Free Access to the whole issue

MATEC Web of Conferences

Volume 138 (2017)

The 6th International Conference of Euro Asia Civil Engineering Forum (EACEF 2017)

Seoul, South Korea, August 22-25, 2017

J.-W. Park, H. Ay Lie, H. Hardjasaputra and P. Thayaalan (Eds.)

Export the citation of the selected articles Export

Select all

Open Access

Statement of Peer review

Published online: 30 December 2017

PDF (48.3 KB)

Open Access

About the conference

Published online: 30 December 2017

PDF (148KB)

Statement of Peer review

In submitting conference proceedings to MATEC Web of Conferences, the editors of the proceedings certify to the Publisher that they adhere to the **Policy on Publishing Integrity** of the journal in order to safeguard good scientific practice in publishing.

1. All articles have been subjected to peer review administered by the proceedings editors.
2. Reviews have been conducted by expert referees, who have been requested to provide unbiased and constructive comments aimed, whenever possible, at improving the work.
3. Proceedings editors have taken all reasonable steps to ensure the quality of the materials they publish and their decision to accept or reject a paper for publication has been based only on the merits of the work and the relevance to the journal.

Title, date and place of the conference

The 6th International Conference of Euro Asia Civil Engineering Forum (EACEF 2017)
August 22-25, 2017
Seoul, South Korea

Proceedings editor(s):

Jae-Woo Park, Ph. D.
Han Ay Lie, Ph. D.
Harianto Hardjasaputra, Ph. D
Parama Thayaalan, Ph. D.

Date and editor's signature

November 22, 2017

Preface

The 6th International Conference of Euro Asia Civil Engineering Forum (EACEF 2017) was held at Hanyang University, in August 22nd to 25th, 2017. The conference was jointly organized by Hanyang University, Korean Society of Soil and Groundwater Engineering and Indonesian Universities Consortium. In this conference, the participants from 20 different countries was attended with various research topics in Civil and Environmental Engineering field.

The world pursues to minimize environmental impact on living and industry in these days. Following the flow, EACEF 2017 focused on environment-focused civil engineering. Under the slogan, “green infrastructure for future world”, the EACEF 2017 aims to achieve and the promote quality growth of civil engineering.

EACEF 2017 consists of 9 different technical sessions: Sustainable Construction Materials, Structural & Construction Engineering, Concrete Engineering, Geotechnical Engineering, Construction & Safety Management, Hydraulics, Hydrology and Water Engineering, Transportation Engineering, Sanitation & Environmental Engineering, Climate Change, Disaster Management.

It was a great privilege to see that the conferences have become an effective platform to link the researchers, academicians and professional engineers from Europe, Asia and another part of continents. Especially those with a commitment to advanced sustainable development and environmental friendly buildings and infrastructures. Through the EACEF conferences, we can establish long-lasting international collaboration among us in research and even in projects. Also, it is great pleasure that we successfully publish nearly 125 of high-quality papers in MATEC Web of Conference.

I would like to thank our prominent speakers and all participants to the conference, as well as students and colleagues who contributions to the EACEF 2017.

Jae-Woo Park

EACEF 2017 Chair

Professor

Hanyang University, Korea

This work was supported by the Korean Federation of Science and Technology Societies (KOFST) grant funded by the Korean Government.

- 1-Sustainable Construction Materials

Open Access
Embodied Energy Calculation in Mitigating Environmental Impact of Low-Cost Housing Construction 01001
Dewi Larasati ZR, Yuni Sri Wahyuni, Suhendri and Sugeng Triyadi
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801001
PDF (467 KB) | References

Open Access
Enzyme based soil stabilization for unpaved road construction 01002
Rintu Renjith, Dilan Robert, Andrew Fuller, Sujeeva Setunge, Brian O'Donnell and Robert Nucifora
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801002
PDF (901.0 KB) | References

Open Access
Ductility Of fly ash - slag based reinforced geopolymer concrete elements cured at room temperature. 01003
N.B. Mahantesh, K. Amarnath and B. K. Raghuprasad
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801003
PDF (783 KB) | References

Open Access
The gelsluice, an innovative idea for the present sluice structures 01004
Jacob Gerrit (Jarit) de Gijt and Bob Heester
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801004
PDF (515 KB) | References

The use of bottom ash for replacing fine aggregate in concrete paving blocks 01005
Antoni, ... Klarens, Michael Indranata, Luthfi Al Jamali and Djwantoro Hardjito
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801005
PDF (1013 KB) | References

Open Access
Processed bottom ash for replacing fine aggregate in making high-volume fly ash concrete 01006
Antoni, Aldi Vincent Sulistio, Samuel Wahjudi, Djwantoro Hardjito and Djwantoro Hardjito
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801006
PDF (1.11 MB) | References

Open Access
Effect of High Temperature on Properties of Glass Concrete 01007
Wei Chien Wang, Shao Yu Wang and Cheng Hsun Lin
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801007
PDF (294 KB) | References

Open Access
Influence of Oil Palm Biomass Waste on Compressive Strength and Chloride Penetration of Mortar 01008
Nor Hasanah Abdul Shukor Lim, Mostafa Samadi, Mohd Warid Hussin, Abdul Rahman Mohd Sam, Nur Farhayu Ariffin, Mohamed A. Ismail, Han Seung Lee and Mohd Azreen Mohd Ariffin
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801008
PDF (293 KB) | References

Open Access
Performance of Lightweight Natural-Fiber Reinforced Concrete 01009
Harianto Hardjasaputra, Gino Ng, Girum Urgessa, Gabriella Lesmana and Steven Sidharta
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801009
PDF (541 KB) | References

Factors influencing strength and setting time of fly ash based-geopolymer paste 01010

Januarti Jaya Ekaputri and Triwulan

PDF (341 KB) | References

Open Access

Flexural strength of walls made of hollow core concrete brick using various notch models as the interlocking device 01011

Nanang Gunawan Wariyatno, Yanuar Haryanto and Sumiyanto

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713801011

PDF (583 KB) | References

Open Access

Effect of cantala fiber as textile reinforcement on the flexural behaviour of polymer modified mortar 01012

Edy Purwanto, Stefanus Kristiawan, Bambang Santosa and Pungky T Istanto

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713801012

PDF (534 KB) | References

Open Access

Optimum concrete compression strength using bio-enzyme 01013

Tony Hartono Bagio, Makno Basoeki, Julistyana Tistogondo and Sofyan Ali Pradana

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713801013

PDF (320 KB) | References

Open Access

Study of Volcanic-Ash-Impregnated-Bacteria Filler to the Compressive Strength of Concrete 01014

Hendry Anjar Purwanto, Ananto Nugroho and Ririt Aprilin S

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713801014

PDF (437 KB) | References

Performance Evaluation of Newly Developed Sustainable Blocks for Affordable Housing in Malaysia 01015
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801015
PDF (470 KB) | References

Open Access
Buoyancy-Driven Ventilation Generated by the Double-Skin Façade of a High-Rise Building in Tropical Climate: Case Study Bandung, Indonesia 01016
Akhlish Diinal Aziiz, Mochamad Donny Koerniawan and Suhendri
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801016
PDF (785 KB) | References

Open Access
Experimental Research of Stabilization of Polluted Marine Dredged Sediments By Using Silica Fume 01017
Ernesto Silitonga
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801017
PDF (1.24 MB) | References

Open Access
An Investigation of Damage Factors in Industrial Scale of Light-Weight Bricks Production 01018
Kiki Dwi Wulandari and Januarti Jaya Ekaputri
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801018
PDF (590 KB) | References

