1ST fib-YMG Indonesia

ANNUAL GATHERING & WORKSHOP

16TH November 2019

JAKARTA DESIGN CENTER

fib Indonesia Young Members

"Disruption in Concrete Technology"

PROGRAM

PROGRAM

08:00 – 08:30	**Registration**	
08:30 – 09:00	**Opening**	
	Indonesia Raya (National Anthem)	MC
	Opening speech	Dr. Andri Setiawan
09:00 – 10:45	**Keynote Lectures**	
09:00 – 09:45	fib and Model Code 2020	Dr. David Fernandez Ordonez
09:45 – 10:30	RSNI3 2847:20XX	Prof. Ir. Iswandi Imran, MA.Sc., Ph.D.
10:30 – 10:45	Q & A session	Moderator
10:45 – 11:00	**Coffee Break**	
11:00 – 11:50	**Session 1: State-of-the-Art**	
11:00 – 11:20	Damage evaluation of lightly reinforced concrete walls in moment resisting frames under seismic loading	Eko Yuniarsyah, S.T., M.T., D.Eng.
11:20 – 11:40	Reinforcement spacers: What are they and how they affect durability of concrete structures?	Fadhilah Muslim, S.T., M.Sc., Ph.D. (DIC)
11:40 – 11:50	Q & A session	Moderator

11:35 – 12:15	**Session 2: Project Presentation**	
11:50 – 12:10	MRT Jakarta	Riska Muslimah, S.T.
12:10 – 12:20	Q & A session	Moderator
12:20 – 13:40	**Lunch break & sponsor presentation**	
12:20 – 13:00	Lunch break	
13:00 – 13:20	Sponsor presentation	PT. PP Persero
13:20 – 13:40	Recruitment of fib-YMG Indonesia	Dr. Andri Setiawan
13:40 – 15:00	**Session 3: Implementation of New Technology in Concrete Projects**	
13:40 – 14:00	Structural Health Monitoring System (SHMS)	Ir. Widi Nugraha, M.T.
14:00 – 14:20	3-D concrete printing	Fajar Saiful Bahri, S.T., M.B.A.
14:20 – 14:40	Building Information Modelling (BIM)	Ir. Novias Surendra, M.Sc.
14:40 – 15:00	Q & A session	Moderator
15:00 – 15:30	**Closing ceremony**	MC

Abstract and speakers' resume

Questionnaire (feedback)

SPEAKERS PROFILE

Dr. David Fernández-Ordóñez

Secretary General of fib
(The International Federation for Structural Concrete)

Invited lecturer for prefabrication at EPFL, École Polytechnique Fédérale de Lausanne. Switzerland

Has been:

- Chairman of *fib* Commission 6, Prefabrication.
- Convener of the groups of Affordable Housing and Sustainability of Precast Structures and Secretary of the group Precast Concrete Bridges.
- Lecturer at the Technical High School of Civil Engineers of Madrid (Escuela Técnica Superior de Ingeniería Civil). Polytechnic University of Madrid.
- Technical Manager of Pacadar and Castelo, both precast concrete companies in Spain for the design and construction of buildings and bridges.
- Member of the Board of the Juanelo Turriano Foundation, dedicated to the study of the history of technology.
- Has written more than 150 publications on prefabrication and history of technology.

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Prof. Ir. Iswandi Imran, MA.Sc., Ph.D.

Full Professor, Institut Teknologi Bandung
Chair of Technical Group [SNI 2847:20xx]

Iswandi Imran is currently a full professor at Institut Teknologi Bandung. He obtained his bachelor degree from Institut Teknologi Bandung in 1987. He obtained his master's and doctoral degree from University of Toronto, Canada. His research interests include: 1) concrete materials and structures; 2) earthquake resistance reinforced concrete structures; 3) corrosion and durability of concrete structures; 4) structural assessment, repair and retrofit of bridges.

He is also an active member of Tim Penasehat Konstruksi Bangunan (TPKB) DKI Jakarta, Tim Ahli Bangunan Gedung (TABG) Kota Bandung and Komisi Keamanan Jembatan dan Terowongan Jalan (KKJTJ). Recently, he was elected as the chair of technical group which is responsible for the development of new Indonesian concrete code, SNI 2847:20xx.

Eko Yuniarsyah, S.T., M.T., D.Eng.

