IIISEE Newsletter

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Number 213

International Institute of Seismology and Earthquake Engineering BRI Japan

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In This Issue

The 27th Global Seismological Observation Course has started

By Mr. Takahiro Yamada, Head of Administration Division, IISEE

Global Seismological Observation Course has started from January 10.

This year, 8 participants from 7 countries (Algeria、Namibia、Nepal、Peru、Philippines、Samoa、Vanuatu) join this course.

In the Opening ceremony held in BRI, after the welcome speech, THOMAS Frieda kahewa-Ketu from Namibia gave an address on behalf of the participants.

The Training Course has the special aim to develop human resources having acquired the skills necessary for detecting nuclear tests applying seismological knowledge.

This training program is carried out by the support and cooperation of CTBTO, MOFA, JICA, Japan Meteorological Agency, and other organizations. From 1995 until now, 280 participants from 78 countries have completed.

The training participants are working actively to learn the knowledge about the international seismic observation and acquire advanced earthquake analysis technique.

This short course will finish on March 3. I hope all the participants enjoy training and staying in Japan. Please bring back a lot of great memories of Japan.

Dr. Takao SAWACHI,
President of BRI

Mr. Yushi KUBO,
Secretary of MOFA

Ms. Emiko MUTSUYOSHI,
Deputy Director General,
Tsukuba Center, JICA

Ms. THOMAS Frieda Kahewa-Ketu
from Namibia

Group Photo

Earthquakes

The 2011 off the Pacific coast of Tohoku Earthquake

Reports of Recent Earthquakes

Utsu Catalog

Earthquake Catalog

Global Course Participants

Symposium jointly hosted by National Graduate Institute for Policy Studies (GRIPS) and Building Research Institute (BRI) – January 16, 2023

By Mr. Takahiro Yamada, Head of Administration Division, IISEE

A symposium jointly hosted by the National Graduate Institute for Policy Studies and the Building Research Institute was held on Monday, January 16, 2023.
The symposium was a success, with many researchers and ex-participants giving lectures and having lively discussions.
It was held online and attended by a total of 207 participants including 193 viewers and 14 speakers and other related staff.

Yushiro Fujii, Chief Reserch Scientiest, IISEE

Dr. Fujii’s Presentation

Call for Papers

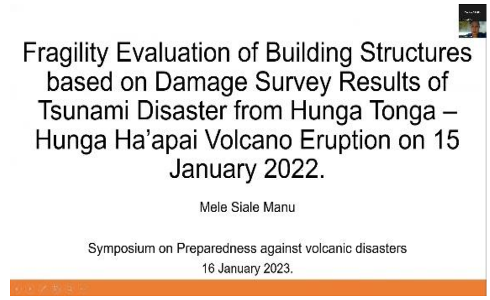
IISEE Bulletin is now accepting submissions of papers for the seismology, earthquake engineering, and tsunami. Developing countries are targeted, but are not limited.

Your original papers will be reviewed by the editorial members and some experts.

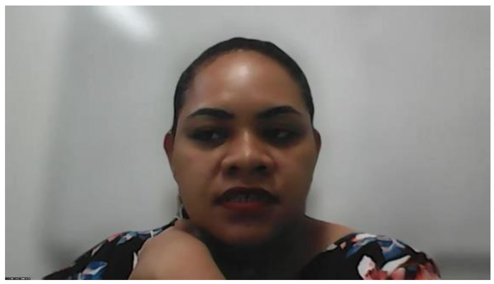
NO submission fee is needed.

Try to challenge!!

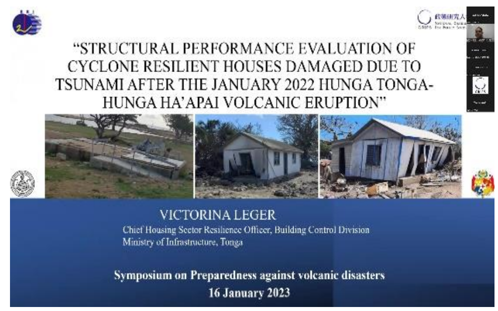
Manu Mele Siale, Geologocal Assistant, Ministry of Lands and Natural Resources, Kingdom of Tonga



Mele-san's Presentation



Leger Victorina Stephanie Nodis, Chief Housing Sector Resilience Office, Ministry of Infrastructure, Kingdom of Tonga



Victorina-san's Presentation

Dr. Esline Garabiti was awarded the 2022 WIN DRR Leadership Excellence Award

By Dr. Tatsuhiko Hara, Chief Research Scientist, IISEE

Dr. Esline Garabiti, who attended the 2006-2007 IISEE one-year course, was awarded the 2022 Women's International Network for Disaster Risk Reduction (WIN DRR) Leadership Excellence Award at the Asia-Pacific Ministerial Conference for Disaster Risk Reduction held in Brisbane, Australia last year.
Her contributions to establishment of the Oceania regional seismic network (ORSNET), improvements of tsunami detection system, and tsunami risk reductions were recognized as significant professional achievements and success in disaster risk reduction across the Asia-Pacific region. Congratulations.
Now she serves as the Director General of the Ministry of Climate Change Adaptation, Meteorology, Geo-Hazards, Environment, Energy and Disaster Management in Vanuatu.

The link to this news:
https://nab.vu/news/dr-esline-garabiti-winners-2022-womens-international-network-disaster-risk-reduction-leadership

Selected Abstracts of 2021-2022 Training Course

By IISEE

Our institution, International Institute of Seismology and Earthquake Engineering (IISEE), mainly conducts three following one-year training courses named (S) Seismology Course, (E) Earthquake Engineering Course and (T) Tsunami Disaster Mitigation Course.

This booklet is a collection of abstracts of individual study reports from the trainees of the 2021-2022 course.

Their further detailed synopsis can be found on the following website.
https://iisee.kenken.go.jp/syndb/
Also, the final presentation from 18 trainees will be released on IISEE E-learning website. (Coming soon)
https://iisee.kenken.go.jp/el/

We hope this booklet will help you.

Haruhiko Suwada, Hiroto Nakagawa, Mai Ito (E Course leader)
Tatsuhiko Hara (S Course leader)
Yushiro Fujii (T Course leader)

International Institute of Seismology and Earthquake Engineering,
Building Research Institute
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E-mail: iisee@kenken.go.jp

Enjoy, Now

4.Determination of Moment Tensor Solution in the Fiji Region Using the Waveform Inversion Technique

5.Strong Ground Motion Simulation of the 2020 Masbate, Philippines Earthquake (Mw6.6) Using Empirical Green's Function Method

6.Stress Field Orientation Obtained from Earthquake Focal Mechanism in Indonesia Region

Earthquake Engineering Course

7.Comparison of Retrofitting Methods on an Existing Residential RC Building in Algeria, Heavily Damaged by The 2003 Boumerdes Earthquake

8.Estimation of the Equivalent Damping Ratio for Low Energy Dissipation Systems Under Mainshock-Aftershock Sequences To Determine the Damage Level

9.Probabilistic Seismic Hazard Assessment of Timor-Leste

10.Seismic Evaluation of Reinforced Concrete Buildings in San Salvador, El Salvador; Considering the Latest Seismic Hazard Analysis

11.Microzonation Map of Seismic Site Condition and Amplification of Greater Accra Region, Ghana

12.Dynamic Behavior Of Traditional Composite Masonry Buildings In Bhutan

13.Structural Performance Evaluation of Cyclone Resilient Houses Damaged Due to Tsunami After the January 2022 Hunga Tonga-Hunga Ha'apai Volcanic Eruption

14.Fragility Evaluation of Building Structures Based on Damage Survey Results of Tsunami Disaster From Hunga Tonga – Hunga Ha'apai Volcano Eruption on 15 January 2022

Contact Us

The IISEE Newsletter is intended to act as a go-between for IISEE and ex-participants.

We encourage you to contribute a report and an article to this newsletter. Please let us know your current activities in your countries.

We also welcome your co-workers and friends to register our mailing list.

iiseenews@kenken.go.jp

https://iisee.kenken.go.jp/en/

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https://iisee.kenken.go.jp/en/newsletter/

15.Seismic Performance Evaluation of Typical Residential RC Buildings at Different Soil Types With Seismic Zones in Bangladesh

Tsunami Course

16.Rapid Magnitude Estimation Using Local Earthquake Waveform Data and the Application to Earthquakes in Indonesia Including the 2010 Mentawai Tsunami Earthquake

17.Solving the Puzzle of the 1996 Biak Indonesia, Tsunami

18.Slip Distribution of the 2006 West Java Earthquake by Inversion of Tide Gauge Data Using Phase-Corrected Green's Functions

IISEE International Institute of Seismology and Earthquake Engineering

Building Research Institute B R I

Selected Abstracts of 2021-2022 Training Course

IISEE Newsletter Special Edition
November 2022

Foreword

Our institution, International Institute of Seismology and Earthquake Engineering (IISEE), mainly conducts three following one-year training courses named (S) Seismology Course, (E) Earthquake Engineering Course and (T) Tsunami Disaster Mitigation Course.

This booklet is a collection of abstracts of individual study reports from the trainees of the 2021-2022 course. Regarding the trainees from S course and T course, only trainees who have volunteered wrote their abstracts. Therefore, please kindly note that not all the abstracts are posted in this booklet.

Their further detailed synopsis can be found on the following website.
https://iisee.kenken.go.jp/jp/information/syndb/

Also, the final presentation from nine trainees will be released on IISEE E-learning website. (Coming soon)
https://iisee.kenken.go.jp/jp/information/el/

We hope this booklet will help you.

Haruhiko Suwada, Hiroto Nakagawa, Mai Ito (E Course leader)
Tatsuhiko Hara (S Course leader)
Yushiro Fujii (T Course leader)

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Table of Contents

Seismology Course

Engineering Course

Tsunami Course

Citation: Ratri, A., H. Miyake, S. Kita (2022), Source modeling of the 2018 Lombok earthquake sequence estimated from the empirical Green's function method, Abstract of IISEE-GRIPS Master's Thesis.

Source Modeling of the 2018 Lombok Earthquake Sequence Estimated from the Empirical Green's Function Method

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Earthquake Research Institute, University of Tokyo, JAPAN
Saeko KITA (Supervisor)
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Conducting source modeling using empirical Green's function (EGF) can be used to capture the rupture and aftershock direction.

