IISEE Newsletter

Dec 22, 2021
Number 200

International Institute of Seismology and Earthquake Engineering BRI Japan
1 Tachihara Tsukuba Japan 305-0802 tel+81-29-879-0678 facsim+81-29-864-6777

In This Issue

IISEE Net and Training

IISEENET

IISEE-UNESCO Lecture Note

IISEE E-learning

Synopsis Database

Bulletin Database

Lecture on Disaster Management Policies at GRIPS

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

Since 2005, the IISEE regular-course program has also been recognized as the master course program of the National Gratitude Institute for Policy Studies (GRIPS) based on the partnership between the BRI and the GRIPS. Therefore, the IISEE regular-course participants can earn their master's degree (Master of Disaster Management) from the GRIPS.

The GRIPS provides a two-week special lecture on disaster management policies for this master course program. Not only for the IISEE participants also other Japanese and international students from other programs participate in this lecture.

Same as the last year, the GRIPS remotely provided the lecture this year due to the COVID-19 issue. The IISEE participants who are in Japan attended the class from their room at the JICA Tsukuba International Center, and the other participants who are not in Japan attended it from their own countries from Friday, November 19 to Friday, December 3. The GRIPS requested all students present natural disasters in their country, countermeasures against them, and their tasks relating to them and discuss their presentation in the lecture session. They had a precious opportunity to learn disaster countermeasures in various countries and know each other well. Three outstanding presentations are selected based on student's mutual votes, and the "Best Presentation Award" is given to winners.

In Japan, we will have cold days for a while, but the daytime from the sunrise to the sunset is getting longer and longer. We hope they overcome cold winter by changing the mood by participating in a short meeting held by the IISEE, enjoying Japanese new year's custom, etc.

Earthquakes

The 2011 off the Pacific coast of Tohoku Earthquake

Reports of Recent Earthquakes

Utsu Catalog

Earthquake Catalog

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!!

JICA President Award Commendation

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

Each year JICA honors individuals and groups for their great contributions to human resource development and social/economic development in developing countries through international cooperation projects.

The 17th Awards Ceremony was held on Thursday, December 9, 2021, and the former participant of IISEE, Mr. Emilio Ventura (Emilio Martin Ventura Diaz, current Deputy Minister of Public Works and Transport of the Republic of El Salvador), has been awarded ***JICA President Award***.

Mr. Ventura completed IISEE's E (Earthquake Engineering) course in 2006-2007 (one year). The award was given in recognition of the following achievements.

- Conducted training on Japan's disaster prevention technology for domestic engineers, students, and engineers in Central American countries based on the knowledge of Japan he had gained from multiple trainings, which contributed greatly to expand the training results across borders.
- Formulated a manual on disaster risk management through "Climate Change and Risk Management Strategy Bureau's Project Phases 1 and 2 for strengthening public infrastructure." The contents are referred to and utilized at the time of infrastructure development as technical standards of six countries in Central America, and the use of a common manual throughout the region has been realized.

Mr. Ventura, congratulations on winning the award!

URL : https://www.jica.go.jp/press/2021/20211206_21.html

A paper by Senior Research Scientist Dr. Yushiro Fujii, published in the *Pure and Applied Geophysics* on 22 November 2021

By Dr. Yushiro Fujii, Senior Research Scientist, IISEE

Senior Research Scientist Dr. Yushiro Fujii published a paper on a re-estimation of the slip distribution for the 2004 Sumatra-Andaman earthquake (Mw 9.2) in the *Pure and Applied Geophysics*. By applying phase corrections to calculated tsunami waveforms, we can increase the reproducibility of observed tsunami data and explain the far-field tsunami waveforms. In this paper, we performed joint inversions of tsunami waveform data in and around the Indian Ocean including ocean bottom pressure gauges in Antarctica and sea surface height data from satellite altimetry measurements to estimate the slip distribution on the fault of the 2004 earthquake. Please inform Dr. Fujii (fujii@kenken.go.jp) if you are interested in this work.

Fujii, Y., Satake, K., Watada, S., Ho T.-C., Re-examination of Slip Distribution of the 2004 Sumatra–Andaman Earthquake (Mw 9.2) by the Inversion of Tsunami Data Using Green's Functions Corrected for Compressible Seawater Over the Elastic Earth. *Pure Appl. Geophys.* **178**, 4777–4796 (2021). https://doi.org/10.1007/s00024-021-02909-6

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

Back Numbers

http://iisee.kenken.go.jp/nldb/

IISEE International Institute of Seismology and Earthquake Engineering

Building Research Institute

Selected Abstracts of 2020-2021 Training Course

IISEE Newsletter Special Edition
November 2021

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 2020-2021 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/syndb/

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

We hope this booklet will help you.

Tatsuya Azuhata (E Course leader)
Tatsuhiko Hara (S Course leader)
Bunichiro Shibazaki (T Course leader)

International Institute of Seismology and Earthquake Engineering,
Building Research Institute
1 Tatehara, Tsukuba, Ibaraki 305-0802, JAPAN.
E-mail: iisee@kenken.go.jp

Table of Contents

Seismology Course

Engineering Course

Tsunami Course

Citation: Nepal, N., T. Hayashida (2021), Geophysical prospecting using microtremors to estimate 1-D shallow shear wave velocity profiles in Thimphu, Bhutan, Abstract of IISEE-GRIPS Master's Thesis.

Geophysical Prospecting Using Microtremors to Estimate 1-d Shallow Shear Wave Velocity Profiles in Thimphu, Bhutan

Nityam NEPAL
Earthquake and Geophysics Division, Department of Geology and Mines, Ministry of Economic Affairs, BHUTAN
E-mail : nnepal@moea.gov.bt
Takumi HAYASHIDA (Supervisor)
International Institute of Seismology and Earthquake Engineering, Building Research Institute, JAPAN

Microtremor array data indicate that site class of Thimphu is categorized as stiff soil or soft rock.

Microtremor array measurements were conducted at 25 sites in Thimphu to obtain 1-D shallow shear wave velocity (Vs) profiles of the subsurface using small arrays. The Vs profiles were obtained from the inversion of the derived phase velocities using Spatial Autocorrelation (SPAC) method. The averaged Vs values in the upper 30 m (Vs30) obtained at 16 sixteen sites are categorized under “class C (dense soil and soft rock)” of the NEHRP classification. The horizontal-to-vertical spectral ratios of the observed microtremors were also obtained and compared to the theoretical ones calculated from the inverted Vs profiles. Almost all sites showed a flat characteristic of the spectral ratios between 1 Hz and 15 Hz. The theoretical site amplifications computed showed most sites in Thimphu have predominant frequencies above 4 Hz.
We also performed microtremor array measurements at six sites in South Ibaraki, Japan, using the same method and same seismometers used in Thimphu to corroborate the applied methods and to understand the effects of geology/geomorphology on the results obtained. The results in Thimphu and South Ibaraki showed clear distinctions in the Vs profiles and predominant frequencies of the site amplifications. Thimphu City, located on mountainous terrain, showed higher values of Vs30 and predominant frequencies compared to most sites in South Ibaraki which is located on deep sedimentary basin.

Figure

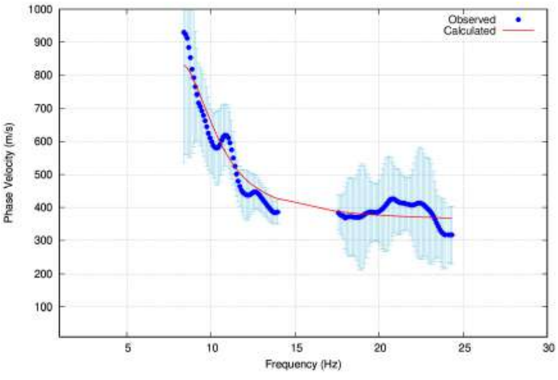


Fig. 1. Comparison between the observed phase velocities and theoretically obtained phase velocities by inversion.

