

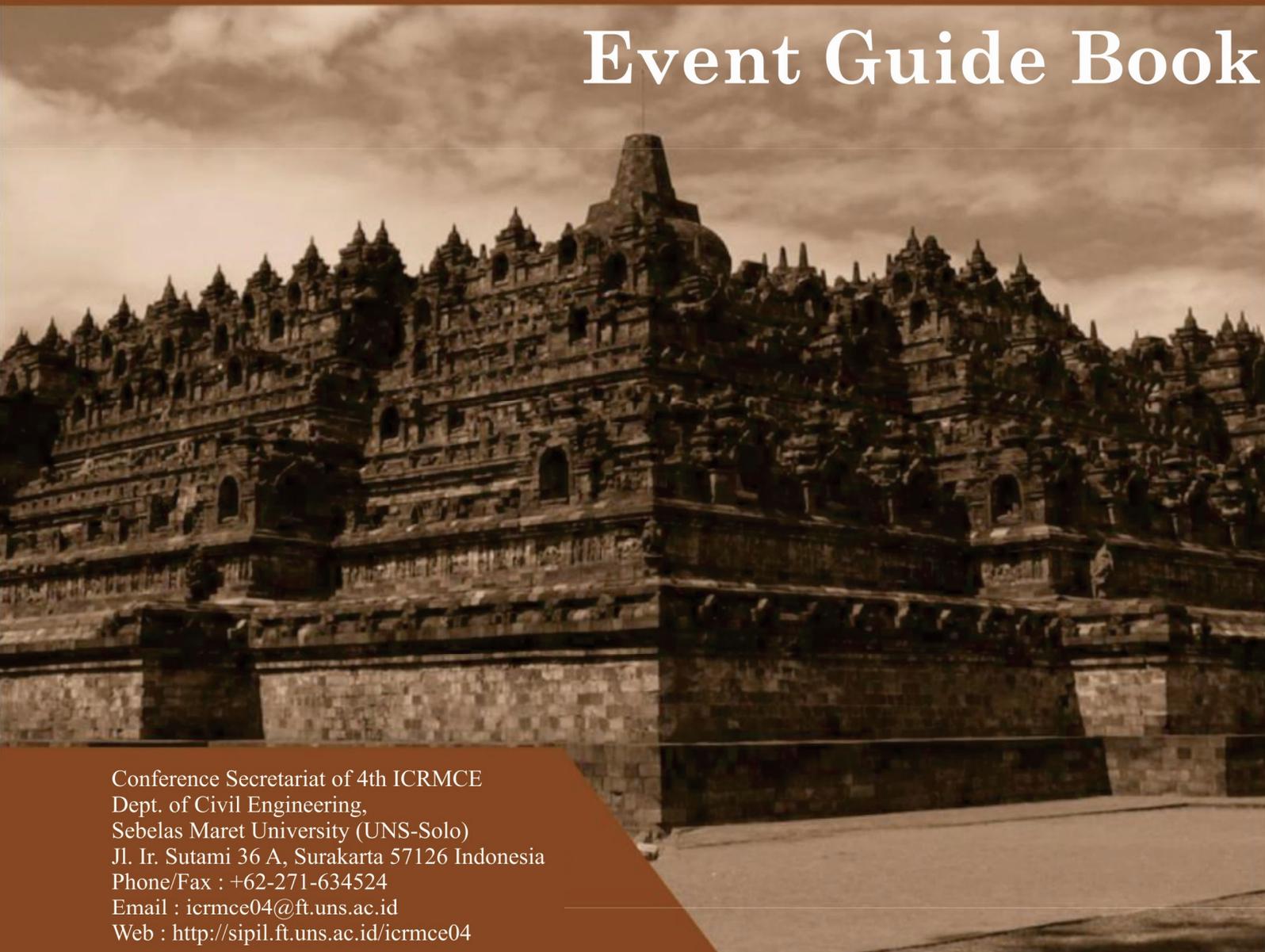
# 4<sup>th</sup> International Conference on Rehabilitation and Maintenance in Civil Engineering (ICRMCE)

Best Western Solo Baru  
July, 11-12 2018



“Smart Rehabilitation and Maintenance in Civil Engineering  
for Sustainable Construction”

## Event Guide Book



Conference Secretariat of 4th ICRMCE  
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In collaboration with:



Partner Universities:





International Conference on Rehabilitation and Maintenance  
in Civil Engineering

**Solo, Indonesia, July, 11-12 2018**

This book belongs to

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## PREFACE



Today and tomorrow, civil engineers, researchers, educators, students and related industries from all over the world are expected to work hand-in-hand to build a sustainable future for our next generation. We do hope that this conference will be a meaningful event for sharing ideas and expertise and strengthening our network. The 4<sup>th</sup> International Conference on Rehabilitation and Maintenance in Civil Engineering (4<sup>th</sup> ICRMCE) is the continuing series of the previous ICRMCE. The theme of the conference is *Smart Rehabilitation and Maintenance in Civil Engineering for Sustainable Construction*.

Rehabilitation and maintenance in civil engineering is not less important than planning and designing. The excessive load, natural hazard, lack of construction procedures and material degradation are causes of infrastructure defects. Rehabilitation and maintenance help to extend the building and infrastructure service life. Rehabilitation is defined as the whole efforts to regain building and infrastructures functions against defect or structure weakening. This covers many aspects such as repairing, strengthening, revitalization, renovation and restoration. While maintenance is the effort to keep the building and infrastructure service as planned.

The objective of the event is to provide a forum for researchers, academicians, government agencies, consultants, and contractors to exchange experiences in technological advancement and innovation related to rehabilitation and maintenance in civil engineering. There may some relevant topics with the theme: building and infrastructure rehabilitation and maintenance, advanced technology for rehabilitation technique, special experiences on rehabilitation, infrastructure performance, performance related to natural hazards, smart materials, damage assessment, maintenance strategy, testing and inspection, restoration on historical building, service life modeling, life cycle cost analyses, code and policy, etc.

For your information, the first, second, and third ICRMCE were held successfully in 2009, 2012, and 2015 respectively. Please kindly check <http://sipil.ft.uns.ac>. Those events were attended by hundreds of researchers in different areas of civil engineering. Seeing to the success of previous conferences, we thought that the forum has to be enhanced and be broaden. For this, the committee offered some domestic and international institutions to participate as partners. We are very happy that some universities and institution such as TU Delft Netherland, KIT Germany, Hiroshima University Japan, UTM Malaysia (UTM), Diponegoro University Semarang, UMY Yogyakarta, Jendral Soedirman University, Jember University, Mataram University, and HATI are ready to participate. They assign some staffs as scientific committee and/or invited speaker. We are also very pleased that in this year event, the Indonesian Fédération Internationale du Béton, *fib* chapter Indonesia is actively involved as co-organiser.

Thus, it can be reported here that compared to the previous ones, there are significant distinction of the 4<sup>th</sup> ICRMCE:

1. The number of the paper: while we have 48, 75, 60 papers in the first, second, and third events respectively, this 4<sup>th</sup> ICRMCE, much more papers will be presented.



2. The involvement of partners: we did not offer the events to any partners for the previous events, they were solely conducted by Sebelas University. However, in this year, 4 overseas together with 6 domestic universities plus 1 non universities were involved and have been working as partners.
3. The breakthrough symposium is being performed during the conference. The symposium is organised by fib Indonesia inviting the world class expert presenting the state of the art finding in this area.
4. We are honored that the president of fib has already here as one of keynote speakers and will officially open the fib Indonesia chapter.

More than 300 abstract has been submitted and finally only 140 papers are strictly selected by peer reviewer to be presented. All of the paper will be published in Scopus indexed Matec. They are coming from 14 countries such as Singapore, Thailand, Malaysia, Japan, Taiwan, Korea, Arab Emirates, Quwait, Khazakhstan, Australia, Czech, Netherland, Nigeria and Indonesia as a host. We are going to hear and discusse the presented result of the researchs. On top of that, we are here very lucky that some outstanding keynote speakers from leading universities are presenting the state of the art finding in civil engineering. They are, Prof. Masyhur Irsyam from ITB, Dr. Apiniti from Kasetsart Univ., Thailand, Prof. Petr Hajek from Czech, Prof. Sri Raviandrajah Rasiah from University Technologi of Sydney, Prof. Hung Jiung Liao from NTUST Taiwan, Prof. Keninichiro Nakarai from Hiroshima University Japan, Prof. Muhammad bin Ismail from UTM Malaysia, and Prof. Chan Weng Tat from NUS Singapore.

The committee extent very kind thanks to all participants for the success of the conference. They are Rector of UNS, the Dean of Engineering Faculty of UNS, the keynote speakers, and invited speakers. Many special thanks to PT PP, PT WIKA, PT HK, PT Adhi Karya, PT HKI, PT Brantas Abipraya, PT Global Sakti, Paton Buana Semesta, and last but not least to Yayasan Alped (a non profit scholarship institustion of the UNS Civil Engineering alumny) for supporting the conference. I would like to express special thanks to Prof. Han Ay Lie for her incredible personal support, as she works almost day and night for the conference.

Finally, on behalf of the committe, we appologise if there are many shortcomings, starting from the beginning, during, and until the end of this event.

Have a nice conference and enjoy your stay in cultural city of Solo.

Thank you,

Yusep Muslih Purwana  
4<sup>th</sup> ICRMCE Chairman

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64. Purwanto Santoso, Universitas Jenderal Soedirman, Indonesia
65. Yanto, Universitas Jenderal Soedirman, Indonesia
66. Yusep Muslih Purwana, Sebelas Maret University (UNS), Indonesia

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## 4<sup>th</sup> ICRMCE RUNDOWN

Date/Day	Schedules	Activities	Annotations	Locations
July, 11 2018	8.00 - 8.30	Registration Tour Registration		Registration Desk
	8.30 - 8.45	Opening: Indonesian National Anthem Reading of Event Agenda by MC	Conductor MC	Convention Room (Ruby 2)
	8.45 - 8.55	Report speech by Chairman of the Committee	Chairman	
	8.55 - 9.10	Opening and Welcoming Remark by Rector of Sebelas Maret University	Rector of Sebelas Maret University	
	9.10 - 9.15	Rewarding to Sponsorship	Rector of Sebelas Maret University	
	9.15 - 9.45	Keynote speech and plenary sessions	MC	
		<b>Prof. Kennichiro Nakarai</b> , Hiroshima University, "Shear Strength of Reinforced Concrete Beams: Effects of Concrete Volumetric Change and Limestone Aggregate"	Moderator : Ary Setyawan, Ph.D.	
	9.45 - 10.15	Coffee break 1	MC	Lunch and Dining Room (Ruby 1)
	10.15 - 10.45	<b>Prof. Hung Jiun Liao</b> , National Taiwan University of Science and Technology, "Ground Anchor Corrosion – the Beginning of the End"	Moderator : Ary Setyawan, Ph.D.	Convention Room (Ruby 2)
	10.45 - 11.15	<b>Prof. Mohammad Bin Ismail</b> , Universiti Teknologi Malaysia, "Rehabilitation of Corrosion of Reinforcement for Sustainable Construction"		
	11.15 - 11.45	<b>Prof. Ing. Petr Hajek</b> , Czech Technical University, "Advanced high performance concrete structures – challenge for sustainable and resilient future"		
	11.45 - 12.00	<b>Launching fib Indonesia</b>		
	12.00 - 13.00	Pray and Lunch	MC	Lunch and Dining Room (Ruby 1)
	13.00 - 15.00	Parallel Class (shift 1)	MC, Parallel Class	Class A, B, C, D, E
		<i>fib</i> Mini Symposium	MC	Convention Room (Ruby 2)
	15.00 - 15.30	Coffee break 2	MC	Lunch and Dining Room (Ruby 1)
	15.30 - 17.00	Parallel Class (shift 2)	MC, Parallel Class	Class A, B, C, D, E
<i>fib</i> Mini Symposium		MC	Convention Room (Ruby 2)	
17.00	End of the first day Conference	MC, Parallel Class	Class A, B, C, D, E	

