Monitoring Ground & Structure Stability from Space

At all project stages, a key tool in the civil engineer's risk mitigation strategy has been the deployment of instrumentation and monitoring systems to closely monitor ground and building movements and the results of any stabilisation work. The satellite remote sensing technology of radar interferometry, or InSAR, provides an effective supplement to conventional methods for monitoring the mm-scale ground movements associated with underground excavations or new building settlement. Read about it on Page no. 3.

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DFI of INDIA News

Quarterly Newsletter from Deep Foundations Institute of India

www.dfi-india.org

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Monitoring Ground and Structure Stability from Space: Satellite-based InSAR

Cover Story

Introduction

At all project stages, a key tool in the civil engineer's risk mitigation strategy has been the deployment of instrumentation and monitoring systems to closely monitor ground and building movements and the results of any stabilisation work. These systems can be highly accurate while streaming almost continuous data. However, they are often invasive, complex and expensive with practical limitations on the number or density of measuring stations that may be deployed. Further, as these systems are only deployed at a specific project stage, for example at the beginning of construction, both spatial and temporal ambiguities can exist in terms of any claims for damage made against the builder.

The satellite remote sensing technology of radar interferometry, or InSAR, provides an effective supplement to conventional methods for monitoring the mm-scale ground movements associated with underground excavations or new building settlement. Based on relatively large image swaths, wider-than-AoI analysis is implicit, and with up to metre-grid coverage, InSAR supplements ground-based instrumentation when it comes to measurement point density.

Significantly, as satellite data have been repeatedly acquired for decades over the same places, time-series plots for every measurement point can be computed that show past movements to the present day, i.e. to reveal when a location's movement profile might have changed – critical in the management of liability.

InSAR Technology

Synthetic Aperture Radar (SAR) Interferometry (InSAR) is a remote sensing technique that provides measurements of ground displacements. Radar sensors mounted on satellites acquire images of the Earth's surface by emitting electromagnetic waves and analyzing the reflected signal. Basic Differential InSAR (D-InSAR) techniques consist of comparing the phase values of two SAR images, acquired at different times with similar looking angles. The phase difference is proportional to the target motion occurring along the sensor-target line -of-sight (LOS) direction during that time interval (Figure 1). As SAR satellites are continuously circumnavigating the globe, a number of radar images can be collected for the same area over time and information about the displacements of the earth's surface can be extracted.

Figure 1. An illustration showing the relationship between ground displacement and signal phase shift. This is the basic principle of InSAR for measuring ground movement

Contd.

In the late nineties, new Advanced DInSAR (A-DInSAR) techniques emerged in order to estimate and remove the atmospheric noises that affect basic DInSAR data and provide more accurate displacement measurements (sub-millimeter precision) by processing multiple images acquired over the same area over time. Permanent Scatterer Interferometry, the first A-DInSAR technique, identifies and monitors point-wise Permanent Scatterers (PS), pixels that display both stable amplitude and a coherent phase throughout every image of the dataset (Ferretti et al. 2000, 2001). PS are related to natural radar targets such as manmade structures (buildings, streetlights, transmission towers, etc.) as well as rocky outcrops, un-vegetated Earth surfaces, boulders, and any structure that can reflect a signal back to the satellite. In order to detect the highest possible density of measurement points in non-urban areas, a new technique known as SqueeSAR™ was presented by Ferretti et al. in 2011, which extracts information from Distributed Scatterers (DS). This extends measurement point coverage to areas with limited infrastructure and light vegetation. Together, these two types of measurement points form a ground network of radar benchmarks, similar to a Global Positioning System (GPS) network, and can be used for monitoring both the displacement of individual structures (a building, for instance) and the evolution of a large displacement field affecting hundreds of square kilometers.

The launch of satellites with a high frequency of acquisitions (up to a few days), combined with the development of sophisticated automatic processing algorithms, have made it possible to continuously provide reliable surface deformation measurements with each new satellite image (Raspini et al., 2018).

From Planning to Design and Construction

The existence of SAR data archives going back to the 1990s has led to the extensive use of InSAR to perform historical ground deformation analyses to assess any pre-existing ground deformation phenomenon at the planning and design phases of a project. At the construction stage, frequent, high-resolution InSAR updates form part of the structural health monitoring program, providing up to thousands of measurement points per square kilometer, in urban areas.