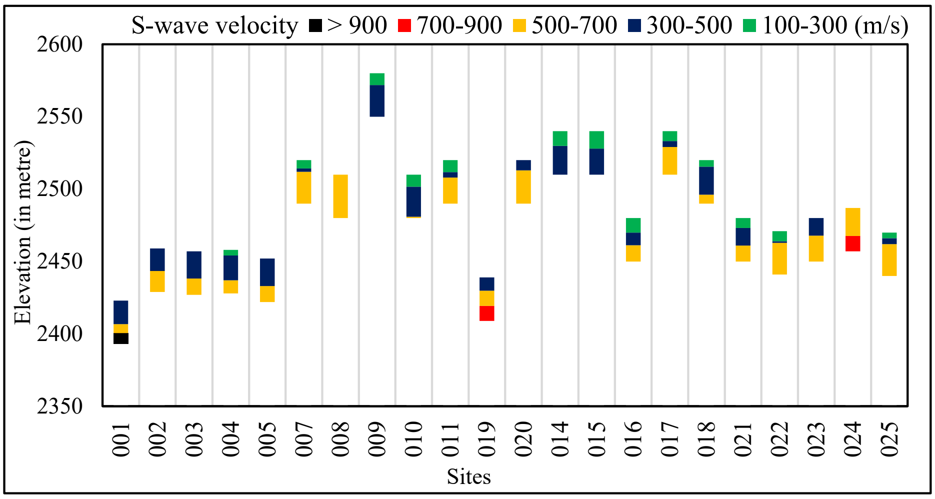


Fig. 2. Cross section of the shear wave velocity profiles representing the first 30m depths obtained for Thimphu. Sites 001-005 were in Dodeyna; sites 007-0011, 019, 020 were in Boegana; sites 014-018 in Chadagang; and sites 021-025 in Kabesa.

Department of Geology and Mines, Ministry of Economic Affairs

The Department of Geology and Mines (DGM) is a government agency responsible for carrying out geological and geophysical activities, and for leasing and regulating mines in the country. The department also carries out seismic related activities and is responsible for monitoring the only existing seismic network in the country.

Citation: Olivar, M., T. Yokoi, T. Hayashida (2021), Site effects estimation from strong ground motion and microtremor records around the city of Tsukuba, Abstract of IISEE-GRIPS Master's Thesis.

Site Effects Estimation from Strong Ground Motion and Microtremor Records Around the City of Tsukuba

Mónica Beatriz OLIVAR AMAYA
GENSAI Project Phase II, EL SALVADOR
E-mail : molivaramaya@gmail.com
Toshiaki YOKOI and Takumi HAYASHIDA (Supervisors)
International Institute of Seismology and Earthquake Engineering, Building Research Institute, JAPAN

Site effects can be determined with at least one broadband sensor when performing the joint inversion based on the seismic interferometry.

In this study we determine site effects in a well-controlled condition with borehole records, and we apply the latest methods for microtremor records, including the application of the seismic interferometry, one of the most eminent advances of the elasto-dynamic wave theory. We estimated the Horizontal to Horizontal Spectral Ratio (HHSR), which is a direct estimation of the site amplification, and the Horizontal-to-Vertical Spectral Ratio (HVSR) from 13 earthquakes recorded at a KiK-NET station. We also calculated the HVSR for microtremor records from measurements of a broadband seismometer and a strong motion accelerometer, and the Dispersion Curves (DC) of Rayleigh waves from array measurements performed with broadband seismometers, and short period sensors. With these products we performed the joint inversion analysis and obtained the S-wave velocity structure for three different groups of data: HVSR and DC with broadband sensors (Fig. 1); HVSR with broadband sensor and DC with short period array; and HVSR with strong motion accelerometer and DC with short period array. This way we highlighted the necessity of a broadband sensor to perform this type of analysis. Additionally we estimated the site amplification factor. The results showed that we can obtain a reliable inverted velocity structure with at least, one broadband sensor. The theoretical amplification factor based on the reference inverted velocity structure can give a good and reliable estimation of the amplification factor of the site, as shown in Fig. 2. The HVSR of earthquakes and microtremor records cannot be regarded as site amplification factor, however, they are useful to determine the resonant frequencies.

Figures

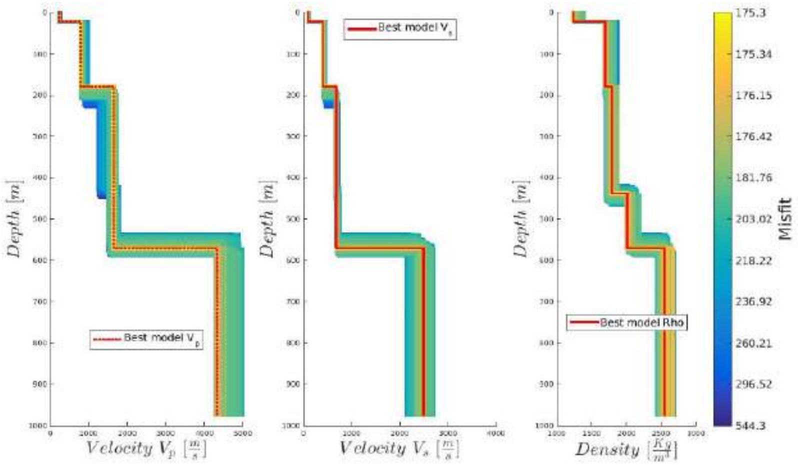


Fig. 1. Inverted reference structure for IBRH10. Red lines indicate the best model for Vp, Vs, and Density. The color scale indicates the misfit of the computed curves with the observed ones.

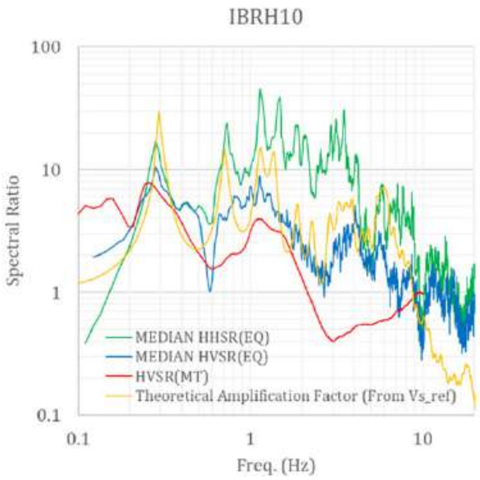


Fig. 2. Comparison of the Theoretical Site Amplification Factor (from the inverted Vs structure using broadband sensors), HHSR(EQ), HVSR(EQ), and HVSR(MT) at IBRH10.

University of El Salvador and GENSAI Project Phase II

The University of El Salvador was founded on 1841. It is an institution that aims to transform higher education through teaching and research opportunities. I am currently working in the “Project for Capacity Development of the Department of Climate Change Adaptation and Strategic Risk Management for Strengthening of Public Infrastructure, Phase II” (GENSAI Phase II), a JICA project focused on reducing the risk of disasters, caused mainly by hydrometeorological and seismic events.

Citation: Rosid, A., Y. Yagi (2021), Complex behavior in the source process of the 18 august 2020, Bengkulu, southwest of Sumatra doublet earthquake, Abstract of IISEE-GRIPS Master's Thesis.

Complex Behavior in the Source Process of the 18 August 2020, Bengkulu, Southwest of Sumatra Doublet Earthquake

Abdul ROSID
Agency for Meteorology, Climatology, and Geophysics (BMKG), REPUBLIC OF INDONESIA
E-mail : rosido.umichiro@gmail.com

Yuji YAGI (Supervisor)
Department of Life and Environmental Sciences, University of Tsukuba, JAPAN

Using the high degree of freedom finite fault inversion method, the complex interaction of the doublet earthquake that shows seismic triggering can be investigated along with its fault geometry.

This study investigated the source process of the 2020 Bengkulu doublet earthquake (Mw 6.9 and Mw 7.2 by this study) using the high degree of freedom finite fault inversion method recently developed by Shimizu et al. (2020). In the process, we applied some unique treatments by considering an identical fault plane and using the same data set for both earthquakes. Consequently, we have succeeded in reconstructing a reliable interaction of the foreshock and mainshock source processes by showing good waveform fitting between the synthetic waves and the observed waves.

We found that the rupture in the fault plane was divided into two distinct areas between foreshock and mainshock. The foreshock earthquake broke the asperity located in the southeast with a total maximum slip of 1.07 meters, while in the mainshock earthquake, the asperity broke with a total maximum slip of 1.17 meters (Fig. 1) in the northwest direction. Furthermore, the extension pattern of the 2020 Bengkulu doublet earthquake rupture shows as if the mainshock earthquake continued the unfinished foreshock earthquake rupture but with a more comprehensive area coverage. It seems that the final stage of the foreshock rupture triggered the mainshock hypocenter, which is closely located. Meanwhile, the suspending pattern of the foreshock's and mainshock's rupture extension to the deeper part appears to be related to the 2007 Bengkulu Great Earthquake (Mw 8.5), in which the rupture of the doublet earthquake (Fig. 2; blue square) was facing the asperity of the great earthquake (Fig. 2; red square) in the deeper part. Moreover, using the high degree of freedom finite fault inversion method, which allows us to extract the fault plane geometry information, we discover that the dip angle changes along the fault plane as the depth increases (Fig. 1).

