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The International Institute of Seismology and Earthquake Engineering (IISEE) was established in 1962 and has provided training courses in the field of seismology and earthquake engineering for the so-called developing countries supported by the Ministry of Land, Infrastructure and Transport (Ministry of Construction until Jan. 2001) of Japanese Government and Japan International Cooperation Agency (JICA). The current activities and history of IISEE are shown in the following URL.
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FOREWORD

The International Institute of Seismology and Earthquake Engineering (IISEE) was established in 1962 within the Building Research Institute (BRI) to provide advanced training in seismology and earthquake engineering for researchers and engineers from developing countries prone to earthquakes, with the aim of developing human resources who can contribute to the mitigation of earthquake and tsunami disasters. Since the international training project on seismology and earthquake engineering began at the University of Tokyo in 1960, 2,050 people from 106 countries and regions have participated in the training program by December 2024.

From 2023 to 2024, IISEE conducted the following training in cooperation with the Japan International Cooperation Agency (JICA). One-year “Seismology (S)”, “Earthquake Engineering (E)”, and “Tsunami Disaster Mitigation (T)” annual training (Regular course), the short-term “Global Seismological Observation (G)” course, and the “Strengthening Seismic Disaster Risk Reduction Countermeasures for Critical Buildings (C)” course which was newly established in October 2024. The breakdown as of December 2024 is as follows.

Regular course	13 participants (S:4, E:6, T:3)	8 countries	1,270 participants in total
G course	9 participants	6 countries	297 participants in total
C course	10 participants	8 countries	10 participants in total

The Regular course became a training program where a master's degree can be obtained through collaboration with the National Graduate Institute for Policy Studies (GRIPS) from 2005. By December 2024, 360 participants in the Regular course were conferred the degrees of Master of Disaster Management. The short-term “Latin American Earthquake Engineering (L)” course, which began in 2014, ended in 2022. In addition, we can also offer individual courses upon request.

After the global spread of the COVID-19 infection, from October 2022 onwards, the Regular and short-term course participants are able to come to Japan from the beginning of the training and attend almost all face-to-face lectures. At IISEE, we are using our experience from the coronavirus crisis to hold the Online IISEE Seminar on an irregular basis, which can also be attended by ex-participants who have returned to their home countries.

In addition, IISEE publishes its bulletin annually to exchange knowledge and technology related to seismology, earthquake engineering, and tsunami disaster mitigation among researchers and engineers. This latest issue contains 13 abstracts of the master's reports of the 2023-2024 Regular course participants. More detailed version (synopsis) for each abstract is available on the IISEE website. We would like to express our sincere gratitude to all the lecturers who taught the participants everything from basic to advanced knowledge, to all the supervisors who guided them in their researches, and above all to the participants themselves who have successfully completed their master's reports.

Yushiro Fujii
Director of IISEE, BRI

CONTENTS

Vol. 59

Abstracts of Individual Study Reports (the 2023-2024 course)

Abstracts of Individual Study Reports

by

the 2023-2024 Course

PRESENT-DAY STRESS FIELD AND TECTONIC REGIME IN ALGERIA FROM INVERSIONS OF EARTHQUAKE FOCAL MECHANISMS

Moustafa ABBOUDA[1] **Supervisor: Saeko KITA[2]**

ABSTRACT

Estimation of stress field orientations is essential for understanding mechanisms of crustal deformation and seismotectonics. Previous studies in Algeria have primarily focused on regional studies; however, this study provides a comprehensive analysis of stress field variations across the entire country. By applying stress inversions to a dataset of 631 earthquake focal mechanisms sourced from international databases and previous studies, we determined the principal stress axes (σ1, σ2, and σ3), SHmax, SHmin, and the stress ratio (R).

The results confirm the overall SHmax orientation and stress regime, which are consistent with previous regional studies. However, a more detailed analysis, achieved by dividing the study area into smaller subregions, reveals spatial heterogeneity in stress conditions. A transition from a compressive-transpressive to a strike-slip stress regime is evident from the western to the eastern Tell Atlas, with the Great Kabylia block emerging as a transitional zone marked by a predominantly pure compressive stress field. The Beni Slimane region shows local perturbations in the stress field, likely linked to the reactivation of underlying structures. Moreover, the analysis of neotectonic data and the P-axis of large events across Algeria shows a clear correlation with the distributed SHmax, indicating that future earthquakes will likely be generated along the reactivation of these faults. These findings have critical implications for seismic hazard assessment, offering insights that can refine seismogenic zone definitions and improve hazard mapping in Algeria.

Keywords: Stress field, Focal Mechanisms, SHmax, Stress Tensor Inversion.

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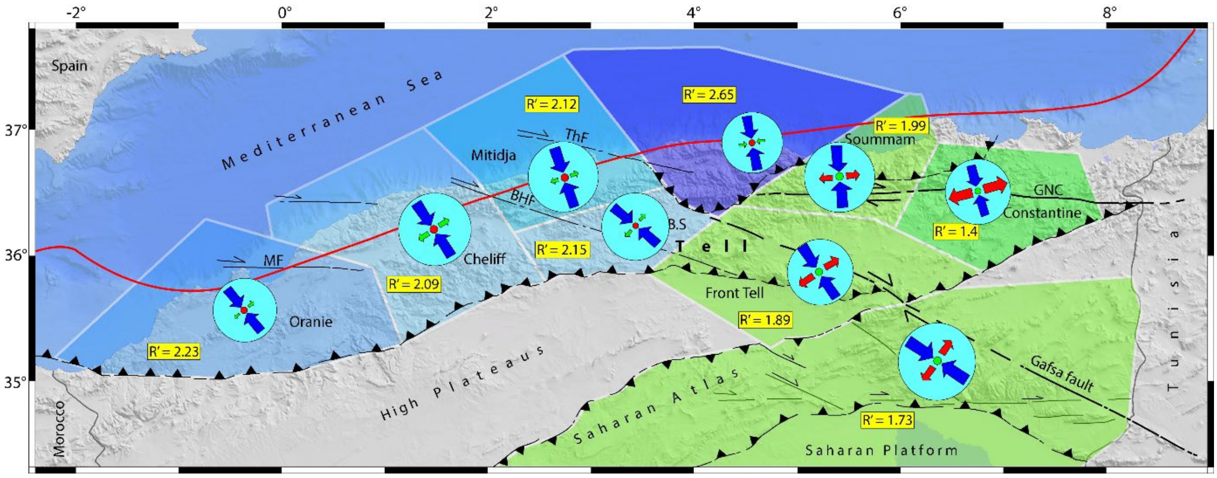

Figure 1. Obtained stress axes orientations and tectonic regime distribution along the entire Algerian area. MF: Mostaganem fault, BHF: Beni Haoua fault, ThF: Thneia fault, GNC: Ghardimaou – North Constantine fault, R': stress index.

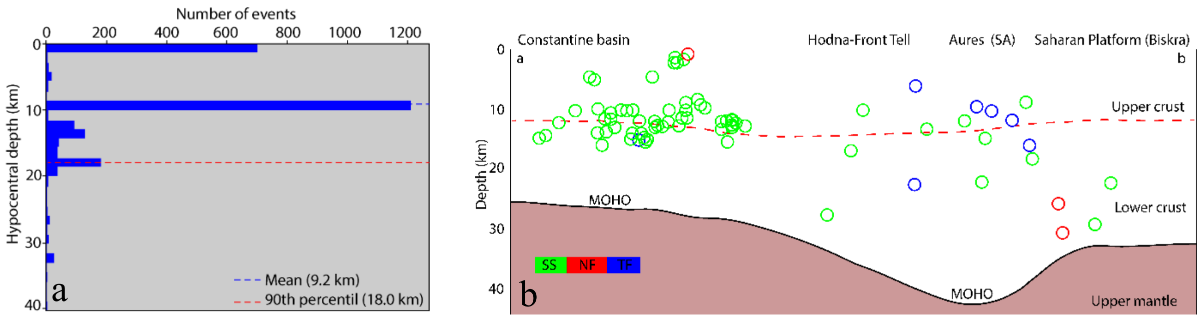

Figure 2. a. The D90 distribution of seismicity in depth in northern Algeria. The seismicity data from ISC Bulletin and USGS. b. Focal depth distribution of the used focal mechanisms data in the Constantine-Mila basin to the Saharan Atlas regions. SS: Strike-Slip, NF: Normal Faults, TF: Thrust Faults.SA: Saharan Atlas.

