November 2017

TECHNOLOGY

Asian Outlook on Engineering and Technology

What can PBD of 100 Buildings Tell us?

Vertical Cities in the Age of Hyper Urbanization

Are You Ready for the Fourth Industrial Revolution?

Advantages of Wind Tunnel Testing in Tall Buildings

A Well-kept Secret in Structural Design: Importance of Ductility in Structural Performance Analysis

[Tall Buildings]

This magazine is a publication of the Asian Institute of Technology

AIT Asian Institute of Technology

AIT Solutions
Technology · Engineering · Environment · Development · Management

Contents

November 2017

Featuring

Also in this issue

ISSN 2286-9158

Technology *Asian Outlook on Engineering and Technology* (M45-1014-0215), is published by AIT Solutions
Asian Institute of Technology, P.O. Box 4, Klongluang, Pathumthani 12120, Thailand.

Editorial

AIT Solutions
solutions@ait.asia
www.solutions.ait.asia

[ilab] **Innovation Lab**
ilab.solutions@ait.asia
www.ilab.solutions.ait.asia

ACECOMS
acecoms@ait.asia
www.acecoms.ait.asia

Habitech Center
sthapit@ait.asia
www.habitech.ait.asia

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

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

Editor's Note

Tall buildings are envisaged as the foundation of future "Vertical Cities" as they can use urban space and resources more efficiently. A new generation of tall buildings is incorporating new developments in technology and design to produce safer smarter, energy-efficient buildings. In the past two decades, the race for constructing the tallest has been extended to include the construction of the most iconic and spectacular high-rise buildings often characterized by complex geometries and leaning/twisting forms. A number of design challenges emerge as the function of tall buildings has changed significantly over the past five years from predominantly office buildings to more residential and mixed-use functions. As population density is high in the locations of tall buildings, public safety is the crucial concern for disasters as well as downtime of interruption of businesses, and essential supplies.

This technology magazine issue with the theme "Tall Buildings" highlights the importance of Performance-based Design (PBD) in developing safer and resilient vertical cities in this age of hyper urbanization as well as give insight to other challenges associated with tall buildings including the advantages of wind tunnel testing for complex structures. PBD provides a systematic methodology for assessing the performance capability of a building, system or component. AIT Solutions has carried out PBD for almost 100 tall buildings in Asia, many of which were reviewed by third party experts based in the United States, and elsewhere.

This issue also gives attention to the fourth industrial revolution as it will significantly change the way we live, work, and relate to one another. Major advances in technology, intelligent robotics, and big data combined together will unleash the immense power of artificial intelligence. New industries and jobs will emerge with more demand for creative people. In parallel, the establishment of Innovation Centers will play significant role in developing the creative economies and will lay the foundation for innovations of tomorrow to help people think and act creatively against unexpected challenges and opportunities. Innovation Lab [ilab] at AIT Solutions, launched this year, aims to promote multi-disciplinary learning and research through unconventional approaches by producing more designers, thinkers, and innovators with multi-disciplinary mindsets.

I would like to extend my gratitude to all our experts and authors who gave their valuable contribution, as well as our editorial team for making this issue both informative and creative.

We intend to develop this periodical into a valuable knowledge product and a professional communication platform for experts and a gateway to its readers towards upcoming technologies, events, and development.

We are happy to receive your feedback anytime, please email us at *solutions@ait.asia*

Naveed Anwar, Ph.D.

Executive Director, AIT Solutions
nanwar@ait.asia

What Can PBD of 100 Buildings Tell Us?

By Naveed Anwar, Thaung Htut Aung

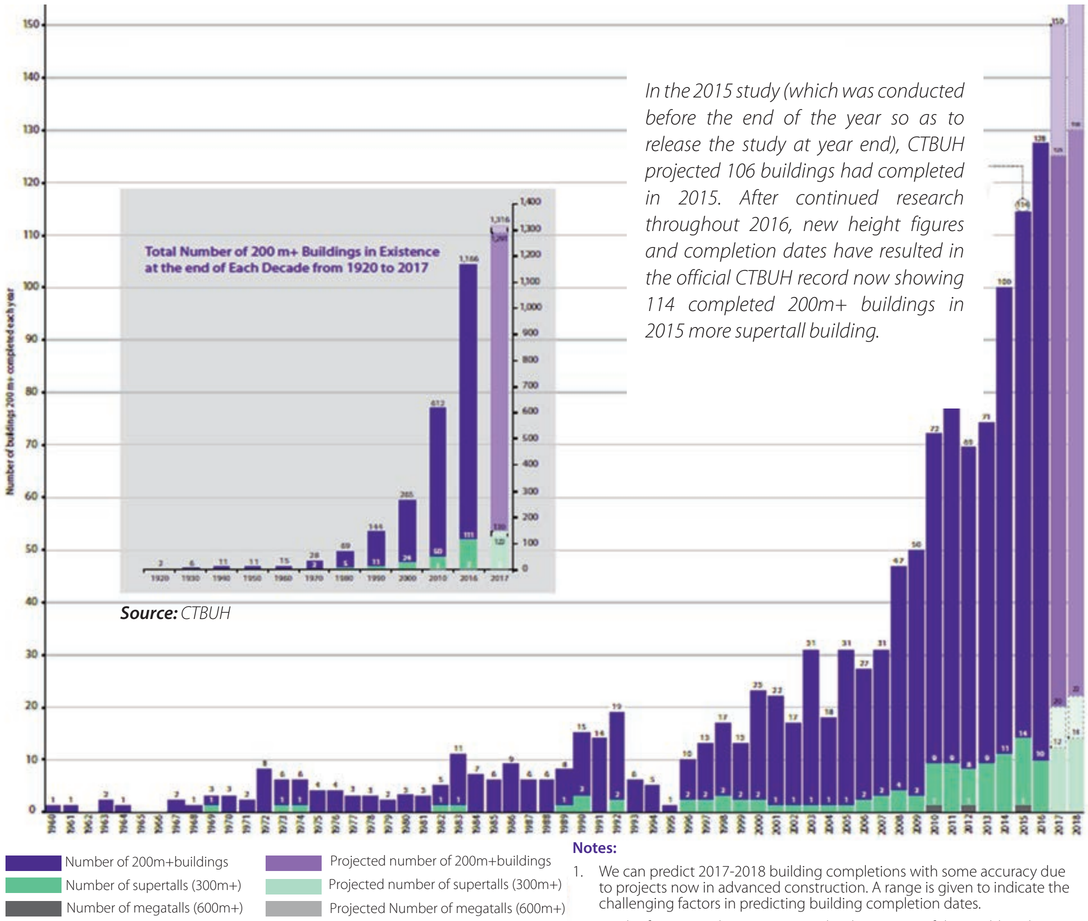
AIT Solutions, together with experts in AIT, have carried out performance-based design review for almost 100 tall buildings in Asia, many of which were reviewed by international third party experts.

What Can PBD of 100 Buildings Tell Us?

Urban migration is one of the major concerns for city planners to anticipate and solve since the cities have been priority destinations for people to find their opportunities in education and business. One of the solutions to urban migration is the vertical civilization, especially for cities with limited available land space. In the past, tall buildings are primary developed for office space, however, they are being developed for mixed-use of residences, hotels and shopping malls. As population density is high in the locations of tall buildings, public safety is the crucial concern for disasters as well as downtime of interruption of businesses, essential supplies (electricity, water, etc.) in post-earthquake situations. For instance, 50-story residential building with the total floor area of 60,000 sqm would be occupied by approximately 2,000 residents (3 people per 100 ft2, ref.). Due to the huge impact to the public in disasters, design professionals need special considerations in their design against natural hazards, using state-of-the-art technologies and tools.

Majority of tall buildings have the height of about 200 m+ (above 60-story) based on tall buildings statistics from the Council on Tall Buildings and Urban Habitat (CTBUH). Tall buildings with the height of 300 m+ (above 90-story) are very few and they are constructed mostly with the purpose to be iconic marvels. In the point of view of practicing structural engineers, tall buildings are vulnerable to the natural hazards caused by strong winds and earthquakes. In seismic prone regions, the seismic demands generally govern the structural design rather than the wind demands, especially for the tall buildings with the heights in the range about 40 to 70 stories. For supertall buildings with

In the view of a practicing structural engineer a gap between what is taught and what is needed to practice in performance-based design is filled by on-job learning and knowledge acquired from experienced engineers.



Notes:
1. We can predict 2017-2018 building completions with some accuracy due to projects now in advanced construction. A range is given to indicate the challenging factors in predicting building completion dates.
2. Totals after 2001 take into account the destruction of the World Trade Center Towers 1 and 2.

Figure 1: *Building 200 Meters or Taller Completed each year from 1960 to 2018*

Authors:

Naveed Anwar, Ph.D.
Executive Director,
AIT Solutions

Director, Asian Center for Engineering Computations and Software (ACECOMS),

Affiliate Faculty,
Structural Engineering,
Asian Institute of Technology

Thaung Htut Aung
Deputy Projects Director,
AIT Solutions,
Asian Institute of Technology

height above 300 m, wind loading may normally govern the design.

In common practice, tall buildings are designed using prescribed analysis and design procedures outlined in the building codes to resist a specified level of earthquake (Design Basis Earthquake) and attempt to satisfy implicitly the specific performance levels for three levels of earthquakes: 1) resist frequent and minor earthquakes without damage to structural and nonstructural components, 2) resist earthquake which may occur once in the life time of a building without substantial loss of life, and 3) resist strongest earthquake ever likely to occur with substantial damage but a very low probability of collapse.

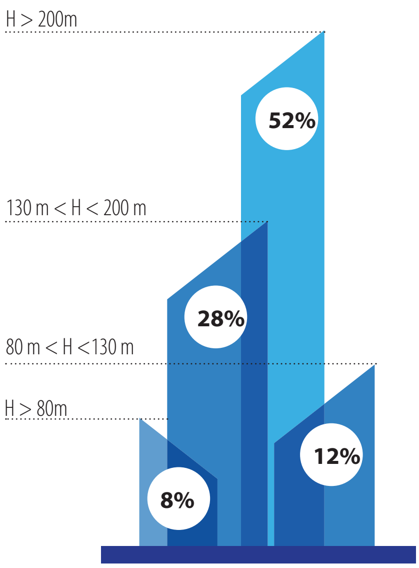


Figure 2: *Building Height Distribution of PBD Projects*

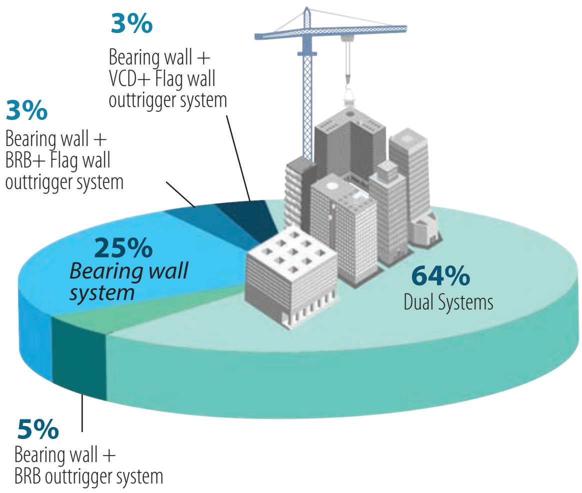


Figure 3: *Structural System Distribution of PBD Projects*

In the past decade, few structural design consultants started application of performance-based design (PBD) approaches in design of some tall buildings. In contrast to the prescriptive seismic design approaches mentioned in the building codes, performance-based design provides a systematic methodology for assessing the performance capability of a building, system or component. Performance-based design explicitly evaluates the response of the building under the potential seismic hazard, considering the different probable site-specific seismic demand levels (Service Level Earthquake (SLE) and Maximum Considered Earthquake (MCE)) as well as the uncertainties in the post-damaging response and behavior of the building. The acceptable building performance for SLE earthquake is "Serviceable behavior" and MCE earthquake is "Low probability of collapse".

In the view of a practicing structural engineer, a gap between what is taught and what is needed to practice in performance-based design is filled by on-job learning and knowledge acquired from experienced engineer. Understanding the behavior and response of the structural system and components, ground shaking hazards and capacity-based design principles of components are important in performance-based design. Especially, interpretation of the analysis results to develop a "feel" for structural behavior is crucial to make the design decisions.

AIT Solutions has carried out performance-based design for more than 100 tall buildings in the Asian region, many of which were reviewed by third party experts based in the United States. Sixty percent of tall buildings designed using PBD are in the range of height between 130 to 230 m.

Contrary to code-based design approaches, no limitation of structural systems in terms of building height and seismic design category in performance-based design, AIT Solutions 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.

To achieve a successful PBD implementation, timing and collaboration between design professionals, such as architect, structural

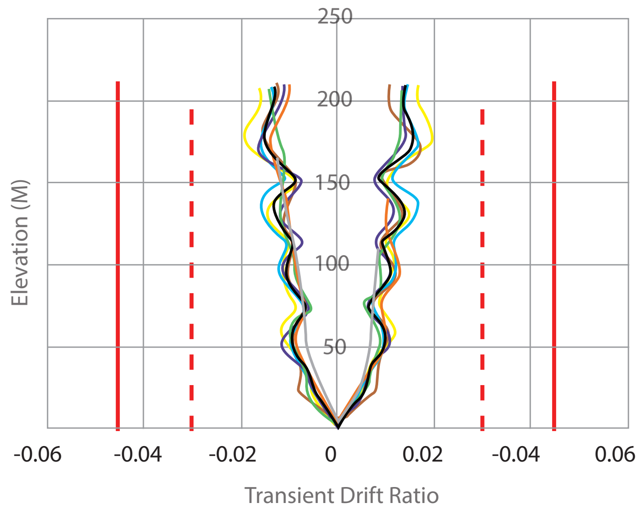


Figure 4: *Story drift*

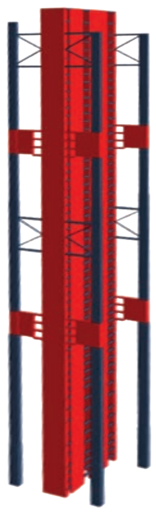


Figure 5: *Building with flag walls and BRBs*

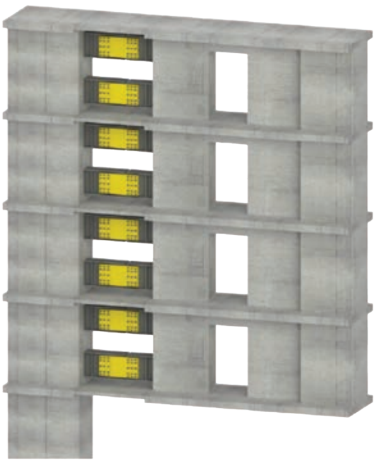


Figure 6: *Viscoelastic coupling damper (VCD)*

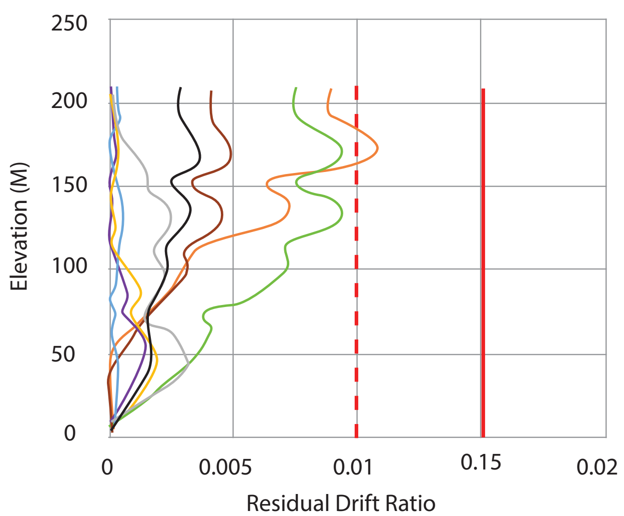
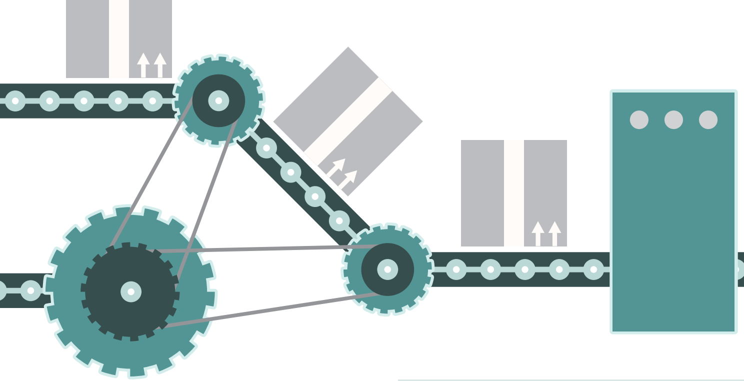


Figure 7: *Residual drift*

design consultant, PBD consultant, PBD peer reviewer, site-specific probabilistic seismic hazard assessment (PSHA) consultant, wind tunnel consultant and geotechnical engineer, is important to complete the design on time, minimizing multiple design iterations design iterations. PSHA consultant and PBD peer reviewer should be engaged at early stage of the project. PBD peer reviewer should review the work of structural design and PBD consultants phase by phase since the early stage of design process. After substantial completion of structural design done by structural design consultant, PBD consultant evaluates the performance of the building using the seismic input provided by PSHA consultant. PBD consultant provides the evaluation results and recommendations to structural design consultant to modify and update the design.

The behavior of the building during an earthquake depends on internally generated inertial forces caused by acceleration of building mass. It is found that the floors accelerate laterally approximately 0.5 to 1.0 g (0.5 g accelerates a car at rest to the speed about 90 km/hr in 5 seconds) in tall buildings located in high seismic regions under MCE earthquakes. In general, inelastic base shear due to summation of inertial forces is approximately one half to two-third of elastic base shear of MCE level earthquakes for the tall buildings in seismic prone region.