Figure

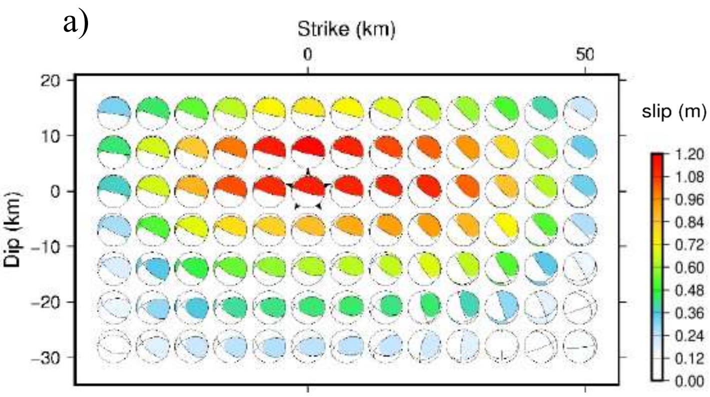


Fig. 1. Total slip distribution of the mainshock (Mw 7.2).

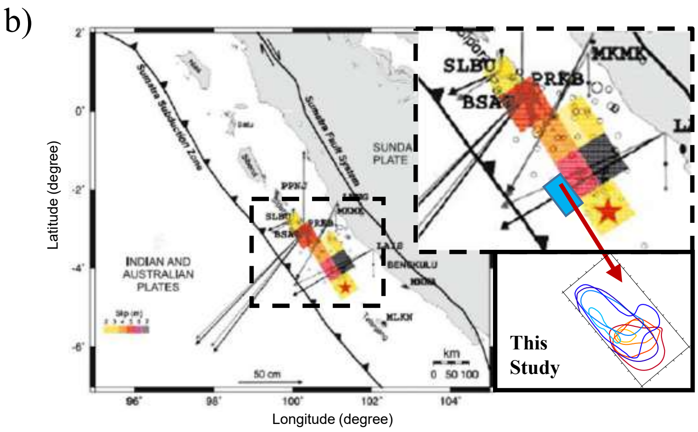


Fig. 2. Slip distribution model of the 2007 Bengkulu earthquake (modified from Ambikapathy et al., 2010).

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. The Indonesia Tsunami Early Warning System at BMKG provides earthquake information and tsunami early warning on a national scale, ASEAN, and to countries around the Indian Ocean.

Citation: Penisoni, M., D. Suetsugu, T. Hara (2021), Determination of focal mechanism of the Tonga-Fiji earthquakes with a sparse regional seismic network, Abstract of IISEE-GRIPS Master's Thesis.

Determination of Focal Mechanism of the Tonga-Fiji Earthquakes with a Sparse Regional Seismic Network

Mafoa Latu Penisoni
Assistant Geologist, Natural Resources Division, Ministry of Land and Natural Resources, Tonga.
E-mail : penisonim@gmail.com
Daisuke SUETSUGU (Supervisor)
Japan Agency for Marine-Earth Science and Technology, Japan
Tatsuhiko HARA (Supervisor)
International Institute of Seismology and Earthquake Engineering, Building Research Institute, Japan

Determination of focal mechanism is feasible with a sparse regional seismic network in Tonga and Fiji

We determined focal mechanism, focal depth and moment magnitude of shallow earthquakes in the Tonga-Fiji region using waveform data from the temporary seismic network Southwest Pacific Seismic Experiment (SPASE) from 1994 to 1995. We focused the shallow earthquakes, since they are more important than deep earthquakes in the viewpoint of disaster mitigation such as tsunami warning. We classified the quality of our solutions mainly on the basis of similarity to those determined by a global seismic network (GCMT) as 'good', 'moderate' and 'poor'. We could obtain 'good' solutions for all of earthquakes with Mw > 6. A proportion of 'good' solutions is a little greater than half for earthquakes with Mw < 5.9. Geographical dependency of the quality shows that the quality of our solutions is much better in the region covered by the SPASE network, while worse in the northern end or south of Tonga. Comparing to Mw by GCMT and depths from the United States Geological Survey (USGS), Mw of this study is underestimated by about 0.1. Differences of Focal depths of this study and the USGS depth are within 15 km. The result based on data from the SPASE network suggests that it is feasible for quick and reliable determination of earthquake parameters for shallow Tongan earthquakes of Mw > 6 off Ha'apai, Vava'u, and Tongatapu, using data only from a regional sparse network. To improve a reliability in the earthquake parameters in the northern Tonga arc, where seismicity is very high, a few stations should be deployed there.

Figure

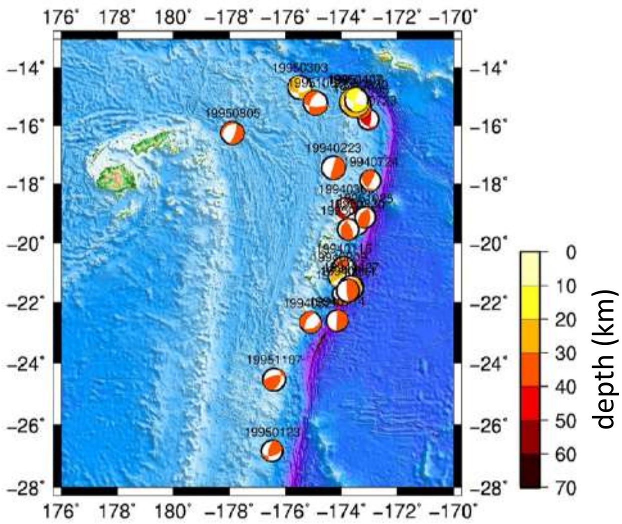


Figure 1. Distribution of focal mechanisms determined by the present study (all the good and moderate solutions).

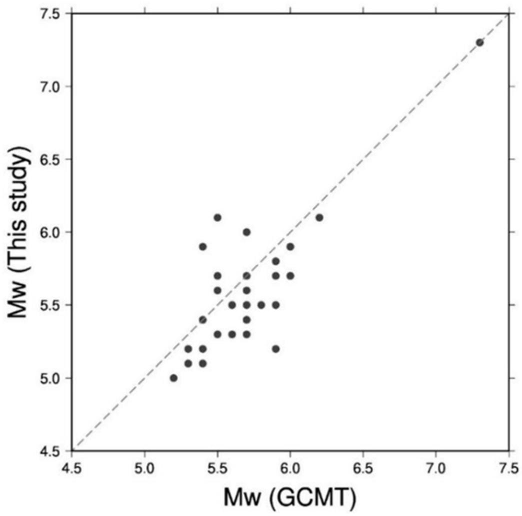


Figure 2. Comparison of Mw determined by this study and GCMT.

Natural Resources Division, Ministry of Land and Natural Resources, Tonga

The Government of Tonga's Ministry of Lands and Natural Resources is a key Ministry that is responsible for delivering one of the principal pillars of the Tonga Strategic Development Framework like effective response and community resilience to natural disasters. The Ministry Natural Resources Division provides relevant appropriate and critical services and products to stakeholders and communities.

Citation: Bidhan C. Dey, M. Seki (2021), Seismic evaluation considering infill wall and retrofit of a five storied RC building in Bangladesh, Abstract of IISEE-GRIPS Master's Thesis.

Seismic Evaluation Considering Infill Wall and Retrofit of a Five Storied RC Building in Bangladesh

Bidhan Chandra DEY
Executive Engineer, Public Works Department, BANGLADESH
E-mail : bcd4job@gmail.com
Matsutaro SEKI (Supervisor)
Visiting Research Fellow, International Institute of Seismology and Earthquake Engineering, Building Research Institute, JAPAN

Consideration of infill wall can improve the performance of the story against lateral loading by improving the deformation behavior.