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ESTIMATION OF VS30 DISTRIBUTION IN THE METROPOLITAN AREA OF SAN SALVADOR

Omar Anthony MADRID MADRID[1] **Supervisor: Takumi HAYASHIDA**[2]

ABSTRACT

El Salvador, situated in the Pacific subduction zone between the Caribbean and Cocos plates, is susceptible to frequent and destructive earthquakes. Historical seismic events have substantially damaged buildings in the country, emphasizing the critical need for robust disaster mitigation strategies. This study aims to develop a Vs30 distribution map for the metropolitan area of San Salvador (AMSS) as a fundamental tool for disaster preparedness. Vs30 represents the average shear-wave velocity in the upper 30 m of the ground and is a crucial parameter for assessing seismic site amplification. Vs30 was estimated using two methodologies: topographic data derived from digital elevation models (DEM) and an empirical formula based on peak amplitude and frequency of the horizontal-to-vertical spectral ratios (EHVSRs) from historical strong ground motion records. Results indicated a notable correlation between Vs30 values obtained from topographic data and local geology. A comparison of Vs30 values from both methodologies revealed substantial similarities, suggesting that the amplified EHVSRs can effectively approximate the Vs30 distribution. The shape of horizontal-to-vertical spectral rations of microtremor records (MHVSRs) measured near strong-motion stations is similar to that of EHVSRs in terms of peak frequency and shape, confirming that MHVSRs can also be used supplementarily to understand the spatial distribution features of site amplification. To enhance the estimation accuracy of Vs30 and strengthen the correlation, future research should incorporate direct ground investigation techniques such as standard penetration tests (SPT), borehole data, and microtremor array measurements. These direct measurements will facilitate the refinement of empirical equations to better align with the specific soil characteristics of the AMSS, ultimately leading to more precise Vs30 values and improved disaster mitigation strategies.

Keywords: Vs30 distribution, EHVRs, topography, seismic site effects.

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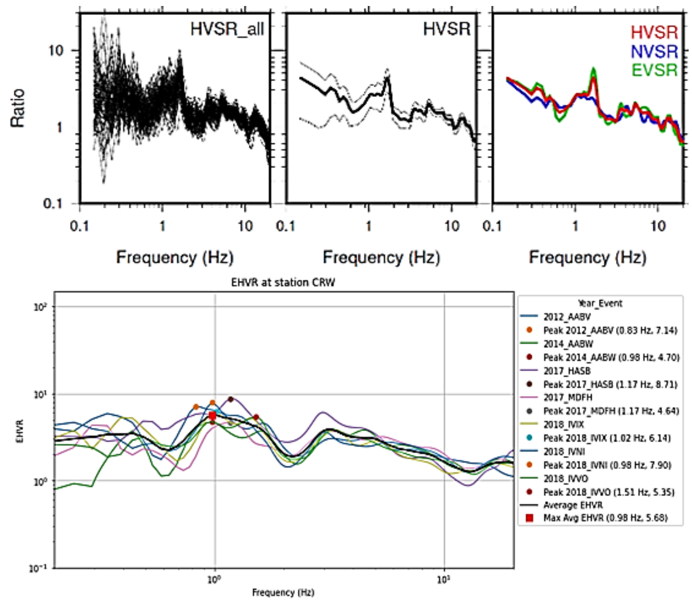

Fig 1. Top panels show the MHVSR obtained near the stroung groun motion station CRW, and bottom panel shows the EHVRs at the station CRW. Both show a high similarity on the ratio and peaks. MHVSR has a peak at 1 Hz and EHVSRs have peaks at around 1 Hz because of their similar soil types (stratovolcanic complex of proximal zone covered by scoria/tuffs)

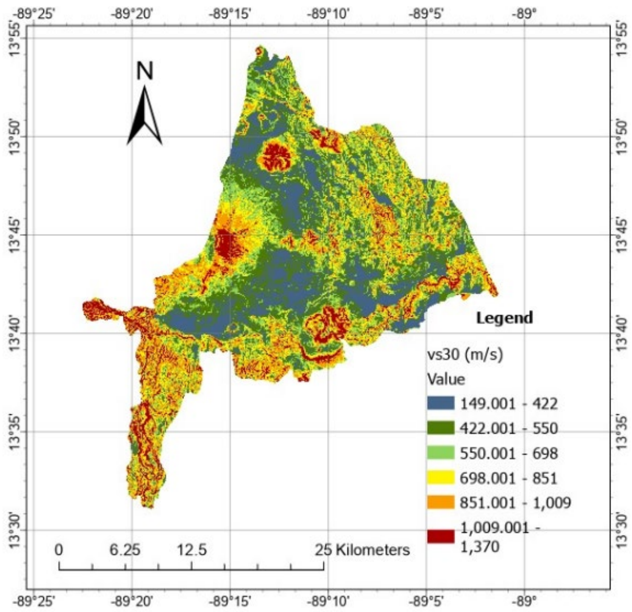

Fig 2. This figure illustrates the distribution of shear wave velocity at a 30-meter depth (Vs30) across the study area, based on data from a 1-arc-second digital elevation model (DEM). The Vs30 values were estimated using a correlation between slope and shear wave velocity, where steeper slopes correspond to higher Vs30 values.

The Vs30 map reveals spatial variations in subsurface conditions, and flatter regions generally show lower Vs30 values, suggesting the presence of softer sediments.

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ENHANCED EARTHQUAKE PHASE PICKERS IN INDONESIA: EVALUATION AND REFINEMENT OF MACHINE LEARNING MODELS

Brilian Tatag SAMAPTA[1] **Supervisor: Masumi YAMADA**[2]

ABSTRACT

Automatic earthquake detection is vital for reliable seismic monitoring, comprehensive cataloging, and effective disaster mitigation, including tsunami early warning systems. Traditional methods, such as the short-term average to long-term average (STA/LTA) algorithm, are widely used to detect earthquakes but have limitations such as noise susceptibility and imprecise arrival time estimation. Machine learning (ML) is a powerful alternative to such methods, as it offers enhanced detection accuracy and noise resistance through advanced architectures. Herein, the performance of ML models was evaluated for enhanced seismic phase detection using data from the Meteorological, Climatological, and Geophysical Agency of Indonesia (BMKG). Twenty pretrained ML models, including Earthquake Transformer, Generalized Phase Detector, PhaseNet, and Basic Phase Autoencoder, trained on five benchmark datasets (STEAD, GEOFON, NEIC, INSTANCE, and ETHZ), were assessed using the SeisBench program on BMKG dataset containing 65,875 segmented traces and 89,227 manually pick phase arrival times. Results showed that PhaseNet, trained on the NEIC dataset, accurately classified the BMKG earthquake data, demonstrating superior recall and precision while maintaining onset time accuracy. The PhaseNet model was optimized using the BMKG dataset via transfer learning, enhancing its phase identification accuracy. The adapted model was applied to continuous waveform data from March 2023 and generated an earthquake catalog with 120% more events than those in the BMKG manual catalog. The optimized model offers a robust solution for real-time earthquake detection systems, potentially enhancing seismic monitoring capabilities and early warning systems.

Keywords: Machine learning, rapid earthquake detection, phase picker, transfer learning.

[1] Climatological, and Geophysical Agency (BMKG), Indonesia.
[2] Disaster Prevention Research Institute (DPRI), Kyoto University.

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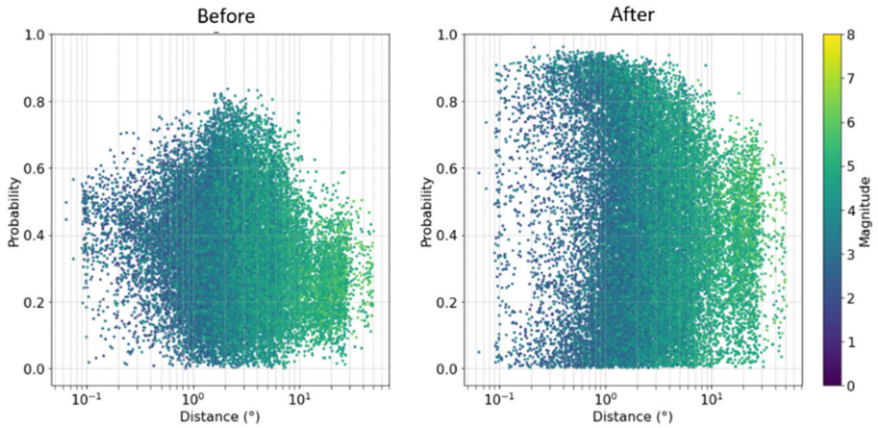

(a) (b)

Fig. 1. Enhancement in probability distribution through transfer learning: (a) The initial model exhibits a distribution concentrated in the low-probability region; (b) Post-transfer learning, the model attains a distribution with significantly higher probabilities.

