This Magazine is a Publication of Asian Institute of Technology

New Issue

TECHNOLOGY

Asian Outlook on Engineering and Technology

DECEMBER 2021

RESILIENCE-BASED DESIGN: THE NEXT LEVEL OF SEISMIC DESIGN

BUILDING BALANCE BETWEEN WORK AND WELLBEING

CIVIL ENGINEERING: NEXT DECADE & BEYOND

SMART DEVICE BASED TSUNAMI EVACUATION EXPERIENCE SYSTEM AND URBAN MODELING BY IMAGING TECHNOLOGY

REVISITING THE CONVENTIONAL STRUCTURAL ENGINEERING EDUCATION IN POST-COVID SCENARIO

KNOWLEDGE SHARING: AITS MEET THE EXPERT TALK SERIES

AIT Solutions

www.solutions.ait.ac.th

CONTENTS







December 2021

ISSN 2286-9158

Technology Asian Outlook on Engineering and Technology, is published by AIT Solutions
Asian Institute of Technology, P.O. Box 4, Klongluang, Pathumthani 12120, Thailand

Editor's Note

Civil engineering is an integral part of the built environment and has played an important role in the development of buildings, infrastructures related to such as transportation, water resources, and waste management. These buildings and infrastructures have helped in shaping our civilization as we know it today. In this respect, civil engineers have played a vital role in designing, developing, and building our built environment.

As we look forward to the next decade and beyond, civil engineers have a key role in future proofing our built environment. The challenges of climate change, urbanization, and natural hazards provides civil engineers with an opportunity to weave the technology into all the facets of the traditional infrastructure as well as to devise ways in advancing designs that are possible.

Through this issue we are sharing with our readers some of the technologies and civil engineering processes that may be utilized by civil engineers for future proofing our built environment. Some of the topics that we have covered in this issue include natural hazards such as tsunami and earthquakes, change in our working environment, and digital learning tools. In one of the articles, the authors have shared on how the integration of three technologies: high-quality modeling, tsunami simulation, and virtual reality on smart devices can help in ensuring smooth evacuation experience. While in another article the author has focused on resilience-based design that assess the performance quantitatively in holistic approach in terms of structural and nonstructural components to enable swift recovery after an exposure to seismic hazard. The authors have also delved upon the sustainable practices that can be incorporated in the new working environment as well as the ways digital technologies can provide the needed learning systems that help in training the engineers for the future.

My gratitude extends to all authors for their valuable contribution and our editorial team for their efforts and creative ideas in making this issue.

This magazine is a knowledge product of AIT Solutions and a professional communication platform for experts and researchers and a window to its readers to the technologies, events, and developments.

We welcome your valuable feedback and opinions.

Thaung Htut Aung

Director, AIT Solutions
Asian Institute of Technology
thaunghtutaung@ait.ac.th

AIT Solutions
solutions@ait.ac.th
www.solutions.ait.ac.th

ACECOMS
acecoms@ait.ac.th
www.acecoms.ait.ac.th

Habitech Center
solutions@ait.ac.th
www.habitech.ait.ac.th

km. 42 Paholyothin Highway
Khlong Luang, Pathumthani
12120, Thailand

Tel : +(662) 524 6388
: +(662) 524 5533
Fax : +(662) 524 6655

Building Balance Between Work And Wellbeing

Jagdish Rele

As we gradually emerge from the pandemic, now is the time to think boldly and adopt radical ideas which will catapult us into the next era. There is considerable experimentation ongoing here, and the ways we used to work and workspaces themselves are being challenged.

Building Balance Between Work And Wellbeing

The COVID-19 pandemic has altered the world in totality, affected our daily lives and forced us to think beyond what was considered "normal." One thing is certain that when the entire world was in lockdown the animal kingdom flourished, and the effects of clean air and climate were felt by one and all. There was an element of beauty all around.

As we gradually emerge from the pandemic, now is the time to think boldly and adopt radical ideas which will catapult us into the next era. There is considerable experimentation ongoing here, and the ways we used to work and workspaces themselves are being challenged. These pilots, once implemented, will require some time before conclusions can be drawn. Construction will continue to be a massive employer and thus a significant driver for economic growth. Civil engineering, which is a vast field, can play a significant role in shaping the future of society and can contribute to retain this state of bliss by espousing wellness-focused objectives that promote sustainable and healthy environments. In this article, I have outlined some of the opportunities in reframing corporate real estate design.

The future of work is flexibility

COVID-19 has raised numerous issues for real estate office planning with staff safety, health, and wellbeing the most paramount.

After a year of homebased work, organizations are reviewing flexible work standards such as assigned and unassigned (flexible) seating arrangements for at least few days in the week. Employees are encouraged to visit the offices primarily to collaborate with colleagues and engage with visitors. Hence, new designs could allow for an increased number of meeting and conference rooms with multiple configurations.

The future of office design lies in flexible planning. The design must be able to adapt to different settings with a common theme of controlling the spread of pathogens, while keeping an eye on mitigating the risk and impact of future health crises.

Zoned spaces to protect staffs

An efficient way of controlling the spread of pathogens is to isolate spaces by creating zones, much like the steps countries are taking. We can start by minimizing the potential points of access, leading into three zones, hot, warm, and cold. In the hot zone entry is permitted to all staffs and visitors. Warm Zone is where only authorized visitors can enter and the public conference rooms are located here. Cold Zone is a secure zone with access card entry open only to staffs.

Indoor air quality with provision for efficient air-conditioning/ ventilation systems and 100% fresh air delivery intake is necessary. This poses its own challenges for which the industry has developed alternate solutions, such as introduction of bi-polar ionization and use of UV technology.

Leveraging technology

Contactless features including use of nanotechnology can be adopted for the main access, internal doors, restrooms, elevators, etc. Technology has and will continue to play a central role in the future, starting with the preference of portable and handheld devices over bulky hardware. This could form the backbone of office design and help to open smaller spaces.

Other aspects to be considered are use of hard, non-porous for the surface finishes that are easy to keep clean, taking care in providing adequate sound attenuation features.

Signage, reinforcing good personal and public hygiene, is an important feature in the workspaces. Amazing advancement has been done in this field including use of digital, voice activated and audio-visual signage.

Facilities management is the most important

Author:

Jagdish Rele

Senior Project Manager, International Real Estate, World Bank

requirement not merely for the upkeep of the office, but to always ensure clean spaces. Sufficient space allocation shall be done for this activity. Gone are the days of small janitorial closet spaces.

Sustainability: Secret weapon for wellbeing

Wellness is no longer limited to something felt by each of us individually. It is closely tied to a sense of harmony between mankind and nature. Thus, awareness about sustainable practices must start at the kindergarten level. Sustainable civil engineering that nurtures a healthy environment is the future. All projects, big and small must strive towards contributing positively to climate change and reducing carbon footprint. There are numerous platforms available globally that define sustainable practices, each with its own green certification. While certification is important, it should not turn into a competitive race to obtain the highest standards at the cost of adopting truly conscious methods.

Energy management & modelling

For energy modelling, steps can be taken to review passive and active strategies, such as use of daylight, natural ventilation, heat insulation, lighting and cooling/ heating systems, moving on to energy management with sensors and building management systems and finally use of renewable energy. I have applied these methods even in remote locations and know that not only is it possible, but it also makes a significant impact on the adoption of sustainable practices.

Many of these principles can be scaled to apply to the design and planning of urban cities and towns, as well as home, to create syncretic environments between work and leisure.

Self-sufficient smart localities

The effects of lockdown have meant that it is essential to create smaller self-contained localities or neighborhoods that can fulfill most daily needs, with facilities within walking/cycling distance to minimize the need of personal vehicles and even mass transit for commuting. By minimizing movement of people across larger distances, we can reduce the chances of contamination and spread of pathogens. As we have seen, calamities can be better controlled in pockets rather than large areas without limiting freedom and movement within these pockets. I would even suggest that each locality should compete in outdoing each other in design creating a melody of spaces.

Smart localities within a finite radius can be equipped with electrical power outlets, broadband connectivity, and sufficient artificial lighting. Neighborhoods can further provide residents with quiet nooks and corners to work out of, while embracing the beauty of nature. This shall be coupled with smart street furniture.

Residences

This article will not be complete without a brief mention of planning of residences to complement the offices design, especially given that homebased work is here to stay.

Designing homes is not easy in any environment, leave alone catering to a pandemic. This is successful only when one has enough space, which is not always the case. Dwellings with higher than normal floor height to enable mezzanine floors can be constructed, so that these areas can be used by family members for homebased work.

To provide natural light and ventilation, the floor plate could be designed around a courtyard concept. Where weather permits, large balconies can be incorporated in the floor plan. Windows must have space to grow potted plants and thus create a green oasis.

Way forward:

Indeed, there are many other aspects of civil engineering which need to be addressed, such as protection of workforce, including organized and unorganized labour. One thought is to consider civil engineering as a manufacturing industry and gravitate towards increased reliance on prefabrication that provides a controlled setting, with all its benefits.

What is clear is that we are at the precipice of change, with many avenues that can be explored. I am confident that the civil engineering fraternity shall rise to the challenge boldly and leapfrog to the next era, much like it has done through the centuries!

Smart Device based Tsunami Evacuation Experience System and Urban Modeling by Imaging Technology

Hiroshi Okawa and Kazuo Kashiyama

The integration of three technologies: high-quality modeling, tsunami simulation, and virtual reality on smart device can ensure a smooth evacuation experience for the residents during natural disasters.

Smart Device based Tsunami Evacuation Experience System and Urban Modeling by Imaging Technology

Introduction

After the Great East Japan Earthquake in 2011, a limitation of human damage reduction by facility-based structural measures has found against natural disasters, and the importance of system-based non-structural measures is reaffirmed. Hazard maps are being prepared and published by local governments in Japan as a system-based measure to protect residents from frequent natural disasters, but in recent years, with the aim of correctly understanding on natural disasters and raising awareness of disaster prevention, the dynamic hazard map to understand the progress of disaster is being prepared and published instead of conventional static hazard map as printed material. In particular, for the evaluation and study of disaster prevention and mitigation measures, evacuation simulation is very important and easy to understand for residents from the point of view of disaster prevention education as well. Therefore, (1) urban and regional high-quality modeling, (2) Tsunami simulation, and (3) Evacuation simulation were performed, and a VR experienced-type tsunami evacuation experience system experiencing on smart device was developed by integrating these 3 items.