In PBD, overall responses of the building, i.e. base shear, transient drifts, residual drifts, lateral displacements, are checked for different levels of earthquakes. Transient drift is the maximum drift that occurs within the entire duration of oscillation of the building while the residual drift is the permanent story drift when the excitation stops. Residual drift is checked to prevent excessive post-earthquake deformations which will pose potential hazards to surrounding buildings and lead the censure from building authorities. Lateral displacements are checked to prevent the pounding with adjacent buildings. Each structural component in lateral force resisting system, i.e. foundation, columns, shear walls, coupling beams, diaphragms, beams and columns in moment resisting frames, is evaluated in terms of strength, capacity and ductility requirements to prevent the deleterious effects on components to carry gravity loads. Since the performance of the building is explicitly evaluated in PBD to resist the strongest earthquake ever likely to occur, marginal analysis is carried out in design optimization without large safety margins, for the use of construction materials for cost effectiveness and sustainability of limited natural resources while meeting the performance objectives of the design.



Are You Ready for the Fourth Industrial Revolution?

By Jennifer Pangilinan, Shehezard Riftie, Javaria Waqar

Experts say, today we stand on the verge of the "Fourth Industrial Revolution" that will significantly change the way we live, work, and relate to one another. The evidence of this imminent change is around us – mobile supercomputing, driverless cars, genetic editing, and proliferation of automation in various industries. There will be major advances in many areas as technology, intelligent robots, and big data combined together will unleash the immense power of artificial intelligence.

Industrial Revolutions

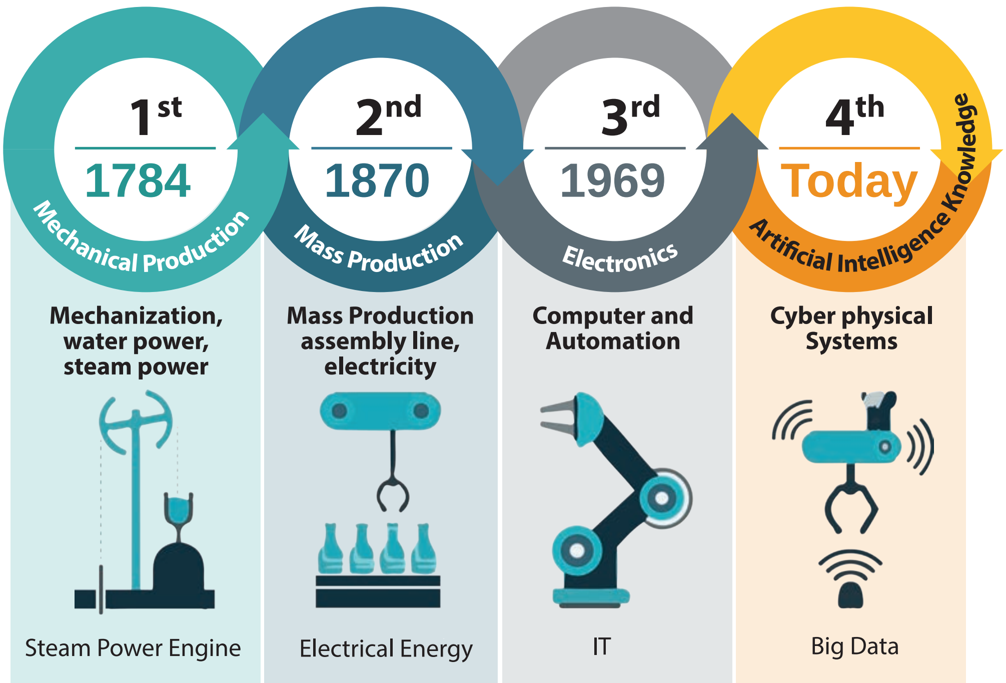
Industrial revolutions are periods in which key innovations lead to new ways of doing things, not just efficiencies or increased production at lower prices.

The First Industrial Revolution introduced early automation through machinery and boosted intra-national connections through the building of bridges and railways. The second industrial revolution in 1870 used electrical energy to produce massively.

All the industrial revolutions beginning from the first industrial revolution in 1784 are based on improvement in automation and connectivity. Whereas, the speed and scale of current technological breakthroughs have not been seen in history. When compared with the previous industrial revolutions, the Fourth is evolving at an exponential rather than a linear pace.

It will be disrupting every industry in every country and will have very different effects on nations, economies, businesses, and individuals. New industries and jobs will emerge with more demand for creative people. The future creative jobs will be more resistant to automation.

The third industrial revolution started with the rise of digital age with more sophisticated automations and increased connectivity. The Fourth Industrial Revolution is based on the same two forces. The first is extreme automation, the product of a growing role for robotics and artificial intelligence in business, government and private life. The second, extreme connectivity, annihilates distance and time as obstacles to ever deeper, faster communication between and among humans and machines.



Exponential Age: The fourth Industrial Revolution

A recent wave of articles, talks, and publications predicts that the fourth industrial revolution is underway. Artificial intelligence (AI) being a pervasive feature of the Fourth Industrial Revolution will increasingly automate some of the skills that formerly only humans possessed. At the same time, extreme connectivity will enable effective universal, global and close-to-instant communication while giving rise to new business models and opening up economic supply in ways previously not possible.

Extreme automation can also be coupled with extreme connectivity, allowing computing systems to control and manage physical processes and respond in ever more "human" ways. This represents a democratization of the ability to communicate between and among governments, corporates, humans, and machines. The advent of "cyber-physical systems" may allow robots and AI, via extreme automation and connectivity, to "cross the chasm" between the technosphere, the natural world, and the human world.

One particular implication of extreme automation and connectivity in the Fourth Industrial Revolution will be the role of "virtual" trade in ideas and intellectual property versus "traditional" trade in physical goods.

Challenges and Opportunities

Automation will create polarization of the labor force as low-skill jobs continue to be automated, and this trend increasingly spreads to middle-skill jobs. By contrast, the potential returns to highly skilled and more adaptable workers are increasing.

One particular implication of extreme automation and connectivity in the Fourth Industrial Revolution will be the role of "virtual" trade in ideas and intellectual property versus "traditional" trade in physical goods. Relative advantages in developed market legal protections of intangible ideas may lead to "onshoring" from emerging markets to the developed world. This trend, however, may reverse over the longer term as emerging nations grow and develop their infrastructure to embrace extreme automation and connectivity.

"Flexibility" will be key to success in the Fourth Industrial Revolution – economies with the most flexible labor markets, educational systems, infrastructure, and legal systems are likely to be relative beneficiaries.

Developed economies are likely to be relative winners at this stage, whereas developing economies face greater challenges as their abundance of low-skill labor ceases to be an advantage and becomes more of a headwind.

Four investment implications from the Fourth Industrial Revolution are:

1. Emerging market assets relative to developed market assets
2. Traditional industries disrupted
3. Big data beneficiaries
4. Blockchain applications

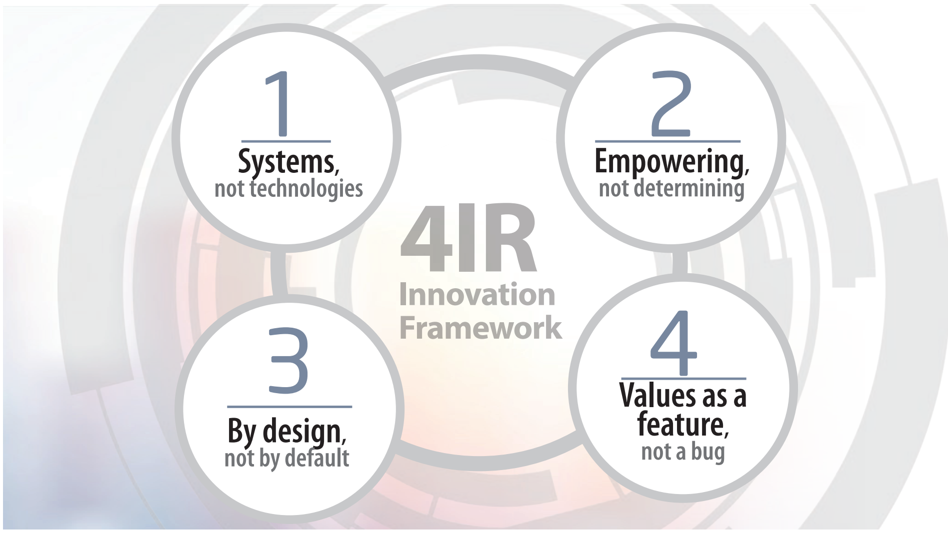
The third main factor other than extreme automation and connectivity that is accelerating the technology advancements is innovation. Innovation systems in the fourth industrial revolution will integrate across different scientific and technical disciplines and incorporate other domains such as education rather than looking on to findings from one area to the next.

Creativity and innovation are two fundamental elements of an innovation ecosystem that drive the development of a knowledge-based economy. Innovation will be supported through crowd sourcing of funds rather than exclusively government or corporate R&D funding.

The value of innovative technologies and their potential for accelerating socio-economic growth is recognized globally by governments. National polices are advancing initiatives for a new economic model with campaigns like Thailand 4.0, Make in India, Creative Economy (South Korea), and Design in Innovation (UK).

4IR Innovation Framework

World Economic Forum defines the framework of innovation based on following components:



Role of Innovation Centers/ Labs

Creativity is becoming the crucial competitive advantage for businesses and people. As the speed of technology advancements continue to accelerate, people will be confronted with more information and more uncertain situations than ever before. Their response to these situations will depend on their ability to think creatively and their ability to come up with their own ways of dealing with new and unexpected situations. Innovation centers/labs whether they are related to academic institutions or industry are already exploring a wide range of innovations. They can enable industry to exploit new and emerging technologies. In future, investment in innovation is essential for a successful economy.

Shaping the Future

The ability to adapt and reinvent will be crucial to be successful in this Exponential age. We need to shape a future that works for all of us by putting people first, empowering them and by paving the way for the innovations of tomorrow that can make our life better.

REFERENCES

1. *Invention, Innovation Systems, and the Fourth Industrial Revolution*
   By Arthur Daemmrich Lemelson Center for the Study of Invention and Innovation, Smithsonian Institution, Washington, DC, USA
2. *Innovation and the Fourth Industrial Revolution*
   By Nicholas Davis, Head of Society and Innovation 10.06.2016, World Economic Forum
3. *Extreme Automation and Connectivity: The Global, Regional, and Investment Implications of the Fourth Industrial Revolution*
   UBS White Paper for the World Economic Forum Annual Meeting 2016
4. *The Fourth Industrial Revolution: What it means, how to respond*
   Author: Klaus Schwab is Founder and Executive Chairman of the World Economic Forum
5. *Creative Learning and the Future of Work*
   By J. Philipp Schmidt, Mitchel Resnick, and Joi Ito1

NEWS IN BRIEF

Experts Talk about Infrastructure Development in Asia

A Technical Seminar on ***Disaster Risk Reduction and Infrastructure Development in Asian Region*** was organized by Eight-Japan Engineering Consultants Inc. (EJEC) in collaboration with the Asian Institute of Technology (AIT) on 26 September 2017 at Tokyo, Japan.

AIT Experts Prof. Pennung Warnitchai, Head of Civil and Infrastructure Engineering and Dr. Naveed Anwar, Executive Director, AIT Solutions were invited to present during the seminar. Prof. Pennung talked about Key Issues of Disaster Risk Reduction while Dr. Naveed focused on the Bridge Infrastructure in the ASEAN and the South Asian Region - An Overview of Opportunities and Challenges.

EJEC and AIT have been collaborating since 2014 through technical seminars and events in areas related to infrastructure development. EJEC also offers scholarship for student to pursue Master's degree in Structural Engineering or the Disaster Preparedness Mitigation and Management (DPMM) program at AIT.

Development of New Building Systems in Concrete

Over the last 100 years, the traditional building and structural systems have efficiently served the purpose of providing built facilities for societal growth and development. However, with recently growing rates of urbanization and population, and the correspondingly increasing needs of better residential and commercial buildings, the necessity of innovative and more efficient building systems is also increasing.

Reinforced Concrete is one of the most widely used construction materials. The flexibility of casting it in any desired form and shape provides several opportunities to develop innovative building systems.

Dr. Naveed Anwar, Structural Engineering Expert and Executive Director of AIT Solutions presented the Development of New Building Systems in Concrete at the ***Asian Concrete Conference*** held on 20-12 September 2017 at Bangkok Thailand.

Mandalay Aims to be a Garden City

The Mayor of Mandalay City, Myanmar and Minister for Development Affairs of Mandalay Region Dr. Ye Lwin has envisioned the city to be resilient and go on a path of sustainable development to achieve its goal to be a 'Garden City'.

Mandalay City Development Committee (MCDC) with support from Department of Urban and Housing Development, Ministry of Construction, Myanmar, AIT Alumni Association and Authentic Group of Companies-Myanmar co-organized a seminar on Urban Resilience and Sustainable Development on 18 August 2017 in Mandalay.

The seminar was organized in the backdrop of the rapid urbanization being witnessed in Myanmar and the consequences as well as impacts from other development activities, and increasing climate change/ environment-related risks.

AIT was represented by Dr. Vilas Nitivattananon, Associate Professor, Urban Environmental Management Program, Dr. Oleg V. Shipin, Associate Professor, Environmental Engineering and Management Program, and Mr. Justin Finch, Manager-Business Development, AIT Solutions.

UN-Habitat Working with Myanmar Engineering Society (MES) on Vulnerability Assessment of Lifeline Buildings in Yangon

Myanmar has been frequently impacted by all sorts of natural hazards like earthquake, flood, cyclone, landslide, and fire. Although major earthquake is less frequent than other hazards but their impact on buildings and infrastructure of exposed areas can be devastating. Yangon lies along the Sagaing fault, in low to moderate seismic zone.

UN-Habitat worked with Myanmar Engineering Society (MES) to conduct vulnerability assessment of lifeline buildings in Yangon. A multi-stakeholder consultation workshop was organized to brief the project activities. UN-Habitat is also working with MES and AIT experts on detailed vulnerability assessment and also provide retrofitting solution for 3 identified solutions.

AIT Experts Prof. Pennung Warnitchai, Engr. Thaung Htut Aung, and Dr. Pramin Norachan attended the workshop in June conducted at Myanmar Engineering Society, Yangon. Prof. Pennung Warnitchai share his expert views on lessons learned from past earthquakes, use nonlinear structural models to evaluate seismic performance of existing building and design retrofitting strategy, and on earthquake loss estimation. Engr. Aung discussed about the seismic evaluation process and criteria and finite element modeling and analysis procedures for evaluation of existing buildings. Dr. Pramin presented the evaluation of analysis results, retrofit strategies and retrofit design details, and case study for seismic evaluation and retrofit design of existing building. The outline of Guidelines for Seismic Evaluation and Retrofit Design of Existing Buildings in Myanmar was also discussed with UN-Habitat and MES.

Nepal Publishes New Design Catalogue for Reconstruction of Earthquake Resistant Houses

The Government of Nepal recently published the Design Catalogue for Reconstruction of Earthquake Resistant Houses Volume II developed by the Department of Urban Development and Building Construction, Ministry of Urban Development. This publication is one of the Knowledge Products following the Post Disaster Needs Assessment (PDNA) conducted in Nepal after the devastating Earthquake in 2015.

The Design Catalogue Volume II comprises of alternative construction materials and technologies to support urban and rural households in reconstruction of their houses. It consists of seventeen model designs based on twelve alternative materials and technologies not covered by Nepal National Building Code. The Catalogue includes architectural design, structural detailing and material estimate.

The Asian Institute of Technology (AIT), through Habitech Center, has developed Interlock Brick Technology consisting of specially designed unburnt bricks with tongue and groove features that allows bricks to interlock each other in masonry and thereby reduces mortar usage. Construction with interlocking brick is economical, quick, and environment friendly.

Catalyzing Innovation for Disaster Resilient Housing: 8th Annual Affordable Housing Projects

In the 8th Annual Affordable Housing Projects event held on 3-6 April 2017 at the Suntec Singapore Convention and Exhibition Centre, experts talked about innovative concepts and solutions to these issues from government, statutory bodies, and specialized agencies.

Dr. Naveed Anwar, Structural Engineering Expert and Executive Director of AIT Solutions, Asian Institute of Technology (AIT) presented Catalyzing Innovation in Performance-based Design for Disaster Resilient Housing where he talked about tall buildings as one solution to urban housing demand. He explained that PBD was initially developed and targeted for earthquake loads but it can be applied to any type of loads.

Twenty-one Newly Built Houses using Habitech Technology were Handed Over to Nepal Villagers

The catastrophic Nepal earthquake in 2015 damaged hundreds of houses and left many underprivileged people with no place to stay.

Immediately after the 7.8 magnitude quake, the Asian Institute of Technology (AIT) and Mekong Organization of Mankind (MOM) launched a public fundraising campaign to build community houses for the affected rural community using AIT's Habitech Interlocking Brick Technology. This 'for-mankind' technology was developed at Habitech Center of AIT Solutions at AIT, which is earthquake resistant, environment friendly, energy-efficient, and cost effective.

Twenty-one disaster resilient houses were built using Habitech Building Technology for poor villagers in Phulbari village, Lubhu, Mahalaxmi Municipality in Nepal.

In March 2017, the 21 "Baan Promchai" (House from the Heart of Thai people) were handed over to the house owners in the presence of H.E. Bhakavat Tanskul, Ambassador of Thailand to Nepal, Mr. Ek-att Thitaram, Minister Counsellor and Deputy Chief of Mission from Royal Thai Embassy in Nepal and other concerned parties. Mr. Noritada Morita, AIT Board Member, and Mr. Gyanendra R. Sthapit, Director of Habitech Center, also were present representing AIT in the ceremony.

This social welfare project was conceived by Ms. Sujintana Chanyatipsakul, President of The Nine Sustainability Foundation (originally MoM), who spent a lot of her efforts, personal resources and time to successfully push through the project. She was assisted by Mr. Gyanendra R. Sthapit

Thailand Learns from Singapore Housing Solutions

The delegation from Thailand which included high-ranking officials and directors from the Ministry of Social Development and Human Security, Housing Finance Association, National Housing Authority and experts from various organizations joined the study tour in Singapore. They visited the Housing and Development Board (HDB); Building Construction Agency (BCA); National Parks (NParks), and Gardens by the Bay.

