. Rajith Kumar, L&T Construction
- Dr. Makarand Khare, Terranova Consultants
- Dr. Jaykumar Shukla, Geo Dynamics Engineers

DFI of India Student Outreach - Groundwork Committee

- Dr. B Umashankar, IIT Hyderabad (**Committee Chair**)
- Mr. Anirudhan I V, DFI of India
- Ms. Annapoorni Iyer, Engosym Consultants
- Dr. N Kumar Pitchumani, Jacobs
- Mr. Sridhar Valluri, Keller India
- Mr. Aminul Islam, Cemindia Projects
- Dr. K Muthukkumaran, NIT Trichy

DFI of India Sustainability Committee

- Dr. Venu Raju, Keller Group plc (**Committee Chair**)
- Mr. Anirudhan I V, DFI of India
- Ms. K Geethanjali, Engineers India
- Mr. Sai Kumar Suggula, Keller India
- Dr. Sujatha Manoj, Tetra Tech Coffey
- Dr. Purnanand Savoikar, GEC
- Dr. Shilton Rica, ArcelorMittal
- Mr. Sandip Bhutale, Menard
- Dr. Lakshmana Rao Mantri, Afcons Infrastructure

Continued

DFI of India Working Group for Bored Cast-in-situ Pile Quality Control

- Mr. Anirudhan I V, DFI of India (**Working Group Coordinator**)
- Dr. Sunil S Basarkar, S&R Geotechniques
- Mr. Mohan Ramanathan, Advanced Construction Technologies
- Dr. Jaykumar Shukla, Geo Dynamics Engineers
- Dr. Jaymin D Patil, Toyo Engineering
- Dr. Lakshmana Rao Mantri, Afcons Infrastructure
- Dr. Makarand Khare, Terranova Consultants
- Dr. Manish Mokal, Afcons Infrastructure
- Dr. V Balakumar, Consultant
- Mr. Aminul Islam, ITD Cementation India
- Ms. B V Sushma, Tata Consulting Engineers
- Mr. Jeyson Samuel, SamGeo Consultants and Constructions
- Mr. Manish Kumar, Cemindia Projects
- Mr. Manos De, Tata Consulting Engineers
- Mr. Prakash Bansod, Afcons Infrastructure
- Mr. R R Maurya, NTPC
- Mr. Ravi Sundaram, Cengrs Geotechnica
- Prof. S R Gandhi, IIT Gandhinagar
- Mr. Satyajit Vaidya, LANGAN
- Mr. Venu Gopal, L&T
- Mr. Vetriselvan A, Bauer Engineering India
- Mr. Viral Patel, Associated Engineers
- Mr. VVS Ramadas, Keller India
- Mr. V K Panwar, Engineers India
- Mr. Sanjoy Bhowmik, Engineers India

DFI of India Helical Pile Technology Implementation Committee

- Mr. Mohan Ramanathan, Advanced Construction Technologies (**Committee Chair**)
- Mr. Manish Kumar, Cemindia Projects
- Dr. Balakumar Venkatraman, Consultant
- Prof. Sumanta Halder, IIT Bhubaneswar
- Ms. Annapoorni Iyer, Engosym Consultants

Women in Deep Foundation (India)

- Ms. SriLakshmi Nagarajan, *Geocomp, Inc.*
- Ms. Annapoorni Iyer, Engosym Consultants
- Mrs. Theresa Engler, DFI
- Ms. Dola Roy Chowdhury, GCUBE Consulting Engineers
- Ms. K Geethanjali, Engineers India
- Dr. Yogini Deshpande, Renuka Consultants
- Ms. Sangeen Desai, Fugro India
- Ms. Akhila Manne, Keller
- Mr. Matthew Glisson, DFI

Technical Committees are the backbone of DFII providing the practical forum for finding common ground in the deep foundations industry. Technical Committees provide opportunities for all members to identify and address issues that impact deep foundations practice. The committees explore and address the special considerations for design and execution of efficient, reliable and safe solutions for foundation applications

DFI of India Groundwork Series - Session 1

DFI of India successfully conducted the first session of the DFI of India Groundwork Series 2026 on 22 January 2026, as an in-person event in association with the Division of Soil Mechanics and Foundation Engineering, Civil Engineering Department, CEG, Anna University. The event was conducted under the DFII Students' Outreach – Groundwork Committee, marking a strong start to this year's Groundwork Series.