Structural Engineer, PT. Adiya Widyajasa
Member of Technical Group [SNI 2847:20xx]

Eko Yuniarsyah obtained his bachelor's and master's degree from Institut Teknologi Bandung in 2009 and 2011 respectively. He worked for 2 years as a structural engineer in Bandung (2011-2013) before pursuing his doctoral degree in Tokyo Institute of Technology (2014-2018). During his doctoral study in Japan, he was involved in several research projects, including: 1) Experimental Study on Confined RC Wall Boundary Regions under Uniaxial Monotonic and Cyclic Reversal Loadings; 2) Damage Evaluation of Lightly RC Walls in Moment Resisting Frames under Seismic Loading through Experimental and Finite Element Analysis; 3) Experimental Study of Lightly Reinforced Concrete Walls Upgraded with Various Schemes under Seismic Loading; and 4) Static Loading Test on A Full Scale Five Story Reinforced Concrete Building Utilizing Wing Walls for Damage Reduction.

He is currently involved as a member of the technical group which is responsible for the development of new Indonesian concrete code, SNI 2847:20xx.

Fadhilah Muslim, S.T., M.Sc., Ph.D. (DIC)

Lecturer, Universitas Indonesia

Fadhilah Muslim is currently a lecturer at the Department of Civil Engineering, Universitas Indonesia (UI). Prior to working at UI, Fadhilah Muslim joined the Concrete Durability Group at the Department of Civil and Environmental Engineering, Imperial College London under the supervision of Professor Nick Buenfeld and Dr Hong Wong and received her PhD degree in September 2018. She was trained as a civil engineer at UI, where she obtained an award as the best-graduated student of her class in 2012 and received an offer to become a lecturer due to her excellent grades. She then completed her M.Sc. in Concrete Materials at the Ecole des Ponts ParisTech (ENPC), funded by both the French and Indonesian governments. Fadhilah Muslim received several prizes and scholarships in recognition of her excellent academic achievements and is involved in many communities and associations due to her outstanding intrapersonal and leadership skills. Her research interests are in the area of microstructure and durability of concrete materials, directed at understanding and improving the long-term performance of the concrete structures that form most of the infrastructure in the world. She teaches undergraduate and postgraduate modules on Structural Mechanics, Concrete Materials and Technology, and Reinforced Concrete Design.

Riska Muslimah, S.T.

Head of Civil Infrastructure Department
PT. MRT Jakarta (Perseroda) (MRTJ)

Riska Muslimah is the Head of Civil Infrastructure Department under Engineering Division, Construction Directorate, at PT MRT Jakarta (Perseroda) (MRTJ). She started working at the company as Civil Engineer in 2015, after having one and a half year working experience as a Junior Structural Engineer at PT Wiratman & Associates. During her five years working at MRTJ, she has been involved in Engineering Management of small-scale to large-scale projects, mainly in Railway or Infrastructure Projects: Basic Engineering Design (BED) and Project Preparation of Jakarta MRT 2nd Phase (Bundaran HI – Kota), Detail Engineering Design (DED) of Transport Hub in Dukuh Atas, Preparation of Tender Document of Sky Bridge connecting ASEAN MRT Station to CSW, Project Funding of Jakarta MRT 2nd Phase (JICA Loan), and DED of Jakarta MRT 1st Phase (Lebak Bulus – Bundaran HI), including its permit process. Riska Muslimah obtained her bachelor's degree with distinction from Institut Teknologi Bandung in 2013.

Ir. Widi Nugraha, M.T.

Researcher in Structural Bridge Engineering, Puslitbang Jalan dan Jembatan
Ministry of Public Works

Widi Nugraha obtained his bachelor's and master's degree from Institut Teknologi Bandung in 2013 and 2015 respectively. After completing his master's degree, Widi Nugraha joined Puslitbang Jalan dan Jembatan, Ministry of Public Works. After completing his engineer professional education in 2017, Widi Nugraha is currently pursuing his doctoral degree at the same university.

Widi Nugraha received several prizes in recognition of his excellent research performance, including: 1) Penghargaan Pegawai Muda Teladan (2018); 2) Penghargaan Peneliti Pertama Terbaik (2016), both by Ministry of Public Works and Housing (PUPR) of Indonesia; 3) Penghargaan Peserta Diklat Jabatan Fungsional Peneliti Terbaik Kedua (2015) by Pusbindiklat LIPI.

Fajar Saiful Bahri, S.T., M.B.A.