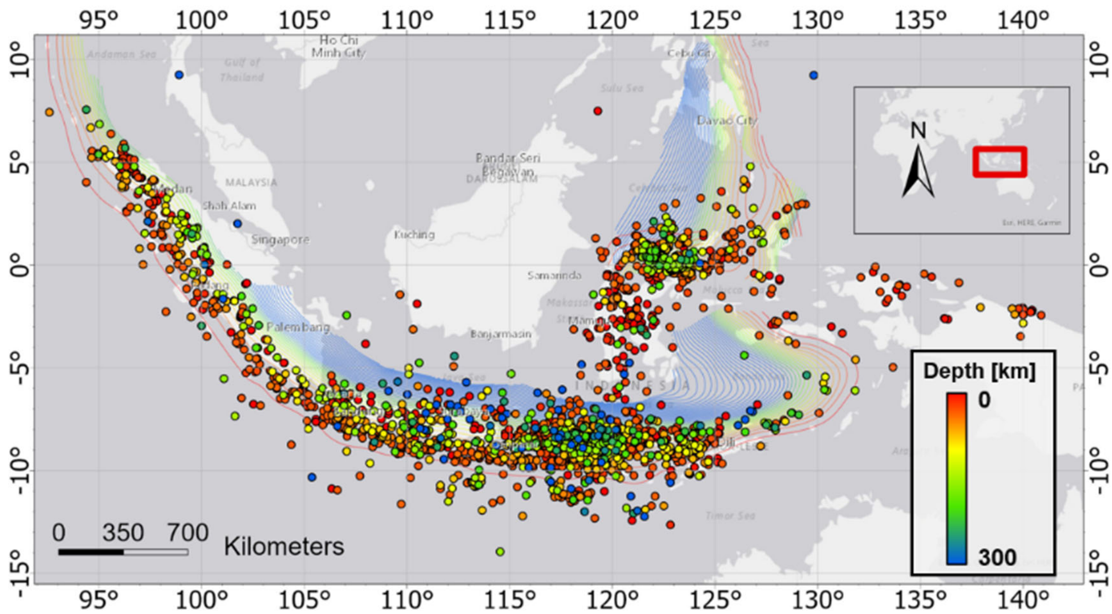

Fig. 2. Map showing the distribution of the new earthquake catalog generated from this study. Most of the earthquake depth distribution aligns with the subduction zone.

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Approved as Master Paper of DMP by BRI/GRIPS, Awarded Best Research Award

ENHANCING INDONESIA'S TSUNAMI EARLY WARNING SYSTEM USING W PHASE INVERSION

Fadly YUSUF[1] **Supervisor: Yuichiro TANIOKA**[2]

ABSTRACT

Earthquake source mechanism parameters are crucial inputs for tsunami early warning systems. However, obtaining accurate parameters promptly remains a challenge, particularly in the Indonesian archipelago, with sparse seismic station network. W phase inversion technique is a promising approach for obtaining accurate source mechanisms. Herein, its applicability in the Indonesian region, was evaluated to optimize the station coverage distance for producing accurate source mechanism parameters in the shortest possible time. To this end, W phase inversion was applied to 23 earthquakes with $M_w \geq 6.5$ that occurred between January 2020 and January 2024. The station coverage distance was varied ($\Delta \leq 5°$, $\Delta \leq 12°$, until $\Delta \leq 20°$) to analyze the accuracy of the resulting focal parameters. The accuracy of the W phase inversion output was assessed by comparing the moment magnitude and angular differences to the source mechanism parameters from the global centroid moment tensor (GCMT) as a reference. Results indicated that W phase inversion could yield fairly accurate parameters even with station coverage of ≤ 5°, achieving results in less than 7 min. This was demonstrated by an average moment magnitude difference of ~0.07 and nearly 50% of the outputs having an angular difference of ≤ 20°. A broader station coverage yielded better focal solutions; however, the process is time consuming because of the propagation delay of seismic waves to distant stations. The accuracy of the W phase solution considerably depended on the number of channels analyzed. Thus, accurate results were obtained as long as a sufficient number of recording channels was available. This analysis revealed that W phase inversion could yield results consistent with the reference data (moment magnitude difference of < 0.2 and angular difference < 30°) with a minimum of 20 recording channels.

Keywords: Source Mechanism, W phase, Inversion Method.

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[2] Institute of Seismology and Vulcanology (ISV), Faculty of Science, Hokkaido University.

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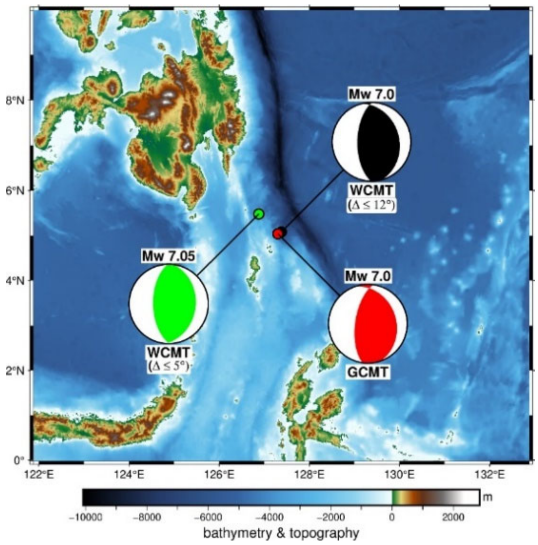

Fig 1. Comparison of source mechanisms results for the January 21, 2021 M_w 7.0 Talaud Earthquake.

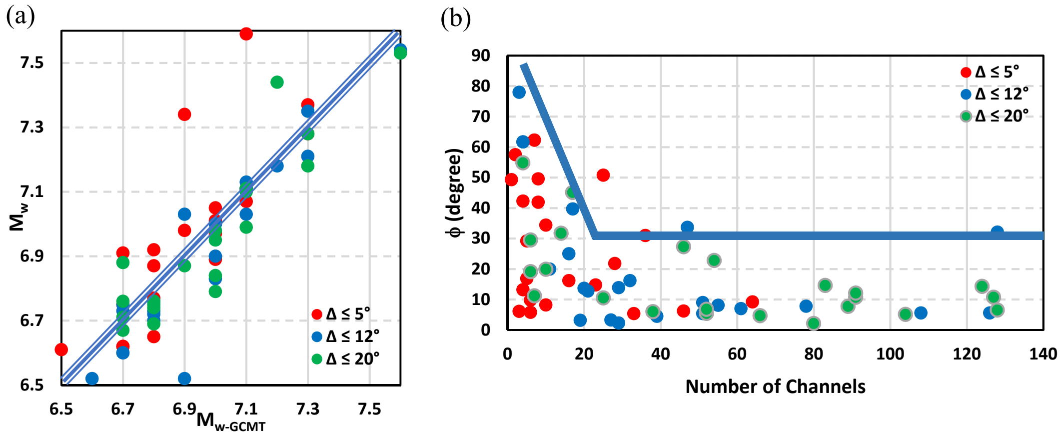

Fig 2. Comparison of W phase inversion results based on epicentral distance: (a). seismic magnitudes between W phase inversion and GCMT solutions; (b). angular difference (ϕ) for the source mechanism solution between W phase inversion and GCMT according to the number of used data within $\Delta \leq 5°$, $\Delta \leq 12°$, and $\Delta \leq 20°$.

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VIBRATION-BASED TECHNIQUE AND ARTIFICIAL INTELLIGENCE FOR STRUCTURAL DAMAGE DETECTION

Islam HAOUAS[1] **Supervisor: Koichi MORITA**[2]

ABSTRACT

Assessing building damage after major earthquakes is crucial but challenging with only visual inspections. This study presents a vibration-based method for detecting structural damage. It employs a numerical reference model to simulate various damage scenarios. The approach uses simulation-based training data for a Machine Learning (ML) model to identify and locate severe damage in real buildings. A case study was selected to validate the method. It involves a three-story steel frame subjected to seismic excitations, conducted by E-Defense and the National Research Institute for Earth Science and Disaster Resilience (NIED). Dynamic properties (natural frequencies and mode shapes) serve as damage indicators. Principal Component Analysis (PCA) is used to extract the principal components from these dynamic properties for the ML model's input features.

The results of the damage detection model were compared with visual inspections reported in experimental reports. The ML model accurately identified structural damage, aligning with visual inspections and effectively determining the building's condition.

Keywords: Structural Health Monitoring, System Identification, Machine Learning.

[1] Earthquake Engineering and Structural Dynamics Laboratory (LGSDS), ENP, Algiers, ALGERIA.
[2] National Institute for Land and Infrastructure Management.

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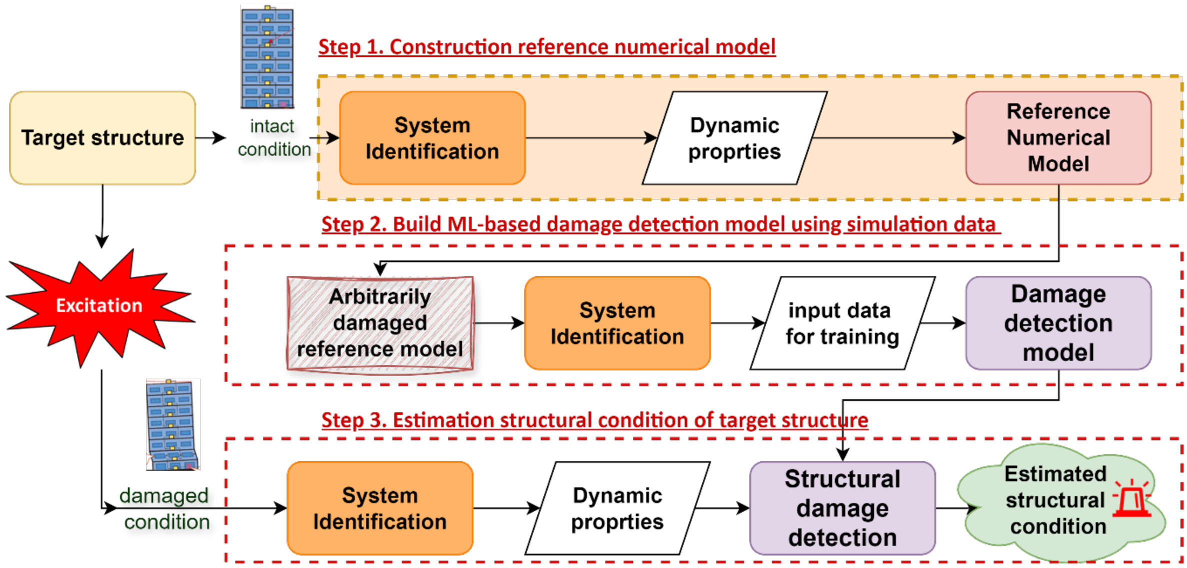