The Government of Thailand is working on poverty reduction and creating opportunity for low-income people to access social welfare and affordable housing. The Ministry of Social Development and Human Security (MSDHS) was tasked to implement housing for low-income people (1,707,437 households) under the Housing Development Strategic Plan (2016-2025).

By 2025, the Thai government aims to provide access to affordable housing for over 2.7 million low income household and develop a network of proper infrastructure and public utility systems.

MSDHS and the National Housing Authority (NHA) in collaboration with the Asian Institute of Technology (AIT) organized a meeting and study visit ***Housing Development for Low Income People: Learn from Singapore Experience*** on 23-25 March at the Republic of Singapore.

This activity is the latest collaboration between NHA and AIT which started in 2014 when NHA Governor inaugurated AIT's Workshop on ***Innovative and Cost-effective Solutions for Cleaner, Greener, and Safer Communities.*** During the workshop, the Governor conveyed his appreciation to AIT and indicated his support towards advancing the concept of sustainable housing development. Since then, several meetings and technical seminars between NHA and AIT were held to discuss collaborative opportunities focusing on ***Affordable Housing.***

World Wildlife Day 2017: Listen to the Young Voices

"Let's save wildlife together" was the message from the youth of the Asian Institute of Technology (AIT), which resonated at the opening of the ***World Wildlife Day 2017*** celebrations in Thailand on 1 March 2017. AIT, through WEMS Secretariat in AIT Solutions and DNP, jointly organized the event to mark the day.

Mr. Surendra Shrestha, Vice President for Development of AIT said, "AIT is a premier graduate institution in the interface of technology, knowledge and development that can significantly contribute towards the collective effort for sustainability through education, applied researches, extensions and trainings".

Dr. Klairoong Poonpon, Director of the Division of Administrative Services of the Department of National Parks, Wildlife and Plant Conservation (DNP) of the Royal Government of Thailand, in her keynote address, remarked on the need of educating the younger generations in order to enable them to appreciate the value of wildlife and vital services they provide and empower them to take positive decisions towards sustainable lifestyles.

Dr. Robert Mather, Chief of Party of USAID Wildlife Asia outlined the activities under Wildlife Asia. A presentation on Community Engagement against Illegal Wildlife Trade was delivered on behalf of Mr. Doley Tshering, Regional Technical Adviser,UNDP.

Dr. Somying Thunhikorn, Director, Division of Wildlife Research, Department of National Parks, Wildlife and Plant Conservation, outlined Thailand's experience on public participation in wildlife management. Mr. Manesh Lacoul, Deputy Director of WEMS Secretariat, AIT Solutions presented about Wildlife Enforcement Monitoring System.

The event continued on March 4, 2017 at the Khao Kheow Open Zoo in Chonburi Province, which served as an opportunity for AIT Community to witness conservation at work, gain up-close understanding of some endangered species of wildlife, and partake in the conservation act.

6th Annual Vertical Cities Conference in Dubai

Dubai is home to more than 900 high-rise buildings, one of which is the current tallest building in the world, Burj Khalifa.

The largest city in the United Arab Emirates (UAE) is the venue for this year's Annual Vertical Cities Conference held on 6-8 March 2017 to leverage on Vertical Cities to resolve rapid urbanization in highly dense cities as a solution to sustainable living.

The conference was designed to gather industrial practitioners, leaders and worldwide delegates to discuss about the spring issues that the industry is facing today. This program also provided an opportunity to gain the insight knowledge and techniques from the experiences of the experts and global speakers.

Dr. Naveed Anwar, Structural Engineering Expert and Executive Director of AIT Solutions, Asian Institute of Technology was invited to present in the conference. Dr. Anwar's presentation focused on the Integrated Performance Based Design of Tall Buildings for Wind and Earthquakes. He covered topics that would explain why the building industry should not rely on *Codes and Standards* but should use Performance-based Design (PBD) Evaluation since this method investigates two important objectives: Service-level Assessment and Collapse-level Assessment.

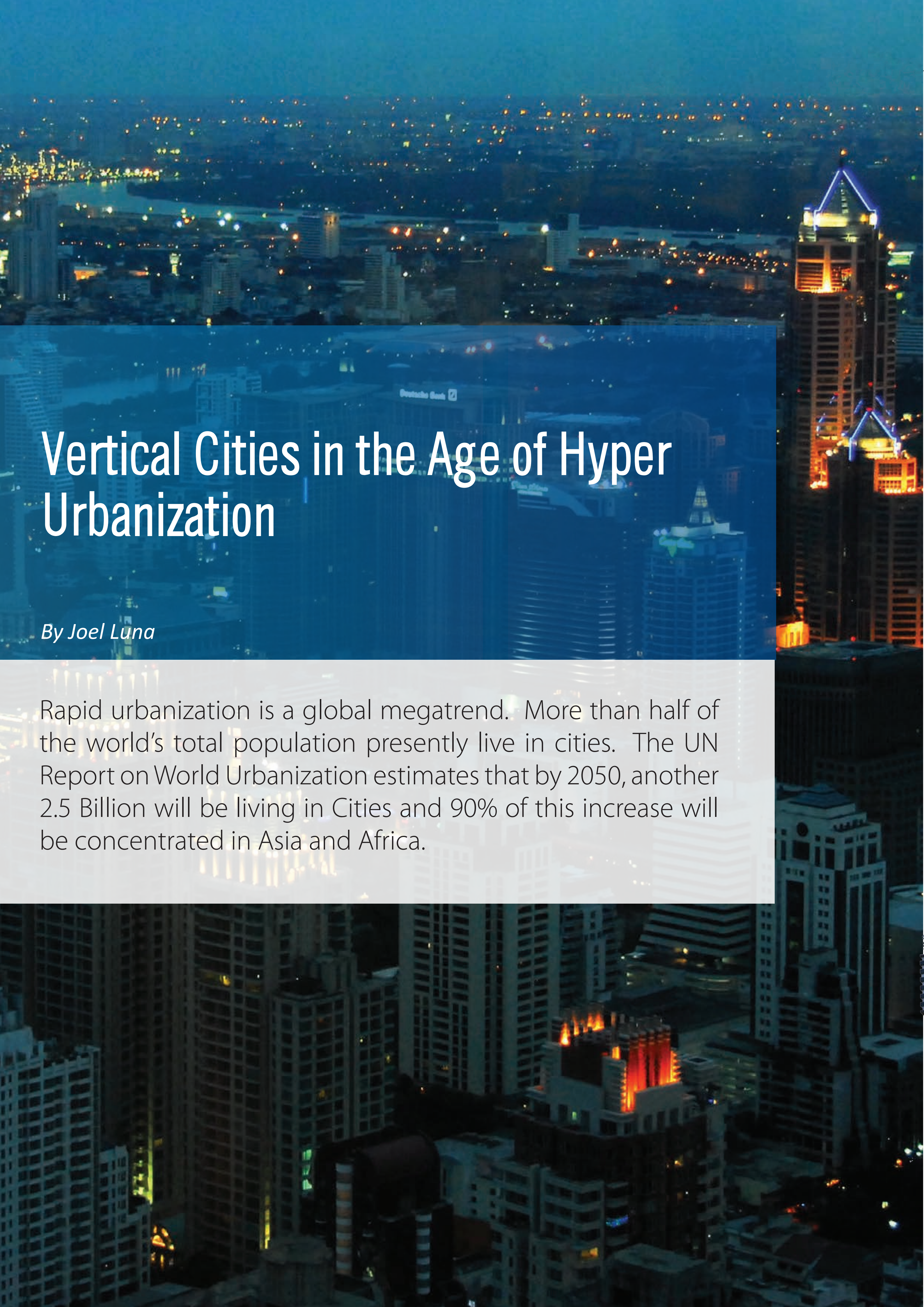
UNDP Social Innovation Workshop: A Meeting of the Minds

UNDP in Thailand launched the Thailand for Social Innovation for Development Facility (TSI4D). Over the past few months, UNDP has engaged a diverse consortium of partners in the social innovation space, including government agencies, private sector firms, non-profit organizations and academic institutions to be part of a new Social Innovation Facility for Development (TSI4D).

UNDP organized a ***Co-creation Workshop with the Partnership Consortium for TSI4D*** held on 23 February 2017 at the UN office in Bangkok to bring together all the partners to co-design the social innovation facility. The workshop focuses on two main topics: understanding the gaps, underlying needs, and key insights and idea generation and possibilities to develop the facility (based on ideas from the workshop)

Mr. Martin Hart-Hansen, Deputy Resident Representative, UNDP Thailand introduced the Social Innovation Workshop

The Asian Institute of Technology AIT was one of the institutions invited to participate in this initiative as it is actively promotes innovation among its students. AIT will formally launch its own Innovation Lab [ilab], a creativity center with state-of-the-art equipment and gadgets that connects entrepreneurs, mentors, industry experts with talented regional students & researchers advance innovation & develop collaborative solutions for social & technological development.



Vertical Cities in the Age of Hyper Urbanization

By Joel Luna

Rapid urbanization is a global megatrend. More than half of the world's total population presently live in cities. The UN Report on World Urbanization estimates that by 2050, another 2.5 Billion will be living in Cities and 90% of this increase will be concentrated in Asia and Africa.

Vertical Cities in the Age of Hyper Urbanization

Author:

Arch. Joel Luna
Principal, Joel Luna Planning and Design
Philippines

Rapid urbanization is a global megatrend. More than half of the world's total population presently live in cities. The UN Report on World Urbanization estimates that by 2050, another 2.5 Billion will be living in Cities and 90% of this increase will be concentrated in Asia and Africa. People are flocking into cities by as much as 60 persons per hour in some countries such as India. And this tide of people moving into cities from the hinterland will continue.

A major reason for this is that cities, for all their flaws, generate economic productivity. Urban areas contribute as much as 80% of global GDP. The economic output is a result of the amplified level of productivity, creativity and efficiency brought about by the concentration of people and ideas. This level of productivity creates the attraction that pulls people from the hinterlands and finds opportunity in the metropolitan areas.

This influx of people towards the urban areas creates tremendous strain on the city. The increase in capacity of the urban areas to service the rapid rise in population and economic activity is often outpaced by the level of urban growth. Often, the result of the mismatch is the rise of informal settlements, the insufficiency of infrastructure, over-congestion and a milieu of other city ills.

As people flock to the city, urban areas try to respond by increasing their capacity to absorb growth. Metropolitan areas have done this in a number of ways:

- Suburbanization (expansion of the city into the countryside)
- Land Reclamation (creation of developable land beyond the coastline)
- Urban Infill development (utilization of undeveloped or underdeveloped parcels in the city)
- Redevelopment/urban renewal (improvement in the capacity of built-up areas and/or improvement in an area's productive output by a change in use or structure)

Vertical City in Jakarta (proposal by MVRDV)

In an age of rapid urbanization, all the above interventions usually involve high density development, which typically translate as tall buildings, to offset rising land costs and to absorb increasing demand for built-up space. Even in suburban areas which have been characterized by low density, residential sprawl, pockets of mixed use higher density districts have emerged as alternative economic hubs to the traditional downtown.

Architects and urban planners have often envisioned cities composed of tall buildings as a way of housing their growing population. Often romanticized, tall buildings have triggered the imagination of visionaries and have actually led to inventions that have gradually enabled the realization of ever taller structures.

The Challenge of Tall Buildings

The Cost Challenge

Going vertical is often a reaction to scarcity of land, which translates to high land values. When unit building costs are less than unit land costs, it makes sense to build tall. But unit construction costs also tend to increase with each increment of height added to buildings. Thus, for any given site with a specific land value, there is a theoretical economic limit to building height, beyond which it may be more practical to simply buy more land than build taller. I say theoretical, because land values are never static and they tend to increase over time. This combination of high land cost and high construction costs make tall buildings inherently expensive and beyond the affordability of the common citizens of the cities they belong to. The challenge therefore, in designing super tall buildings is in lowering the marginal cost of building taller. Doing so will require innovations in structural design, vertical transport systems and mechanical electrical systems and regulatory controls that will facilitate progressively lower unit costs as buildings get taller. Perhaps inspiration can be gained from nature, and buildings can somehow require less materiality while increasing functionality even as the impact of gravity and wind increases as structures get taller.

Productivity and Resilience

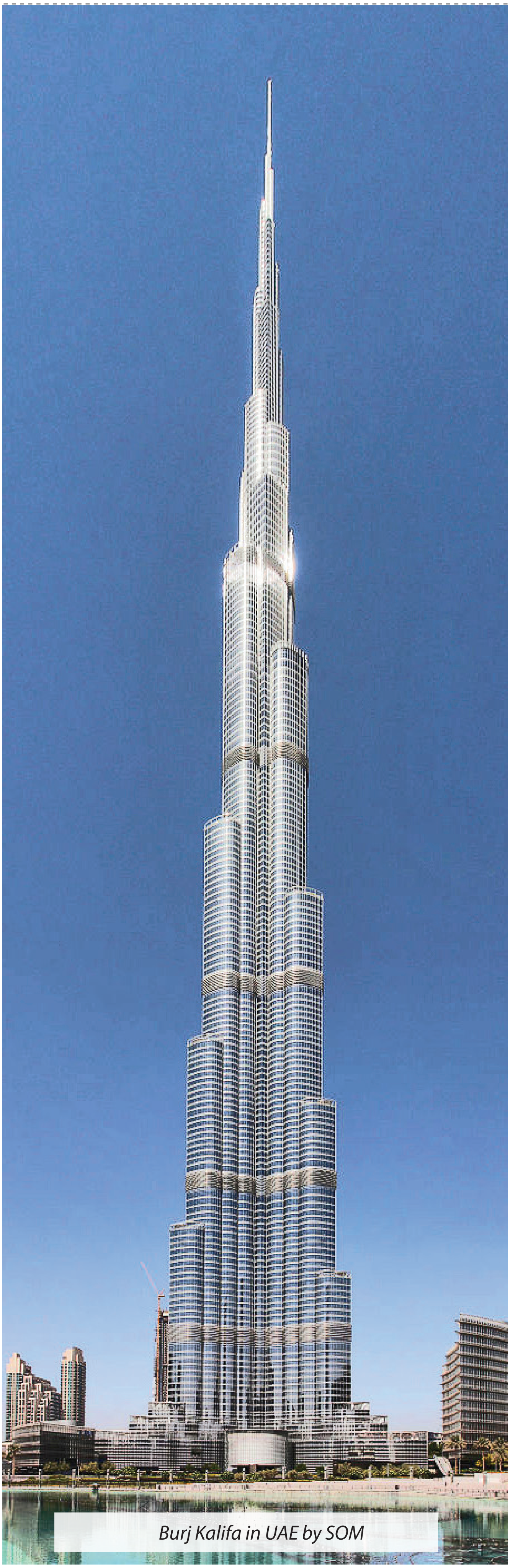
High concentrations of people bring about the benefits of increased productivity, creativity and efficiency. Studies by Geoffrey West of Santa Fe Institute have revealed that cities exhibit super linear scaling where productivity and creative output increases exponentially as population and density increases. Even more interesting is West's findings that per capita productivity also increases exponentially with population and density increase.

The flipside is that the risks associated with urban agglomeration such as the spread of disease, crime, urban poverty, environmental damage and vulnerability to disasters, terrorist attack and social conflict are also compounded as population and density increases. History has shown, however, that benefits have tended to outweigh these risks, and hence, cities continue to thrive through the ages. A major planning challenge is in addressing these risks and arriving at innovative measures that will mitigate and address the negative effects of urbanism without limiting the inherent capacity and potential of cities to contribute to the improvement and overall progress of society.

Inclusivity and Community

The tendency of tall buildings to be situated in expensive land and to be expensive to construct raises a concern on whether tall buildings are just meant to cater to the affluent. A major criticism of suburban sprawl is the proliferation of single-use, homogenous, gated enclaves that often cater to homogenous markets and income segments at the exclusion of the rest. Tall buildings often suffer from a similar flaw, often serving narrow, upscale markets in towers that are effectively gated communities tilted on their ends. If higher density is inevitable and verticality is the sustainable response to urbanization, then a true vertical city is one where its buildings are able to serve a good cross-section of society, where democratic and inclusive space can exist several meters above the street.

Even within the exclusive and homogenous domain of high rises, achieving a sense of community is also a challenge.

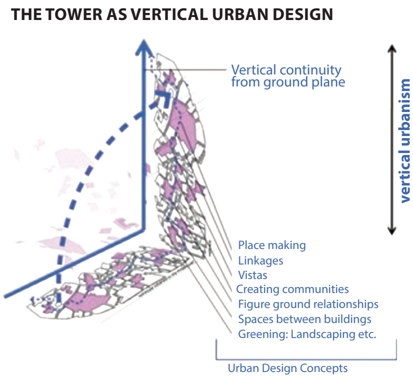


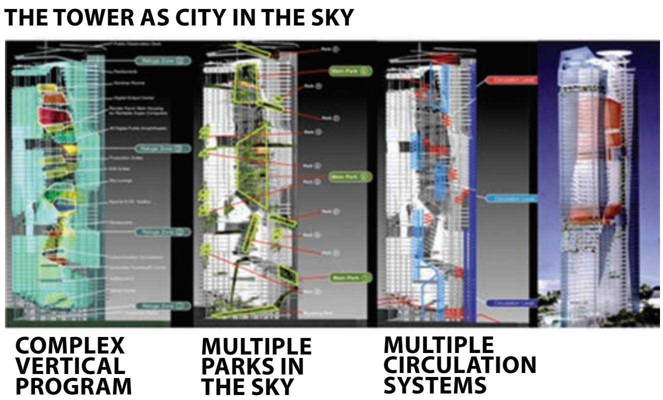
Burj Kalifa in UAE by SOM

Tall buildings offer limited opportunities for congregation, serendipitous encounters and the simple ritual of meeting neighbors that leads to the formation of extended social bonds that exist even in exclusive, gated communities. The concept of neighborhood or of community in the context of high rise living is yet to be defined. The mix happens at the street but not in the buildings. But if rapid urbanization will push people to live in ever taller buildings, then these future buildings will have to counteract the tendency towards isolation, loss of community and of social connectivity.