Senior Manager, Business Development and Investment Division
PT PP (Persero)

Fajar Saiful Bahri obtained his bachelor's degree in Civil Engineering from Universitas Diponegoro in 2004. In 2019, he obtained his M.B.A from Prasetiya Mulya Executive Learning Institute, in collaboration with University of Queensland. He is actively involved in several professional trainings, including: lean construction, engineering professional ethics, and project managements.

Fajar Saiful Bahri started his career in PT. PP (Persero) in 2004 and since then, he has been experiencing several technical roles, including: site engineer, site engineering manager, site operational manager, project manager, contract administration manager, construction manager. Currently, he is a Senior Manager in Divisi Pengembangan Bisnis dan Investasi at PT. PP (Persero).

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Ir. Novias Surendra, M.Sc.

General Manager
Departemen Pengembangan Sistem
PT. Wijaya Karya (Persero)

Novias Surendra obtained his bachelor's degree in Civil Engineering from Institut Teknologi Bandung (ITB) in 1993. He directly joined PT Wijaya Karya Tbk (WIKA) after completing his study in ITB. In 2011, he obtained his master's degree from Hochschule für Technik und Wirtschaft (HTW) Berlin, Germany.

During his career in WIKA, he has been involved in several infrastructure projects, both nationally (Terminal Mobil Tanjung Priok, Pelebaran Toll Jagorawi Seksi E3 Cibubur – Cibinong – Sentul, Semarang Northern Ring Road, Niru Connecting Track in South Sumatera) and internationally (Algerian Highway Project in North Africa). He was promoted to a project manager position in 1998 and, in 2012, he was further promoted to a position at the senior management level in Departemen Konstruksi Infrastruktur, Investasi dan Power. Since 2017, he has served as general manager (GM) in Departemen Pengembangan Sistem WIKA.

ABSTRACT

Damage Evaluation of Lightly Reinforced Concrete Walls in Moment Resisting Frames under Seismic Loading

Eko Yuniarsyah, Susumu Kono[a], Masanori Tani[b]
Taku Obara[a], Hidekazu Watanabe[c], Tomohisa Mukai[c]

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[b]*Department of Architecture and Architectural Engineering, Kyoto University, Nishikyo, Kyoto 615-8540, Japan*

[c]*Department of Structural Engineering, Building Research Institute, Tsukuba, Ibaraki 305-0802, Japan*

Masonry walls are generally used as infills in reinforced concrete (RC) frames in many countries. In Japan, however, RC moment resisting frames are usually constructed monolithically with lightly reinforced infill walls with opening (spandrels, wall piers, and wing walls). Lightly RC walls are typically 120 to 200 mm thick, and have a single curtain of reinforcement in two directions with a few additional boundary vertical reinforcing bars at section ends. Although such walls are connected rigidly to the surrounding frame, structural engineers do not necessarily treat them as structural components due to large openings and often neglect their contributions to the lateral load carrying capacities in practical structural designs. In the 2011 Tohoku and the 2016 Kumamoto Earthquakes, many lightly RC walls in residential and government office buildings suffered severe damage. Most damages to these walls were due to shear cracking or failure. Such damage

may not hinder the building safety but is likely to suspend the continuity of the building functions. Although several studies have been conducted on the seismic performance of frames with lightly RC walls, no general method has been established to evaluate their seismic damages quantitatively. Therefore, further research is necessary to understand the behavior of lightly RC walls, in particularly focusing on their damage processes including failure modes. An experiment was conducted on four lightly RC wall specimens to study the effects of axial force, amount of shear reinforcement, and shear span to wall length ratio on damage process. The main objective is to obtain fundamental data, such as damage state, load carrying capacity, and failure mode of lightly RC walls under seismic loading. A quantitative seismic damage evaluation in terms of crack width, crack length, and concrete spalling area was carried out to investigate the correlation between seismic damage and lateral drift. The damage level of walls was assessed using the 2004 Architectural Institute of Japan (AIJ) Guidelines, which takes into account the level of damage such as residual crack width or stress level of concrete and reinforcement. Considering the total amount of damage (crack length and spalling area), the criteria of the guidelines well captured damage level of lightly RC walls.

Reinforcement spacers: What are they and how they affect durability of concrete structures?

Fadhilah Muslim[a]

[a]*Lecturer, Department of Civil Engineering, Universitas Indonesia*

Spacers are important devices in reinforced concrete that are used to support reinforcing steel during concreting in order to achieve the required cover. They are placed at every meter length or less of steel reinforcement and left permanently in the structure. However, very few studies have been carried out on the effect of spacers on the performance of concrete. The work aims to develop a better understanding of the influence of spacers on the microstructure and long-term durability of concrete structures. The work also aims to develop methods to enhance bonding and mechanical interlocking of spacers with concrete.

