Journal of Physics

Conference Series

The 11th Biennial Conference on Classical and Quantum Relativistic Dynamics of Particles and Fields

1239

EDITOR:
Martin Land

The open access journal for conference proceedings

iopscience.org/jpcs

PAPER • OPEN ACCESS

The Third International Conference on Combinatorics, Graph Theory, and Network Topology 2019

To cite this article: 2020 *J. Phys.: Conf. Ser.* **1538** 011001

View the article online for updates and enhancements.

The Third International Conference on Combinatorics, Graph Theory, and Network Topology 2019

Dafik

Editor in Chief   of International Conference on Combinatorics, Graph Theory, and Network Topology 2019
E-mail: d.dafik@unej.ac.id

We would like to express our gratitude to all participant who were joining "The Third International Conference on Combinatorics, Graph Theory, and Network Topology (ICCGANT)". It is the 3rd International conference held by the CGANT Research Group held by University of Jember in cooperation with Indonesian Combinatorics Society (INACOBMS) on 26-27 October 2019. The conference is held to welcome participants from many countries, with broad and diverse research interests of mathematics especially combinatorial study. The mission is to become an annual international forum in the future, where, civil society organization and representative, research students, academics and researchers, scholars, scientist, teachers and practitioners from all over the world could meet in and exchange an idea to share and to discuss theoretical and practical knowledge about mathematics and its applications. The aim of the third conference is to present and discuss the latest research that contributes to the sharing of new theoretical, methodological and empirical knowledge and a better understanding in the area mathematics, application of mathematics as well as mathematics education. The themes of this conference are as follows:

(1) Connection of distance to other graph properties, (2) Degree/diameter problem, (3) Distance-transitive and distance-regular graphs, (4) Metric dimension and related parameters, (5) Cages and eccentric graphs, (6) Cycles and factors in graphs, (7) Large graphs and digraphs, (8) Spectral Techniques in graph theory, (9) Ramsey numbers, (10) Dimensions of graphs, (11) Communication networks, (12) Coding theory, (13) Cryptography, (14) Rainbow connection, (15) Graph labelings and coloring, (16) Applications of graph theory The topics are not limited to the above themes but they also include the mathematical application research of interest in general including mathematics education, such as: (1) Applied Mathematics and Modelling, (2) Applied Physics: Mathematical Physics, Biological Physics, Chemistry Physics, (3) Applied Engineering: Mathematical Engineering, Mechanical engineering, Informatics Engineering, Civil Engineering, (4) Statistics and Its Application, (5) Pure Mathematics (Analysis, Algebra and Geometry), (6) Mathematics Education, (7) Literacy of Mathematics, (8) The Use of ICT Based Media In Mathematics Teaching and Learning, (9) Technological, Pedagogical, Content Knowledge for Teaching Mathematics, (10) Students Higher Order Thinking Skill of Mathematics, (11) Contextual Teaching and Realistic Mathematics, (12) Science, Technology, Engineering, and Mathematics Approach, (13) Local Wisdom Based Education: Etnomathematics, (14) Showcase of Teaching and Learning of Mathematics, (15) The 21st Century Skills: The Integration of 4C Skill in Teaching Math.

There were 250 participants in ICCGANT 2019, consist of research students, academics and researchers, scholars, scientist, teachers and practitioners from many countries. The selected papers to be published on IOP Conference Series: Journal of Physics are **114** papers.

On behalf of the organizing committee, finally we gratefully acknowledge the support from the University of Jember of this conference. We would also like to extend our thanks to all lovely participants who have been joining this unforgettable and valuable event.

Prof. Drs. Dafik, M.Sc., Ph.D.

THE COMMITTEES

The committees of the Second International Conference on Combinatorics, Graph Theory, and Network Topology would like to express gratitude to all Committees for the volunteering support and contribution in the editing and reviewing process.

Table of contents

Volume 1538

2020

3rd International Conference on Combinatorics, Graph Theory, and Network Topology 26-27 October 2019, East Java, Indonesia

Accepted papers received: 14 April 2020

Published online: 19 June 2020

Open all abstracts

Preface

OPEN ACCESS   011001

The Third International Conference on Combinatorics, Graph Theory, and Network Topology 2019

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   011002

Peer review statement

+ Open abstract   📄 View article   📄 PDF

Combinatorics

OPEN ACCESS   012001

On total edge irregularity strength of tadpole chain graph $Tr(6, n)$

E Nurdini, I Rosyida and Mulyono

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012002

The sigma chromatic number of the Sierpiński gasket graphs and the Hanoi graphs

A D Garciano, R M Marcelo, M J P Ruiz and M A C Tolentino

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012003

Sigma chromatic number of graph coronas involving complete graphs

A D Garciano, M C T Lagura and R M Marcelo

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012004

Twin chromatic indices of some graphs with maximum degree 3

J D Tolentino, R M Marcelo and M A C Tolentino

+ Open abstract   View article   PDF

OPEN ACCESS   012005

Colour segmentation of Gram-Negative bacteria using graph Quadratic Form and Random Walker

B D Satoto, I Utoyo and R Rulaningtyas

+ Open abstract   View article   PDF

OPEN ACCESS   012006

The modification of caesar cryptosystem based on binary vertices colouring

K A Santoso, I H Agustin and R M Prihandini

+ Open abstract   View article   PDF

OPEN ACCESS   012007

Characteristic polynomial of anti-adjacency matrix of directed cyclic friendship graph

N Anzana, S Aminah, S Utama and D R Silaban

+ Open abstract   View article   PDF

OPEN ACCESS   012008

The matrix Jacobson graph of fields

S Humaira, P Astuti, I Muchtadi-Alamsyah and A Erfanian

+ Open abstract   View article   PDF

OPEN ACCESS   012009

On the set chromatic number of the join and comb product of graphs

B C L Felipe, A D Garciano and M A C Tolentino

+ Open abstract   View article   PDF

OPEN ACCESS   012010

On Ramsey (P_3, C_7)-minimal graphs

G A Muttaqin, D Rahmadani, Purwanto and I M Sulandra

+ Open abstract   View article   PDF

OPEN ACCESS   012011

On Ramsey (P_3, C_6)-minimal graphs for certain order

F Nisa, D Rahmadani, Purwanto and H Susanto

+ Open abstract   View article   PDF

OPEN ACCESS   012012

On spectra of square edge-corona graphs

S R Zulkarnain and Rinurwati

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012013

Application of the local antimagic total labeling of graphs to optimise scheduling system
for an expatriate assignment

W Utami, K Wijaya and Slamin

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012014

Local super antimagic total vertex coloring of some wheel related graphs

S A Pratama, S Setiawani and Slamin

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012015

Odd harmonious labeling on squid graph and double squid graph

F Febriana and K A Sugeng

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012016

Unicyclic Ramsey (P_3, P_n)-minimal graphs obtained from trees in the same class

D Rahmadani, H Assiyatun and E T Baskoro

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012017

On the super $\mathcal{H}$-decomposition local antimagic total labeling of subdivision graph