In 2018, a series of earthquakes in Lombok, Indonesia, occurred close together, causing a lot of casualties and property damage. In this study, we conducted source modeling for these earthquakes by simulating the target event with strong motion data of the smaller event in the surrounding area, which have the closest hypocenter and similarity of focal mechanism to the target event using empirical Green's function method. Then, we determined the source model parameters, including source dimension ratio (N) and stress drop ratio (C) to conduct broadband ground motion simulation. After that, we did a grid search calculation to get the best-fit value for the strong motion generation area (SMGA) parameters. We obtained the best-fit of SMGA size and rupture starting point from the grid search to conduct source modeling. The SMGA size (Figure 1) indicated that the western part (green line) of Lombok was lower stress drops than the eastern part (purple line) of Lombok. The relative SMGA location (Figure 2) indicated the rupture direction extends radially toward the bottom right-hand direction. Furthermore, there is a relationship among the foreshock, the mainshock, and the largest aftershock that may have triggered each other and have similar source characteristics with rupture directions.

Figure

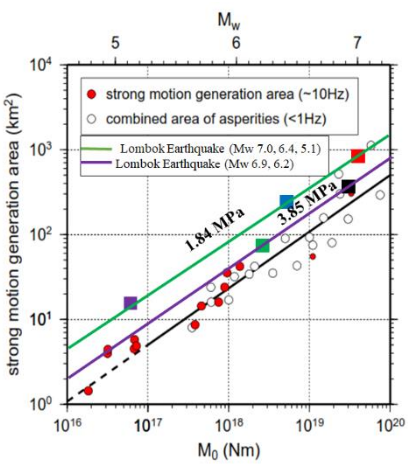

Fig. 1. Scaling relationship between strong motion generation area and seismic moment.

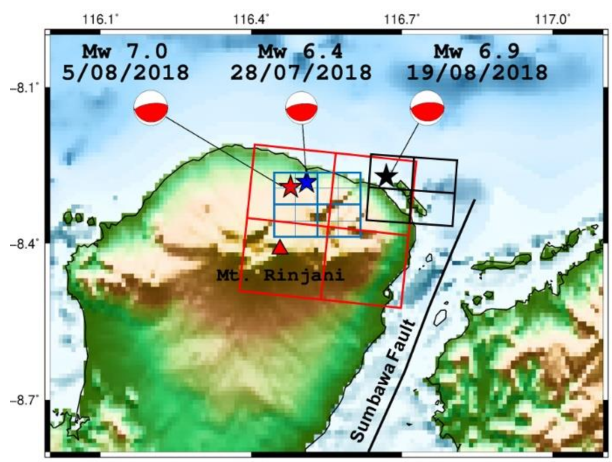

Fig. 2. Combination of three source models for the 2018 Lombok earthquake sequence. The star and rectangle respectively show the hypocenter and the SMGA for the foreshock (blue), the mainshock (red), and the largest aftershock (black).

Indonesia Agency for Meteorology, Climatology, and Geophysics (BMKG)

Indonesia Agency for Meteorology, Climatology, and Geophysics (BMKG) is an Indonesian non-departmental government institution that carries out government tasks in Meteorology, Climatology, Air Quality, and Geophysics following the provisions of the applicable laws and regulations. BMKG also plays an essential role at the International level by providing earthquake information and tsunami early warning to national, ASEAN, and countries around the Indian Ocean.

Citation: Wijaya, A., M. Yamada (2022), Development of an earthquake early warning system in the western part of Java using a strong motion network, Abstract of IISEE-GRIPS Master's Thesis.

Development of an Earthquake Early Warning System in the Western Part of Java Using a Strong Motion Network

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The IPFx method has the potential as an EEWS for Indonesia with high accuracy and faster in providing earthquake warnings.

The development of an earthquake early warning system (EEWS) has been done in this study by applying the extended integrated particle filter (IPFx) method using a strong ground motion network in the western part of Java, Indonesia. The method was applied to continuous waveforms including 95 earthquakes (M > 4 and seismic intensity ≥ II MMI) and to the one-day waveforms including the 2022 Banten earthquake sequences. We used 190 stations divided into 99 conventional force-balanced accelerometer sensors (FBA) and 91 Micro-Electro-Mechanical System (MEMS) sensors. Early warning criteria were given when the number of picks was more than five and the maximum seismic intensity was ≥ 3.5 (IV MMI) based on the seismic attenuation equation. This system has successfully detected 95 earthquakes and provided warnings to 46 from 49 events with observed seismic intensity ≥ 3.5 MMI. The IPFx method shows good accuracy to estimate earthquake source locations with median errors of 12 km, 22.7 km, 0.27, and 0.62 for the epicenter, depth, magnitude, and seismic intensity, respectively, relative to the Indonesia Agency for Meteorology, climatology, and Geophysics (BMKG) catalog as show in Fig. 1. The IPFx method was also more accurate and 12 seconds faster in source estimation of the Mainshock of the 2022 Banten Earthquake than The Earthworm Based Earthquake Alarm Reporting System (eBEAR) that BMKG has tested, as shown in Fig. 2. Based on the good accuracy and speed in estimating earthquake sources, the IPFx method has the potential to be developed into an earthquake early warning system in Indonesia in the future.

Figure

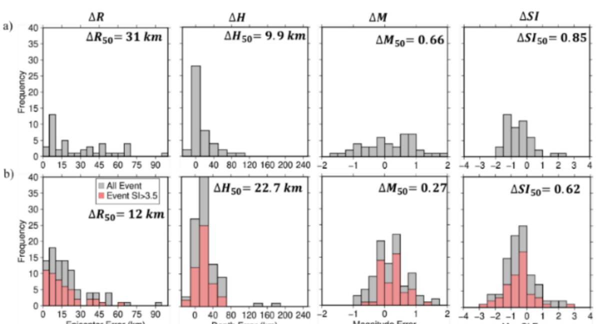

Fig. 1. Histograms of epicenter, depth, magnitude, and SI errors in first warning catalog for earthquake with SI ≥ 3.5 (a) and final catalog (b). Red histogram in (b) shows the parameters error for earthquake with SI ≥ 3.5. The top-right numbers in each histogram show the median error for IPFx method compared with BMKG catalog.

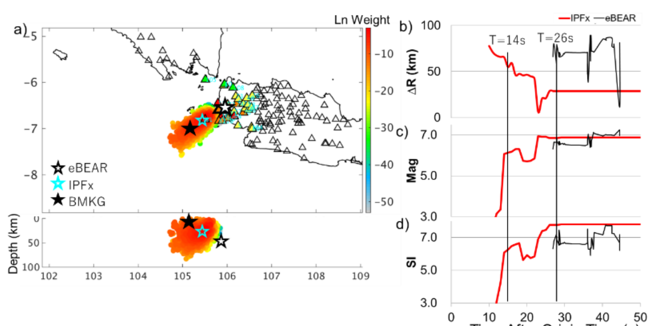

Fig. 2. Result of the Banten Mainshock on January 14, 2020, with magnitude 6.7 and SI 7.5 (VIII MMI). a) Estimated source location at converged time. The colored and white triangles, respectively, indicates the triggered and non-triggered stations in estimation group. (b)-(d) Time history of estimated earthquakes parameters after origin time. The vertical black lines indicate time of earthquake warning.

Indonesia Agency for Meteorology, Climatology, and Geophysics (BMKG)

The Indonesia Agency for Meteorology, Climatology, and Geophysics (BMKG) is a non-departmental government agency established in 1947 and carries out government duties in Meteorology, Climatology, Air Quality, and Geophysics. BMKG conveys information about natural phenomena, early warnings, and natural disasters such as earthquakes, climate change, weather, etc.

Citation: Pineda, K., T. Hayashida (2022), S-wave velocities estimation using seismic ambient noise analysis at San Miguel volcano, El Salvador, Abstract of IISEE-GRIPS Master's Thesis.

S-Wave Velocities Estimation Using Seismic Ambient Noise Analysis at San Miguel Volcano, El Salvador

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Transforming noise into signal to understand San Miguel volcano

San Miguel volcano is considered one of the most active volcanoes in El Salvador due to its multiple eruptions; however, its structural properties are not fully understood. Four broadband seismometers were deployed from February 2014 to April 2014. We analyzed ambient noise data (>0.2 Hz) using the spatial autocorrelation (SPAC) method and seismic interferometry technique. The spatial autocorrelation technique enabled us to calculate the phase velocity of the surface waves from 0.2 to 1.0 Hz. We also calculated Rayleigh-wave group velocities with seismic interferometry, which exploits Green's function from the cross-correlation of ambient noise recordings. The combined use of the two methods offered ways to gain information about the subsurface seismic velocity structure from the same dataset. Seismic interferometry retrieved the shallow soil structure, while the SPAC method yielded deeper structures. Our results made it possible to perform a joint inversion of phase and group velocities to obtain the S-wave velocity (Vs) structure of the volcano (Fig. 1),
We located 15 volcano-tectonic earthquakes using the velocity model. The earthquakes were located with a root minimum square lower than 0.5. The hypocenter locations show a focus distribution, beneath the volcanic building with a shallow depth (Fig 2). The locations of the earthquakes are consistent with a deformation zone, known as the San Miguel Zone Fault, on the volcano's northern flank**.**

Figure

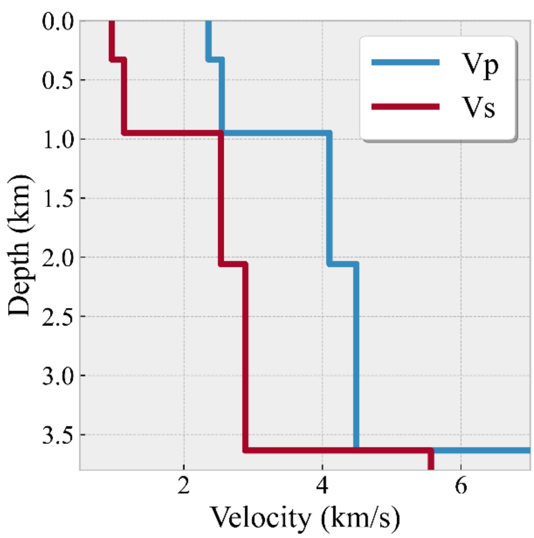


Fig. 1. P-wave and S-wave velocity model computed for the San Miguel volcano.

