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2021 ICCIM

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Analysis of Asphalt Damping Ratio on Shear Test

26th July 2021
Universitas Tarumanagara
Jakarta - Indonesia

Dean of the Faculty of Engineering
Universitas Tarumanagara

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Analysis of Asphalt Damping Ratio on Shear Test

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Abstract. Seismic resistance structure on high-rise buildings is considered vital to be applied in present days to reduce structural damage caused by the earthquake. Therefore, it requires technology to control the dynamic response of the structure due to lateral forces, including earthquake force. Passive structure control system altering mass or stiffness and incorporating damping material is one representative technology in which could be applied. This study focuses on damping material-Pertamina asphalt with 60/70 penetration as the additional substance for the damper. Asphalt addition in seismic force damping system is to increase damping ratio on building structure and therefore lateral force from earthquake influencing it, is reduced and diverted to damping system. The behavior of asphalt on the shear test conducted on contact fields 9.3333 cm^2, 23.0667 $cm^{2,}$ and 34.7 cm^2 become the main objective of this research. The law of Hooke and force equilibrium dynamic equation is applied to analyze the damping ratio. Verdict on the investigation of this study has shown results to be supercritical (ζ>1).

Keywords: Asphalt, Damping, Stiffness

1 Introduction

The gravitational and lateral force is a fundamental contributing factor in the design of structural systems due to the importance of earthquake force. Lateral force on high-rise buildings is considered to be more destructive, in particular, due to seismic force. Therefore, the application of earthquake resistance structure is necessary to be carried out on the design of high-rise buildings.

A structure may be designed for earthquake resistance by making it strong and ductile, or by designing it so that plastic beam-column joint may occur in which results in energy reduction and damped structure [1]. In order to decrease the damage to building structures from the earthquake, an alternative design is being established. The reduction of seismic force is able to be practiced by incorporating a damping system on structural components where the primary force from the earthquake working on the building is absorbed.

Increasing the damping ratio on building structure damping systems is another possible method to be applied. Additional damping is expected to carry out more energy absorption due to the occurrence of seismic force so that only a small portion of earthquake force working on the building which reduces possible damage from happening. The method of designing this earthquake resistance structure is known as the passive control system [2].

Damping system using passive control system existing in the time being requires a further upgrade to overcome few issues such as the addition of building mass which results in P-delta effect, influence on structure stiffness and deflection [3,4]. Due to these objectives, more advanced damping equipment needs to be established. Asphalt could be implemented as an alternative material to increase damping effectivity on the damping apparatus due to the large damping value it has, which results in the absorption of primary force from seismic activity working on building [5].

On a previous study conducted on the analysis of the influence of viscosity on asphalt damping ratio as earthquake force damper with a penetration test method had shown result that asphalt is able to be applied as damping material [6,12]. The high viscosity of asphalt is able to provide a larger coefficient of damping.

2 Materials and Method

An Analog model is applied to this study to mimic an asphalt damping system focusing on asphalt behavior on conducted shear tests [7]. The area of contact tested on this study vary between 9.3333 cm^2, 23.0667 cm^2, and 34.7 cm^2. An illustration of the model is displayed in Fig. 1 .

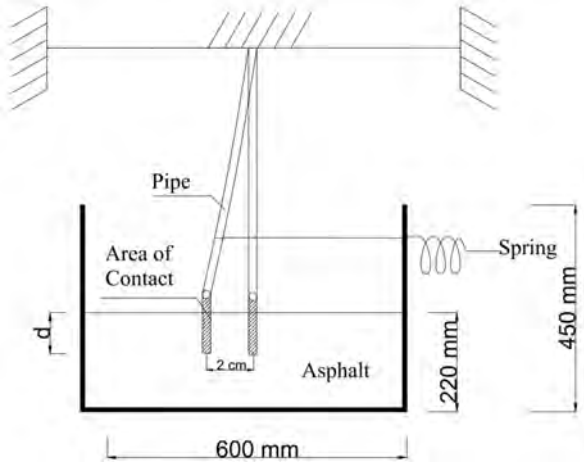

Fig. 1 Asphalt Shear Test

General equation of motion from the system is stated in Eq. 1:

$$M\ddot{U}(t)+C\dot{U}+KU=0 \quad (1)$$

where:
Ü = acceleration (m/s^2)
U̇ = velocity (m/s)
U = displacement (m)
M = mass (kg)
C = damping (N.s/m)
k = stiffness (N/m)
which also can be written as displayed in Eq. 2:

$$U = e^{-\zeta.\omega_n.t}(A \text{ Cos } \omega_d.t + B \text{ Sin } \omega_d.t) \quad (2)$$