S L Fauziah, Dafik, I H Agustin and R Alfarisi

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012018

Elegant labeling of some graphs

R M Prihandini, Dafik, I H Agustin, R Alfarisi and R Adawiyah

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012019

The upper bound of vertex local antimagic edge labeling on graph operations

Ika Hesti Agustin, Dafik, Marsidi and E Y Kurniawati

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS 012020

On the local (adjacency) metric dimension of split related wheel graphs

E R Albirri, Dafik, I H Agustin, R Adawiyah, R Alfarisi and R M Prihandini

+ Open abstract   View article   PDF

OPEN ACCESS 012021

On the local antimagic vertex coloring of sub-devided some special graph

Dafik, I H Agustin, Marsidi and E Y Kurniawati

+ Open abstract   View article   PDF

OPEN ACCESS 012022

Properties of cartesian multiplication operations in complete fuzzy graphs, effective fuzzy graphs and complement fuzzy graphs

T Yulianto, N Hayati, I H Agustin, R Amalia, Faisol, Kuzairi and B Irwansyah

+ Open abstract   View article   PDF

OPEN ACCESS 012023

On the local multiset dimension of graph with homogenous pendant edges

R Adawiyah, Dafik, I H Agustin, R M Prihandini, R Alfarisi and E R Albirri

+ Open abstract   View article   PDF

Applied Sciences

OPEN ACCESS 012024

Implementation of xgboost for classification of parkinson's disease

G Abdurrahman and M Sintawati

+ Open abstract   View article   PDF

OPEN ACCESS 012025

Effect of addition waste bottle and fly ash variation to compressive strength environmentally friendly paving block

A I N Diana and D Deshariyanto

+ Open abstract   View article   PDF

OPEN ACCESS 012026

The application of the factor analysis method to determine the performance of IT implementation in companies based on the IT balanced scorecard measurement method

W Sardjono, E Selviyanti and W G Perdana

+ Open abstract   View article   PDF

012027

Evaluation model of knowledge management systems implementation using factor analysis and regresion analysis at the corporation

W Sardjono, E Selviyanti and W G Perdana

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012028

Properties of content semimodules

Z Ni'mah, M Hafiyusholeh and W D Utami

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012029

Enviromental housing planning with rainwater harvesting system as clean water resources using 3D in Sumenep regency

S Fansuri and N Zainah

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012030

Navigation and guidance control system of UNUSAITS AUV based on dynamical system using ensemble kalman filter square root

T Herlambang, Subchan and H Nurhadi

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012031

Measurement of maturity of small medium agroindustry business processes in Jember, Indonesia

W Utami, N G Khrisnabudi, L Farida, M Apriono, E S Utami, Sudarsih, T A Gumanti and D A R Wulandari

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012032

Fitting the rice production model using generalized additive mixed model and generalized estimating equation with shiny web application

A S Darmawan, D Anggraeni and I M Tirta

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012033

Modification of Chaos Game with variation of compression ratio

K D Purnomo, M H Dewi and B Juliyanto

+ Open abstract   📄 View article   📕 PDF

OPEN ACCESS   012034

Estimation of Whole Blood(WB) and Anti-Hemophiliate Factor using Extended Kalman Filter in PMI Surabaya

A Muhith, T Herlambang, M Y Anshori, R Rizqina, D Rahmalia and Hermanto

+ Open abstract   🗏 View article   📄 PDF

OPEN ACCESS   012035

Trajectory Estimation of Autonomous Surface Vehicle Using Extended Kalman Filter

T. Herlambang, D. Adzkiya and H. Nurhadi

+ Open abstract   🗏 View article   📄 PDF

OPEN ACCESS   012036

Profitability estimation of a Company in PT.ABCD using extended kalman filter

M Y Anshori, T Herlambang, D F Karya, A Muhith and R A Rasyid

+ Open abstract   🗏 View article   📄 PDF

OPEN ACCESS   012037

The commutator of raising and lowering operators for angular momentum to the free particle's hamiltonian

A F Sugihartin, B Supriadi, Subiki, V Rizqiyah, N Rizky and F Utami

+ Open abstract   🗏 View article   📄 PDF

OPEN ACCESS   012038

Complete solutions of particle in three dimensional box with variations in main quantum number

B Supriadi, L Nuraini, A S R Maulani, D D Damayanti, A F Sugihartin and M I Baihaqi

+ Open abstract   🗏 View article   📄 PDF

OPEN ACCESS   012039

Analysis of the relationship between the distance barriers GaAs and GaAs with the transmission coefficient and the reflection coefficient

B Supriadi, N Rizky, Yushardi, N C Agustin, S Epiningtiyas and M S Makmun

+ Open abstract   🗏 View article   📄 PDF

OPEN ACCESS   012040

Numerical simulation of mass in core decay of radioactive substance Thorium-232 series

Yushardi, B Supriadi, D S Tresnowati and Z R Ridlo

+ Open abstract   🗏 View article   📄 PDF

OPEN ACCESS   012041

The effect of lerak foam and kapok as a silencer on lightweight concrete

Dwi Nurtanto, Hernu Suyoso, Ahmad Hasanuddin, Zahra Hikmah Hayati and Mukhlisin

+ Open abstract   🗏 View article   📄 PDF

OPEN ACCESS
012042

Using factor analysis and regression analysis to develop mathematic modeling to support online application implementation in transportation business

W Sardjono, E Selviyanti and W G Perdana

+ Open abstract 　　　📄 View article 　　　📄 PDF

OPEN ACCESS
012043

Analysis of magic table in completin of closed flow circuits

B H Antoro, B Supriadi, T Prihandono, M R Muttaqin, N H Azizah and S Epiningtiyas

+ Open abstract 　　　📄 View article 　　　📄 PDF

OPEN ACCESS
012044

Comparison between Neural Network (NN) and Adaptive Neuro Fuzzy Inference System (ANFIS) on sunlight intensity prediction based on air temperature and humidity

D Rahmalia, T Herlambang, A S Kamil, R A Rasyid, F Yudianto, L Muzdalifah and E F Kurniawati

+ Open abstract 　　　📄 View article 　　　📄 PDF

OPEN ACCESS
012045

Measuring maturity level of information technology governance at the television broadcasting company

Erna Selviyanti and Wahyu Sardjono

+ Open abstract 　　　📄 View article 　　　📄 PDF

OPEN ACCESS
012046

Modelling of an electromagnetic wave radiation exposure on a smartphone by using the mat lab program

S H B Prastowo, T Prihandono, N Fadilah, S Bahri and A Ariyani

+ Open abstract 　　　📄 View article 　　　📄 PDF

OPEN ACCESS
012047

Optimal control of microalgae growth using linear quadratic regulator method with firefly algorithm optimization

