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Ni Nyoman Kencanawati <nkencanawati@unram.ac.id>

[jets] Submission Acknowledgement from Journal of Engineering and Technological Sciences

2 pesan

Prof.Dr. Tjandra Setiadi <jets@lppm.itb.ac.id> 7 Februari 2020 pukul 20.18
Kepada: Dr Ni Nyoman Kencanawati <nkencanawati@unram.ac.id>

Dear Dr Ni Nyoman Kencanawati,

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With kind regards,

Prof.Dr. Tjandra Setiadi
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Prof.Dr. Tjandra Setiadi <jets@lppm.itb.ac.id> 7 Februari 2020 pukul 20.36
Kepada: Dr Ni Nyoman Kencanawati <nkencanawati@unram.ac.id>

Dear Dr Ni Nyoman Kencanawati,

This is to confirm that the manuscript, "Evaluation of Building Seismic Design Parameters in Mataram City Using Lombok Earthquake 2018 Ground Motion", has been received for consideration in the Journal of Engineering and Technological Sciences.

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Revision 13104 [jets] Editor Decision from Journal of Engineering and Technological Sciences

4 pesan

jets@lppm.itb.ac.id <jets@lppm.itb.ac.id> 22 April 2020 pukul 11.32
Kepada: nkencanawati@unram.ac.id
Cc: itbjournal <itbjournal@gmail.com>

Dear Dr Ni Nyoman Kencanawati,

We have reached a decision regarding your submission to Journal of Engineering and Technological Sciences, "Evaluation of Building Seismic Design Parameters in Mataram City Using Lombok Earthquake 2018 Ground Motion".

Our decision is: Revision Required.

If you are able to correct the paper taking into account all of the points raised in the referees' report, I would be willing to arrange for the paper to be reviewed again. Revisions should be submitted within 14 days.

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To upload your revision's comments and other additional files (if any), click on "Add a Supplementary File" under Summary tab.

Thank you, and we look forward to receiving your revised manuscript.

With kind regards,

Prof.Dr. Tjandra Setiadi
Journal of Engineering and Technological Sciences
Institut Teknologi Bandung
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Yes

Do the data presentation and interpretation valid and reasonable?:
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Have the discussion and/or analysis been relevant with the results of the study?:
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Are the references used relevant?:
Yes

Contribution to science::
Very Good

Originality:
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Is the research methodology or the approach of the problem solving clearly described?:
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Do the data presentation and interpretation valid and reasonable?:
Yes

Do the use of tables and figures help to clarify the explanation?:
Yes

Have the discussion and/or analysis been relevant with the results of the study?:
Yes

Are the references used relevant?:
See Comment

Contribution to science::
Good

Originality:
Good

Systematic::
Very Good

Language::
Good

Writing Accuracy::
Very Good

Comments to Author::
literature should be added to the more recent, in addition to journals also books about the earthquake and articles that are more relevant to lombok earthquake.

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Ni Nyoman Kencanawati <nkencanawati@unram.ac.id> 22 April 2020 pukul 12.39
Kepada: "Prof.Dr. Tjandra Setiadi" <jets@lppm.itb.ac.id>

Dear Prof Setiadi,

I would like to say thank you for your email.
I will revise the manuscript according to the comments and suggestions and submit back the revised version to JETS online system according to the specified time.

Sincerely yours
Ni Nyoman Kencanawati, Ph.D

[Kutipan teks disembunyikan]

Ni Nyoman Kencanawati <nkencanawati@unram.ac.id> 23 April 2020 pukul 12.42
Kepada: I G P Suta Wijaya <gpsutawijaya@unram.ac.id>

[Kutipan teks disembunyikan]

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Ni Nyoman Kencanawati <nkencanawati@unram.ac.id> 25 April 2020 pukul 13.57
Kepada: "Prof.Dr. Tjandra Setiadi" <jets@lppm.itb.ac.id>

Dear Prof. Setiadi,
Editor in Chief of JETS

I would like to inform you that I have submitted the revision file along with the supplementary file (author's response form) in the system successfully. However, when I try to attach another file as a supplementary file which is required from Reviewer A (plagiarism checker), the file can not be uploaded. Therefore, I attach the supplementary file required from Reviewer A through this email. Thank you for your attention.