Extensive experimental testing was performed. Concrete samples containing a range of commercially available spacers (plastic or cementitious) were prepared with different binder types including Portland cement CEM I and CEM I blended with silica fume, fly ash or ground granulated blast-furnace slag. Samples containing horizontal or vertical spacers were prepared, cured in a fog room (100% RH, 21°C) for various periods before bond strength measurement. Samples were also conditioned at 75% RH, 21°C or in a 50°C oven for microstructure analysis

and transport testing such as oxygen diffusion, oxygen permeation, water absorption, electrical conduction, chloride penetration, and fluorescent epoxy impregnation. Finally, a large number of prefabricated modified cementitious spacers were prepared with a range of mix compositions and surface textures and then cast into concrete for splitting tensile strength and transport testing. Results showed that the inclusion of spacer in reinforced concrete produces a weak, porous and micro-cracked interface regardless of whether the spacer was cast for horizontal or vertical reinforcement. This lowers the resistance of concrete to ingress of aggressive agents. Cross-sections of fluorescence epoxy impregnated samples images under UV light showed a preferential transport along the spacer-concrete interface. Higher penetration of chloride ions was also detected along the interface compared to the bulk paste farther away from the spacer and to the control sample without a spacer. The extent of the effect of spacer depends on the spacer type and binders used, and drying regime.

Modifying the spacer surface textures has a clear effect on increasing their interlocking with concrete, and this leads to a significant improvement in the bond strength of the spacer-concrete interface by up to 133%. This was found to decrease the tendency for cracking at the spacer-concrete interface due to differential volume changes, thus leading to a significant decrease in pressure-induced flow. The effect of surface texture on the overall strength of spacer-concrete interface and transport properties is dependent on the roughness, shape, and orientation of the spacer surface texture.

Planning & Construction of Jakarta MRT System - Increasing Mobility, Improving Life Quality

Riska Muslimah [a]

[a]*Head of Civil Infrastructure Department, PT MRT Jakarta (Perseroda)*

Jakarta MRT System has been introduced through series of studies since 1982. Early studies were focusing on route selection for North-South line, which was the busiest line. Considering the scope of the project, it was recommended to build the North-South line into two stages, namely Phase 1 and Phase 2. Phase 1 corridor was finalized in the Basic Engineering Design (BED) (November, 2009): Lebak Bulus – Bundaran HI, and the 1st Groundbreaking was done on October 2013.

The construction works took almost 6 years, with various challenges both in the technical and non-technical aspects. Generally, Japanese Standard and other international recognized codes and standards were adopted for the design concept. However, compliance to relevant and applicable local regulations (SNI, PM, etc.) was essential, especially in order to get the required certification. Although some discrepancies found were properly justified, this shall be a trigger for the Government to make local regulation for MRT system. For instance, MRTJ has been supporting Kementerian PUPR (Balitbang Pusjatan) in their research since 2016, to develop guidelines (Pedoman) for earth pressure balance tunneling.

The Project was successfully completed and the commercial operation of 15.7 km MRT line was launched on 24 March 2019. There was, however, many rooms for improvement as lesson learned for planning and building the next phases and MRT project in other cities. These included improvement for advanced works (land acquisition & utility handling), design integration (BIM application), SHES requirement, etc.

PT MRT Jakarta (MRTJ) is currently finalizing the BED of North-South extension line, starting from Bundaran HI going underground 6 km all the way to northern Jakarta (Kota). In fact, DKI Jakarta Government has plan to expand MRT network for another ±200 km to be completed tentatively in 2030. In order to achieve this "ambitious" target, not only MRTJ and the Government but also the society, need to work together. Ultimately, planning and building MRT system is not only about increasing mobility, but also improving our life quality.