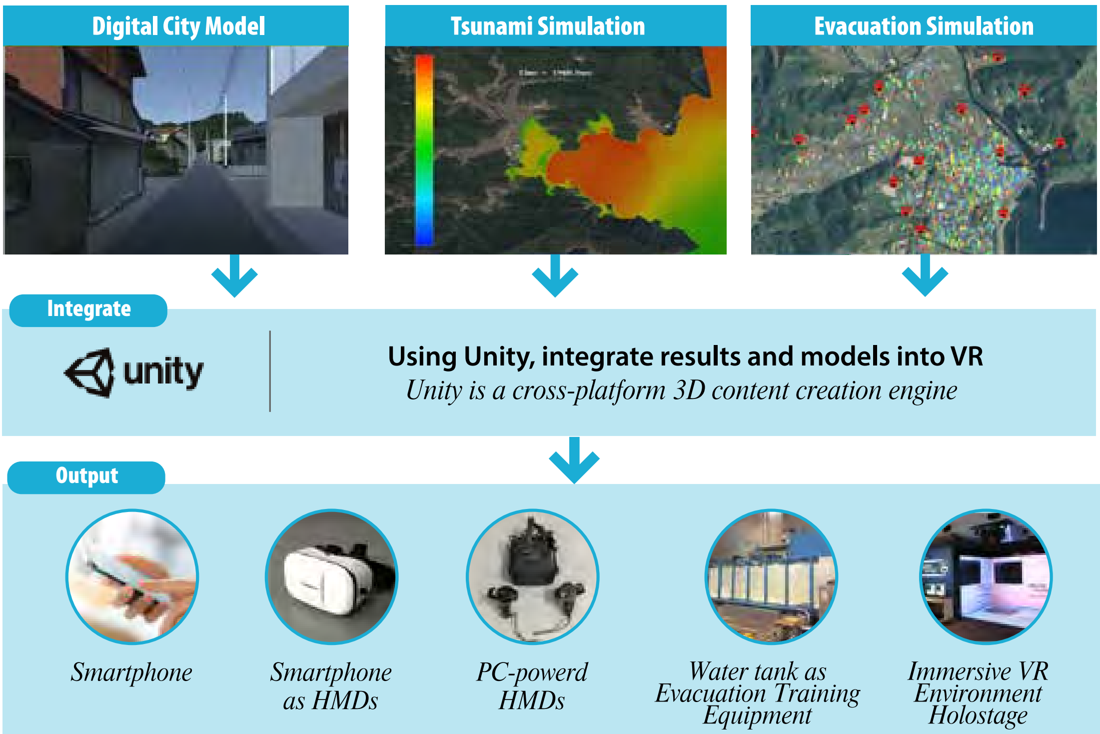


Figure 1: *Outline of the system and its output*

Authors:

Hiroshi Okawa
Eight-Japan Engineering Consultants Inc., EJ Innovation Technology Center

Kazuo Kashiyama
Technical Advisor, Eight-Japan Engineering Consultants Inc.
Professor, Faculty of Science and Engineering, Chuo University, Japan

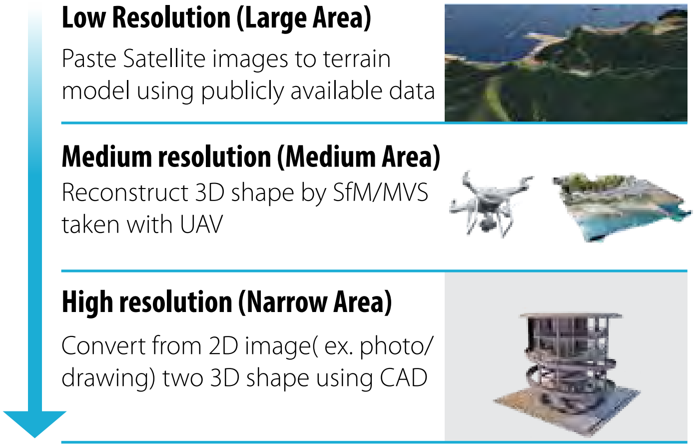


Figure 2: *Methodology of urban modeling*

High-quality Modeling of Cities/ Regions

In the water related disaster simulation such as a tsunami or flood, accuracy of reproduce (modeling) of the target area is important. Conventionally, GIS data containing elevation data has generally been used for topography, and CAD data has been used for modeling of structures. However, although CAD data is effective for expressing artificial objects such as structures, the use of CAD software is not suitable for modeling of non-artificial objects such as trees. Also, regarding the modeling of structures, there is a problem that it's inefficient in terms of time to model the entire building with 3D CAD software.

Therefore, in addition to the conventional GIS / CAD data, we conducted a modeling based on photographic measurement technology (imaging technology) using drones and digital camera images. Specifically, the publicly available terrain GIS data is used to reproduce a large area over a wide area, and the aerial image data acquired by a drone is used to reproduce a medium area composed of non-artificial objects such as trees. For the reproduction of each structure, modeling was performed from digital camera images in addition to 3D CAD software. The target area is Nakatosa Town, Kochi Prefecture in Japan, which is assumed to be damaged by the tsunami caused by the Nankai Trough Earthquake.

Modeling using a drone (middle area)

For the modeling including non-structures such as trees and natural coasts, we use photogrammetry software for modeling based on SfM (Structure from Motion) / MVS (Multi View Stereo) technology and use a drone captured image data.

Specifically, a point cloud model is created and edited using image data taken with a drone, and a 3D mesh is created from them. If there are structures in the area that accurately reproduce the shape, they are deleted in advance. The deleted structure will be created with the 3D modeling software described later, and the final model (see Fig. 3) will be obtained by integrating the models.

Figure 3: *Integrated model*

Modeling using a digital camera (small area)

3D software is used for modeling artificial objects such as buildings. At that time, use high-end 3D modeling software for important structures for which dimensional data can be obtained (see Fig.4),

Figure 4: *Modeling of important structure*

and use digital camera images for buildings with simple geometric shapes such as private houses, the shape was created using a simple 3D modeling software.

The target area for modeling is a typical fishing village with many private houses. For this reason, modeling using digital camera images was frequently used. Modeling using digital camera images is performed by taking pictures of the building from multiple angles and using the photographic data. Specifically, a photograph is input to 3D modeling software, and a shape is created by aligning the feature lines of the structure in the photograph with the coordinate axes of the modeling software and using a trimming function etc.

Figure.5 shows the target area model by this method. You can see that the block modeling is done fairly accurately.

Figure 5: *Modeling of target area*

Finally, the GIS/ CAD data and drone/digital camera data are converted into integrateable data (FBX, etc.), and all models are integrated on Unity, which is an integrated development engine for creating games and 3D contents, to achieve reproducibility. It is possible to create a high-level regional model (see Fig.6).

Figure 6: *Urban model integrated by Unity*

Tsunami Simulation

Using the created terrain model, a tsunami simulation by the stabilized finite element method using the shallow water long wave equation was carried out. This method is a two-dimensional analysis integrated in the water depth direction, and since it is not possible to directly consider the effects of buildings, etc., those effects are considered in the form of a roughness coefficient. For the initial conditions of the tsunami, the amount of water level fluctuation calculated from Case 4 (see Fig.7) of the fault model provided by the Central Disaster Prevention Council of Japan, which is the condition that maximizes the tsunami damage in the area, is used. Fig.8 shows the amount of water level fluctuation in the entire analysis area 240 seconds after the earthquake and the inundation situation 2,400 seconds after the earthquake.

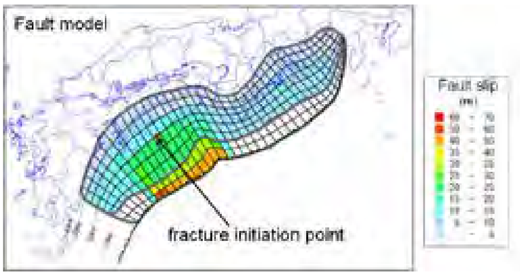


Figure 7: *Fault model*

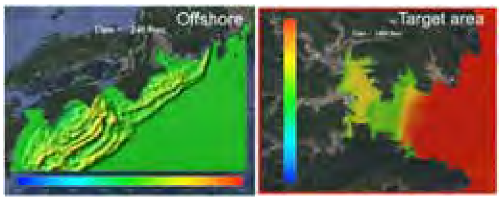


Figure 8: *Simulation result after 240 seconds (left) and 2,400 seconds (right)*

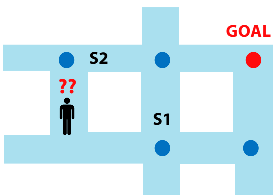
Evacuation Simulation

The flood evacuation system that we are constructing considers the shortest path to the evacuation site, altitude, distance from the waterfront, and hyperactive entrainment bias as factors in determining the evacuation route for evacuees. We also conducted a simulation using a multi-agent system that considered walking speed considering age, gradient, crowd, and fatigue, damage judgment, and the number of people accommodated in evacuation shelters.

A multi-agent system refers to an environment/ aggregate in which a large number of activists who act autonomously according to their own value standards coexist.

$$S_{Utility} = \frac{a}{s^{\alpha}} - \frac{b}{z^{\beta}} - \frac{c}{w^{\gamma}} - \frac{d}{t^{\delta}}$$

Distance from evacuation | Elevation | Distance from Water's front | Majority Synching Bias



Each node has each S

If S1>S2, Evacuees move to S1

S: *Utility (judge larger S)*
a, b, c, d : *Weighting coefficient*
α, β,γ,δ : *Weighting coefficient of distance*
s: *Distance from evacuation site*
z: *Elevation*
w: *Distance from water's front*
t: *Number of people*

Figure 9: *Evacuation route selection*

Age	-14	15-34	35-54	55-64	65-74	75-84	85-
M	1.33	1.47	1.39	1.41	1.32	1.04	0.50
F	1.29	1.44	1.36	1.46	1.48	1.32	0.62

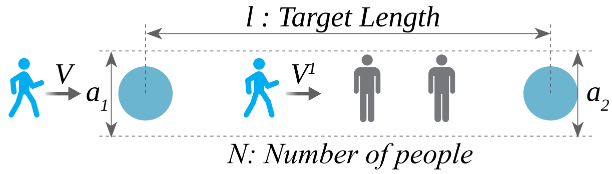


Figure 10: *Walking speed by age and crowding*

Figure 11: *Example of evacuation simulation*

(Top: Initial position of evacuee, Bottom: After 5 minutes from evacuation starts)

This time, the simulation was performed with the range of the target area set to 3,300 m in length x 2,300 m in width, 3,526 pedestrians, and 26 evacuation sites.

Figure 11 shows an example of executing an evacuation simulation. In addition, Figure 12 shows the evacuation start time and the number of victims from the occurrence of the earthquake.

It can be seen that the number of victims increases as the evacuation start time from the occurrence of the earthquake becomes later. As a result, if evacuation can be completed within 10 minutes after the occurrence of the earthquake, the evacuation will be completed without encountering the first wave, and no casualties will occur. However, if you evacuate within 25 minutes of the earthquake, the second wave will flow into the target area, which will increase the inundation area and the number of victims increase sharply.