Sincerely yours,
Ni Nyoman Kencanawati
[Kutipan teks disembunyikan]

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TABLE Author's Respond Form

Paper ID	: 13104
Title	: Evaluation of Building Seismic Design Parameters in Mataram City Using Lombok Earthquake 2018 Ground Motion
Authors	: Ni Nyoman Kencanawati, Didi Supriyadi Agustawijaya & Rian Mahendra Taruna
Submission date	: February, 7th 2020
Revision date	: February, 23rd 2020
Round	: 1
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Round : 1

Reviewers' Evaluation	**Details of Author's Respond**	**Modification**
Reviewer A Comments	**Author's Respond**	
1. If the probability is 2% with a 50-year probability, is the confirmation cycle 2500 years? Does that mean that an event occurs onc every 2500 years?	1. SNI-1726:2012 specifies the ground motion values with a 2% probability of being exceeded in 50 years. It means that the spectral acceleration has a return period of 2475 years as this equation show. The return period of earthquake with 2% probability of being exceeded in a 50 years building expected life time, can be estimated by: $R_n = \left\{1-\left(1-\frac{1}{T_R}\right)^N\right\} x100\%$ Where: R_N is the probability of an earthquake occurring during the building expected life (2%). N is the expected life of a building (50 years). Thus, it gives the return period (T_R) = 2475 years.	
2. Is the title more appropriate for Investigation than Evaluation?	2. Yes, we accept the reviewer's suggestion	1. The title has been changed to: An Investigation of Building Seismic Design Parameters in Mataram City Using Lombok Earthquake 2018 Ground Motion

3. Units are not shown in italics. (Second; s)	3. Yes, we revised the manuscripts arcording to reviewer's suggestion	2. The unit '*s*' has been replaced by a normal style. All the unit of 's' in entire text is highlighted by yellow color to facilitate the checking process.
4. Since g of the gravitational acceleration is different from g of the unit (gram) of the mass, it is necessary to change the font face.	4. Yes, we accept the reviewer's suggestion	3. The gravitational acceleration 'g' has been written as your suggestion using italics serif letter. All the changes are highlighted in the text by yellow color to help the checking process.
5. There may be other grammatical or notational problems. Therefore, it is necessary to perform proof-reading	5. Yes, we agree with the reviewer's suggestion.	4. To consider the reviewer's suggestion, we used the Grammarly Checker and Turnitin tool for revising the manuscript. In addition, the result of Turnitin that indicates the plagiarism score is attached on the supplementary file.
6. Reviewer attach the other file as reference for revision. Please see carefully.	6. Please see the entire revised manuscript that the suggestion has been accommodated and all the correction has been made to the text with highlighted yellow color and red typed.	
Reviewer C Comments	**Author's Respond**	
1. Literature should be added to the more recent, in addition to journals also books about the earthquake and articles that are more relevant to lombok earthquake.	1. Yes, we accept the reviewer's suggestion.	1. Books and journals related to Lombok 2018 earthquake have been added to enrich the literature and to improve the analysis. **Books:** Two books related to earthquake engineering and earthquake resistant's structures have been included, therefore three books are referred in the manuscript. a. The book related to basic earthquake engineering to strengthen the review on the ground motion is provided in: [21] A. S. Elnashai and L. Di Sarno, *Fundamentals of earthquake engineering*. Wiley New York, 2008. b. The book related to earthquake resistant structures to improve the analysis of the building design paramaters is provided in: [22] V. Gioncu and F. M. Mazzolani, *Earthquake Engineering for Structural Design*. New York, USA:

		Roudledge, 2013. [23] S. K. Duggal, *Earthquake resistant design of structures*. Oxford university press New Delhi, 2007. **Journals** There are 5 journals that published in most recent years have been cited in the manuscript. a. Journals related to damage after earthquake: [3] A. Pomonis, J. Daniell, R. Gunasekera, A. Schaefer, and J.-U. Skapski, "The 2018 Lombok and Palu, Indonesia, earthquakes: Loss data uncertainties, cascades and implications.," in *Geophysical Research Abstracts*, 2019, vol. 21. [4] Asmirza, M Sofian, "Analysis of school damage due to Lombok earthquake on August 2018," *E3S Web Conf.*, vol. 156, p. 5019, 2020. b. Journals related to the occurrence of Lombok earthquake: [18] P. Supendi *et al.*, "Relocated aftershocks and background seismicity in eastern Indonesia shed light on the 2018 Lombok and Palu earthquake sequences," *Geophys. J. Int.*, vol. 221, no. 3, pp. 1845–1855, 2020. [19] Agustan, R. N. Hanifa, Y. Anantasena, M. Sadly, and T. Ito, "Ground Deformation Identification related to 2018 Lombok Earthquake Series based on Sentinel-1 Data," *{IOP} Conf. Ser. Earth Environ. Sci.*, vol. 280, p. 12004, Aug. 2019. c. Journal related to the results of the post-Lombok earthquake study is needed to better disaster mitigation for the future: [27] F. Ramdani, P. Setiani, and D. A. Setiawati, "Analysis of sequence earthquake of Lombok Island, Indonesia," *Prog. Disaster Sci.*, vol. 4, p. 100046, 2019. Please see all the additional journals suggested in cyan highlighted and red typed in the manuscript.

An Investigation of Building Seismic Design Parameters in Mataram City Using Lombok Earthquake 2018 Ground Motion

Ni Nyoman Kencanawati[1], Didi Supriyadi Agustawijaya[1] & Rian Mahendra Taruna[2]

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[2] Meteorology, Climatology and Geophysics Agency, Jl. Tgh. Ibrahim Khalidi, 83362 Lombok Barat, Indonesia
Email: nkencanawati@unram.ac.id

Novelty: The strong earthquake in Lombok in 2018 caused an increase in spectral acceleration compared to what is stated in Indonesia's current earthquake code. As a result, changes affect building design parameters. This paper showed that the seismic response factor of the building increased by 10.782% and 13.168% on medium and soft soil, respectively, compared to that of the current code. It also recommends that seismic codes need to be improved to provide better preparedness for future seismic risk reduction.

Highlight:
- Spectral acceleration using the Lombok Earthquake 2018 is analyzed,
- The spectral acceleration is greater than the existing seismic code acceleration,
- The seismic response coefficient is higher than the existing seismic codes,
- Existing seismic building standards need to be improved.

Abstract. Mataram is the capital of West Nusa Tenggara. West Nusa Tenggara is made up of two islands, Lombok and Sumbawa. The 2018 earthquake on Lombok has undoubtedly affected spectral acceleration. This is an important factor to be addressed in structural design. Short period spectral acceleration, S_S increases 18.323% compared to the value listed in the seismic code SNI 1976:2012 corresponding to the 2500 return period. However, even if the S_S value increases, the design category of the building does not change and remains in the D category. In general, the acceleration value in this study is found relatively greater than that of the existing code for periods of less than 0.462 s for site class D, and in periods of less than 0.830 s in site class E. In addition, the seismic response coefficient, $C_{S,}$ for medium soil, it increases by 10.782% compared to the C_S calculated using of the current code. This effect is more severe in soft soil areas where the increase reaches 13.168%. Improving existing codes with seismic design parameters for new buildings affected by the ground motion of recent strong earthquakes will lead to more preparedness and will be an important part of local disaster risk reduction.