Source : Barla et al. 2016

Figure 2. SqueeSAR Monitoring during tunnel excavation of single-track rail tunnel in a historic city centre where there was suface subsidence related to tunnel face advancement

Case History: High-Speed Railway Station (Bologna, Italy)

As part of the high-speed railway from Milan to Naples in Italy, the construction of a major station and tunnel under the city of Bologna were completed in the early 2000s. This consisted of a double-track tunnel with an excavation area of approximately 130m2, crossing an urban area at shallow depths (approximately 10m) with a high density of commercial and residential buildings.

Contd. on Page 14

Reconnecting to the well-wishers of DFI India

Director of Operations Message

Mr. G Venkata Prasad

DFII office team is in an upbeat mood that July-Aug quarter turned out to be more productive on various fronts. After one and a half years, I ventured traveling braving covid scenario to Chennai first. This is to get connected to DFII well-wishers personally to thank them for their support for the success of DFII programs, to meet other stakeholders of the construction/ foundation industry to present about DFII programs to seek their support to serve mutual interests.

I had fruitful meetings with the leadership of six L&T companies, the Director (Project) & CGM of Chennai metro rail project, a three-member professor team of IITM, MD of GMMCO, dealers for IMT & Juntan pile drilling machines apart from other construction equipment. I held discussions with them covering opportunities in making use of current DFII programs to their advantage, and to explore new areas of collaboration.

During the third week, travelled to Mumbai to meet the leadership of ITDCEM and IRB Infra to personally thank them for the financial and other support they have been extending over the last few years and to brief them on interesting DFII developments in the recent past. I had a fruitful meeting with the L&T Corporate Strategy Head and also the Head of Housing division for discussing possible areas of collaboration. I could get connected to Mr. Rajeev Shrikhande, leading structural consultants and he agreed to have one small webinar program organized for around 10 structural consultants known to him. This is to familiarize them with DFII programs that may benefit them in their projects in related areas. He was introduced to us by Dr. Conrad Felice, Trustee of DFII Board during his visit to India in 2018 in connection with the DFII annual conference event. Since then, we have kept our contacts live, and Mr. Rajeev has extended his support to DFII programs.

We will endeavour to reach out to more stakeholders to canvas about current DFII programs and encourage them to reap its benefits, as otherwise, the busy executives are hardly finding time to go through regular updates we are sharing through other modes. This approach is helping us to expand DFI Community steadily every year. Collective efforts involved right from Chair Mr. I V Anirudhan and Vice-Chair Mr. Mohan Ramanathan, Past Chair, Dr. K S Ramakrishna, and active EC members in this direction will see DFII growing as the finest institute.

The recent meetings gave us hope of seeing CFA pile technology implemented in few projects in coming future, which will set the tone for this technology to penetrate smoothly in Indian foundation industry in a greater number of projects. It will be good news for the DFII CFA pile committee who toiled hard over the last 4 years under the leadership of Dr. Sunil Basarkar to see this dream coming true.

DFII committee for geotechnical characterization for foundation

Contd.

sustained efforts under the leadership of Mr. Amol Shingarey and past chairman Prof V S Raju over the last three years started bearing some fruits. We have a plan to launch short term training and certification program covering lab technicians in a few of the soil labs of like-minded geotechnical investigation agencies soon. This will be expanded to a greater number of soil labs after fine-tuning the program based on our learnings. As a part of this goal, the training the trainers' workshop was conducted on 11th Sept'21 covering around 12 prospective trainers from 5 different companies.

DFII 2021 conference technical committee, organizing committee, and DFII office team is scaling up their efforts for the success of this event planned during **Nov'21**. It benefit us in connecting with the past sponsors, exhibitors, delegates to present the progress of DFII programs, to seek their renewed support for the conference program.

DFII team is doing its homework to launch more programs in the future and we will share this exciting news soon.

On behalf of DFII, I extend festive season greetings to all well-wishers and patrons of this institute and seek their support for the grand success of DFII 2021 conference.

Congratulations!!!

Sangeen Desai
Deputy Manager - BD
Keller Ground Engineering (India)

WiDF 2021 Professional Development Grants

The DFI Educational Trust awards **Sangeen Desai** along with four other women professionals the *"Women in Deep Foundations (WiDF) 2021 Professional Development Grants"* of $1,750 each. The recipients are invited to attend DFI's 46th Annual Conference in Las Vegas, October 12-15. The grant includes complimentary conference registration and covers related expenses for attending the conference.