Date/Day	Schedules	Activities	Annotations	Locations
<b>July, 11 2018</b>	19.30 - 22.00	Dinner Party	MC	Lunch and Dining Room (Ruby 1)
	19.00 – 19.30	<ul style="list-style-type: none"> <li>• Registration</li> <li>• Performance (Electone)</li> </ul>		
	19.30 – 19.35	Event Opening	MC	
	19.35 – 19.45	Opening Remark by Chairman of the Committee	Chairman	
	19.45 – 20.00	Opening Remark by Dean of Engineering Faculty	Dean of Engineering Faculty	
	20.00 – 20.15	Rewarding to Sponsorship	Rector of Sebelas Maret University	
	20.15 – 21.15	Performance (Electone)		
	21.15 – 21.45	<ul style="list-style-type: none"> <li>• Impression Speech</li> <li>• Photo session</li> <li>• Announcement for tomorrow schedule</li> </ul>	MC	
<b>July, 12 2018</b>	8.00 - 8.30	Registration		Registration Desk
	8.30 - 8.45	Opening: Reading of Event Agenda by MC	MC	Convention Room (Ruby 2)
	8.45 - 9.15	Keynote speech and plenary sessions <b>Prof. Chan Weng Tat</b> , National University of Singapore	Moderator: Dr. Eng. Syaffi	
	9.15 - 9.45	<b>Dr. Sri Ravindrarajah Rasiah</b> , University Technology of Sydney, "Waterproofing practices in Australia for the Building Construction"		
	9.45 - 10.15	Coffee break 1	MC	Lunch and Dining Room (Ruby 1)
	10.15 - 10.45	<b>Prof. Masyhur Irsyam</b> , Bandung Institute of Technology, "Development of the National Seismic Hazard Maps 2017 for Design of Earthquake Resistance Design in Indonesia"	Moderator : Dr. Techn. Sholihin As'ad	Convention Room (Ruby 2)
	10.45 - 11.15	<b>Assoc. Prof. Apiniti Jotisankasa</b> , Kasetsart University, "Bioengineering for erosion control and slope stabilization in Thailand: research and practice"		
	11.15 - 12.00	<b>Yusep Muslih Purwana, Ph.D</b> , Sebelas Maret University, "Seeing Surakarta based on Civil Engineering Perspective"		
	12.00 - 13.00	Pray and Lunch	MC	Lunch and Dining Room (Ruby 1)
	13.00 - 15.00	Parallel Class (shift 1)	MC, Parallel Class	Class A, B, C, D, E, F, G
	15.00 - 15.30	Coffee break 2	MC	Lunch and Dining Room (Ruby 1)
	15.30 - 16.35	Parallel Class (shift 2)	MC, Parallel Class	Class A, B, C, D, E, F, G
	16.35 - 17.30	End of the second day Conference	MC, Parallel Class	Convention Room (Ruby 2)
<b>July, 13 2018</b>	7.30 - 8.00	Registration		Best Western Premiere
	8.00 - 12.00	Conference Tour		Yogyakarta
	12.00 - 13.00	Pray and Lunch		
	13.00 - 16.35	Conference Tour		

Note :

1 st Floor : Registration and Parallel Class

2 nd Floor : Convention Room (Ruby 2), Lunch and Dining Room (Ruby 1)



**fib Mini Symposium: Past Achievements, Current Issues and Future Development of Concrete**

Day	Time (WIB)	Duration (mnt)	Topic of Presentation	Invited Speaker	Moderator	Room		
July, 11 2018	13.00 - 13.30	30	<i>From Model Code 2010 to 2020</i>	Prof. Hugo Corres Peiretti (fib President)	Prof. Stefanus Kristiawan	Ruby 2		
	13.30 - 13.40	10	Q & A					
	13.40 - 14.10	30	<i>Long time efforts to improve the seismic resilience of concrete structures in Indonesia</i>	Prof. Iswandi Imran (Bandung Institute of Technology)				
	14.10 - 14.20	10	Q & A					
	14.20 - 14.50	30	<i>Past, present and future of prefabrication</i>	Dr. David Fernández-Ordóñez (fib Secretary General)				
	14.50 - 15.00	10	Q & A					
	15.00 - 15.30	Coffee Break						
	15.30 - 16.00	30	<i>Biodegradation of concrete in tropical marine environment-field experimental study at north Java sea</i>	Prof. Bambang Suhendro (Gadjah Mada University)			Prof. Antonius	Ruby 2
	16.00 - 16.10	10	Q & A					
	16.10 - 16.40	30	<i>Progressive precast and demountable construction system from HPC for sustainable and resilient building</i>	Prof. Petr Hajek (Chair of COM7 fib)				
	16.40 - 16.50	10	Q & A					
	16.50 - 17.20	30	<i>Concrete development need in 3D printing development era</i>	Hadjar Seti Adji (Director of Human Capital Management- PT Waskita Karya)				
	17.20 - 17.30	10	Q & A					

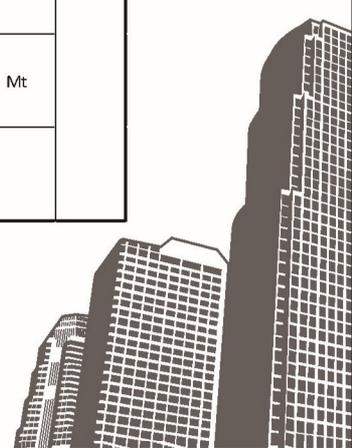
**PARALLEL CLASS A**  
DAY 1

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room
13.00 - 13.10		Moderator			Class A
13.10 - 13.30	343	Improvement the California Bearing Ratio of Expansive Subgrade using SICC Column	Agus Setyo Muntohar	Invited Speaker	
13.30 - 13.40	18	Numerical modelling of dynamic stability of RCC dam	Omer Mughieda*, ADU	G	
13.40 - 13.50	19	Stability evaluation of Sermo dam, Yogyakarta, using two components acceleration time histories causes by Java subduction earthquake scenarios	Partono Windu*, Universitas Diponegoro	G	
13.50 - 14.00	22	Probabilistic Seismic Hazard Assesment for Surakarta, Central Java, Indonesia	Muhammad Adi Ibrahim*, PT Wijaya Karya (Persero) tbk; Yusep Purwana, University of Sebelas Maret	G	
14.00 - 14.10	39	Parametric Study On The Behavior Of Bagasse Ash-Calcium Carbide Residue Stabilized Soil	John Hatmoko*, Universitas Atma Jaya Yogyakarta, INDONESIA	G	
14.10 - 14.20	42	Application of Woven Tires Waste Gabion Wall as Slope Reinforcement for Preventing Landslide in Laboratory	Arwan Apriyono*, Jurusan Teknik Sipil Universitas Jenderal Soedirman	G	
14.20 - 14.30	43	Study of Geotechnical Aspect Base on GIS as Basic Design of Road	Mrs Indrayani*; Arfan Hasan; Andi Herius; Ahmad Mirza, State Polytechnic of Sriwijaya	G	
14.30 - 15.00		Question and Answer			
15.00 - 15.30		Coffee Break			
15.30 - 15.35		Moderator			Class A
15.35 - 15.45	46	Bearing Capacity Analysis of Helical Pile Foundation on Peat	Ferry Fatnanta, Universitas Riau; Andarsin Ongko*, University of Riau	G	
15.45 - 15.55	47	Inverse Distance Weighting Interpolated Soil Properties And Their Related Landslide Occurrences	Purwanto Santoso*; Yanto Yanto; Arwan Apriyono; Rani Suryani, Universitas Jenderal Soedirman	G	
15.55 - 16.05	55	The Effect of Cement Stabilization on the Strength of the Bawen's Siltstone	Edi Hartono*, Diponegoro University	G	
16.05 - 16.15	76	Chemical Stabilization of Expansive Soil using Wood Charcoal Powder and Salt	Paksitya Putra*; Mokhammad Farid Ma'ruf; Diah Ayu Paramiswari; Abdullah Ilham, Teknik Sipil Universitas Jember	G	
16.15 - 16.25	158	Ground Settlement Prediction of the Improved Embankment with Prefabricated Vertical Drain in Soft Soil	Siswoko Saputro*, National Taiwan University of Science and Technology	G	
16.25 - 16.35	200	Determination of the seismicity and peak ground acceleration for Lombok Island: An evaluation on tectonic setting	Didi Agustawijaya*, University of Mataram	G	
16.35 - 17.05		Question and Answer			

\*G=Geotechnical \*M=Management \*Mt=Materials \*S=Structure \*H=Hydrology \*T=Transportation

**PARALLEL CLASS A**  
**DAY 2**

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room	
13.00 - 13.10		Moderator			Class A	
13.10 - 13.30	4	Proposed Concrete Compaction Method Using An Electrical Internal Vibrator: A Review Of Compaction Standard For Concrete In Laboratory According To Sni 2493:2011	agus maryoto*, Jenderal Soedirman University	Invited Speaker		
13.30 - 13.40	6	Rice Husk As An Alternative Energy For Cement Production And Its Effect On The Chemical Properties Of Cement	agus maryoto*, Jenderal Soedirman University	Mt		
13.40 - 13.50	16	Repair of Rigid Pavement Using Micro concrete Mtials	Jonbi Jonbi*, Pancasila University	Mt		
13.50 - 14.00	17	Effect of added the Polycarboxylate Ether on Slump Retention and Compressive Strength of the High Performance Concrete	Jonbi Jonbi*, Pancasila University	Mt		
14.00 - 14.10	49	Mechanical Properties of Concrete Composed of Sintered Fly Ash Lightweight Aggregate	puput risdanareni*, universitas negeri malang; M. Mirza Abdillah Pratama, Universitas Negeri Malang	Mt		
14.10 - 14.20	52	The Effect of Additional Aluminium to the Strength of Geopolymer Paste	Aulia Rahman, ITS; Januarti Ekaputri*, ITS	Mt		
14.20 - 14.30	64	The influence of molarity variations to the mechanical behaviour of geopolymer concrete	Purwanto Khusnan*, Diponegoro University; Ay Lie Han, Universitas Diponegoro; Nuroji Nuroji, Diponegoro University; Januarti Ekaputri, ITS	Mt		
14.30 - 15.00		Question and Answer				
15.00 - 15.30		Coffee Break				Ruby 2
15.30 - 15.35		Moderator				Class A
15.35 - 15.45	73	Slant shear strength of polyvinil acetat (pva) modified fiber reinforced mortar	Stefanus Kristiawan*, Universitas Sebelas Maret	Mt		
15.45 - 15.55	82	Modulus of elasticity of the graded concrete	M. Mirza Abdillah Pratama*; Bunga Arumsari Mutiara Wulandari, Universitas Negeri Malang; Zhabrinna Zhabrinna, University of Birmingham	Mt		
15.55 - 16.05	89	Microscopic Investigation on Concrete Cured Internally by Using Porous Ceramic Roof-tile Waste Aggregate	Azusa Shigeta*, Hiroshima University; Yuko Ogawa, Hiroshima University; Kenji Kawai, Hiroshima University	Mt		
16.05 - 16.15	276	Evaluation of Bond Strength Between Normal Concrete and High Performance Fiber Reinforced Concrete (HPFRC)	SK MUIZ SK ABD RAZAK*, Universiti Malaysia Perlis	Mt		
16.15 - 16.25	288	Effects of Microbial Agents to The Properties of Fly Ash-Based Paste	Kiki Dwi Wulandari*, Department of Civil Engineering, Institut Teknologi Sepuluh Nopember; Januarti Ekaputri, ITS	Mt		
16.25 - 16.55		Question and Answer				