With A and B presented in Eqs. 3–4:

$$A = U_0 \quad (3)$$

$$B = \frac{\dot{U}_0 + \zeta.\omega_n.U_0}{\omega_d} \quad (4)$$

Where:
U = displacement (m)
ζ = damping ratio
ω_n = natural frequency of undamped vibration (rad/s)
ω_d = natural frequency of damped vibration (rad/s)
t = time variable (s)
U_0 = initial displacement (m)
$\dot{U}_0$ = initial velocity (m/s)

There are three following conditions on viscously damped free vibration [1]:

1. Underdamped system oscillates about its equilibrium position with a progressively decreasing amplitude, where $c < c_{cr}$ and $\zeta < 1$
2. Critically damped system returns to its equilibrium position without oscillating, where $c = c_{cr}$ dan $\zeta = 1$
3. The overdamped system does not oscillate and returns to its equilibrium position as in the critically damped system but at a slower rate, where $c > c_{cr,} \zeta > 1$

Fig. 2 shows a plot of the motion U(t) due to initial displacement U($_0$) for three values of ξ.

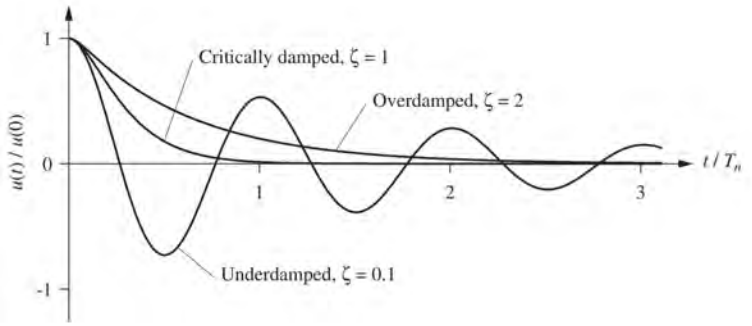

Fig. 2 Free vibration of underdamped, critically damped, and overdamped systems [1]

By assuming damping is supercritical, the general solution from Eq. 2 are obtained as Eq. 5:

$$U(t)=A.e^{(P_1.t)}+B.e^{(P_2.t)} \tag{5}$$

With A and B values to be calculated as Eqs. 6–7:

$$A=\frac{\dot{U} - U_0.P_2}{P_1-P_2} \tag{6}$$

$$B=\frac{U_0.P_1-\dot{U}}{P_1-P_2} \tag{7}$$

And P_1 and P_2 to be written as Eqs. 8–9:

$$P_1 = -\zeta.\omega+\omega_d \tag{8}$$

$$P_2 = -\zeta.\omega - \omega_d \tag{9}$$

Where:
$\dot{U}$ = velocity (m/s)
U_0 = initial displacement (m)
ζ = damping ratio
ω = forcing frequency (rad/s)
ω_d = natural frequency of damped vibration (rad/s)

Through entering boundary condition of the experiment where damped vibration time variable (t_d) and initial velocity ($\dot{U}_0$) equal to zero onto Eq. 6 and Eq. 7. Therefore a new formula is calculated as displayed on Eq. 10:

$$2\omega_d.U(t)=U_0.\zeta.\omega^{-\zeta.\omega_t}.e^{\omega_d.t}+U_0.\omega_d.e^{-\zeta.\omega_t}.e^{\omega_d.t}-U_0.\zeta.\omega.e^{-\zeta.\omega_t}.e^{-\omega_d.t}+U_0.\omega_d.e^{-\zeta.\omega_t}.e^{-\omega_d.t} \tag{10}$$

where:

ω_d = natural frequency of damped vibration (rad/s)
U(t) = displacement at certain time variable (m)
U_0 = initial displacement (m)
ζ = damping ratio
ω = forcing frequency (rad/s)
t = time variable (s)

Eq. 10 is used on Matlab to analyze the damping ratio of asphalt. The procedure of this study is presented in Fig. 3.