Open Access
The effect of steam curing on chloride penetration in geopolymer concrete 01019
Januarti Jaya Ekaputri, Inne Syabrina Mutiara, Siti Nurminarsih, Nguyen Van Chanh, Koichi Maekawa and Davin H. E. Setiamarga
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713801019
PDF (551 KB) | References

The Application of PVA Fiber to Improve the Mechanical Properties of Geopolymer Con... 01020

Mu... Januarti Jaya Ekaputri

Pu... online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713801020

PDF (490 KB) | References

Open Access

Mechanical properties of lightweight aggregate concrete reinforced with soda can waste fibre 01021

Yanuar Haryanto, Arnie Widyaningrum, Gathot Heri Sudibyo and Agus Maryoto

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713801021

PDF (518 KB) | References

Open Access

Mechanical Properties of Geopolymer Concrete Exposed to Combustion 01022

Annisa Rahmadina and Januarti Jaya Ekaputri

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713801022

PDF (533 KB) | References

Open Access

Modelling of chloride penetration in concrete under wet/dry cycle 01023

Sung-In Hong and Ki-Yong Ann

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713801023

PDF (382 KB) | References

Open Access

Mechanical properties of different bamboo species 01024

Dinie Awalluddin, Mohd Azreen Mohd Ariffin, Mohd Hanim Osman, Mohd Warid Hussin, Mohamed A. Ismail, Han-Seung Lee and Nor Hasanah Abdul Shukor Lim

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713801024

PDF (737 KB) | References

Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713802001
PDF (498 KB) | References

Open Access
Applications of vertical steel pipe dampers for seismic response reduction of steel moment frames 02002
Junaedi Utomo, Muslinang Moestopo, Adang Surahman and Dyah Kusumastuti
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713802002
PDF (895 KB) | References

Open Access
Flexural Capacity of the Concrete Beams Reinforced by Steel Truss System 02003
Rudy Djamaluddin, Pieter Lourens Frans and Rita Irmawati
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713802003
PDF (414 KB) | References

Open Access
Stress distributions of PSC box girder bridge due to creep shrinkage effect 02004
Baskoro Abdi Praja
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713802004
PDF (928 KB) | References

Open Access
Fragility function for assessing seismic risk of typical concrete bridge by means of nonlinear static and dynamic analysis 02005
Senot Sangadji, Niam A. Wibowo, Enjels N. Tropormera, Edy Purwanto and S. A. Kristiawan
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713802005
PDF (1.41 MB) | References

Development of Acacia Glulam Wood Exterior Beam-to-Column Connection with Angl... d Steel Rods System 02006

Djo... ono and Johannes A. Tjondro

Pu... ed online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802006

PDF (756 KB) | References

Open Access

Numerical Modelling of Interior RC Beam-Column Joints for Non-Engineered Buildings Strengthened Using Steel Plates 02007

Yulita Rahmi, Ashar Saputra and Suprapto Siswosukarto

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802007

PDF (506.3 KB) | References

Open Access

Dynamic Response of AP1000 Nuclear Island Due to Safe Shutdown Earthquake Loading 02008

Buntara S. Gan, Dinh Kien Nguyen and Ay Lie Han

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802008

PDF (689 KB) | References

Open Access

Finite element modelling of composite castellated beam 02009

Richard Frans, Herman Parung, Achmad Bakri Muhiddin and Rita Irmawaty

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802009

PDF (420 KB) | References

Open Access

Flexural behaviour and punching shear of selfcompacting concrete ribbed slab reinforced with steel fibres 02010

Hazrina Ahmad, Mohd Hisbany Mohd Hashim, Afidah Abu Bakar and Siti Hawa Hamzah

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802010

PDF (527 KB) | References

The Priority Importance of Economic Motivation Factors Against Risks for Green Building Development in Malaysia 02011

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802011

PDF (380 KB) | References

Open Access

On the effect of drag forces in mooring system restoring forces 02012

Zahid Ullah, Naik Muhammad, Ji-Hoon Lim and Dong-Ho Choi

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802012

PDF (609 KB) | References

Open Access

Investigation of Non-Uniform Rust Distribution and Its Effects on Corrosion Induced Cracking in Reinforced Concrete 02013

Wahyuniarsih Sutrisno, Priyo Suprobo, Endah Wahyuni and Data Iranata

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802013

PDF (699 KB) | References

Open Access

Concrete Filled Square Steel Tubular Deep Beam subjected to Bending-shear 02014

Kojiro Uenaka and Hisao Tsunokake

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802014

PDF (578 KB) | References

Open Access

Dispute resolution methods in the construction industry sector in the Kingdom of Saudi Arabia 02015

Saad Alshahrani

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802015

PDF (167 KB) | References

Precast System as Green Construction in Indonesia 02016

Hari ... Gambiro, Suprapto, Lutfi Faizal and Haerul Sitepu

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802016

PDF (1.07 MB) | References

Open Access

Application of Impact Vibration Test Method for Bridge Substructure Evaluation 02017

Pham Hoang Kien

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802017

PDF (755 KB) | References

Open Access

The Effects of Reduced Beam Section on Castellated Beam 02018

Nini H Aswad, Herman Parung, Rita Irmawaty and A Arwin Amiruddin

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802018

PDF (514 KB) | References

Open Access

Use of Stress Wave to Evaluate The Repair Quality of Concrete Crack 02019

Keng-Tsang Hsu, Chia-Chi Cheng, Chih-Hung Chiang and Hung-Hua Wang

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802019

PDF (518 KB) | References

Open Access

Structural damage detection using MAC-Fast Multi Swarm Optimization technique (MAC-FMSO) 02020

Richard Frans and Yoyong Arfiadi

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802020

PDF (476 KB) | References

Open Access

Stefanus Kristiawan, Agus Supriyadi, Senot Sangadji and Duwi Santosa

---

Open Access

Model of Bamboo Strip Notch Reinforced Concrete Beams On The Flexural Capacity 02022

Agus Setiya Budi and Agus P Rahmadi

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802022

PDF (497 KB) | References

Open Access

Finite element analysis on seismic performance of EWECS composite column 02023

Fauzan, Ruddy Kurniawan and Zev Al Jauhari

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802023

PDF (733 KB) | References

Open Access

Damage Level Prediction of Reinforced Concrete Building Based on Earthquake Time History Using Artificial Neural Network 02024

Reni Suryanita, Harnedi Maizir, Enno Yuniarto, Muhamad Zulfakar and Hendra Jingga

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802024

PDF (446 KB) | References

Open Access

Factor Analysis on Criteria Affecting Lean Retrofit for Energy Efficient Initiatives in Higher Learning Institution Buildings 02025

Nur IzieAdiana Abidin, Rozana Zakaria, Eeydzah Aminuddin, Abdul Rahim Abdul Hamid, Vikneswaran Munikanan, Shaza Rina Sahamir and Siti Mazzuana Shamsuddin

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802025

PDF (405 KB) | References

The role of cable stiffness in the dynamic behaviours of submerged floating tunnel 0202…

…-Wo Park and Dong-Ho Choi

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713802026

PDF (479 KB) | References

- 3-Concrete Engineering

Open Access

Effect on the Load Transferring Properties Fiber Reinforced Steel in Concrete based on Different Mix Ratio 03001

Yoonjung Han, Sangkeun Oh and Byoungil Kim

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803001

PDF (543 KB) | References

Open Access

Quick Assessment of the Anomalies in Concrete Structure Using Dispersive Characteristic of Surface wave 03002