The recent revision of the Bangladesh national building code (BNBC) necessitates the buildings designed in the old code be assessed for their adequacy to satisfy seismic provisions of the revised BNBC. The existing evaluation manual in Bangladesh is based on the Japanese second-level evaluation method that considers the strong-beam weak-column failure. However, the buildings designed according to the previous code consider the strong-column weak-beam failure. Therefore, the proposed detailed seismic evaluation (DSE) method capable of capturing this effect and providing a simple index resembling the existing manual was tested in a low-rise building. Moreover, in design, ignoring the brick infill can alter the strength and deformation behavior of the columns and the story's capacities accordingly by inducing short column effect, story-wise significant lateral stiffness variation causing a soft-story issue, etc. The objective of this research is to assess the variation of story-wise performance considering the infill wall. Additionally, the low-cost strength-based ferrocement (FC) retrofit was tested as a performance improvement technique. The draft copy of the SATREPS manual was used as a basis for calculating wall capacity for both untreated and FC treated. This research found that the DSE method provides more realistic seismic performance capturing reasonable failure mechanisms initiated by plastic hinges in beams compared to the JBDPA second level evaluation. The contribution of suitably configured solid walls can improve both strength and deformation behavior and thus increase safety, leading to more economic evaluation. Additionally, the Out-of-plane capacity for walls was found to be larger than the in-plane capacity. FC retrofit method proved to be a convenient way to improve performance without intervening in the columns or RC walls.

Figure

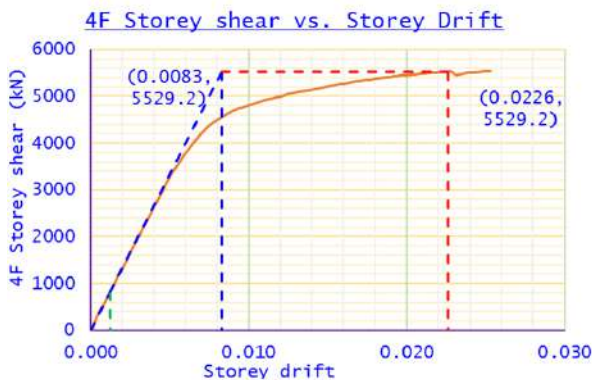


Fig. 1. Calculation of strength and ductility index of a story and thus the seismic index (I_S) by performing the pushover analysis based on the DSE method.

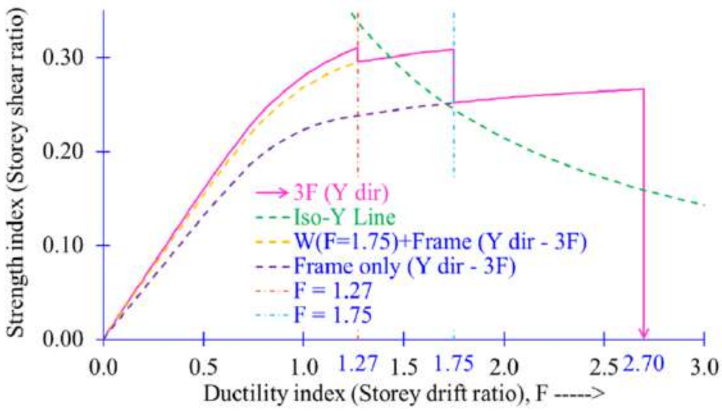


Fig. 2. Performance improvement by improving the deformation behavior after considering the infill wall (Third floor in Y direction is shown as an example).

Public Works Department (PWD), Bangladesh

Public Works Department (PWD), under the Ministry of Housing and Public Works, is the pioneer government organization for designing, construction & regulating buildings in Bangladesh. Over about two centuries, PWD could successfully keep up the country's infrastructure development trend and standard. PWD is also involved in projects related to earthquake disaster management, especially in retrofit buildings and other structures, evaluation and retrofitting manual publication etc.

Citation: Warah, M., T. Azuhata (2021), Seismic performance evaluation of a RC building with masonry infill designed by previous seismic code in Bangladesh, Abstract of IISEE-GRIPS Master's Thesis.

Seismic Performance Evaluation of a RC Building with Masonry Infill Designed by Previous Seismic Code in Bangladesh

Md. Ibnul WARAH
Research Engineer, Housing and Building Research Institute, BANGLADESH
E-mail : ibnulwarah@gmail.com
Tatsuya AZUHATA (Supervisor)
International Institute of Seismology and Earthquake Engineering, Building Research Institute, JAPAN

Determination of the effect of masonry infill and seismic performance evaluation of a RC building for the revised seismic code.

Bangladesh is in a moderately seismic-active region. Due to the unplanned construction, many buildings have been built without proper seismic consideration. Also, the seismic zone factors in the seismic code were revised in 2020. This revision raised the seismic design force to 1.5 times the previous in some areas. In this situation, it is necessary to check the seismic safety of the existing buildings. This study aims to evaluate the seismic performance of RC frame buildings considering the effect of infill brick masonry designed by the previous code. In Bangladesh, the load-bearing capacity of masonry walls is not considered during structural design. However, for dealing with more severe seismic conditions assumed in the current code, we attempt to include the effects of infills in the seismic performance evaluation. To investigate these effects, we execute earthquake response analyses to three models. One has high-quality masonry infills, and the other has low-quality infills. The third model is the bare frame model. To get seismic responses, we apply the capacity spectrum method and response history analyses. By comparing the earthquake responses for three models, we concluded that high-quality masonry infills could improve the seismic performance of the RC buildings sufficiently so that the existing building may resist even against the seismic forces assumed in the current code. Instead of being a brittle element, the infill masonry wall changes the seismic behavior and influences the seismic capacity, story drift, and displacement. Therefore, consideration of masonry walls is advisable for both the new design of buildings and the assessment of existing structures.

Figure

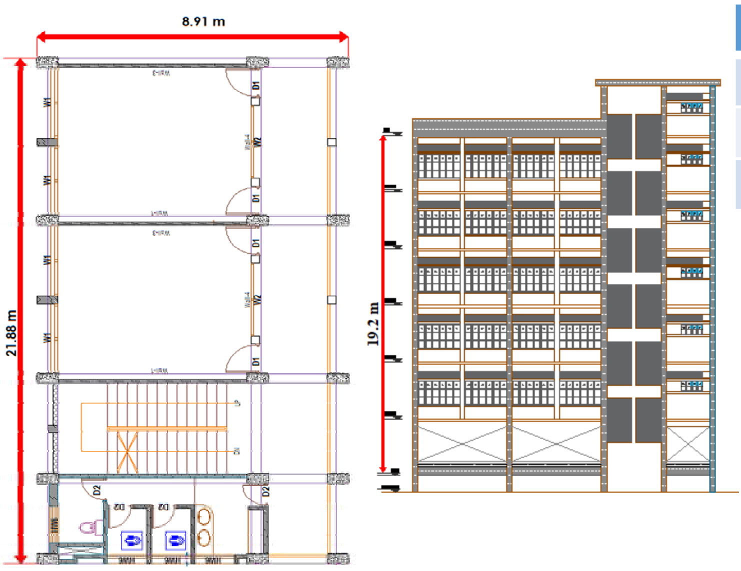


Fig. 1. Typical floor plan and elevation of the school building investigated in this study

Type of frame	Strength of bricks	Strength of mortar
High quality infill	14 MPa	10 MPa
Low quality infill	4 MPa	2 MPa
Bare frame	-	-

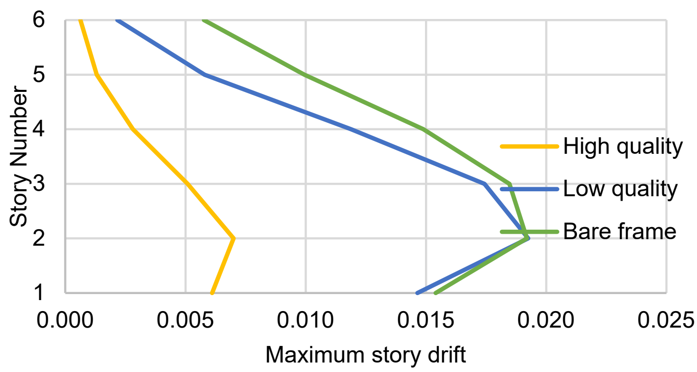


Fig. 2. Seismic responses for artificial ground motion with Kobe phase following the updated seismic code

Housing and Building Research Institute (HBRI)

HBRI has conducted researches to formulate and update the Bangladesh national building code for safe and sustainable building construction across the country. This institution has introduced a variety of environment friendly construction materials. It is working on the development of compressed sand-cement block which is alternative to burnt-clay brick. It is providing regular training on various topics related to housing and building construction.