Received ________, Revised _________, Accepted for publication __________

Keywords: *Lombok earthquake 2018; spectral acceleration; seismic design parameters, seismic code*

1 Introduction

The West Nusa Tenggara region is an area of high seismic activity, surrounded by two active seismic sources. In the south is the subduction zone of the Indo-Australia Sea Plate, and in the north is the back-arc thrust zone. According to the National Institutes of Meteorology, Climatology, and Geophysics (Indonesian: Badan Meteorologi, Klimatologi, dan Geofisika (BMKG)), a magnitude 6.2 magnitude earthquake on June 9, 2016, occurred in Mataram and Central Lombok and caused some damages. Later, in 2017, several quakes were hit at the scale of II-III MMI in Mataram City, as written by Taruna et al. in [1]. In addition, officials reported that there were 3699 earthquake events in 2018 and 215 events were felt. One of a series of Lombok earthquakes on August 5, 2018, with a magnitude of 7.0, caused severe damage to a number of buildings and houses, even some collapsed in Lombok area, including the city of Mataram, as announced by BMKG in [2] and published by Pomonis in [3] and Asmirza in [4].

In the past, some countries have changed their seismic codes after large earthquakes that caused various damage to structures and buildings. As studied by Okamura in [5] and Karakostas et al. in [6], the seismic code has been improved with a new response spectrum affected by recent ground acceleration. Similarly, Indonesia has the current code for seismic structures, namely SNI 1726: 2012 in [7]. The ground motion is calculated with a 2% probability of being exceeded within 50 years. The return period of the spectral acceleration is 2500 years. It replaces SNI 1726:2002 in [8]. SNI 1726:2002 provides spectral acceleration by dividing all areas of Indonesia into six seismic zones. The current Seismic Building Code has been improved by providing spectrally accelerated design values at each coordinate point in Indonesia. Seismic acceleration maps are also attached for spectral accelerations at T = 0 s (PGA), T = 0.2 s (short period), and T = 1 s (long period).

The previous seismic design code, SNI 1726:2002, has been reviewed by Sengara et al. [9]. In addition, compared to the previous seismic code SNI 1726:2002 presented by Arfiadi and Satyarno in [10], some of the Indonesian short period design spectral acceleration, S_{DS}, have a significant increase in current seismic code SNI 1726:2012. Significant increases in S_{DS} are evident in some areas, such as Aceh, Palu, Yogyakarta, and Padang, which were affected by major earthquakes during the time when the previous code was applied. Therefore, the values have been modified in the current code. In Palu, S_{DS} has the largest increase, with 116.7%, 85.7% and 41.2% in hard, medium, and soft soils, respectively. This region was hit by a magnitude 7.7 earthquake in 2008, and the 2012 seismic code changed the spectral acceleration. In the other prone areas mentioned above, the S_{DS} of three types of soil has risen from 10% to 80%. Conversely, Lombok did not show significant seismic activity during that period. Therefore, the 2012 seismic code shows little change in acceleration.

To obtain a new spectral acceleration that includes the site amplification factor, strong ground motions after the earthquake must be considered. This is compared to the existing spectral acceleration provided by the existing code to make sure there is a sufficient design to face strong earthquakes that may occur in the future, as reported by Panzera et al. in [11] and Mase, Likitlersuang, and Tobita in [12]. Furthermore, the evaluation of seismic codes after earthquakes has been carried out in some countries. The earthquake code has been updated to consider the recent ground acceleration due to the earthquake. In addition to the response spectrum, details of the structural design have been improved further as given by Okamura in [5], Karakostas et al. in [6], Sezen et al. in [13], Ergün, Kiraç, and Bacsaran in [14], Mosleh et al. in [15] and Baros and Santa-Maria in [16].