Chia-Chi Cheng, Keng-Tsang Hsu, Chih-Hung Chiang, Fong-Jhang Ke and Hong-Hua Wang

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803002

PDF (691 KB) | References

Open Access

Ultimate Compressive Strength and Its Deformation of Normal and High Strength Concrete Cylinder Confined With External Lateral Pre-Stressing 03003

Harianto Hardjasaputra, Joey Tirtawijaya, Gino P. Ng and Selvira Ayuningtias

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803003

PDF (1.60 MB) | References

Open Access

Pure rate effect on compressive strength of concrete 03004

Sangho Lee, Kyoung-Min Kim and Jae-Yoel Cho

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803004

Yun-Wang Choi, Sung-Rok Oh and Byung-Keol Choi

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803005

PDF (461 KB) | References

Open Access

Effect of Applying Techniques and Polymer Content on Strength and Drying Shrinkage of Glass Fiber Reinforced Concrete 03006

Ratthanan Ianleng and Thatchavee Leelawat

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803006

PDF (474 KB) | References

Open Access

Fiber Orientation Effect on Flexural Response of UHPFRC 03007

Doo-Yeol Yoo, Min Jae Kim, Soonho Kim and Young-Soo Yoon

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803007

PDF (543 KB) | References

Open Access

Thirty Years Researches on Development for Sustainable Concrete Technology 03008

Jongsung Sim, Minkwan Ju and Kihong Lee

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803008

PDF (1.45 MB) | References

Open Access

Benefits Of Using Fiber on Impact Resistance of FRC Slabs 03009

Jin-Young Lee, Tian-Feng Yuan, Doo-Yeol Yoo and Young-Soo Yoon

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803009

PDF (569 KB) | References

DOI: https://doi.org/10.1051/matecconf/201713803010

PDF (365 KB) | References

Open Access

Preliminary studies on steel slag as a substitute for coarse aggregate on concrete 03011

Rahmi Karolina and Jannes Pandiangan

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803011

PDF (347 KB) | References

Open Access

Strength Properties and Micro-structure of Steel Slag Based Hardened Cementitious Composite with Graphene Oxide 03012

Mao Li and Jin-man Kim

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803012

PDF (575 KB) | References

Open Access

Bamboo Waste as Part of The Aggregate Pavement The Way Green Infrastructure in The Future 03013

Mudjanarko Sri Wiwoho, Mayestino Machicky, Rasidi Nawir, Indrawan and Setiawan Ikhsan M.

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713803013

PDF (583 KB) | References

- 4-Geotechnical Engineering

Open Access

Overview: Microbial amendment of remediated soils for effective recycling 04001

Soo-Bin Kim and Jun-Boum Park

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804001

PDF (793 KB) | References

Tunnel Portal Construction using Sequential Excavation Method: A Case Study 04002

Rana ... hmad ... Khan, Zaka Emad and ByungWan Jo

Pu... 17

DO... ps://doi.org/10.1051/matecconf/201713804002

PDF (880 KB) | References

Open Access

Designing an Ardunio-microprocessor-and-Labview-based system for monitoring wave spread in the ground caused by constructing activities 04003

Nguyen Lan and Chau Ngoc Bao

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804003

PDF (433 KB) | References

Open Access

Influence of Rice Husk Ash and Clay in Stabilization of Silty Soils Using Cement 04004

Jack Widjajakusuma and Hendo Winata

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804004

PDF (382 KB) | References

Open Access

Systematic Approaches for Signal Processing of Soil Shaking Table Test 04005

Jun Xian Lim, Min Lee Lee and Yasuo Tanaka

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804005

PDF (753 KB) | References

Open Access

Stability assessment of enzyme stabilized road embankments 04006

Jaspreet Singh, Dilan Robert, Peihan Wang, Filippo Giustozzi, Mojtaba Mahmoodian, Sujeeva Setunge and Brian O'Donnell

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804006

PDF (489 KB) | References

Open Access

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804007

PDF | References

Open Access

Bearing Capacity Characteristics of Steel Pipe Piles with Wings installed in Soil Cement Column 04008

Pham Hoang Kien and Daisuke Ito

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804008

PDF (3.17 MB) | References

Open Access

Evaluation of the causes of Bukit Antarabangsa 2008 landslide by using fault tree analysis 04009

Danish Kazmi, Sadaf Qasim and I.S.H Harahap

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804009

PDF (353.0 KB) | References

Open Access

A Review on the Use of Bamboo for Earthwork Construction 04010

Mokhammad Farid Ma'ruf

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804010

PDF (502.5 KB) | References

Open Access

The stability of clay using volcanic ash of Mount Sinabung North Sumatera and sugarcane bagasse ash with cbr and uct value 04011

Ika Puji Hastuty, Roesyanto and Giovanni Ramadhany

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804011

PDF (604 KB) | References

Open Access

Rizki Ade Khoir and Annisa Dewanti Putri

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713804012

PDF (2 MB) | References

- 5-Construction and Safety Management

Open Access

Bridge Deterioration Prediction Model Based On Hybrid Markov-System Dynamic 05001

Jojok Widodo Soetjipto, Tri Joko Wahyu Adi and Nadjadji Anwar

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713805001

PDF (384 KB) | References

Open Access

A framework of initiatives for successful application of life cycle costing (LCC) in industrialised building system (IBS) in Malaysian construction industry 05002

Siti Mazzuana Shamsuddin, Rozana Zakaria, Norfashiha Hashim, Norazian Mohamad Yusuwan, Shaza Rina Sahamir and Nur IzieAdiana Abidin

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713805002

PDF (347 KB) | References

Open Access

Improving construction claim management in Malaysian construction industry 05003

Nor Azmi Bakhary, Hamimah Adnan and Azmi Ibrahim

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713805003

PDF (232 KB) | References

Open Access

Construction Worker Fatigue Prediction Model Based on System Dynamic 05004

Tri Joko Wahyu Adi and Lila Ayu Ratnawinanda

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713805004

PDF (732 KB) | References

Model of Construction Waste Management Using AMOS-SEM for Indonesian Infrastructure Projects 05005

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713805005

PDF (312.2 KB) | References

Open Access

Characteristics of small medium contractor entrepreneurs: a study of Indonesia 05006

Harijanto Setiawan, Ferianto Raharjo and Koesmargono

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713805006

PDF (329 KB) | References

Open Access

Using BIM as a Tool to Teach Construction Safety 05007

Biemo W. Soemardi and Ray G. Erwin

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713805007

PDF (454 KB) | References

Open Access

Implementation of life cycle costing for a commercial building: case of a residential apartment at Yogyakarta 05008

Peter F Kaming

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713805008

PDF (389 KB) | References

- 6-Hydraulics, Hydrology and Water Engineering

Open Access

Stability Analysis Quay Wall at The Amazonehaven, Port of Rotterdam 06001

Nadevah K.N. Mourillon, Jarit de Gijt, Klaas Jan Bakker, Henk Brassinga and Erik Broos

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713806001

PDF (566 KB) | References

Characteristic of macroinvertebrates abundance in cascade-pond system at Universitas Indonesia Campus, West Java, Indonesia 06002
Mu... ...tjiningsih and Evi Anggraheni
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713806002
PDF (342 KB) | References

Open Access
Green infrastructure in oil rich states; Abu Dhabi Emirate-Alain as a ca se study 06003
Mohamed El Amrousi and Mohamed Elhakeem
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713806003
PDF (1.43 MB) | References