Citation: Bhattarai, Y., T. Aoki, M. Miyamoto (2021), The simplified seismic performance evaluation of the stone masonry houses and seismic band's effects to prevent the seismic failure, Abstract of IISEE-GRIPS Master's Thesis.

The Simplified Seismic Performance Evaluation of the Stone Masonry Houses and Seismic Band's Effects to Prevent the Seismic Failure

Yadav Lal Bhattarai
International Institute of Seismology and Earthquake Engineering, Building Research Institute, JAPAN
E-mail: yadavsharma270@gmail.com
Takayoshi AOKI and Mitsuhiro MIYAMOTO (Supervisors)
Nagoya City University and Kagawa University, Japan

The analysis results presented the possibility of seismic bands to control the in-plane and out-of-plane failure of stone masonry houses

The frequent and subsequent earthquakes in Bhutan and around the Himalayan thrust significantly damaged masonry structures in Bhutan, particularly in rural regions. Potential harms are likely to hit the nation if a similar or higher earthquake occurs within or peripheral. The masonry houses scattered across the country towards the rural region are vulnerable. The damage is likely to happen almost all across the districts when there is an earthquake. The past 2009 and 2011 earthquakes also showed similar patterns of damage all over the country. They mostly failed in shear and out-of-plane (Fig. 1) in different severity. This study applies the simplified method for seismic diagnosis of a masonry structure and investigates the effect of seismic bands by carrying out numerical analyses. We aim to mitigate earthquake disasters in Bhutan's rural regions and save the community there, and the methods also meet the financial requirements.

The behavior of the stone masonry houses was compared with and without seismic bands. The traditional stone masonry house is vulnerable to the strong ground motion of the seismic action, particularly in the out-of-plane direction (Fig.1). The seismic performance may improve by incorporating the seismic bands in the stone masonry house(Fig.2). The simplified seismic diagnosis results of the normal one story stone masonry model house may overturn (Fig.3). The FEM analysis results for the stone masonry house with and without seismic bands; The seismic bands and posts increase the ductility and prevent sudden failure (Fig. 4).

Figures

Figure 1. Damage pattern of stone masonry houses due to earthquake in Bhutan. The failure shows in-plane, out-of-plane and missing the key components like cornerstones and bonding stones.

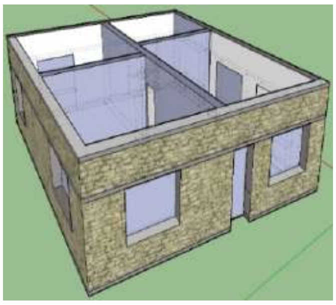


Figure 2. Stone Masonry with seismic bands. The horizontal seismic bands at three levels on the walls, vertical posts at corners, T-junction, adjacent to openings and at maximum of 1.5m interval in case of continuous wall.

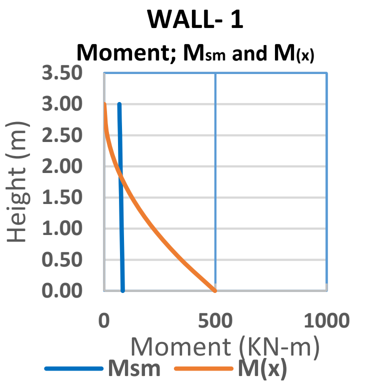


Figure.3. The overturning moment (Mx) due to seismic action and the traditional house's Moment capacity (M_{sm}) in out-of-plane direction. The Mx surpasses M_{sm} vastly. We should reinforce the walls to prevent overturning in this direction.

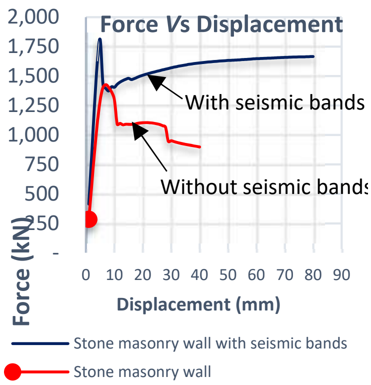


Figure 4. The result of the FEM analysis. The stone masonry wall with brittle failure and wall with seismic bands stands with the gain of ductility. The Initial load carrying capacity also increased with seismic bands and posts.

Ministry of Works and Human Settlement

The Ministry was established in 1959 as the "Bhutan Road Project," now looking across the nation to build quality, sustainable and economical infrastructure. The Department of Engineering Services under the ministry reviews construction plans and issues permits. It performs inspections to ensure engineering projects are built safely and in compliance with approved codes in force and regulations, helping to create a vibrant, livable, and safe-built community. The Division is the focal agency under the Ministry, responsible for the development and institution of appropriate construction technology for sustainable constructions, disaster-resilient constructions with risk reduction measures, and high-quality constructions through practical assurance plans.

Citation: Durán, S., T. Saito (2021), Basic study on the development of design code for seismically isolated buildings in El Salvador, Abstract of IISEE-GRIPS Master's Thesis.

Basic Study on the Development of Design Code for Seismically Isolated Buildings in El Salvador

Susan Ivania DURAN SARAVIA
Urban Development Department, Mayors Council and Planning Office of the Metropolitan Area of San Salvador, EL SALVADOR.
E-mail : susan_ids@hotmail.com
Taiki SAITO(Supervisor)
Professor, Department of Architecture and Civil Engineering, Toyohashi University of Technology.

The deformation at the tensile failure of the base isolation device largely depends on the load distribution. The uniform load distribution is more appropriate in the capacity spectrum method.

In El Salvador, the first project with seismic base isolation technique began construction in 2019. However, there are no regulations to analyze buildings with base isolation. The current Urban Regulation in the Metropolitan Area of San Salvador (Master Plan, 2017) encourages the densification in the territory and promotes the growth in height due to the lack of land. The project developers are more interested in using new seismic response control systems. In 2018, the number of the projects increased approximately three times the amount of the previous year. This trend highlights the urgency of updates to the regulations. The isolation layer of the target building designed in this study based on the Japanese Standard using the Capacity Spectrum Method includes three important design criteria: the ultimate shear strain of the device, the gap limitation, and the horizontal deformation at the tensile failure of the device. In this study, it was found out that the deformation at the tensile failure of the base isolation device largely depends on the load distribution, and the “Ai” load distribution is very conservative. This study was focused on the load distribution of the capacity spectrum method. The accuracy of estimating the horizontal deformation at the tensile failure of the device was discussed by models with two different aspect ratios (lower than and higher than 4) by comparing the results obtained by the Time History Analysis (THA). Through this study, it was found that the uniform load distribution is more appropriate in the capacity spectrum method.

Figure

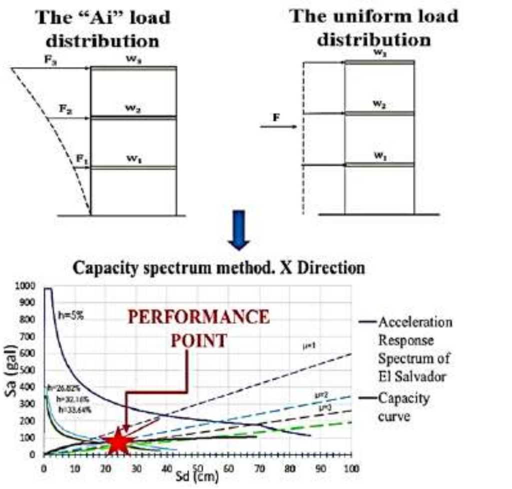


Fig. 1. Procedure of the capacity spectrum method considering “Ai” and the uniform load distribution.

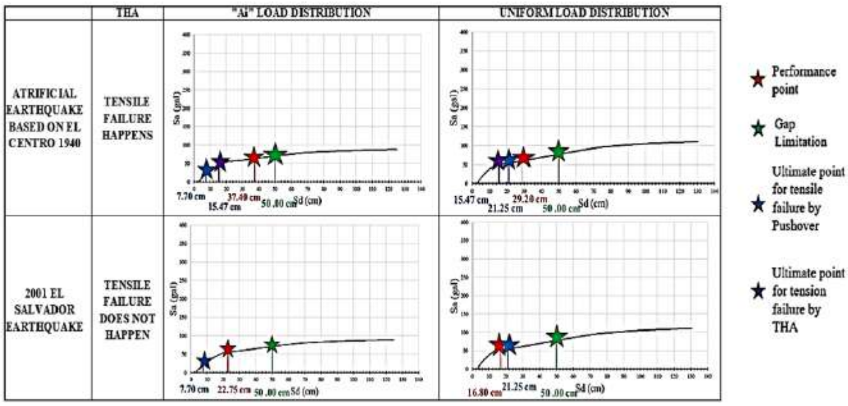


Fig. 2. Results of THA and capacity spectrum method with “Ai” and uniform load distribution of the model with aspect ratio 4.5. The results of uniform load distribution are compatible with THA.