The analysis describes the seismic hazard in Mataram city using seismic data up to 2017 with a 2% probability of being exceeded in 50 years (return period of 2500 years). The short period of bedrock acceleration S_S (T = 0.2 s) and the long period of bedrock acceleration S_1 (T = 1 s) were reported to be in the range of 0.37-0.45 g (g = 9.81m/s^2) and 0.16-0.18 g, respectively. Furthermore, the values of S_S and S_1 in the northern region of Mataram are higher than those in the southern region of Mataram. This is due to the superiority of the Back Arc Thrust activity in northern Lombok as given by Taruna in [1].

The 2018 earthquake on Lombok is an important consideration in spectral acceleration. This is an important factor to be addressed in structural design. Improving the calculation of parameters will lead to the reproduction of the structural design under seismic loading, which is part of disaster risk reduction. It could potentially save millions of people and reduce major risks in the region in the future. Therefore, a new spectral acceleration needs to be approached using the recent 2018 seismic data, which applies to some seismic parameters that will help better seismic structures.

2 Related Research and Theory

According to Agustawijaya, Sulistyono, and Elhuda in [17], Lombok is classified as moderate to high seismic activity. Before the strong earthquake of 2018, this study states that the South Subduction Megathrust and the North Back-Arc Thrust have established the tectonic pattern of Lombok Island as an effect of compression between the Australian continental plate and Eurasia. Then in 2018, a series of earthquakes occurred in North Lombok which was triggered by Flores back arc trust. The ground motion initially began on July 28 with an M_w 6.4 earthquake in the northern part of Lombok. Aftershocks with M_w<5 followed the first earthquake a few hours later. On August 5, a larger shock of M_w 7.0 occurred. Then, in the following two weeks, an M_w 6.9 earthquake hit the island on August 19, 2018. The sequences of Lombok ground motions have been studied in detail by some researchers in [18], [19].

As reported by Marjiyono in [20], in general, the plains of Mataram City are dominated by alluvial deposits with sandy materials, either product of the eastern river process or marine products of the West Side. The alluvium fills an ancient form in the form of a basin in the western part of Mataram. Physically, alluvial sediments are soft and are indicated by low shear wave velocity values. This condition is potentially for areas that experience such wave amplification during an earthquake [21]. In addition, the average measurement of shear wave velocity v_s shows the value range of 135-201 m/s in Mataram City. This value is included in site class D (SD) and site class E (SE) of the current building seismic code.

S_S and S_1 must be determined at T = 0.2 s and T = 1 s, respectively, provided in the ground motion map of the SNI 1726:2012 code, and may exceed 2% in 50 years. By multiplying the S_S and S_1 values by the amplification factor from each site class, the short-period, S_{MS}, and long-term S_{M1} surface maximum ground acceleration can be calculated directly [22], [23]. The amplification factor F_a is related to the acceleration of the short-period S_S, while the amplification factor associated with S_1 is F_v. Furthermore, S_{MS} and S_{M1} values are used to calculate design spectral acceleration parameters for short period, S_{DS} and long period S_{D1}, as described by in SNI 1726:2012 in [7].

3 Method

3.1 Ground Acceleration Data

Ground acceleration data is based on previous work studied by Taruna, Agustawijaya, and Kencanawati in [24]. Earthquake data was obtained from Engdahl ISC (EHB), USGS, and BMKG in 1922-2018. The data was taken at coordinates of the latitude of 7°-12° and longitude of 113.5°-122.5° or about 300 km from Mataram City with magnitude, $M_w \geq 4.5$. This magnitude is assumed to be the standard for earthquakes related to the risk of seismic disasters. In this study, the values of peak ground motion in the bedrock soil layer from the previous study are used. Ground motion or maximum acceleration will be adopted as the parameters used in this study. These parameters are S_S and S_1 which are related to the technical design of earthquake-resistant structures, as shown in Figs. 1-2.