Sangeen is an active member of DFI India. She hold's a bachelor's in Civil engineering from Maharaja SayajiRao University Baroda of and master's of Geotechnical engineering from Indian Institute of Technology Roorkee.

Join us in congratulating Sangeen for this achievement and best wishes for her future.

DFI members can post their professional achievements, corporate achievements, awards, other news related to geotechnical profession here. Please send the details 15 days before every quarter, April, July, October and December to activities@dfi-india.org

Youth Corner - WiDF India

Divya Shaunik
Adjunct Faculty at Seattle University, WA, USA

My passion for academia goes back to my childhood days. I grew up on a University Campus and was always surrounded by intelligent teachers and dedicated researchers who inspired me towards this divine and selfless profession. My parents are also the recipient of Doctorate degrees. Following the lead, I completed my Ph.D. in Civil Engineering with a specialization in Geotechnical Engineering from the IIT Roorkee. At the undergraduate level, I wasn't thoroughly aware of various engineering streams, and by sheer destiny, I opted for civil engineering. While going for a post-graduate degree, I became quite sure about my interest in pure experimental studies related to engineering aspects of soil. Fortunately, in Ph.D., I got a chance to understand and implement the theories of Rock Mechanics. In a constant work of 9 years, I conducted various laboratory experiments on soils and rocks.

For society, Ph.D. is a mere degree that adds up a Prefix 'Dr.' behind a name, but for me, it turned into a once in a lifetime experience. I was lucky enough for having the constant support of an excellent supervisor, motivating committee members and friendly fellow scholars. My research topic was analysing the strength behaviour of non-persistent jointed rock specimens with foreign discontinuity material. I performed an experimental study on model rock specimens and suggested an approach to assess uniaxial compressive strength.

Besides a highly demanding research life, female researcher face endless unsaid obstacles that are not mentioned anywhere in dissertation. Still, I will like to share few experiences that are worth mentioning. One such experience was being the only female working in the laboratory for the first four years of my degree. My usual day was performing experiments from morning till evening and afterwards analysing the test results and writing research papers. I did notice the fellow male scholars were allowed to work overnight, and their assistants were comparatively happier by earning the extra bucks. I was a little skeptical about taking permission to work in odd hours that resulted in the unfriendly repo with my assistants, and this act cost me time (most important in Ph.D.) that went into searching for new assistants and training them again and again. Another issue that specifically a scholar with experimental studies faces are the breakdown of laboratory machines. The setup on which a scholar works is very high maintenance, and god forbid if it breaks down, then straight one to two months gets wasted. The last experience that I would like to highlight was converting my degree into part-time to accompany my husband, who worked in America. Then came the struggle of managing publications remotely from a completely different time zone, but nothing is unachievable if you decide to accomplish it. My hard work did pay off well in appreciation and praise received on dissertation from eminent Professors.

I will conclude with a life lesson that I learnt in seven years (2013 to 2020) of my Ph.D., 'Every research is unique to its researcher and is full of good and bad surprises, and even the bad ones can result in a groundbreaking discovery or lifelong skill'. Hats off to all the budding scholars who have learnt the art of maintaining sanity while facing immense hardships. Kudos!

Join Women in Deep Foundation (WiDF) India group to connect with like minded professionals advocating & encouraging participation of women in all segments and positions of construction Industry.

New Data Management for Foundations Specifications by the DFI Project Information Management Systems Committee

Introduction

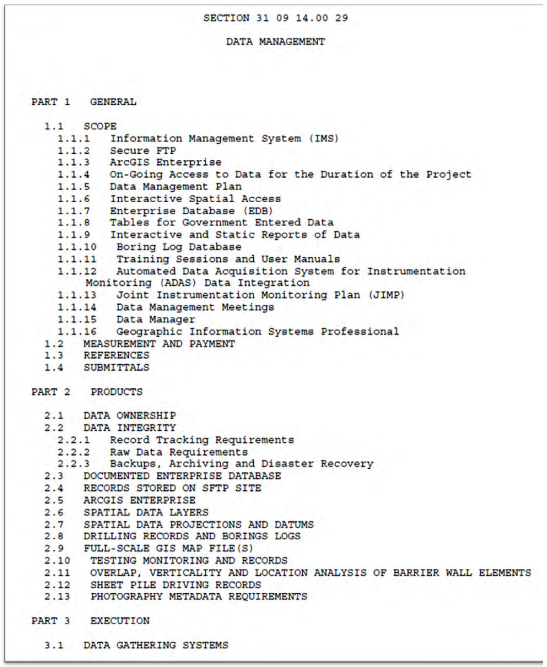
The United States Army Corps of Engineers (USACE) and other owners of seepage barrier wall projects (including diaphragm walls, secant pile walls, jet grout columns, grout curtains, and more) increasingly require specific Information Management methods in their Specifications. The Project Information Management Systems (PIMS) Committee of the Deep Foundations Institute (DFI) has edited a USACE Information Management Guide Specification for general use throughout the foundations industry be removing USACE-specific language and language specific to the United States. Version 1.0 of this Specification is now available for general use (see DFI.org), and further revisions are pending with updates and expanded sections on specific technologies.