Fig 1 Outline of the proposed methodology

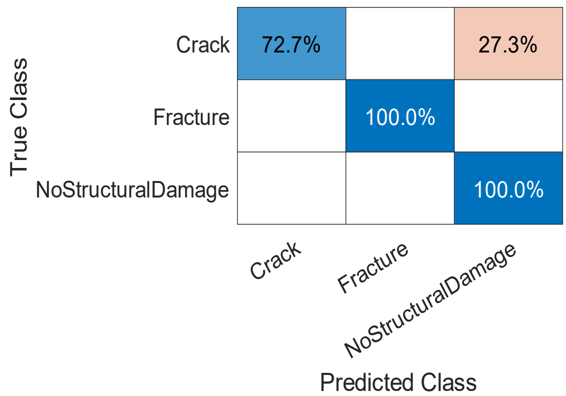

Fig 2. Damage Detection Results

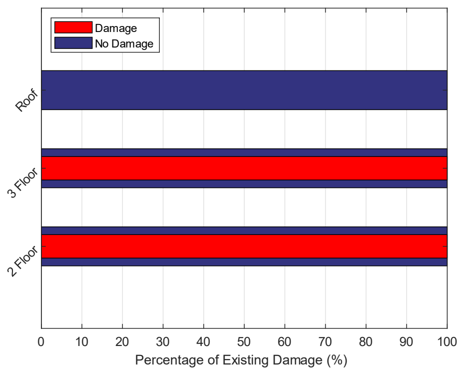

Fig 3. Predicted damage location

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SEISMIC EVALUATION AND RETROFITTING PROPOSAL OF REINFORCED CONCRETE SCHOOL BUILDING IN EL SALVADOR

Jose Ricardo ULLOA UMANZOR[1]

Supervisors: Matsutaro SEKI[2], **Yuri OTSUKA**[2]

ABSTRACT

The urgency for an official seismic evaluation guideline for buildings in El Salvador is driven by the historical damage from earthquakes, which have caused significant economic and human losses. Currently, local engineers depend on various international standards due to the absence of national regulations. In response, the HOKYO Project aims to develop manuals and guides for seismic evaluation and retrofitting of buildings in the San Salvador metropolitan area. This study focuses on a detailed seismic evaluation (DSE) and retrofitting of a reinforced concrete school building in El Salvador. The DSE method integrates the seismic index method from Japanese standards with non-linear analysis criteria from American standards, providing a comprehensive approach to assess and enhance the seismic performance of buildings.

The research evaluates the building's seismic performance both as a bare frame and with the inclusion of four different retrofitting techniques, such as reinforced concrete walls, steel bracing, ferrocement lamination, and reinforced concrete block walls. This research suggested an optimal seismic evaluation and retrofitting method suitable for typical school buildings in El Salvador. It also proposed a method to improve the safety of educational infrastructure built before the current seismic design standards.

Keywords: Retrofitting, detailed seismic evaluation method, reinforced concrete building.

[1] Council of Mayors and Planning Office of the Metropolitan Area of San Salvador (COAMSS-OPAMSS), El Salvador.

[2] International Institute of Seismology and Earthquake Engineering, Building Research Institute.

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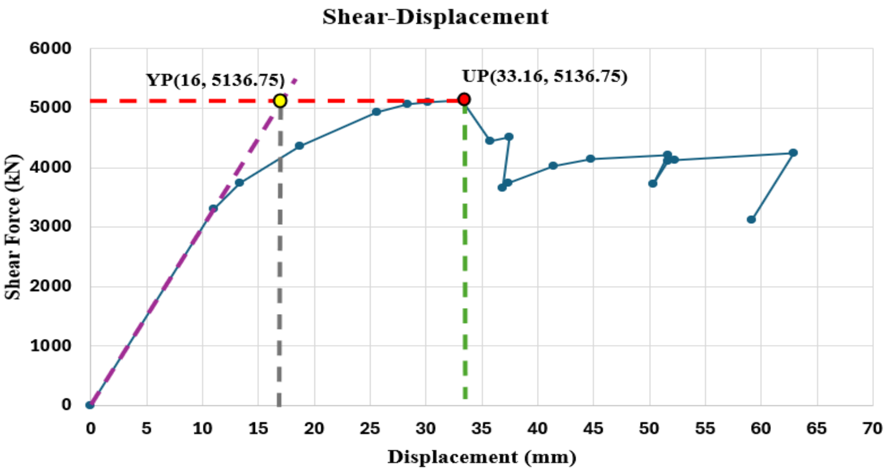

Fig 1. Displacement-Shear Force curve, used for calculating strength and ductility indices of a story through pushover analysis using the DSE method.

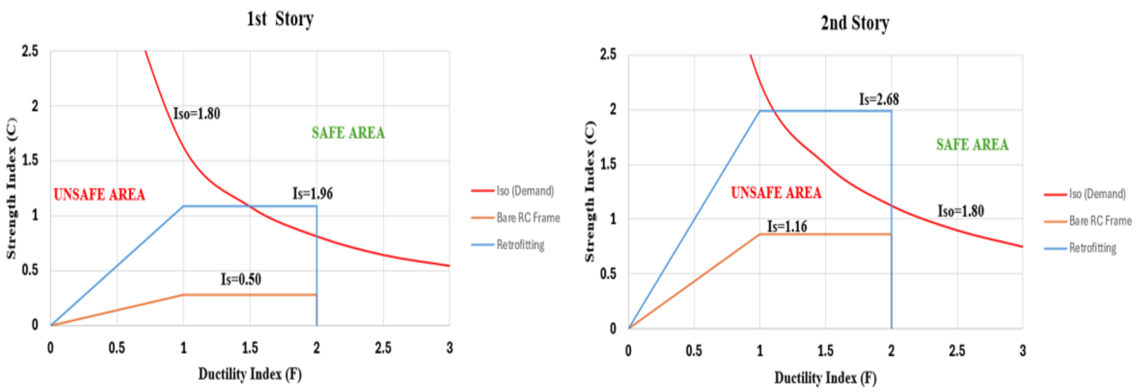

Fig 2. Improvement in performance by integrating steel bracing retrofitting in the X direction

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SEISMIC FRAGILITY EVALUATION OF TYPICAL REINFORCED CONCRETE SCHOOL BUILDING IN MALAYSIA

Mohamad Hazwan Bin Zahari [1] **Supervisor: Taiki SAITO**[2]

ABSTRACT

The purpose of this study is to evaluate the seismic performance level of a typical four-story RC school building designed as per Eurocode (EC) that does not cooperate with seismic consideration was analyzed. Incremental dynamic analysis (IDA) corresponding to 40 selected ground motion records were used to produce maximum inter-story drift ratio (IDR_{max}) that is used to obtain fragility curve representing the seismic performance level of the building. Four cities with different peak ground accelerations (PGAs) values based on the seismic hazard map of Malaysia were selected, and a limit state of five performance level used to evaluate the performance level of the target building. The seismic performance levels of target building and an additional school building (SMK Ranau) designed as per British Standard (BS) were compared. Results show that the structural strength of the target building was sufficient to withstand a certain levels of ground motion based on the seismic hazard map. Moreover, the damage probability increased with increasing PGAs, particularly in the X-direction. The aforementioned comparison also showed that the building designed as per the BS was weaker than the target building designed as per the EC, particularly in the X-direction.

Keywords: Fragility curve, performance level, maximum inter-story drift ratio, incremental dynamic analysis.