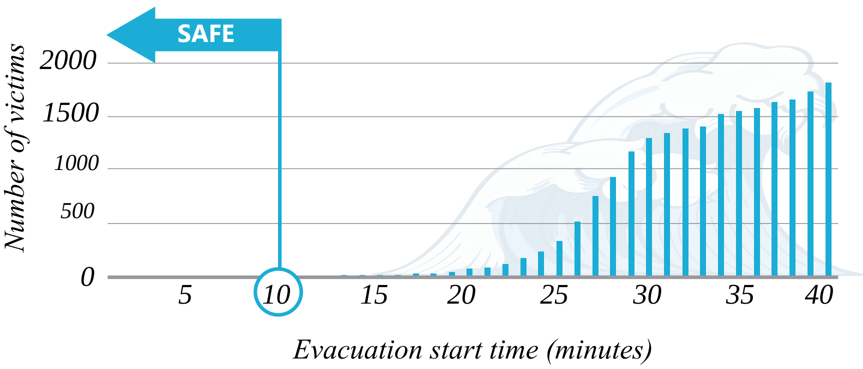


Figure 12: *Relationship between evacuation start time and the number of victims*

Tsunami evacuation experience system from the perspective of evacuees

The results of (1) city / region model, (2) tsunami simulation, and (3) evacuation simulation constructed by the above method were integrated using Unity to create a spherical video from the evacuees' perspective.

Within Unity, we have created a total of 12 humanoid models according to age and gender, which are controlled by the movement history obtained by evacuation simulation. Figure 13 shows how evacuees evacuate within the target area from the perspective of evacuees.

With this visualization function, it is possible to easily view videos from the start of evacuation to arrival at the evacuation shelter and the viewpoint from the evacuation shelter using a smartphone. In addition, by attaching it to a smartphone-inserted HMD (Head Mount Display), it is possible to experience a highly realistic VR tsunami in a situation where it is swallowed by the tsunami.

Figure 13: *View from evacuation site and evacuee*

Conclusion

In this way, we efficiently create high-quality cities and regions model using photographic measurement technology by drones and digital camera images, and build and integrate highly applicable evacuation experience methods with tsunami simulation.

Since it is a system that enables VR viewing even with a single smartphone widely used worldwide, and a more realistic tsunami evacuation experience by using a smartphone-inserted HMD, the degree of understanding of tsunami disasters and disaster prevention. From the viewpoint of raising awareness and disaster prevention education, it is expected to be used and disseminated as a useful tool for easier understanding to residents.

REFERENCE

Kazuo Kashiyama, Hiroshi Okawa: Urban Modeling Using Drone and Digital Camera and Tsunami Experience System; Journal of the Japan Society for Simulation Technology(-JSST), Vol38,No.4,pp.210-214,2019

Application of Crack Detection Algorithm and Unmanned Aerial Vehicle

The core domains of AIT Solutions are structural engineering and software development, and as our team sat together, we discussed on further integration of innovative structural engineering and IT solutions. This discussion led to us to focus on the application of crack detection algorithm and unmanned aerial vehicles. As we further discussed our team was mentored by the experts in Asian Institute of Technology, experts who are at the forefront of developing software's and introducing innovative IT solutions in engineering, knowledge dissemination, and social development areas.

Discussions and mentoring led our team to focus on the periodic inspections that are needed for reinforced concrete infrastructures, to ensure that they are performing as intended. These infrastructures/ buildings experience wear and tear/ deterioration over a period of time. To detect deterioration, cracks are the earliest signs that can be seen on a structure. Interventions needs to be undertaken upon the detection of the cracks to avoid any further damage or deterioration. Currently, the inspections are mostly carried out manually which is time consuming, costly (if infrastructure requires special equipment to inspect hard to reach areas), and ever-present safety concern for the people carrying out the inspection. We thought why not apply the rapidly evolving cameras and UAVs for the inspection of the infrastructures/ buildings. Besides the crack detection, our team decided to go further by assigning severity index to detected crack and suggest the possible intervention that need to be undertaken to address the detected crack.

The System in a Glance

The system that is developed by **AIT Solutions** covers three main steps

Pre-processing

This involves acquiring the images. This is basically done by flying an UAV (drone) over the target area (building/ infrastructure) along its elevation. Once the images from multiple locations are stitched together to form a single image, it is cleaned to remove any unwanted images/ materials from the background, followed by overlaying the elevation to its corresponding elevation in a BIM model.

Crack Analysis

This step involves three main steps i.e., crack detection, crack measurement, and severity analysis. In the crack detection step, the image of each of the structural members is taken as an input. The developed algorithm isolates all the cracks in the images and creates a binary crack map. This binary crack map is then used by the crack measurement algorithm to measure the length, orientation, and coordinates of the end points of the cracks. For the severity index, the in-house developed machine learning algorithm (for which several crack scenarios were created for training it) is used to predict the severity of the cracks. A report is generated that provides details on individual cracks, its severity and recommended intervention that need to be undertaken for maintenance purposes.

Post-processing

In this step the detected cracks are color coded in the original image of the structural element based on their severity value. This helps in visualizing the current state of the structural member in color coded severity index. Each element is tagged with a report that contains the number of cracks, their measurements, severity and the corrective action to be taken for the maintenance of that element.

The developed system is a unique method of utilizing the best of image processing and machine learning techniques to detect cracks as well as to have a periodic monitoring of structures to assess the propagation of the cracks. The developed system goes a step forward by predicting the severity of the cracks and providing recommendation on the interventions that need to be undertaken. The system developed by AITS is a smart and a convenient tool for structural inspection, and the utilization of this by the construction industry can lead to an efficient, economic, and reliable image-based structural inspection/ monitoring system. AITS is currently working including several crack scenarios that account for various structures.

AIT Solutions Services in a Glance

As AIT Solutions embarks with its new brand identity that symbolizes simplicity and stability with a modern outlook, the mission continues to connect with industry and community partners to spread AIT's expertise in engineering, technology, infrastructure, and knowledge transfer activities. Since its establishment in 2010, AIT Solutions (AITS) have provided services as well as collaborated with partners in its core domain of structural engineering and software development. These domains are built upon the extensive research and development conducted by the experts in Asian Institute of Technology. AITS works across the domains of structural engineering and software development as well as allied fields to develop solutions for the industry and government partners.

This section provides a glance over the key services provided by AITS in its core domain of structural engineering and software development.

Structural Engineering

AITS has been involved in over 150 tall buildings projects where it has provided solutions and services on: performance-based seismic evaluation, wind engineering studies, and structural health monitoring.

Performance-based Seismic Evaluation

AITS, together with experts in Asian Institute of Technology, have carried out performance-based seismic evaluation for more than 150 tall and mid-rise buildings in Asia (Philippines, Thailand, India, and Nepal), many of which were reviewed by international third party experts. AITS has carried out PBD for different types of structural systems, some of which do not strictly conform to all prescriptive provisions of building codes and verify that the structure meets the stated performance objectives and provide a level of public safety and overall building ductility requirements equivalent to that of a building that follows the prescriptive building code requirements. Scope carried out by AIT Solutions to conduct Performance-based Seismic Evaluation includes:

- Review of suitability of structural concepts/systems with an objective to achieve good performance and cost effectiveness.
- Advanced modeling of structural system of buildings using state-of-the art modeling and analysis tools.
- Simulation of buildings under different levels of earthquakes, using linear static, nonlinear static and nonlinear response history analysis procedures.
- Evaluation of the performance of building in terms of global response and local components' response.
- Provide recommendations and suggestions on design to enhance the structural performance and cost effectiveness.

Wind Tunnel Testing

Specific to wind tunnel testing, AITS has done several projects in Philippines (Makati, Pasig, Davao), Pakistan (Karachi) and Thailand (Bangkok, Kanchanaburi). In these projects, AIT Solutions worked closely with the various stakeholders (project engineers and developers) to enhance the reliability and cost effectiveness of the structural designs thereby ensuring occupant comfort, façade design optimization, and improving pedestrian comfort. Scope carried out by AITS to conduct Wind Tunnel Testing includes:

- Carrying out wind climate study with several statistical analysis, together with the historical wind speed information obtained from the local weather stations and roughness changes experienced by the wind passing by the proximity buildings.
- Developing physical models of target building and surrounding buildings within 400 m radius from target building.
- Conducting structural load study tests for target building.
- Conducting cladding pressure study tests for target building to measure the local pressures on the exterior surface of the building.
- Conducting environmental wind tests to measure the wind velocity at the pedestrian height at various critical areas that include ground and amenity floors.

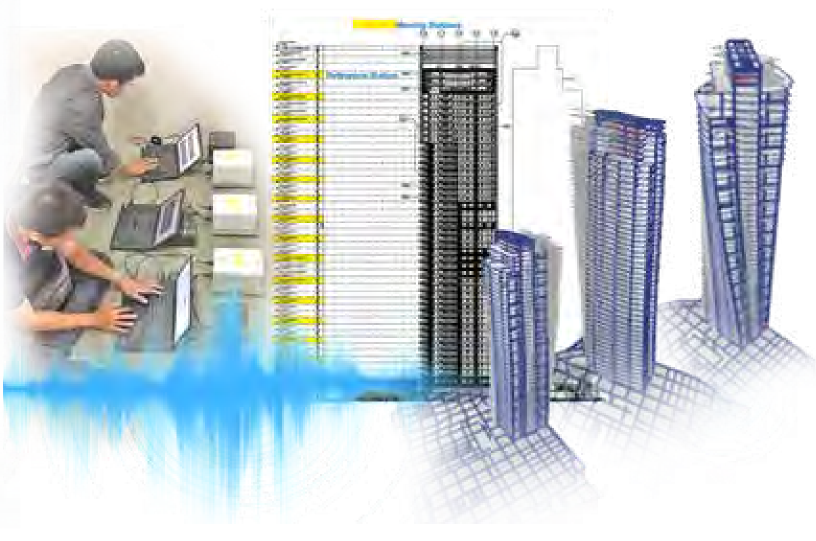
Structural Health Monitoring for Tall Buildings

The Structural Health Monitoring (SHM) for Tall Buildings provided by AITS is an automated and integrated system for assessment of structural health of the buildings. The solution works on the components of Calibration, Input, Analysis, and Output.

The "Calibration" part of the solution consists of measurement of the dynamic properties of the building at the site with portable sensors to determine the vibration modes and frequencies of the building. This information is used as benchmark and calibrate the computer models to represent the behavior closely with actual building.

The "Input" part comprises of the structural models, pre-event damage information, sensor data, seismic event information, and architectural and structural drawings. The "Analysis" part is divided into basic post-processing and detailed analysis based on which the "Output" is generated in the form of reports for Project Developers/Owners, Buildings Managers, and Structural Engineers. This solution provides answers to questions such as:

- What is the current structural health of the building?
- In case of an earthquake, what is the level of damage that may occur?
- Can the building continue to serve its intended function after an event?
- Does the building require any immediate repair/ retrofitting?
- How do the various buildings compare in the overall network comparison?