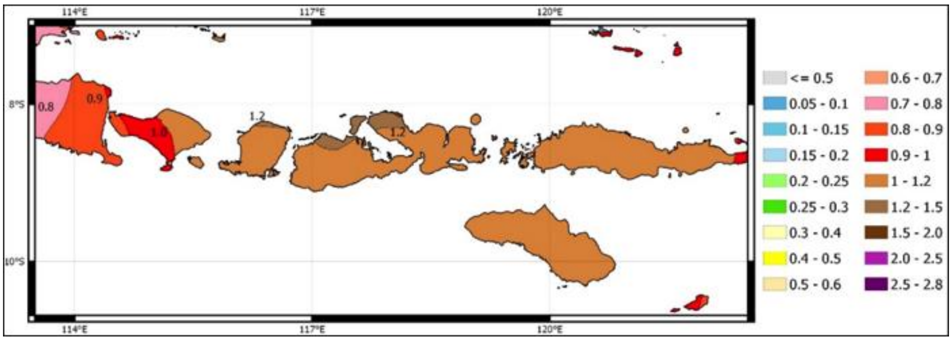

Figure 1 Spectral Acceleration at T = 0.2 s in bedrock with a probability exceeding 2% in 50 years for Bali-West Nusa Tenggara region, Taruna in [24]

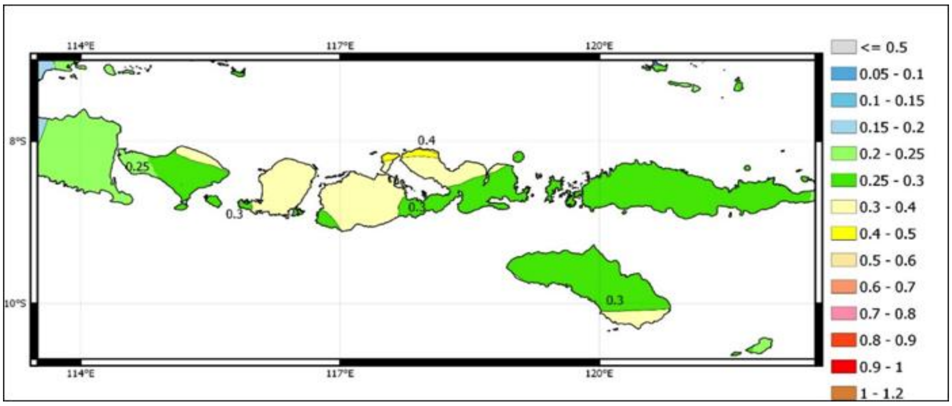

Figure 2 Spectral Acceleration at T = 1 s in bedrock with a probability exceeding 2% in 50 years for Bali-West Nusa Tenggara region, Taruna in [24]

As shown in Fig. 1, in most Lombok regions, S_S values range from 1-1.2 *g*, and in North Lombok, the values are over 1.2 *g*. S_S values tend to be larger than the 0.9-1.2 *g* values for Lombok, calculated in SNI 1726:2012 (Fig. 3). This could be caused by the large earthquake data used in previous studies, especially the increase in the 2018 Lombok earthquake series. On the other hand, the maximum acceleration of S_1 is 0.25 to 0.4 *g*. The S_1values in the Lombok region used in this study are lower than those of SNI 1726:2012 (Fig. 4). In SNI 1726:2012, Lombok's S_1 values range from 0.3 to 0.5 *g*, with the maximum seen in the north.