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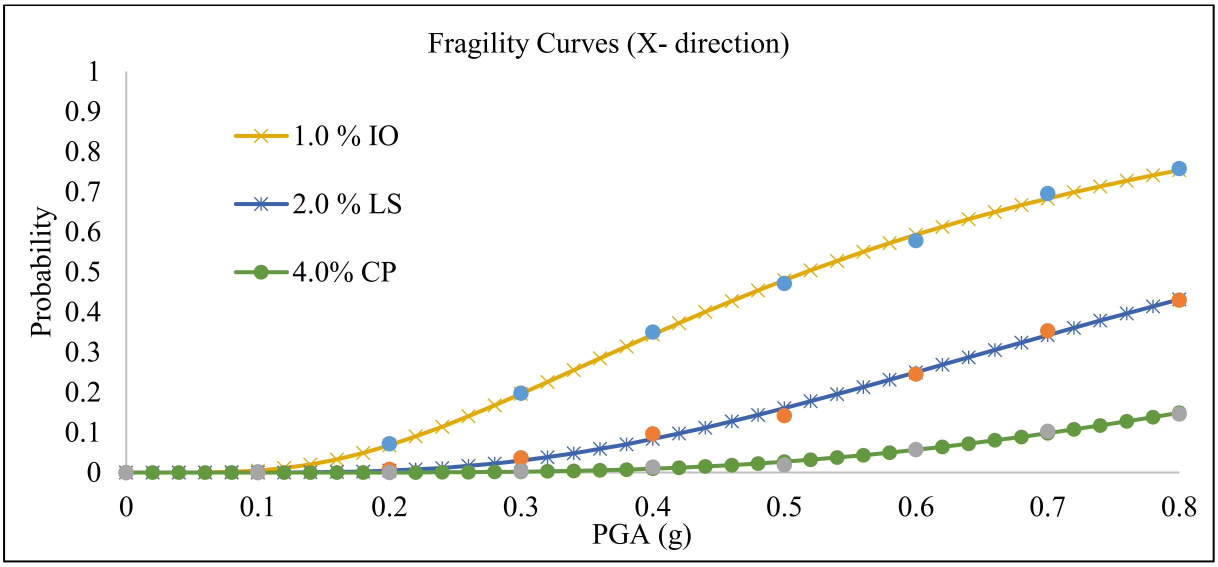

Fig 1. Fragility curve based on criteria by FEMA 356 for target building in X- direction

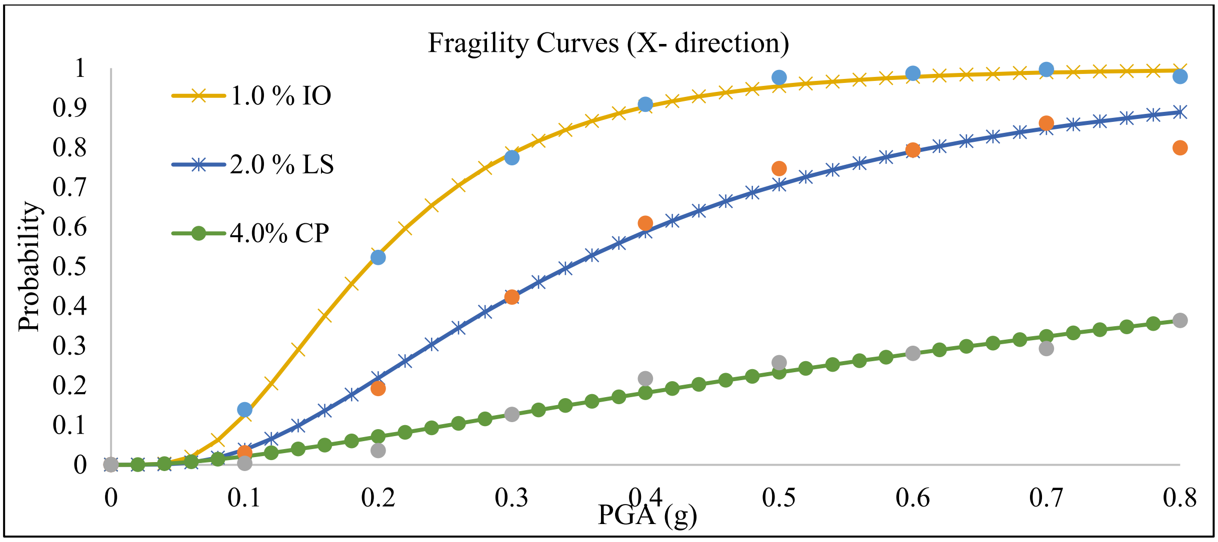

Fig 2. Fragility curve based on criteria by FEMA 356 for SMK Ranau in X- direction

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WAVELET-HILBERT TRANSFORM-BASED APPROACH FOR BUILDING CAPACITY CURVE ESTIMATION IN STRUCTURAL HEALTH MONITORING

Joseph Darwin JARAMILLO DEL AGUILA[1] **Supervisor: Koichi KUSUNOKI**[2]

ABSTRACT

Signal processing is essential in Structural Health Monitoring (SHM) for accurate building damage assessment. Previous studies have addressed this by estimating the building capacity curve by reducing Multi Degree of Freedom (MDOF) system to an equivalent Single Degree of Freedom (SDOF) system. However, challenges remain in correctly isolating the fundamental vibration mode while neglecting higher mode contributions to obtain the equivalent SDOF response. Based on this issue, the present study synergistically combines the Discrete Wavelet Transform (DWT) and the Hilbert Transform (HT) to perform a dynamic filtering process in both time and frequency domains, enhancing the isolation of the fundamental vibration mode. This new approach is validated with numerical simulations from several Reinforced Concrete (RC) frame buildings models subjected to different seismic scenarios for different levels of non-linearity. Results indicate that the proposed approach significantly improves the isolation of the fundamental vibration mode compared to previous research, although it has minimal impact on the final capacity curve estimation in most cases. However, there is a substantial improvement in the estimated hysteretic response curves, offering a significant advantage in producing more accurate hysteretic models for constructing reliable mathematical models. Further research is recommended to explore scenarios with significant impact on the estimated capacity curve, considering capturing the progression of structural damage over time during seismic events. Additionally, algorithms for the automatic definition of the boundary frequencies for the dynamic filter process should be developed to reduce the subjective judgment and its practical application in SHM systems.

Keywords: RC building, DWT, HT, Capacity curve, SHM.

[1] Japan Peru Center for Earthquake Engineering Research and Disaster Mitigation (CISMID), Peru.
[2] Earthquake Research Institute (ERI), The University of Tokyo.

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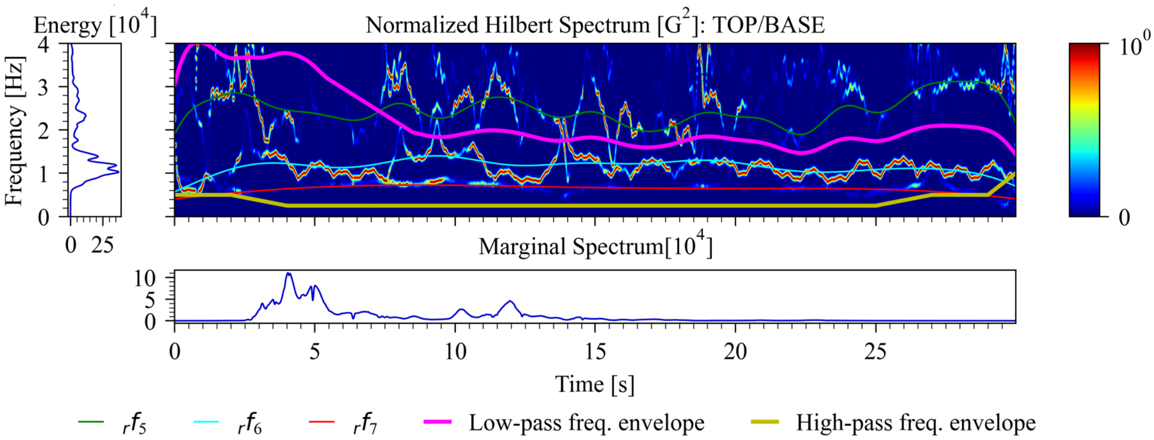

Fig 1. Results from the normalized top over base Hilbert spectrum for the most critical scenario. The spectrum is shown as an intensity color map (blue and red colors for low and high energy levels, respectively), where the frequencies decrease due to the high level of damage, which stars at approximately the second 7. Here, the second mode after damage overlaps the first mode before the damage, and then the defined low and high-pass frequency envelopes successfully isolate the fundamental vibration mode response.

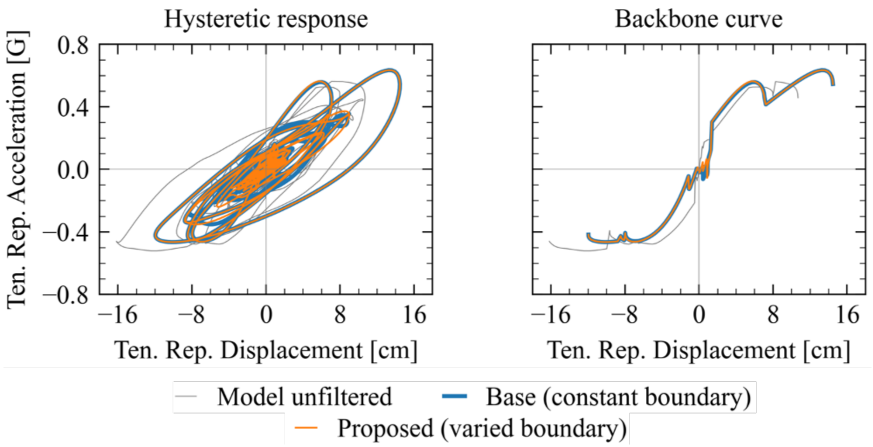

Fig 2. Hysteretic relationship between the equivalent accelerations and displacements and the extracted backbone curve. In the time interval (from 7 to 18 s), both methodologies diverge considerably. The time history of the representative acceleration in the base methodology (blues curves) exhibited local variations attributable to the residual contribution of the second mode. These variations manifest in the hysteretic response as concave and less-smooth shapes contrary to the proposed methodology (orange curves). Although the obtained capacity curves were practically identical, their hysteretic response curves differed considerably, where a substantial improvement was observed, particularly in the section that examined the influence of the contribution of the second mode. Then, this proposed methodology offers a significant advantage in enhancing the precision of hysteretic model estimation, which is crucial for constructing reliable mathematical models.