Benefits to various parties include:

Parties	Information through AITS SHM
Developer	• Information on the current structural health of the building. • In case of an event, information on post-event condition of the building and the expected level of damage. • Recommendations on the need for repair/ retrofitting. • Predict the level of damage in case of a future event. • Relative performance of different buildings in the network.
Building Managers	• Detailed report on the current structural health of the building. • Detailed report on post-event response of the building.
Structural Engineers	• Relatively detailed assessment of the magnitude and location of the actual damage incurred in the building to help improve the design of the buildings and validate buildings safety
Residents	• An assessment of safety conditions. • Immediate occupancy status.

Software Development & IT

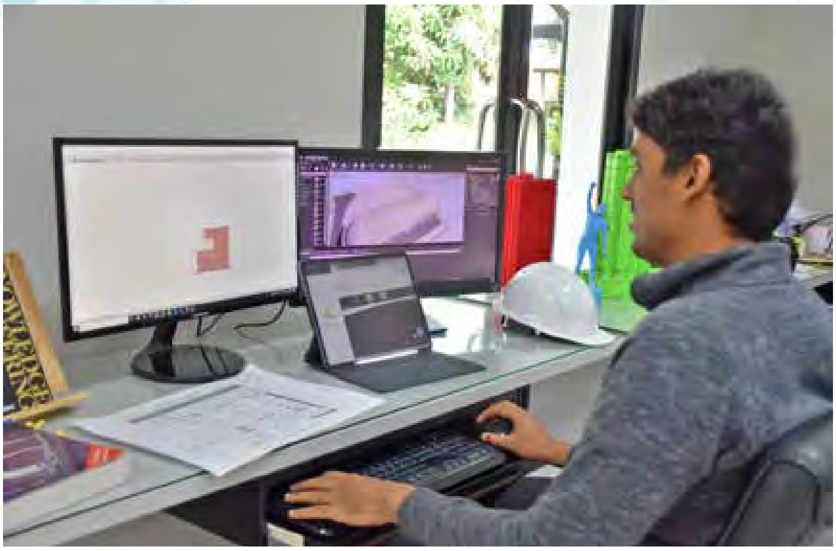
AITS in-house team has collaborated with several leading industry partners to research and develop software solutions in the field of structural engineering, mobile computing, knowledge products, construction monitoring & management, travel & leisure, and smart living. AITS develops customized desktop, web, mobile and cloud-based applications to fulfill the needs of partners and clients. To provide customized solutions, AITS team collaborates with partners & clients to:

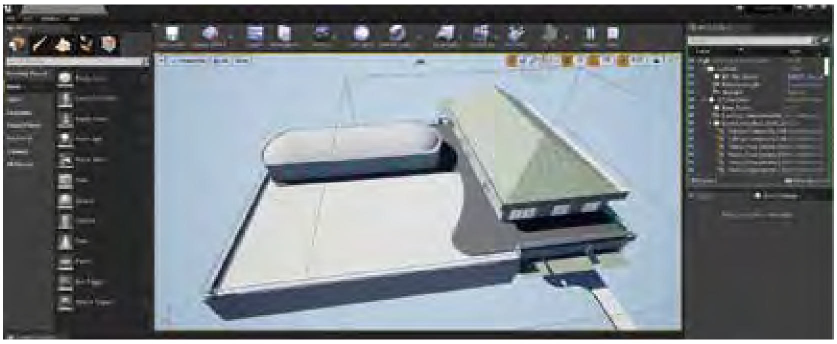
- Conduct Research & Analysis: which involves preliminary study of the existing market and future trends.
- Design: this involves designing and reviewing of software user interface and required features.
- Gather Requirements: this focuses on reviewing the existing software and application of the partner/ client, based on which the required software specifications are defined.
- Development, Testing, and Deployment: once the features are developed by AITS team, it is tested and delivered periodically such that the partner/ client can operate it as well as provide feedback for further updates and/ or customization.
- Track & Monitor: Upon handing over the developed solution/s, AITS continues to support the partner/ client by periodically tracking and monitoring the deployed software.

Building Information Modeling (BIM)

The Computers and Structures, Inc. (CSi), the pioneering leader in software tools for structural and earthquake engineering, partnered with AIT Solutions to establish CSi BIM Lab at AIT for the advancement of the application of BIM in various aspects of building design, construction, management and operation. BIM Lab team carries out the research and development of platform and tools to read and check the different data format of BIM models as well as development of BIM models from scanned data. The team at AITS supports it partner and clients by:

- Developing 3D BIM models, which focuses on transforming 2D drawings to 3D BIM from the provided drawings.
- BIM clash detection.
- BOQ and quantity take-off from highly detailed BIM models.
- Developing plug-in tools to read and check the different data format of BIM models
- Developing BIM models from scanned data by drones





Besides the services mentioned above, AITS is actively focusing on transferring the knowledge generated during the application of research at AIT in real projects. This knowledge transfer activities is delivered through:

- Seminars on the latest trends in the field of structural engineering.
- Workshops focused on knowledge dissemination for equipping practicing engineers with the relevant skill sets.
- Professional Master Degree Program – a collaboration with academia and the industry.
- Customized short-term trainings for practicing engineers on topics such as Performance-based Seismic Design, and understanding tools and techniques in using CSi software.

To know more about our services, knowledge transfer activities, collaboration activities kindly contact us at solutions@ait.ac.th

Revisiting the Conventional Structural Engineering Education in Post-COVID Scenario: The New Normal

Fawad Ahmed Najam

With a growing exposure of students to easily accessible internet resources and online educational tools, the traditional one-way approach of delivering knowledge seems no longer effective.

Revisiting the Conventional Structural Engineering Education in Post-COVID Scenario: The New Normal

The world is passing through a big transformation in the ways we interact, communicate and collaborate. The global impact of COVID-19 on almost all sectors (including health, economy, and education) is multi-layered and has long-term consequences. With the termination of on-campus activities at schools, colleges, and universities, the academic sector worldwide is directly affected by this pandemic. The educational organizations are forced to shift to the online learning mode as a replacement for in-class face-to-face lectures. The universities have now shifted from the conventional schooling process to the online and e-learning platforms so that the students may continue their education from home. This so-called COVID-driven shift has several aspects and implications which may permanently alter the way we learn and teach new concepts and technologies. This article explores how this *new normal* has impacted professional education in general and structural engineering education in particular.

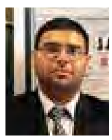
Learning is a social process that proceeds by and through conversations and is constructed mainly by the learners themselves. In the traditional model of a classroom, the instructor uses his/her presentation skills along with audio-visual aids to transfer complex concepts to his students. However, recent teaching practices have now drifted away from this conventional model. Nowadays, with the advent of online educational tools and with growing exposure to easily accessible internet resources, this one-way approach of delivering knowledge is no more effective. Today's classrooms need to be more interactive, alive, and collaborative to fulfill the educational needs of the students. Instead of traditional ways of problem-solving, engineering instructors nowadays are trying to equip their students with the development and use of efficient programming codes, software, and advanced computational tools. Several studies have shown that the instructional approaches based entirely on self-paced computer assistance are extremely effective. The development of online tutoring systems provides a new way to harness and exploit the educational potentialities of computers keeping in mind the social dimensions of the learning process. The goal of an intelligent tutoring system can be expressed as its ability to customize or rather individualize the learning process.

In this shifting paradigm from conventional teaching methodologies to the information technology-based learning environments, the current situation has expedited this transformation. It has converted the use of online learning management and assessment systems from "just an option" to "a need". Turning this challenge into an opportunity, many educational organizations have converted their teaching content and resources into online formats which can be readily and globally available to the learners. Several educational courses and training materials are shifted permanently to the online delivery mode providing an opportunity to a wider audience that can now learn at their own pace and convenience. This shift is redefining the process of skill development in several fields of professional education including engineering and information technology. Let's take the example of civil and structural engineering. This profession has come a long way from its conception and diverse history spanning over several centuries. The process of structural proportioning and design has been rightly recognized as one of the world's oldest expressions of art and engineering in human history. Therefore, the story of this profession is considered as old as the story of human civilization.

Nowadays, structural engineers are capable of simulating the close-to-real behavior of buildings and bridges made with a variety of innovative materials and having complex shapes and sizes. They are embracing the fruits of recent discoveries and developments in information technology. This has opened a variety of new possibilities where structural engineers can completely change the way we live in today's society. The story which may have started from "an intuitive use of a wooden log to cross a waterway" has now evolved into the "explicit consideration of multidimensional loadings applied to highly sophisticated computer models". This shift-although was inevitable considering a huge knowledge explosion in IT-related fields in recent years-has been expedited by the recent COVID situation. In the context of structural engineering education, let's split the discussion based on the following two important aspects of professional learning.

Several studies have shown that the instructional approaches based entirely on self-paced computer assistance are extremely effective.

Author:



Fawad Ahmed Najam
Assistant Professor
National University of Sciences and Technology

1) Conventional Schooling: From in-Class Lectures to Online Learning Sessions

The conventional structural engineering curriculum covers a broad spectrum of concepts and activities including the conception, selection, and design of structural systems suitable for a particular application. The development of these skills also requires coordination and collaboration with several other disciplines such as architects, mechanical and services engineers, electrical engineers, and geotechnical engineers. These skills require an extensive, rigorous, and efficient instructional system and curriculum in universities.

A large part of the existing curriculum comprises calculations and solutions to numerical problems. This is a basic cognitive process and generally requires direct and constant interaction of students with instructors. In such cases, the use of pre-recorded online sessions may not be an effective replacement for in-class lectures. In fact, one of the important roles of technology in the learning process is to assist the mentors in their effort to facilitate interaction. Therefore, the first challenge for instructors is to get themselves familiarized with the capabilities and tools available in the conventional video conferencing software used for online teaching. Besides the audio-video calls, nowadays many features and tools are available in mainstream online learning environments to facilitate a live interaction between participants. These include the facilities e.g. sharing multiple screens with all participants, controlling the mouse cursor and digital writing pen by multiple participants, group chats, markers, and digital indications to start an interaction with the instructor or asking a question, etc. Using multimedia (images, videos, sounds, and animations), an instructor can also develop" learning objects"to covey a concept. Learners can then explore these digital learning objects in dynamic and interactive ways at their own pace, instead of following the textual instructions. All these features are rapidly bridging the gap between the online mode of lecture delivery and the direct face-to-face class instruction in the learning process.

Software-based learning environments provide an opportunity for students to investigate, visualize and discuss their own ideas and explanations of various engineering principles being taught as curriculum.