The session featured two technical lectures: one by Ms. Padma Tiruvengala (Cemindia Projects) on "Design and Construction Challenges of Vertically Stacked Underground Metro Stations and Tunnels – A Case Study from Chennai Metro Phase-II" and another by Mr. Jeyson Samuel (SamGeo Consultants & Construction) on "Permanent Embedded Retaining Structures". The lectures generated insightful discussions and offered valuable technical perspectives to the participants.

More sessions are planned under the DFII Students' Outreach – Groundwork Series, both in-person and online, to continue fostering learning and engagement.



DFII & DFI Upcoming Events

Event	Date	Venue
Conference on Foundation Decarbonization and Re-use	Mar 24-26, 2026	Amsterdam, the Netherlands
DFI-PFSF Piling & Ground Improvement Conference	May 18-20, 2026	Sydney, Australia
SuperPile '26	June 24-26, 2026	New Orleans, Louisiana
S3 2026	Aug 11-13, 2026	Charlotte, North Carolina
DFI-India 2026	Sept 17-19, 2026	Guwahati, India
DFI51	Nov 2-5, 2026	Orlando, Florida

DFI-India 2026: 15th Annual Conference



DFI of India (DFII), in collaboration with the Indian Institute of Technology (IIT) Guwahati and the Indian Geotechnical Society (IGS), Guwahati Chapter, is pleased to announce the DFI-India 2026: 15th Annual Conference, scheduled to be held from **September 17–19, 2026**.

DFI-India 2026 conference provides a platform for discussion and knowledge exchange in deep foundation and geotechnical engineering. It brings together professionals from academia, research organizations, consulting and contracting firms, infrastructure developers, equipment manufacturers and policy bodies from India and abroad. The conference focuses on sharing insights into current challenges, practical solutions and evolving practices in the design, construction, testing and performance of deep foundations, particularly under complex ground conditions.

Conference Venue

The Conference will be held at IIT Guwahati, one of India's most premier technical education institutes. IIT Guwahati campus is renowned for its breathtaking natural beauty, set amidst rolling hills, serene lakes and lush greenery along the banks of the Brahmaputra River. The institute offers a modern, well-planned auditorium and conference halls, with comfortable guest houses and hostels, as well as a host of amenities to make the conference truly

enriching and convenient for delegates. This venue sets the perfect stage for insightful discussions, networking and innovation at DFI-India 2026.



DFI of India invites all stakeholders to mark their calendars for DFI-India 2026. The conference will facilitate the exchange of ideas and practical experience in deep foundation engineering, with a focus on improving productivity, safety, sustainability and quality standards. The event offers meaningful interactions, knowledge sharing and professional networking. DFI of India looks forward to welcoming you to DFI-India 2026.



For more information, [visit: dfi-events.org/india26/](https://dfi-events.org/india26/)

DFII Technical Committee News & Reports

DFII Sustainability Committee

Formed in June 2025, the DFII Sustainability Committee presented its objectives at the DFI-India 2025 Conference and conducted an online training session on the EFFC-DFI Carbon Calculator in November 2025. It also regularly contributes sustainability-focused articles to the DFII Quarterly Newsletter.

The committee is presently working on organizing a one-day in-person Carbon Calculator workshop in Delhi during March–April 2026.

DFII BCIS Pile QC Working Group

Established in August 2025, this committee focuses on identifying key quality control challenges in the construction and testing of bored cast-in-situ piles and formulating mitigation measures. Contributions from experienced industry professionals are being compiled to develop a comprehensive guideline document highlighting common mistakes and best practices for field engineers. The committee is currently working toward preparing the first draft of the guideline by October 2026.

DFII Training Committee on Foundation Technologies

The committee has conducted multiple online and hybrid training programs covering key foundation technologies such as reverse circulation drilling, efficient piling methods, support fluids, tremie concrete, ground improvement and diaphragm walls. These programs have received strong participation from professionals across India.

The committee is currently developing a new training program on deep excavation support systems, planned for delivery in the first half of 2026.

DFII Student Outreach Committee-Groundwork

The Groundwork Committee continues its flagship webinar and lecture series, now in its sixth year, aimed at bridging the gap between academic learning and industry practice. In January 2026, the committee conducted its first in-person Groundwork lecture at Anna University, Chennai (Refer to [Page 16](#) for a detailed report on the session). The committee also administers the DFII Student Awards program, recognizing outstanding master's and doctoral research, with awards presented annually during the DFI-India Conference.