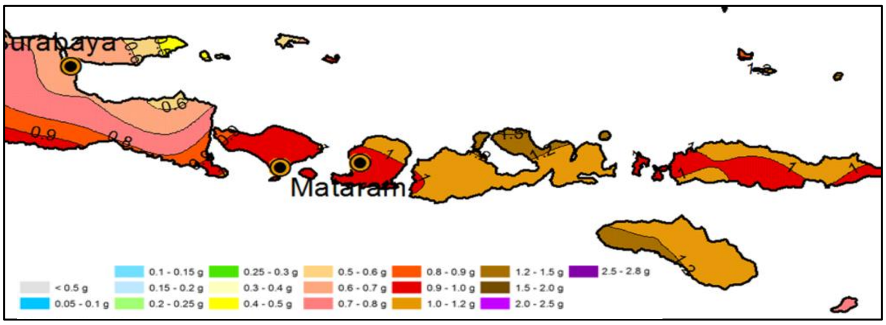

Figure 3 Spectral Acceleration at T = 0.2 s in bedrock with a probability exceeding 2% in 50 years for the Bali-West Nusa Tenggara region, SNI 1726:2012 in [7]

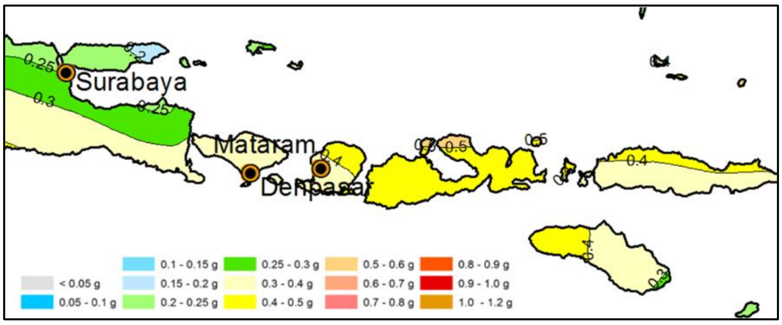

Figure 4 Spectral Acceleration at T = 1 s in bedrock with a probability exceeding 2% in 50 years for the Bali-West Nusa Tenggra region, SNI 1726:2012 in [7]

3.2 Equivalent Lateral Load Factor

The dynamic properties of seismic loads are simplified to horizontal forces with an equivalent lateral load procedure. For the analysis, the seismic response coefficient C_S is determined. SNI 1726:2012 provides instructions for obtaining C_S. It depends on spectral acceleration, S_{DS} and S_{D1} values and parameters such as seismic design category, importance factor, structural fundamental period, response modification factor, etc.

4 Result and Discussion

4.1 Spectral Acceleration

As shown in Figs. 5-6, the strong earthquake in Lombok in 2018 increased the spectral acceleration S_S of Mataram by 1.143 *g*. This value represents the location of Mataram latitude: -8.5606 and longitude: 116.0707. This is an increase of 18.323% from the value listed in SNI 1976:2012. Approximately the same increase as the spectral acceleration in Padang City when provided in the previous seismic code compared to the current code (SNI 1976:2012). This is because Padang experienced a major earthquake in 2009, the transition period between the previous code and the current code. The following Indonesian seismic code assumed that the acceleration of Mataram would be potentially higher due to the 2018 Lombok earthquake, as this study shows. Meanwhile, Sharma in [25] reported that after the Nepal earthquake (M_w 7.9) ground motion, existing spectral accelerations were still applicable to seismic structural engineering design.

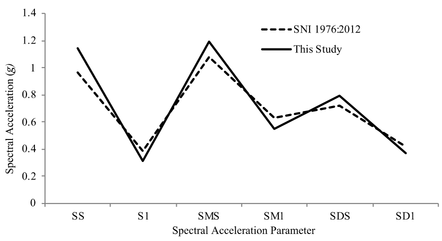

Figure 5 Spectral acceleration parameters in medium soil

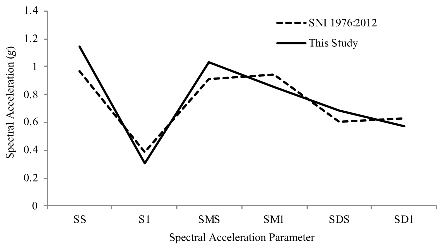

Figure 6 Spectral acceleration parameters in soft soil

Figure 5-6 also shows the spectral acceleration of the maximum considered and design basis earthquakes on the surface at T = 0.2 s (S_{MS} and S_{DS}) and T = 1 s (S_{M1} and S_{D1}) on medium soil (Fig. 5) whereas the parameters for soft soil is illustrated in Fig. 6. The acceleration of the surface is calculated for site class D (SD) and site class E (SE) because Mataram city is made up of medium and soft soils as given by Marjiyono in [20]. The spectral acceleration provided by SNI 1726: 2012 is also shown for comparison.