Suci Yongki Setyowati and Mardlijah

+ Open abstract 　　　📄 View article 　　　📄 PDF

OPEN ACCESS
012048

The base matrix of hermitian operator order n<4

S Epiningtiyas, B Supriadi, T Prihandono, B H Saputra, M S Makmun and B H Antono

+ Open abstract 　　　📄 View article 　　　📄 PDF

OPEN ACCESS
012049

Estimation of crude oil price using unscented kalman filter

❌

D F Karya, M Y Anshori, R Rizqina, P Katias, A Muhith and T Herlambang

+ Open abstract   View article   PDF

OPEN ACCESS   012050

Bias correction and statistical downscaling of earth system models using quantile delta mapping (QDM) and bias correction constructed analogues with quantile mapping reordering (BCCAQ)

F Fauzi, H Kuswanto and R M Atok

+ Open abstract   View article   PDF

OPEN ACCESS   012051

Spatial extreme modeling using student t copula approach in Ngawi Regency

M Fauziyah, Sutikno and J D T Purnomo

+ Open abstract   View article   PDF

OPEN ACCESS   012052

Modeling the volatility of gross domestic product based on the volatility of money supply, inflation, interest rate, and exchange rate using the fractional cointegration model

A Abdullah, H Kuswanto, D D Prastyo and Suhartono

+ Open abstract   View article   PDF

OPEN ACCESS   012053

The performance evaluation of the bivariate EWMAcontrol chart using CARL distribution and EPC

Selly Acita, Muhammad Mashuri and Dedy Dwi Prastyo

+ Open abstract   View article   PDF

OPEN ACCESS   012054

Three-parameter bivariate gamma regression model for analyzing under-five mortality rate and maternal mortality rate

G H Wenur, Purhadi and A Suharsono

+ Open abstract   View article   PDF

OPEN ACCESS   012055

Analyzing the roles of the construction sector by using multiplier analyses: the cases of Indonesia and Japan

Ubaidillah Zuhdi

+ Open abstract   View article   PDF

OPEN ACCESS   012056

The comparison of exponentially weighted moving variance and double moving average-S control charts based on neoteric ranked set sampling

R J M Putri, M Mashuri and Irhamah

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012057

The simulation of weathering processes in three different types of oil

N Millah, K Nugraheni and I Anggriani

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012058

Three form fourier series estimator semiparametric regression for longitudinal data

Kuzairi, Miswanto and I Nyoman Budiantara

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012059

Recognition of person's character through the shape of signature using Radial Basis
Function Neural Network (RBFNN) method

Faisol, Ahmad, Halumatus Sakdiyah, Qurratul Aini, Kuzairi and Tony Yulianto

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012060

Sentiment analysis for Indonesia hotel services review using optimized neural network

D Apriliani, T Abidin, E Sutanta, A Hamzah and O Somantri

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012061

Semiparametric regression curve estimation for longitudinal data using mixed spline
truncated and fourier series estimator

A W Wening, I N Budiantara and I Zain

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012062

On the modeling of the new student acceptance status through science and technology
written test using bernoulli mixture model

D P Shiela Novelia, Ismaini Zain, Nur Iriawan and W Suryaningtyas

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012063

Analysis of factors affecting competition in bottled drinking water sales in Madura

T Yulianto, Fatmawati, Windarto, M Rohmaniyah, Faisol and M F F Mardianto

+ Open abstract   📄 View article   📄 PDF

❌

OPEN ACCESS   012064

Forecasting competition for sales of local and national bottled drinking water in madura using fuzzy sugeno method

T Yulianto, Fatmawati, Windarto, A Halim, Faisol, Suprianto and A K Dharmawan

+ Open abstract   📄 View article   📄 PDF

Education

OPEN ACCESS   012065

The development of student worksheets: questions of PISA model to analyze the ability of mathematical literacy in junior high school

Sutama, S Narimo, S Anif, H J Prayitno, D P Sari and M Adnan

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012066

The sustainability concept of Riau cultures through development of mathematics learning devices based on Riau folklore at elementary schools

S Rezeki, D Andrian, A Wahyuni and H Nurkholisah

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012067

The effect of emotional intelligence, learning discipline and peer interaction on mathematics learning outcomes of state junior high school students in Samarinda

Azainil, K R Amalia, Sugeng, A Dimpudus and Ramadiani

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012068

Mathematics creativity skill of student in junior high school based on students thinking style

F Isyrofinnisak, T A Kusmayadi and L Fitriana

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012069

Scaffolding profile in solving geometry problems in terms of van Hiele level

H S Rahman, Susanto, Hobri, M Irfan, R Karimah' and A U Albab

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012070

Student's problem solving abilities in Project Based Learning (PjBL) based on Learning Community (LC)

A K A Faozi, Hobri, M Fatekurohman, K Aini and D Yuniar

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012071

Profile of students' creative and innovative thinking in solving open-ended mathematics problems about the coffee plantation

A U Albab and Y Wangguway

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012072

The analyze of students' creative thinking skills on Lesson Study for Learning Community (LSLC) based on Science, Technology, Engineering, and Mathematics (STEM) approach

D Yuniar, Hobri, A C Prihandoko, K Aini and A K A Faozi

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012073

The influence of mathematics academic potential and learning motivation of Papuan college students in Jember on academic achievement

Y Wangguway and A U Albab

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012074

Student's higher-order thinking skills on creative problem solving based on caring community

C F Lestari, Hobri, M Fatekurohman, D Lutvita and F Y W Ningrum

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012075

The students' mathematical communication skill on caring community-based learning cycle 5E

K Aini, Hobri, A C Prihandoko, D Yuniar, A K A Faozi and Asmoni

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012076

Student's higher order thinking skills on problem solving based on jumping tasks

D Lutvita, Hobri, D S Pambudi, C F Lestari and F Y Wahyuningrum

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012077

Students' metacognitive ability in solving quadrilateral problem based on adversity quotient

R Damayanti, Sunardi, N Yuliati, R Karimah and A U Albab

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012078

The students' mathematical reasoning ability based on problem based learning model

M P Sari, Susanto, N Yuliati, E N Imamah and N I Laily

➕ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012079

The effect of problem based learning model on junior high school students' higher order thinking skills

E N Imamah, Sunardi, E Yudianto, M P Sari and N I Laily

➕ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012080

The profile of students conceptual understanding and procedural knowledge in solving geometry problems based on van hiele levels

N I Laily, Sunardi, N Yuliati, E N Imamah and M P Sari

➕ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012081

Scientific approach learning implementation based on lesson study for learning community in solving sequence and series and its effect to student creative thinking ability

E Guswanto, Susanto, Hobri, P A Inawati and A R Sya'Roni

➕ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012082

Students' mathematical communication skills of the straight line equation based on gender in junior high school

H Aliyah, T A Kusmayadi and L Fitriana

➕ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012083

Analysis of students' verbal and written mathematical communication error in solving word problem

M A Maulyda, A M Annizar, V R Hidayati and M Mukhlis

➕ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012084

Student's mathematical creative skill using interactive application media based on collaborative learning

P A Inawati, Hobri, D S Pambudi, E Guswanto and A R Sya'roni

➕ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   0120⊗

Analysis of higher order thinking skills of SMP students in completing the problem of the numbers through the application of problem based learning