While vertical mixed use buildings offer a richer variety of uses compared to gated enclaves, the ultimate victory of a vertical city is when it is able to create socially-facilitative spaces within the buildings themselves in an interconnected fashion that foster the kind of community interaction that occurs naturally in the public streets and squares of many successful cities.

Signs of Hope: Elevating the public realm and emancipating the ground plane





Vertical City by Ken Yeang

A way to democratize the high-rise is if there is in finding a way to elevate the public realm, up within the floors of the buildings themselves. Attempts to achieve this include publicly accessible roof gardens, observation decks, building-integrated amenity spaces or the incorporation of civic uses such as museums, health clubs or libraries. Others attempt to offer cross-tower connectivity via elevated bridges as seen in Moshe Safdie's Marina Bay Sands or in Surbana's Pinnacle in doing, both in Singapore. With these elevated connections, the vertical city ceases to be simply a connection of unidirectional towers connected at the ground plane, (sort of a vertical cul-de-sac) and instead show the beginnings of a truly circulatable vertical mixed use development. All of these ideas could emancipate the ground plane, and allow the city to exist across multiple layered planes in 3 dimensions.

Innovative ideas from some architects such as WOHA, NBBJ, Ken Yeang, MVRDV and a few others proposed truly mixed environments within several floors of tower buildings, emulating the richness of fabric and activity in most cities. Numerous design explorations vertical agriculture using on multi-layered urban farms reframes cities to also become hubs of agricultural and not just commercial productivity. Dr. Ken Yeang likens the Vertical City as a row of urban blocks tilted on one end with parks, retail spaces, residential and office units in a seeming random patchwork that departs from the current practice of stacking single uses into a tower. Innovations in vertical transport will be necessary to handle not just the volume of people, but also to enable multi-directional mobility within buildings. As buildings become taller and denser, vertical transport will begin to take on the role of vertical mass transit. Already, ideas on vertical subways and magnetic levitation applied to elevators are being explored. Advancement in high capacity multi-directional elevator technology will enable the revolution in tall buildings, in much the same way that Otis' prototype ushered in the era of the skyscrapers. Perhaps with the combination of structural design technology, vertical transport innovation and creative people-centric building design adopted to high-rises, a multi-layered city where 3-dimensional urbanism happens at multiple levels will be the next incarnation of the increasingly urban city.

AIT-TIGER LEONG INTERNATIONAL INNOVATION & LEADERSHIP CAMP II

Inspiring Innovative Leaders of the Future

A Step towards Creating Global Citizens: AIT and Alumnus Co-sponsor Summer Camp for Bright Undergraduate Students

How can we support the youth to emerge as leading global citizens in today's highly competitive environment?

The AIT-Tiger Leong International Innovation and Leadership Camp (ATLIILC) is a summer camp for bright and brilliant undergraduate students organized with a purpose to contribute to the nurturing of young minds in Asia by providing an interactive learning program while promoting cultural exchange and exposure.

The Camp was sponsored by AIT and AIT alumni Mr. Tiger Leong, who described AIT as a very unique institute, credited his achievements to his days as a student. Mr. Leong, hopes the students will gain from their exposure at AIT and attain greater success in the future.

The first camp was held in January 2017 with a total of 21 participants from ASEAN countries Cambodia, Indonesia, Malaysia, Philippines, Thailand, and Vietnam.

The second camp in July 2017, the organizers decided to widen its reach and included other Asian countries. The second camp had 25 participants from Bangladesh, Cambodia, India, Lao, Malaysia, Pakistan, Philippines, Thailand, and Vietnam.

The participants were selected based on several criteria including: average GPA (3.5 and above); diversity in nationalities, regions, fields of study. The participants were also asked to submit a short essay on why they want to be part of this camp and the important issues the world is facing today. A short self-introduction video was also required in the application.

With focus on leadership, innovation, exposure to current issues & trends and cross-cultural

Camp Batch 1: *16-27 January 2017*

Camp Batch 2: *24 July - 04 August 2017*

Dr. Naveed Anwar, AIT Solutions Executive Director welcoming the participants during Opening Ceremony.

AIT President Prof. Worsak Kanok-Nukulchai sharing his thoughts on how to become global leaders.

Netsol Technologies Founder and President Mr. Naeem Ghauri discussing about the World of IPOs.

exchange, ATIILC was a great platform for bright minds from diverse backgrounds to come together, With focus on leadership, innovation, exposure to current issues & trends and cross-cultural exchange, ATIILC was a great platform for bright minds from diverse backgrounds to come together, share ideas and gain useful knowledge and skills in a fun, interactive, dynamic, and challenging environment. The format of the camp involves a mixture of seminar, interactive workshops, motivational talks, presentations on important issues, site visits, and study tours.

Renowned experts in various fields were part of the camp as speakers and mentors including: Prof. Worsak Kanok-Nukulchai, President, AIT; Dr. Naveed Anwar, Executive Director, AIT Solutions; Dr. Jonathan Shaw, Executive Director, AIT Extension; Dr. Yuosre Badir, Associate Professor, AIT; Dr. Mokbul Ahmad, Associate Professor, AIT; Dr. Indrajit Pal, Assistant Professor, AIT; Dr. Robin Gravesteijn, Data Management Specialist (Analytics and Research), UNCDF); Mr. Naeem Ghauri, Founder, Director, President NETSOL Technologies Europe, Ltd, Head of Global Sales NETSOL Technologies, Inc.; Mr. Nophol Techaphangam, Country Director, Nexus; Mr. Robert Steele, Director, Systainability Asia (SA); Mr. Stuart Bailey, Coach and Trainer NLP Top Coach; Mr. Faisal Niaz, Entrepreneur, Educator, Corporate Consultant, Social Worker, Artist & Motivational Speaker.

Aside from interactive workshops, two major activities were introduced during the second camp: the study visit at renowned organic farm in Chang Rai, Rai Ruen Rom and Mini-Hackathon: Sensors Challenge. In Rai Ruen Rom students immersed in local community and experienced first-hand the many facets of sustainability. In the Hackathon the students were challenged to think creatively by coming up with innovative ideas that would solve global and local issues using sensors and IOT (Internet of Things) technology.

Importance of PBD, Value Engineering, and Peer Review

By Thaung Htut Aung, Shabir Ali Talpur

Combination of Performance-based Design (PBD) which provides the explicit confirmation of higher or expected performance level and value engineering which satisfies the performance requirements at the lowest possible cost, will lead the better performance and cost-effective designs.

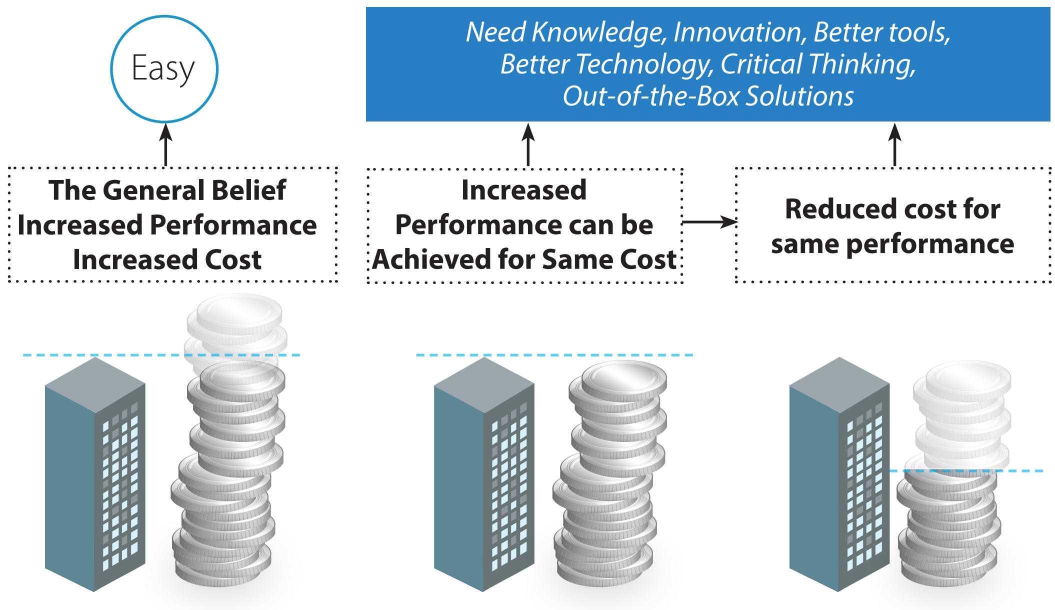
Importance of PBD, Value Engineering, and Peer Review

Stakeholders, in general, involved in real estate development or property development are developers, designers, contractors, and buyers or residents. Developers buy land, finance real estate deals, usually take the greatest risk and receive the greatest rewards. Profit of the project primarily relies on designers who design the building, by satisfying building codes, regulations and meeting the developer's requirements as well as contractors who build the building in accordance with instructions and specifications from designers. Buyers or residents, the ultimate stakeholders, have utmost concern about livability, safety and comfort which are the values for money they spent for. On the other hand, developers care about reputation, brand, continued business, focusing mainly on their profit. Generally, developers are willing to spend more to increase the profit and reputation and buyers are willing to pay more for higher value. The values to be improved so that the developers and the public willing to invest more are location, brand, finishes, structural safety, and design quality with additional values of green and sustainability. A safer and high performance building is more environmentally sustainable. People have propensity to invest more for buildings with higher sustainability, so they should pay more for safer and high performance.

General belief is that increase in performance will lead the increase in cost for construction. This statement does not need to be always true as increase in performance can be achieved for same cost or reduced cost for same performance. To improve the cost and performance relationship, efficient design solutions are needed which require knowledge, innovation, better tools, better technology, critical thinking and out-of-the-box solutions. In the view of a structural designer, conscious effort is needed in optimizing the structural design to reduce the cost. Both code-based design and performance-based design approaches can lead to cost reduction, by conducting value engineering. However, performance-based design provides a greater opportunity to refine and economize with confidence for safety.

Combination of performance-based design which provides the explicit confirmation of higher or expected performance level and value

A safer and high performance building is more environmentally sustainable. People have propensity to invest more for buildings with higher sustainability, so they should pay more for safer and high performance.



Need Not be True

Improved/ Efficient Designs

Authors:

Thaung Htut Aung
Deputy Projects Director,
AIT Solutions,
Asian Institute of Technology

Shabir Ali Talpur
Senior Structural Engineer,
AIT Solutions,
Asian Institute of Technology

engineering which satisfies the performance requirements at the lowest possible cost, will lead to the better performance and cost-effective designs. Additional benefits that can be delivered include, the reduction in life cycle costs which are maintenance and rehabilitation due to environmental impacts. Generally, building codes intend to ensure safety by definition of appropriate hazard or load levels, prescribed limited structural systems, members, and materials, prescriptive rules of detailing, and specifications for construction and monitoring. Building codes expect implicitly that following the prescriptions in the codes will lead the buildings to be safe from specified hazards. However, a couple of questions about building codes remain: 1) Will the building and occupants always be safe from hazards when the designer follows the code?, 2) Can all the building codes be correct if they differ?, 3) Did we inform the structures to follow which code when earthquake or hurricane strikes?, 4) Should we upgrade our structures every 3 or 5 years to conform the codes when new versions of codes are released every 3 or 5 years?. Rather than designing the building by following the prescribed instructions mentioned in the codes, design the building with explicit verifications to ensure the safety and performance be achieved. Lack of explicit check of performance in design codes becomes the primary motivation for performance-based design. Performance-based design can be applied to any type of loads, but is typically suitable and targeted for earthquake loads. Performance-based design requires the designer to assess how a building is likely perform under earthquake shaking and other extreme events and their correct application will help to identify unsafe designs. At the same time this approach enables arbitrary restrictions to be lifted and provides scope for the development of safer and more cost-effective structural solutions. Generally, performance-based design investigates at least two performance objectives of buildings explicitly: 1) Service level assessment for earthquakes have a return period about 50 years, and 2) Collapse level assessment for strongest possible earthquake with a return period about 2500 years.

Efficient structural system comprised of right member types and sizes in right places with right amount of reinforcement which are detailed in correct way is required to achieve the cost effective design with maximum value for resources.

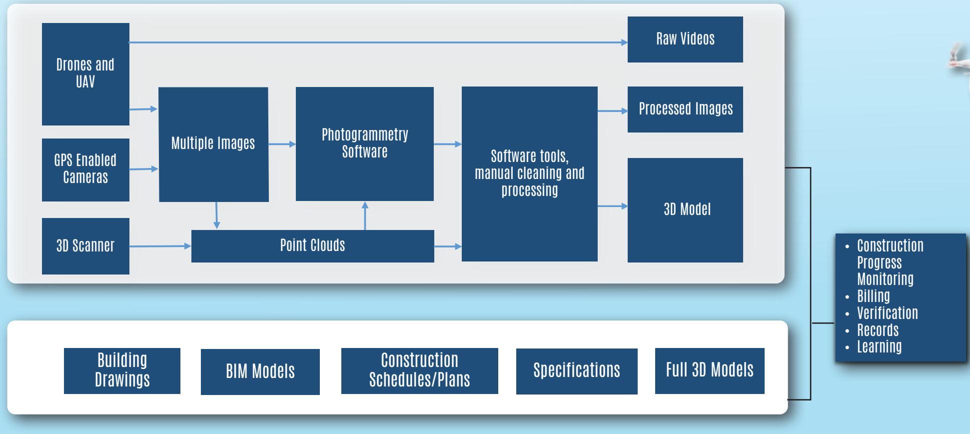
In balancing cost and performance of structural system of building, the local and global optimizations are needed in consideration of dynamic response, lateral load response, capacity utilization ratios of components, reinforcement ratios, concrete strength and quantity, rebar quantity, constructibility and time. Efficient structural system comprised of right member types and sizes in right places with right amount of reinforcement which are detailed in correct way is required to achieve the cost effective design with maximum value for resources. The materials would be reduced in unnecessary locations and increased in required locations. Different types of innovative structural systems, avoiding the generalities in design, may be evaluated with the advice of industry experts to optimize the overall cost and performance.

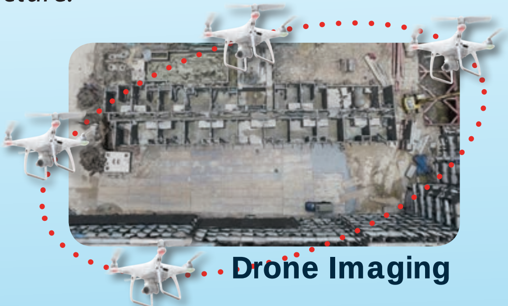
Due to advanced analysis and design approaches in performance-based design, qualified independent peer review is required to ensure the design meets the stated performance objectives. The independent peer review is a process whereby a design project (or aspect of) is reviewed and evaluated by a person, or team, not directly involved with the project, but appropriately qualified to provide input that will either reinforce a design solution, or provide a route to an improved alternative. The invaluable input from broad base and independent experience at each stage of a design project will often result in technical improvements, lower costs, avoidance of sourcing issues, and improved performance. Furthermore, technical collaboration between designer and peer reviewer will be developed by sharing their knowledge and experience. In general, peer reviewer checks the structural engineering concept, constructability, basis of design, geotechnical and site seismicity reports, analytical models, design calculations, drawings, and specifications. The peer reviewer's report states his or her opinion regarding the design by the engineer of record. The structural engineer of record shall retain sole responsibility for the structural design. The activities and reports of the peer reviewer shall not relieve the structural engineer of record of this responsibility.

New Solutions for
Tall Buildings & Other Structures

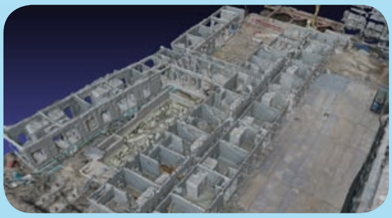
Drone Based Construction Monitoring

Drone Based Construction Monitoring uses 3D images captured by a Drone during construction to accurately monitor the progress of a structure.