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SEISMIC FRAGILITY EVALUATION OF MID-RISE RC STRUCTURES INCLUDING SOIL-STRUCTURE INTERACTION

Mustafa Mert EYÜPGİLLER[1] **Supervisor: Shoichi NAKAI[2]**

ABSTRACT

Seismic vulnerability assessment of mid-rise residential RC structures is critical for urban earthquake risk mitigation, especially in seismically active regions like Istanbul. Traditional fragility evaluations often treat structures as fixed-base systems, neglecting the significant influence of soil-structure interaction. This study aims to develop comprehensive seismic fragility curves for mid-rise residential RC structures that explicitly incorporate soil-structure interaction effects, providing a more accurate representation of structural vulnerability under various earthquake scenarios. Three different modeling approaches were employed: the fixed-base model, the sway-rocking soil springs model, and the finite elements model with solid elements for soil. Additionally, the latter model is used to investigate the effects of plasticity on the fragility assessment. The results indicate that the third model, which incorporates detailed soil-structure interaction, consistently shows higher probabilities of exceeding performance levels at lower PGAs compared to the other two models. This suggests that simplified models may underestimate the seismic vulnerability of structures. It is also found that the building is less damaged when the soil is modeled as elastoplastic since it decreases the amplitude of the strong ground motion. The study highlights the importance of considering SSI in seismic fragility assessments to achieve more accurate and realistic predictions of building performance. The methodology developed, including the semi-automated analysis process using programming languages, provides a robust framework for conducting large-scale seismic fragility assessments. This approach can be extended to evaluate a wider range of building types, heights, and soil conditions, contributing to more comprehensive seismic risk assessments for urban areas. The findings of this research contribute to the ongoing efforts to improve earthquake resilience in Istanbul and similar seismically active regions. By demonstrating the critical role of SSI in fragility assessments, the study calls for a reevaluation of current seismic design practices and risk assessment methodologies.

Keywords: Seismic Fragility Assessment, Fragility Curves, Soil-Structure Interaction, Soil Springs, Numerical Models.

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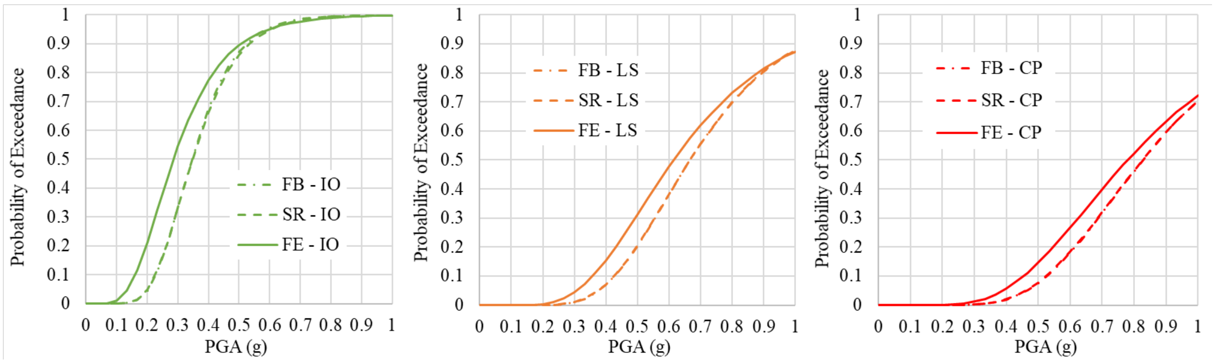

Figure 1: Comparison of Immediate Occupancy Damage Level (IO), Life Safety Damage Level Damage Level (LS) and Collapse Prevention (CP) fragility curves for each damage limit and for the Fixed-Base model (FB), the Sway-Rocking model (SR) and for the Finite Elements model with the solid elements (FE)

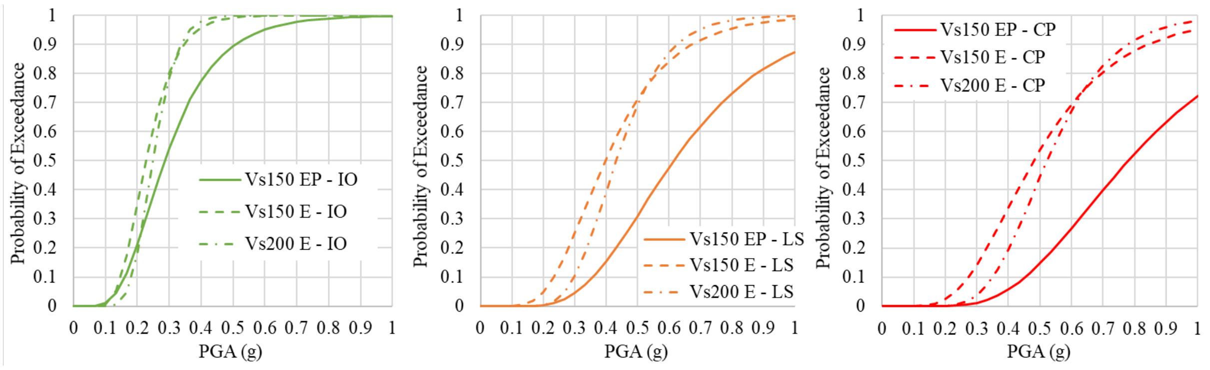

Figure 2: Comparison of various soil fragility curves for elastoplastic (EP) soil with Vs = 150 m/s, elastic (E) soils with V_s = 150 m/s and V_s = 200 m/s for the finite elements model with the solid elements

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SEISMIC SAFETY EVALUATION OF REINFORCED CONCRETE TUNNEL FORM RESIDENTIAL BUILDINGS IN TURKMENISTAN

Perhat CHARYYEV[1] **Supervisors: Tatsuya AZUHATA**[2]**, Yusuke OKI**[3]

ABSTRACT

Turkmenistan is vulnerable to earthquakes. Over the last thirty years, the country has witnessed a rise in construction, particularly with multi-story RC tunnel-form buildings. To evaluate the potential risk of seismic damage from a significant earthquake, which is likely to happen in the future, we have decided to assess the safety of a typical RC tunnel-form building.

The study evaluated the seismic performance of reinforced concrete (RC) tunnel-form buildings with marble panels in Turkmenistan. These buildings are generally designed using the equivalent elastic method with linear analysis. Although this performance verification method is standard worldwide, it only indirectly evaluates safety in major earthquakes by reducing the design seismic force by the response modification factor (R factor), making it difficult to ascertain the ultimate performance. Therefore, we survey the ultimate seismic performance of the target building in this study using the first screening method of JBDPA and the capacity spectrum method using the Pushover analysis. The results of the first screening were less than the standard value of 0.8, and the seismic resistance was judged insufficient. The same result was also obtained by the capacity spectrum method. The risk of falling of the marble exterior was judged to be not so great because of the use of a joint method with excellent deformation-following properties.

The findings suggested that the case did not have sufficient seismic resistance to a major earthquake. The study recommended increasing the R factor and wall shear strength, as well as leveraging advanced non-linear analysis tools for better prediction of seismic behavior. While the analysis was based on a single case, it underscores the need for broader research on Turkmenistan's RC buildings, highlighting significant potential for enhancing seismic performance through strategic design adjustments.

Keywords: seismic performance, RC tunnel-form building, JBDPA.

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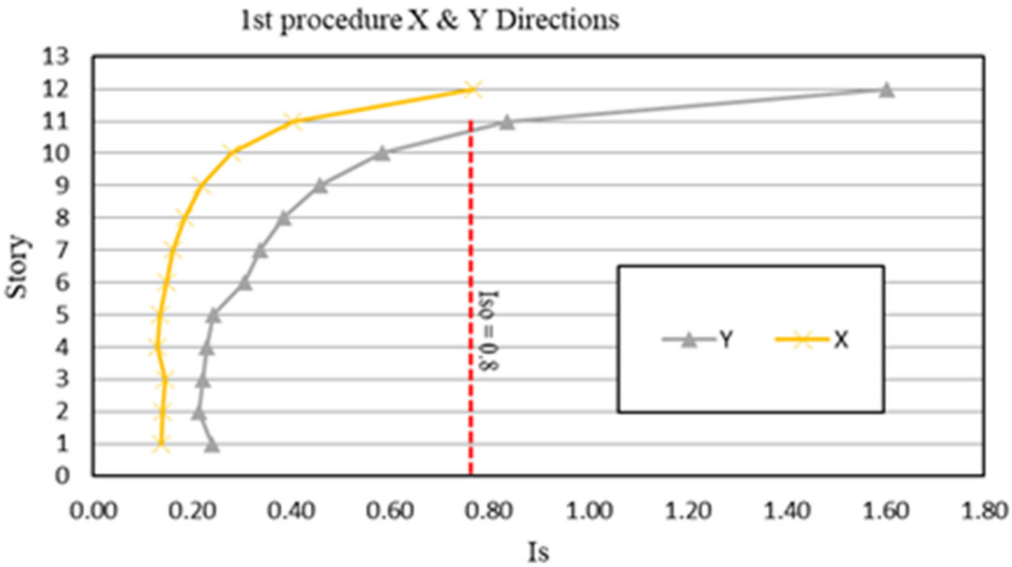

Fig 1. Results from First Screening Evaluation according to JBDPA (x, y dir.).