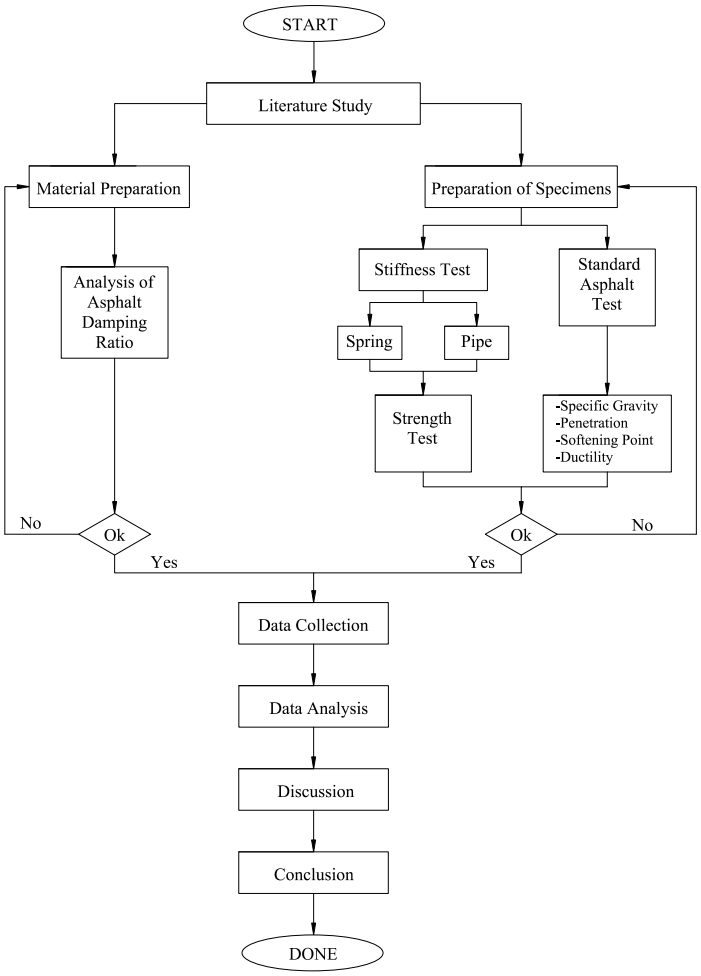

Fig. 3 Research flow chart

3 Results and Discussion

There are few test objectives conducted in this study which include investigation on asphalt physical properties, stiffness of pipe and spring, and the influence of contact area variation. Test results on asphalt physical characteristics are displayed in Table 1.

Table 1 Results of Asphalt Physical Test

Asphalt Test	First Experiment	Second Experiment	Testing Standards
Penetration (%)	59.5	73	[8]
Specific gravity (gr/cm^3)	1.04	0.95	[9]
Softening point (^{o}C)	45	45	[10]
Ductility (cm)	>100	>100	[11]

The different areas of contact will result in variation of damping coefficient value. This study runs testing on three different areas of contact, where each size of areas is assessed five times. The area of contact tested on this study vary between 9.3333 cm^2, 23.0667 cm^2 and 34.7 cm^2.

Results of damping ratio analysis using Matlab and Eq. 10 are presented in Table 2.

Table 2 Result of Damping Ratio Analysis

Trial	ζ		
	9.3333 cm^2	23.0667 cm^2	34.7 cm^2
1	1.168	1.166	1.060
2	1.151	1.211	1.099
3	1.171	1.148	1.106
4	1.153	1.204	1.093
5	1.116	1.190	1.095

The relation of damping ratio and area of contact is shown in a graphical form in Fig. 4.