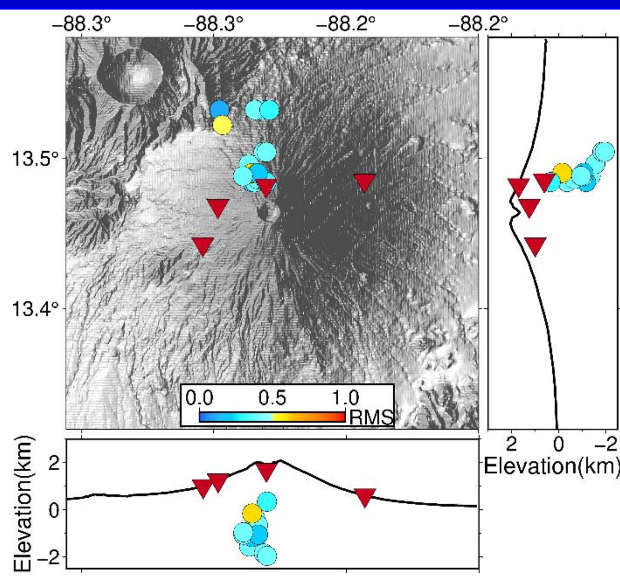
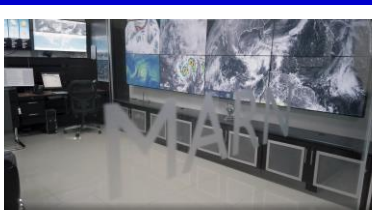


Fig. 2. Located seismicity around the San Miguel volcano. Inverted triangles represent seismic stations.

Ministry of Environment and Natural Resources (MARN)



The Ministry of Environment and Natural Resources (MARN) is an organization established in 1997 to protect natural resources, as well as the diversity and integrity of the environment to guarantee sustainable development.

Citation: Mule, S., D. Suetsugu, T. Hara (2022), Determination of moment tensor solution in the Fiji region using the Waveform inversion technique, Abstract of IISEE-GRIPS Master's Thesis.

Determination of Moment Tensor Solution in the Fiji Region Using the Waveform Inversion Technique

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Daisuke SUESTSUGU (Supervisor)
Japan Agency for Marine-Earth Science and Technology (JAMSTEC)
Tatsuhiko HARA (Supervisor)
International Institute for Seismology and Earthquake Engineering (IISEE)

Moment Tensor determination in the North Fiji basin

We conducted moment tensor determination for 27 events that occurred in the North Fiji Basin from 2015 – 2022 with a magnitude of Mw > 4.0 and depths less than 350 km. We used seismograms from seismograph stations in Fiji and the neighboring countries. We used a regional velocity model with a 10-km thick crust by Xu and Wiens (1997) to compute Green's functions. Among 27 solutions, 12 solutions shown in Fig. 1 were then validated in reference to the Global Centroid Moment Tensor (GCMT) solutions. We found that the solutions obtained by the present study are generally consistent with the GCMT solutions in terms of focal mechanism and moment magnitude. Stress axes of the focal mechanisms are consistent with the tectonic process reported by previous studies. Focal depths were shallower than the GCMT centroid depths by 1.4 km on average. We also evaluated the effect of the velocity model on focal mechanism solutions by comparing waveform fitting and similarity to GCMT. We performed the moment tensor inversion for events with Mw > 5.0 using the original regional model, its modified model with a 20-km thick crust, and a global standard model. For most of the events used for comparison, the waveform fitting is best for the original regional model with a 10-km thick crust than the other two velocity models (Fig. 2). We compared focal mechanisms determined from data including and excluding stations from the neighboring countries. The comparison shows that the mechanisms are closer to the GCMT by including data from neighboring countries, suggesting the importance of international data exchange.

Figure

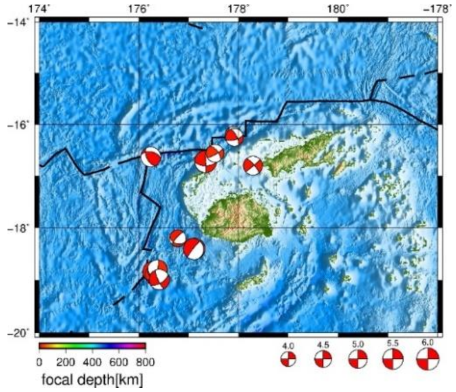

Fig. 1. Focal mechanism solutions obtained in this study which are consistent with the GCMT solutions.

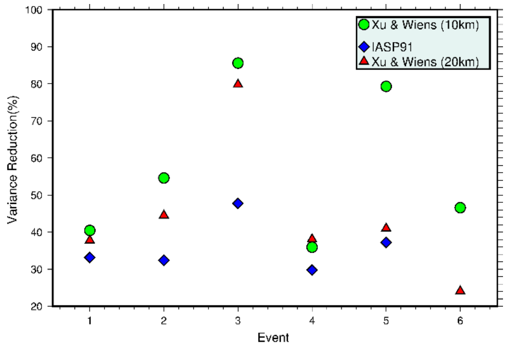

Fig. 2. Effects of the velocity model. Comparison of variance reductions for three velocity models of Xu and Wiens (1997) with a 10km-thick crust (green circle), Xu and Wiens (1997) with crustal thickness modified to 20 km (red triangle), and the iasp91 model (blue square) are shown.

Minerals Resources Department Fiji

Mineral Resources provides geoscientific information about Fiji, develops policies on mining and provides information and assistance to investors on mining sectors, facilitates exploration, and provides information on the non-living resources of the country. The Seismology unit's primary role is to provide information on geohazards assessment and timely dissemination of information at the time of any local or felt regional event.

Citation: Simborio, T., T. Yokoi, T. Hara (2022), Strong ground motion simulation of the 2020 Masbate, Philippines earthquake (Mw6.6) using Empirical Green's Function method, Abstract of IISEE-GRIPS Master's Thesis.

Strong Ground Motion Simulation of the 2020 Masbate, Philippines Earthquake (Mw6.6) Using Empirical Green's Function Method

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The Empirical Green's Function method is applicable to the current Philippine strong motion network.

Strong ground motions of the August 18, 2020 Mw 6.6 Masbate, Philippines earthquake were simulated using the August 11, 2020 Mw 4.9 Masbate, Philippines earthquake records of the Philippine Strong Motion Network through the Empirical Green's Function (EGF) method. The fault dimensions and stress drop ratios were calculated through the source spectral fitting method. A grid search was done to obtain a set of parameters for the EGF method that explains the observed strong motion data well. These parameters include the rupture starting point, rupture velocity, rise time, length, and width of the strong motion generation area (SMGA). The result suggests the rupture started in the shallow southern segment of the fault plane (Fig. 1). The peak ground accelerations (PGAs) from the simulated waveforms (Fig. 2) are consistent with the observed PGAs, and a directivity effect was also simulated (Fig. 3). The PGAs calculated using a ground motion prediction equation used for hazard estimations in the Philippines overestimates for three stations among the four stations analyzed in this study. The peak ground displacements (PGDs) from the simulated waveforms are underestimates compared to the observed PGDs. The ratio of the size of the SMGA to the moment magnitude and the ratio of the rise time to the moment magnitude are smaller than those obtained in previous studies.

Figure

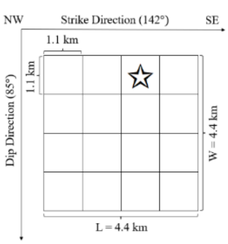

Fig. 1. Schematic illustration of the strong motion generation area of the August 18, 2020, Masbate, Philippines earthquake. The star represents the rupture starting point.

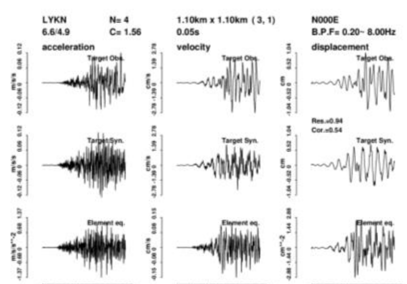

Fig. 2. Observed and synthetic waveforms of LYKN station (N-S) component.

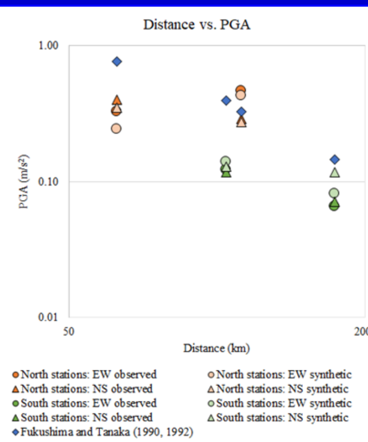

Fig. 3. Comparison of the observed PGAs and the calculated PGAs.

Department of Science and Technology-Philippine Institute of Volcanology and Seismology (DOST-PHIVOLCS)

The Department of Science and Technology-Philippine Institute of Volcanology and Seismology is the mandated institute to raise awareness and mitigate disasters from volcanic eruptions, earthquakes, tsunamis, and other geotectonic hazards in the Philippines.

Citation: Pratama, W., S. Kita (2022), Stress field orientation obtained from earthquake focal mechanisms in Indonesia region, Abstract of IISEE-GRIPS Master's Thesis.

Stress Field Orientation Obtained from Earthquake Focal Mechanism in Indonesia Region

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E-mail : wahyudi.nasrul@bmkg.go.id
Saeko KITA (Supervisor)
International Institute of Seismology and Earthquake Engineering, Building Research Institute, JAPAN

First report of the spatial mean of stress orientation and fault type in entire Indonesia region

Determination of the stress field is essential to understanding the stress source and earthquake mechanism. However, the stress field study has been rarely conducted in the Indonesia region. We constructed the stress map in Indonesia derived from the Global Centroid Moment Tensor (GCMT) and the National Research Institute for Earth Science and Disaster Prevention (NIED) focal mechanism data from 1990 until 2021. Overall, we used 3,756 earthquake focal mechanism data with a depth of ≤30 km. We applied two methodologies in this study; firstly, we created a mesh size of 75 km x 75 km of spatial mean of maximum horizontal compression stress (SHmax) and fault type. Then, we also performed the stress tensor inversion method to confirm the spatial mean of SHmax orientations. We got very declivous plunges of σ_1 in the northern North Maluku, southern North Maluku, and Batu-Mentawai-Pagai subduction segments. Meanwhile, the West and Central Java, the East Java, and the Sumba subduction segments have relatively steeper plunge angles than other regions. We found that the two methodologies we used yielded the same results in general. In our stress map, the orientations of SHmax are commonly perpendicular to the trench in the subduction zone and subparallel to the plate motion. This stress map also revealed the fault type distribution, which is generally consistent with the tectonic setting and focal mechanisms of large earthquakes. We confirmed that the normal faulting associated with SHmax parallel to the trench is intense near the trench of Java and Sumba subduction segments, indicating this area as the uncouple subduction zone.