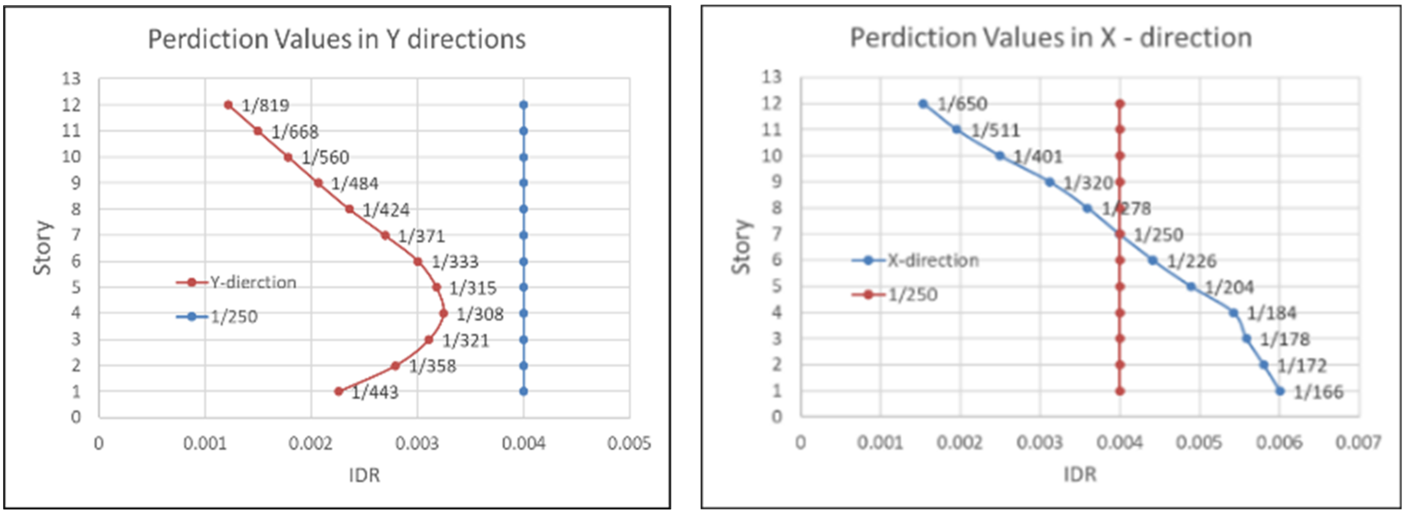

Fig 2. Prediction values in (a) x and (b) y -directions

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EFFECTIVENESS OF TSUNAMI TEMPORARY EVACUATION SITES (TES) IN PANGANDARAN VILLAGE USING AGENT-BASED MODELING

Fajar Tri HARYANTO[1]

Supervisors: Shunichi KOSHIMURA[2]**,**
Erick MAS[2]

ABSTRACT

In 2006, a tsunami triggered by an Mw 7.7 earthquake hit Pangandaran village, causing around 600 fatalities. Subsequently, efforts to improve tsunami preparedness were initiated and have been steadily advanced ever since. At present, Pangandaran is acknowledged as one of the nine villages by UNESCO-IOC for being a tsunami-prepared community in Indonesia, which indicated by having a tsunami evacuation plan, including nine Tsunami Temporary Evacuation Sites (TESs). This research evaluates those nine TESs by determining based on demand (over and under) using the capacity demand index (CDI). Additionally, the streets that are likely to be congested during evacuation were investigated. The CDI was calculated from the result of an agent-based model, which was based on the Tohoku University numerical analysis model for investigation of evacuation no. 1 (TUNAMI-EVAC1), an agent-based tsunami evacuation simulation framework written in NetLogo. A worst-case earthquake with Mw8.7 that occurred in the southern Java subduction zone was considered herein. This model was customized to represent the actual state of Pangandaran village using population data from UNESCO-IOC and questionnaire data from a previous study. The developed model contained an uncertain variable, i.e., population distribution. The model was thus run with 150 repetitions to obtain a reliable conclusion. The corresponding results revealed that an average of two TESs faced over-demand, whereas the other seven experienced under-demand. The highest demand was observed for the Pangandaran Grand Mosque, with an average CDI of 2.78, followed by the Krisna Beach hotel with an average CDI of 1.05. Significant congestion was noted on Parapat street and Kidang Pananjung street located in the center of Pangandaran village.

Keywords: agent-based modeling, tsunami evacuation simulation, NetLogo, Pangandaran.

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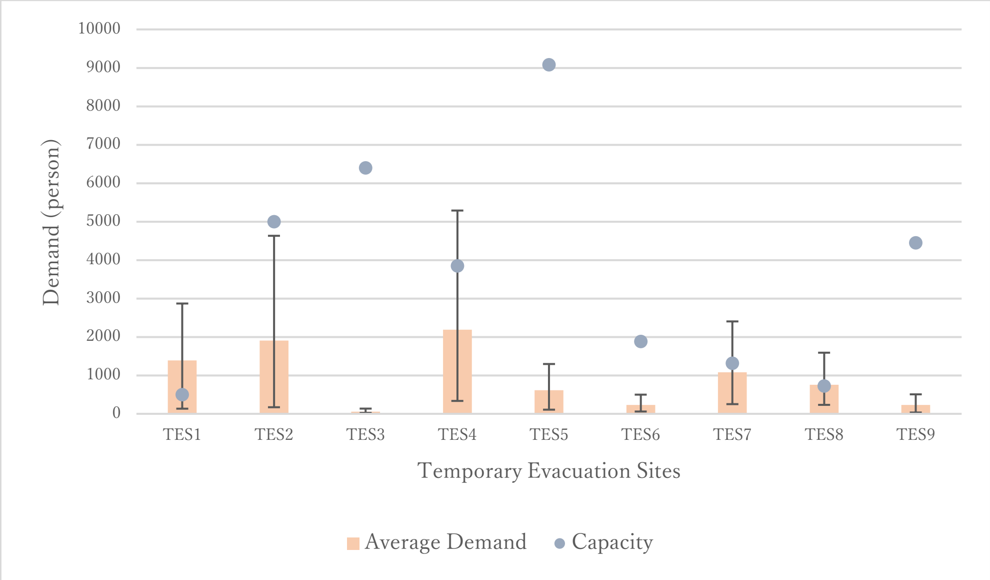

Fig 1. TES capacity vs. average demand. On average, TES1 and TES8 are over-demanded, whereas other TES are under-demanded.

Fig 2. Congestion severity map indicates how severe the congestion is on a specific road. The higher the number (dark red), the more severe the congestion was.

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HIGH-RESOLUTION TSUNAMI INUNDATION PREDICTION USING MACHINE LEARNING TECHNIQUES

Sesar Prabu Dwi SRIYANTO[1]

Supervisors: Shunichi KOSHIMURA[2], Bruno ADRIANO[2]

ABSTRACT

A tsunami early warning system is crucial for mitigating tsunami impacts by providing immediate warnings after earthquakes, which enables prompt evacuations. Current systems estimate shoreline tsunami heights but lack detailed inundation maps due to high computational demands. This study aims to apply a U-Net model-based prediction algorithm to generate these inundation maps efficiently. A pre-computation tsunami database was created with low-resolution tsunami height and high-resolution inundation models using 1044 scenarios from the Sunda subduction zone targeting Pangandaran, West Java, Indonesia. The U-Net network was then trained with low-resolution inputs and high-resolution outputs. During training, 15 experiments were conducted with varying numbers of samples (1044, 800, 600, 400, and 200) and input resolutions (81, 27, and 9 arc-seconds) to find the optimal model. Evaluation using six synthetic scenarios showed that the mean square error (MSE) approached zero and the intersection over union (IoU) scores were near one, indicating high accuracy. The best results came from the largest sample size (1044) and highest resolution (9 arc-seconds). However, a 27 arc-second resolution was chosen to balance accuracy and computational efficiency, allowing inundation maps to be produced in about three minutes. When applied to the 2006 Java tsunami, this U-Net model matched the numerical model with an MSE of 0.45 and an IoU of 0.97. The model also accurately predicted inundation heights at field survey locations, with a K number of 1.13, showing close alignment with observed values.

Keywords: Tsunami Early Warning, Tsunami Inundation, Machine Learning.