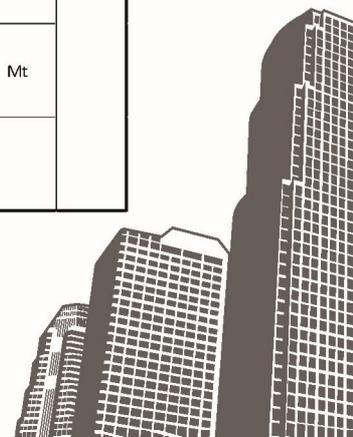


**PARALLEL CLASS B**  
DAY 1

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room
13.00 - 13.10		Moderator			<b>Class B</b>
13.10 - 13.20	201	The Effect of Egg Shell Powder on The Compression Strength of Fine-Grained Soil	Niken Surjandari*, Sebelas Maret University Surakarta	G	
13.20 - 13.30	206	Contribution of suction on the stability of reinforced soil retaining wall	Nurly Gofar*, Nanyang Technological University; Hanafiah Hanafiah, Sriwijaya University	G	
13.30 - 13.40	233	Method of Removing Secondary Compression on Clay Using Preloading	EGA DHIANITY*, Institut Teknologi Sepuluh Nopember; INDRASURYA B. MOCHTAR, Institut Teknologi Sepuluh Nopember	G	
13.40 - 13.50	235	Effect of Moisture Content of Cohesive Subgrade Soils	Dian Agustina*, Universitas Riau Kepulauan; Adnan Bin Zainorabidin, Universiti Tun Hussein Onn Malaysia	G	
13.50 - 14.00	266	Predicting Heave on The Expansive Soil	Willis Diana*, Universitas Muhammadiyah Yogyakarta	G	
14.00 - 14.10	267	Water Table Evaluation Post the Construction of Canal Blocks on Peatland in West Kalimantan, Indonesia	Henny Herawati*, Tanjungpura University; Dwi Farastika, Tanjungpura University	G	
14.10 - 14.20	275	The Effect of Lime Addition in Physical and Mechanical Soil Properties Due to Drying Process on Bengawan Solo River Embankment in Plangwot Area, Lamongan	Alpha Putri*, Institut Teknologi Sepuluh Nopember	G	
14.20 - 14.30	277	Application of Microtremor HVSr Method for Preliminary Assesment of Seismic Site Effect in Ngipik Landfill, Gresik	Siti Nurlita Fitri*, Institut Teknologi Sepuluh Nopember Surabaya	G	
14.30 - 15.00		Question and Answer			
15.00 - 15.30		Coffe Break			Ruby 2
15.35 - 15.45		Moderator			<b>Class B</b>
15.45 - 15.55	278	A Study on Association between Tilt Angle, Solar Insolation Exposure and Output of Solar PV Panel Using BIM 3D Modelling	SK MUIZ SK ABD RAZAK*, Universiti Malaysia Perlis	M	
15.55 - 16.05	279	The Implementation of Sustainable Concept in Waste Management through Project Life Cycle Process in Gold Coast	Zhabrinna Zhabrinna*, University of Birmingham; M. Mirza Abdillah Pratama, Universitas Negeri Malang	M	
16.05 - 16.15	297	Are Indonesia contractors ready to implement Last Planner System? - An early investigation	Jati Hatmoko*, Universitas Diponegoro	M	
16.15 - 16.25	313	Corporate entrepreneurship level: a case study of contractors in Indonesia	Harijanto Setiawan*, Universitas Atma Jaya Yogyakarta	M	
16.25 - 16.35	341	Reducing Carbon Emission in Construction Base On Project Life Cycle (PLC)	Mochamad Wibowo*, Diponegoro University Semarang	M	
16.35 - 17.05		Question and Answer			

**PARALLEL CLASS B**  
**DAY 2**

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room	
13.00 - 13.10		Moderator			Class B	
13.10 - 13.20	92	Effect of co-existing ions on lead leaching behavior from hardened cement paste	Takumi Nishiwaki*, Hiroshima university	Mt		
13.20 - 13.30	100	Effect of Recycled Coarse Aggregate (RCA) with Surface Treatment on Concrete Mechanical Properties	Anggun Atmajayanti*; Chrisyanto Saragih G, Universitas Atma Jaya Yogyakarta; Yanuar Haryanto, Jenderal Soedirman University	Mt		
13.30 - 13.40	104	Development of Self-compacting Fibre Reinforced Structural Mortar for Concrete Repair	Ernie Sahari*; Dr. A.B.M Amrul Kaish; Nyiam Len Fong, Infrastructure University Kuala Lumpur (IUKL)	Mt		
13.40 - 13.50	108	Microstructure and mechanical properties of FA/GGBS-based geopolymers	Apriany Saludung*, Hiroshima University	Mt		
13.50 - 14.00	133	Strength development of cement-treated sand using different cement types cured at different temperatures	Lanh Ho*; Kenichiro Nakarai; Kenta Eguchi, Hiroshima University; Takashi Sasaki, Denka Co., Ltd; Minoru Morioka, Denka Co., Ltd	Mt		
14.00 - 14.10	180	The Influence Of OPC And PPC On Compressive Strength Of Alwa Concrete	Fedy Aryani*, Institut Teknologi Sepuluh Nopember Surabaya	Mt		
14.10 - 14.20	194	The usage of Andesit sand grinded and foaming-agent on porosity of foam concrete	Erwin Rommel*, Muhammadiyah University of Malang	Mt		
14.20 - 14.30	198	A Comparative Analysis of the Quality of Concrete Blocks Produced from Coconut Fibre, Oil Palm Empty Fruit Bunch, and Rice Husk as a Filler Materials	MOHAMMAD LUTFI*, STT MIGAS	Mt		
14.30 - 15.00		Question and Answer				
15.00 - 15.30		Coffee Break				Ruby 2
15.30 - 15.35		Moderator				Class B
15.35 - 15.45	199	A Preliminary Study of the Low Density Particle Boards Quality using Rice Husk and Oil Palm Empty Fruit Bunch with Plastic Waste Adhesive	MOHAMMAD LUTFI*, STT MIGAS ; Muh Yamin, State Agricultural Polytechnic of Samarinda	Mt		
15.45 - 15.55	252	Characterization and Compressive Strength of Geopolymer Paste Based on Fly Ash	Ari Widayanti*; Ria Asih Aryani Soemitro, Institut Teknologi Sepuluh Nopember Surabaya; Hitapriya Suprayitno; Januarti Ekaputri, ITS	Mt		
15.55 - 16.05	256	The Effect Of Addition Of Banana Tree Bark For Compressive Strength And Crack Tensile Strength Of Rice Husk Ash Concrete	Muhammad Rizqi*, University of Jember	Mt		
16.05 - 16.15	289	Experimental Study of Accelerating High Early Strength Concrete under Elevated Temperature, Steaming, and Chemical Admixture of Normal and High Strength Concrete	Suryawan Murtiadi*, Mataram University	Mt		
16.15 - 16.45		Question and Answer				



**PARALLEL CLASS C**  
DAY 1

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room	
13.00 - 13.10		Moderator			Class C	
13.10 - 13.20	12	Towards Competitive Traditional Market in Metropolitan City: a proposal of public building policy in Semarang	Ferry Hermawan*, Diponegoro University; Ismiyati Ismiyati, Diponegoro University; Himawan Indarto, Diponegoro University	M		
13.20 - 13.30	63	The Maintenance Priority for Construction Reliability and Sustainability in Ampel Mosque Surabaya	Agung Sedayu*, Maulana Malik Ibrahim State Islamic University of Malang	M		
13.30 - 13.40	95	Intelligent BIM Record Model for Effective Asset Management of Constructed Facility	Md Aslam Hossain*, Nazarbayev University; AHMAD TARMIZI HARON, FKASA	M		
13.40 - 13.50	124	Development of Quality Management System in Maintenance and Monitoring Process of Repair Work Risk-Based in Government Building	Yusuf Latief, Universitas Indonesia; Rossy Machfudiyanto*, Universitas Indonesia; Khairina Pamudji, Universitas Indonesia; Riany Aldesty, Universitas Indonesia	M		
13.50 - 14.00	126	BIM Adoption Towards the Sustainability Of Construction Industry in Indonesia	Zhabrinna Zhabrinna*, University of Birmingham; M. Mirza Abdillah Pratama, Universitas Negeri Malang; Muhammad Yusuf, University of Leeds; Richard Davies,	M		
14.00 - 14.10	143	Improvement of Business Processes in Developing Standard Operation Procedures on Government Building Maintenance Work in Indonesia	Rossy Machfudiyanto*, Universitas Indonesia	M		
14.10 - 14.20	208	Service Life Planning for Electronics, Mechanical and Electrical Components of an Hotel Building	Peter Kaming*, Universitas Atma Jaya Yogyakarta; Michael Boenardi, UAJY; Desi Maryani, UAJY	M		
14.20 - 14.30	227	Current State Mapping of Supply Chain in Engineering Procurement Construction (EPC) Project: A Case Study	Moh Sholeh*, Diponegoro University	M		
14.30 - 15.00		Question and Answer				
15.00 - 15.30		Coffee Break				Ruby 2
15.30 - 15.35		Moderator				Class C
15.35 - 15.45	263	Readiness Of Local Government In Ppp Project Development - Case Of Lrt Bandung	Revana Putri*, Institute Technology Bandung; Reini Wirahadikusumah, Institut Teknologi Bandung	M		
15.45 - 15.55	272	Optimization Of Waste Management Infrastructure Planning Using Linear Programming Model (Case Study Of Waste Management In Sragen Regency)	Albert Pramono Soesanto*, Program Studi Magister Teknik Sipil Sekolah Pascasarjana Universitas Muhammadiyah Surakarta; Mochammad Solikin, Program Studi Magister	M		
15.55 - 16.05	182	User Cost Estimation On The Construction Of Flexible And Rigid Road Pavement	Fajar Handayani*, Universitas Sebelas Maret Surakarta; Florentina Pramesti, Universitas Sebelas Maret Surakarta; Mochamad Wibowo, Diponegoro University Semarang;	M		
16.05 - 16.15	304	The Management Strategy for Government Building Disposal Process in Jakarta	Ayomi Rarasati*, Universitas Indonesia; Mulyadi Mulyadi, Universitas Indonesia	M		
16.15 - 16.45		Question and Answer				