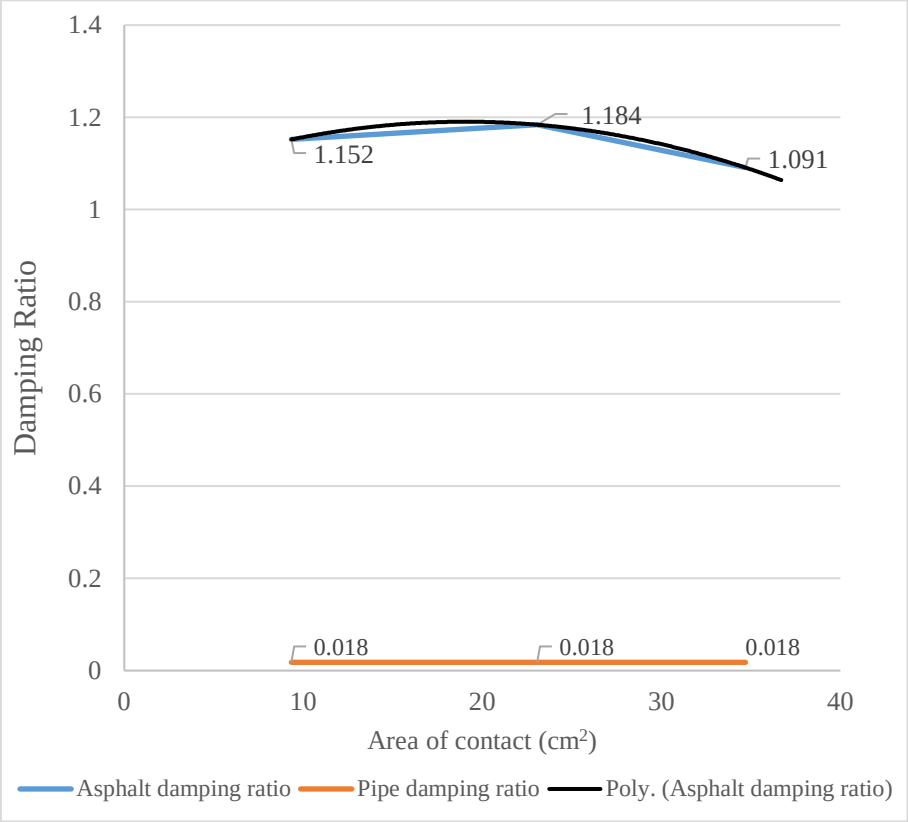

Fig. 4 Damping Ratio Value

From Fig. 4, it can be seen that the asphalt damping ratio for 9.3333 cm^2 large area is calculated as 1.152, for area size of 23.0667 cm^2 is 1.184 and for the area of contact 34.7 $cm^{2,}$ the analysis of asphalt damping ratio results in the value of 1.091. In contrast, the damping ratio without asphalt incorporation is approximately 0.0018.

4 Conclusion

Analysis conducted for the objective of this study has shown results that the asphalt damping ratio is larger than one ($\zeta>1$). This occurrence proves that asphalt damping is found to be supercritical. The damping ratio of asphalt varies between 1.08–1.18. On the contrary, the damping ratio of a damping system without asphalt is only 0.018, which proves the compatibility of asphalt as a damping material. Correlation between the area of contact and damping ratio value is presented through $y = 0.0004\ x^2 + 0.0155\ x + 1.0426$, where y is the damping ratio value and x is the size of the contact area.

The supercritical result of the asphalt damping ratio test makes it a feasible, innovative material to be applied on seismic force damping systems, where it could be studied further in future research.

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ICCIM 2021

Research and Technology in Civil Engineering to Enhance the Sustainability of the Built Environment

PROGRAM BOOK

26th July 2021
Universitas Tarumanagara
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Program Book

THE SECOND INTERNATIONAL CONFERENCE
Of Construction, Infrastructure, and Materials

Research and Technology in Civil Engineering
To Enhance the Sustainability of the Built Environment

26 July 2021

Universitas Tarumanagara

Jakarta – Indonesia

The Second
International Conference
of Construction, Infrastructure, and Materials

Contents

Forewords by
Rector of Universitas Tarumanagara

Good morning ladies and gentlemen. Thank you for having me on this online International Conference: ICCIM 2021.

First of all, I would like to give my thanks to all of keynote speakers: Prof. Roesdiman Soegiarso, Indonesia; Prof. Monty Sutrisna, New Zealand; Dr. Ing. Joewono Prasetijo, Malaysia; Dr. Tam Chat Tim, Singapore; to the moderator, to all speakers, to committee members and to all participants.

Welcome to the ICCIM 2021 with topic: Research and Technology in Civil Engineering to Enhance the Sustainability of the Built Environment. The topic is very interesting and very relevant to be discussed at our current condition.