All around the globe, various interactive learning systems are being developed aiming to provide state-of-the-art knowledge as per the convenience and need of the learners. Several amazing technologies and cutting-edge research outputs are about to revolutionize the way we learn and interact with our environment. Various hardware (e.g. the headset computer, smart glasses, etc.) developed based on the augmented reality are already available in the market with brilliant applications. Imagine that in the future you may have the facility of scanning a bar code through your eyes to additionally watch, interact or know what exactly you are looking at. Similarly, imagine that by just looking at a structure, you may be able to virtually visualize its deflected shapes or mode shapes in real-time. This may be the future of structural engineering education.

2) Development of Problem-solving Skills: The Role of Software-based Education

One of the direct impacts of IT-related fields on structural engineering practice over the last several decades is the availability of highly efficient and faster computing tools. The computational cost has almost exponentially reduced over the last two decades resulting in the development of faster numerical solvers. The introduction of cloud computing is soon going to revolutionize the conventional practice of structural analysis. A similar development is happening in the computing paradigm with a special focus on visualizing the results of structural analysis and simulations. The widespread use of intranet, internet, and more recently cloud computing is changing the way computers are being used, and the information is being shared and stored. Although this rapidly growing automation is often been accused of making the practicing structural engineers a bit inattentive, their efficient use is continuously resulting in the construction of miraculous engineering facilities.

On the other side, the world is also facing rapidly growing construction needs and infrastructural requirements. Many densely populated cities around the globe are facing challenges in the provision of safe and quality housing facilities to their residents. In order to take up some of the future challenges, we need to train the next generation of structural engineers in a manner that they are well-conversant with the latest software, computing facilities, and tools. One of the efforts required in this domain involves the integration of structural engineering software training in several undergraduate and graduate-level courses. Software-based learning environments provide an opportunity for students to investigate, visualize and discuss their own ideas and explanations of various engineering principles being taught as curriculum.

Frontiers of Software-based Learning and Applications in Structural Engineering

In order to provide an idea of where the technological advancements are heading, here we enlist a few areas and ideas having the potential to completely revolutionize the conventional structural engineering practice. A software-based education-as facilitated by the online learning environments and tools-is an essential future requirement to acquire and adopt these technologies. A quick realization of this requirement may hold the key to solve many real-world problems and challenges.

a. Artificial Intelligence and Machine Learning in Structural Engineering

Like all other technological fields, the use of artificial intelligence and machine learning has also profound applications in structural engineering. For example, the so-called "past experience" can be effectively replaced in the future with an intelligent learned system capable of a priori prediction of structural demands. An advanced version of such an intelligent system in the future may even qualify to bypass altogether the conventional process of structural analysis.

b. Automation in Construction Industry

In the 21st century, a building is perhaps the only consumer product left which we humans still mostly make with our hands. The use of 3D printing is another area where structural engineering can "stand on the shoulders of giants". The applications can be endless, ranging from the automated concrete printing of individual components to the printing of reduced-scale shake table or wind tunnel models of structures. Apart from direct applications in the field, the use of 3D-printed models can also be very handy for instructional purposes, e.g. to convey educational concepts, like the deflected shapes, mode shapes, complex detailing of reinforced concrete elements, etc.

c. Virtual Reality and Augmented Reality in Structural Engineering

Structural engineers of the future may be able to virtually enter and live into their structures before even they are constructed. The applications of augmented reality in structural engineering may range from a convenient construction monitoring of structures on one hand, to understand the feelings and lifestyle of the inhabitants on the other hand. Before the actual construction of a tall building, the future engineers may be able to first it in a virtual reality environment (created for exactly the same location) and study the socio-economic impacts of that building on its surroundings.

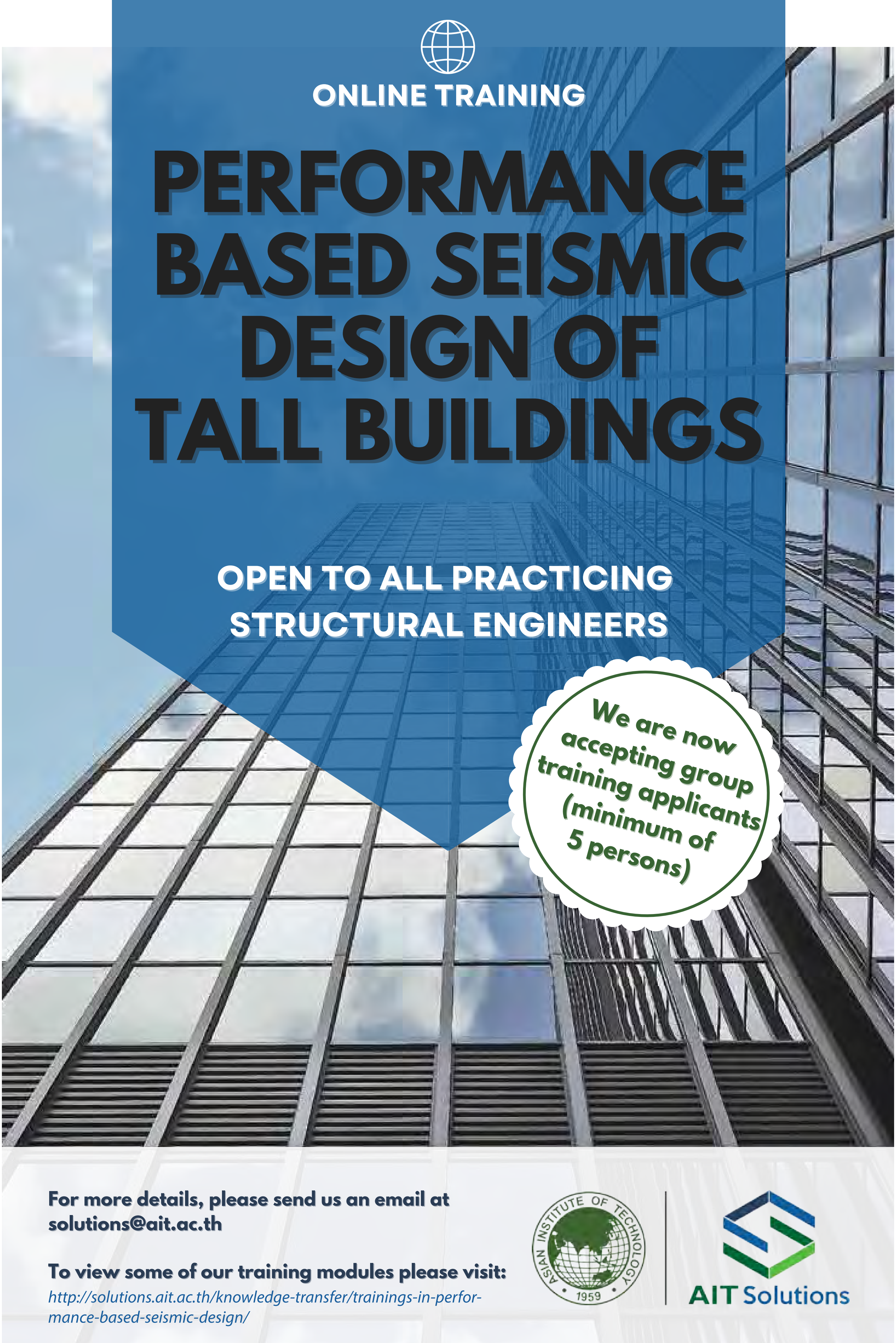
d. Drone-based Laser Imaging and Structural Modeling

Another exciting area is the use of drone-based imaging and photogrammetry to construct 3D models of existing structures. An automated system for constructing the detailed finite-element models using the captured drone images may completely mechanize the process of structural analysis. Structural engineers of the future may have to develop a completely different set of capabilities compared to what is required nowadays. A combination of 3D printers, intelligent robots, and automated decision-support systems in the future may partially replace several jobs and activities of structural engineers.

e. Automated Structural Assessment in Post-disaster Scenarios

Another important area where the use of IT-related products (especially the use of advanced sensor technologies) can be beneficial to structural engineering is the automated post-disaster assessment of the structures. The recorded signals from sensors during any disaster (e.g. the recorded response acceleration during an earthquake) can be fed as an input to expert computing systems. Such systems may be trained to assess the structural condition in real-time and to predict the expected performance in case of future events. We already have smartphones, smart TVs, and smart cars. The development of smart structures in the future would be a major development in the construction industry. The future structures may be adaptable and intelligent enough to effectively mitigate the effects of imposed excitations.

Apart from various wider technological areas mentioned above, few individual ideas also have the potential to bring a breakthrough in our understanding of the structures. One such example is the use of "visual vibrometry" i.e. to extract the modal properties (and therefore the structural characteristics) by analyzing the recorded video of an existing structure vibrating in ambient conditions. The ground-breaking works have already been conducted at MIT where a team of researchers has successfully able to develop a system that can analyze the mute video of an object vibrating due to striking sound waves. The system can trace back the original audio that was being played or spoken during the video recording. The same underlying theory is now being used to determine the characteristics (e.g. stiffness) of structures by

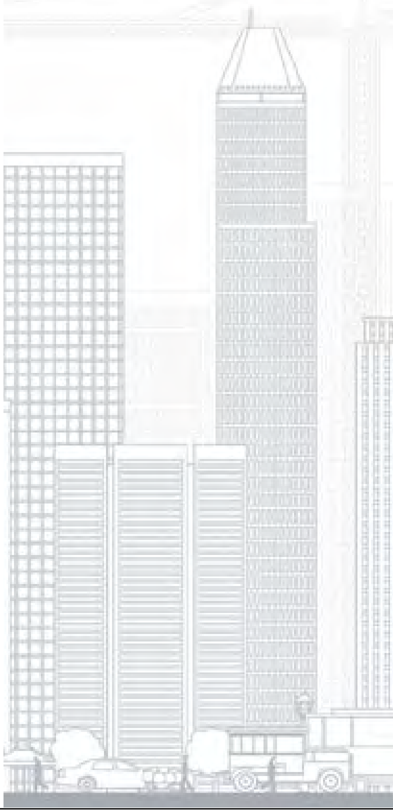

ONLINE TRAINING
PERFORMANCE BASED SEISMIC DESIGN OF TALL BUILDINGS
OPEN TO ALL PRACTICING STRUCTURAL ENGINEERS
We are now accepting group training applicants (minimum of 5 persons)
For more details, please send us an email at solutions@ait.ac.th
To view some of our training modules please visit:
http://solutions.ait.ac.th/knowledge-transfer/trainings-in-performance-based-seismic-design/
ASIAN INSTITUTE OF TECHNOLOGY 1959
AIT Solutions

Another important area where the use of IT-related products (especially the use of advanced sensor technologies) can be beneficial to structural engineering is the automated post-disaster assessment of the structures. The recorded signals from sensors during any disaster (e.g. the recorded response acceleration during an earthquake) can be fed as an input to expert computing systems. Such systems may be trained to assess the structural condition in real-time and to predict the expected performance in case of future events. We already have smartphones, smart TVs, and smart cars. The development of smart structures in the future would be a major development in the construction industry. The future structures may be adaptable and intelligent enough to effectively mitigate the effects of imposed excitations.