Open Access
Enhancing community role in catchment area of cascade-pond system at the campus of Universitas Indonesia, Depok, West Java, Indonesia 06004
Caya Maitri, Dwita Sutjiningsih and Evi Anggraheni
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713806004
PDF (746 KB) | References

Open Access
Assessment of hydropower potential in small karst catchments: the case of the Rocche Plateau, Central Italy 06005
Maurizio Leopardi and Anna Rita Scorzini
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713806005
PDF (1.14 MB) | References

Open Access
Lowering the Beneluxtunnel 06006
Tomas Weeda, Jarit de Gijt, Klaas Jan Bakker, René Braam, Eric Broos and Bas Jonkman
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713806006
PDF (487 KB) | References

Placement of BMPs in urban catchment area using SUSTAIN model: case study at Universitas Indonesia Campus, Depok, West Java, Indonesia 06007
Tingsanchali and Dwita Sutjiningsih
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713806007
PDF (711 KB) | References

Open Access
Cascade-pond System Health Assessment Based on Macroinvertebrate Indices and Its Relationship with Impervious Cover and Aquatic Buffer Zone in Urbanized Catchments 06008
Faris Zulkarnain, Dwita Sutjiningsih and Yasman
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713806008
PDF (696.8 KB) | References

Open Access
Analysis of Spring Development and Gravity Flow System to Capture Water for Local Communities 06009
Cita Adiningrum
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713806009
PDF (1.06 MB) | References

Open Access
A Study on the Estimation of Flood Damage in Medan City 06010
A. Perwira Mulia Tarigan, Asril Zevri, Rudi Iskandar and Ivan Indrawan
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713806010
PDF (736 KB) | References

- *7-Transportation Engineering*

Open Access
Motorcycles as public transport service based on smart phone android applications 07001
Ansusanto Dwijoko and Hangganararas Sterya
Published online: 30 December 2017

Aldias Bahatmaka, Dong-Joon Kim, Deddy Chrismianto, Joga Dharma Setiawan and Aditya Rio Prabowo

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713807002

PDF (618 KB) | References

Open Access

Optimization of thrust propeller design for an ROV (Remotely Operated Vehicle) consideration by Genetic Algorithms 07003

Aldias Bahatmaka, Dong-Joon Kim, Deddy Chrismianto, Nguyen Hai and Aditya Rio Prabowo

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713807003

PDF (434 KB) | References

Open Access

Integrated sustainability for transportation infrastructure development in Indonesia: A case study of Karawang region 07004

Ayomi Dita Rarasati and Tamara R.F. Iskandar

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713807004

PDF (270 KB) | References

Open Access

Analysis of The Time Value for Public Transport Passenger by Using Random Regret Minimization 07005

Medis Surbakti and Fransiscus Pinem

Published online: 30 December 2017

DOI: https://doi.org/10.1051/matecconf/201713807005

PDF (394 KB) | References

Open Access

Effect of sedimentation volume on productivity and dwelling time of ships at bom baru port 07006

Putranto Dinar DA and Buchari Erika

Published online: 30 December 2017

Fajar Sri Handayani, Ary Setyawan, F. Pungky Pramesti and M. Agung Wibowo
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807007
PDF (335 KB) | References

Open Access
Engineering model of traffic and transportation safety with pattern of cooperation between sustainable region in Bogor 07008
Syaiful
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807008
PDF (544 KB) | References

Open Access
Comparison of the behavior of motorists in traffic safety in Yogyakarta Special Region by gender 07009
Poei Purnamasari and Dwijoko Ansusanto
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807009
PDF (382 KB) | References

Open Access
The Design of Road Evaluation and Monitoring System based on Geographical Information System 07010
Ary Setyawan, Muhammad Farid Al Alimi, Dewi Handayani and Agus Sumarsono
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807010
PDF (404 KB) | References

Open Access
Analysis and design of road and bridge infrastructure database using online system 07011
Joni Arliansyah, Yadi Utama, Maureen Arlini Wijayanti, Rachmat Gusti and Arifianto
Published online: 30 December 2017

Erika Buchari, Dinar Dwi Anugerah Putranto and Aulia Rahman
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807012
PDF (264 KB) | References

Open Access
Providing facilities to improve accessibilities to railway station for all 07013
Wanrawee Nawagawong and Wasaporn Techapeeraparnich
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807013
PDF (343.0 KB) | References

Open Access
A comparative study of performance measurement standards of railway operator 07014
Siripong Pongjirawut, Wasaporn Techapeeraparnich and Waranon Dilokkhunanan
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807014
PDF (866 KB) | References

Open Access
Internet of Things (IoT) as Green City Economic Development Smart Transportation System 07015
Winardi Slamet, Kamisutara Made, Purworusmiardi Tubagus, Sukoco Agus and Mudjanarko Sri Wiwoho
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807015
PDF (807 KB) | References

Open Access
The Assessment of Natural Rock Asphalt for Thin Surfacing Mixture Design 07016
Ary Setyawan, Arif Budiarto, Djumari Djumari and Salvatore Sukmana
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807016

Lasmini Ambarwati, Amelia K. Indriastuti, Yatnanta P. Devia and Deputri N. Sari
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713807017
PDF (599 KB) | References

- 8-Sanitation and Environmental Engineering

Open Access
Riverside sustainability – Overcome problems and reliable approaches 08001
Irma Novrianty Nasution and Syahreza Alvan
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713808001
PDF (712 KB) | References

Open Access
Leachate of Demolition Waste 08002
Yatnanta Padma Devia and Eko Andi Suryo
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713808002
PDF (1.00 MB) | References

Open Access
Removals of colour and turbidity from stabilized leachate by using alum and glutinous rice flour dual coagulants 08003
Shaylinda Mohd Zin Nur and Azizan Mohd Omar
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713808003
PDF (271 KB) | References

Open Access
Analysis of Microbial Air Quality in the Surrounding Hospital's Wastewater Treatment Plants in Jakarta, Indonesia 08004
Gabriel Andari Kristanto and Fatma Nur Rosana
Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713808004

Harith Noor Sheena Herayani, Adnan Azlan and Shoushtari Abdollah Vaez

Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713809001

PDF (956 KB) | References

Open Access

Specifying risk management standard for flood risk assessment: a framework for resources allocation 09002

Anastasia Yunika, Matthijs Kok and Jacob Gerrit (Jarit) de Gijt

Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713809002

PDF (291.0 KB) | References

Open Access

Assessing the impact of climate change on the water intake of the headworks on the Red River Basin in Viet Nam 09003

Lan Pham Thi Huong and Nguyet Le Minh

Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713809003

PDF (637 KB) | References

Open Access

Mapping of Biomass Production of Land Damage Assessment to Reduce Environmental Changes In East Java Probolinggo 09004

Ali Mahrus, Hariyadi Bambang Wicaksono, Nurlina, Hasyim Cholil and Mudjanarko Sri Wiwoho

Published online: 30 December 2017
DOI: https://doi.org/10.1051/matecconf/201713809004

PDF (322 KB) | References

MATEC Web of Conferences

MATEC Web of Conferences **138**, 02002 (2017)
EACEF 2017
DOI: 10.1051/matecconf/201713802002

Applications of vertical steel pipe dampers for seismic response reduction of steel moment frames

Junaedi Utomo[1*], *Muslinang* Moestopo[2], *Adang* Surahman[2], and *Dyah* Kusumastuti[2]

[1]Civil Engineering Department, Universitas Atma Jaya Yogyakarta, Yogyakarta, Indonesia.
[2]Faculty of Civil and Environmental Engineering, Bandung Institute of Technology, Bandung, Indonesia.