Figure

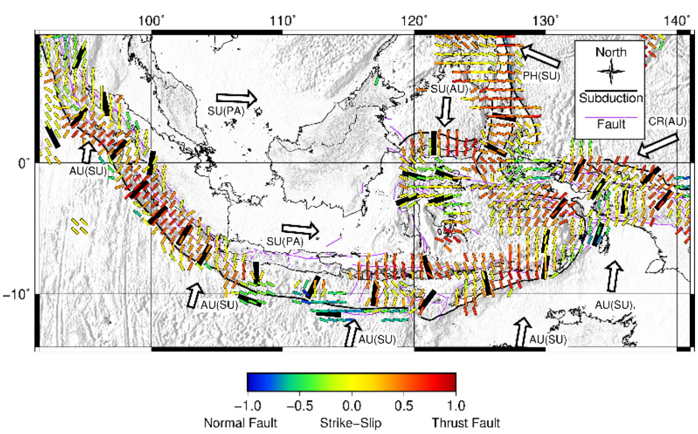

Fig. 1. SHmax orientation. Spatial SHmax (colored rectangle) and SHmax from inversion (black rectangle)

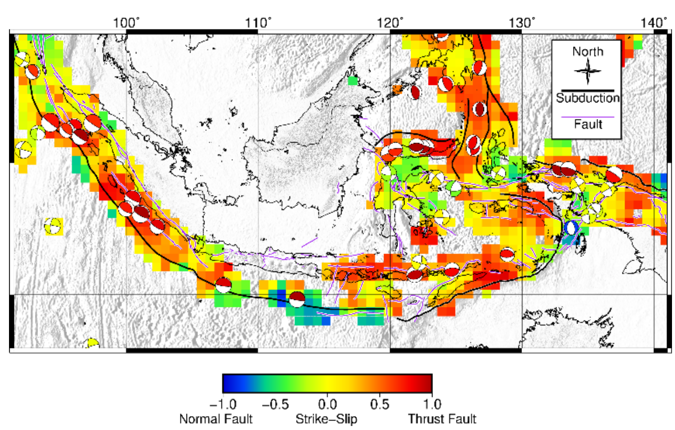

Fig. 2. Comparison between spatial mean fault type with earthquake focal mechanism M≥7

The Agency for Meteorology, Climatology, and Geophysics (BMKG)

The Agency for Meteorology, Climatology, and Geophysics (BMKG) is a governmental institution that has responsibility to observe and analyze in the fields of Meteorology, Climatology, Air Quality and Geophysics. In field of geophysics, BMKG provide information about earthquake, tsunami, engineering seismology, potential geophysics and time code.

Citation: AIT ALI SLIMANE, N., T. Saito (2022), Comparison of retrofitting methods on an existing residential RC building in Algeria, heavily damaged by the 2003 Boumerdes earthquake, Abstract of IISEE-GRIPS Master's Thesis..

Comparison of Retrofitting Methods on an Existing Residential RC Building in Algeria, Heavily Damaged by The 2003 Boumerdes Earthquake

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Comparison of retrofitting methods applicable in Algeria on a reinforced concrete residential building

The 2003 Boumerdes earthquake caused a large amount of damage, particularly in the city of Boumerdes. After the disaster, a revision of the Algerian code and the retrofitting of the 1,200 dwellings of Ibn Khaldoun city were made. The retrofitting method at that time was based on an experimental approach without following a specific code. In Japan, being especially advanced in seismic evaluation and rehabilitation of different structures, the JBDPA method was used during this study to evaluate and retrofit a building of Boumerdes and compare 4 models of retrofitting under 3 different earthquakes. The comparison was based on the seismic index “Is”, the story drift and shear at each floor, to find the most safely and economically effective result. During the study, the Japanese code and factor had to be adapted to Algerian seismic activity and ground proprieties. The use of STERA-3D and the THA method was also necessary for the calculations. The final result in Figure 1. showed the model (Both) from the after earthquake retrofit having higher safety, but the JBDPA method proposed retrofitting model with lower capacity, which satisfy the minimum safety conditions and by following Figure 2. were more economical than the retrofit proposed at that time. Therefore, it would be beneficial for Algeria to be inspired by the JBDPA method for the future changes in the Algerian seismic code and add to it an evaluation and rehabilitation procedure adaptable to the different seismic zones of Algeria.

Figure

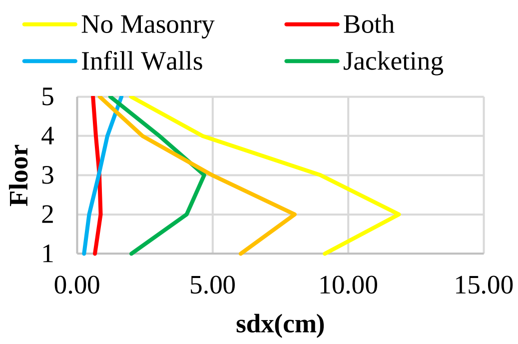

Fig. 1. Graphe of Story drift “sdx” of each floor for the 4 models (without retrofitting, with jacketing, with infill walls, with both), obtained by the THA on STERA-3D using the record of Boumerdes 2003 Eq.

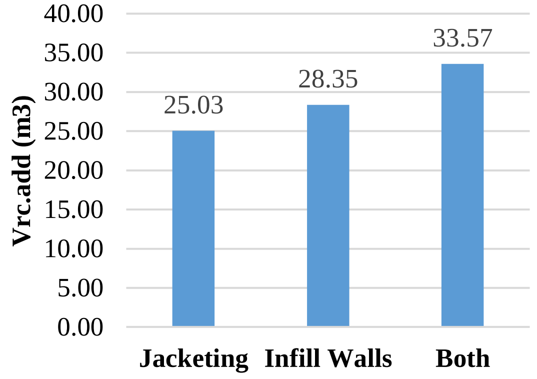

Fig. 2. Volume in m3 of additional reinforced concrete, added for each retrofitting method (Jacketing, infill walls, Both).

University of Science and Technology Houari Boumediene, Faculty of Civil Engineering

Created in 1974, the Faculty of Civil Engineering has as its main missions research and teaching. They offers theoretical lessons supported by experiments in practical work laboratories, field trips and internships which train each year nearly 1,282 undergraduate students and more than 1,052 second-cycle master students in the Building industry who will become the country's future engineers.

Citation: Cueva, J., K. Kusunoki (2022), Estimation of the equivalent damping ratio for low energy dissipation systems under mainshock-aftershock sequences to determine the damage level, Abstract of IISEE-GRIPS Master's Thesis.

Estimation of the Equivalent Damping Ratio for Low Energy Dissipation Systems Under Mainshock-Aftershock Sequences To Determine the Damage Level

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To estimate more accurately the equivalent damping ratio during aftershocks and to determine the damage level in RC buildings.

The assessment of Reinforced Concrete (RC) buildings, considering mainshock-aftershock (MA) sequences, has been addressed in previous studies in which the main objective is to predict the damage level after a maximum expected aftershock and then judge if the building can continue operating or not. This study uses numerical simulations to determine the equivalent damping ratio for structures with low energy dissipation and under mainshock-aftershock sequences and uses several Single Degree of Freedom (SDOF) systems with different hysteresis models (Degrading trilinear, Origin-oriented, Takeda, and Takeda-slip), changing some parameters of the Capacity Curve (Trilinear curve) and different initial periods (0.2 to 1.2s). Results indicate the variation of the damping ratio for each hysteresis model, and the higher and lower values correspond to the Degrading trilinear and Origin-oriented models, respectively. In addition, the parameter a_2, which is defined as the ratio of the yielding stiffness to the elastic stiffness of the capacity curve, presents a significant influence on the equivalent damping ratio. For that reason, this study presented a new expression to determine the damping ratio, which considered a new reduction factor values "γ" and a new coefficient to quantify the additional damping ratio due to the damage before yielding point *"b,"* both were determined for specific values of the parameter a_2. Due to the high values and the uncertainty of coefficient *"b,"* the new expression was reduced for practical purposes during the mainshock and aftershock. Additionally, the damage level (ductility) for the maximum expected aftershock, and using the new "γ" values, presented a lower error percentage than the previous studies, which considered γ equal to 0.06.

Figures

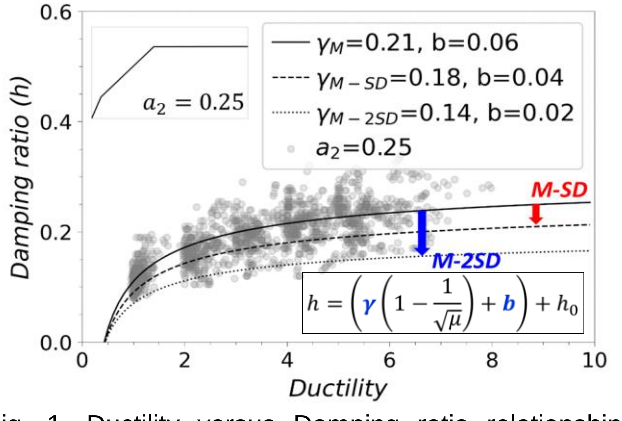

Fig. 1. Ductility versus Damping ratio relationship during Aftershock for $a_2 = 0.25$ (Takeda slip), and curve fitting for the median and median minus standard deviation (SD).

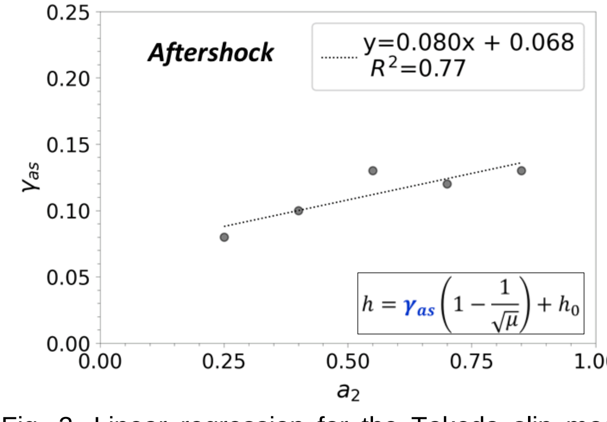

Fig. 2. Linear regression for the Takeda slip model and during the aftershock to determine the damping ratio for a specific to a_2 value.