Hybrid Mode of Learning for Professional Education – An Example of PMTB Degree Program at AIT

The fundamental idea of interactive learning is to help learners become actively engaged in collaborative work via various computer-supported processes. The example of "digital libraries" is quite obvious which has completely changed the way students can search and use resources in traditional libraries. Similarly, in the current pandemic situation, many international conferences and educational events are being conducted in fully online mode. This is changing our perceptions and expectations associated with traditional conferences, seminars, and similar events. Realizing this ongoing shift and need in structural engineering education, the Asian Institute of Technology (AIT) has designed and developed a world-class Professional Master Degree Program in the Structural Design of Tall Buildings (PMTB). This program delivers practical experience in this educational domain using a blended learning approach (i.e. online learning environment + in-class training sessions). The program is designed for the practicing structural engineers by the experts involved in tall buildings projects and having an extensive professional experience. In order to facilitate the online part of the learning process, a networked information environment (AIT Share) is developed and the users are allowed to access information and educational resources anywhere and anytime. The curriculum is designed to be aligned with industry trends and is delivered using AIT Share system to facilitate flexible learning. The courses and their contents consist of high-quality digital learning resources which are delivered under the supervision of course instructors. In the face-to-face (in-class) part of the program, the students get a chance to meet, interact and learn from the faculty and practitioners at AIT's campus in Thailand to facilitate applied learning. The program also provides an opportunity to its participants of having hands-on project experience at leading structural engineering/ infrastructure companies. This results in the most effective use of time and resources for professional development without compromising on job commitments. The participants of this program also have the access to AIT's extensive knowledge products, research programs, project experiences, labs, and professional network.

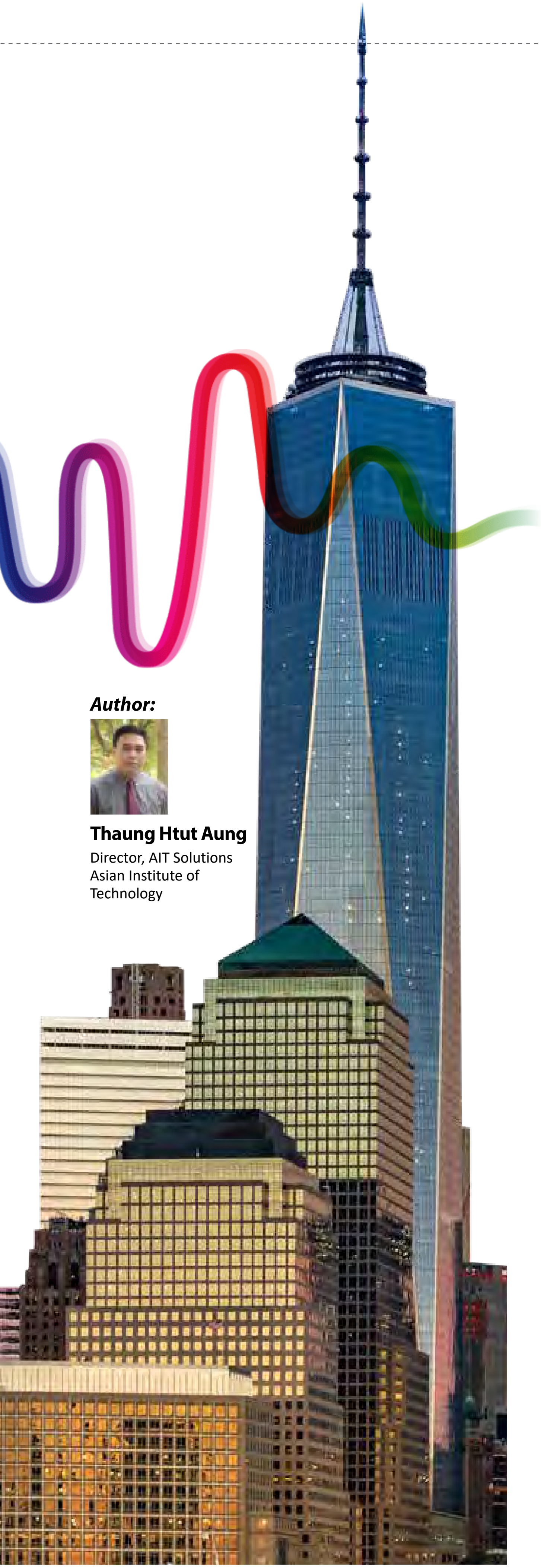
It's high time for structural engineers to come forward and embrace several exciting and emerging ideas to advance their profession. Many fields and professions are already being benefitted from these ideas. The structural engineers, who were once among the first to innovate and developed trust in their intuition, should again be the flag-bearers of knowledge and innovation. They should be part of all future efforts which are going to transform the art of living. The story which may have started from "an intuitive use of a wooden log to cross a waterway" will continue; since it is not just the story of structural engineering, it's the story of our civilization.



Resilience-based Design: The Next Level of Seismic Design

Thaung Htut Aung

Resilience-based design assesses the performance quantitatively in holistic approach in terms of structural and nonstructural components damage, casualties, repair cost, repair time and environmental impacts to enable swift recover post major earthquake.



Resilience-based Design: The Next Level of Seismic Design

Author:

Thaung Htut Aung
Director, AIT Solutions
Asian Institute of Technology

In the current practice of seismic design, safety is primarily considered to measure the performance of the structure. The recovery of the functionality of the structure, resilience, is not well addressed in the current design approaches. To quantify the functional recovery, time is the key component to gauge how fast to return to basic functionality of the structure. In buildings, functional recovery is not only restoration to allow safe re-entry for the purposes of providing or protecting building contents but also to support the occupants with basic functions and utilities such as water, electricity, natural gas, sewage and sanitation.

Although today's performance-based seismic design approaches assess the structural performance of the buildings explicitly for different levels of earthquakes, post-earthquake functionality and consequences are not evaluated in the design process. In extreme earthquake events, although the global and local responses of structural system of the buildings are generally checked to prevent the total or partial collapse of the building, the extent of damage to nonstructural components, building contents, repair time and cost and casualties are not specifically analyzed.

In considering the resulting consequences due to earthquake, methodology mentioned in FEMA P-58, precursor guidelines of resilience-based design, assesses the performance quantitatively in holistic approach in terms of structural and nonstructural components damage, casualties, repair cost, repair time and environmental impacts. For environmental impacts, it is assessed embodied carbon and embodied energy associated with production of construction materials which are used to repair or replace the building.

To evaluate the above-mentioned key indicators, not only the seismic input and information of behavior of structural components but also the information of vulnerability of non-structural components, building contents, occupant population, estimated construction time and materials required for repair or replace the building after earthquake are required.

Together with the additional information and data which will be considered in next generation seismic design approaches, uncertainties associated in the performance assessment is also significant. In the current performance-based seismic

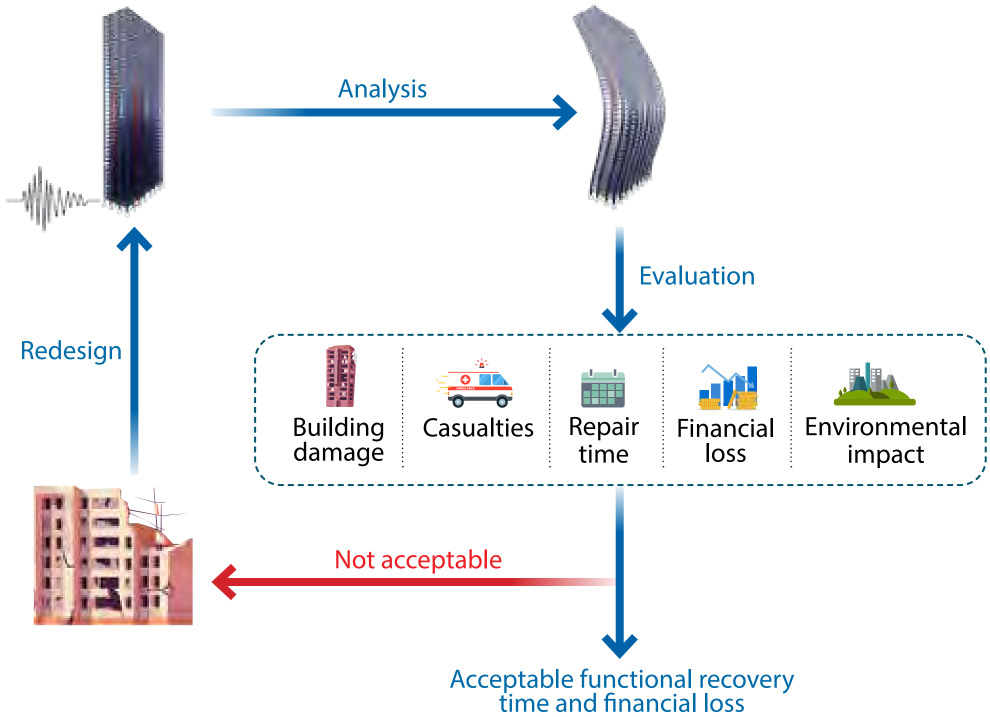


Figure1: *Resilience-based Design Process*

design approaches, uncertainties mainly come from seismic sources in which the intensity, spectral shape, and the time when the earthquake will occur. In structural modeling and analysis side, although analysis tools and computing power of computers are dramatically improving, there are still uncertainties left in the assumptions of material properties, construction quality, modeling approaches such as soil-structure interaction, damping, common ignorance of non-structural components in the structural model. Considering the response and behavior of non-structural components, occupancy information and post-earthquake retrofit, the uncertainties will be increased. Tested behavior of sample non-structural components in the laboratory and the types of non-structural components used in actual building may not be identical. Furthermore, number of occupants inside the building at the time of earthquake happens cannot be well estimated. Availability of labor and materials, efficiency of contractors and accessibility of the building for post-earthquake retrofit are also uncertain.

To deal with all those uncertainties, probabilistic simulations are required to measure the performance of the building and impacts after earthquake. In FEMA P-58 methodology, performance functions are used to present the probability of incurring earthquake impacts such as number of casualties, amount of component losses, repair cost and construction time for repair. In general, seven to eleven sets of ground motions are used in nonlinear response history analysis of current performance-based seismic design approaches to compute the global response (story drift, displacement, velocity and acceleration) and local response of structural components (deformation and force demands). To predict the earthquake impact and consequences for resilience assessment, a large number of simulated demand sets (hundreds to thousands) from structural analysis is required for reliable outcome. For practical purpose, FEMA P-58 methodology uses Monte Carlo simulation in which demands from limited number of analyses are mathematically transformed into a large series of simulated demand sets.