**PARALLEL CLASS C**  
DAY 2

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room
13.00 - 13.10		Moderator			Class C
13.10 - 13.20	218	Experimental Analysis of T- Beam Reinforced Concrete with hole	Nicxson Pakpahan*, Universitas Sumatera Utara	S	
13.20 - 13.30	224	APPLICATION OF HIGH STRENGTH REINFORCING BARS IN EARTHQUAKE-RESISTANT STRUCTURE ELEMENTS	Kumiawan Kamaruddin*, Institut Teknologi Bandung; Iswandi Imran, ITB; Maulana Derry Imansyah, Institut Teknologi Bandung;	S	
13.30 - 13.40	226	Seismic performance of four-storey building with masonry infilled reinforced concrete frame	isyana hapsari*, universitas sebelas maret; Senot Sangadji, Universitas Sebelas Maret; Stefanus Kristiawan, Universitas Sebelas	S	
13.40 - 13.50	232	Numerical analysis of castellated beam with oval opening	Yanuar Setiawan*, Universitas Islam Indonesia; Ay Lie Han, Universitas Diponegoro; Buntara S. Gan, Department of	S	
13.50 - 14.00	273	PREDICTING BENDING CREEP OF LAMINATED VENEER LUMBER (LVL) SENGON (PARASERIANTHES FALCATARIA) BEAMS FROM INITIAL CREEP TEST DATA	Achmad Basuki*, Universitas Sebelas Maret	S	
14.00 - 14.10	274	One-Way Translational Magnetic Mass Damper Model for Structural Response Control against Dynamic Loadings	SK MUIZ SK ABD RAZAK*, Universiti Malaysia Perlis	S	
14.10 - 14.20	298	A Comparison of Retrofitting Methods on Nursing Faculty Building of Andalas University with Concrete Jacketing and Shear Wall Systems	Fauzan Fauzan*, Andalas University	S	
14.20 - 14.30	300	Survey, Investigation and Repairing on Concrete Wall of Waste Treatment Building	Partogi Simatupang*, Universitas Nusa Cendana	S	
14.30 - 15.00		Question and Answer			

**PARALLEL CLASS D**  
DAY 1

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room
13.00 - 13.10		Moderator			Class D
13.10 - 13.30	118	Temporal Variations of Bedload Transport Rate and the Grain Size Distribution of Non-Uniform Size Sediment During A Constant Flow Rates	Yusron Saadi*, Universitas Mataram	Invited Speaker	
13.30 - 13.40	10	The Interrelationship between ISTN lake, Babakan lake and the surrounding wells of shallow groundwater using stable isotopes $\delta$ 2H and $\delta$ 18O for the LakeBank Filtration potential	W Marsiano; S Syafalni*; Wawan Kuswaya; M Falaqi Djamhuri, Institut Sains dan Teknologi Nasional; BungKus Pratikno, National Nuklir Energy Agency	H	
13.40 - 13.50	40	Multisite daily precipitation simulation in Singapore	Suroso Suroso*, Department of Civil Engineering, Jenderal Soedirman University	H	
13.50 - 14.00	65	The Concept of Lomaya And Pilohayanga Dam Rehabilitation Based On Technical And Economic Aspects	Ninik Khorida*, Universitas Sebelas Maret	H	
14.00 - 14.10	115	Priority Development Of Smalldam In Wonogiri Regency	fisnu pramono*, PT. Inakko Internasional Konsulindo; YUNITTA CHANDRA SARI, BBWS Bengawan Solo; Suripin Suripin, Diponegoro University	H	
14.10 - 14.20	116	Surakarta City Flood Control	fisnu pramono*, PT. Inakko Internasional Konsulindo; YUNITTA CHANDRA SARI, BBWS Bengawan Solo; Suripin Suripin, Diponegoro University	H	
14.20 - 14.30	134	Evaluation of watershed carrying capacity for watershed management (a case study on Bodri Watershed, Central Java, Indonesia)	Sriyana Sriyana*, Diponegoro University	H	
14.30 - 15.00		Question and Answer			

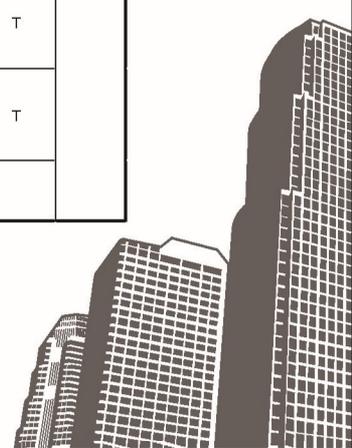
**PARALLEL CLASS D**  
DAY 2

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room
13.00 - 13.10		Moderator			
13.10 - 13.20	150	Evaluation of sediment management for two large reservoirs in Lombok Island	Ery Setiawan; syamsul hidayat*; M Bagus Budianto; IB Giri Putra; Salehudin Salehudin, University of Mataram	H	
13.20 - 13.30	175	Tsunami Simulation using Particle Method	Raden Harya Dananjaya*, Universitas Sebelas Maret	H	
13.30 - 13.40	178	Field Performance of Shallow Recharge Well	Edy Susilo*, Diponegoro University	H	
13.40 - 13.50	148	Technical Audit and Performance Assessment of Irrigation Tlatak in District Magetan	Yuli Iswahyudi*, UNS	H	
13.50 - 14.00	255	Analysis of the Distribution of Domestic Wastewater in the Brantas River Area of Malang City	Bekti Prihatiningsih*, Universitas Merdeka Malang	H	
14.00 - 14.10	257	The Analysis of Ancol Polder System as Flood Prevention Infrastructure in Jakarta	Rian Mantasa Salve Prastica*, Universitas Indonesia	H	
14.10 - 14.20	261	The Impact Of Drainage Towards Roads In Maintenance Cost	Erna Ismiyani*, UNS student; Dewi Handayani, Universitas Sebelas Maret; RR. Rintis Hadiani, Universitas Sebelas Maret	H	
14.20 - 14.30	338	Assesment of temporary protection infrastructure performance related to tidal flood in Mulyorejo, Pekalongan, Indonesia	Slamet Imam Wahyudi*, Universitas Islam Sultan Agung, Semarang	H	
14.30 - 15.00		Question and Answer			



**PARALLEL CLASS E**  
DAY 1

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room
13.00 - 13.10		Moderator			Class E
13.10 - 13.30	318	Design and optimization of a rubber-bitumen blend in preparation for a rubberized-asphalt road trial in the State of Kuwait	Salah Zoorob*, KISR	Invited Speaker	
13.30 - 13.40	1	Data Mining Applied for National Road Maintenance Decision Support System	Andri Irfan*, Universitas Internasional Batam; Susanty Handayani, Jabodetabek Transportation Authority	T	
13.40 - 13.50	339	Data Mining Applied for Earthwork Movement Optimization of Toll Road Construction Project	Andri Irfan*, Universitas Internasional Batam	T	
13.50 - 14.00	5	Analysis Of Air Pollution As An Impact Of The Change Of Mass Transportation Design	Ismiyati Ismiyati*, Diponegoro University; Ismiyati Ismiyati, Diponegoro University	T	
14.00 - 14.10	7	Performance Analysis of Underpass Gilingan Development	Setiono ST, MSc, Universitas Sebelas Maret; Budi Yulianto*, Sebelas Maret University	T	
14.10 - 14.20	8	Analysis of Signalized Intersections Performance Using IHCM Method and PTV VISTRO Software	Budi Yulianto*, Sebelas Maret University; Setiono ST, MSc, Universitas Sebelas Maret	T	
14.20 - 14.30	13	Control Of Urban Parking Based On Zoning Rates In The Context Of Sustainable Transportation	Ismiyati Ismiyati*, Diponegoro University	T	
14.30 - 15.00		Question and Answer			
15.00 - 15.30		Coffee Break			
15.30 - 15.35		Moderator			Class E
15.35 - 15.45	41	Evaluation of Hub and Spoke Airport Networks in Sumatra Island, Indonesia to increase Efficiency of Air Transportation	Gito Sugiyanto*, Universitas Jenderal Soedirman	T	
15.45 - 15.55	44	Analysis of Travel Pattern and the Need to Develop Sustainable Transportation Infrastructure in Sarbagita Metropolitan Area, Bali-Indonesia	Putu Suthanaya*, Udayana University	T	
15.55 - 16.05	81	Assessment Of Magetan Regency's Road Performance Based On Pavement And Off Pavement Components	Joko Haryanta*, UNS	T	
16.05 - 16.15	105	Correlation Analysis between Speed Bumps Dimensions and Vehicles Speed in Residential Area	RA Dynasty Purnomo A*, Universitas Sebelas Maret; Dewi Handayani, Universitas Sebelas Maret; syafii syafii, Universitas Sebelas Maret	T	
16.15 - 16.25	138	Application of Deflection Bowl Parameters for Assessing Different Structures of Road Pavement	Bagus Hario Setiadji*, Diponegoro University	T	
16.25 - 16.35	144	The Influences of Age and Gender of Students' Motorcycle Riders on Traffic Violations and Accidents in a Small City using a Structural Equation Model	I Suteja*, Universitas Mataram	T	
16.35 - 16.45	146	The Sustainability of Public Transport Operation Based on Financial Point of View	ARIF BUDIARTO*, CIVIL ENGINEERING DEPARTEMENT UNIVERSITY OF SEBELAS MARET SURAKARTA	T	
16.45 - 17.15		Question and Answer			



**PARALLEL CLASS E**  
DAY 2

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room
13.00 - 13.10		Moderator			
13.10 - 13.20	154	A Study of CO2 Emission Reduction Due to Transportation Activities in Brebes District through Road Repair	Fajar Mubarak*, Universitas Sebelas Maret; Dewi Handayani, Universitas Sebelas Maret; Syafi'i Syafi'i, Universitas Sebelas Maret	T	Class E
13.20 - 13.30	101	Assessment Of The Road Based On Pci And Iri Roadroid Measurement	Donny Putra*, Universitas Sebelas Maret	T	
13.30 - 13.40	204	The Influence of Vehicle Speed Changes at Mechanistic Performance of Asphalt Mixture	Senja Rum Harnaeni*, Doctoral Program in Civil Engineering, Faculty of Engineering, UNS, Surakarta	T	
13.40 - 13.50	238	Evaluation of Urban Freight Transport Operations in Surakarta City	Budi Yulianto*, Sebelas Maret University	T	
13.50 - 14.00	251	Analysis of Influencing Factors on Using Rental Bikes at Shopping Tourism Sites in Surakarta	Erlin Setyowati*, Universitas Sebelas Maret; Dewi Handayani, Universitas Sebelas Maret	T	
14.00 - 14.10	285	System Model For Physical Conditions of Road Components In Magetan District	Ferro Gilang Kencana*, Universitas Sebelas Maret	T	
14.10 - 14.20	295	Performance Evaluation of a Trunk-A Road in North Central Nigeria	Mustapha Mohammed Alhaji*, Federal University of Technology, Minna; Musa Alhassan, Federal University of Technology, Minna	T	
14.20 - 14.30	311	Application of Android-based Parking Violations Reporting System to Support Green Campus Program	Setiono ST, MSc, Universitas Sebelas Maret; Budi Yulianto*, Sebelas Maret University	T	
14.30 - 14.40	322	The Analysis of Land Use Weights on Road Trace Selection	Mrs Indrayani*, State Polytechnic of Sriwijaya; Erika Buchari, Sriwijaya University; Dinar D.A. Putranto, Sriwijaya University; Edward Saleh, Sriwijaya University	T	
14.40 - 15.00		Question and Answer			