These generic Specifications require Contractors to use geospatial and other methods for compiling, organizing, analyzing, and visualizing data to demonstrate that sufficient quality control measures have been applied to the barrier wall construction. These data include:

- Element position/verticality;
- Slurry quality;
- Exploratory and Verification Borehole position and geology;
- Surveys of constructed elements;
- Photographs and other site documentation;
- and more, depending on the design and technologies used in the construction.

The Specifications dictate that these data be managed using a series of components:

- A centralized relational database;
- A Geographic Information System (GIS) and associated editable files and web-based viewers, generally in planimetric, profile, and 3D systems (including web-based viewers and editable desktop files);
- Reports for each element (or each secondary element in the case of closure reports) showing the calculated position of the element (and overlap with adjacent elements) at several depth intervals and in a profile view; and
- Progress and As-Built Drawings showing the positions of all proposed and completed elements.



SECTION 31 09 14.00 29

DATA MANAGEMENT

PART 1 GENERAL

1.1 SCOPE
1.1.1 Information Management System (IMS)
1.1.2 Secure FTP
1.1.3 ArcGIS Enterprise
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1.1.9 Interactive and Static Reports of Data
1.1.10 Boring Log Database
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1.1.13 Joint Instrumentation Monitoring Plan (JIMP)
1.1.14 Data Management Meetings
1.1.15 Data Manager
1.1.16 Geographic Information Systems Professional
1.2 MEASUREMENT AND PAYMENT
1.3 REFERENCES
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PART 2 PRODUCTS

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2.12 SHEET PILE DRIVING RECORDS
2.13 PHOTOGRAPHY METADATA REQUIREMENTS

PART 3 EXECUTION

3.1 DATA GATHERING SYSTEMS

Figure 1. Example USACE Foundations Data Management Specification Outline

An example outline of a typical data management Specifications for a deep foundations project is shown as Figure 1. Details of the Specifications will change depending on the barrier wall technology, however the major components listed above are applied universally.

Contd.

The major components listed in Figure 1 can be developed with a range of technologies that vary with the barrier wall methodology.

Centralized relational database

A single database that stores and, importantly, relates all project data is the "heart" of a data management system. Modern PIMSs generally use an enterprise (i.e., intranet or internet-accessible) database (EDB) that allows storage of spatial objects. Most enterprise database platforms meet this need, including Microsoft SQL Server and Oracle. The EDB (and its various associated scripts and tools) is used to receive raw data, organize that data into tables and views, and serve the data to the GIS, reports, and drawings listed below.

In addition to the reports and drawings, PIMSs generally allow raw and organized data in the EDB to be accessed securely by team members and owners via the internet. This can be accomplished through web-based tables, or more commonly by having the tables and views exported on a routine (i.e., nightly) basis to text files (i.e., comma separated values or csv files), spreadsheets, or tables in a desktop database application like Microsoft Access (i.e., a "mirror database"). These static offline files can then be used outside of the PIMS and as a routine archive of the state of the database.

Geographic Information System (GIS)

A GIS is used to organize, visualize, and analyze foundations data in 2 or 3 dimensions. A typical foundations project GIS will include planimetric, profile, and 3D views of the structure, ideally updated on some high frequency (i.e., daily or weekly) to efficiently track the project process. Modern GIS include secure web views (Figures 2 to 4) to allow access to data without requiring specialized software, and owners may require both web viewers for daily access and source files for offline analysis and to create a project archive.