Further in-person and online Groundwork sessions are planned for 2026, along with the launch of the Student Awards 2026 cycle.

CFA Pile Technology Implementation Committee

The DFII CFA Pile Technology Implementation Committee successfully achieved most of its mandate, including execution of India's first CFA pile field trials, preparation of construction guidelines and promotion of CFA pile technology through workshops and industry outreach. The committee also played a key role in initiating the development of an Indian Standard (IS) Code on CFA pile design and construction through BIS, with guidelines expected in 2026.

As CFA piles are now being increasingly implemented in projects across the country, the committee was formally dissolved in January 2026.

**Follow DFI of India on social media
for updates & announcements**



Leadership Change at DFI of India

The Deep Foundations Institute of India has undergone a leadership transition following the completion of the tenure of Mr. Mohan Ramanathan, who served as chair for the two-year term (2023 & 2024) along with a one-year extension (2025). During this period and under the collective guidance of the Executive Committee, DFI of India recorded meaningful progress in furthering its objectives by broadening the reach of its conferences, workshops and webinars, attracting growing participation from international professionals and strengthening its position as a recognized platform for knowledge exchange in deep foundations engineering.

In accordance with the decision of the DFI of India Board, Dr. Sunil Basarkar has been appointed as chair of the Deep Foundations Institute of India with effect from January 2026. Dr. Basarkar previously served as vice chair assisting Mr. Mohan Ramanathan as chair, during which his contributions to the Institute's initiatives, professional programs were significant. Mr. Ravikiran Vaidya, a long-standing member of the DFI of India Core Committee and Executive Committee, has been selected as vice chair. He has made notable contributions to the Institute through his sustained involvement in its annual conferences, training programs and workshops.

With the newly constituted leadership for the term 2026-2027, DFI of India is well positioned to build upon its existing achievements and continue its progress on a sustained and structured growth path.



Dr. Sunil Basarkar
Chair, DFII



Mr. Ravikiran Vaidya
Vice-Chair, DFII



Mr. Mohan Ramanathan
Immediate Past Chair, DFII

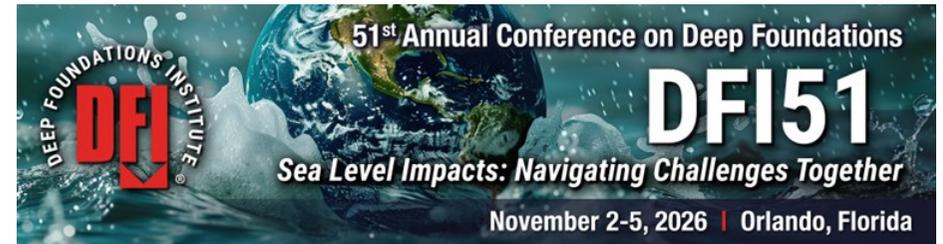
WHAT CAN DFI DO FOR YOU?

Overview

DFI is an international association of contractors, engineers, suppliers, academics and owners in the deep foundations industry. For more than 50 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 25 plus active Technical Committees, Regional Chapters or a DFI group
- Gain visibility with a corporate member listing on the DFI website, which has more than 20,000 views each month
- Connect and communicate with industry peers through social media such as DFI's LinkedIn Groups or follow DFI on LinkedIn, Facebook, Instagram or YouTube
- Access OneMine.org and download up to 145,000 articles, technical papers and books from DFI and organizations all over the world - at no cost



51st Annual Conference on Deep Foundations

November 2-5, 2026

DFI's 51st Annual Conference on Deep Foundations will be held **November 2-5, 2026, in Orlando, Florida**. The theme of this international conference is "*Sea Level Impacts: Navigating Challenges Together*," focusing on the complex challenges and far-reaching implications of rising sea levels. The conference will explore advancements in industry practices, innovative techniques and project delivery through expert perspectives, case studies and research-based papers and presentations. Participants will have the opportunity to engage with global experts, exchange ideas and gain practical insights that can shape the future of foundation engineering.

Registration is open for the Conference. **For more details and registration, visit:** dfi-events.org/dfi51/

This eNewsletter of DFI of India is available at DFI of India website: dfi.org/india/

Editorial Team: Anirudhan I. V., Matthew Glisson, Pranav Jha, P. Sai Sindhu and Aswin V Hari

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.