Implementation of Structural Health Monitoring System on Indonesia Bridge Infrastructure

Widi Nugraha[a]

[a] *Institute of Road Engineering, Ministry of Public Works and Housing Republic of Indonesia*

Nowadays, infrastructure sector is one of top priority of Indonesian government. The main focus of government in this sector is to build new one so it can be use immediately for economic growth sake. But that wasn't enough, since infrastructure also need attention in operational and maintenance. Indonesia has many existing bridge infrastructures that was built around 1970 to 1980 on main logistic line that need special attention since bridge structure condition deteriorate over time. The conventional method to monitor bridge structure performance is by doing routine visual inspection and special inspection periodically by engineers. Since Indonesia has very large number of bridge all across islands, also there are many old bridge that need special attention and detailed inspection, there is Structural Health Monitoring System (SHMS) come to handy. SHMS is a method to monitor the health of a structure using different kind of sensors installed on the structure that has structure response and loads that working on the structure as the output on continuous real time basis. Sensors that commonly used in SHMS are strain gage, structure load sensor (WIM for bridge loads, temperature, anemometer for wind, etc.), accelerometer, and also deformation sensor such as LVDT. Lately in

Indonesia, implementation of SHMS on bridge structure has been done, for example on Merah Putih Bridge in Ambon, Maluku. From that implementation experience, the bridge operational and maintenance can be done effectively and efficiently. The system also has early warning system that automatically activated when some threshold limit of the response from the sensors has been reached, and then the bridge administrators can make quick decision to prevent and minimize danger that could happened for the structure or the bridge users.

Questions & Answers

Q&A Session 1

Speakers:
Dr. David Fernandez-Ordonez
Prof. Ir. Iswandi Imran, MA.Sc., Ph.D.

1. Question

Does the "escape clause" section in the new concrete code (RSNI3 2847:20xx) allow the adoption of other design codes?

Answer (Iswandi Imran)

Yes, it is plausible to implement other codes, especially for design codes that have been accepted worldwide. However, it is important to remark here that the final decision must be made by the committee (checker) after conducting a thorough review process. In addition, the compatibility between other codes and SNI in terms of design parameters (i.e. safety factor, load factor, etc.) must be carefully checked.

2. Question

How practitioners could inform their colleagues who could not attend the fib events about recent activities/updates of fib?

Answer (David Fernandez-Ordonez)

This can be done through journal papers, bulletins, conference proceedings that are published in a frequent time basis (monthly/annually) by the fib.

3. Question

Is there any formal standard or standardized guideline that can be referred to when determining an ideal curing temperature for geopolymer concrete? We had an experience of curing the concrete with a controlled temperature of 120^0 C during the hydration stage and it ended up damaging the concrete itself.

Answer (Iswandi Imran)

In general, curing for geopolymer concrete can be distinguished into two types: 1) room temperature curing; 2) high temperature curing. It is important that, even for the latter type, the curing temperature should not be increased beyond 80^0 C.

For the high temperature curing, it is recommended to use non-reactive material types. However, it is important to note that the steam curing process should be performed with a temperature less than 80^0 C for a duration of around 4-5 hours. At the construction site, the use of very high temperature is also not practical (unless if precast elements are used).

In addition, different material types are activated at different temperature levels. Thus, future research to derive a nomogram relating the hydration temperature with the material types would be useful.

Q&A Session 2 & 3

Speakers:
Eko Yuniarsyah, S.T., M.T., D. Eng
Fadhilah Muslim, S.T., M.Sc., Ph.D. (DIC)
Riska Muslimah, S.T.

1. Question

Why does MRT also handle the TOD (Transit Oriented Development)?

Answer (Riska Muslimah)

MRT Jakarta was granted three responsibilities, one of them is to handle the TOD. MRT Jakarta also holds the rights according to Pergub (Peraturan Gubernur) to manage the region. In addition, MRT Jakarta requires additional income in order to afford the subsidized MRT fares.

2. Question

It was stated during the presentation that the goal of MRT Jakarta is not only increasing mobility but also improving life quality, the question is: how much life quality has been improved since the commencement of phase 1 – MRT Jakarta?

Answer (Riska Muslimah)

Development of MRT Jakarta has become the center of attention, especially from the perspective of media. There is an interesting article discussing about how people in Jakarta "unconsciously" change their behavior when using the MRT.

For example, violation against rules, which are quite common elsewhere, were not observed inside the MRT Jakarta facilities. This indicates that MRT Jakarta also helps educating the society. Besides, people in Jakarta are fully aware that maintaining MRT Jakarta facilities are not only government but also their collective responsibility.

3. Question

From your perspective, what would be the future research of concrete spacers?

Answer (Fadhilah Muslim)

The results described earlier in the presentation were acquired from the first two years of my PhD study. In the 3rd and 4th year of my PhD, I focused on improving the performance of the spacers. The main issue with the use of spacers is high porosity level, especially in the interface region between spacers and concrete. There are some potential solutions:

1. Modification of the shape and texture of the spacers to maximize the penetration path (distance) from the concrete surface to the level of reinforcement bars (to delay the corrosion process).
2. Modification of the interface region between concrete and spacers to minimize the porosity level.
3. Installing sensors at the interface between concrete and spacers to detect any durability issue as early as possible.