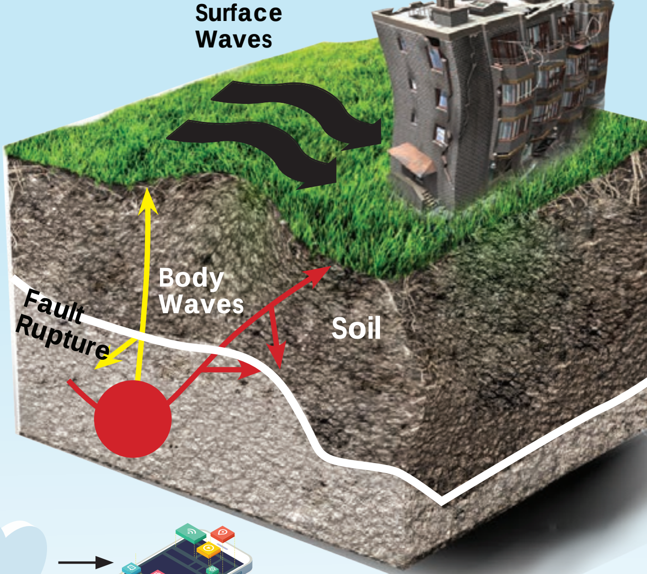
Drone Imaging

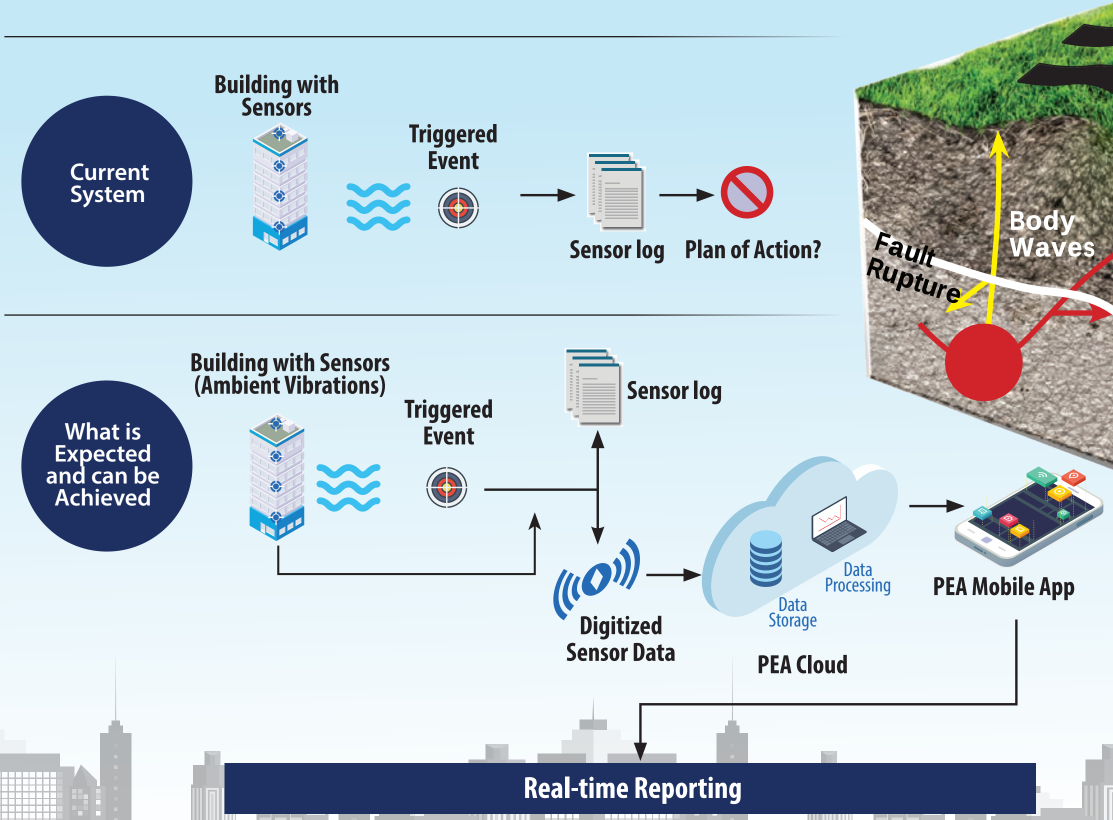


3D Model from drone

Post Earthquake Assessment (PEA)

PEA efficiently uses recorded earthquake data from the building sensors after a seismic event to determine the structural integrity of the building and the economic & social cost of future event.





Innovation Lab at AIT Solutions

Creativity and innovation are two fundamental elements of innovation ecosystem that drive the development of a knowledge-based economy. Governments around the world are utilizing innovation as the main catalyst for achieving sustainable economic growth.

In an innovation ecosystem, education institutes play a vital role and provide the perfect venue to encourage and nurture young minds to develop their entrepreneurial skills.

The Asian Institute of Technology (AIT) as a leading regional academic institution, launched the Innovation Lab [ilab] at AIT Solutions to complement the role of research institute as a vital center of innovation and competence to help tackle social challenges and drive regional economic growth.

The launch ceremony, held on 24 May 2017 was attended by AIT administration, executives from partners and clients of AIT Solutions, experts from public and private sectors and development agencies.

Dr. Naveed Anwar, Executive Director, AIT Solutions opened the event with an introduction to Innovation Lab, sharing a brief background on how and why [ilab] was established. Prof. Worsak Kanok-Nukulchai, AIT President, in his welcome address, emphasized the importance of an innovation center in an institution like AIT to nurture entrepreneurial skills in students and prepare them to be global citizens. Chief Guest Dr. Subin Pinkayan, Chairman of AIT Board of Trustees, in his address underlined that creativity is becoming the crucial competitive advantage for business and people. [Ilab] can be a catalyst to think and act creatively to the unexpected challenges and opportunities, and will lay the foundation for the innovations of tomorrow"

President Worsak with Prof. Karl E. Weber, Executive Committee, AIT; Dr. Subin Pinkayan; Prof. Emeritus Dr. Sahas Bunditkul, Executive Committee; Dr. Naveed Anwar; Prof. Kazuo Yamamoto, AIT Vice President, Administration

The launch was attended by private and public organizations and development agencies including Asian Development Bank (ADB), National Innovation Agency (NIA), National Housing Authority NHA, National Science and Technology Development Agency (NSTDA), Nexus, Siam Cement Group (SCG), Sixense Group, Traveliko, United Nations Development Programme (UNDP), USAID, WorldBank, Xynteo

An Open House was arranged in the afternoon to accommodate more faculty, students, and staff who would like to visit the new lab.

A Brainstorming Session chaired by President Worsak was arranged after the Launch to discuss the objectives of [ilab] and plan the direction and strategies to move forward. The session was attended by various experts from AIT, partners and clients, other organizations and development agencies.

Congratulations!
Punchaya Raksasakul
for Winning in SwissInnovation Challenge Thailand 2017

One of the challenges of the visually impaired is the lack of ability to distinguish color. Oftentimes, this affects their self-confidence in accomplishing daily activities like identifying colors in clothes, bank notes, and consumer goods, perceiving artistic works or colored graphical images or even participating in social activities.

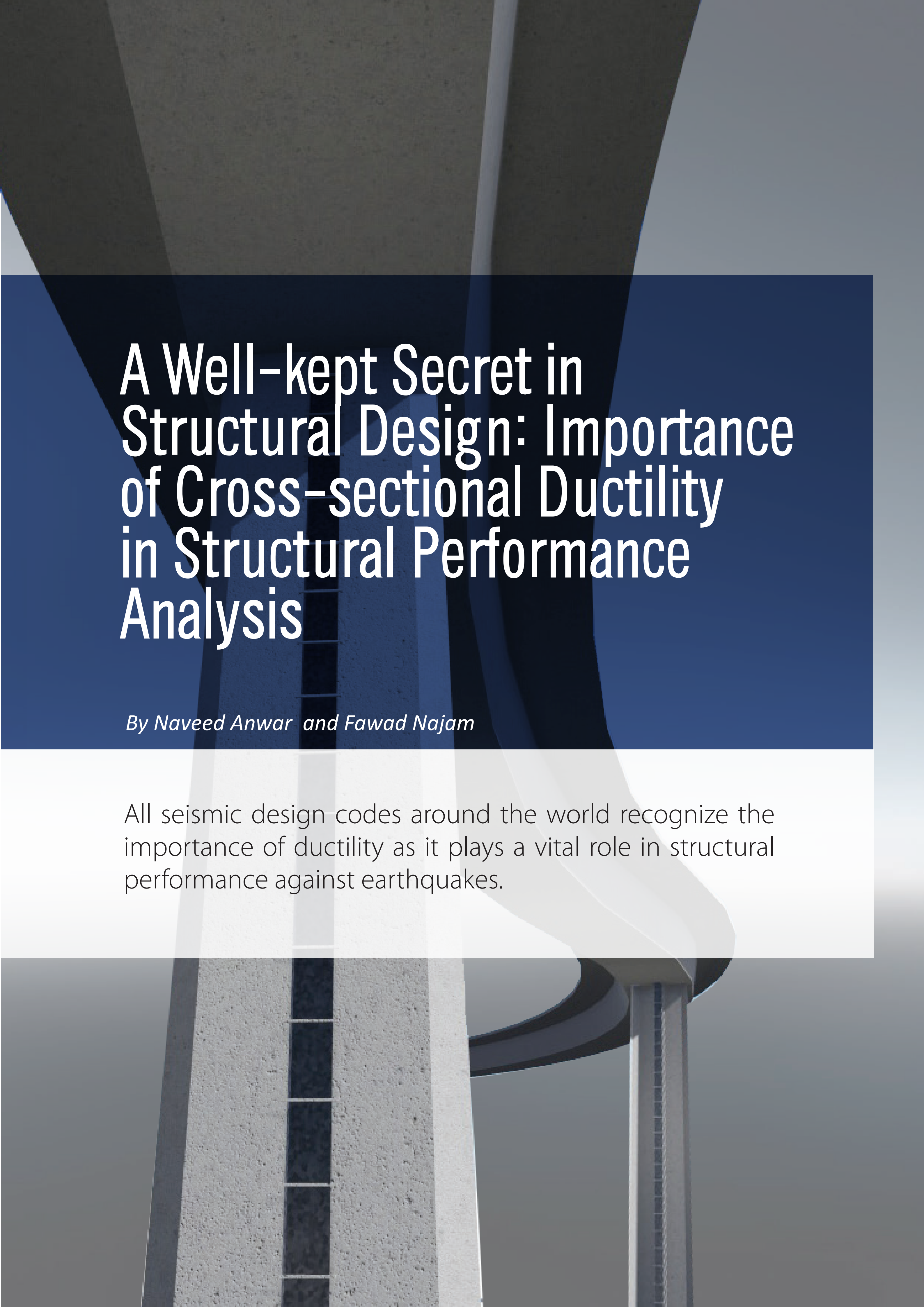
WAWTA

Punchaya Raksasakul, a recent graduate of Master of Information Management, Computer Science and Information Management at Asian Institute of Technology (AIT) has developed Color Identification Mobile Application for Visually Impaired: An Integration of Haptic and Auditory Sensories as her research thesis in AIT.

Prior to her winning, Punchaya started working at the **Innovation Lab [ilab]** established at **AIT Solutions** as a creativity hub for students and researchers to provide needed support for the development of their research or business idea.

Punchaya with her thesis advisor Dr. Vatcharaporn Esichaikul, Associate Professor, Computer Science and Information Management, AIT who encouraged her to join the SwissInnovation Challenge

The SwissInnovation Challenge Asia is a unique promotion programme with an integrated innovation competition for projects at the ideation, conceptualization and startup stage as well as for established businesses.
Visit website: http://www.swisschallenge.org/



A Well-kept Secret in Structural Design: Importance of Cross-sectional Ductility in Structural Performance Analysis

By Naveed Anwar and Fawad Najam

All seismic design codes around the world recognize the importance of ductility as it plays a vital role in structural performance against earthquakes.

A Well-kept Secret in Structural Design: Importance of Cross-sectional Ductility in Structural Performance Analysis

Introduction

The Ductility is the ability of a material, cross-section, member or structure to sustain large deformations without fracture/failure. For most practical cases, it is defined in terms of the ratio of maximum deformations to the deformation level corresponding to a yield point. This ratio is often referred to as the ductility ratio. The deformations can be strains, rotations, curvature or deflections. Strain-based definition of ductility is generally used at material level, while rotation- or curvature-based definition also includes the effect of shape, size and stiffness of cross-section. All seismic design codes around the world recognize the importance of ductility as it plays a vital role in structural performance against earthquakes. The greater the ductility, the greater is the capacity of the member to undergo large deformations without losing strength capacity. Similarly, a higher ductility also ensures an efficient energy dissipation mechanism. Well-detailed steel and reinforced concrete (RC) structures, fulfilling the ductility requirements of codes are expected to undergo large plastic deformations with little decrease in strength.

With this brief introduction, it is imperative to think that practicing structural engineers would already be making use of this effective property to the fullest, for designing safer and more efficient built facilities. However, this seems not to be the case here. Very few young engineers seem to have good knowledge about it. An understanding and effective use of ductility for safer and more economical design seem to be an intentionally well-kept secret in structural engineering. Considering its significance, and for the benefit of those who are not familiar with this secret, let's discuss it in more detail.

Ductility is the key to good (seismic) performance of structures; confinement is the key for improving ductility in reinforced concrete members, and the moment-curvature relationship is the key for computing cross-section and member ductility.

What are Action-Deformation Curves?

For any deformable physical object subjected to some applied force actions, the resulting deformational effects can be related to applied actions through the corresponding action-deformation relationships/curves. These curves provide very useful information about the overall behavior of that object. From the structural engineering point-of-view, the entire response of a structure can be described in an integrated manner using these curves. They can be obtained in different ways. The most common methods are:

a. By actual application of action on member and measurement of the corresponding deformation. This approach is used in laboratory testing, strength evaluation of existing structures, verification of theoretical models, and so on.

b. By theoretical computations of stress resultants for assumed strain profiles corresponding to some deformation pattern.

Authors:

Naveed Anwar, Ph.D.
Executive Director,
AIT Solutions
Director, Asian Center for Engineering Computations and Software (ACECOMS),
Affiliate Faculty,
Structural Engineering,
Asian Institute of Technology

Fawad Najam, Ph.D.
Assistant Professor,
National University of Sciences and Technology (NUST),
Islamabad, Pakistan

c. By the computation of deformations for various levels of action values using material properties. This is useful in steel sections but is not very reliable for reinforced concrete members where the stiffness properties cannot be computed reliably for various levels of actions.

The overall response of a structure is derived from its members depending upon the structural configuration, geometry and member behavior. The response exhibited by an individual member is derived from the cross-sectional behavior, which ultimately is dependent on its constituent material behavior. Therefore, the action-deformation curves can be obtained at several levels, for example,

Structural Level: Load – Deflection Curve

Member Level: Moment – Rotation Curve

Cross-section Level: Moment – Curvature Curve

Material Level: Stress – Strain Curve

The load-deformation curves can also be plotted between the axial load and axial shortening of a member, the shear force and shear deformation, and the torsion and corresponding twist angle.

However, the moment-curvature curve (Figure 1) is probably the most interesting, important and useful action-deformation curve especially for the design of axial-flexural members such as beams, columns and shear walls. It also seem to be the least-understood or least-utilized tool in the normal structural design practice. Many of the text books, design codes and handbooks do not provide sufficient information for the computation and use of these relationships.

The moment-curvature curve of a cross-section is dependent on several parameters including the cross-sectional stiffness (which itself is comprised of material and geometric stiffnesses) and the level of axial load on the cross-section. The term "curvature" can be defined in several contexts. In geometry, it is the rate of change of rotation. In structural behavior, the curvature is related to the moment through stiffness. For a cross-section undergoing flexural deformation, it can be computed as the ratio of the extreme fiber strain to the depth of neutral axis and is measured in radians/length units. For the reinforced concrete members, the direct solution to determine the moment-curvature curve is not possible because the determination of neutral axis depth for a given extreme fiber strain and for a given set of axial load is an iterative process.

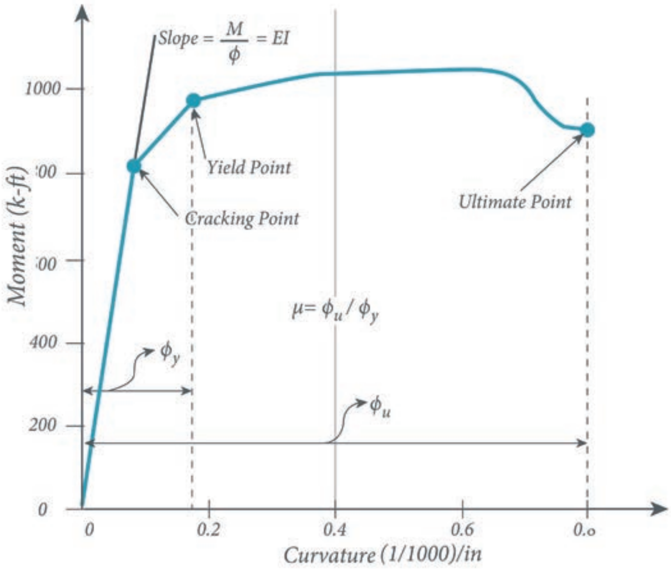


Figure 1: *Curvature ductility from M-ϕ curve (CSI Col)*

Important Outputs from the M-ϕ Curve

The most interesting information contained in these curves is the effective flexural stiffness of the cross-section for any given moment, or for any given curvature. It can be determined as the slope of moment-curvature curve at the corresponding given point. The curvature of a cross-section at a given moment can also be converted to other deformation-related responses (e.g. strains, rotations and deflections) at any point in the member. The strain value (corresponding to a certain moment) at the bottom of a reinforced concrete beam can be used to determine the crack width for an assumed crack spacing or pattern (see Figure 2). The ductility of the RC cross-section can be determined as the ratio of the curvature at any given point on this curve to the curvature at the yield of first rebar. In fact, several ductility ratios can be computed for various required or specified performance levels during the nonlinear analysis of structures.

The moment-curvature curves are useful in determining the ductility of RC cross-sections (defined as the ratio of the curvature at any given point to the curvature at the yield of first rebar).

Role of Ductility in Performance-based Design of Cross-sections

The performance-based design is basically a comparison between the capacity curve of the section, member or entire structure against the demand curve for the section, member or the structure as a whole. The capacity curve is a load-deformation curve and the demand curve or demand levels are the expected deformation levels for certain loads or the expected load capacity at specified deformation levels. A complete range of cross-sectional response quantities is required for its performance evaluation against the anticipated loads.

As a simple example, let us consider a beam carrying a point load as shown in Figure 3. The demand curves could simply be limits on deformation while carrying a certain load. For example, it may be specified that the beam should not crack before reaching a load of 50 KN. The beam should not deflect more than say 20 mm for a load of 75 KN. The beam should not deflect more than 50 mm for a load of 100 KN. Now if a section for the beam is assumed, then a load deformation curve can be generated by using a moment-curvature curve. These points can then be marked on this curve and the limits checked against the actual performance of the beam for carrying this load. If some of the demands are not satisfied then the section can be revised and the load-deformation curve is regenerated each time, until the desired performance levels are achieved. It is important to note that there is no need to specify a design load or ultimate load or load factors or capacity reduction factors. They are all automatically built into the expected demands and provided capacities. It covers everything from serviceability considerations such as cracking and service load deflection to maximum load carrying capacity and ductility.