**PARALLEL CLASS F**  
DAY 1

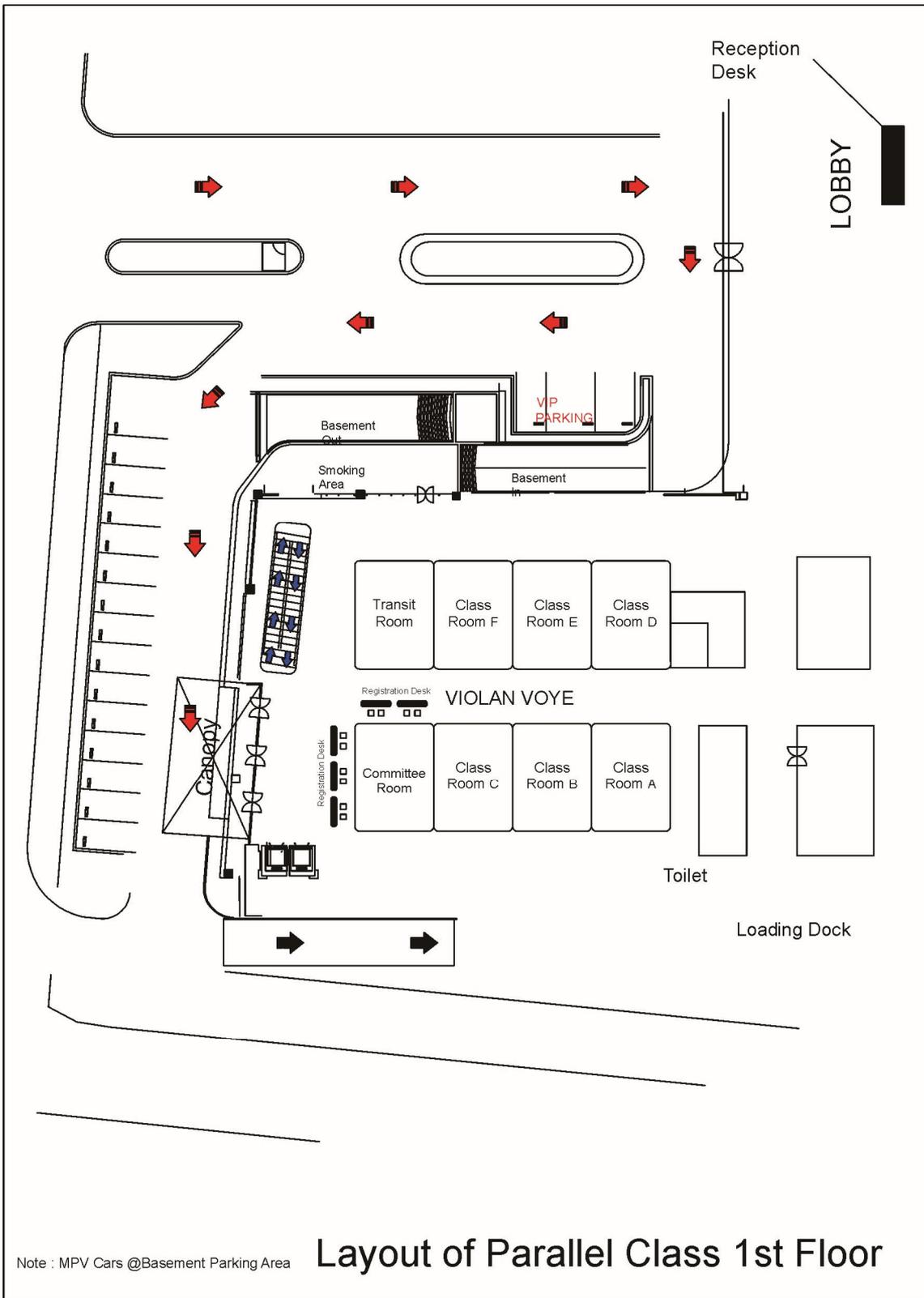
Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room
13.00 - 13.10		Moderator			Class F
13.10 - 13.20	140	Study of Inertia Weight Parameter for Boundary Element Inverse Analysis to Detect RC Corrosion	Syarizal Fonna*, Syiah Kuala University	S	
13.20 - 13.30	58	Analysis of Steel Reinforced Functionally Graded Concrete Beam Cross Sections	Shota Kiryu, Nihon University; Ay Lie Han, Universitas Diponegoro; Ilham Nurhuda, Diponegoro University; Buntara S. Gan*, Nihon University	S	
13.30 - 13.40	210	Aerodynamic Performance of Long Span Steel Truss Bridges in Indonesia	Made Suangga*, Bina Nusantara University; Herry Irpanni, Directorate General of Highway, Ministry of Public Work and Housing	S	
13.40 - 13.50	183	Diagonal Reinforcement as Strengthening to Increase the Stiffness and Strength of Concrete Frame	Yenny Nurchasanah*, Universitas Muhammadiyah Surakarta	S	
13.50 - 14.00	306	Comprehensive condition assessment program on the fire damaged structure – a project case in Singapore	Gunawan Budi Wijaya*, Universitas Kristen Petra	S	
14.00 - 14.10	37	Numerical Analysis on Stress and Displacement of Tapered Cantilever Castellated Steel Beam with Circular Openings	Taufiq Ilham Maulana*; Hakas Prayuda; Bagus Soebandono; Martyana Dwi Cahyati; Eva Hanfatu Zahra, Universitas Muhammadiyah Yogyakarta	S	
14.10 - 14.20	96	Application of NDT Apparatus for Possible Use as Structural Health Monitoring of Concrete Building in the Field	Akmaluddin Akmaluddin*, Universitas Mataram	S	
14.20 - 14.30	320	Crashworthiness assessment of double-hull tanker structures under ship grounding actions	Aditya rio prabowo; Jung Min Sohn; Dong Myung Bae, Pukyong National University; Bangun Harsritanto*, Universitas Diponegoro	T	
14.30 - 14.40	114	The study of ultrasonic pulse velocity on plain and reinforced damaged concrete	Ni Nyoman Kencanawati*, Mataram University	S	
14.40 - 15.00	20	Question and Answer			

**PARALLEL CLASS F**  
DAY 2

Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room	
13.00 - 13.10		Moderator			Class F	
13.10 - 13.20	121	Analytical Study on Creep Shear Failures of RC Slender Beams without Web Reinforcements	Halwan Saifulah; Kenichiro Nakarai*, Hiroshima University; Nobuhiro Chijiwa, Tokyo Institute of Technology; Koichi Maekawa, Yokohama National University	S		
13.20 - 13.30	142	Influence of Shape Modification and Stirrups On the Axial Capacity of Concrete Columns	Ida Bagus Rai Widiarsa*, Universitas Udayana; Ida Bagus Dharma Giri, Universitas Udayana	S		
13.30 - 13.40	145	Shear Properties Evaluation of Natural Fibre Reinforced Epoxy Composites Using V-Notch Shear Test	Jauhar Fajrin*, Universitas Mataram; Nasmi Sari, Universitas Mataram	S		
13.40 - 13.50	153	Dynamic Bayesian Updating Approach for Predicting Bridge Condition Based on Indonesia-Bridge Management System (I-BMS)	Jojok Widodo Soetjipto*, Universitas Jember; Tri Joko Wahyu Adi; Nadjadji Anwar, Institut Teknologi Sepuluh Nopember Surabaya	S		
13.50 - 14.00	161	Performance of Composite Local Glass Fibre Sheets and Epoxy on Flexural Strengthening of Reinforced Concrete Beams	I Ketut Sudarsana*, Universitas Udayana	S		
14.00 - 14.10	169	Comparative Study on Behaviour of Reinforced Concrete Beam-Column Joints with Reference to Monolith and non-monolith Connection	Ninik Catur Endah Yuliati*, Universitas Merdeka Malang; Sri Murni Dewi; Wisnumurti Wisnumurti; Ari Wibowo, Universitas Brawijaya	S		
14.10 - 14.20	192	Improving Resilience of Moment Frames Using Steel Pipe Dampers	Junaedi Utomo*, Universitas Atma Jaya Yogyakarta	S		
14.20 - 14.30	185	Analytical Prediction on Tension Force of Stirrups in Concrete Beams Longitudinally Reinforced with CFRP Bars	Rendy Thamrin*, Universitas Andalas	S		
14.30 - 15.00		Question and Answer				
15.00 - 15.30		Coffee Break				Ruby 2
15.30 - 15.35		Moderator				Class F
15.35 - 15.45	188	A Comparative Study of Base Isolation Systems featured with Lead Rubber Bearing and Pendulum in Light Rail Transit Structure	Santi Nuraini*; Asdam Tambusay; Priyo Suprobo, Institut Teknologi Sepuluh Nopember	S		
15.45 - 15.55	312	The effect of HVFAC as substitution of fine aggregates to the shear strength of reinforced concrete beams	Ade Lisantono*, Universitas Atma Jaya Yogyakarta	S		
15.55 - 16.05	323	Performance of Glue Laminated Timber Beams Composed of Sengon Wood ( <i>Albizia falcatara</i> ) and Coconut Wood ( <i>Cocos nucifera</i> ) with Nylon-Threads Reinforcement	Kusnindar Kusnindar*, Brawijaya University	S		
16.05 - 16.15	79	Stress-strain response of high-volume fly ash self compacting concrete (HVFA-SCC) under uniaxial loading and its effect on the reinforced HVFA-SCC nominal strength	Stefanus Kristiawan*, Universitas Sebelas Maret	S		
16.15 - 16.25	340	Analysis of Floating House Platform Stability Using Polyvinyl Chloride (PVC) Pipe Material	Henny Adi*, UNISSULA	S		
16.25 - 16.55	30	Question and Answer				