Figure 2. Planimetric GIS web viewer showing the position and overlap of cutter soil mixer panels at a specific depth

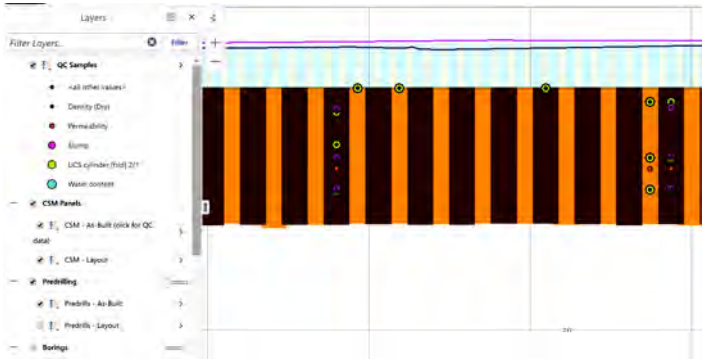

Figure 3. Profile GIS web viewer allowing access to quality control sample data

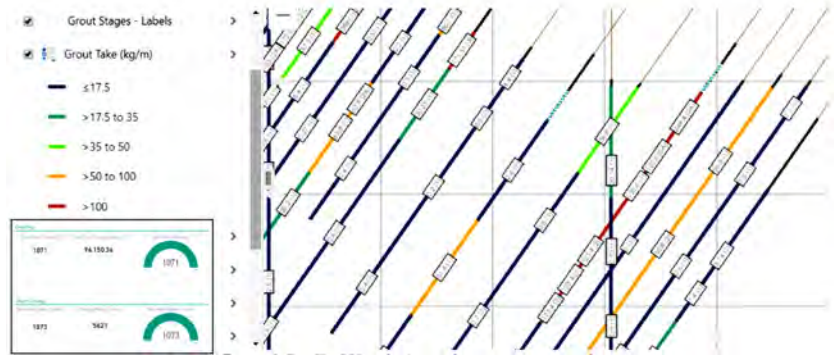

Figure 4. Profile GIS web viewer showing grout stage data and production status

Contd.

Element Reports

Specifications typically also require that reports be created for each barrier wall element (or each "closure" of secondary element and adjacent primary elements) visualizing and summarizing the data for that element (Figure 5).

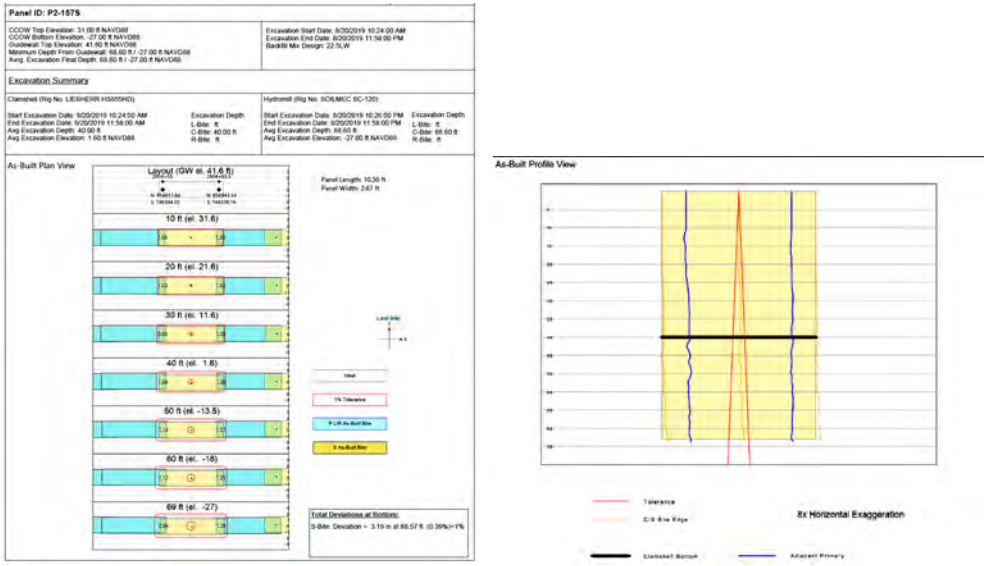

Figure 5. Element Report showing as-built position and overlap of diaphragm wall panel

Progress And As-Built Drawings

Finally, Specifications require drawings to be produced on some regular basis (i.e., weekly) that represent an offline record of progress through that date. An example of a typical progress drawing showing proposed and completed elements of a barrier wall is in Figure 6:

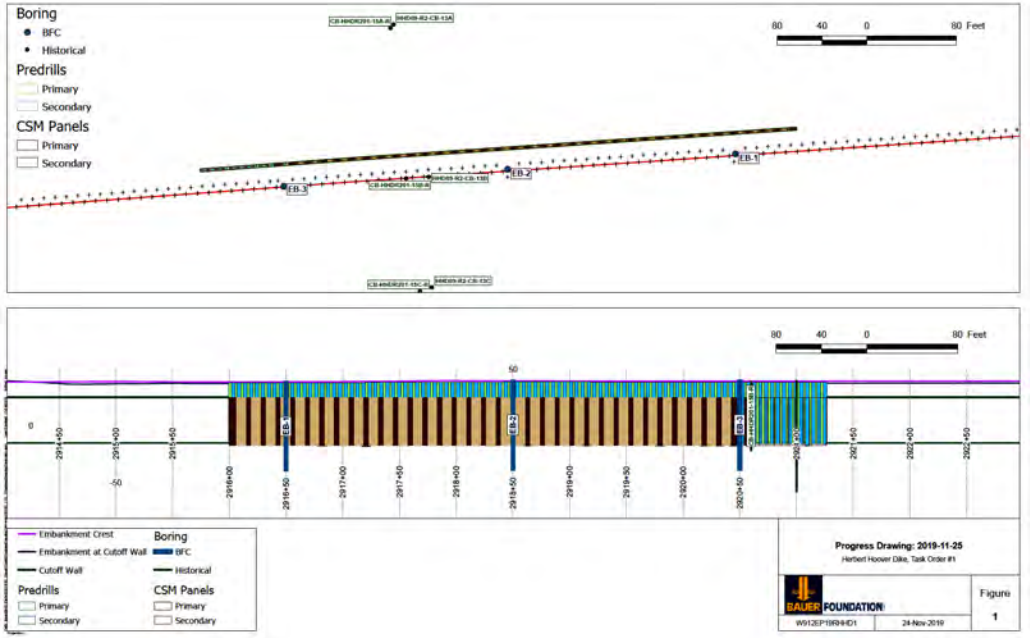

Figure 6. Progress Drawing

Conclusions

As PIMS technologies develop and become more widespread across the foundations industry, there is an increasing need for specifications to allow owners to be clear on what they want to receive from contractors with respect to data formats and work products. The DFI PIMS Committee is working on an evolving Specifications document that will assist owners in meeting these needs.

Author: Jamey Rosen, Chairperson, Deep Foundations Institute Project Information Management Systems Committee

DFII & DFI Upcoming Events

DFI-India 2021 10th Anniversary conference preparations are in full swing, and the participation from industry and academia is overwhelming. We thank all the sponsors, delegates, authors, and speakers for their active participation.

The conference offers a wide forum for geotechnical professionals to present, discuss and debate many aspects of the latest technologies appropriate for the speedy execution of deep foundation for major infrastructure projects in India. It is scheduled in Nov 2021 in online format. The technical program is spread over two consecutive weekends, i.e., on 12-13 Nov & 19-20 Nov'21, giving sufficient networking & exhibition opportunity during the in-between week days on 15, 16, 17 & 18 Nov'21. More details available on Page 13.

For more details on technical program, schedule, sponsorship/exhibition opportunities, and registration visit the conference website: https://www.dfi-india.org/DFII2021/index.html

Event	46th Annual Conference on Deep Foundations	DFI-India 2021	6th International Conference on Grouting & Deep Mixing	DFI-PFSF Piling & Ground Improvement Conference	DFI-SMIG-GI-ISSMGE 5th International Conference on Deep Foundations
Date	Oct 12-15, 2021	Nov 12-20, 2021	February 13-16, 2022	February 23-25, 2022	March 3-4, 2022
Venue	Las Vegas, Nevada	Online Conference	New Orleans, Louisiana	Sydney, Australia	Mexico City, Mexico

Check DFI membership benefits & rate under different categories here: https://dfi.org/members/#join

DFII Technical Committee News & Reports

DFI India Student Outreach program 'Groundwork' in DFII2021

DFII Groundwork program was launched last year during DFI India's annual conference. As a part of DFI-India 2020 annual conference a student competition was organised which received overwhelming response from the students community and encouraged to committee to take bigger steps.

Following the conference, 5 monthly webinar programs specially designed for the students community were conducted fromJan'21 to May'21 which was attended by students from India & abroad, more than 900 people registered for the webinars. Groundwork committee is already working on resuming the programs from Jan'22 with more interesting presentations and more active participation from students. Stay connected on DFI India social media account to receive timely announcements.