It is important to note that in this case, the beam section is expected to meet all performance criteria simultaneously. It is also important to note that various modifications in the cross-section design will have different impact on performance levels. For example, if cracking criteria is not being met then section size may be increased, tension reinforcement may be increased or concrete with greater modulus of rupture may be used. If the final ductility criterion is not being met, then concrete in compression may be confined or more compression reinforcement may be used.

Role of Cross-sectional Ductility in Nonlinear Analysis

In recent years, nonlinear analysis has gained significant popularity and acceptance for evaluating the performance of structures, especially buildings, both for seismic and non-seismic loads. It provides improved

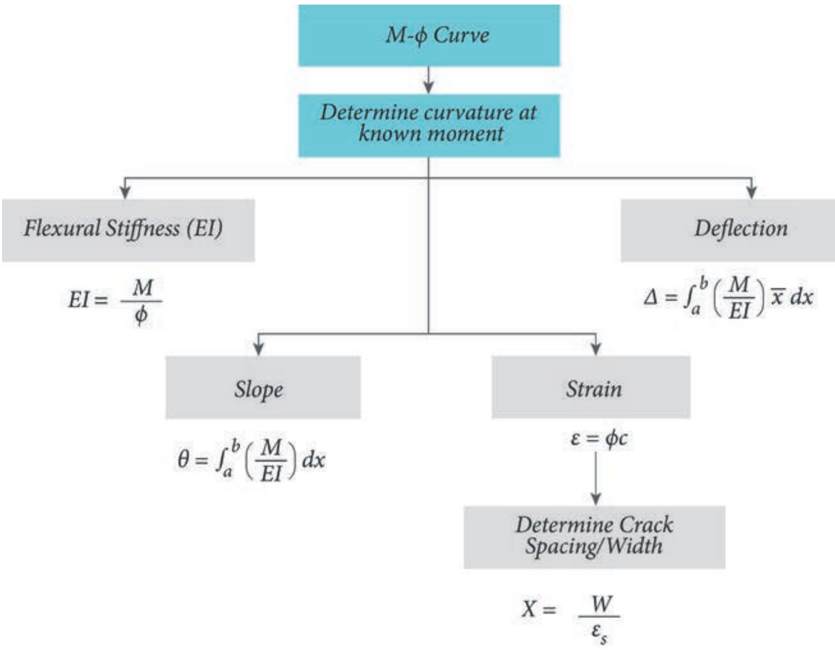


Figure 2: *Important information obtained from M-ϕ curve*

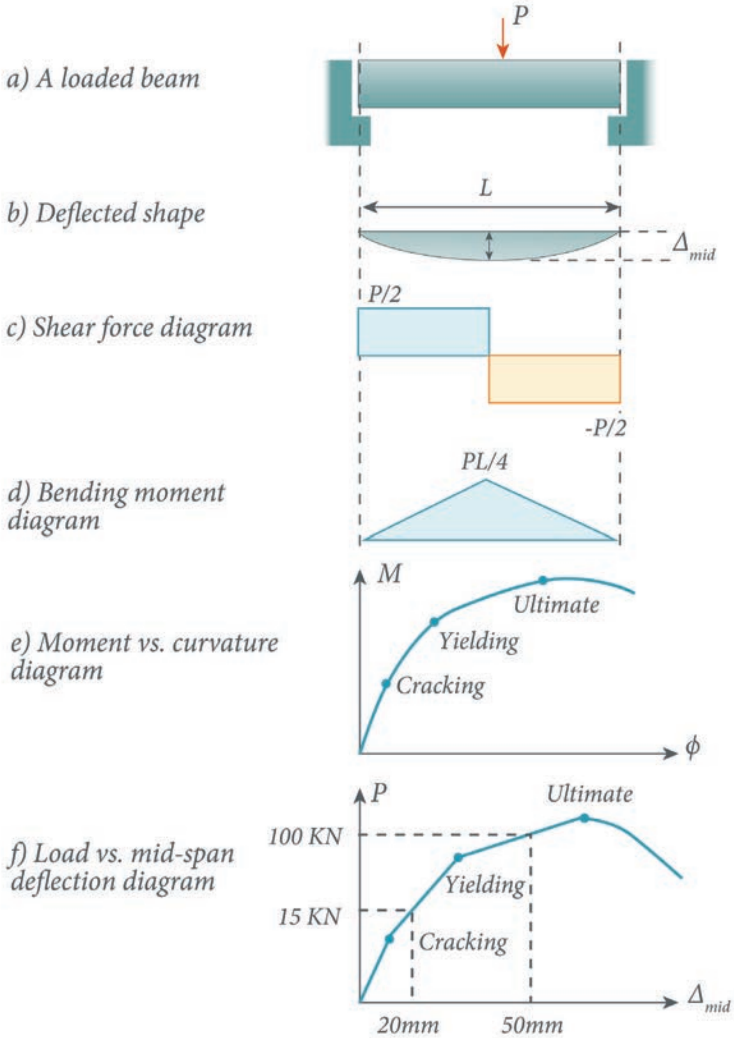


Figure 3: *Performance evaluation of a simply supported point-loaded beam in terms of mid-span deflection*

understanding of building behavior and provides accurate predictions of global displacement, realistic predictions of earthquake demand on individual components and elements and more reliable identification of "bad actors" in structural performance. The information provided by the moment-curvature curve is also very useful for the nonlinear analysis of a structure including the post-elastic behavior. Being an important component of a nonlinear structural model, these relationships are also the basis for the capacity-based or the performance-based design methods. They are useful in determining the rotational capacity of plastic hinges assigned in inelastic models for the static pushover analysis and the detailed nonlinear time history analysis of structures.

The most common nonlinear analysis procedure is the Pushover Analysis which is a static procedure. In this analysis, the magnitude of the structural loading is incrementally increased in accordance with a certain predefined pattern. With the increase in the magnitude of the loading, weak links and failure modes of the structure are found. The procedure also helps to identify ductility requirements for various members. Although the applied loading is monotonic, the effects of cyclic behavior and load reversals are included by using a modified monotonic force-deformation criteria and additional hysteretic damping approximations. Static pushover analysis is an attempt by the structural engineering profession to evaluate the real strength of the structure and it promises to be a useful and effective tool for performance based design. It is also most suitable for evaluating the performance of existing structures, especially for lateral loads such as earthquake or even wind. Since the structures do not respond in a linear elastic manner during strong ground shakings, the linear analysis cannot provide the true picture of expected structural behavior.

The pushover analysis relies on the nonlinear cross-section response parameters as the basic input for determining the load-deformation and performance curves. Many software that carryout the pushover analysis, have the capability to generate such parameters (after basic cross-section design) for simple sections and material models. However, for complex cross-sections and material models, these parameters often need to be computed separately and then provided as an input to the analysis programs.

Figure 4 illustrates that significance of moment-curvature curve as one of the key inputs in performance-based assessment of structures using the pushover analysis. It shows how the material stress-strain curves contribute to the moment-curvature curve, which in turn, affects the moment-rotation behavior of plastic hinges. The properties of plastic hinges affect the overall

The nonlinear analysis provides an insight into complex structural behavior and results in a more reliable identification of "bad actors" in structural performance.

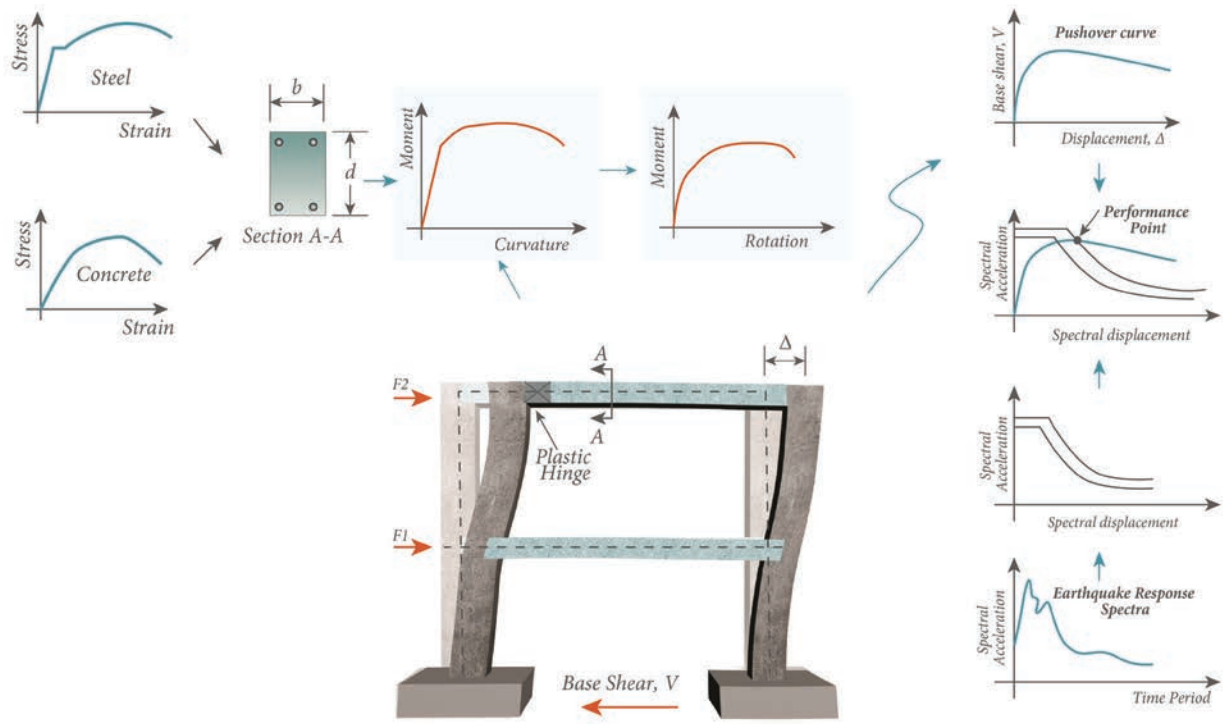


Figure 4: *Moment-curvature curve is one of the key inputs in performance-based design using pushover analysis*

structural performance curve and finally relates to the seismic demand curve defined in the form of Acceleration Response Spectra.

In summary, the moment-curvature curve is a valuable tool which can provide an insight of structural response at an individual cross-section level. It is the basic cross-sectional response that must be determined to carry out any type of nonlinear analysis. It can help in developing a quick understanding of the nonlinear behavior of a member or any assembly of members. The information provided by this curve should be considered by the practicing structural engineers for an effective design structures, not only for the earthquake effects and extreme events, but also for the normal loads. This should not be a secret, rather disclosed and discussed extensively for the benefit of structural engineering and for designing the structures with better performance.

The secret is out! Let's make use of it.

References

1. *ACECOMS (1997) General Engineering Assistant and Reference, GEAR, released by Asian Center for Engineering Computations and Software, ACECOMS, Asian Institute of Technology, Thailand.*
2. *CSI (2001). Section Builder, released by Computers and Structures Inc (CSI), Berkeley, California, USA, (2001)*
3. *CSI (2008). CSICOL 8.4.0 released by Computers and Structures Inc (CSI), Berkeley, California, USA.*
4. *CSI (2012). Section Designer ETABS 2013, released by Computers and Structures Inc (CSI), Berkeley, California, USA.*

From Student Research to Industry Solution

Innovation Lab [ilab] Pioneer Success Stories

Educational institutes like the Asian Institute of Technology (AIT) are well springs of knowledge and research. Students pursue their post graduate studies to achieve higher learning and carry out research studies that can solve issues in society or industry. Innovation Lab [ilab] at AIT Solutions was established for the purpose of finding a new method for developing solutions through innovative and collaborative work between academia and industry.

Researches from students are being converted into industry solutions through [ilab], some of which are presented below:

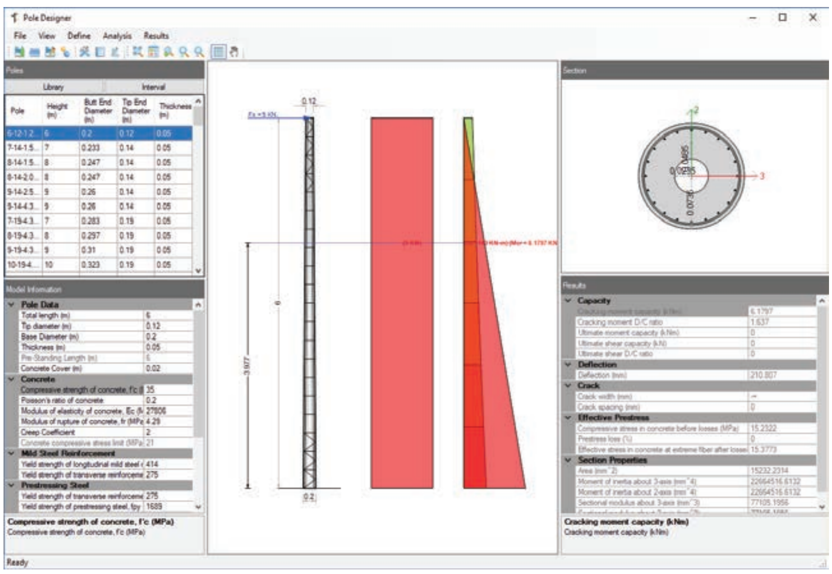
Research: Development of Procedure for Optimize Design of Pre-stressed Poles

Solution: Pole Designer Software

Researcher: Hnin Zar Chi Win

Pre-stressed spun concrete poles are used primarily for supporting electric power transmission lines and for area lighting. It is common to have them placed in aggressive environments, and in many applications they are placed directly in brackish or salt water, resulting in deterioration of the concrete pole due to steel corrosion. The poles that are optimized by developing the procedure used in the design process can provide the desired structural characteristics for high strength pre-stressed concrete poles.

This research work presents an approach to optimize the flexural behavior of spun pre-stressed concrete poles by developing the design procedure. The flexural behavior of the poles was evaluated in terms of load deflection curves, cracking moment, ultimate moment capacities. Primary design equations to estimate these terms were developed based on the equations available in the literature, and the design guidelines for concrete poles. Prototype specimens were manufactured and tested to verify the proposed equations. Pole Designer Software was conducted to increase understanding of the behavior of these poles under loading. The specimens were modeled using the Pole Designer Software and the results were compared with the test results.



Pole Designer is a software developed to analyze and design electricity poles

Research: The Use of Artificial Neural Networks (ANN) for the Preliminary Design of High-Rise Buildings

Solution: Machine Learning Analysis for Tall Buildings Analysis

Researcher: Aadhish Man Rajbhandari

The need for high-rise buildings is increasing in order to meet the challenges posed by rapid urbanization and the exponential growth in population. With recent advancements in computing technologies, innovative materials and new structural systems, the need of prior knowledge about proportioning the geometry and configuration of structural members is also increasing. A relatively quicker and reliable estimation of approximate sizes of members can greatly facilitate the preliminary design and feasibility of the project.

This study uses an Artificial Neural Network (ANN) based approach to directly determine some key design parameters based on experience gained from previously designed buildings. It uses a heuristic tool using ANN that can provide fast and reliable results based on two algorithms (i.e. Multi-layer Perceptron with Back Propagation using Levenberg-Marquardt algorithm MLP-BP, and PCA-Sparse-Extreme Learning Machine with online Sequential learning). The ANN models are trained to determine structural design indicators from architectural parameters. The proposed approach can not only provide means for quick estimation of design output, but can also for crosschecking of code based & performance based design very quickly. The objective is to provide means of assisting the design team and clients to make key design decisions based on cumulative experience rather than relying on judgment of individual designers. The approach is demonstrated through the sample networks trained on various case study high-rise buildings for which the required architectural and structural design results have been generated through detailed design.

Research: Performance Based Evaluation of Nonstructural Components in Buildings

Solution: Machine Learning for Non-structural Damage Analysis

Researcher: Nwe Ni Sein Toe

With the development of seismic design of building, the performance of structural components and systems have been focused for load resisting systems, on the other hand, nonstructural components are mostly overlooked in structural design analysis. During earthquakes, when the harmonization does not occur between structural and nonstructural parts, the nonstructural components which are not considered under seismic requirements are easily more fragile and damaged than structural components. The poor behavior of nonstructural components can trigger to structural load resisting systems when earthquake comes. Moreover, in previous earthquakes, the vulnerability of nonstructural building systems and components has been studied in buildings.

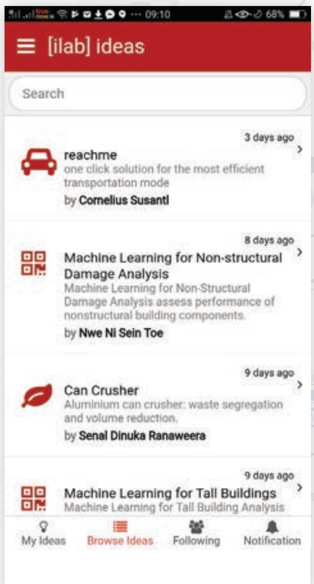
The objective of this study is to assess performance of nonstructural building components including architectural components, mechanical components and building contents in high rise buildings locating in Bangkok and Philippines under the three earthquake levels such as Service Level Earthquake, Design Based Earthquake and Maximum Considered Earthquake. The performance of nonstructural components can be measured by nonstructural damage and the damageability can be translated to losses associating with social losses in term of serious injuries and casualties, direct economic losses regarding with repair cost and indirect losses relating with downtime and business interruption loss. Thus, this study provides the better understanding of nonstructural components from different aspects such as what structural demand parameters they are sensitive to, nonstructural damageability and damage consequences in term of losses.