Imelda and D Anzelina

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012086

Male students' visual reasoning in solving mathematical problem

Darmadi, Sanusi, E Wihardjo, Karim, Suprianto and S Prayitno

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012087

The analysis of research-based learning implementation and its affect to the students' metacognition skill in solving a resolving domination number of a graph

Y Wangguway, Slamin, Dafik, I N Maylisa and S Kurniawati

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012088

The students' problem solving abilities in science, technology, engineering and mathematics (stem) based on lesson study for learning community (lslc)

F Y W Ningrum, Hobri, Susanto, Dafik, D Lutvita and C F Lestari

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012089

The analysis of problem-based learning implementation and its effect on students creative innovative skills in solving rainbow antimagic coloring based on cognitive style

Z L Al Jabbar, Dafik, A F Hadi, Y Wangguway and B Sulistiyono

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012090

The influence of research-based learning implementation in improving students' combinatorial thinking skills in solving local irregularity vertex r-dynamic coloring

I N Maylisa, Dafik, A F Hadi, Y Wangguway and L O Harjito

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012091

The analysis of output based learning implementation in improving students creative and innovative thinking skills in solving H-Irregularity

D M O Suni, Dafik, I M Tirta, Y Wangguway and M H Mukaromah

✚ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012092

The analysis of problem based learning implementation and its influence to the students generalization thinking skills on solving r-dynamic vertex coloring

L O Harjito, Dafik, A I Kristiana, I N Maylisa and Y Wangguway

+ Open abstract   View article   PDF

OPEN ACCESS   012093

The analysis of the implementation inquiry based learning to improve student mathematical proving skills in solving dominating metric dimention number

A N Hayyu, Dafik, I M Tirta, Y Wangguway and S Kurniawati

+ Open abstract   View article   PDF

OPEN ACCESS   012094

Improving creative problem solving performance of mathematics students by digital multimedia in graph theory course

S Wahyuningsih, D Satyananda and A Qohar

+ Open abstract   View article   PDF

OPEN ACCESS   012095

The analysis of the implementation of project based learning and its influence to the student deductive reasoning based on cognitive style on solving super edge local antimagic total labelling

M Karimah, Dafik, I M Tirta, Y Wangguway and Z L A Jabbar

+ Open abstract   View article   PDF

OPEN ACCESS   012096

Students' creative-innovative thinking skill in solving rainbow antimagic coloring under research based learning model

B Sulistiyono, Slamin, Dafik, Y Wangguway and Z L Al Jabbar

+ Open abstract   View article   PDF

OPEN ACCESS   012097

The analysis of the discovery learning implementation and its affect to the students conjecturing skills in solving a resolving domination number

S Kurniawati, Slamin, Dafik, Y Wangguway and A N Hayyu

+ Open abstract   View article   PDF

OPEN ACCESS   012098

The shadow reckoning problem from ancient society as context for learning Trigonometry

A D Fachrudin, R Ekawati, A W Kohar, S Widadah, I B Kusumawati and R Setianingsih

+ Open abstract   View article   PDF

OPEN ACCESS   012099

An analysis of problem solving ability in linear equation systems with two variables

❌

B Mustofa, Mardiyana and I Slamet

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012100

The analysis of algebra creative thinking skill based on strong mathematical habit of mind

S W P Nugroho, Riyadi and Triyanto

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012101

Students' mathematical reasoning ability viewed from self-efficacy

D I Jumiarsih, T A Kusmayadi and L Fitriana

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012102

Students' mathematical communication abilities in solving geometry problems viewed from learning styles

A N Sholihah, Riyadi and Triyanto

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012103

The written mathematical communication ability of junior high school students in solving set problems

N Azizah, B Usodo and D R S Saputro

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012104

Investigation of the students' number sense in seventh grade

S A Marga, T A Kusmayadi and L Fitriana

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012105

Analyzing students' representation ability: viewed from reflective-impulsive cognitive style

D Septiani, Riyadi and Triyanto

+ Open abstract   📄 View article   📄 PDF

OPEN ACCESS   012106

Mathematical connections ability of junior high school students viewed from mathematical resilience

S Rohmah, T A Kusmayadi and L Fitriana

+ Open abstract   📄 View article   📄 PDF   ❌

OPEN ACCESS   012107

The SOLO taxonomy: classify students' responses in solving linear program problems

L F Claudia, T A Kusmayadi and L Fitriana

+ Open abstract   **▤** View article   **▾** PDF

OPEN ACCESS   012108

PCK (*Pedagogical Content Knowledge*) profile of mathematics education students at Universitas PGRI Yogyakarta

B Wicaksono and N M S Dwipa

+ Open abstract   **▤** View article   **▾** PDF

OPEN ACCESS   012109

Students' metacognitive ability in contextual teaching and learningof mathematics based on jumping task

M Khoirudin, Hobri, M Irfan, E Guswanto and D Purwandi

+ Open abstract   **▤** View article   **▾** PDF

OPEN ACCESS   012110

The development of mathematical problem based on Higher Order Thinking Skill (HOTS) on comparative material by implementing PBL and its effect on the teacher's creative thinking skill

A Widiatsih, D A R Wardani, U Royhana, F Djamali and B J Septory

+ Open abstract   **▤** View article   **▾** PDF

OPEN ACCESS   012111

The effect of comic-based realistic mathematics approach on students' learning motivation and conceptual understanding

T N Sipayung, S D Simanjuntak, A Wijaya and S Sugiman

+ Open abstract   **▤** View article   **▾** PDF

OPEN ACCESS   012112

The effect of Islamic interactive media by using adobe flash CS6 on students' learning outcomes of class 7 in one-variable linear equation material

U Farihah and S N Fadilah

+ Open abstract   **▤** View article   **▾** PDF

OPEN ACCESS   012113

The implementation of research based learning and the effect to the student metacognition thinking skills in solving H-irregularity problem

M Hidayatul, Dafik, I M Tirta, Y Wangguway and D M O Suni

OPEN ACCESS   012114

Development of *Remedial* mathematics learning based on *Lesson Study for Learning Community* against problem solving

D Purwandi, Susanto and Hobri

+ Open abstract   📄 View article   📕 PDF

Combinatorics

OPEN ACCESS   012115

Scheduling algorithms for an expatriate assignment using vertex coloring of graph

N O Adiwijaya and Slamin

+ Open abstract   📄 View article   📕 PDF

JOURNAL LINKS

Journal home

Journal Scope

Information for organizers

Information for authors

Contact us

Reprint services from Curran Associates

PAPER • OPEN ACCESS

The effect of lerak foam and kapok as a silencer on lightweight concrete

View the article online for updates and enhancements.