We are currently going through a difficult situation, but don't forget that there are still opportunities for improvement and development in the future. Infrastructure development continues to be carried out in various countries including Indonesia, to improve the welfare of the community. This development requires research results and innovations in the field of civil engineering, which have been developed by researchers, lecturers, students, and practitioners. Therefore, ICCIM 2021 is very important to be implemented as a medium for publication and communication of various research results from the experts.

Through all keynote speakers, we can learn useful knowledge that can be implemented in our research and innovation.

I hope the discussion in this conference will make a breakthrough to contribute for good research and innovation for everyone. Thank you for the collaboration of universities from many countries. I hope this collaboration will continue in the future. To all my fellow students, lecturers, or participants, I hope you enjoy today's discussion, and don't forget to give your opinion or question at the end of the conference.

Thank you very much for your attention and contribution. Have a nice online conference.

Jakarta, July 2021
Rector,

Prof. Dr. Agustinus Purna Irawan

Forewords by Conference Chairs

Dear distinguished guests, ladies, and gentlemen,

It is indeed a great pleasure to welcome you to the Second International Conference of Construction, Infrastructure, and Materials (ICCIM 2021). The theme of ICCIM 2021 is "Research and Technology in Civil Engineering to Enhance the Sustainability of the Built Environment."

Seeing the participants' enthusiasm for The First International Conference of Construction, Infrastructure, and Materials (ICCIM 2019), the committee commits to continuing the Conference biennially.

ICCIM 2021 is organized by the Civil Engineering Undergraduate Study Program of Universitas Tarumanagara and supported by Massey University, New Zealand; Universiti Tun Hussein Onn Malaysia, Malaysia; Nihon University, Japan; fib Indonesia; Diponegoro University, Indonesia; Soegijapranata Catholic University, Indonesia; Universitas Sebelas Maret, Indonesia; and Universitas Atma Jaya Yogyakarta, Indonesia.

ICCIM 2021 has received papers from various countries, such as Indonesia, Japan, Thailand, the United Kingdom, the United States of America, the Philippines, India, Nigeria, and Bangladesh. We have diverse paper topics, including Structural Engineering, Construction Materials, Geotechnical Engineering, Transportation System and Engineering, Construction Management, Water Resources Engineering. And Infrastructure Development. Through the double-blind peer review processes by the reviewers from diverse expertise, we accept 57 papers for the presentation and publication in the Lecture Notes in Civil Engineering; a reputable Scopus indexed series published by Springer.

I am likewise grateful to the keynote speakers for bringing the exciting topics to ICCIM 2021: Prof. Roesdiman Soegiarso (Universitas Tarumanagara, Indonesia); Prof. Monty Sutrisna (Massey University, New Zealand); Dr.-Ing. Joewono Prasetijo (Universiti Tun Hussein Onn Malaysia, Malaysia); and Dr. Tam Chat Tim (National University of Singapore, Singapore)

I would also like to take this opportunity to extend my appreciation to the supporting institutions. Secondly, thank you to the sponsors for the utmost support and kind contribution: PT. Waskita Karya (Persero) Tbk, PT. Pamapersada Nusantara, and PT. Bank Negara Indonesia Tbk.

Forewords by Conference Chairs

Many people have worked very hard for the organization of this Conference. Special thanks are needed to the Organizing Committee, Steering Committee, Editorial Board, and Scientific Committee. All of whom have generously worked to make this Conference rich in content and pleasant for the attendees.

I hope you will take advantage of all the Conference has to offer throughout the day – time to be social and grow friendship, educational and knowledge exchange, research opportunities, and so much more.

I wish you all a wonderful experience through ICCIM 2021. Thank you.

ICCIM 2021 Chairman,

Prof. Ir. Chaidir Anwar Makarim, MSE., Ph.D.

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C. The display name format in zoom meetings are listed below:

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D. Participants are required to attend the Plenary Session from start to finish to get E-Certificate as Participants.

E. Presenters are required to attend Plenary and Parallel sessions to get E-Certificate as Presenters.

F. While every attempt is made to ensure that all aspects of the symposium mentioned in this announcement will occur as scheduled, the Organizing Committee reserves the prerogative to make last-minute changes should the need arise without prior notice.