To predict the earthquake impact and consequences for resilience assessment, a large number of simulated demand sets (hundreds to thousands) from structural analysis is required for reliable outcome.

From the perspective of seismic input, the building is subjected to an earthquake scenario, considering the specific magnitude of historic earthquakes in the specific region where is building is located in the current performance-based seismic design procedures. In that scenario-based assessment, the performance of the building is evaluated in the event that is identical to the past earthquake event, or probable future earthquake events. In future practices, the building will be assessed not only for the scenario-based, but will also be based on a specified earthquake intensity requested by the building owner or evaluation of its performance over a specified period of time (e.g. 10 years, 20 years or 30 years) based on the intended usage life time of the building. Those time-based assessments are beneficial for existing buildings, considering the probable magnitude and location of future earthquakes within pre-defined duration.

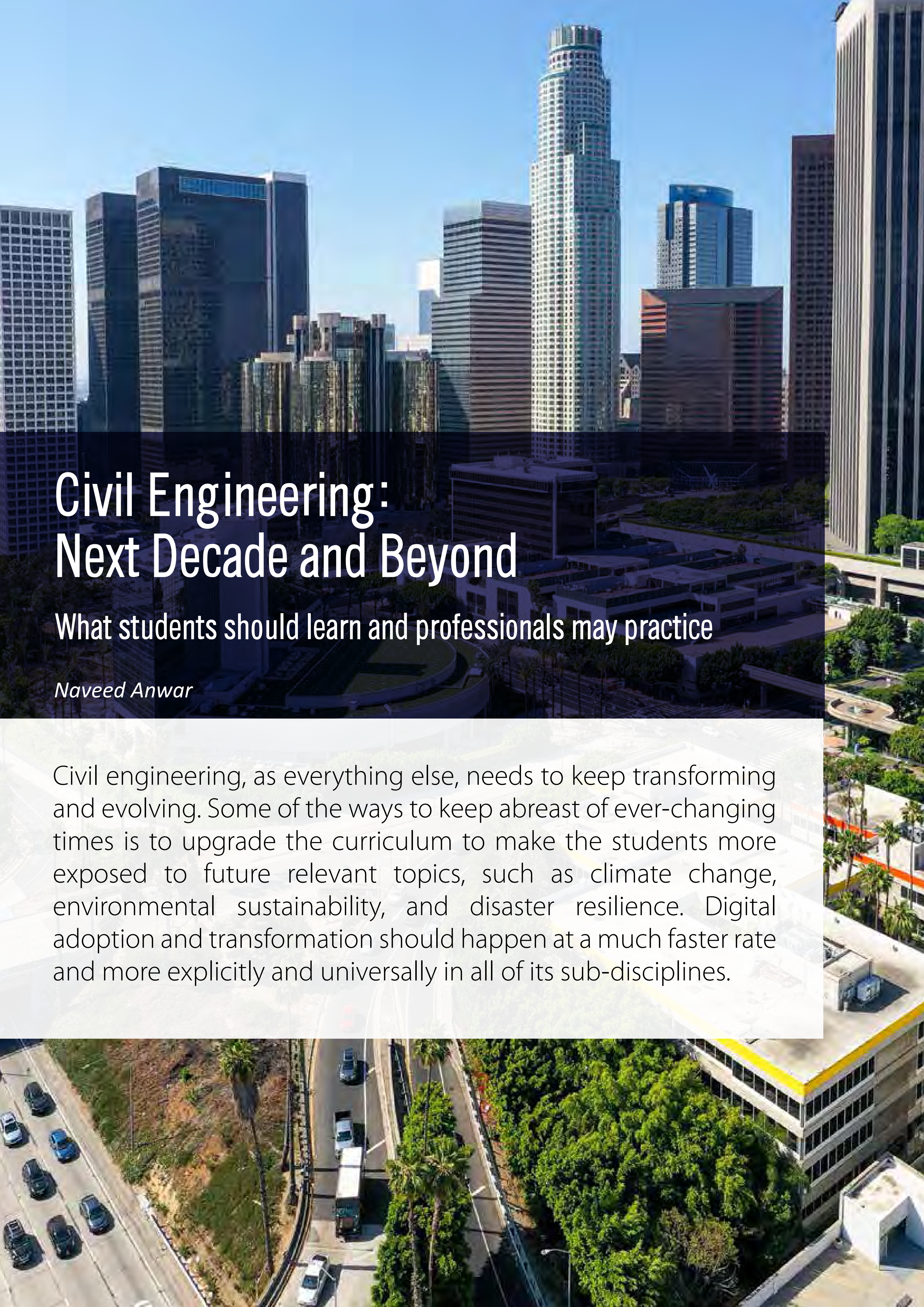
Presently, structural engineers assess the performance of the building using linear or nonlinear analysis procedures for scenario-based earthquakes to determine the base shear, base moment, transient drift, residual drift, lateral displacement, story acceleration, inelastic rotation and strain in ductile failure mode of structural components and force demands in brittle failure mode of structural components to check against the strength capacity. Design decisions are made using those demand parameters to determine the sizes of the structural members and reinforcement. In resilience-based design, those analysis results will not be final outcome for design decisions. They are just the outcomes in the midway of design process and tremendous amount of assessments need to be carried out further in order to quantify the consequences of earthquake and functional recovery.

Structural engineers need to handle enormous data of building information, occupant intensity, repair timeline apart from the structural components in design stage. Interpreting and evaluation of the data to achieve the sensible results is crucial in the process to make final design decisions. Basic knowledge and understanding of mechanical, electrical and piping systems in the building and estimates of architectural components and building contents would be helpful in assessment of the impact of earthquakes. Close coordination with the developer, architect and other engineering consultants in the design stage is essential to develop the reliable database of the building information for the assessment.

In addition, structural engineers need to be equipped with knowledge and skill sets in the areas of probabilistic simulations, risk assessment, usage of big data, application of BIM and holistic thinking and planning practices. Innovative and resilient structural systems, such as mechanical damping devices, rocking connections by prestressing are required to be researched so that it meets with the practice in order to avoid the disposable buildings. In quantitative measurement of cost-efficiency of resilience-based design, developers, engineers and architects will also need to move away from short-sighted focus on up-front construction cost in favor of entire life-cycle costs which considers the total cost of an asset over its life cycle including initial capital costs, maintenance costs, operating costs and the asset's residual value at the end of its life.

In addition, structural engineers need to be equipped with knowledge and skill sets in the areas of probabilistic simulations, risk assessment, usage of big data, application of BIM and holistic thinking and planning practices.

Resilience-based design will be the next level of structural design approach that structural engineers will embrace in near future to ensure that the next generation buildings and infrastructure systems besides meeting the nominal expectations, also has the resilience to perform during its exposure to natural hazards as well as the ability to rapidly recover from it.



Civil Engineering: Next Decade and Beyond

What students should learn and professionals may practice

Naveed Anwar

Civil engineering, as everything else, needs to keep transforming and evolving. Some of the ways to keep abreast of ever-changing times is to upgrade the curriculum to make the students more exposed to future relevant topics, such as climate change, environmental sustainability, and disaster resilience. Digital adoption and transformation should happen at a much faster rate and more explicitly and universally in all of its sub-disciplines.

Civil Engineering: Next Decade and Beyond

What students should learn and professionals may practice

Back in 1975, when I was about to complete my college education, equivalent to 12th grade in most countries, I was, like most of my classmate and friends, faced with an important crossroad. The next stage of education, and choices of subjects for the undergraduate study would determine the career path for the rest of the life. In those days, if one has studied science in the first and second year, and done relatively well, the most preferred choices were either medicine or engineering. In my case, I had not taken biology as the minor, but chosen mathematics instead, which basically eliminated the option to pursue a medical degree, and the only preferred path seemed to be was to go for an engineering university and select one of several options. At that time civil, mechanical and electrical engineering were the most highly sought after followed by several others, including architecture and town planning. My interest and inclination had always been towards "design" aspects, or to make things, so I was leaning towards mechanical engineering or architecture. But as fate would have it, I made civil engineering as my final choice for undergraduate, then leading to structural engineering as specialization in master and doctoral studies.

It has been nearly 45 years since I have been studying, practicing, teaching and interacting in various aspects of civil engineering, gradually and sometimes narrowly focusing on structural engineering. During this period, I have recognized that civil engineering and structural engineering are really the backbone of the built infrastructure. Practically anything built for any purpose has some aspects of civil engineering behind it. It's hard to think of any other disciplines that can operate or function without the civil engineering providing the buildings, structures or other physical infrastructure needed for it. When thinking about what civil engineering discipline will look like in next decade and beyond, what the civil engineers will or should learn and practice, I am inclined to think of several challenges and opportunities that our profession may need to embrace if it has to maintain its fundamental place in the built environment and remain relevant to the humankind and other life in the rapidly changing world.

Climate Change

The first and foremost is climate change, both the adaptation and mitigation aspects. Most of civil engineers have not been taught or exposed to the aspects of civil engineering that directly affect and contribute to climate change and the fact that it is one of the fundamental disciplines that can help to adapt and mitigate the effects. The design and construction of any and all infrastructure, be it dams, water resource management system, irrigation systems, bridges, roads, tunnels, buildings, or any other physical structure, climate change should be a key consideration. Creating the understanding for civil engineers, in and all of its sub-disciplines of paramount importance.

Environmental Sustainability and Disaster Resilience

The second closely related aspects are the environmental sustainability and disaster resilience management. In big scheme of things, every built infrastructure, which is within the overall preview of civil engineering, effects the environmental sustainability either as a cause or an effect. The carbon footprint of the materials used in construction is well known, and the environmental impacts of the infrastructure projects have

The design and construction of any and all infrastructure, be it dams, water resource management system, irrigation systems, bridges, roads, tunnels, buildings, or any other physical structure, climate change should be a key consideration.

Author:

Naveed Anwar, Ph.D.
Vice President for
Knowledge Transfer, AIT

gained increasing scrutiny, and have become an essential part of project evaluation. In the same way, almost every built infrastructure has some relation to disaster resilience. Be it from natural hazards such flood, hurricane, earthquake, or manmade due to fire, overload, or inappropriate design. Every decision made by the designer of the infrastructure project, every step taken during the construction and every system and process adapted during its operation and management affect both the environmental sustainability and the disaster resilience of not only the structure but of the communities they serve. The teaching and practice of almost all civil engineering discipline should and will need to explicitly recognize this, if not already done at some level.