Mayors Council and Planning Office of the Metropolitan Area of San Salvador, El Salvador

The Planning Office of the Metropolitan Area of San Salvador (OPAMSS), created in October 1988, is the institution in charge of the control and urban planning of the Metropolitan Area of San Salvador (AMSS) and responsible for generating technical information for decision making on the integral development of the AMSS.

Citation: Saadun, M. A., S. Nakai (2021), Fragility evaluation of typical RC government quarters buildings designed by BS 8110 in Sabah, Malaysia, Abstract of IISEE-GRIPS Master's Thesis.

Fragility Evaluation of Typical RC Government Quarters Buildings Designed by BS 8110 in Sabah, Malaysia

Mohd Assyarul Bin SAADUN
Civil and Structural Engineering Branch, Public Works Department of MALAYSIA
E-mail : mohd_assyarul@yahoo.com
Shoichi NAKAI (Supervisor)
Professor Emeritus, Chiba University, and Visiting Research Fellow, International Institute of Seismology and Earthquake Engineering, Building Research Institute, JAPAN

Fragility curves as preliminary evaluation in describing the performance levels of existing buildings without incorporating seismic actions.

This research topic introduced a study to evaluate the performance of existing buildings by the development of fragility curves. A typical five-story residential government RC building designed based on BS 8110 without incorporating any seismic action was chosen as a target building. It incorporates plan and elevation irregularities. The target building was analyzed by performing Incremental Dynamic Analysis (IDA) and excited by several recorded ground motions by equally scaling from 0.1 g to 0.8 g with every 0.1 g increment. Nonlinear time-history analysis was also conducted using STERA 3D software and the structural response in terms of maximum inter-story drift ratio (IDR_{max}) was obtained. Then fragility curves were plotted based on the IDA results by obtaining mean (μ) and standard deviation (σ) of the natural logarithm of Peak Ground Accelerations (PGA). This study adopted two different methods of developing fragility curves: (1) using a limit state of five levels of performance-based seismic designs, and (2) the conditional probability of IDR_{max} exceeding the specified limit state of *IDR* with the aid of static pushover analysis. Performance levels consist of Operational (OP), Immediate Occupancy (IO), Damage Control (DC), Life Safety (LS), and Collapse Prevention (CP). It is noted that flexural failure becomes a limit state for the second method in developing the fragility curves. In addition to this, the target building was examined in both X- and Y-directions to investigate the irregularity effect. Findings indicate that X-direction is weaker than Y-direction for both methods in terms of reaching or exceeding specific performance levels as well as of the conditional probabilities of exceeding the target limit state at a given peak ground acceleration (PGA).

Figures

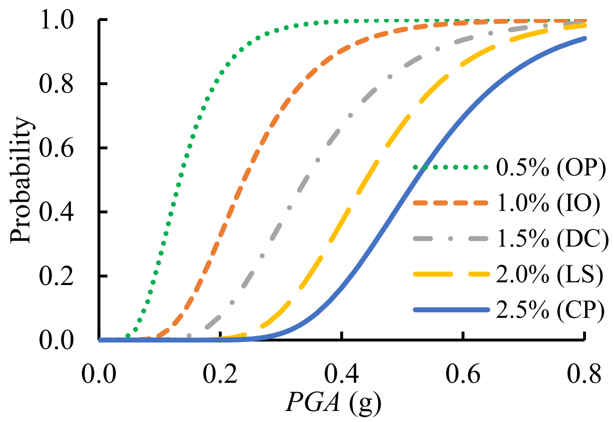


Fig. 1. Fragility curves of the target building in X-direction. Each line corresponds to five different performance level range. Similar curves are also developed for Y-direction of the target building.

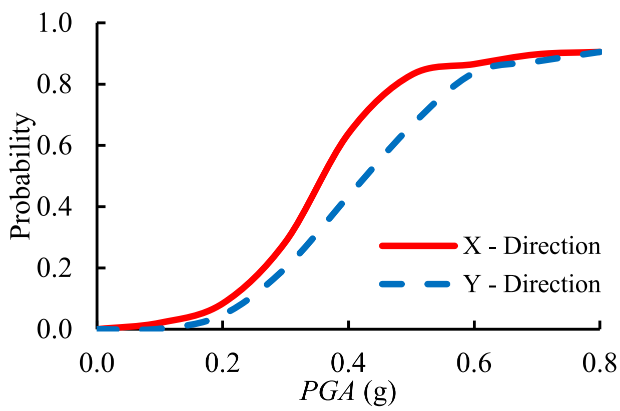


Fig. 2. The fragility curves of conditional probabilities of exceeding damage measure at the first flexural failure of a column at 1/125 rad in X-direction and Y-direction.

Public Works Department (PWD) of Malaysia

The Public Works Department (PWD) of Malaysia is the federal government department in Malaysia under the Ministry of Works (MOW). As a principal consultant to the Government of Malaysia with providing services in asset management, project management, and engineering services. One of the missions is to strengthen existing engineering expertise which Earthquake Engineering is one on the list to become a niche area in the department jurisdiction.

Citation: Suaib, S., T. Azuhata, Y. Ishiyama (2021), Seismic performance evaluation for health facilities (clinic) in Malaysia, Abstract of IISEE-GRIPS Master's Thesis.

Seismic Performance Evaluation For Health Facilities (Clinic) in Malaysia

Syuhaida SUAIB
Public Works Department of Malaysia, MALAYSIA
E-mail : syuhaida@jkr.gov.my; aidasuaib@gmail.com
Tatsuya AZUHATA(Supervisor)
International Institute of Seismology and Earthquake Engineering, Building Research Institute, JAPAN
Yuji ISHIYAMA (Supervisor)
Professor Emeritus, Hokkaido University, JAPAN

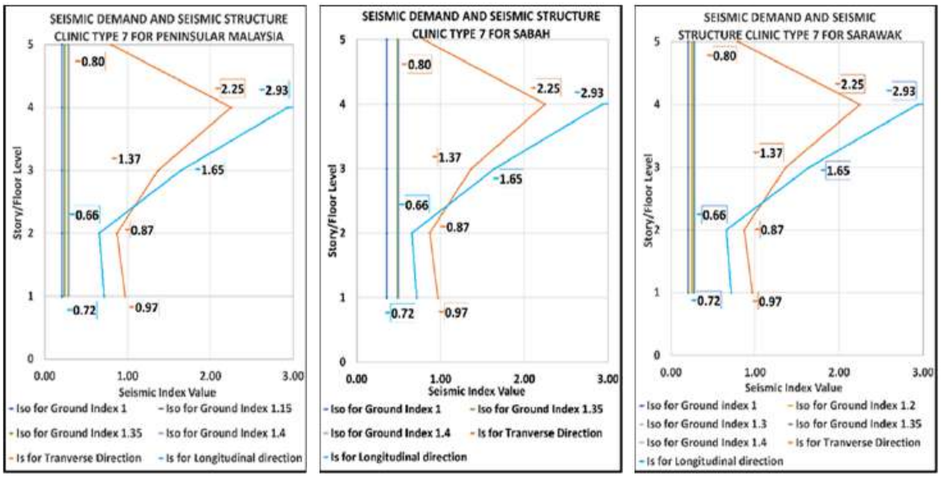
Seismic safety of clinic buildings with shear walls for higher seismic zone in Malaysia were confirmed

The Malaysian government has focused on earthquake disaster management after the Ranau Earthquake (6Mw) occurred on 5 June 2015. It is essential to know the seismic performance for existing design and building behaviors. The clinic is categorized as a critical building because it needs to remain functional during disasters. The target buildings for this study are clinic type 3 and type 7 (figure 1 and figure 2), where they were designed by Eurocode 2 but not applied to Eurocode 8 (seismic code). Therefore the Standard for Seismic Evaluation of Existing Reinforced Concrete Building, 2001 by the Japan Building Disaster Prevention Association, is applied with considering concept's Eurocode 8 and researchers from Japan also Malaysia. The maximum value of peak ground acceleration (PGA) for the return period of 475 in hazard map in Peninsular Malaysia (9%), Sarawak (9%), and Sabah (16%) are used in this study to identify the worst case. The result shows that clinic type 7 has a good condition in every level (figure 3) because the designer applies a shear wall and lightweight building. But clinic type 3 is not in good condition from story three and below. The study extends the use of clinic type 3 for executing column section analysis to get suitable column size and main bar specifications, also searching for appropriate shear wall locations on each floor for guidelines development to achieve a sustainable project in the future. For high-rise buildings (especially in the seismic region), the shear wall location must not be focused only on the lift area. For earthquake resistance, need the proper place of shear walls without disturbing building function. Thus, a collaboration between all disciplines (civil, mechanical, electrical, architects, and medical planners) is essential to ensure it is achievable to make the building more ductile and earthquake resistant.