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7. Please set your microphone in mute mode throughout the whole plenary session.
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11. The session chair may put the Q&A session at the end of all presentations if the presenters agree with it.
12. At the end of the session, the Session Chair will conclude the session. The room admin will take the photo.
13. After the end of the session, you can go back to the main room for the closing at 17.05 WIB (UTC+7).

Presenter Guidelines

1. Please join at least 10 minutes before your parallel session and be present during your video playback as well as the Q&A session. Test your audio and camera as you join.
2. Your microphone will be muted during the video playback. You are encouraged to keep your camera on during the video playback and Q&A.
3. During the replay of the presentation video, participant may ask questions related to the presentation through the chat room or by raising hand at the end of the presentation.
4. You are encouraged to keep an eye on the questions to answer them during the Q&A Session.
5. The session chair may tell the room admin to stop playing the video if it exceeds 10 minutes.
6. At the end of the pre-recorded presentation, the Host will unmute your microphone and spotlight your video. The Session Chair will then ask you to answer some of the questions in the sequence they were submitted and within the allotted Q&A time.
7. You should be virtually present for their entire session to answer questions and participate in the discussion.
8. You can ask questions to other presenters via chat room during the presentation or by using the raising hand tool at the end of the video playback. In the chat room, please use this format: Q_TypeYourQuestionHere.

Session Chairs Guidelines

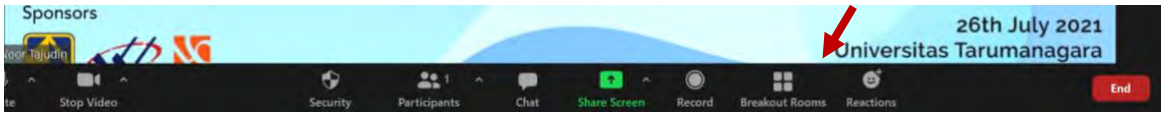
1. Please join the session at least 10 minutes in advance. Please test your microphone and video once joined so that the session can start on time.
2. One Room Admin will accompany you in the session. Feel free to ask for assistance when you need it.
3. Please always turn on your video during the introduction, Q&A, and closing session.
4. During the playback of the presentation video, please keep track of the questions in the chat room.
5. Please make sure to ask the questions submitted to the chat room according to the time they were first submitted. If there are not many questions, please check whether participants raise hands to ask questions.
6. Be prepared with a few opening questions to start a discussion, if necessary
7. Sometimes the audience may need to clarify their question. In that case, it is upon the discretion of the Session Chair to unmute the attendee who placed the question to make clarifications.
8. Please be mindful of the Q&A time limits.
9. If the video playback exceeds 10 minutes, it is upon the discretion of the Session Chair to tell the Room Admin to stop the video.
10. The session chair may put the Q&A session at the end of all presentations if the presenters agree with it.
11. At the end of the session, please ask all attendees to open the camera to take a picture together. The room admin will take the picture.

Participant Guidelines

1. You can join any session/room that interests you by using the breakout room button provided on the Zoom meeting.
2. During the playback of the presentation video, you are welcome to ask questions using the chat room. You can also use the raising hand tool at the end of the presentation.
3. The moderator or Session Chair will select and ask the questions during the Q&A session. We understand that there may not be time to ask all the questions. The Chair will make sure to ask complementary questions and hopefully according to the first submitted question.
4. The organizer will have the ability to unmute participants if this is needed to elaborate on their questions.

Guidelines for Using Zoom Breakout Room

1. Make sure to install Zoom on your computer or update it to the latest version (version 5.3.0 or higher).
2. Participants not joined with the desktop or mobile app (version 5.3.0 or higher) will not be able to self-select a breakout room and will need to be assigned by the Host.
3. To join the parallel session room of your choice:
4. Click **Breakout Rooms** in your meeting controls (menu bar below).



5. This will display the list of open breakout rooms (e.g., Room 1.1) created by the Host.
6. Hover your pointer over the number to the right of the breakout room you wish to join, click **Join**, then confirm by clicking Join.