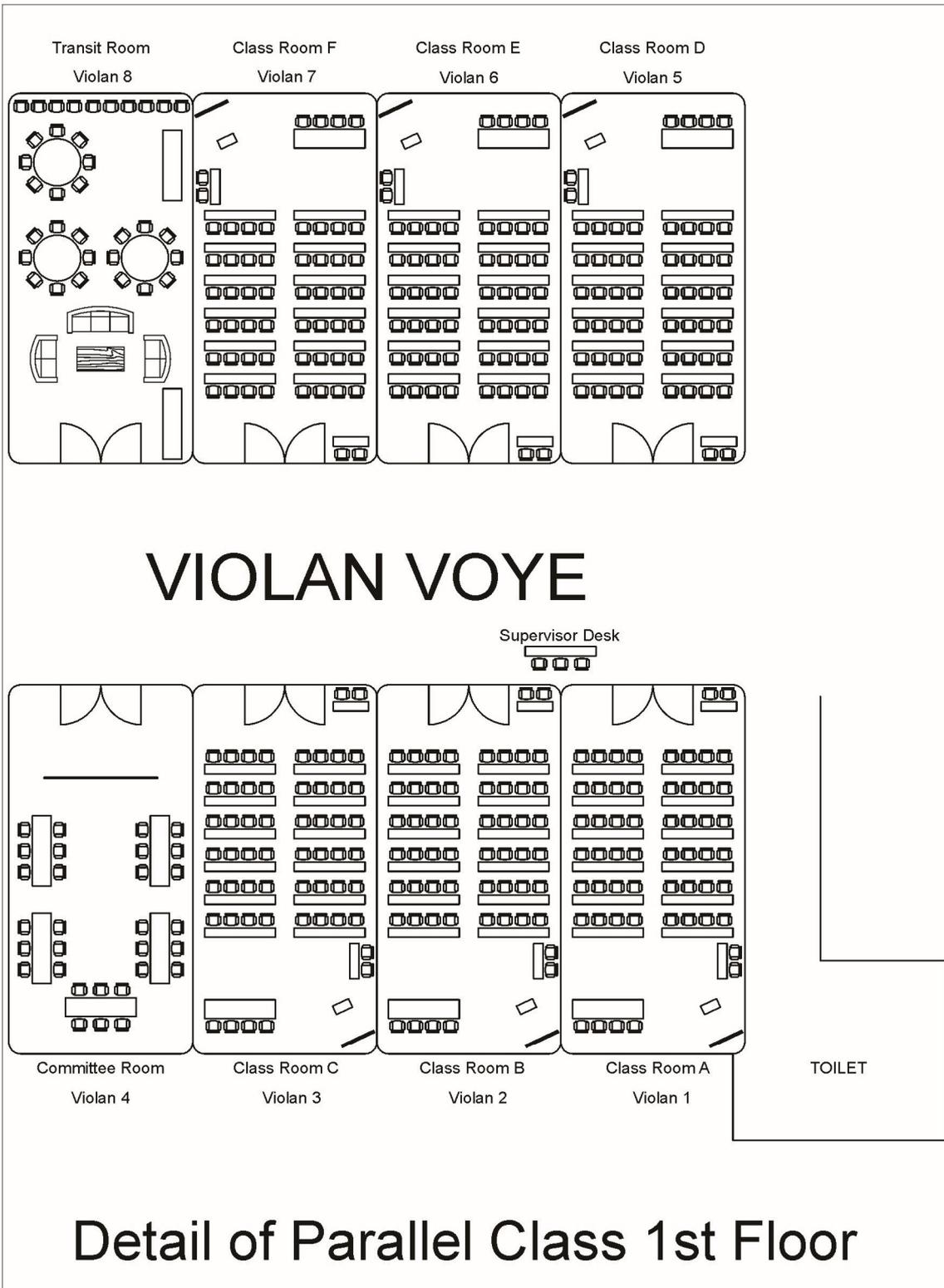
**PARALLEL CLASS G**  
**DAY 2**

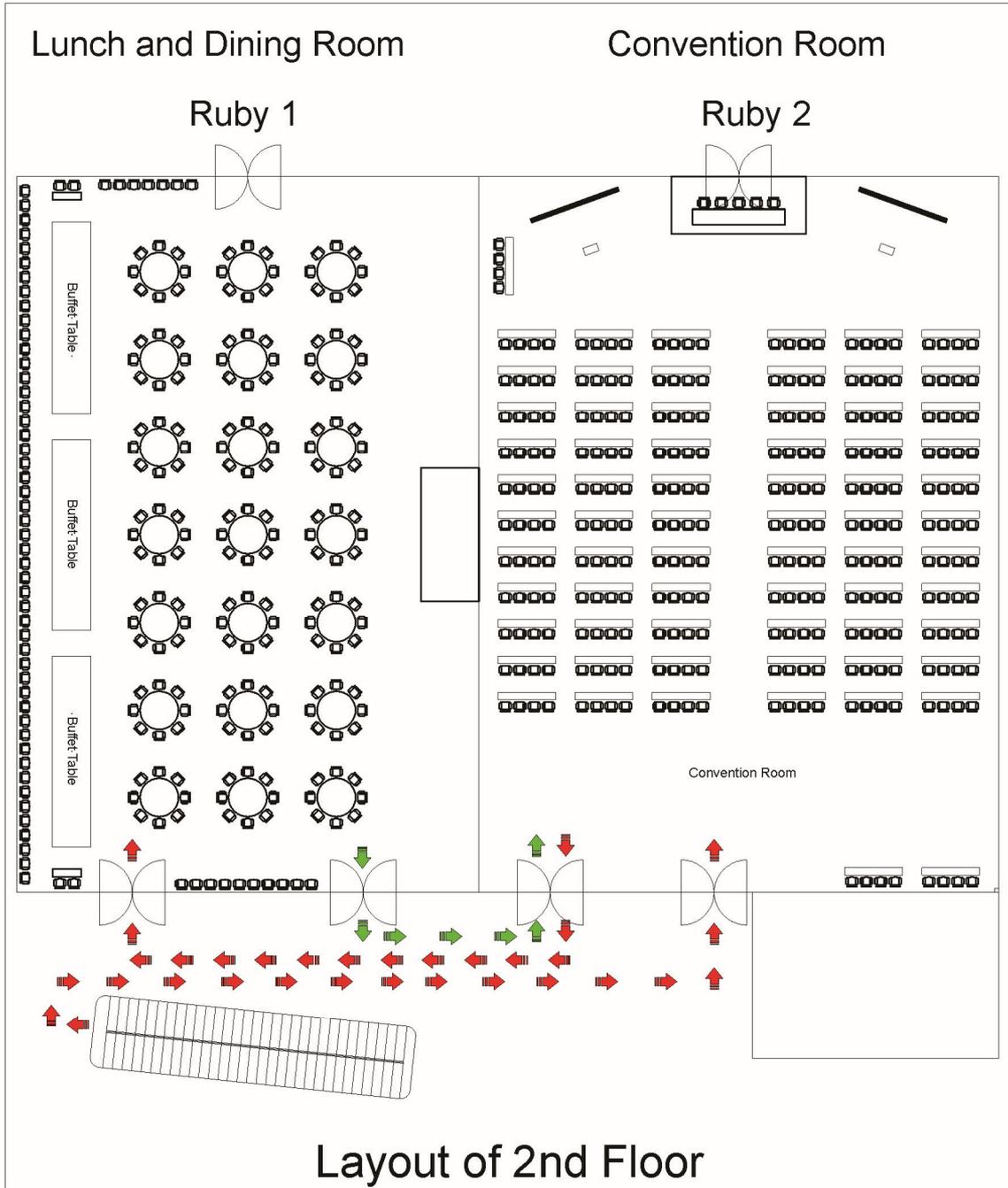
Time (WIB)	Paper ID	Paper Title	Author Names	Category	Room
13.00 - 13.10		Moderator			Ruby 1
13.10 - 13.30	56	Shear-bond behaviour of Fibre Reinforced Polymer (FRP) rods and sheets	Ay Lie Han*, Universitas Diponegoro; Buntara S. Gan, Nihon University; Agung Budipriyanto, Institut Teknologi Sepuluh Nopember	Invited Speaker	
13.30 - 13.40	3	Structural Performance Evaluation of Vertical Housing Model due to Increased Seismic Loads in Semarang Indonesia	Arnie Widyaningrum*; Yanuar Haryanto; Nor Intang Setyo Hermanto, Universitas Jenderal Soedirman	S	
13.40 - 13.50	9	Building evaluation using two component acceleration time histories causes by shallow crustal fault earthquakes with maximum magnitude 7 Mw	Partono Windu*, Universitas Diponegoro	S	
13.50 - 14.00	34	Numerical Study on Beam-Column Connection of Cantilever Precast Concrete Beam with Asymmetric Shape under Static Load	Hakas Prayuda*; Robbi'al Rollyas Syandy; Bagus Soebandono; Taufiq Ilham Maulana; Martyana Dwi Cahyati, Universitas Muhammadiyah Yogyakarta	S	
14.00 - 14.10	88	Peak Ground Acceleration at Surface for Mataram City with a Return Period of 2500 Years using Probabilistic Method	Rian Mahendra Taruna*, Mataram University; Vrieslend Haris Banyunegoro, Stasiun Geofisika Mata le. BMKG; Gatut Daniarsyad, Earthquake and Tsunami Center of BMKG	G	
14.10 - 14.20	67	Flexural Performance of HPFRC Plates using PPC and Variation of Steel Fiber Composition	Krisnamurti Krisnamurti*, University of Jember; Agoes Soehardjono; Achfas Zacoeb, University of Brawijaya; Ari Wibowo, Universitas Brawijaya	S	
14.20 - 14.30	74	Effect of monotonic lateral load on the performance of reinforced graded concrete column	M. Mirza Abdillah Pratama*; Gista Prasiwi, Universitas Negeri Malang; Zhabrinna Zhabrinna, University of Birmingham; puput risdanareni, universitas negeri malang	S	
14.30 - 15.00		Question and Answer			



Layout of Parallel Class 1st Floor









**Telkom University  
College Building**



**BNI BSD Building  
Construction Project**



**Tamansari Iswara**



**Casablanca Non-highway  
Flyover Project**



**PT WIJAYA KARYA (Persero) Tbk.**

## **PT Wijaya Karya (Persero) Tbk.**

JL. D.I. Panjaitan Kav. 9-10, Jakarta 13340

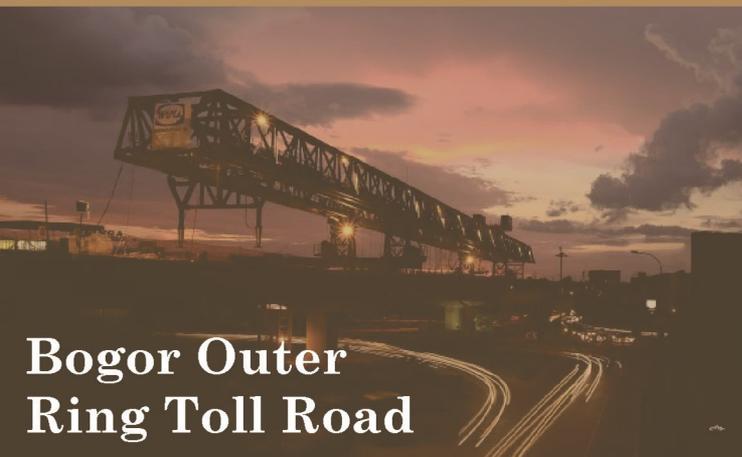
Phone : +6221 8067 9200

Fax: +6221 2289 3830

Homepage : <http://www.wika.co.id>

Email : [humas@wika.co.id](mailto:humas@wika.co.id)