Figure

Fig. 1. Architectural concepts clinic type 7

Fig. 2. Clinic type 7 distribution



(Peninsular Malaysia) (Sabah) (Sarawak)

Fig. 3. Seismic evaluation for clinic type 7

Public Works Department of Malaysia (PWD of Malaysia)

Public Works Department of Malaysia (PWD of Malaysia) responsible as a technical agency under the Malaysian Government to implement infrastructure development, maintenance operations for government buildings, gives technical advice and also one of National Disaster Management Agency (NADMA) strategic partners. PWD of Malaysia also involve in research and innovation that handle Center of Excellence in Engineering and Technology (CREaTE) which are one of division under PWD of Malaysia

Citation: Pulido, G., S. Koshimura (2021), Developing tsunami fragility functions using numerical modeling and remote sensing data from the 2010 Chile tsunami, Abstract of IISEE-GRIPS Master's Thesis.

Developing Tsunami Fragility Functions Using Numerical Modeling and Remote Sensing Data from the 2010 Chile Tsunami

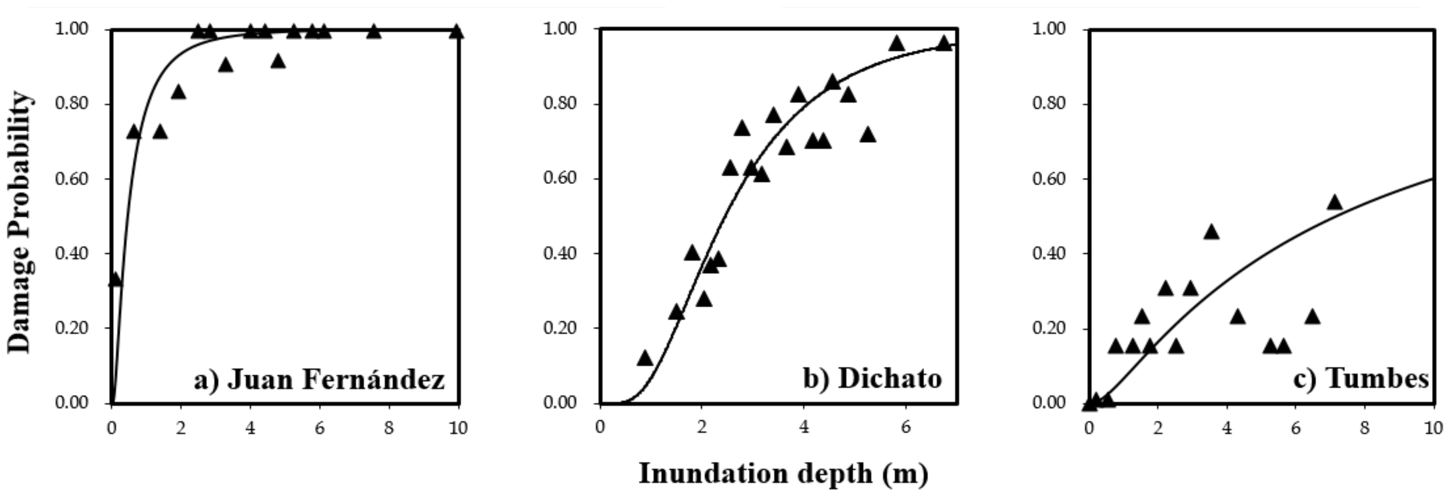
Gerónimo PULIDO IPARRAGUIRRE
Chilean Association of Port and Coastal Engineering (ACHIPYC), CHILE
E-mail : geronimopulido@gmail.com

Shunichi KOSHIMURA (Supervisor)
Professor, International Research Institute of Disaster Science (IRIDeS), Tohoku University, JAPAN

The first tsunami fragility functions constructed from remote sensing and numerical modeling for Juan Fernandez Island, Dichato, and Tumbes.

On February 27, 2010, a megathrust earthquake of Mw 8.8 (USGS) provoked a destructive tsunami in Chile. The tsunami damaged about 600 km area along the coast of Chile, including the coastal towns of Dichato and Tumbes in the Bio-Bio region and Robinson Crusoe Island on the archipelago of Juan Fernandez, about 670 km off the coast of Chile. To estimate the structural damage in a quantitative manner, we newly developed tsunami fragility functions for Juan Fernandez, Dichato and Tumbes using tsunami modeling results and damage data from remote sensing. We obtained the tsunami propagation and inundation depths using Tohoku University's Numerical Analysis Model for Investigation of Near-field tsunamis (TUNAMI) for the numerical simulations. We also compiled the damage data from visual inspection of satellite images to estimate damage probabilities for the target areas. The proximity to the tsunami source was expected to indicate that the cities of Dichato and Tumbes would present a higher calculated damage probability than the distant place at Juan Fernandez, but the obtained fragility curves suggest the different aspects; for an inundation depth of one meter, the damage probabilities are 7%, 48%, and 82% for Tumbes, Dichato, and Juan Fernandez, respectively. Taking into an account that the construction type (wood, masonry, and mixed) is similar in the three cities, we could say that the areas' exposure and building configuration have the most significant impact on the structural damage, considering that Juan Fernandez island was not affected by the ground motion of the 2010 event and the buildings were not damaged or degraded by the strong ground motion before the tsunami wave arrives.

Figure



Fragility functions for structural damage in terms of the tsunami inundation depth at (a) Juan Fernandez, (b) Dichato, and (c) Tumbes.

The Chilean Association of Port and Coastal Engineering

The Chilean Association of Port and Coastal Engineering (ACHIPYC) is a non-profit group that promotes and encourages interaction between engineers from related disciplines. In addition, we create, organize, coordinate and disseminate initiatives aimed at advancing the research and development of specific topics in our area of competence, with particular emphasis on the problems and needs of the country.

Citation: Sinki, K., Y. Fujii, B. Shibazaki (2021), Numerical simulations of the 1992 Flores tsunami using earthquake fault and landslide models, Abstract of IISEE-GRIPS Master's Thesis.

Numerical Simulations of the 1992 Flores Tsunami Using Earthquake Fault and Landslide Models

Kian Purna Sinki
Indonesia Agency of Meteorology, Climatology and Geophysics (BMKG), INDONESIA
E-mail : qq.sinki@gmail.com
Yushiro FUJII (Supervisor)
International Institute of Seismology and Earthquake Engineering (IISEE), BRI ,JAPAN
Bunichiro SHIBAZAKI (Supervisor)
International Institute of Seismology and Earthquake Engineering (IISEE), BRI ,JAPAN

Tsunami modellings using TUNAMI code by adopting two earthquake fault models and three landslide models to reproduce measured higher tsunamis

This study models the tsunami propagation and inundation for the 1992 Flores tsunami and compares the numerical results with the observed data obtained at 37 locations by the field survey (Tsuji et al., 1995). We performed tsunami numerical simulations using a finite difference TUNAMI code (Yanagisawa, 2021) that solves the non-linear shallow water equations. We used 6 arc-second BATNAS bathymetric data and 0.27 arc-second DEMNAS topographic data. First, we adopted a modified fault model from the two-fault model by Imamura et al. (1995) and the 360-subfault model constructed by Pranantyo and Cummins (2019) for tsunami simulations as shown in Figures 1a and 1b. Second, in addition to the two fault models, we assumed three landslide models referring the limited information such as the landslide width of 2 km (Yeh et al., 1993) as shown in Figure 1c. The landslide models were located near the coastal area where higher tsunamis more than 10 m were observed, and the slide directions were set perpendicularly to the coast lines. As the output points for the calculated tsunami waveforms, we selected five locations, Waibalen, Riangkroko, Bunga, Uepadung and Pantai Lela in the finest grid layer of 10/3 arc-second (Layer 3). Uepadung and Pantai Lela are located behind and in front of the landslide model near Waibalen, respectively. The landslide models had a good contribution to reproduce the higher tsunami heights. Figure 2 shows the comparison of the calculated maximum tsunami heights and the observed ones by the field survey and the ones simulated by the previous study (Hidayat et al., 1995). To validate the simulation results, we calculated the Aida's (1978) K and κ for the 37 locations and obtained K = 1.49 and κ = 1.39 for the two-fault model with the three landslide models, and K = 1.47 and κ = 1 for the 360-subfault models with the three landslide models. The validation results showed that the earthquake fault and landslide models explained the observation data better than the fault models without the landslide models.