Japan-Peru Center for Earthquake Engineering Research and Disaster Mitigation (CISMID)

Japan Peru Center for Earthquake Engineering Research and Disaster Mitigation (CISMID) was established in May 1986 by the Faculty of Civil Engineering of the National University of Engineering (FIC-UNI) and financed thanks to the cooperation of the Government of Japan through its International Cooperation Agency (JICA).

Citation: Da Costa Oliveira, V., T. Itoi (2022), Probabilistic seismic hazard assessment of Timor-Leste, Abstract of IISEE-GRIPS Master's Thesis.

Probabilistic Seismic Hazard Assessment of Timor-Leste

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Using the probabilistic seismic hazard approach to identify the seismic hazard level for seismic building code of 10% and 2% exceedance in 50 years.

This dissertation examines the purpose of defining the seismic hazard level in Timor-Leste for seismic building codes based on past earthquakes and tectonic settings. The historical earthquake occurrences from 1960 to 2021 were collected from the United States Geological Survey (USGS) and the Institute of Geology and Petroleum (IPG) with a magnitude between 2 and 8.1 Richter Scala. Earthquake source zoning was based on the occurrences of historical earthquakes surrounding Timor-Leste, and the frequency magnitude distribution by using the Gutenberg-Richter recurrence law was estimated. The kernel density function has been used to modulate the probability distribution of hypocenter distance from different source zones. The simulation procedure was to determine peak ground acceleration using the Ground Motion Prediction equation adapted from Si et al, 1999. The result gave the seismic hazard curves, and a seismic hazard map plotted for the return period of 475 (Fig. 1)and 2500 years (Fig. 2) (10% and 2% exceedance in 50 years, respectively). The highest total hazard observed in the Atauro site was a very high hazard level with a PGA value of 440 gal and 209 gal, which was included in class V and class III, corresponding to a 2% and 10% probability of exceedance in 50 years respectively. However, the smallest total hazard observed in the Viqueque site for 2% probability of exceedance for 50 years was a moderate hazard level with a PGA value of 171 gal, consisting of class II, and in RAEOA site was a low hazard level with a PGA value of 80 gal, which corresponding to class I, for a 10% probability of exceedance for 50 years.

Figure

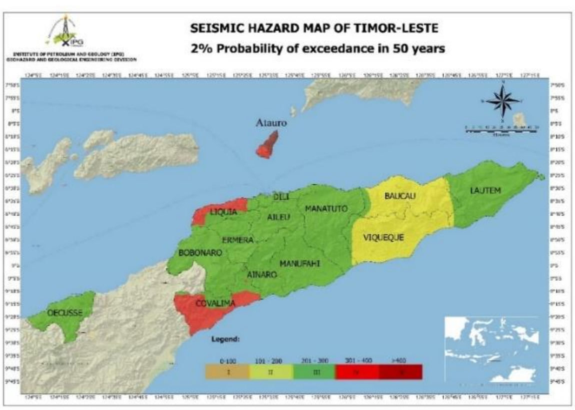

Fig. 1. Peak ground acceleration for 2% probability of exceedance in 50 years.

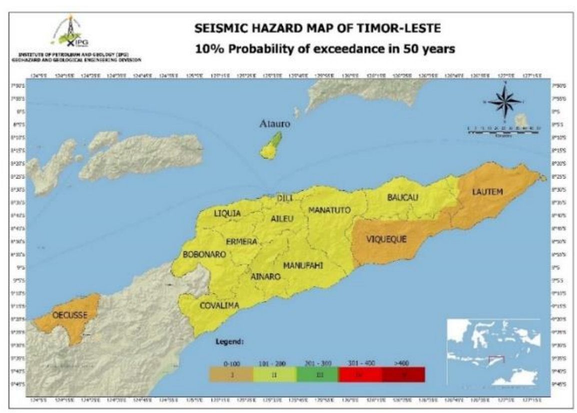

Fig. 2. Peak ground acceleration for 10% probability of exceedance in 50 years.

Institute of Petroleum and Geology-Public Institute (IPG-IP)

The Institute of Petroleum and Geology (IPG), established in 2012 based on Decree-Law nº 33/2012 of July 18, is a public institution of the Timor-Leste Government, under the supervision of the Ministry of Petroleum and Mineral (MPM) to develop geological studies of mineral resources, including Timor-Leste's oil and gas, and, Geo-hazard, using modern technical and scientific basis, enabling the development of the country.

Citation: Campos, E., T. Azuhata, Y. Otsuka (2022), Seismic evaluation of reinforced concrete buildings in San Salvador, El Salvador; considering the latest seismic hazard analysis, Abstract of IISEE-GRIPS Master's Thesis.

Seismic Evaluation of Reinforced Concrete Buildings in San Salvador, El Salvador; Considering the Latest Seismic Hazard Analysis

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The seismic performance of RC buildings in EL Salvador and Japan designated by current seismic codes were compared based on the probability of collapse. The results revealed problems with the seismic performance of RC buildings in El Salvador.

This investigation focused on the seismic evaluation of low-midrise reinforced concrete buildings in San Salvador, considering the inelastic demand defined by the current seismic design code (NTDS-94). Moreover, the latest Probabilistic Seismic Hazard Assessment (PSHA) for the country, which will be the base for the new seismic code, was used. The implemented methodology was the Probabilistic Based Earthquake Engineering (PBEE) framework, which involves a holistic overview of the performance integrating hazard, structural, and damage analysis. Four simplified framed structures treated as a single degree of freedom (SDOF) systems were studied, two are based on El Salvador seismic standard, and the others are based on Japanese seismic provisions. The above with the intention to compare the influence of the hazard definition and the required capacity specified in each building code on the building's performance. Two approaches were employed to give a solution to the PBEE basic formulation; numerical integration and approximate analytical solution. Based on the results of the Incremental dynamic Analysis using 40 Inland waves, we calculated the probabilities of limit state exceedance in 50 years in terms of inter-story drift ratios. The probabilities of exceeding the design limit drift imposed by El Salvador's seismic code of 0.015 rad are more than 5% for both Salvadoran SDOF systems (6-story and 10-story buildings) calculated using both approaches. We observed that El Salvador models have higher probabilities of exceeding safety limits than Japanese models. Hence, the influence of the seismic hazard curve and the seismic demand, which in the case of El Salvador depends on the response reduction factor R, was evident. The approximate solution derived more conservative results in the performance of the models.

Figure

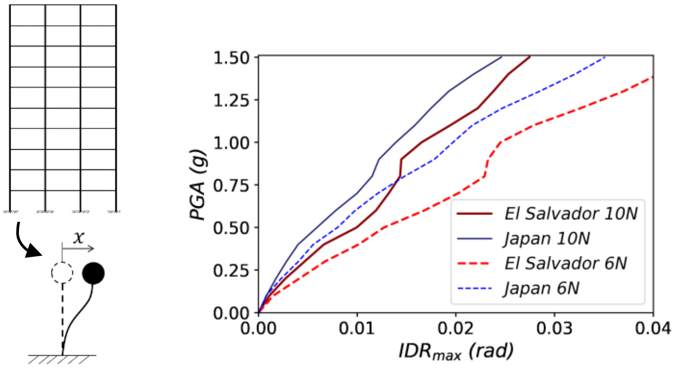

Fig. 1. Example of an SDOF model of the buildings in the left and Mean IDA curves or 50% percentile curves for the 4 model buildings to the right.

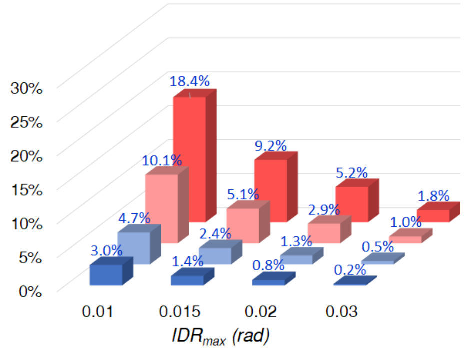

Fig. 2. Probability of exceedance limit states in 50 years calculated by Numerical Integration.

Engineers and Architects, specialized services INGENYARSE

INGENYARSE S.A. de C.V. is a consulting and structural design company in El Salvador that have carried out the design of many important public infrastructure, mostly of them bridges. Moreover, the company is actively involved in the development of human talent offering training courses in structural design topics to students and professionals trough the civil engineering national associations.

Citation: Fordjour, B., S. Nakai (2022), Microzonation map of seismic site condition and amplification of Greater Accra Region, Ghana, Abstract of IISEE-GRIPS Master's Thesis.

Microzonation Map of Seismic Site Condition and Amplification of Greater Accra Region, Ghana

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The Vs30 and site amplification map will serve as an improved first-order approximation and geotechnical base map for the capital region.

The capital city of Ghana, Accra, is located within the most seismically active region of the country. This study seeks to assess the seismic site condition and amplification based on the shear wave velocity for the regional capital by the topography as a proxy method. Point slope measurements are extracted and subjected to seismic site condition correlation of the NEHRP for stable regions. The correlative seismic site condition within a limiting slope boundary corresponding to a specific soil class is obtained using regression analysis. We first analyzed available single-point microtremor measurements to know the fundamental subsurface ground frequencies for the study area, after which some inversion parameters based on diffusion assumption were considered concerning the soil frequencies to understand the terrain within the study area. The inversion outcome could not support the actual representation of soil layers since it did not include dispersion curves to aid in generating profiles with relatable soil layers. The obtained Vs30 is then further subjected to the linear site amplification equation for stable regions by Stewart et al. (2017). Scaling ground condition for linear soil response over an average oscillator period of 0.4 to 2 seconds. An interpolation using the inverse distance weight method was applied to the calculated seismic site conditions and the site amplification data sets to generate a representative map at a square kilometer area raster. A comparison will then be made between the global seismic site condition map to understand the changes and possible similarities. The newly generated map could serve as an improved first-order approximation of Vs30 for the capital region.