<http://www.wika.co.id/project/>



**Bogor Outer  
Ring Toll Road**



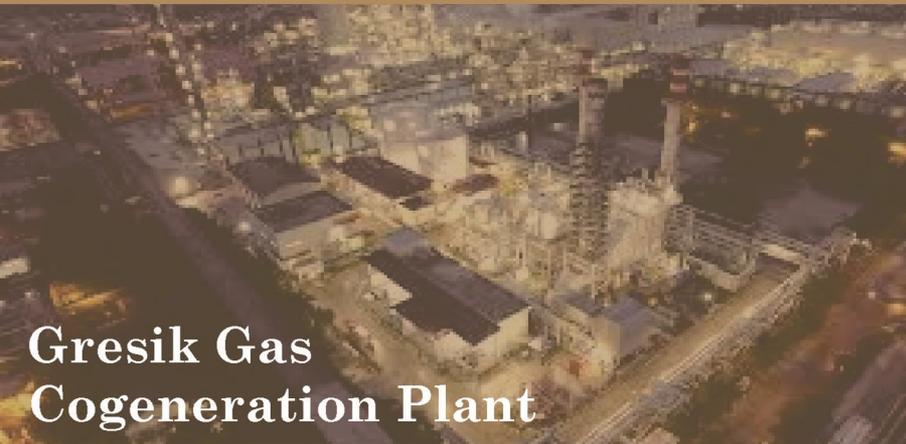
**Jembatan  
Merah Putih**



**Kemang View  
Apartement**



**PLTG Jayapura  
Kendari 100 MW**



**Gresik Gas  
Cogeneration Plant**



**Jembatan  
Holtekam**



**EPCC  
PLTP 50 MW**



**Landmark  
Pluit**

<http://www.pt-pp.com/our-business/project>

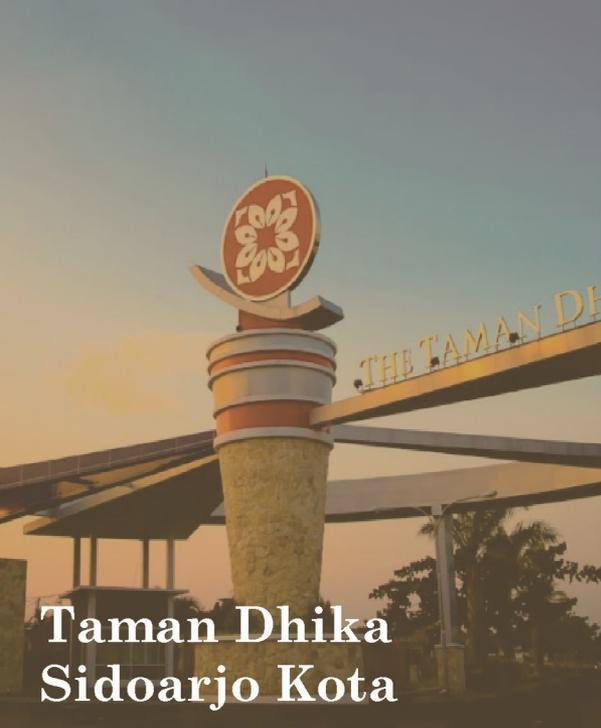


**CONSTRUCTION & INVESTMENT**

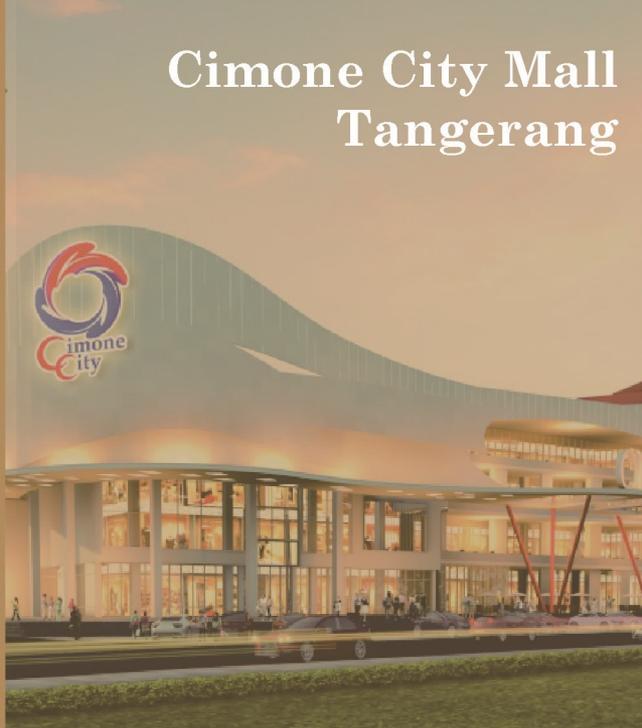
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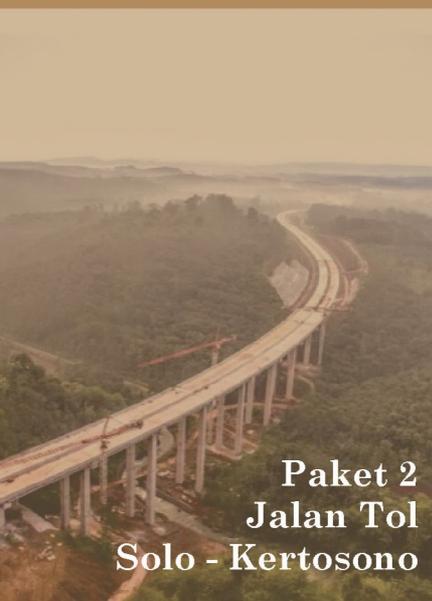
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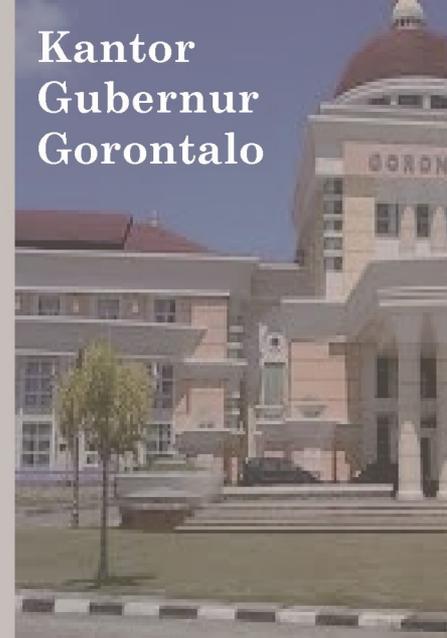
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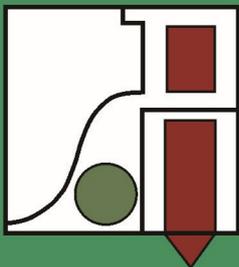
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# Data mining applied for national road maintenance decision support system

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**Abstract.** National roads are one of the main networks of a country's transportation system. To maintain the performance level of national roads requires a well-structured pavement management system (PMS). The decision support system (DSS) is inseparable in the modern PMS, which required the development of a new approach for the DSS in support of national road network maintenance. The proposed model integrates data mining (DM) and geographical information system (GIS) to construct a simple DSS. DM is used to developed road maintenance optimization models, and then integrated with DSS with the help of GIS as an interface application. Historical data on the national road network in West Java, Indonesia is used as a case study. Examples show that the proposed model can determine a decision support solution efficiently. In addition, a user-friendly computer interface is developed so that PMS stakeholders can plan pavement maintenance simply and effectively.

## 1 Introduction

The pavement management system (PMS) is carried out continuously, starting from design, planning, development, operation, maintenance, to the control stages. All stages of the pavement management system cycle have an equally important role and have a significant influence in maintaining road performance if implemented sustainably [1]. PMS is influenced by the nature and character of the pavement structures that can be patterned with various data approaches and other historical records. Higher pavement maintenance standards are currently required, in line with increasing road length, increased traffic volume, and other traffic space requirements [2].

The primary data required in the pavement management system is road performance data. Underperformance of the road can be reduced in proportion to the increasing age of pavement and the traffic load [3]. In general, the age of the pavement is determined based on the cumulative equivalent standard axle (CESA) estimated across the road pavement, calculated from the start of the construction and operation until the road pavement is categorized as damaged. Decreases in the overall road performance follow the function of volume increases and traffic load, changes in environmental conditions, and other conditions [4].

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Degradation of road performance does not take place in real time but gradually follows the time function. The speed and shape of performance changes have certain patterns and trends. Data collection in big data is absolutely necessary to produce a good and sustainable pattern [5]. New engineering approaches and the latest technology need to be used so that collected data can be utilized in a structured and scalable manner to support a better pavement management system through accurate interpretation and prediction of data. DM is one of the most recent approaches capable of performing accurate interpretations in predicting road service levels [6]. Regarding this matter, [7] has developed a road maintenance optimization model using information technology supported by a combination of a mathematical approach and genetic algorithm optimization.

Finally, a proven PMS is a system capable of providing a tool for users and decision makers to be able to understand and easily use. Coutinho-Rodrigues et al. [8] write that the easier a system is to use, the more the system can support the performance of the organization. In this regard, it is necessary to develop a DSS that is simple and easy to understand to optimise the existing pavement management system. The GIS approach is believed to be able to help simplify the DSS developed, as GIS contributes to the provision of a systematic method for the control of the maintenance and rehabilitation (M&R) process for paved networks [9].

Based on the description of some existing model concepts, the GIS approach is the main choice in explaining how optimization and prioritization are carried out. The development of this GIS model is expected to be an alternative complement to some of the existing concept models and other tools. The result of this GIS model development is expected to provide repair solutions for the improvement of the optimization model and the preparation of the DSS concept of road maintenance more comprehensive.

## 2 Literature review

DSS is needed to provide support to decision-makers in reaching the right policies. Likewise, in the issue of road maintenance, an approach is needed that can simplify the tools in making this decision. Maintenance optimization-based DSS is feasible for developing reasonable and consistent pavement maintenance [10]. In the process of pavement maintenance, a support system that can provide tools in decision-making is necessary. The decision support tools have neatly tiered and structured properties.

Some of the decisions that can be arranged into a system are strategic planning decisions, management control decisions, operational control decisions, and operational performance decisions. Various series of management activities, of course, require a system that can assemble all the node activities. Integration with existing systems such as computerized maintenance management systems and GIS is seen as the largest challenge for developing and using decision-support tools in the area of asset management [11].

DSS is often used in different contexts related to decision-making and refers to our support capabilities in making decisions; thus decision support is related to human decision-making. Generally, decision-making consists of three main components: intelligence, design, and choice [12].

The decision support model has been used in various fields, including pavement management. Moreover, plans and projects often impact multiple and contrasting interests in a complex institutional setting that result from decision-making processes involving several actors, both public and private [13]. Decision-making processes in infrastructure industries have increased due to the high level of inherent uncertainty. This is illustrated by the increasing complexity of the needs of decision support models, tools, and systems to assist the process. The decision-making model should also be applied to road infrastructure

investment. It is impossible to know exactly how accurate a particular investment decision is; therefore, DSS tools can assist in improving investment choices.