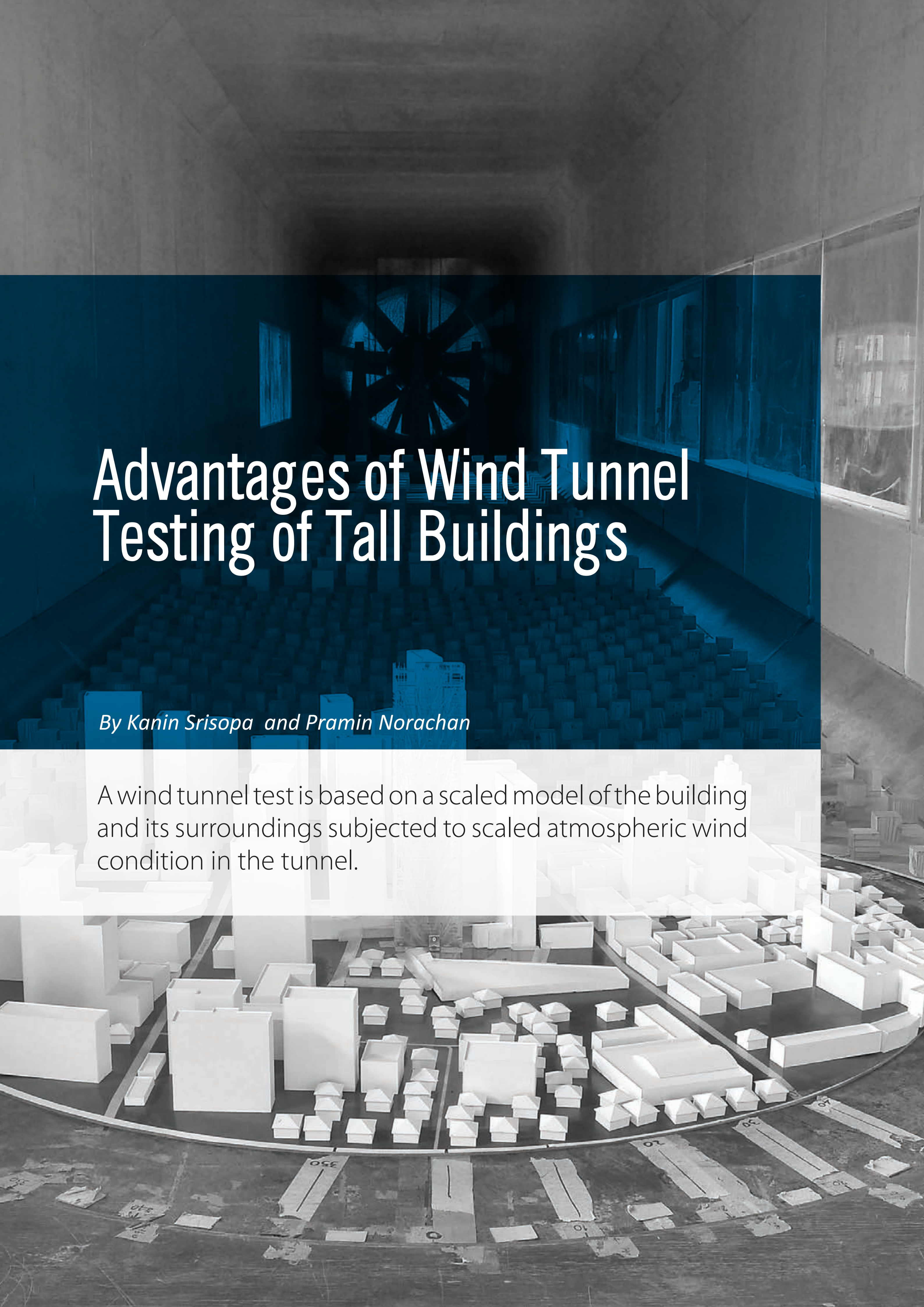

Available in Google Play and App Store
ANDROID APP ON
Google play
Available on the
App Store
DOWNLOAD NOW!
[ilab]
ideas
ETABS
VIEWER
Mobile app for innovators, students, researchers to share, collaborate, and accelerate their ideas to become industry solutions.


[ilab]
ideas


[ilab] ideas
AIT Solutions
[ilab]
AIT Solutions [ilab] ideas is your go-to-app to upload, update, manage your idea and share, collaborate and follow other ideas too.
Login
Sign Up


[ilab] ideas
Search
Ideas can come to you anytime, anywhere. What do you do when you have that lightbulb moment?
Follow Ideas
My Ideas
Browse Ideas
Following
Notification


[ilab] ideas
Search
3 days ago
reachme
one click solution for the most efficient transportation mode
by Cornelius Susanti
8 days ago
Machine Learning for Non-structural Damage Analysis
Machine Learning for Non-Structural Damage Analysis assess performance of nonstructural building components.
by Nwe Ni Sein Toe
9 days ago
Can Crusher
Aluminium can crusher: waste segregation and volume reduction.
by Senal Dinuka Ranaweera
9 days ago
Machine Learning for Tall Buildings
Machine Learning for Tall Building Analysis
My Ideas
Browse Ideas
Following
Notification



Advantages of Wind Tunnel Testing of Tall Buildings

By Kanin Srisopa and Pramin Norachan

A wind tunnel test is based on a scaled model of the building and its surroundings subjected to scaled atmospheric wind condition in the tunnel.

Advantages of Wind Tunnel Testing of Tall Buildings

Nowadays there is no doubt that tall building trends become more slender and complex in terms of building configurations and shapes as designers consider not only functionality but also creativity which leads to put structural engineers to their limit of slenderness. Most of the time, these complex-shape buildings are heavily sensitive to wind loads. Minor modifications of building corners may reduce overall wind loads significantly on the other hand with the particular shape may amplify overall wind loads. Additionally, proposed buildings are going to be constructed where it is surrounded by a number of proximity buildings in city areas that usually create sophisticated situations (i.e. dense tall buildings in some directions and low-rise buildings in some directions or even near the substantial terrain)

With all mentioned above, most of standard wind codes are not able to provide sufficiently precise for an optimal design. They are typically based on a number simple building shapes tested in wind tunnel and do not account for an effect of adjacent buildings (also known as aerodynamic interference effect) which typically, but not always benefits to leeward buildings. To obtain accurate and reliable wind loads, wind tunnel test is commonly carried out which incorporates key factors as follows:

- The aerodynamic effect of the actual geometric of the building
- The aerodynamic interaction between adjacent buildings (aerodynamic interference effect)
- Wind directionality effects

Figure 1: *Example of complex surroundings (taken from AIT-TU wind tunnel)*

A wind tunnel test is based on a scaled model of the building and its surroundings subjected to scaled atmospheric wind condition in the tunnel. The sensors are installed on the model to measure physical quantities such as shear forces, overturning/twisting moments, pressures, etc. These quantities are then converted to full scale using similarity law. By doing this, it allows designers and wind engineers working collaboratively to come up with creative ideas to meet the optimal design. For example, corner shape modification of Taipei 101 to suppress large across-wind loads dramatically. This is not limited to building geometric shape, in some cases, re-orientation of unsymmetrical building footprint may lower down overall wind loads by avoiding coincidence between the critical wind direction obtained from wind tunnel test and the prevailing wind. Apart from that, when a group of tall buildings with closed-spaces are going to be constructed by a single developer, the appropriate layout of group of buildings can be experimentally investigated to avoid amplification of aerodynamic interference effect.

Authors:

Kanin Srisopa
Lead Engineer-
Wind Engineering,
AIT Solutions
Structural Engineering,
Asian Institute of Technology

Pramin Norachan, Ph.D.
Civil and Environmental System Engineering, AIT Solutions,
Asian Institute of Technology

The wind tunnel is used as the main tool for wind engineering to explore different types of wind effects on buildings. A number of techniques are adopted to predict wind responses. A brief description of key wind tunnel tests especially for tall buildings is summarized as follows:

Figure 3: *Complex development with closed-space tall buildings (taken from One Bangkok project)*

Overall wind loads or structural wind loads:

wind loads acting on building can be measured either by High Frequency Force Balance (HFFB) or High Frequency Pressure Integration (HFPI) techniques. The former technique is to use very light-weight and stiff model mounting on the force balance to measure shears and moments at the base of model. While another technique is to simultaneously measure local pressures across the model and then combine them to obtain overall wind loads. These loads will be incorporated with dynamic structural properties provided by structural engineers to come up with equivalent-static wind loads which can be readily added into FEA software.

Cladding wind-induced pressures:

a scaled model is instrumented by hundreds of pressure taps at many locations to measure external pressures. After that, pressure time histories for each tap are processed by statistical analysis to obtain the design external pressures at specific time-averaged wind speed (e.g. 3-seconds gust wind speed). Finally, these design external pressures are then combined with internal pressure to produce recommended cladding pressures. This study will allow façade engineer to know wind load acting on cladding elements locally which leads to cost saving.

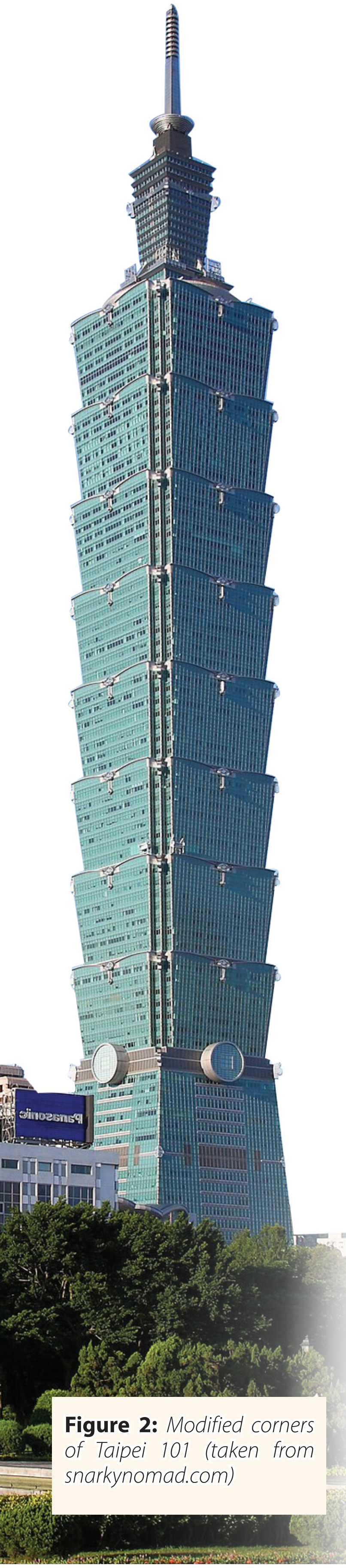


Figure 2: *Modified corners of Taipei 101 (taken from snarkynomad.com)*

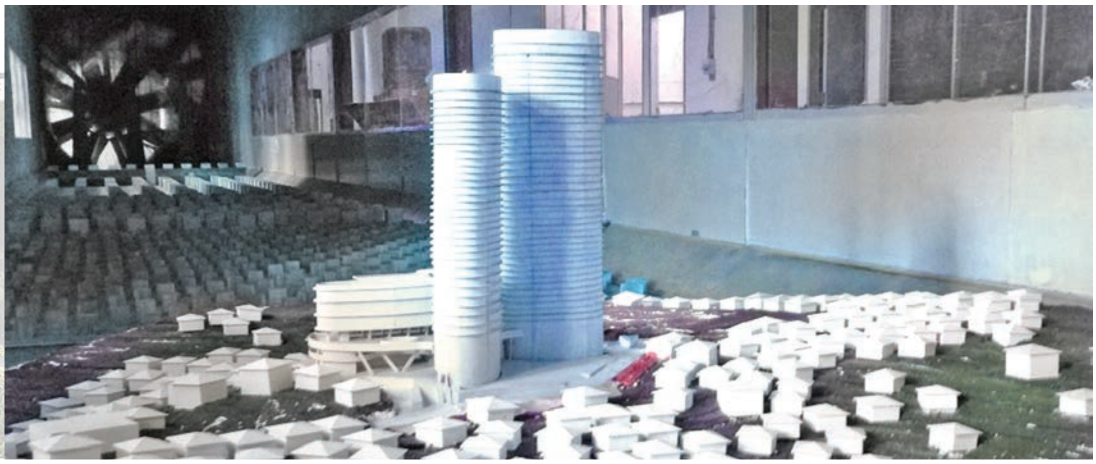


Figure 4: *Example of Force balance model for HFFB technique (taken from AIT-TU wind tunnel)*

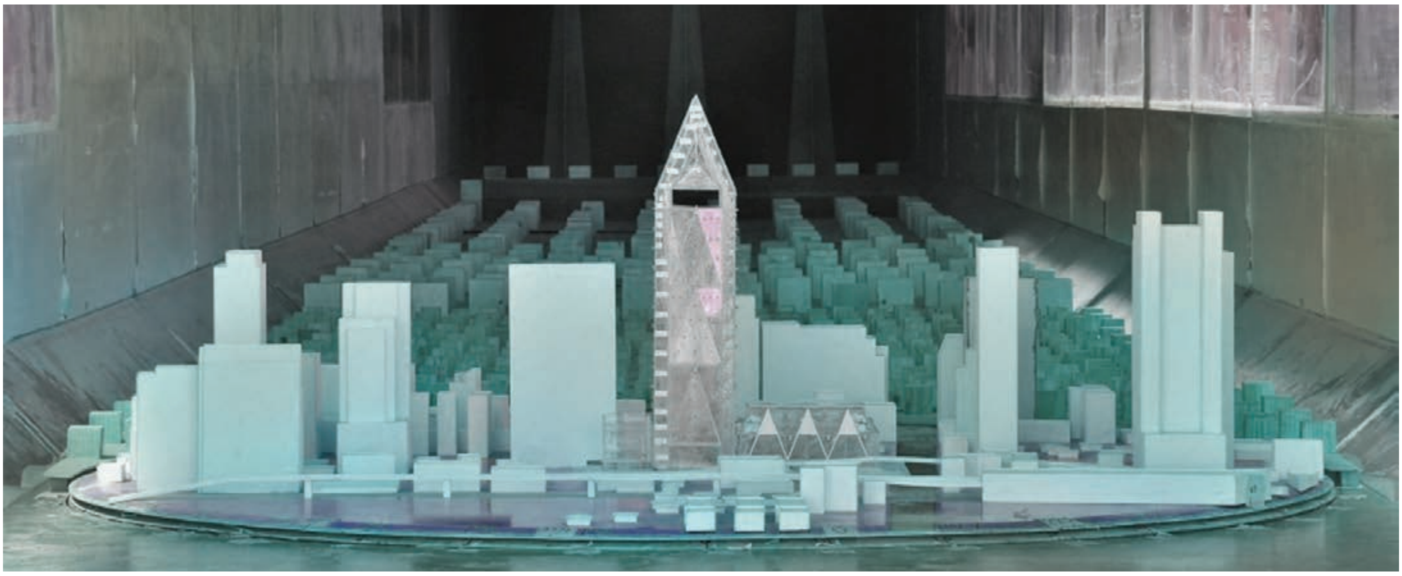


Figure 5: *Example of pressure model with its surroundings (taken from AIT-TU wind tunnel)*

Table 1: Comparison of types of wind tunnel testing

Type	Key results	Advantageous to
Overall wind loads/ structural wind loads study	Structural wind loads in the form of floor by floor and base loads, load effects such as building accelerations for motion sickness assessment	Structural engineers on designing the structure resisting wind loads for both structural design and serviceability
Cladding wind-induced pressures study	Recommended wind-induced pressure contour	Façade engineers in cladding design and optimization of cladding cost
Pedestrian wind comfort study	Wind speeds at pedestrian height with pedestrian comfort & safety assessment	Architects in planning outdoor areas for their intended use

Figure 6: *Example of public areas to be concerned on pedestrian wind comfort (taken from One Bangkok project)*

Pedestrian wind comfort:

Irwin sensors are installed on key different areas such as walking, entrances, outdoor seating, and recreational areas. This is not limited to ground level, measuring locations can be rooftop, balcony, etc. The pedestrian wind speed measured by Irwin sensors will be then assessed with standard criteria for both human- comfort and safety. This will ensure whether considering areas are suitable for their intended use.

Performance Based Seismic Design: Best Practices

The Asian Institute of Technology through AIT Solutions cordially invites everyone to attend a Special Talk by the world's pioneer in Performance Based Seismic Design

Friday, 3 Nov 2017 | 13:00 - 16:00
AIT Conference Center, Thailand

Ron Klemencic

Chairman and CEO
Magnusson Klemencic Associates
(MKA)

"Performance-based Design provides the structural engineer with the opportunity to understand the response of a particular building relative to site-specific conditions."

- Ron Klemencic
(Structure magazine, June 2008)

About the Speaker

Ron Klemencic, P.E., S.E., Hon. AIA is the Chairman and C.E.O. of Magnusson Klemencic Associates (MKA), a 185-person international structural and civil engineering firm headquartered in Seattle. The firm has completed projects in 47 states and 54 countries with an aggregate construction cost of $99 billion. Ron has been the structural engineer-in-charge for more than 175 buildings over 27-stories high in 19 countries. This represents over 190-million square feet of space and over $39-billion in construction cost. He was recognized with the 2016 Fazlur Khan Lifetime Achievement Medal awarded by the Council on Tall Buildings and Urban Habitat (CTBUH) for his engineering excellence of tall buildings and his leadership of the multi-discipline Council.

In 2008, he was named Structural Engineer of the Year by Structural Design of Tall and Special Buildings Journal. His leadership in the collaborative design of tall buildings was recognized with the rare election of an engineer to Honorary Membership by the American Institute of Architects.

His leadership in the development and advancement of performance-based seismic design (PBSD) of tall buildings was recognized with both the 2016 ASCE Ernest E. Howard Award and as a 2008 Top 25 Newsmaker by Engineering News-Record magazine.

AIT Asian Institute of Technology

AIT Solutions
Technology · Engineering · Environment · Development · Management

AIT Experts in the News

AIT's Experts in Structural and Wind Engineering, Prof. Pennung Warnitchai and Dr. Naveed Anwar, shared their expertise several times on media. Prof. Pennung Warnitchai is head of Civil and Infrastructure Group, AIT School of Engineering and Technology (SET) and leading expert on earthquakes. His research also encompasses the areas of structural dynamics, wind effects of structures, bridge engineering, and control of structural vibration.