Figure

Soil Class	Vs30 Range (m/s)	Slope range (m/m) (stable continent)	Slope (*M*)	Intercept (*C*)
E	<180	<2.0E-5	9000000	0
D	180–240	2.0E-5–2.0E-3	30303	179
	240–300	2.0E-3–4.0E-3	30000	180
	300–360	4.0E-3–7.2E-3	18750	225
C	360–490	7.2E-3–0.013	22414	199
	490–620	0.013–0.018	26000	152
	620–760	0.018–0.025	20000	260
B	>760	>0.025	30400	0

Fig. 1. Table Summary of slope ranges for subdivided National Earthquake Hazard Reduction Program (NEHRP) Vs30 categories

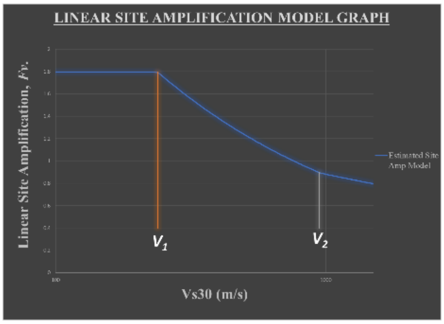

Fig. 2. Graph model designed to estimate the intended amplification for the study area with corner velocities V1 and V2 at 239 and 945 m/s, respectively, at an average slope of -0.505

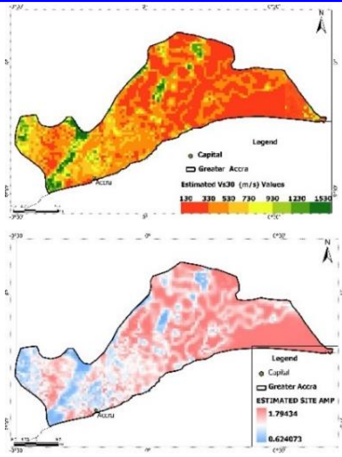

Fig. 3. Final Vs30 and Site Amplification Map showing clusters within geological units

Ghana Geological Survey Authority, (GGSA)

The Ghana Geological Survey Authority (GGSA) is an institution under the Ministry of Lands and Natural Resources of Ghana, established in 1962. The institution under the GGSA Act 2016 (Act 928) is mandated to advise, promote and research geoscientific issues concerning mineral resources, groundwater, environment, geo-hazards and land use planning to support sustainable economic development in Ghana.

Citation: Tenzin, K., M. Miyamoto, T. Aoki (2022), Dynamic behavior of traditional composite masonry buildings in Bhutan, Abstract of IISEE-GRIPS Master's Thesis.

Dynamic Behavior Of Traditional Composite Masonry Buildings In Bhutan

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The dynamic behavior of traditional composite masonry building in Bhutan are studied by shaking table test and numerical analysis

In this study the seismic performance of the composite masonry buildings in Bhutan is evaluated by shaking table test and numerical analysis. The shaking table test was executed on four 1/6 reduced scale models which comprises of two rammed earth models (unreinforced and retrofitted) and two stone masonry models (unreinforced and retrofitted). The numerical analysis was carried by transforming the model specimen into the lumped mass models of the two-degree freedom system. The linear and nonlinear time history analysis was executed using the input motion from the experimental test. The experimental results show that natural frequency of the specimens decreases with an increase in input ground motion, reflecting the degradation of stiffness due to occurrence of damages. Comparing the natural frequencies, the retrofitted models showed a higher value than unreinforced models. The proposed retrofitting measures improved the seismic performance of the structures by preventing the occurrence of cracks and limiting the damage propagation. The comparative analysis was made between the numerical analysis and experimental test results in terms of the maximum acceleration response at each floor level at each input ground motion. From the results we conclude the numerical simulation results are in close range to the experimental test. Further, the good correlation between the damage occurrence and results of time history analysis is observed in all the models.

Figure

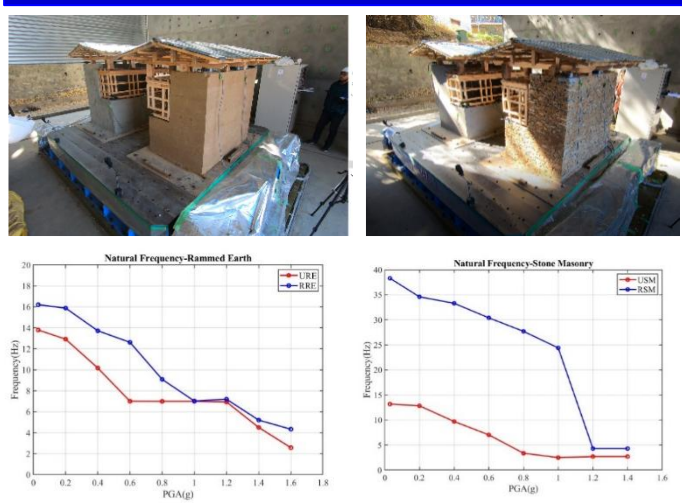

Fig. 1.Shaking table test on 1/6 models of unreinforced and retrofitted rammed earth and stone masonry. The natural frequency at each input motion is presented.

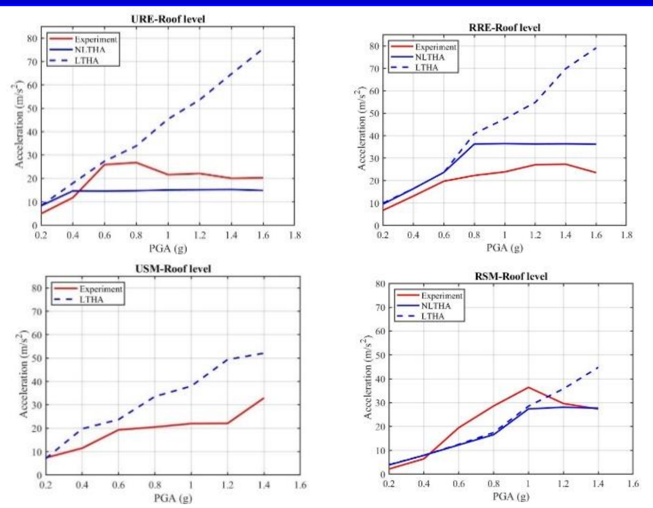

Fig. 2. Results from numerical analysis performed by forming lumped mass system. The experimental results is compared with the numerical in terms of acceleration response at roof level for each specimen

Department of Culture, Ministry of Home and Cultural Affairs, Bhutan

The Department of Culture is central agency for realization of harmonious and progressive society through preservation, protection, development and promotion of the shared ideals & values and unique cultural identity and its expression. The Department is responsible for carrying out conservation and preservation of heritage structures and traditional construction practices in the country.

Citation: Leger, V., T. Azuhata (2022), Structural performance evaluation of cyclone resilient houses damaged due to tsunami after the January 2022 Hunga Tonga – Hunga Ha'apai volcanic eruption, Abstract of IISEE-GRIPS Master's Thesis.

Structural Performance Evaluation of Cyclone Resilient Houses Damaged due to Tsunami after the January 2022 Hunga Tonga-Hunga Ha'apai Volcanic Eruption

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This method should be regularized as a first step towards identifying the building's risks for future disaster mitigation planning of housing in Tonga.

After the event of January 2022, it has been an eye opening for buildings located in the coastlines and specifically our Cyclone Resilient Houses (CRH) that were damaged. The CRH that had been popularized in the past 40 years for housing reconstruction programs are now questionable after the January 2022 event. The study of the lateral forces impact by wind, earthquake and tsunami against re-evaluating the strength of the CRH timber shear walls using the Australia Standard AS1684.2 – 2010 Capacity of Wall Bracings on timber framed structures. This is assessed against the demand lateral forces from tsunami in addition to wind and earthquakes based on the Australia standard AS1170.2 and AS1170.5 - 2002 and tsunami force using the Japanese guideline because Tonga have not adopted one. The result shows that the capacity of the shear walls is safe in the case of tropical cyclones and earthquakes because of the adequate nailed connections. However, tsunami load is too big to compare against the capacity of the CRH and therefore CRH can never withstand tsunami with inundation depth over 1m. Shear wall capacity of CRH depends mainly on the nail-joint properties although not specifically enforced in the construction of the CRH. The Cost review analysis of the CRH have been more expensive recently to approximately 8 times more and there should be other alternatives to consider other type of structures instead of timber. This draws attention into enforcing structural performance evaluation of existing buildings through updating the current Building Regulations to suggest future disaster mitigation planning of housing.

Figure

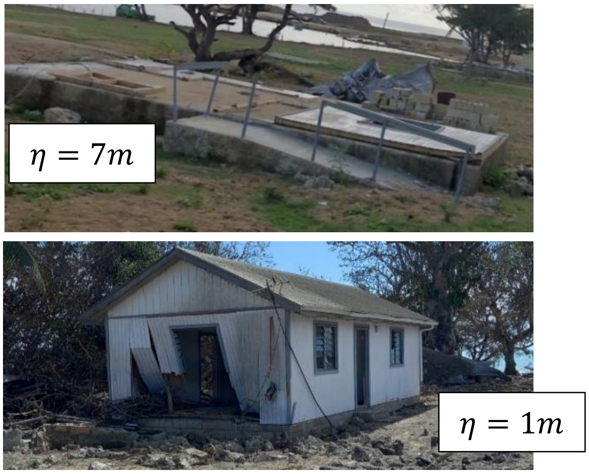
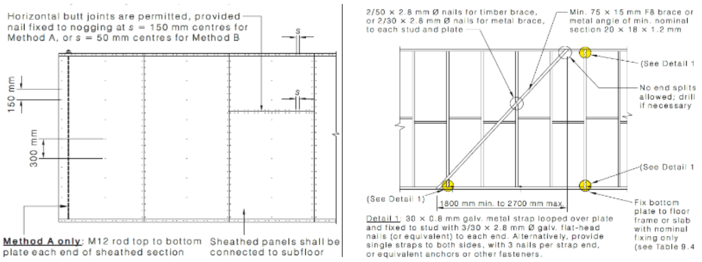


Fig. 1. Damages to the CRH at different inundation depths



CAPACITY			
Direction	**Timber Panel**	**Steel Strap**	**Total**
X (Longtidunal)	**114.48**	**16.05**	**130.53**
Y (Transverse)	**66.13**	**24.75**	**90.88**
DEMAND			
Direction	**Wind**	**Earthquake**	**Tsunami (h=1.0m) [*]**
X (Longitudinal)	**29.72**	**73.08**	**52.92**
Y (Transverse)	**61.52**	**73.08**	**105.84**

Fig. 2. Types of Wall Bracings Considered for capacity of shear walls (AS 1684.2) and the Table of the compared Capacity vs. Demand of CRH

The Ministry of Infrastructure Tonga

The Ministry of Infrastructure Tonga was established as a reform to combine both the Ministry of Works and the Ministry of Transport in 2015. We plan, build, regulate and facilitate construction and maintenance of public infrastructure relating to housing, transportation on land, sea and air to achieve better quality, safer, affordable and readily available roads, buildings and transport infrastructures and services that support sustainable well-being and resilience of the people of Tonga.