DSS is an interactive system-based computer system that helps decision-makers by utilizing data and models to solve unstructured and ambiguous problems. Network level infrastructure maintenance decision-making is a multi-factor and multi-criteria problem [14], which serves the needs of all levels of management decisions but is preferred for strategic decision support. The DSS function revolves around the scope of collecting and presenting information, and extrapolating, inferencing, and elaborating complex modelling. While the information system is based on the structure of analysis and decision support generated in the form of a unique answer, DSS emphasizes the importance of interactive activities and direct involvement of end users. Based on the feedback mechanisms inherent in the DSS, its use can improve the quality of decision-making and can optimize the limitations of dynamic moving resources. Furthermore, decision-making requires other supporting instruments besides technical approaches; economic, environmental, and social approaches require the same attention. Thus, in implementing effective management processes, the practical implication for making a decision is the dynamics of their collaborative networks. [15].

The role of the DSS is to help answer the question: "what is, what would, and what if". Without DSS it is quite difficult to reach the right decision. The problem of subjective presentation is sufficiently understood by the decision maker to be confronted with a statement that is inconsistent with the facts. Therefore, decision-making is a process based on knowledge and not just a "black box". To extract knowledge from hidden data, a tool is required that can interpret information with structure. DM extends the possibilities for decision support by discovering patterns and relationships hidden in the data and, therefore, enabling an inductive approach to data analysis [16]. The DSS model can be expected to have high accuracy if the approach model implanted in the system has high accuracy as well. All subsystems jointly or alone contribute to the various functions of the sub-system.

### 3 Method

The research method in this study consists of several components that can be synchronized with an input-process-output-process, which is the character of a system. The condition of road pavement is obtained from Directorate General Highway (DGH). Performance Index (PI), and road maintenance data are the main components of processes that use inputs to optimize road maintenance models. Pavement deterioration and maintenance models are the key components of the processes that use the inputs to optimize the model of pavement maintenance. Optimal road maintenance activities with minimum measures and costs must still meet minimum standards of job implementation. The iteration process of selecting maintenance actions starts from the easiest maintenance actions required each year to the end of the analysis period. The output of this model is a data mining-based DSS concept with PI prediction components and maintenance optimisation. The validity of a deterioration model is based on the accuracy and reliability of its data. This step entails taking several sources of data and combining them to create a comprehensive dataset.

The pavement condition data is mostly obtained from IIRMS. This data is a historical record of road conditions, road performance, and other relevant information, including roughness, cracks, ruts, potholes, Average Annual Daily Traffic (AADT), and Equivalent Single Axle Load (ESAL). Road condition data obtained from IIRMS dates from 2000 to 2017. Some of the data are incomplete, but the DM approach can be used to estimate lost or biased data in the database. Data used in this study, other than that obtained from IIRMS, is sourced from a report of Hawkeye vehicle surveys.

### **3.1 Data entry and acquisition**

Data is one of the critical components in GIS; the methods available for adding or obtaining data are paramount. Methods to achieve this are importing digital information available in a compatible format, using a global positioning system (GPS) device, and digitalizing from analog data.

On the one hand, the development of information technology with the emergence of digital information and database has made GIS access easier, especially internet-based. On the other hand, compatibility between software is increasingly common, allowing one to convert data originating in one type of software to use in other formats, Formats such as CAD (e.g., DWG, DXF), vectorial, and raster data widely used in commercial GIS (ARC/Info, ARC/View, Intergraph MGE, etc.) and general image data (e.g., tiff, bmp, etc.) are some examples of data that can be added directly to most GIS software.

It is widely known that a method for GIS data acquisition is with the use of GPS. The method is performed by transmitting signals to multiple satellites and using triangulation to determine positions and altitudes with low error margins (e.g., under one meter). GPS can be connected to GIS for various purposes such as mapping, determining coordinate handling, and others. The data used to perform design simulation is pavement management data on Java Island, while for the simulation interface a map of the West Java region is used.

### **3.2 Data mining approach**

In the development of this model, the researcher used a DM road-based performance prediction approach by using data from Java Island, Indonesia. Data is divided by province for calibration, learning, test, and validation purposes. Validation of road conditions and coordinate details were collected by direct data retrieval with Hawkeye in 2017. The road performance prediction model, in the form of PI with a DM approach without any assumption of limitation by considering input data is used to learning stages.

In this research, three DM techniques were trained using the previously described dataset to make predictions. The two DM algorithms are obtained by SVM and ANN models that have the same appearance. The performance of this model is confirmed by the values of  $R^2$ , MAD, and RMSE. Modelling results are presented with 95% confidence intervals in accordance with the t-distribution. Furthermore, SVM is adopted as a reference algorithm because it has a fairly high degree of accuracy with the number of iterations (20 iterations).

The DM technique, also known as association rule mining, has the purpose of finding associative rules between a combination of items. The importance of an associative rule can be identified by two parameters; the support, the percentage of the combination of attributes in the database, and the confidence, namely the strength of the relationship between attributes in the associative rules. The algorithm used in this research, paradigm generation and testing, makes candidate combinations of possible attributes based on a certain rule and is then tested. The combination of eligible attributes is called the frequent itemset, which is then used to create rules that meet the minimum confidence requirements.

### **3.3 Network implementation and analysis**

Among the various GIS capabilities, network analysis is an important step in this research. The limited analysis is performed on vectorial data because its use may represent the availability of a road network, defined as a series of interconnected features, representing potential routes, vehicle characteristics, and road maintenance activities. At this stage, accurate connectivity and characteristics are more important than geographical views. The ability of the QGIS Lisboa version is expected to perform the various minimum functions

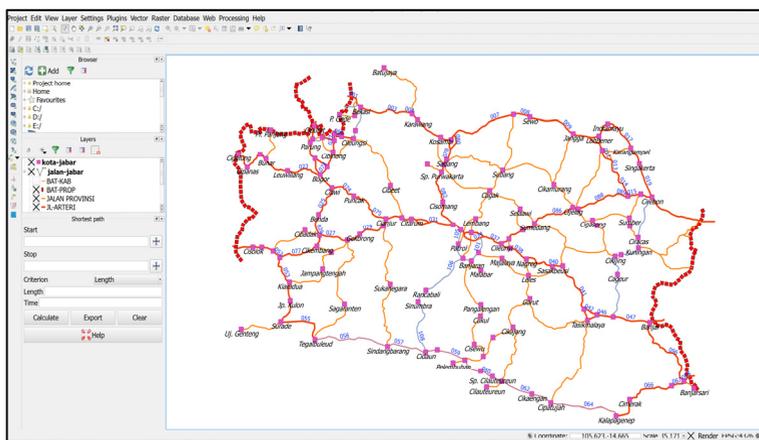


new record-set, which contains all the records from the map layer together with all their attributes.

## 4.2 Map layer

The five basic map layers below are used in the GIS module. **ANALYSIS RESULTS:** Contains detailed project-level results, including project ratings in each future analysis year, treatment methods and costs, AADT, and spatial location information, such as SegmentNo, NetworkNo, ProvinceNo, Sta. From and Sta. To, District, Office, and others. It is created by the MDS method. **STATEROUTE:** This layer is provided by the Integrated Indonesian Integrated Road Management System (IIRMS). After data integration, the layer contains the complete information on state highway routes in Java Island. **DISTRICT:** Contains the detailed district information of Java Island. **PROVINCE:** Contains the IIRMS Province boundary information and the IIRMS District-level needs analysis results. **NETWORK:** Contains the Network boundary information.

The five basic map layers include most of the information generated from the maintenance model results that can be displayed on GIS maps. Results from the Project-level Analysis Module related to individual project information are displayed on the ANALYSIS RESULTS layer; see figure 2. Results from the Network-Level Analysis Module related to State Congressional Districts, provinces, and states are displayed respectively on the DISTRICT and PROVINCE map layers.



**Fig. 2.** GIS base map.

## 4.3 Visualization

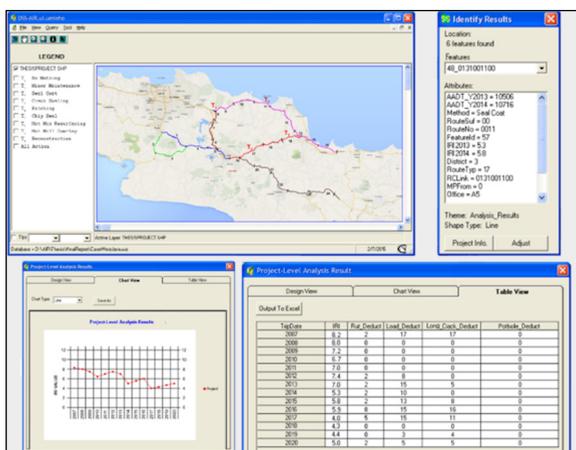
GIS provides a powerful visualization and mapping capability, which is useful for pavement rehabilitation needs analysis. In order to facilitate the decision support on multi-year rehabilitation needs analysis, several advanced functions have been developed. The design concept of these functions is to facilitate pavement rehabilitation needs analysis using GIS visualization. The potential uses of the visualization and mapping functions are: Visualize spatial and temporal treatment strategies on one map; Identify projects with abnormal pavement conditions; Investigate detailed historical information and needs analysis results of the interested project dynamically and interactively; Make comparison among different jurisdictions; Monitor routes not surveyed.

Several potential GIS applications are presented in the following to demonstrate the potential uses of these functions to facilitate the decision-making for planning pavement rehabilitation needs activities.

### 4.4 Interactive analysis of maintenance

To facilitate decision support on pavement maintenance needs analysis, a maintenance scenario analysis is developed with GIS capabilities, including visualization, spatial identification, and analysis, with maintenance optimization model including barriers to segment level and road performance prediction, determination of improvement and priority maintenance work. The interactive pavement scenario maintenance function based on maps has been developed to make it easier for decision-makers to develop and evaluate different improvement scenarios intuitively and directly on GIS-based maps.

Some potential GIS applications are presented below to demonstrate the potential use of functions in facilitating decision makers in the planning of pavement rehabilitation activities. Information from the maintenance segment, not only the condition of the previous pavement but also the rehabilitation information, is important in helping the engineer make a good assessment of the pavement rehabilitation plan. Engineers can retrieve previous information with GIS maps dynamically and can be connected directly to GPS devices to import the latest data. Figure 3 shows an example.



**Fig. 3.** Visualization of GIS module.

Using the above module, the user can select a special segment on the GIS-based map. In figure 3, there is sufficient information, including AADT, the year of improvement, rating, and repair methods on the selected segment shown in the table. By clicking on the "project info" button, various segment information, such as the level of the segment, the difference in the value of the segment, and AADT, can be retrieved from the database. Their relation to the road performance prediction information derived from the maintenance model results and stored in the database, can also be displayed in graphical or table formats.

This module is structured for users to understand that with technical knowledge, the management strategies generated by this DSS program can be improved. Good decisions can reduce the costs of mobilization of segments and congestion caused by the construction of two segments in a separate year, even reducing total construction costs. The module is considered to be an additional tool for stakeholders in implementing a pavement management system. The system was compactly designed for the road performance prediction model, optimization model, and DSS process and can be simply understood in an integrated manner.

## 5 Conclusion

The DSS concept was developed by integrating DM to develop PI prediction models and GIS to develop DSS interfaces, all capable of displaying simple interface applications and providing convenience to stakeholders to implement pavement management systems with simple steps. The DM approach that has been adapted to the needs of the road maintenance management system that has a wide area of coverage can simplify the constraint. The interface concept developed in this research is quite simple and flexible, and therefore can be developed in accordance with local needs.

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