7. Repeat as necessary to join other breakout rooms.
8. You can leave the breakout room and return to the main meeting room at any time, or you can leave the meeting entirely from the breakout room.
9. To leave the breakout room, click **Leave Breakout Room** and choose if you want to leave the breakout room or the entire meeting (if you're going to switch to a different parallel session, make sure to use the 'Leave Room' option to re-enter the main meeting room and join the other room).
10. When the Host ends the breakout rooms, you will be notified and given the option to return to the main room immediately or in 60 seconds.

Useful Links

If you need more information on how to use Zoom:

How to join a Zoom meeting

How to configure your audio and video

Participating in breakout rooms

Conference At a Glance

Time			Programme
WIB (UTC +7)	NZST (UCT +12)	MYT and SGT (UCT +8)	
07.30-08.00	12.30-13.05	08.30-09.00	Registration
08.05-08.45	13.05-13.45	09.05-09.45	Opening Ceremony
08.45-09.25	13.45-14.25	09.45-10.25	Keynote Speech 1 (Prof. Roesdiman Soegiarsa – Universitas Tarumanagara) Moderator: Andy Prabowo, S.T., M.T.
			QnA
09.25-10.05	14.25-15.05	10.25-11.05	Keynote Speech 2 (Prof. Monty Sutrisna – Massey University) Moderator: Dr. Basuki Anondho
			QnA
10.05-10.15	15.05-15.15	11.05-11.15	Campus Virtual Tour
10.15-10.55	15.15-15.55	11.15-11.55	Keynote Speech 3 (Dr. -Ing. Joewono Prasetijo – Universiti Tun Hussein Onn Malaysia) Moderator: Dr. Eng. M. Zudhy Irawan
			QnA
10.55-11.35	15.55-16.35	11.55-12.35	Keynote Speech 4 (Dr. Tam Chat Tim – National University of Singapore) Moderator: Andy Prabowo, S.T., M.T.
			QnA
11.35-11.50	16.35-16.50	12.35-12.50	Interlude
11.50-12.00	16.50-17.00	12.50-13.00	Parallel Session Technical Briefing
12.00-13.00	17.00-18.00	13.00-14.00	Break
13.00-14.45	18.00-19.45	14.00-15.45	Parallel Session 1
14.45-15.15	19.45-20.15	15.45-16.15	Break
15.15-17.00	20.15-22.00	16.15-18.00	Parallel Session 2
17.05-17.30	22.05-22.30	18.05-18.30	Closing

Parallel Session Schedule: Geotechnical Engineering

Time : **13.00 - 14.15**

Room : **1.1**

Track : **Geotechnical Engineering**

No	Time (UTC +7)	Paper ID	Paper Title	Authors
1	13.00 - 13.15	6	Additional Horizontal Movement of The Single Pile Foundation with Combined Loads	Sumiyati Gunawan, Niken Silmi Surjandari, Bambang Setiawan, and Yusep Muslih Purwana
2	13.15 - 13.30	32	The Combined Effects of Terraces Slope Model and Geotextile Reinforcement Design in Sendangmulyo, Wonogiri.	Siti Nurlita Fitri and Niken Silmi Surjandari
3	13.30 - 13.45	59	REVIEW: Effects of Climate on the Geochemical Properties of Volcanic Rocks	Novi Asniar, Yusep Muslih Purwana, Niken Silmi Surjandari, and Bambang Setiawan
4	13.45 - 14.00	69	Analysis of Shift Pile Foundation on Mall and Hotel Projects in Bontang, East Kalimantan	Nicholas Joshua and Alfred Jonathan Susilo
5	14.00 - 14.15	70	Analysis of Diaphragm Wall Stability with Dewatering and Ground Freezing Treatment	Eduard Teja and Aniek Prihatiningsih