Q&A Session 4

Speakers:
Ir. Widi Nugraha, M.T.
Fajar Saiful Bahri, S.T., M.B.A.
Ir. Novias Surendra, M.Sc.

1. Question

Bridges are typically designed with service life of around 75 years, the question is: how to maintain the SHMS (especially the sensors) to function optimally during this whole service life?

Answer (Widi Nugraha)

Each of sensor devices integrated in the SHMS has their own service life (may vary depend on their exposure level). For devices that are directly exposed to external environment, the service life is typically shorter hence is more critical for maintenance. Generally, annual calibration is required to check and ensure that all the sensors are working properly. If some errors beyond the accepted tolerance are observed, the corresponding sensor must be immediately changed with the new one.

2. Question

Contractors, owners, design consultants and quantity surveyor are currently using different BIM software. Consequently, the information gathered by each stakeholder may vary depending on their focus, the question is: what is the best way to synchronize the data exchange process

between stakeholders?

Answer (Novias Surendra)

BIM is a communication medium that can be manifested as different platforms (or software). The main consideration when determining an appropriate platform is interoperability so that it can still be used compatibly with other platforms. Ideally, it would be best to ensure all the stakeholders use the same platform for the whole project. PT Wijaya Karya decided to take the first initiative to use BIM and determine the chosen platform so that other involved stakeholders may simply follow.

3. Question

In the future, construction process will be mostly autonomous. However, this ideal situation would require a huge initial investment that is much higher than the conventional (traditional) approach, the question is: how to ensure that the implementation of cutting-edge technologies may still be profitable from the business perspective?

Answer (Fajar Bahri)

Investment in construction technology should always be preceded by a comprehensive feasibility study. In 3-D printing, a unique approach in the business planning is required. Currently, the use of 3-D printing in Indonesia is still too costly since both the printers (robots) and the printing materials are imported. In the future, a collaboration between several state-owned companies (BUMN) can be proposed to reduce the operational cost. In addition, value engineering could be done by adjusting the dimension of the structural

components to environmental condition in Indonesia. For example, thickness of the external wall (façade) could be made thinner in Indonesia because the temperature difference between inside and outside the room is negligible, unlike in Europe.

Answer (Novias Surendra)

'A good formula' to introduce an innovation (disruption) in construction world is: "Better, Faster, and Cheaper". As long as the new technology can satisfy these three pillars then it would be quickly accepted worldwide. In terms of the implementation of BIM in Indonesia, the third variable which is cheaper is probably the main hindrance. To anticipate this, it is important to ensure that the technology will be used not for a single but for multiple projects. Thus, the ratio of the BIM investment cost to total project cost would be smaller.

Answer (Widi Nugraha)

From the owner's perspective, which is PUPR (Pekerjaan Umum dan Perumahan Rakyat), we have the urgency to introduce a new technology in Indonesia. Thus, the initial investment cost on implementing the SHMS has been considered within the project cost itself. In addition, PUPR has already developed a long-term roadmap which has an end goal to enforce the use of SHMS in all the future PUPR projects.

4. Question

1) How far is the current implementation of BIM in PT Wijaya Karya?

2) Is there any limitation of the laser scanning process, for example: is there any materials that cannot be detected?

Answer (Novias Surendra)

1) In PT Wijaya Karya, we have a specific department working regularly to develop the implementation of BIM in our projects, we call it as DPS (Departemen Pengembangan Sistem). Within the department, we have approximately 30 young engineers who are actively learning the BIM. We also have the e-learning system which allows people who are interested to know more about BIM. Our future goal is to spread the knowledge about BIM and to conduct further discussion about the technological advancement in Indonesia with universities. There are several levels of implementation in BIM, for example: Level 1 deals with the project's cost; Level 2 deals with scheduling and, at highest level, it deals with Asset Management. We are continuously progressing to reach the highest level. We are hoping that in the future, PT Wijaya Karya would become the most prominent BIM user in Indonesia.

2) Regarding the laser scanning process, there must be some limitations, but it can be stated that the benefits should outweigh these limitations. Unfortunately, we have not systematically identified the list of materials that cannot be detected by the laser scanner. As additional information, laser scanning can also be utilized for Asset Management purpose. Laser scanning can be used to quickly check whether the constructed facilities in site matches well with the provided As-Built drawing.