Dr. Naveed Anwar holds an experience of over 30 years in structural modeling, analysis and design of buildings, bridges, and other structures. He is teaching academic courses to Master's and Ph.D. students in Tall Buildings, Bridge Design and Advanced Concrete Design at AIT. The following is a compilation of their articles and interviews published with various reputable Thai media groups.

Quaking with Anticipation

Published on 10 January 2017
Published by Bangkok Post, Thailand
Prof. Pennung Warnitchai and Dr. Naveed Anwar interviewed by Bangkok Post in a feature story titled "Quaking with anticipation."

Quaking with anticipation

How worried should Bangkokians be about a major earthquake?

Bangkok Post 10 Jan 2017 STORY: YVONNE BOHWONGPRASERT

The question of whether Bangkok's infrastructure is prepared for an earthquake arises whenever we hear news about it happening elsewhere the world. Earthquake-prone New Zealand suffered two months back, and Japan has them often, big and small. Should Bangkok, situated in a safer part of the Earth's untrustworthy crust and yet with more and more tall buildings, be complacent?

At a seminar held last month titled "Design Of Tall Buildings: Trends And Advancements For Structural Performances", Pennung Warnitchai, a leading scholar on earthquakes, offered his view on the subject. Pennung is a professor in structural engineering, disaster preparedness, mitigation and management, and his advice is that we shouldn't be complacent.

"It is difficult say how vulnerable the city is to earthquakes. What I can share with you is the ground motion expected in the event of an earthquake in the capital, which according to our research should not be that strong. But although it is not expected to be so strong, it is possible to shake some types of buildings to the level that they can be seriously damaged. Some of them may even collapse.

"We have seen that in some countries the ground motion might not be that strong, but it's the long-period ground motion that can create a resonant response, which in turn can cause the shaking of tall buildings.

"The problem now is that we have a large number of tall buildings in Bangkok, and some of them are weak and some strong."

Statistics from the Seismological Bureau, Thai Meteorological Department, reveal that tiny earthquakes happen in Thailand nearly every day, though most of them are too small for us to even feel. For instance, a week into 2017 there have already been nearly 50 registered quakes, with only one of them — in Tak province, at 3.9 on the Richter scale — felt by civilians. In December 2016, there were three quakes in the North with reports of people feeling the shakes.

Bangkok, however, seems safer. There are many levels of earthquakes that could also occur in Bangkok, Pennung continued. The one that most people residing or working in high-rises can experience every three or four years is not a strong one. People living in low-rise buildings, under 15 floors, generally don't experience these.

"The worrisome earthquakes are the ones 10 to 20 times larger than that. And, yes, it is possible that we can experience them in Bangkok. The earthquake that can

Create this type of impact will most likely originate about 6-8km from Bangkok. We have geological evidence that a large earthquake happened about 300 years ago in that particular area, and that it could happen again," said the researcher.

"We have determined the location to be around the boundary between two tectonic plates, from the western side of Myanmar down to the Andaman Islands. If indeed a large earthquake happens there, it will have a big impact on tall buildings in Bangkok. There is no

Pennung Warnitchai, a leading expert on earthquakes, conducts tests during a research project with his students.

The story raises the question *"How worried should Bangkokians be about a major earthquake?"* and seeks answers from AIT experts. The interviews were conducted at the AIT seminar *"Design of Tall Buildings: Trends and Advancements for Structural Performances"* held in Bangkok.

The question of whether Bangkok's infrastructure is prepared for an earthquake arises whenever we hear news about it happening elsewhere the world. Earthquake-prone New Zealand suffered two months back, and Japan has them often, big and small. Should Bangkok, situated in a safer part of the Earth's untrustworthy crust and yet with more and more tall buildings, be complacent?

Dr. Naveed Anwar on the impact of Earthquakes and PBD

Broadcast by Radio Thailand's Business News
Broadcast date 3 August 2014 | 7 PM

Dr. Naveed Anwar was interviewed by Radio Thailand's Bruce Avasadanond about the possibilities and impacts of earthquakes in Thailand and the potential of performance-based design (PBD) to evaluate structures by sophisticated simulations. These topics and more were discussed in detail during the recent seminar *"The Theory and Practice of Performance-based Design - The Future of Earthquake Engineering"* hosted by Computers and Structures, Inc. and the Asian Institute of Technology at the Sofitel Bangkok Sukhumvit on 7 August 2014.

Naveed Anwar (NA): *As you know, this question of likelihood of earthquake in Bangkok has been asked many times and a lot of people have commented on it. And in the past people have been sort of led to believe that Thailand and especially Bangkok is not really prone to earthquakes. But recent research in many universities in Thailand including Chulalongkorn, AIT, and Thammasat have now concluded that actually there is a risk in Bangkok and in Thailand in general which may be generated outside the country's boundaries. For example, the one in Myanmar shows a good chance that a reasonably strong earthquake could hit or could affect Bangkok. And the earthquake itself may not be generated nearby, it could be from even farther away.*

Furthermore, he mentioned that the building codes in Thailand did not consider earthquakes as a probable risk. Thus, most of the buildings designed, like 20 years ago may not have considered earthquake and seismic risk in design and construction. The new codes developed recently, however, require that all buildings be designed for a certain level of earthquake and that is based on the current research. This means there are higher risks to the buildings constructed and designed in the past, especially the buildings in the range of 15 to 20 or 30 story buildings - especially pertaining to the type of the soil they have.

Bruce Avasadanond: Talking about your upcoming seminar, you'll be introducing new software. Is that right?

NA: *Actually it's not all that new. This software has been developed by a company called Computers and Structures, Incorporated. It is a California based company and as you know California is a very seismically active area. This company has been doing research in this field for last 30 or 40 years. The founder and president of the company, Mr. Ashraf Habibullah, together with his two vice presidents, will be coming here to share with us the knowledge on earthquake engineering as well as their software that we are also using here which have specially been developed to address the issues of the earthquake resistant buildings.*

We have been very fortunate that we have seen a considerable interest from the engineering community as well as the academia not just pertaining to Thailand. We are getting about 50 participants from Philippines and Myanmar. In fact the entire committee from the Tall Building Council in Myanmar, which validates the designs of tall buildings being constructed in Myanmar, is coming here to join the seminar.

AIT Solutions has been actively doing a lot of training programs. In 2004, when we first started the program, we set up a center called Asian Center for Engineering Computations and Softwares (ACECOMS). The focus was to work on these computational aspects. We started in Philippines because that's where the higher danger was, and now we are very glad that many developers in Thailand are also having their buildings checked by these performance-based criteria and that's very encouraging.

More and more engineers are getting involved. In fact, in the Philippines, we recently evaluated about 60 tall buildings and almost all are new buildings. Our expertise is now, I would say, highly developed in this particular field.

Seminar & Workshop

Design of Tall Buildings: Trends and Advancements for Structural Performance

November 2016 | Thailand

As buildings become taller, the challenges for engineers and architects intensify. As population increases, cities become denser and more innovative buildings are needed to accommodate families living in urban areas. These were some of the many issues deliberated on the seminar Design of Tall Buildings: Trends and Advancements for Structural Performance organized by the Asian Institute of Technology (AIT) in collaboration with Computers and Structures, Inc. (CSI) USA, supported by the Council on Tall Buildings and Urban Habitat (CTBUH), and thyssenkrupp as technology exhibitor held on 7-9 November 2016 at the Sofitel Hotel Bangkok Thailand.

Nearly 150 professionals, engineers, architects, developers, researchers, and students from countries including Cambodia, Indonesia, Myanmar, the Philippines, Singapore, and Thailand joined the seminar. Notable speakers included Arch. Joel Luna, Vice President, Chief Architect, Innovation and Design Group, Ayala Land, Philippines; Engr. Jose A. Sy, President and CEO, Sy^2 + Associates Inc., Philippines; Dr. Karoon Chandrangsu, President, K.C.S & Associates Co.,Ltd; Arch. Maythin Chantra-ou-rai, Executive Director, Architects 49 Limited Thailand; Arch. Winyou Wanichsiriroj, Executive Vice President, Design 103 International Ltd.; Dr. Teraphan Ornthammarath, Lecturer, Mahidol University; Engr. Apichai Siridumrongphun, Project Development Director, Siam Sindhorn.

Speakers from AIT include Prof. Pennung Warnitchai of School of Engineering and Technology; Dr. Naveed Anwar, Executive Director, AIT Solutions (AITS); Engr. Thaung Htut Aung, Deputy Projects Director (AITS), Engr. Keerati Tunthasawatana, Deputy Director, ACECOMS, Dr. Pramin Norachan, Senior Manager, Structural Engineering, AIT Solutions; Shabir Ali Talpur, Senior Engineer, AITS; Engr. S.M.Zia Uddin, Structural Engineer, AITS; and Engr. Fawad Najam, Ph.D. Candidate (AIT).

"We need structural solutions to architectural challenges," Dr. Naveed Anwar, Executive Director of AIT Solutions said while welcoming participants. Dr. Naveed highlighted that the difference of mindsets between structural engineers and architects is that the former are trained to follow procedures, equations, rules, and conform whereas the later are encouraged to dream and be defiant. To pioneer new techniques in designing tall buildings, both need to merge these differences for better collaboration.

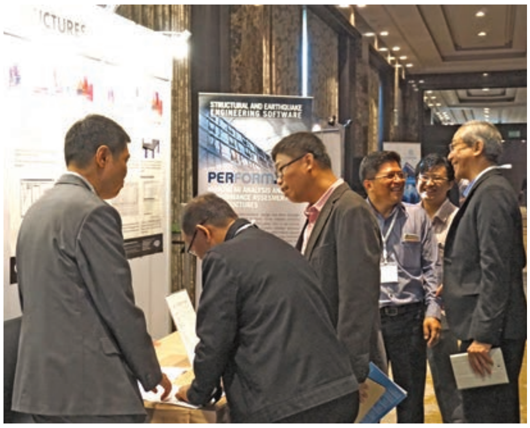
The difference of mindsets between structural engineers and architects is that the former are trained to follow procedures, equations, rules, and conform whereas the later are encouraged to dream and be defiant.

From left: Engr. Earl P. Bonita Head of PBD Department, Sy^2+ Associates Inc.; Arch. Joel Luna, Vice President, Chief Architect, Innovation and Design Group, Ayala Land, Philippines; Engr. Jose A. Sy, President and CEO, Sy^2 + Associates Inc., Philippines; Dr. Karoon Chandrangsu, President, K.C.S & Associates Co.,Ltd.; Dr. Naveed Anwar, Executive Director, AIT Solutions; Rex Sirilan Head of R&D Department, Sy^2+ Associates Inc.

Architect Joel Luna of Ayala Land, Inc., the largest property development firm in the Philippines (during the event, Arch. Luna was still with Ayala Land), stated that by 2050, two-thirds of humanity will be residing in cities. He emphasized that the key challenges and opportunities in developing Tall Buildings include: connectivity, to foster community interaction, sustainability, to create a balance between built and natural environment, and inclusivity, which can serve more people.

Engineer Jose A. Sy, President of Sy^2 + Associates Inc., Philippines elaborated that engineers should not be bound by the limitations of building codes, as code compliance is not enough to address design and architectural challenges. The Philippines is located along the Ring of Fire and faces 24 typhoons every year, which means that the country has the same earthquake risk as California, Japan, New Zealand and Haiti. The practices, however, of earthquake engineering are not yet at par with the mentioned countries which can be addressed with combining collaboration and creativity.

Developments discussed during the three-day seminar included ***Progression of Structural Design Approaches, Structural Engineering Solutions to Architectural Challenges, Smart Systems for Structural Response Control, Performance-Based Design, Value Engineering, Peer Review, Probabilistic Seismic Hazard Assessment, Wind Tunnel Test, State of Practice in Design of Tall Buildings in Philippines, and Architectural Innovations and Challenges in Tall Buildings.*** The seminar was followed by hands-on workshop using CSI software for structural engineers held in AIT campus for two days and a field visit at wind tunnel lab and G Land Tower.



The event served as a networking platform for professionals working in design and construction of tall buildings

Mr. Ian Smith, Vice President, Special Projects, thyssenkrupp Elevator, presented ***"Vertical Transportation for a High Rise World"***

Panel discussions were held at the end of each day for participants to be able to interact and ask questions to experts

Design of Tall Buildings and Affordable Housing

March 2017 | Oman

Participants included structural designers, engineers, consultants, architects, researchers, and post-graduate students

Rapid urbanization has led to an increased demand for innovative and sustainable commercial, residential, and social infrastructure solutions. This demand in infrastructure that cover broadly office buildings, public facilities, schools, and clinics, highlights the emerging need for the engineers to know about the latest in engineering tools required to ensure safety and performance of buildings and housing facilities.

The Asian Institute of Technology (AIT) in collaboration with Sultan Qaboos University (SQU) and Oman Society of Engineers organized a One-day Seminar: Design of Tall Buildings and Affordable Housing held on 12 March 2017 at Sultan Qaboos University Campus in Muscat.

SQU and AIT (through AIT Solutions and Habitech) started collaborating in 2014 on a research project to develop a way to provide an effective onsite solution utilizing the water generated during oil extraction in the drilling sites of Petroleum Development Oman.

Tall Buildings Design Trends and Advancements for Structural Performance

April 2017 | Pakistan

AIT Solutions in collaboration with National University of Science and Technology (NUST), Islamabad, Pakistan organized a two-day international seminar and workshop on Design of Tall buildings: Trends and Advancements certified by Pakistan Engineering Council held on 24-25 April 2017 at NUST Institute of Civil Engineering building.

More than 100 professionals, engineers, developers, researchers, and students joined the event. During the second day workshop, Dr. Naveed Anwar discussed the Application of Performance-based Design to actual projects through Case Studies. Use of software tools: ETABS and Perform 3D, Matlab and SIMULINK was discussed by Dr. Munir Ahmed and Dr. Muhammad Usman respectively.

Analysis and Design of Tall Buildings

October 2017 | Philippines

The Association of Structural Engineers of the Philippines (ASEP) in collaboration with AIT and AIT Solutions hosted the Seminar and Workshop on Analysis and Design of Tall Buildings from 3-6 October 2017 in Manila, Philippines.

The seminar was conducted by experts and experienced engineers and software developers from AIT Solutions who are working on more than 100 tall buildings in Asia led by Dr. Naveed Anwar, Executive Director; Engr. Thaung Htut Aung, Deputy Projects Director; Engr. Mir Shabir Ali Taipur, Senior Project Engineer; Engr. S.M. Ziauddin, Senior Project Engineer.

CSi CLOUD

Your models on the Go

A NEW SERVICE FROM COMPUTERS AND STRUCTURES, INC.

SAP2000 VIEWER

ETABS VIEWER

Available on the App Store

ANDROID APP ON Google play

Available on the App Store

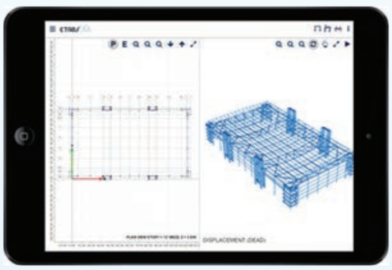
ANDROID APP ON Google play

CSI Cloud is a new service enabling users to upload their SAP2000 and ETABS models to their Dropbox accounts via linked CSI Cloud accounts.

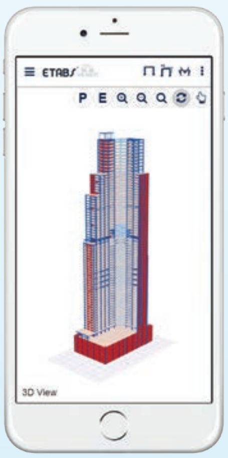
Engineers can then view their uploaded models in the new SAP2000 and ETABS Cloud Viewer apps, now available for iOS and Android.

ETABS Cloud Viewer

Cloud Viewer helps in viewing mode shapes, structural deformations and force diagrams produced by various loading conditions, including wind and earthquake on smartphones.

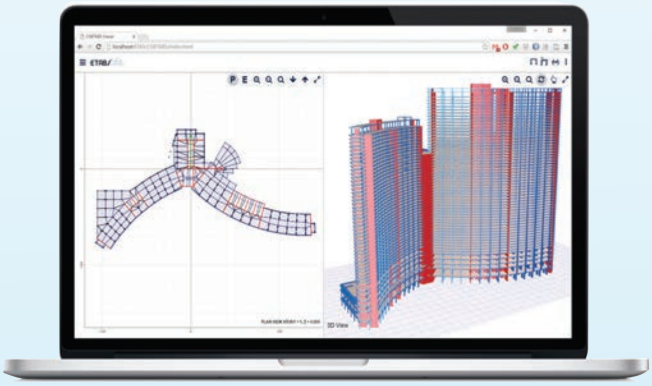


Tablets



iOS

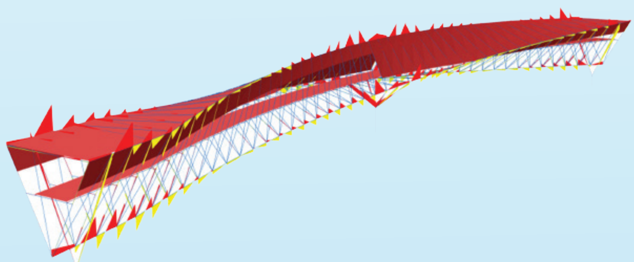
Android



PC/Mac

SAP 2000 Viewer

Cloud Viewer helps in viewing mode shapes, structural deformations and force diagrams produced by various loading conditions, including wind and earthquake on smartphones.



VISIT OUR WEBSITE

Our website *www.solutions.ait.asia* is regularly updated with news, upcoming events, multi-media, and our initiatives.

JOIN OUR FACEBOOK PAGE

Visit our Facebook pages:

@aitsolutionsasia

@ilabaitsolutions

@aittigerleongcamp

@WEMSSecretariat

SIGN UP TO OUR NEWSLETTER

Get monthly updates on our news and events when you subscribe to our newsletter.

WATCH OUR VIDEOS

We upload lectures, presentations, experts talk, and other informative videos in our Youtube channel so please subscribe to AIT Solutions channel.

LET'S GET SOCIAL