Parallel Session Schedule: Water Resources Engineering

Time : **15.15 - 16.45**

Room : **1.2**

Track : **Water Resources Engineering**

No	Time (UTC +7)	Paper ID	Paper Title	Authors
1	15.15 - 15.30	36	Erosion and Distribution of Total Suspended Sediment (TSS) Using Landsat-8 in Krueng Pase Watershed	I. Ramli, A. Achmad, H. Basri, and A. Izzaty
2	15.30 - 15.45	50	Nonlinear Effect of Fluid–Structure Interaction Modeling in the Rock-Fill Dam Jatiluhur	Albert Sulaiman, Wati A. Pranoto, Tati Zera, and Mouli D. Dewantoro
3	15.45 - 16.00	54	Assessment of Flooding Event in the Upper Sunter Watershed, Jakarta, Indonesia	A. A. Laksmi, A. H. S. Putro, W. S. Dharma, P. D. Saputra, N. Purwanti, and M. H. Fansuri
4	16.00 - 16.15	66	Analysis of the Utilization of the Embung Klampeyan, Tlogoadi Village, Mlati District, Sleman Regency, Indonesia	Edy Sriyono
5	16.15 - 16.30	38	Shoreline Change Cause of Abration in Bantan District Bengkalis Island as the Outstanding Beach Area	Hotmauli Tampubolon
6	16.30 - 16.45	58	Modeling of Flood Propagation in the Lower Citarum River Using a Coupled 1D-2D HEC-RAS Model	Angga H. Prawirakusuma, Sri Legowo Wignyo Darsono, and Arno Adi Kuntoro

Parallel Session Schedule: Structural Engineering & Construction Materials

Time : **13.00 - 14.45**

Room : **2.1**

Track : **Structural Engineering & Construction Materials**

No	Time (UTC +7)	Paper ID	Paper Title	Authors
1	13.00 - 13.15	13	Artificial Aggregate Made from Expanded Polystyrene Beads Coated with Cement Kiln Dust - An Experimental Trial	A. P. Wibowo, M. Saidani, and M. Khorami
2	13.15 - 13.30	11	The Use of Fly Ash in Pervious Concrete Containing Plastic Waste Aggregate for Sustainable Green Infrastructure	Steve W.M. Supit and Priyono
3	13.30 - 13.45	56	On-Field Testing of The Monolith Joint of The Full Slab on A Slab-On-Pile Bridge	A. Z. Risadi, J. I. Rastandi, B. O. B. Sentosa, and N. Handika
4	13.45 - 14.00	29	Structural Analysis Using Matched Acceleration Time Histories	Windu Partono
5	14.00 - 14.15	16	Load Transfer Shear Wall to Pile Cap Modelling Partially for Group Precast Pile	Daud Rahmat Wiyono, Roi Milyardi, Yosafat Aji Pranata, Asriwiyanti Desiani, Ginardi Husada, and Maria Christine Sutandi
6	14.15 - 14.30	41	Non-Linear Analysis of Steel Shear Key at Epoxy Joint	Khairunnisa Masturoh, Nuraziz Handika, and Heru Purnomo
7	14.30 - 14.45	8	Characterization of Heat Insulating Ceramic Fiber Raw Material for Green Environment	T. M. S. A. Hossain, Mst Alpona Akter, M.A Matin, M. A. Hakim, and M. F. Islam

Parallel Session Schedule: Structural Engineering & Construction Materials

Time : **15.15 - 16.45**

Room : **2.2**

Track : **Structural Engineering & Construction Materials**

No	Time (UTC +7)	Paper ID	Paper Title	Authors
1	15.15 - 15.30	5	Analysis of Hollow Concrete Column with CFRP Wrapping Using Finite Element Method	William Supardjo and Sunarjo Leman
2	15.30 - 15.45	57	Seismic Design Load Comparison of Reinforced Concrete Special Moment Frame and Dual Systems Based on SNI 1726:2019	Suradjin Sutjipto and Indrawati Sumeru
3	15.45 - 16.00	62	Analysis of The Sand Grains Influence on Damping Ratio Using Shear Test	Daniel Christianto, Vryscilia Marcella, Channy Saka, Alvira Nathania Tanika, and Yuskar Lase
4	16.00 - 16.15	24	Effect of Cement-Water Ratio on the Mechanical Properties of Reactive Powder Concrete with Marble Powder as Constituent Materials	Widodo Kushartomo, Henny Wiyanto, and Daniel Christianto
5	16.15 - 16.30	63	Parametric Study on Neutral Axis Growth of Concrete Beams Reinforced with Fiber-Reinforced Polymer and Steel Bars	Ahmad Zaki and Rendy Thamrin
6	16.30 - 16.45	61	Analysis of Asphalt Damping Ratio on Shear Test	Sunarjo Leman, Maria Kevinia Sutanto, Elizabeth Ivana Harsono, Vryscilia Marcella, Anugerah Tiffanyputri, and Yuskar Lase