Figure

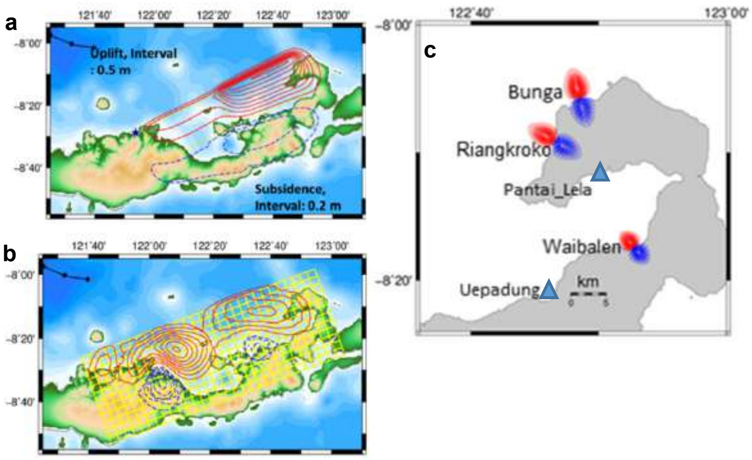


Fig. 1. Source models used for this study.
(a) Two-fault model modified from Imamura et al. (1995).
(b) 360-subfault model by Pranantyo and Cummins (2019).
(c) Three landslide models were assumed.

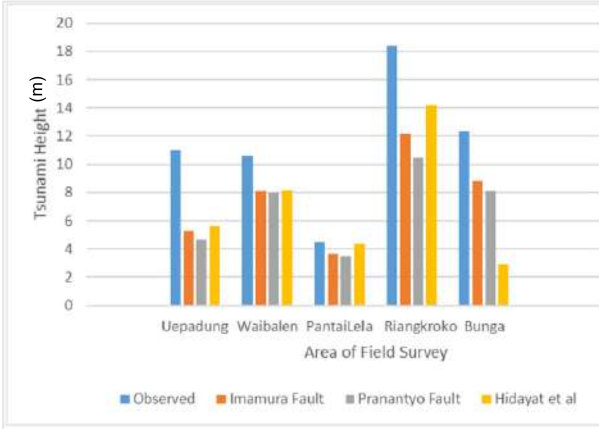


Fig. 2. Tsunami heights resulted from the tsunami modellings using the fault and landslide models comparing with the observed data and the previous study (Hidayat et al., 1995).

Indonesia Agency of Meteorology, Climatology and Geophysics (BMKG)

BMKG has the tasks of carrying out government duties in the fields of Meteorology, Climatology, Air Quality, and Geophysics in accordance with the provisions of the applicable laws and regulations. We play an important role for the sustainability of living by disseminating information on weather, climate change, air quality, earthquakes, and tsunami early warnings. BMKG's headquarter is located in Central Jakarta and provides services to the public, 183 BMKG offices are spread throughout Indonesia.

Citation: Tatapu, C., B. Shibazaki, Y. Fujii (2021), Tsunami simulation and hazard assessment for megathrust earthquakes along the coasts of the Solomon Islands, Abstract of IISEE-GRIPS Master's Thesis.

Tsunami Simulation and Hazard Assessment for Megathrust Earthquakes Along the Coasts of the Solomon Islands

Carlos TATAPU
Geological survey Division, Ministry of Mines, Energy & Rural Electrification (MME&RE), Honiara, SOLOMON ISLANDS.
E-mail : ctatapu@mmere.gov.sb
Bunichiro SHIBAZAKI, Yushiro FUJII (Supervisors)
International Institute of Seismology and Earthquake Engineering, Building Research Institute, JAPAN

Tsunami simulation along subduction zone in the Solomon Islands for disaster planning and mitigation

The Solomon Island has experienced earthquakes that were highly tsunamigenic in nature. Recent events in western Solomon in 2007 and 2010 together with the 2013 event in eastern Solomon have caused casualties to coastal settlements. These events occurred near the collision zone between the Australian and the Pacific Plates. Still, seismic gaps exist in areas along the subduction zone. Therefore, this study investigates scenario earthquakes along these seismic gaps in the western and eastern parts of the Solomon Islands. The assumed fault model with 10m slip for two scenario earthquakes. For the western Solomon study areas, the maximum wave height is 4.8 m on Rennell Island and is 3.6 m at the coastline of Guadalcanal. For the eastern Solomon study areas, the maximum wave heights of 5 m and 2 m are observed at Nama and Avita on Santa Cruz Islands, with arrival times of 10 to 20 minutes, respectively. The tsunami inundation modeling shows run-up distance of more than 100 m for Managakiki coastlines and run-up distance of 84 m for the coastline of Nama settlement in Santa Cruz Islands. The study demonstrated an overview of possible seismic events that will help tsunami disaster management and planning for the Solomon Islands.

Figure

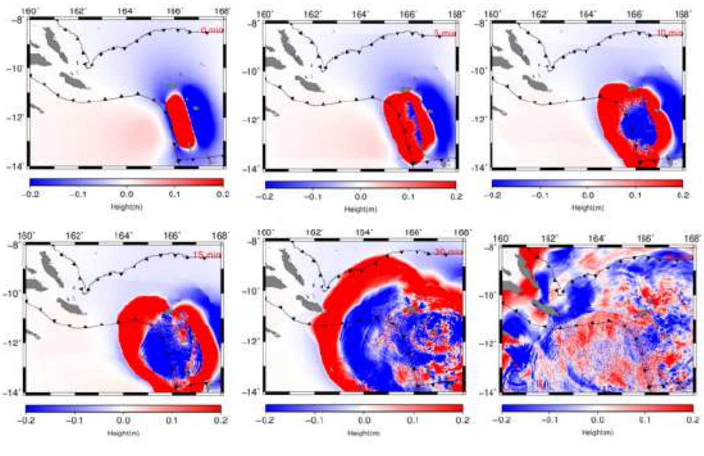


Fig. 1. Tsunami wave propagation for the eastern Solomon region with 10 m slip earthquake scenario

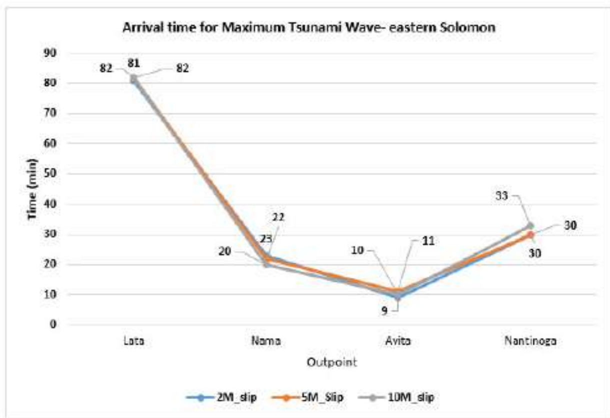


Fig. 2. Arrival Time for maximum waves of for output points in eastern Solomon study region with 10m slip earthquake scenario.

Geological Survey Division, Ministry of Mines, Energy & Rural Electrification (MME&RE)

The Geological Survey Division is a division within the Ministry of Mines and Energy (MME&RE) that was Established in 1960's. The Division is responsible for Geological,Seimological and Geo-hazard work for the Solomon Islands. Government Policies mandated to the division includes programs and activities that will help reduce the populations' vulnerability to Geo-hazards such as earthquakes, volcanic eruptions and tsunamis.