Abstract. A newly developed vertical steel pipe damper is introduced to improve the seismic performance of steel moment frames. The damper exhibits large lateral stiffness and excellent capability to dissipate energy due to earthquakes. It provides a reliable, compact, inexpensive, and replaceable damper. Improved performance of the structure is verified analitically using a four-story steel moment frame equipped with steel pipe dampers. Vertical steel pipe dampers are placed between any two points where large relative motion exists during earthquake excitation. A nonlinear dynamic analysis of the structure using PERFORM-3D software demonstrated the significant benefit of equipping the structure with steel pipe dampers. All structural components, except the steel pipe dampers, remain elastic during earthquake excitation. Structures properly designed with vertical steel pipe dampers will only require minimum post-earthquake inspection and limited damage. Some practical issues associated with the application of vertical steel pipe dampers to building structure for seismic response reduction are presented in this paper.

1 Introduction

A newly developed vertical steel pipe damper has been introduced to improve the seismic performance of steel moment frames [1]. The damper has large lateral stiffness, small yield displacement and excellent capability to dissipate a tremendous amount energy. The damper is intended to be installed in low to medium rise structures. An improved performance of a four-story steel moment frame with and without steel pipe dampers was verified analytically using north-south components of the El-Centro 1940, Chi-Chi 1999, Fukushima-Hamadori 2011 and Padang 2009 earthquakes accelerograms. The structure was not intended to be designed for a specific site. Therefore no spectral matching, to obtain design ground motion time histories to match a target response spectra of a site, was done. The results of the nonlinear dynamic analysis of the structure demonstrated the significant benefit of equipping the structure with vertical steel pipe dampers. All structural components, except the dampers, remain elastic during four strong earthquake excitations.

* Corresponding author: utomoj@live.com

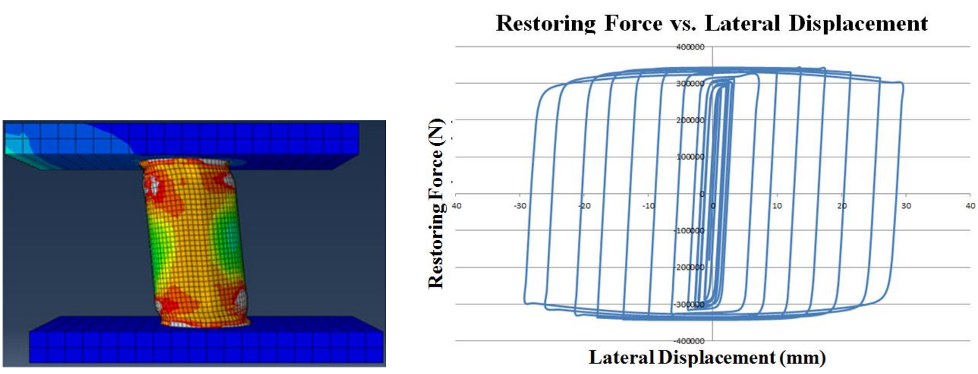
2 Vertical steel pipe damper

Steel pipes in vertical position are sensitive to the diameter (D) to thickness ratio (t) of the pipes. The schedule 80 carbon steel pipe which has small D/t ratio was chosen to avoid buckling in middle part of the pipe. Pipe having D = 114.3 mm, t = 8.6 mm and height (h) = 200 mm was used as the material of the damper. Abebe et al. [2] proposed the ratio of height to diameter of the pipe as √3 so that bending and shear stress yield simultaneously. The results of simple tensile tests to obtain the material properties of the steel pipe and plate are shown in Table 1. Figure 1 shows the results of numerical simulation using ABAQUS [3] for bare pipe fixed at both ends subjected cycles of increased amplitude of lateral displacement by 1xδ_y in each consecutive cycle (δ_y is the yield displacement of the damper). As shown in Figure 1, no local buckling occurred at the middle part of the pipe but local buckling occurred at the ends of the pipe manifesting in unstable hysteretic curve. The specimen of the bare pipe had been tested using the same cyclic loading above, and fracture occurred at the heat affected zone area (HAZ) close to the ends of the pipe. Some kind of strengthening to the bare pipe are required to avoid buckling at ends of the pipe, to relieve the stresses at the ends of the pipe, and to relocate the fracture away from HAZ area.

Figure 2 shows the two improved model of vertical steel pipe dampers. The model of vertical steel pipe dampers shown in Figure 2a had been tested, and fracture occurred at the heat affected zone area (HAZ) close to the ends of the pipe. The details of the strengthening plate outside the pipe were improved so that: (1) buckling at the pipe was eliminated; (2) connection failure at the ends of the pipe was avoided; (3) fractures at HAZ region were avoided; (4) early fractures at points of high intense stress were postponed, and (5) extensive yielding was concentrated in the middle part of the pipe. As shown in Figure 2b, curved and tapered strengthening plate were used to prevent buckling at the ends of the pipe, to concentrate the extensive yielding in the middle part of the pipe and to postpone and to shift fracture locations away from HAZ areas.

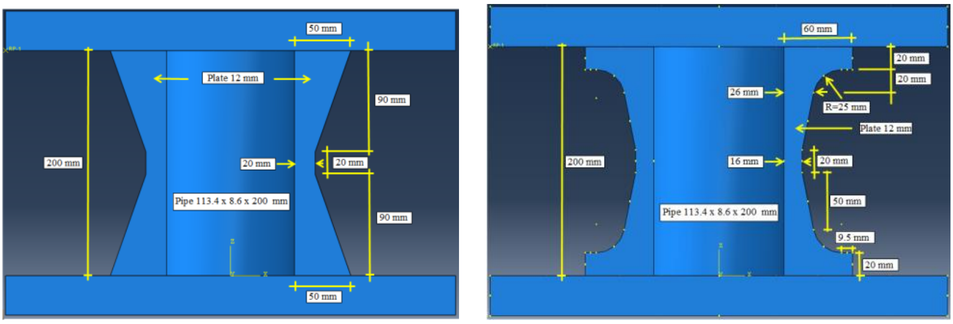
Table 1. Material properties of the steel used for numerical simulation

Steel	Modulus of elasticity (MPa)	Yield stress (MPa)	Ultimate stress (MPa)	Breaking strain (%)
Pipe	200.000	330	465	37
Plate	200.000	360	500	25



(a) (b)

Fig. 1. Local buckling at the ends of the bare pipe: (a) von Mises stress distribution and (b) Hysteretic curve



(a) (b)

Fig. 2. Details of the improved model of vertical steel pipe dampers: (a) Strengthened with a pair of trapezoidal shape plates and (b) Strengthened with a pair of curve shape plates

Figure 3 shows the von Mises stress distribution of the improved model shown in Figure 2b. The results of the numerical simulation show: (1) The point of high intense stresses where fractures are expected to happened has been shifted away from HAZ region near the ends of the pipe; (2) Welded connections are placed at low stress areas, and (3) The high stresses at the ends of the pipe are relieved. The improved model of the vertical steel pipe damper has been tested using ATC-24 loading protocol using cycles of increased amplitude of lateral displacement by 1xδ_y in each of three consecutive cycles.