The effect of lerak foam and kapok as a silencer on lightweight concrete

Dwi Nurtanto[1]**, Hernu Suyoso**[1]**, Ahmad Hasanuddin**[1]**, Zahra Hikmah Hayati**[1] **and Mukhlisin**[1]

[1]Civil Engineering Department, Faculty of Engineering, University of Jember, Indonesia

Email: dwinurtanto999@gmail.com, hernu.suyoso@gmail.com, damha_sipilunej@yahoo.co.id, zahrahikhay98@gmail.com, muklisin987@gmail.com

Abstract. Lerak Foam is Foam produced by Lerak fruit mixed with water. This Foam is very suitable as an air cavity enhancer in lightweight concrete. Kapok is a natural material commonly used as pillows, mattresses and stuffed toys. Kapok with fine fibers and easily formed in a concrete mixture is expected to reduce noise. The purpose of this study is to reduce the noise of concrete materials by adding Lerak Foam and Kapok. This research was conducted in the Concrete Laboratory University of Jember, by making a sample of 40 cm x 40 cm x 40 cm concrete box with a thickness variation of 3 cm and 7 cm. This study intend to compare the value of noise reduction and transmission loss from the concrete specimen model with the addition of 100cc Lerak Foam and Kapok with 0%, 1.5%, 2.5%, 3.5% and 5% from the weight of concrete. The different values can be found by giving a noise gauge inside from the concrete box. The level of noise reduction is affected by the thickness of concrete. The level of noise reduction will increase as much as the addition of Kapok Fibers in concrete mixtures.

1. Introduction
One result of the rapid development of infrastructure is noise. The sound from heavy equipment, dump trucks, hammers, has made noises. Loud sounds can impact human life psychologically and biologically. Loud sounds can impact human life psychologically and biologically. The noise can disrupt the hearing system, disrupt the respiratory system, and reduce the concentration. It is necessary to apply sound absorbing devices by using appropriate materials. The development of construction materials that can absorb sound has evolved, but the price of this material is still expensive and not friendly for our environment, such as Styro-Foam [6,13]. Sound absorbing material commonly used is high-density walls such as red bricks, which have a density of 2,000 kg/m3. Therefore, it is required to reduce weight by using lightweight materials, such as lightweight bricks or lightweight concrete [8]. Lightweight concrete has been used since ancient times and it becomes the most interesting part of this research because of the benefits are more economical than conventional concrete, such as lower transport costs, low hydration heat, good heat insulation material, superior in sound absorption, low production costs due to the use of a lightweight and inexpensive aggregates [4]. However, this type of concrete has several disadvantages

including lower mechanical properties and durability, higher shrinkage and drying creep[7].

Generally, lightweight concrete research used natural material, such as pumice, diatomic, Skoria, volcanic ash, lightweight artificial aggregates such as tile flakes, slate, and ceramic [5,14,17]. Making a lightweight concrete also can be applied in porous concrete, for example, the porous concrete road. According to Nurtanto (2017), Malaysia, the Philippines, and Indonesia, precisely on the island of Java, are producers of cotton in Southeast Asia. The dried cottonwood fruit is a source of fiber source, used as a basis for mattresses, pillows, wall decorations, protective clothing, and stuffed fillings and heat insulation and soundproofing. Dry skin of kapok fruit can be used as a fuel. The seeds that contain oil are used as lubricants and lamp oil, thus can be used as energy raw materials. Lerak or also known as rerek or lamuran is a plant known for its useful uses as traditional detergent. Batik is usually recommended to be washed by Lerak because it is considered as the most suitable washing instrument to maintain the color quality of batik. Lerak seeds contain saponins, a toxic alkaloid, these saponins produce Foam and function as a washing instrument, and can be used as a cleaner for various kitchen appliances, floors, even bathing and cleaning [1]. Lerak fruit can produce large amounts of Foam expected in a lightweight concrete mixture that can make air cavities [11]. Kapok is the lightweight concrete mix is expected to be able to absorb sound. In this study, the addition of cotton fiber is assumed to increase the ability of lightweight concrete to reduce the noise with the same mechanical properties as conventional concrete. This research was conducted to compare the value of noise reduction and transmission loss from conventional lightweight concrete models with lightweight concrete with the addition of Lerak Foam and Kapok.

2. Experiment investigation

2.1 Material used

Lightweight concrete is planned to have a compressive strength characteristic of 20 MPa. The cement used is portland pozzolan cement (PPC) type 1 with a volume weight of 1.195 gr/cm3 and a specific gravity of 3.02 gr/cm^3, using Jember local sand mining with volume weight of 1.57 gr/cm^3 and a specific gravity of 2.73 gr/cm^3. Pumice as coarse aggregate with a volume weight of 0.54 gr/cm^3 and a specific gravity of 0.93 gr/cm^3. The Lerak Foam used is 100 cc. Kapok was made in such a way to form a circle with a diameter of 1 cm with a weight of 0%, 1.5%, 2.5%, 3.5% and 5% of the weight of cement.

(a)   (b)

Figure 1. Lerak Foam (a) and Kapok (b)

2.2 Mix Proportions

To investigate the ability to absorb sound in lightweight concrete with the addition of Lerak Foam and cotton, conventional concrete is used as a control mixture. The proportion of the control concrete mixture is with a compressive strength of 20 MPa plan by using pumice as the rough aggregate (BN). The Lerak Foam used is 100 cc/m3 of concrete and uses 0% (B0), 1.5% (B1), 2.5% (B2), 3.5% (B3) and 5% (B4) kapok from the weight of cement. From the Table 1, shows the physical properties of

fine aggregates and coarse aggregates. A mixture of proportions and all decreases in value concrete mix is presented in Table 2.

Table 1. The results from the test materials

No	Test Variables	Fine aggregate (%)	Coarse Aggregate (%)
1	Absorption	1.59	1.49
2	Water Content	1.61	0.33
3	Density	2.67	2.54

Table 2. Details of the concrete mixes (per m^3).

Mix Code	Cement (Kg)	Water (Kg)	W/C	Sand (Kg)	Pumice (Kg)	Lerak Foam (cc)	Kapok (Kg)
BN	544	201	0,37	575	54,5	-	-
B0	544	201	0,37	575	54,5	100	-
B1	544	201	0,37	575	54,4	100	8,16
B2	544	201	0,37	575	54,5	100	13,6
B3	544	201	0,37	575	54,5	100	19,04
B4	544	201	0,37	575	54,5	100	27,2

2.3 Test Method

Concrete specimens were cast in a steel cylinder with a height of 300 mm and a diameter of 150 mm to determine the compressive strength. The size of hollow-shaped square specimens is 40 cm x 40 cm x 40 cm with the variation of concrete thickness between 3 cm and 7 cm to determine sound absorption. The concrete compressive strength test and density at 28 days that carried in this study based on SNI [15,16]. Sound suppression test with a sound meter based on ASTM [3]. At least, three test specimens were served to obtain an average compressive strength and sound absorption.