Citation: Manu, M.S., T. YOKOI, T. AZUHATA (2022), Fragility evaluation of building structures based on damage survey results of tsunami disaster from Hunga Tonga – Hunga Ha'apai volcano eruption on 15 January 2022, Abstract of IISEE-GRIPS Master's Thesis.

Fragility Evaluation of Building Structures Based on Damage Survey Results of Tsunami Disaster From Hunga Tonga – Hunga Ha'apai Volcano Eruption on 15 January 2022

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Tsunami fragility curves indicate that timber structures are the most vulnerable structural system to a tsunami in Tonga.

On 15 January 2022, Tonga was hit by a tsunami caused by the eruption of the HUNGA TONGA – HUNGA HA'APAI (HT-HH) volcano. This study aims to detect the vulnerable structural systems from this disaster, using fragility curves for future disaster mitigation planning. I gathered data on the inundation depth and structural damages through the government ministries' post-disaster field surveys and completed the required dataset on an independent field survey. This study focused on Hihifo and Nuku'alofa on Tongatapu island. The method used to determine fragility functions was the Grid Search method. Structural damages have two classifications: destroyed and survived. Fragility curves for structural damages were developed for all building types of Hihifo and Nuku'alofa, timber buildings of Hihifo and Nuku'alofa, and Reinforced Concrete (RC) buildings with masonry infill of Hihifo. The result showed that the Hihifo area has a stronger structural system than Nuku'alofa. The fragility curves of Hihifo and Nuku'alofa were compared with those developed in other countries. It showed that the timber buildings and RC structures with masonry infill of Hihifo are stronger than in other countries. However, American Samoa's RC structures are more resilient than Hihifo at higher inundation depths. Therefore, the timber buildings of Nuku'alofa need to be assessed in detail. The RC with masonry infill buildings of Hihifo must follow the building code so that all RC buildings will be equally resilient to a tsunami. Lastly, areas exposed to tsunami disasters should have RC structures instead of timber.

Figure

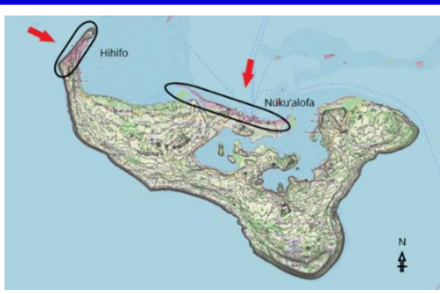

Fig. 1. A map showing the inundation area of Tongatapu island (light pink shade), the study areas (black oval), contour lines showing elevations (grey lines), and the direction of incoming tsunami waves (red arrows).

Fig. 2. Typical examples of destroyed timber buildings (top and middle) and destroyed RC with masonry infill structure (bottom).

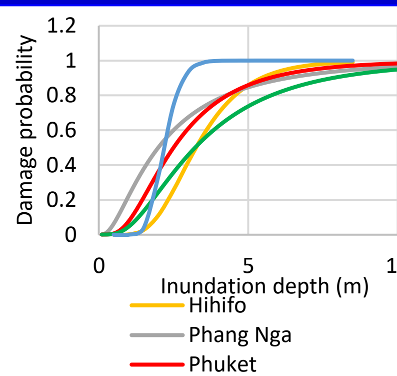

Fig. 3. Comparison of tsunami fragility curves for RC with masonry infill structures (orange) and timber buildings (blue) of Hihifo with those of RC buildings in Phang Nga (grey) and Phuket (red), Indonesia and American Samoa (green).

Natural Resources Division, Ministry of Lands and Natural Resources

The Natural Resources Division (NRD) operates under the Ministry of Lands and Natural Resources. One of the core duties of the NRD is monitoring, assessing, researching and advising the public on the status of geo-hazard activities and potential threats to the Tonga Islands. These geo-hazard activities include earthquakes, tsunamis and volcanic eruptions. We also provide broad sector awareness on the causes, behaviour, response, and evacuation plans to reduce risk per disaster event.

Citation: Paul, I K., S. Nakai (2022), Seismic performance evaluation of typical residential RC buildings at different soil types with seismic zones in Bangladesh, Abstract of IISEE-GRIPS Master's Thesis.

Seismic Performance Evaluation of Typical Residential RC Buildings at Different Soil Types With Seismic Zones in Bangladesh

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Using the average N-SPT(N_{30}) values, the effect of different soil site classes with seismic zones to evaluate the seismic performance level of the typical residential RC buildings in Bangladesh.

Soil site classes and seismic zones are the integral parts of building design. During the earthquake, the effect of local soil site conditions with zone coefficient plays an important role in building vulnerability. The Bangladesh National Building Code (BNBC-2020) recommends the guideline for design response spectrum to reduce the vulnerability during the seismic activity. This paper presents the maximum seismic performance level, for example, Operational (OP), Immediate Occupancy (IO), Damage Control (DC), Life Safety (LS), and Collapse Prevention (CP) of the two model buildings located in the different site classes (SB, SC and SD) of four seismic zones. The model buildings used in this analysis are typical residential RC buildings in Bangladesh. The site classification is usually conducted using average shear wave velocity $\overline{V}_S$ if available. Otherwise, the value of $\overline{N}$ may be used for site classification. In this study, average N-SPT(N_{30}) values of 160 boreholes locations were determined based on soil properties up to 30m of site profile as per BNBC-2020. The seismic performance level of the buildings was estimated by using the Capacity Spectrum Method (CSM), compared with the results of nonlinear pushover analysis, and explained in detail based on the equivalent single degree of freedom (ESDOF) system. Two maximum inter-story drift ratios of 0.5% (1/200) and 0.4% (1/250) are used to determine building performance levels and to compare with code limitation allowable story drift. It has been observed that the two model buildings having the limited drift angle of 1/200, are only operational in soil site classes SB and SC with a Peak Ground Acceleration (PGA) up to 0.12g. On the other hand, in both drift angles, these buildings in soil classes SB, SC, and SD with a higher PGA than 0.12g are not operational. Even at a PGA of 0.12g with soil classes SD and SC (only 1/250), the buildings are not operational. Therefore, the evaluation results of the building performance levels for the lower drift angle (1/250) are more resilient than the higher one (1/200).

Figure

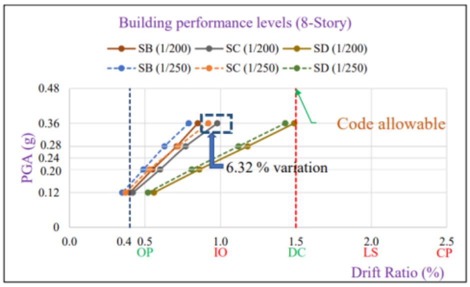

Fig. 1. Performance level of the 8-story building with two different drift angles (1/200) and (1/250).

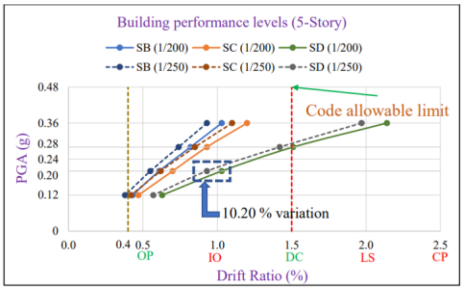

Fig. 2. Performance level of the 5-story building with two different drift angles (1/200) and (1/250).

HOUSING AND BUILDING RESEARCH INSTITUTE (HBRI)

Housing and Building Research Institute" (HBRI) is a national research institute in the field of the housing sector in Bangladesh. HBRI has conducted research to formulate and update the Bangladesh national building code for safe and sustainable building construction across the country. This institute has conducted sub-soil investigation work for the different infrastructure development projects of the Bangladesh Government. This institution has introduced a variety of environment-friendly construction materials. It is providing regular training on various topics related to housing and building construction.

Citation: Widiarso, A., A. Katsumata (2022), Rapid magnitude estimation using local earthquake waveform data and the application to earthquakes in Indonesia including the 2010 Mentawai tsunami earthquake, Abstract of IISEE-GRIPS Master's Thesis.

Rapid Magnitude Estimation Using Local Earthquake Waveform Data and the Application to Earthquakes in Indonesia Including the 2010 Mentawai Tsunami Earthquake

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The maximum amplitude of any earthquake's wave phase can be used for rapid magnitude determination for tsunami warning purposes.

We propose the M_{ID} magnitude formula for tsunami warnings. The M_{ID} was formulated using 135 earthquakes from 2012 to 2021 recorded by Broadband Seismographs. Selected broadband seismographs were used to formulate integrated displacement data that is proportional to the seismic moment of an earthquake. We performed instrument response correction (Katsumata et. al., 2021), numerical integration, and high-pass Bessel filter (Katsumata et. al., 2013) with a cut-off of more than 100 seconds on the earthquake waveform. The selection of the maximum amplitude value is carried out at any phase of the earthquake wave. The formulation uses the empirical formula as follows: $M = a\ \log_{10} A + b\ \log_{10} R + c$, where A is maximum amplitude, R is hypocentral distance, and a, b, c are constants.
We find the values of a, b, and c through the weighted least square method as 0.789; 1.167; and 5.359, respectively. This formula shows a low standard deviation value of 0.1269 when compared to M_W from Global CMT (Fig. 1). In the 2010 Mentawai tsunami earthquake, we observed the changes in M_{ID} and M_{SUM} over time. M_{SUM} is the weighted average magnitude installed in the Seiscomp3 system, and is currently used for tsunami warnings in Indonesia. As can be seen in Fig. 2, M_{ID} gives a better estimation than M_{SUM}, rising steadily and reaching the final value after 3 minutes, on the other hand, M_{SUM} fluctuates in the first 2 minutes. However, those 2 magnitudes show underestimated values as expected for tsunami earthquake type in the empirical magnitude formula.