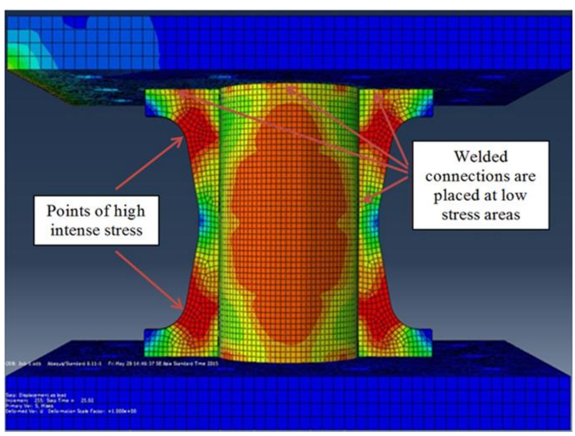
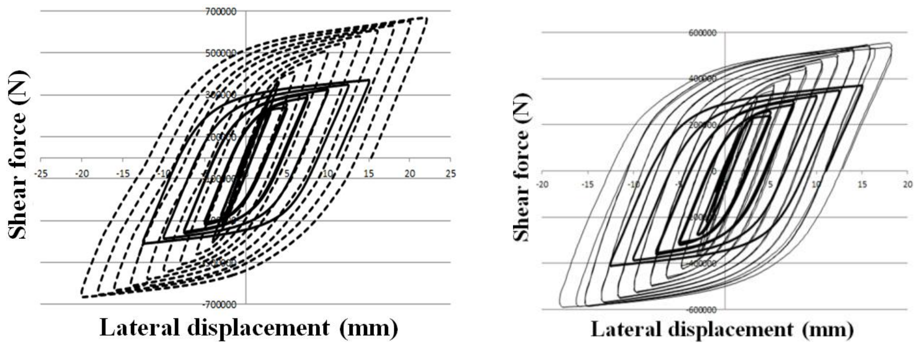


Fig. 3. von Mises stress distribution of the improved model of the vertical steel pipe damper

The stable parts of the hysteretic curves of the test results of the dampers were plotted in Figure 4. Figure 4a shows the plot of two graphs of the bare pipe damper and the vertical pipe dampers strengthened with a pair of trapezoidal shape plates on one Cartesian coordinate system, and Figure 4b shows the same plot of the bare pipe damper and the vertical pipe dampers strengthened with a pair of curve shape plates. The number and distribution of plastic cycles from the test results determined the energy dissipation capacity of the dampers. Table 2 shows the number of plastic cycles and the energy dissipated by each of damper due to the following cyclic displacement loadings: (1) For the bare pipe and the pipe strengthened with a pair of trapezoidal shape plates, the displacement loading amplitude was increased in each consecutive cycle by 1xδ_y, and (2) For the pipe strengthened with a pair of curve shape plates, the displacement amplitude was increased in each three consecutive cycles by 1xδ_y (ATC-24). The number of plastic cycles from the test results reflects the quality of the detailing of the dampers. As shown in the last row of Table

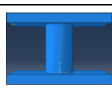
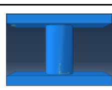
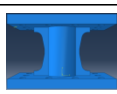
2, applying smooth geometry configuration to the strengthening plate outside the pipe manifested in the increase capacity of the energy dissipation of the damper significantly.



(a) (b)

Fig. 4. Plot of two graphs of stable parts of hysteretic curves of vertical steel pipe dampers: (a) Bare pipe vs. pipe strengthened with a pair of trapezoidal shape plates, and (b) Bare pipe vs. pipe strengthened with a pair of curve shape plates

Table 2. Number of plastic cycles and increase capacity of energy dissipation

Vertical steel pipe dampers	Number of Plastic Cycles	Total Dissipated strain energy (N.mm)	Increase capacity of energy dissipation (%)
	7	0.325e+08	-
	8	1.09e+08	236.72
	**29**	**2.45e+08**	**654.08**

3 Application of vertical steel pipe dampers

The vertical steel pipe damper strengthened with a pair curve and tapered plates will be installed in a four-story steel moment frame to reduce the seismic response of the building due to four strong earthquakes. Nonlinear dynamic procedure was used to access the performance capability of the building. Limiting the lateral defection of the damper to 10xδ_y (δ_y = 1.80 mm is the yield lateral displacement of the damper) due to four strong earthquakes was selected as one of the performance objective of the building. A preliminary designed has been carried out to estimate the required number of dampers in each story of the building. A computational model of the building that incorporates the nonlinear load-deformation characteristic of the individual damper was built using PERFORM-3D [4]. The computational model was then subjected to the north-south component of the Chi-Chi 1999, El-Centro 1940, Fukushima-Hamadori 2011, and Padang 2009 ground motion time-histories. The resulting maximum absolute deflection of the dampers was directly compared to the performance objective of the building.

DOI: 10.1051/matecconf/201713802002

3.1 Steel moment resisting frame

A four-story steel moment resisting frame shown in Figure 5 was used to study the application of the vertical steel pipe damper. A number of end releases were applied so that the lateral load resisting systems in the building are the peripheral frames. One-way slab systems were applied to all floors. The secondary beams were not shown in Figure 5.

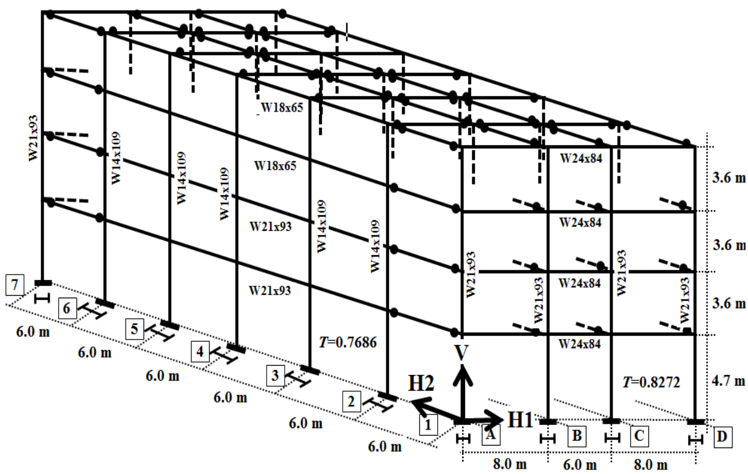


Fig. 5. Four-story steel moment resisting frame

The superimposed specified loads are as follows:
Gravity loading:
- Live load: Roof LL = 1.0 kPa, Floor LL = 2.4 kPa
- Dead load: Floor weight plus topping = 3.6 kPa, Partitions = 1 kPa

Materials:
- Concrete: 24.0 MPa
- Reinforcing steel: ASTM A572 steel, grade 50 f_y = 345 MPa

Elements dimension:
- Exterior columns: W21x93 (along H1), and W14x109 (along H2)
- Interior columns: W12x72 (along H2)
- Exterior beams: W24x84 (along H1), W21x93 and W18x95 (along H2)
- Interior beams: W24x84 (along H1), W21x93 and W18x95 (along H2)

Fundamental periods:
- T = 0.8272 seconds (along H1)
- T = 0.7689 seconds (along H2)

3.2 Modelling dampers as inelastic components

Originally all the columns height were 3.6 m and the four-story steel moment frames had been designed to withstand moderate intensity earthquake. The height of the first floor column was modified to 4.7 m and the doubler plate at panel zones were eliminated to purposely create problems into the four-story steel moment frames. These problems will be eliminated by installing dampers in the peripheral frames of the buildings.

DOI: 10.1051/matecconf/201713802002

Test results data of the vertical steel pipe damper were used to model shear vs. lateral displacement of the damper. Seismic isolator component in PERFORM-3D [4] was used to model the damper as shown in Figure 6.