3. Test results and discussion

3.1. Density

Table 3 and Picture 2 present the relationship between the level of addition of Lerak Foam and Kapok with density. Test results prove that the addition of Lerak Foam and Kapok is decreased the concrete density Test results prove that the addition of Lerak Foam and Kapok is decreased the concrete density. This occurs because of the specific gravity from kapok is lower than sand and pumice. Concrete control density normal (BN mixture) 1881 kg/m^3. In this range, concrete is considered as lightweight concrete [19]. The addition of 100cc Lerak Foam can reduce the concrete density of about 0.4%.

The addition of Lerak Foam and Kapok with 1.5% cement, 2.5%, 3.5% and 5% can reduce the density of about 1%, 1.9%, 3.4%, and 4.4%. All of the concretes that have dry density of less than 2000 kg/m^3 can be considered as lightweight concrete [2]. In the same mixture, the thickness specimen with the smallest density is 3 cm. This is because the concrete constituent material has been partially replaced with Lerak Foam and cotton. The volume with 3 cm thick is smaller than the 7 cm thick, with the volume of Lerak Foam and kapok mixed, the volume of concrete (pasat, aggregate) composition is more often replaced at 3 cm volume. This causes the density of 3 cm thick concrete with the addition of Lerak Foam and kapok lighter.

Table 3. The test results of density

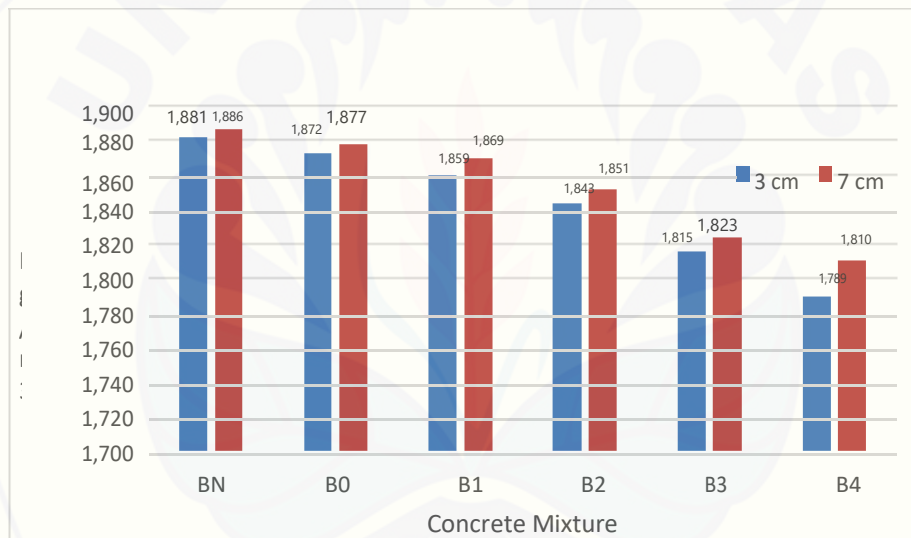| Mix Code	Average of Density (Kg/m3)	
	3 cm	7 cm
BN	1.881	1.886
B0	1.872	1.877
B1	1.859	1.869
B2	1.843	1.851
B3	1.815	1.823
B4	1.789	1.810

Figure 2. Concrete Density with different thickness 3.2 Compressive Strength

The compressive strength of all concrete mixes at 28 days is shown in BN containing a rough aggregate of pumice without the addition of Lerak Foam and kapok that considered as a control concrete. Table 4 and Picture 3, shows the relationship between the level of addition of Lerak Foam and kapok with compressive strength. Concrete compressive strength, BN, shows the compressive strength of 28 days is 21.76 MPa. The compressive strength decreased due to the addition of Lerak Foam and Kapok. The mixture of B0, B1, B2, B3, and B4 showed 2.6%, 5.1%, 7.3%, 8.96%, and 10.4%, reveals the lower compressive strength compared to control mix (BN).

The decline of the concrete compressive strength is mostly caused by weak bonds between aggregates, kapok, and cement matrix. Also, cotton has a significantly lower density which also generates lower compressive strength than concrete. Lo et al stated that the strength of lightweight concrete is dependent on the strength of the aggregates that used, cement paste, and the bonding interface between aggregate and cement paste. The decline of the concrete compressive strength is also caused by an increase of W / C. W / C increases due to the addition of Lerak Foam where the

basic ingredients are from the water. The addition of Lerak Foam with 100cc provides a decrease in compressive strength within 2.6%.

The previous study reveals that the decrease of concrete compressive strength is generally due to the bond damage between the cement glue and aggregate [9]. The weak bond between aggregate and cement mortar is mainly due to the addition of Lerak Foam and cottonwood. High strength lightweight concrete usually has compressive strength in the range of 34-69 MPa with dry air density less than 2000 kg /m^3 [20].

Table 4. Results of concrete compressive strength test at 28 days

Mix Code	Average Compressive Strength (MPa)
BN	21.76
B0	21.19
B1	20.64
B2	20.18
B3	19.81
B4	19.505
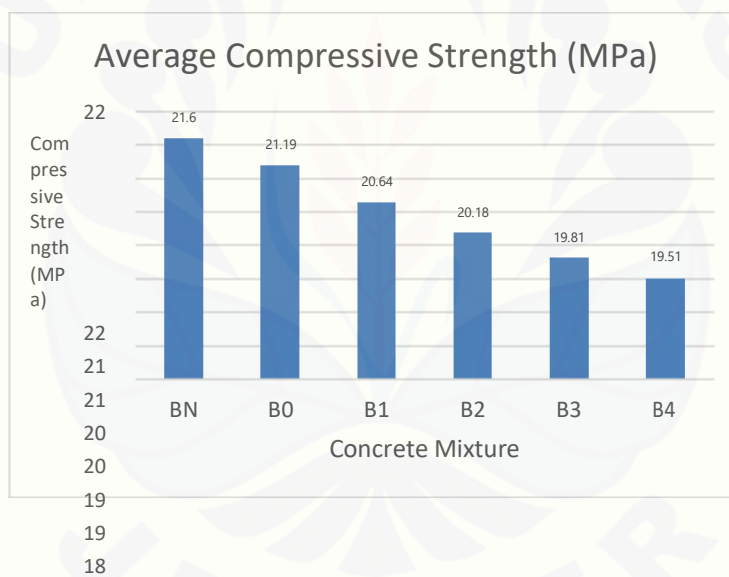
Figure 3. Concrete Compressive Strength

3.2. Sound Absorption

Because of the limitations of equipment, space and test objects, in this study, absolute values cannot be generated, but the differences sound levels at each frequency are represented by Noise Reduction (NR) and transmission loss (TL) on the decibels (dB) scale. Decibels (dB) are used to measure sound intensity or loudness. The stronger the sound, the higher dB level is increased. Decreasing the unwanted sound levels with one of several ways of acoustic treatments is known as a noise reduction. Transmission loss (TL) generally illustrates the accumulation of reduced energy intensity in the form of waves when the waves propagate out from a source or spread through certain areas or certain types of structures.

Sound transmission class (STC) is a numerical rating of the wall, floor/ceiling capability assembly or other building elements such as a door or window to minimize channel transmission. The higher the STC class, the more voice it has blocked or reduced by building elements[10].