[1] Agency for Meteorology, Climatology, and Geophysics (BMKG), Indonesia.
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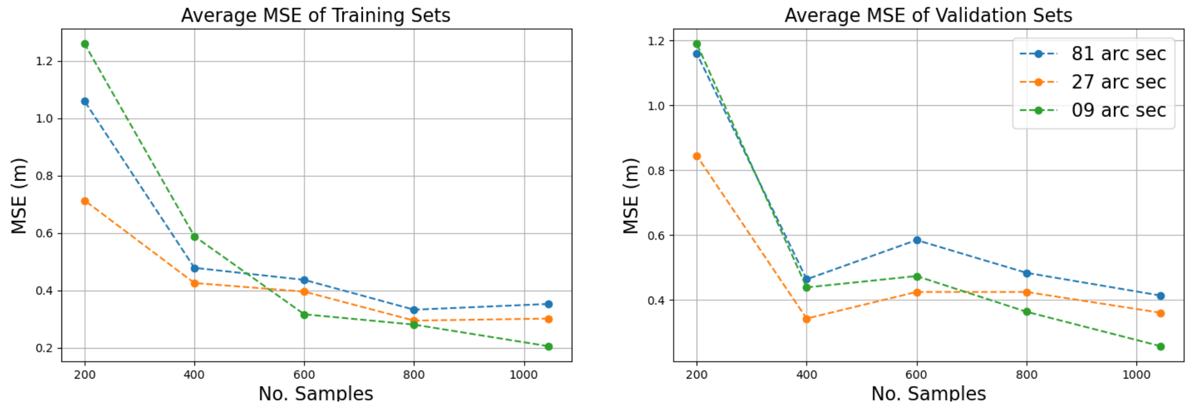

Fig 1. Average MSE for training (left) and validation (right) datasets as a function of the total number of training samples for different input resolutions.

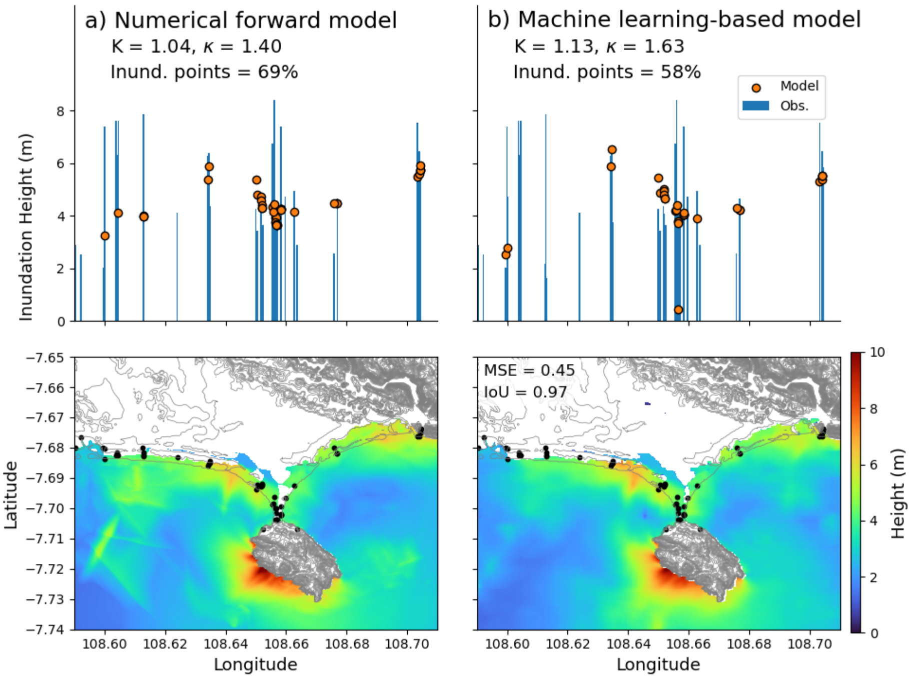

Fig 2. Retrospective test result for the 2006 Java tsunami using the (a) numerical forward and (b) machine learning-based models. These charts plot only the inundation height on survey points that are inundated by the modeled tsunami.

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STUDY ON THE STABILITY OF SEAWALL/ EMBANKMENT IN SULTAN KUDARAT AGAINST HISTORICAL LARGE TSUNAMI IN THE PHILIPPINES

PONCE Engracio Jr. Carpio[1]

Supervisors: Naoki TSURUTA[2], Hideaki YANAGISAWA[3], Bunichiro SHIBAZAKI[4]

ABSTRACT

In this study, tsunami hazard assessment was conducted along the constructed seawall in Sultan Kudarat, Philippines, and its slope stability against the August 15, 1918, historical tsunami event was verified. The nesting grid system was used to simulate a nonlinear long wave tsunami. The maximum tsunami height at the front of the seawall was 7.79 m without seawall and 9.42 m with seawall conditions, whereas the maximum tsunami inundation at the front of the seawall is 5.93 m without seawall and 6.85 m with seawall conditions. Due to the constructed seawall, the inundation at the rear side was reduced by ~40%. In addition, the wave coefficient of hydrostatic pressure at the front and rear sides of the seawall was derived using CADMAS-SURF/3D, and three sections of the seawall were analyzed for slope stability. One section was typical with no loading condition. The pressures computed using the semi-empirical equations at the front bottom (p_1), front top (p_2), rear bottom (p_3), and rear top (p_4) of the seawall, in KPa, were 57.68, 41.32, 9.12, and 3.41 for section 1 and 71.70, 37.44, 33.10, and 22.77 for section 2, respectively. Slope stability analysis against sliding performed using the circular slip method by Fellenius/Petterson and simplified Bishop shows that an acceptable factor of safety of 2.55 and 2.84 for a typical section, 1.47 and 1.68 for section 1, and 1.33 and 1.55 for section 2. Hydraulic experiment was conducted for the future design of the required mass of armor units for additional stability. In future studies, other historical events such as August 17, 1976, may be considered. Tsunami inundation and the necessity of seawalls in other areas in Southern Mindanao may also be evaluated in the future. Other sections of the seawall, including other modes of failure, may also be considered to obtain a more disaster-resilient structure.

Keywords: Seawall, Tsunami Wave Forces, Slope Stability, Sultan Kudarat

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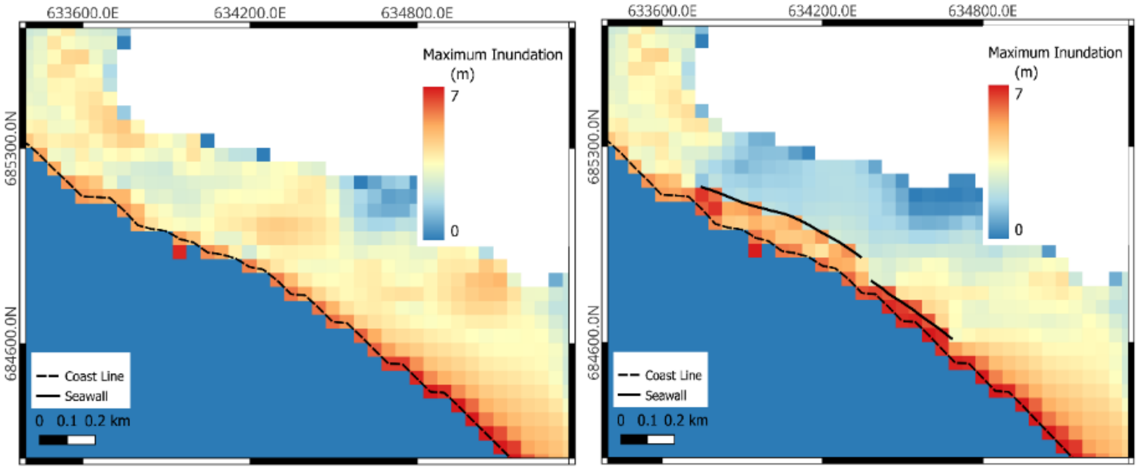

Fig 1. Maximum tsunami inundation without (left) and with (right) seawall conditions. The figures are magnified view near the seawall from layer 04.

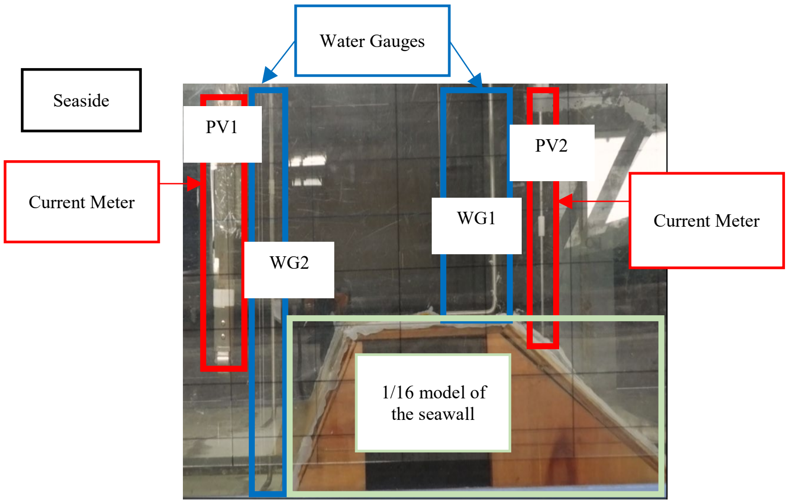

Fig 2. Setup for the hydraulic experiment.

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