Figure

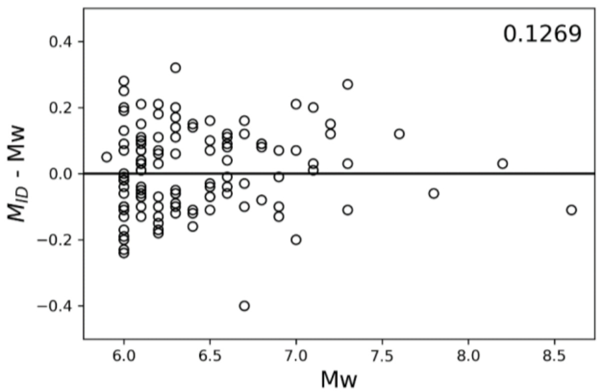

Fig. 1. *M_{ID} compared to M_W* from Global CMT catalog. The open circle represents the magnitude differences for each earthquake.

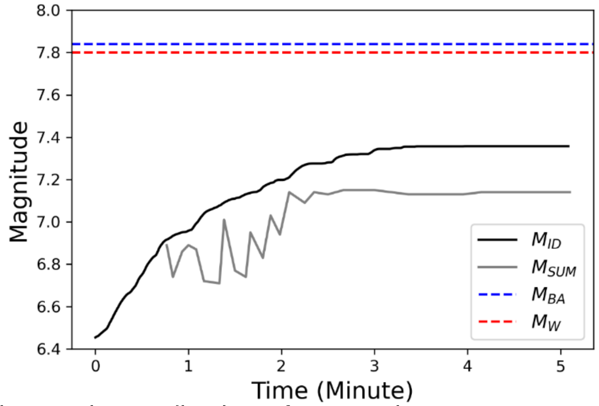

Fig. 2. The application of M_{ID} to the 2010 Mentawai tsunami earthquake over time. The blue dash line, red dash line, black line and grey line represents the M_{BA}, M_W, M_{ID}, and M_{SUM} , respectively.

Agency for Meteorology, Climatology, and Geophysics (BMKG)

BMKG is a non-departmental government agency that carries out government tasks in the fields of Meteorology, Climatology, Air Quality, and Geophysics to support public safety and the success of national development. Moreover, BMKG also plays an active role at the international level as the agency that provides earthquake information and tsunami warning for ASEAN and Indian Ocean countries with Indonesia Tsunami Warning System.

Citation: Pandadaran, S.H., H. Yanagisawa, B. Shibazaki, Y. Fujii (2022), Solving the puzzle of the 1996 Biak, Indonesia tsunami, Abstract of IISEE-GRIPS Master's Thesis.

Solving the Puzzle of the 1996 Biak Indonesia, Tsunami

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Solving the unsolved hypothesis regarding the contribution of the submarine landslide in the 1996 Biak, Indonesia tsunami case

On February 17, 1996, an earthquake occurred northeast of Biak Island, Indonesia, and caused a tsunami. Interestingly, the southwest side of Biak Island, which was not facing the epicenter, had a higher tsunami runup than the facing side. Previous researchers assumed that the earthquake triggered submarine landslides. As no one has addressed this phenomenon, this assumption remains an unsolved hypothesis.
The tsunami arrival time obtained from local people's eyewitness testimonies was used to perform backward tsunami raytracing. Considering the raytracing result and multibeam topography, we found two submarine landslide candidates: one large submarine landslide and a small submarine landslide were located in the southwest and south of Biak Island, respectively. Since the small submarine landslide only had a small effect on the land, we only performed a tsunami simulation for the large submarine landslide. The result showed that the submarine landslide located at 135.62ºE and -1.01ºS with a geometry of about 950 m x 5000 m and a thickness of about 50 m seems to explain the observed runup and arrival time.
Previous researchers made a slip distribution without considering the submarine landslide event. As a result, their model could not explain the observed runup in the southwest coastal area of Biak Island. To accommodate this problem, we propose a new model by combining the submarine landslide model with a modified fault model from the previous researchers. Our new model explains observed runup heights well; we obtained a geometric mean of 1.00 and a geometric standard deviation of 1.40.

Figure

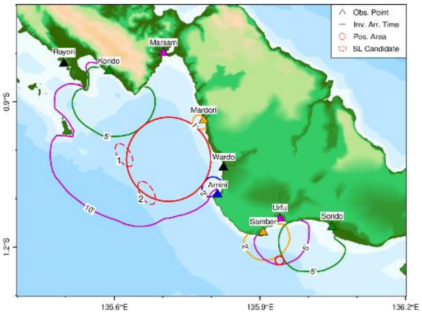

Fig. 1. Backward tsunami raytracing to estimate the possible submarine land-slide location.

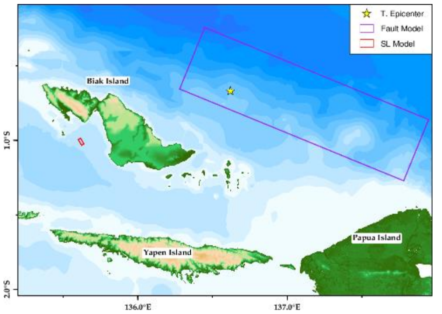

Fig. 2. Our suggested combi-nation model for the 1996 Biak, Indonesia tsunami.

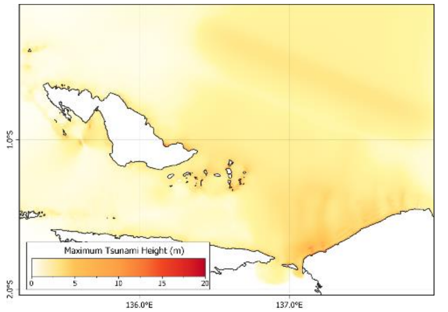

Fig. 3. Maximum tsunami height from our suggested combination model.

Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG)

In general, BMKG has duties in meteorological, climatological, air quality, and geophysical services. BMKG is responsible for being the frontline in delivering earthquake and tsunami information in Indonesia. Also, BMKG actively disseminates earthquake and tsunami information in Southeast Asia and surrounding countries around the Indian Ocean.

Citation: Putra Y. M. K., Y. Fujii (2022), Slip distribution of the 2006 West Java earthquake by inversion of tide gauge data using phase-corrected Green's functions, Abstract of IISEE-GRIPS Master's Thesis.

Slip Distribution of the 2006 West Java Earthquake by Inversion of Tide Gauge Data Using Phase-Corrected Green's Functions

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The slip models of the 2006 West Java earthquake are updated by tsunami waveform inversions of tide gauge data including far-field stations.

In this study, we re-estimated the slip distribution of the 2006 earthquake by tsunami waveform inversions of tide gauge data using phase-corrected Green's functions. Then, to evaluate our slip models, we performed tsunami inundation simulations and computed the K and κ numbers. The slip distribution obtained with an assumed rupture velocity of 1.25 km/s shows that the maximum slip was around 5.9 to 11.8 m in the shallower part near the trench, as shown in Figure 1a. The total source length was 300 km, while the seismic moment calculated from this source was 6.4 x 10^{20} Nm (Mw = 7.8). To make a comparison, we also show the slip model obtained without phase correction in Figure 1b. The dominant shallow slips in our slip models support the previous study that classified the 2006 earthquake as a tsunami earthquake event. We successfully updated the source model based on the previous study, as shown in Figure 2, although we found that the K and κ numbers of our slip models were unsatisfied with recommended standard values. We also found that the tsunami inundation simulation results were still underestimated around the Pangandaran, Cilacap, and Binangun. One possible reason for the underestimation at some survey points may be local (near coasts) bathymetry effects. Furthermore, we tried to assess the possible locations of the landslide source in front of the Permisan region. We found that a near-coast landslide source looks better to reproduce the extreme tsunami heights in the Permisan region. However, a landslide source far from the coastline was preferable to reproduce the tsunami heights for the western and eastern sides. Nevertheless, further studies are needed to determine more accurate landslide sources.

Figure

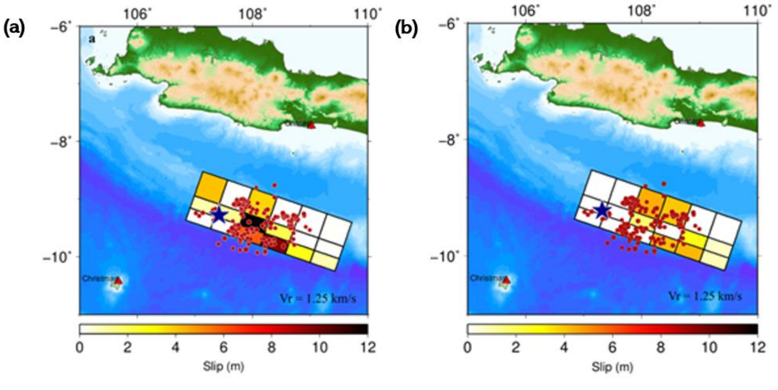

Fig. 1. Slip distributions estimated for the 2006 West Java earthquake by tsunami waveform inversions using Green's functions (a) with phase correction and (b) without phase correction in cases of rupture velocity 1.25 km/s.

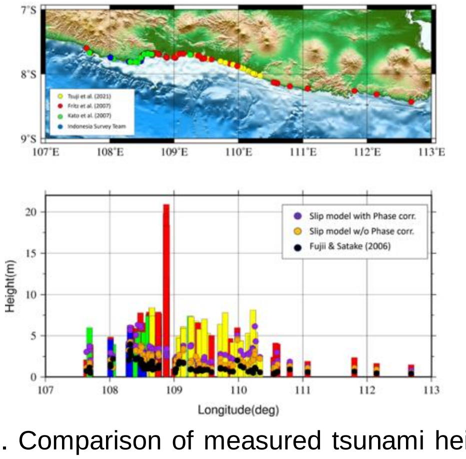

Fig. 2. Comparison of measured tsunami heights from the four data sources and tsunami inundation simulation results using the three different slip models.

Indonesia Agency for Meteorology, Climatology, and Geophysics (BMKG)

BMKG is an Indonesian non-departmental government agency that carries out government responsibility in the fields of Meteorology, Air Quality, and Geophysics. BMKG is a member of the World Meteorological Organization (WMO). BMKG also has responsibilities as the service provider for Tsunami Early Warning Center (InaTEWS), ASEAN Earthquake Information Center (AEIC), and Indian Ocean Tsunami Warning and Mitigation System (IOTWMS).