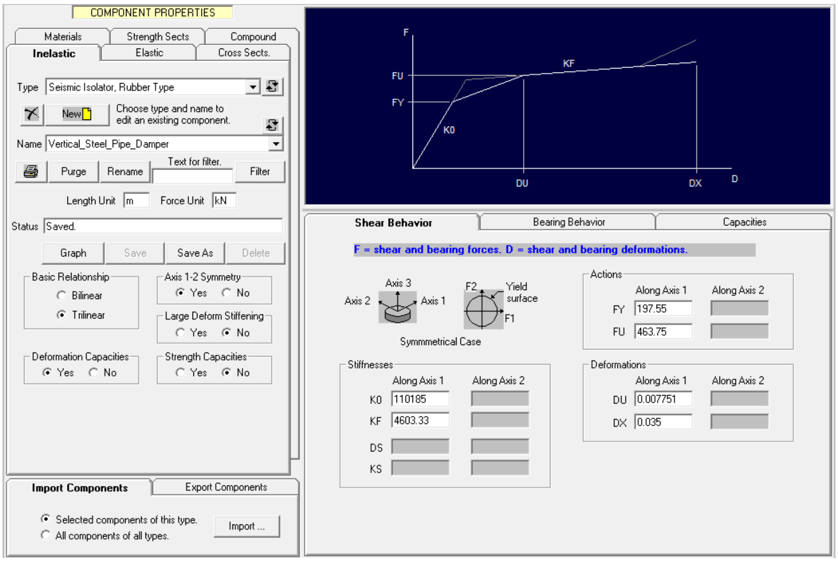


Fig. 6. Trilinear model of the force vs. displacement of the vertical pipe damper

The performance objectives of the steel frames equipped with dampers are:

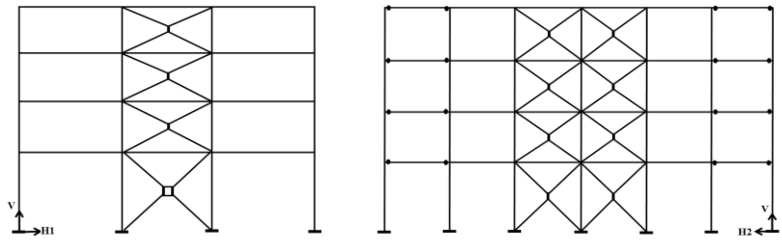
1. Energy dissipation is concentrated in dampers meaning other components of the steel frames, except the dampers, remain elastic.
2. Inter-story drifts reduction at all levels are significant
3. Absolute lateral deflection of the dampers is less than 10xδ_y.

3.3 Estimating the number of dampers in each story

The required number of dampers in each story had been estimated using energy-based method proposed by Benavent-Climent [5]. The required lateral stiffness and lateral strength of the damper for near-fault ground motion were determined from input energy spectra for moderate-seismicity regions proposed by Benavent-Climent et al. [6]. The configuration of the dampers in the peripheral frames along H1 and H2 are shown in Figure 7. Auxiliary structures in the form of triangular bracings are needed to install dampers between two points where large relative motion exists during earthquake. Auxiliary structures shown in Figure 7 were chosen to minimize the influence of axial forces to the dampers.

A computational model of the four-story frames, that incorporate the nonlinear load-deformation characteristic of the individual damper shown in Figure 6, was built using PERFORM-3D [4]. For assessment of the performance of the building equipped with dampers, the computational model was then subjected to the north-south component of the four strong earthquakes time histories, and the results were evaluated.

 DOI: 10.1051/matecconf/201713802002



(a) (b)

Fig. 7. Configuration of the dampers in peripheral frames: (a) Two peripheral frames along H1, and (b) Two peripheral frames along H2

3.4 Combined acceleration spectrum

The Peak Ground Accelerations (PGAs) of the Chi-Chi 1999, Fukushima-Hamadori 2011 and Padang 2009 were scaled down to El-Centro 1940. Figure 8 shows the combined acceleration spectra of the four earthquake time-histories. Spectral matching would reduce the peaks and valleys in each earthquake time history. No spectral matching was done because the four-story steel moment frame was not designed for specific site. Therefore peaks and valleys in Figure 8 of each acceleration spectra are very obvious.

Two cases of the peripheral frames along H1 considered:

1. Case 0 is the four-story frame without dampers ($T =$ 0.8272 seconds)
2. Case 1 is the four-story frame with dampers ($T =$ 0.4918 seconds)

It is well understood that each point in a response spectra represents the energy content of the earthquake at a certain frequency. For the frame without damper along H1 subjected to Padang earthquake accelerograms, the corresponding point for T=0.8271 seconds lies in a valley. Therefore significant response reduction is not expected for Padang earthquake. Significant response reductions are expected for three other earthquakes.

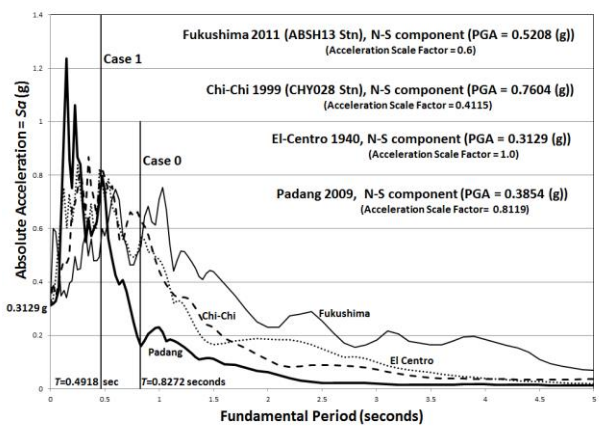
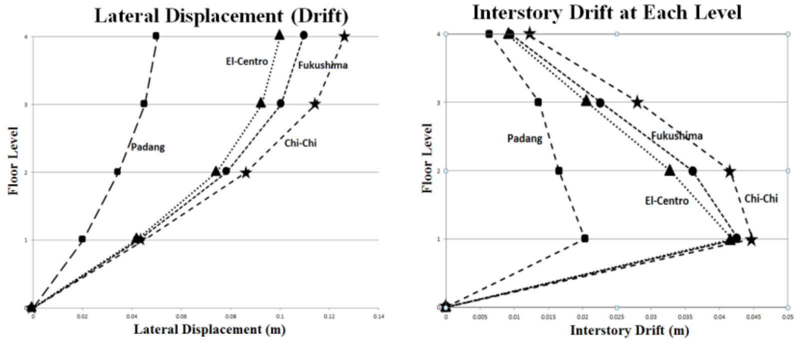


Fig. 8. Combined acceleration spectra

3.5 Inter-story drift reduction

The results of nonlinear dynamic analysis of Case 0 and Case 1 were used to quantify the lateral displacement (drift) and inter-story drift ratio of the four-story steel moment frame. The drift and inter-story drift for Case 0 and Caser 1 are shown in Figure 9 and Figure 10 respectively.