Table 5. STC Ranting's

Sound Transmission Class (STC)	Speech Audibility *	Noise Control Rating
15 to 25	Normal speech easily understood.	Poor
25 to 35	Loud speech easily understood. Normal speech 50% understood.	Marginal
35 to 45	Loud speech 50% understood. Normal speech is heard, but not understood	Good
45 to 55	Loud speech faintly heard, but not understood. Normal speech is usually inaudible.	Very Good
55 and up	Loud speech usually inaudible	Excellent

*Given a typical background noise level of 30 dB on the "listening" side

The measurements were executed by testing the model of the test object in a closed room in the Structure Laboratory, Jember University. In every test gap, the specimen is closed by plasticine to avoid the entry of sound from outside through the small gaps from the test object. The hollow specimen is 40x40x40 cm within 3 cm and 7 cm thickness. ASTM E 1050 90, the test object was given a sound source to measure the difference in sound inside and outside the test object model. The sound source is captured by 2 microphones, which are placed inside the test specimen and outside the test specimen. The microphone inside the test specimen is placed 10 cm from the sound source. While the microphone outside the test specimen is placed 60 cm from the test specimen, the sound level inside and outside the test specimen is measured in decibels (dB) using a sound meter.
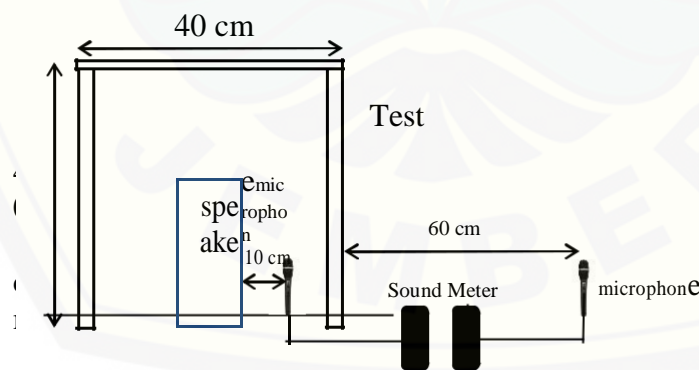

Figure 4. Lay Out

The amount of sound source used is 57 dB, 69 dB, and 80 dB. To calculate the amount of transmission loss, use the following formula below:

$$NR = SPL1 - SPL2 \tag{1}$$
$$A = a.L$$
$$TL = NR + 10 \log S/A \tag{2}$$

Annotation:
NR   = Noise Reduction (dB).
SPL1   = SPL sound sources (dB).
SPL2   = SPL sound receiver (dB).
TL   = Transmission Loss (dB).
S   = Partition field area (m^2).
A   = Absorption level from receiving room (m^2).
a   = Absorption coefficient of material in receiving room
L= Field area on receiving room (m^2).

Table 6. Average noise reduction on specimens of 3 cm thickness

Mix Code	Noise Reduction (dB) and Tranmission Loss (dB					
	Sound Sources (dB)					
	57		69		80	
	NR	TL	NR	TL	NR	TL
BN	12,33	23,39	12,67	23,55	12,75	23,72
B0	13,67	24,64	13,67	24,64	13,75	24,72
B1	15,58	26,55	15,33	26,30	15,33	26,30
B2	17,92	28,89	17,92	28,89	17,50	28,47
B3	19,67	30,64	19,83	30,80	19,58	30,55
B4	21,58	32,55	21,75	32,72	21,42	32,39

Table 7. Average noise reduction on specimens of 7 cm thickness

Mix Code	Noise Reduction (dB) and Tranmission Loss (dB)					
	Sound Sources (dB)					
	57		69		80	
	NR	TL	NR	TL	NR	TL
BN	14,83	25,80	14,92	25,89	14,50	25,80
B0	18,25	29,22	17,67	28,64	17,67	28,64
B1	19,50	30,47	19,58	30,55	19,42	30,39
B2	20,67	31,64	20,75	31,72	20,25	31,30
B3	21,25	32,22	21,75	32,72	21,67	32,64
B4	22,42	33,39	22,67	33,64	22,42	33,39

Table 6 and Table 7 present the results of NR and also TL on three sound sources of 57 dB, 69 dB and 80 dB. The average values of NR and TL in three sources provide almost the same value in the same lightweight concrete mixture. For the lowest NR and TL values in conventional concrete mix is BN. For the highest NR and TL values in the concrete mixture is B4.

Picture 5 and Picture 6, shows the Noise Reduction value and Transmission Loss value in each concrete mixture. The mix code B0 increases the value of Noise Reduction with the addition of Lerak Foam only. The value of Transmission Loss of 8.85%, 4.72% in the thickness of the specimen 3 cm and 21.11%, 11.61% in the thickness of the specimen 7 cm, with the conventional concrete (BN) as a guideline. Increasing the Kapok's addition also makes the value of Noise Reduction and Transmission Loss increased. This is because of the increasing Kapok's addition to the mixture the value of concrete density decreases[8].
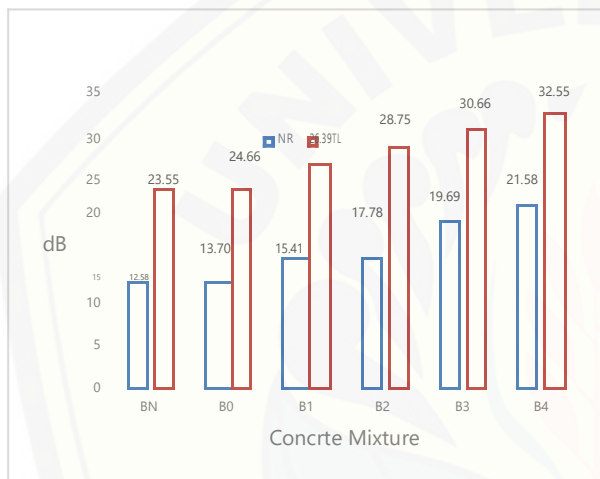

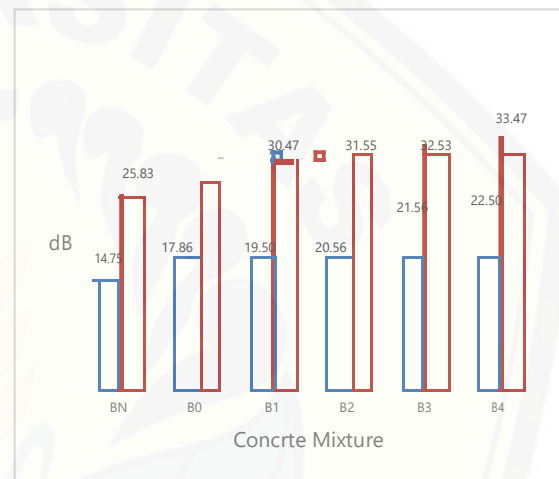**Figure 5.** Average Noise Reduction and Tranmission Loss test specimens 3 cm thick