DFII Groundwork committee also decided to organise another student competition under DFI-India 2021 conference. A question set of 5 practical problems was prepared & published by the committee, solution to 3 problems were sought. Students had the option to participate in a group of up to 5 members.

Top two teams will be announced soon and will be awarded free passes to the DFI-India annual 2021 conference, where, during the Groundwork session, they will get a chance to present their solutions and subsequently the final winning team will be announced.

For more information visit: https://www.dfi-india.org/DFII2021/groundwork.html

Women in Deep Foundations (WiDF) India

WIDF India webinar discussion

WiDF India group conducted the popular webinar series 'Civil Engineering Careers - Connect & grow'. The third and last installment of the series came in May'2021 which received extremely positive reviews for the open discussion between the panelists.

Following the success WiDF India group is working on organising a session in DFI-India 2021 annual conference where panelists from Industry and Academia will share their experiences and opportunities for women professionals in construction industry. The discussion will also focus on the available work environment, and possible improvements to encourage more women engineers to take the core responsibilities in the industry.

The session is scheduled on 20th Nov'21 at 06:05pm to 07:05pm IST.

For more information and registration, visit: https://www.dfi-india.org/DFII2021/index.html

Follow DFI of India on social media for updates & announcements

DFI-India 2021 10th Anniversary Conference

The six keynote presenters are Benjamin (Ben) Rivers, P.E., senior geotechnical engineer, Federal Highway Administration (FHWA); Duncan Nicholson, retired director – Ove Arup and Partners and Arup Fellow Ove Arup and Partners; John Endicott, Ph.D., AECOM Fellow and executive director at AECOM Asia Co., Hong Kong; R. P. Singh, Ph.D., DGM (Civil), National High-Speed Rail Corporation, Mumbai; Alok Bhowmick, managing director, B&S Engineering Consultants; and Nikolas Schmitz, MHWirth, Germany. There will be 18 live paper presentations from authors. Prerecorded video of rest of the papers will be available on the conference platform, which will be launched a few weeks before the conference.

The in-between weekdays, November 15-18, will have theme Networking Sessions on different technical topics where participants can directly interact with the subject matter experts and add their opinion. It will be followed by a 2-hour exhibition sessions where exhibitors will present about interesting new technologies, equipment. products, and services in their respective exhibit booths. This will give an opportunity to the delegates to know more about new developments in the foundation industry.

Check the detail schedule here: https://www.dfi-india.org/DFII2021/technical-schedule.html

Conference Leadership and Committees

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Dr A. Boominathan, IIT Madras, Conference Technical Chair

Organising Committee

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Mr Ravikiran Vaidya, Geo Dynamics
Dr Jaykumar Shukla, Geo Dynamics
Mr Govind Raj, Keller India
Mr PVSR Prasad, Keller India

Cover Story - Continued from Page no. 4

Considering the delicate urban and geo-technical context and the tunneling-related subsidence, a comprehensive in situ monitoring system was combined with satellite remote sensing data during the construction phase (Pigorini et al., 2010).

After processing the SAR data archive, it was possible to identify a significant ground displacement trend. The alluvial deposits on which the city of Bologna is built are affected by land subsidence mainly induced by natural sediment compaction and ground-water exploitation for industrial, residential and agricultural uses. This was compounded with the effects induced by tunnel construction. In order to highlight the displacements induced by tunnelling activities alone, a reference point was selected in order to minimize the displacement gradients due to generalised subsidence and to isolate the displacements induced by the excavation works. The removal of masonry buildings on the surface caused the ground to rebound, with movement extending beyond the area monitored by the in-situ instrumentation, levelling benchmarks and total stations (Figure 3).