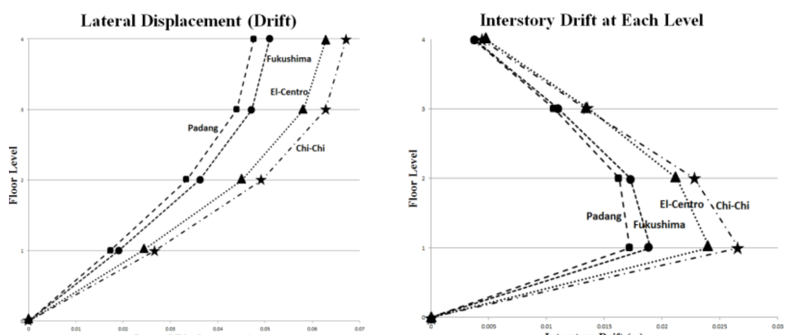


(a) (b)

Fig. 9. Drift and inter-story drift for Case 0: (a) Drift, and (b) Inter-story drift

Figure 9a shows the maximum drift at each floor of the four-story frame without damper. The maximum drift due to Padang 2009 earthquake is small as expected (see Figure 8). Figure 9b shows the maximum inter-story drift at each floor of the four-story frame without damper.

Figure 10a shows the maximum drift at each floor of the four-story frame equipped with dampers. Figure 10b shows the maximum inter-story drift at each floor of the four-story frame with dampers installed. Comparing Figure 9 and Figure 10, it can be seen that the lateral displacement and the inter-story drift were reduced significantly due to the present of dampers in the four-story steel moment frame.



(a) (b)

Fig. 10. Drift and inter-story drift for Case 1: (a) Drift, and (b) Inter-story drift

The reduction of inter-story drift at each floor due to the dampers is shown in Figure 11.

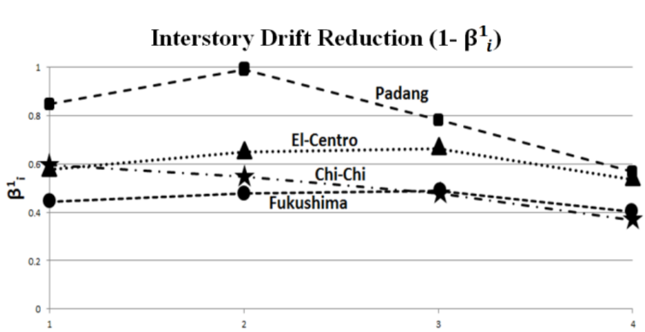


Fig. 11. Inter-story drift reduction

Parameter $\beta^1{}_i$ [7] is used to quantify the ratio of maximum drift at each floor for the frame with dampers to the frame without dampers. The inter-story drift reduction is quantified as 1-$\beta^1{}_i$. Except for Padang 2009 earthquake where the inter-story drift reduction is expected to be small, the inter-story drift reduction at each floor due to the other earthquakes is significant. On average the inter-story drift reduction at each floor is about 40%.

3.6 Dissipated inelastic strain energy

Dissipated strain energy quantified at each component of the four-story steel moment frame in nonlinear dynamic analysis is shown in Table 3.

Table 3. Dissipated strain energy at each component of the peripheral frames along H1

	Earthquake			
Group name	**El-Centro - 1940**	**Fukushima - 2011**	**Padang - 2009**	**Chi-Chi - 1999**
Perimeter Columns	0	0	0	0
Perimeter Beams	0	0	0	0
Interior Columns	0	0	0	0
Interior Beams	0	0	0	0
Connection Panel Zones - along H1	0	0	0	0
Connection Panel Zones - along H2	0	0	0	0
Vertical Steel Pipe Dampers	**261.49**	**422.4**	**202.35**	**233.29**
Bracing HSS-H1-1st floor	0	0	0	0
Bracing HSS-H2-1st floor	0	0	0	0
Bracing HSS-H2-other floors	0	0	0	0
Bracing HSS-H1 other floors	0	0	0	0
Total for All Groups	**261.49**	**422.4**	**202.35**	**233.29**

Only the vertical steel pipe dampers dissipate energy. All other components except the dampers remain elastic. The present of the dampers installed at strategic locations in the four-story steel moment frame were able to protect the structure against strong earthquakes. Extensive yielding in dampers is the energy dissipation mechanism. By dissipating strain energy, the dampers control the vibration of the structure during strong earthquakes.

The strain energy dissipated by individual damper is shown in Table 4. The largest value of strain energy dissipated by individual damper located between the 2nd and 3rd floor is due to Fukushima-Hamadori 2011 earthquake. The values of dissipated strain energy of individual damper reflect the damage (the degree of yielding) experienced by the dampers.

Table 4. Dissipated strain energy of individual damper along H1

Earthquake	**Dissipated Energy of Individual Damper (kN.m)**			
	Damper btw 1st and 2nd floor	**Damper btw 2nd and 3rd floor**	**Damper btw 3rd and 4th floor**	**Damper btw 4th floor and roof**
El-Centro	36.40	46.30	11.65	0.0
Fukushima	59.32	**76.71**	15.86	0.0
Padang	26.37	35.18	13.26	0.0
Chi-Chi	34.85	37.38	9.58	0.0

3.7 Maximum absolute shear force and shear displacement

The maximum absolute value of the shear force and the maximum absolute value of the shear displacement shown in Table 5. The maximum absolute shear force is 513.21 kN which is less than the shear-force capacity of the vertical steel pipe damper. The maximum absolute shear displacement is 18.5 mm which is very close the 10xδ_y of the damper (δ_y of the damper is 1.80 mm). Therefore the performance objectives of the structure had been achieved.

Table 5. Maximum absolute shear force and lateral displacement

Earthquake	Maximum Absolute Shear Force (kN)		Maximum Absolute Shear Displacement (m)	
	Damper btw 1st and 2nd floor	Damper btw 2nd and 3rd floor	Damper btw 1rd and 2nd floor	Damper btw 2nd and 3rd floor
El-Centro	502.63	501.88	0.0162	0.0161
Fukushima	480.78	484.38	0.0115	0.0122
Padang	470.01	480.17	0.0099	0.0113
Chi-Chi	**513.21**	508.34	**0.0185**	0.0175

4 Conclusion

The newly developed vertical steel pipe damper was successfully apllied to reduce the seismic response of the moment frame due to four strong earthquakes. The energy dissipation were concentrated in the dampers so that other components of the structure, except the dampers, remain elastic. The performance of the four-story steel moment frame with slender columns at the first floor has been improved significantly by installing dampers at strategic locations. After strong earthquakes, dampers that already experience yielding can be replaced easily.

This research was supported by the Decentralization Research Grant (FTSL PN-1-08-2014 and FTSL PN-1-08-2015) of Directorate General of Higher Education (DIKTI), Ministry of National Education, Indonesia.

References

1. J. Utomo, *Development of Steel Pipe Dampers for Seismic Protection of Buildings*, (In Indonesian), Doctoral Dissertation, Institut Teknologi Bandung, Indonesia (2017).
2. D. Y. Abebe, J. W. Kim, and J. H. Choi, *Hysteresis Characteristics of Circular Pipe Steel Damper Using LYP225*, Steel Innovations Conference 2013, Christchuch, New Zealand, 21-22 February (2013).
3. _________, *ABAQUS user's manual, version 6.11*, Dassault Systems Corp., Providence, RI, USA (2011).
4. G. H. Powel, *User Guide Perform-3D Version 5 – Nonlinear Analysis and Performance Assessment for 3D Structures*, Computer and Structures Inc., California (2011).
5. A. Benavent-Climent, Soil Dynamics and Earthquake Engineering, **31**: 1385-1396 (2011).
6. A. Benavent-Climent, L. G. Pujades and F. Lopez-Almanza, Earthquake Engng Struct. Dyn.; **31**:1151-1172 (2002).
7. C. Tovar, and O. A. Lopez, *Effect of The Position and Number of Dampers on The Seismic Response of Frame Structures*, 13th World Conference of Earthquake Engineering, Vancouver, B.C., Canada (2004).