Digital Adoption and Transformation

We are all well aware of the impact of the new technologies and developments such as extensive use of data mining and analytics, business intelligence, various forms and facets of Artificial Intelligence, proliferation IoT, increased use of robotics, and the potential integration of AI with biology and nano devices in many areas. Civil engineering in its broad spectrum and specifically certain specialization within, have been using traditional computing and digital systems for a long time, and are to some extend adopting and integrating new technologies into their own knowledge and application. However, this will need to happen at a much faster rate and more explicitly, and universally. The civil engineering curriculum in universities will need to include more exposure to such subject and probably replace some of the traditional, and possibly redundant topics. The practicing engineer will need to rapidly learn and embrace these technologies to leverage the design construction and operation of the infrastructures. The use of various forms for virtual reality such as VR/AR/MR, drone imaging as well as use of 3D printing are and can be used to a great advantage, as well.

The civil engineers often do consider the life cycles aspect specially for large projects, but more explicit requirement in education, planning, design and execution can greatly increase the acceptability of the civil engineering as a relevant and valuable discipline.

The Human Side

As in any other engineering and science subject, the technical aspects of the civil engineering discipline often take major part of the educational content, and the focus of the practice. However, the challenging expectations of the society from the built environment to be not only environmentally friendly, but also socially acceptable, economy efficient, easily maintainable and having an "end of life" plan and friendly to us. The civil engineers often do consider the life cycles aspect specially for large projects, but more explicit requirement in education, planning, design and execution can greatly increase the acceptability of the civil engineering and its contribution as a relevant and valuable discipline. Often, engineers in general and civil engineers, as no exception lack the ability to effectively communicate and present and project their work to the public in an "lay-person" terms that can be appreciated by them for its value. Civil engineering not only helps to bring necessities to the societies such as water, drainage, roads, buildings, bridges but also support the infrastructure for power, transport, irrigation, food, logistics etc., but also provides safety and resilience against hazards. This needs to be communicated and emphasized.

The "Cool" Image

Civil engineering is one of the fundamental engineering disciplines to have developed. While that makes it very important for the physical infrastructure development but at the same time, it also has acquired the image of being more "traditional", and not as "cool" as some of new disciplines such as AI or bio-medical engineering or nano technology or some of the good science. This means that civil engineering might not be attracting the attention and interest of the top performing or innovative high school graduates in the new generation. There is a need to not only improve and enhance the image of civil engineering and make it attractive to the top students but also to ensure that civil engineering keep up with latest development in technologies, social development, economic attractiveness. Civil engineering, as everything else needs to keep transforming and evolving, if not to be extinct.

"Civil engineering needs to take ownership & leadership on key challenges facing the humanity in the future."

Knowledge Sharing: AIT Solutions Meet the Expert Talk Series

Since its establishment in 2010, **AIT Solutions (AITS)** has been connecting with the industry and community partners to spread AIT's expertise in engineering, technology, infrastructure, and knowledge transfer activities. One of the key aspects of AITS since its establishment has been to share knowledge with the professionals in its domains of structural engineering and software development.

The global uncertainty due to the pandemic, provided a renewed focus to AITS to develop knowledge sharing programs that will benefit professionals with varied levels of experience. Besides developing customized training programs focusing on Structural Performance-based Design, and CSi software's (ETABS, SAP2000, SAFE), AITS started a Talk Series which brought leading experts in civil engineering and allied fields to share their experience, tools, practices, and processes. These Talk Series have been titled ***"Meet the Expert"*** as it brings together knowledge experts and practitioners from a range of institutions that include the private sector, international organizations, and academia. The Meet the Expert Talk Series started in October 2020, and since then this platform has provided participants with engaging engineering talks, best practices, innovative and effective problem-solving ideas. This Talk Series has provided the participants from South-east Asia as well as from other parts of the world an exposure to diverse knowledge resources over a connected platform.

The Talks Series started with a talk by ***Mr. Yahya Jan*** on the design of the Ciel Tower located in Dubai. Mr. Yahya Jan, President & Design Director at NORR Group, provided the integrated design process considering the architecture, structure, landscape, and environmental forces. In the following Talk Series, some of the noted experts provided inspirational, and innovative talks specifically focusing on civil engineering professionals.

In the inspirational talk by ***Mr. Ron Klemencic***, Chairman & Chief Executive Officer of Magnusson Klemencic Associates, three ideas from his experience in making the industry and the world around us were shared. The talk titled ***"Always Striving for Better"*** provided the three ideas with the first on being the importance of *"Why"* and trying to understand why things are by using the first principles of physics, mathematics, and science. The second idea that was shared focused on *"Why not"*, that encouraged the participants to think in different ways from how they do

things and think. The last idea focused on the collaborating and sharing the ideas between the professionals through which together the world could be changed and make the future better. Besides, the three ideas that Mr. Klemencic also mentioned about the various research and innovations in structural engineering and shared helpful guidelines from the past decade which meet the practice of the practicing engineers.

In the following session of the Talk Series, Prof. C.V.R. Murty from Indian Institute of Technology-Madras was invited to share his experience as well as best practices that the professional engineers could take up in their real-life projects. In his talk titled "Shear and Flexure and Earthquake Resistant Structures", Prof. Murty presented the importance of failure load, failure mode, and location in reinforced columns and bridge piers under earthquakes. Prof. Murty also explained about the application of analytical equations and experimental results of moment and shear capacity of various sectional and member dimensions.

With the Talk Series focus on structural engineering, AITS invited experts in the field of wind engineering and prefabricated modular construction with an aim to provide the participants with understanding on new approaches, methods and processes. In the Talk Series session focusing on wind engineering, Mr. Stefano Cammelli, Technical Director-Wind Engineering, WSP UK Limited provided his insights on "Tall Buildings: Wind, Forms, and Structures". In his talk Mr. Stefano provided the relationship between wind directionality, exposure, architectural shape and form, wind pressures, structural system and structural response. He also presented the nature of wind, the evolution of technologies and knowledge in wind engineering and next frontiers of wind engineering industry. Wind optimization approaches were also provided with the samples of optimization of various forms aerodynamically. He also explained about the application of auxiliary damping devices to control the wind responses and measurement of wind induced responses in full scale and model scale. Various methods which will be applied in future together with computational fluid dynamics (CFD) approaches were also presented.

While in the Talk Series session focusing on Prefabricated Modular Construction, Prof. Priyan Mendis, Professor of Civil Engineering, The University of Melbourne, and Director of Australian Research Council's Centre of Prefabricated Buildings, presented the history of off-site manufacturing and modular structures, characteristics of prefabricated modular structures and their benefits with sample projects which have been implemented. He explained the special design considerations for transportation, construction, connection design and fire resistance. He also mentioned his research activities in innovation in design for manufacturing and assembly, advanced building systems and assembly techniques, high performance materials, and supply chain and financing innovation.

AITS Meet the Expert Series continued where we invited several experts:

Dirk Bondy, President, Seneca Structural Engineering Inc. USA – Strengthening and Repair of Existing Structures Using External Post-tensioning

Mr. Bondy presented the application of external post-tensioning to retrofit the damage in concrete structures due to exposure and change of occupancy for strength and serviceability requirements. He explained with real problems checking at the site to understand the nature of concrete. Art of external post-tensioning was presented with various patterns which were applied in real projects. He not only focused on concrete structures, but also provided sample applications in retrofitting of timber structures. He also mentioned the building code provisions that the engineers need to be aware of when applying external post-tensioning.

Antonino Clodoaldo S. Aligaen – Construction Project Management During the Pandemic: Don't Work Hard, Work Smart

Mr. Antonino started his talk with the definitions of construction, project and management for basic understanding. He presented the objectives of construction project management and activities involved in each phase of the management process. He also mentioned the importance of planning and investing the time in planning stage to accomplish the project successfully.

Dr. Erol Kalkan, CEO and Founder, Quakelogic – Next Generation Structural Health Monitoring and Smart Cities

Dr. Kalkan presented the structural health monitoring technologies and computational methods which that are being employed with the support of sensors, data logging devices and cloud computing. He mentioned the development of user-friendly platform that provides real time data about earthquake and structural responses. He also provided sample applications of earthquake early warning systems which identifies and indicates that an earthquake shaking is imminent at the structure site. The early warning system can trigger visual and audible alarm systems, text alerts to decision makers and automatic safe shutdown of operations, services and equipment as programmed.

Dr. Christian Meinhardt, Director, TMD Systems, GERB Vibration Control Systems – Supplementary Damping for High-rise Buildings

In his informative talk, ***Dr. Meinhardt*** explained the nature of wind and seismic loads, effects of vibrations on tall buildings and solutions to control the vibration problems. He presented the inherent damping in the tall buildings from empirical measurements as well as various distributed and isolated damping systems for providing supplementary damping. He explained varieties of supplementary damping systems together with their hysteresis behavior, how to model as idealized mechanical model, type of loading application, level of cost and advantages and disadvantages.

Prof. Fumio Yamazaki, Professor Emeritus, Chiba University, Japan, and Research Fellow at National Research Institute for Earth Science and Disaster Resilience, Tsukuba, Japan - Monitoring and Sensing Technologies of Earthquake Engineering in Japan

Prof. Fumio presented large-scale real-time earthquake and tsunamic monitoring systems and testing facilities which are employed in Japan. He shared research programs in earthquake engineering which evolved after 1995 Kobe Earthquake. He also explained the technologies which use of GPS and satellite data to assess the post-earthquake damage of buildings and infrastructures which facilitates the disaster response and recovery.

The experts that we mentioned earlier and the talks they presented are part of the initial phase of knowledge sharing platform i.e. AITS Meet the Expert Talk Series. AITS continues to organize the Talk Series with an aim to help participants harness the unique ideas, innovations, and practices of the leading engineering experts and amplify it to create engineering trends that enable professionals to leapfrog in applying latest and innovative engineering applications.

Some of AITS Meet the Expert Talk videos can be viewed in our website

www.solutions.ait.ac.th/kps/expert-talks/

PROFESSIONAL MASTER IN STRUCTURAL DESIGN OF TALL BUILDINGS

Specialized Program for Professional Structural Engineers

AN OPPORTUNITY TO UPSKILL YOURSELF IN STRUCTURAL ENGINEERING

ENROLL NOW FOR AUGUST 2022 INTAKE

Be a part of Global Network of fellow Professionals & Alumni from over 50 countries through self-paced blended learning (online + in-class) approach

PROGRAM HIGHLIGHTS

- Applied Learning
- Aligned with Industry Trends
- World-class Faculty
- Flexible Learning
- Flexible Payment
- Experience Campus Life

www.linkedin.com/in/aitpmtb

www.facebook.com/aitpmtb

pmtb@ait.asia

www.solutions.ait.ac.th/pmtb

ASIAN INSTITUTE OF TECHNOLOGY 1959

PMTB

PROFESSIONAL MASTER DEGREE IN STRUCTURAL DESIGN OF TALL BUILDINGS