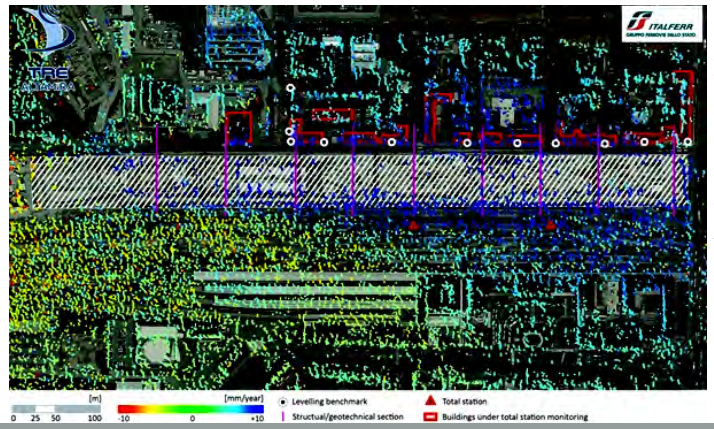

Figure 3. SqueeSAR measurements (coloured points) during the contruction of an underground high-speed rail station in a Bologna. Levelling benchmarks are indicated with white circles and total stations are indicated with red triangles.

Critical analysis of single measurement point displacement time series along with the chronology of the site and tunnel excavation activities (even before initiation of ground works) provided a detailed evaluation of any correlation and other interesting deformation effects that have occurred at on the ground's surface.

Figure 4 shows an example of a displacement time series of a measurement point located near the tunnel centre line. After the first period (2003-2007), which exhibits general stability, the image shows an increase in the displacement rate during 2007 and 2009-2010, both followed by stable periods. This behaviour is in exact agreement with the site work activities. The first acceleration is related to the construction of 10 micro-tunnels between March and October 2007; the second is related to tunnel advancement in the first months of 2010. In the subsequent period, the excavation front was far from this particular measurement point and displacement stopped, coinciding with the stable period at the end of the time series in the plot.

Figure 4. Modified from Pigorini et al. (2010): displacement time series showing the effect of tunnelling.

Comparing InSAR to Levelling Techniques

In a 2011-2017 SqueeSAR analysis over the Bond Street Station in Central London, measurements were validated using BRE (Building

Research Establishment) levelling data obtained from Crossrail Ltd. Work at this site involved the construction of two 10 m diameter platform tunnels between 20 and 24 m deep within the London Clay Formation. The construction site is located underneath historical buildings that are largely supported by shallow footings, which meant that ground deformation during construction was closely monitored.

Figure 5 shows a comparison between three types of deformation monitoring techniques: BRE levelling (blue squares), levelling points/ plates (red triangles) and SqueeSAR (green circles). The time series shown on the graph are from measurement points of the three techniques, which are located within less than 10 m of each other, as indicated on the map. To enable a comparison with the remote measurements, the ground-based measurements were averaged over 11 days. The time series are in excellent agreement, tracking relatively sudden movement such as the peaks in September 2012 and in August 2014.

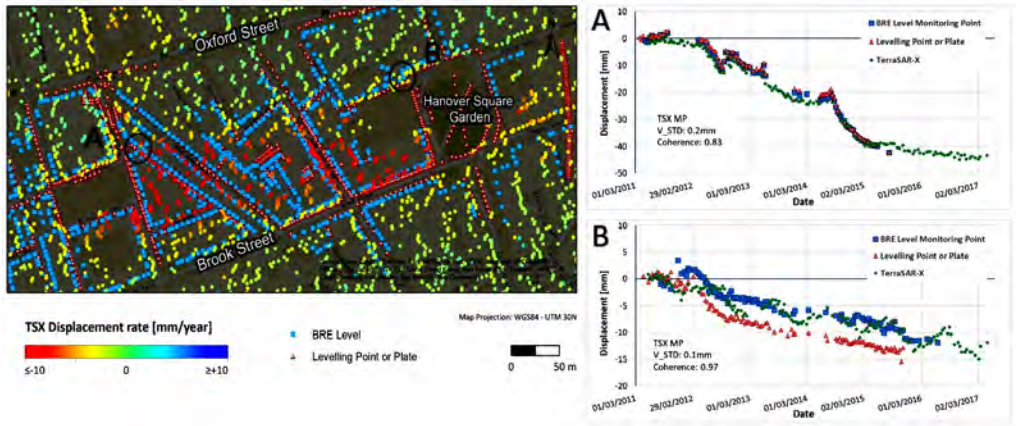

Figure 5. Comparison of SqueeSAR measurement values with BRE Levelling and Levelling Points around Bond Street.

Conclusion

Surface deformation monitoring is a key component in the identification and mitigation of risks related to construction, particularly in urban areas. Space-based InSAR has been validated in in -situ data and is now being included into comprehensive geotechnical monitoring program. It offers a synoptic, wide-area view, that coupled with localized, sparse in-situ real-time systems, provides the most thorough combination of spatially and temporally dense ground deformation data.

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