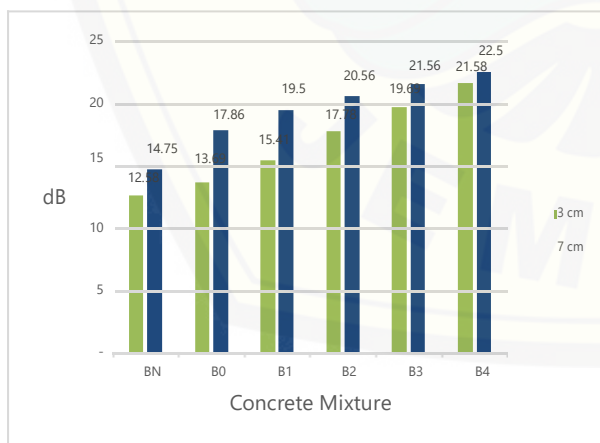**Figure 6**. Average Noise Reduction and Tranmission Loss test specimens 7 cm thick

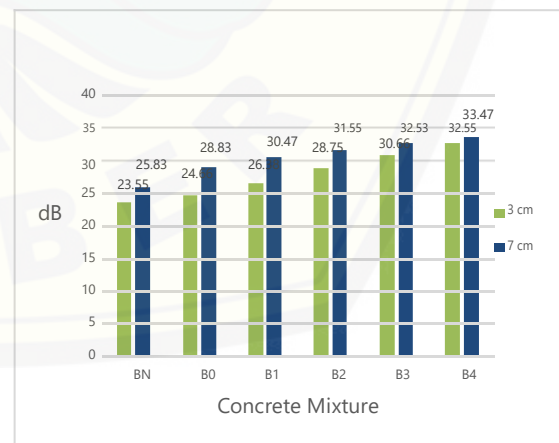**Figure 7.** Average Noise Reduction

Figure 8. Average Transmission Loss

Picture 7 and Picture 8 show the effect of specimen thickness with a thickness of 7 cm have better noise reduction and transmission loss values than specimens with a thickness of 3 cm. According to NAIMA Building Insulation Committee (2010), in the B0 mix code, the addition of Lerak Foam has a

significant difference in noise reduction and transmission loss within 4.17 DB. Even though the value of the density decreases, with the addition of cotton fiber the more differences in noise reduction and transmission loss decrease[10].

4.　Conclusions

In this study, the lightweight concrete using pumice stone as coarse aggregate with the addition of Lerak Foam and Kapok to examine the possibility of producing soundproof lightweight concrete. The study analyzes the effectiveness of this substitution on density, mechanical properties, and noise reduction and transmission loss of concrete. Based on the test results, then the following conclusions can be drawn:

a. The addition of 100ccs of Lerak Foam and kapok 1.5%, 2.5%, 3.5% and 5% by weight of cement can decrease the density of concrete.

b. Concrete with Lerak Foam shows a lower compressive strength and keep decreases simultaneously with the addition of kapok.

c. Contribution of 100 ccs of Lerak Foam and Kapok up to 5% significantly increases the value of noise reduction and transmission loss in the concrete mixture. This proves that Lerak Foam and Kapok can improve sound absorption performance on lightweight concrete.

d. Insulation thickness has a more significant effect on noise reduction and transmission loss than density.

Acknowledgment

References

[1]　Ardita, Ferdi. Natural Soap. edition 6. Percik Junior.

[2]　Aslam, Muhammad, Payam Shafigh, Mohammad Alizadeh Nomeli, and Mohd Zamin Jumaat. 2017. "*Manufacturing of High-Strength Lightweight Aggregate Concrete Using Blended Coarse Lightweight Aggregates.*" Journal of Building Engineering 13(July): 53–62.

[3]　ASTM E1050 - 12. Standard Test Method for Impedance and Absorption of Acoustical Materials Using a Tube, Two Microphones and a Digital Frequency Analysis System. Annual Book of ASTM Standards.

[4]　Bayuaji, Ridho. 2011. "Literature Study and Prospect of Porus Concrete Research as Structural Materials and Building Materials." m: 1–10.

[5]　Green. S. 2014. *Pumices Aggregates for Structural Lightweight and Internally Cured Concretes*. New Zealand: Department of Civil and Environmental Engineering University of Auckland.

[6]　Irwan, Yusril. 2013. "Manufacture and Test of Acoustic Characteristics of Coconut Fiber Composite Board,"

[7]　J. Newman, P. Owens 2003 *Properties of Lightweight Concrete, Advanced Concrete Technology Set*. Butterworth-Heinemann, Oxford.

[8]　Kristanto, Luciana, H Sugiharto, R O Wibowo, F Harijono 2013 Conventional Brick Walls and Lightweight Brick Walls, 98–105.

[9]   M.A. Mannan, H.B. Basri, M.F.M. Zain, M.N. Islam. 2002. "Effect of Curing Conditions on the Properties of OPS-Concrete." Building and Environment 37(11): 1167–1171.

[10] NAIMA Building Insulation Committee. 2010. "Sound Control For Commercial And Residential Buildings.*http://www.eaglerocksupply.com/application/files/4514/4890/6046/Sound_Control.pdf.*

[11] Nugroho, Ananto. 2017. "Effect of Rice Husk Ash on the Mechanical Properties of Lightweight Foam Concrete." Journal of Civil and Engineering 24(2): 139–44.

[12] Nurtanto, Dwi. 2017. "Contribution of Polycarbonate Flexural Strength to Porous Concrete Plates." Journal of Civil and Environmental Engineering. 1(4): 1–6.

[13] Putra A. 2015. "Characteristics of Lightweight Concrete with StyroFoam Fillers.

[14] Raka, I Gusti Putu, Tavio, and Dionisius Tripriyono. 2010. "Lightweight Aggregate Concrete with Pumice Stone Substitution as Rough Aggregate Substitution. "National Conference on Civil Engineering (4): 173–80.

[15] SNI 1974. 2011. "Indonesian National Standard Test Method for Concrete Compressive Strength with Cylinder Test Objects of the National Standardization."

[16] SNI 3402. 2008. "Method for Testing the Weight of Structural Lightweight Concrete."

[17] Suseno, Hendro. 2013. "The Effect of Skoria Rocks from Mount Kelud Blitar as Rough Aggregates in Structural Lightweight Concrete." Journal of Civil and Engineering 7(2): 149–56.

[18] T.Y. Lo, W. Tang, H. Cui. 2007. "*The Effects of Aggregate Properties on Lightweight Concrete.*" Building and Environment 42(8): 3025–29.

[19] Tjokrodimulyo, K. 2007. Concrete Technology. Yogyakarta: KMTS Engineering Faculty,Universitas Gajah Mada.

[20] Yew, Ming Kun, Hilmi Bin Mahmud, Bee Chin Ang, and Ming Chian Yew. 2014. "*Effects of Oil Palm Shell Coarse Aggregate Species on High Strength Lightweight Concrete.*" 2014.