Contrary to the acceleration of T = 0.2 s, the acceleration of T = 1 s used in this study is smaller than that of SNI 1726:2012 because the constant attenuation equation is not the same between S_S and S_1. Furthermore, theoretically, S_1 is a long period spectrum affected by far-field earthquakes. On the other hand, this study is more dominant near earthquakes.

4.2 Building Seismic Design Category

Considering the ground motion of recent earthquakes, the S_{DS} and S_{D1} values for Mataram are 0.795 *g* and 0.367 *g* for medium soil and 0.686 *g* and 0.569 *g* for soft soil, respectively. According to SNI 1976:2012, buildings at sites with an S_{DS} greater than 0.5 *g* are designed as D categories for all risk categories I-IV (shown in bold in Table 1). Similarly, for S_{D1} values, as shown in Table 2, Mataram has values greater than 0.2 *g* in both medium and soft soils. Therefore, it is included in the D seismic design category (shown in bold in Table 2). S_{DS} values exceed 0.5 *g* and S_{D1} values exceed 0.2 *g*. This is similar to the value in the current code. Thus, even though the results of the study's spectral acceleration appear larger than those present in the current seismic code, there is no change in the seismic design category between the current seismic code and the results of this study.

The D-design seismic category is intended for structures built in the sites which to be potential for severe and damaging earthquakes, but not located close to major faults. As given by Giouncu and Mazolani in [22] dan Duggal in [23], structures on poor soils generally fall into the D class for seismic design. According to Sharma et al. in [25] as mentioned above, there is no change in the spectral acceleration between the existing code and the spectral acceleration after the Nepal earthquake, however, it is recommended to implement the existing code to develop mitigation strategies and structures.

Table 1. Seismic design category for short period response acceleration S_{DS} [5]

S_{DS} (*g*)	**Risk Category**	
	I or II or III	**IV**
$S_{DS} < 0,167$	A	A
$0.167 \leq S_{DS} \leq 0.133$	B	C
$0.133 \leq S_{DS} \leq 0.50$	C	D
$0.50 \leq S_{DS}$	**D**	**D**

Table 2. Seismic design category for long period response acceleration S_{D1} [5]

S_{D1} (*g*)	**Risk Category**	
	I or II or III	**IV**
$S_{D1} < 0,067$	A	A
$0.067 \leq S_{D1} \leq 0.133$	B	C
$0.133 \leq S_{D1} \leq 0.20$	C	D
$0.20 \leq S_{D1}$	**D**	**D**

4.3 Response Spectrum Curve

The spectral acceleration parameters previously obtained in Sub Section 4.1 are described using a response spectrum, which is important for building design as presented in Fig. 7 and Fig. 8, intended for medium soil (SD) and soft soil (SE) respectively. For comparison, the dashed line also shows the spectral acceleration graph based on the current earthquake code SNI 1726:2012. In general, the acceleration in this work is found relatively greater than that of in the current code for periods of less than 0.462 s for D site class (SD), and for periods less than 0.830 s in E site class (SE). The maximum acceleration in SD is 0.795 *g* in the period of 0.092-0.462 s. Meanwhile, in site class E, the maximum spectrum acceleration value is 0.686 *g* in the period of 0.1166-0.830 s. Also, it can be seen that over this period, medium soils amplify the spectral acceleration response more than soft soils.

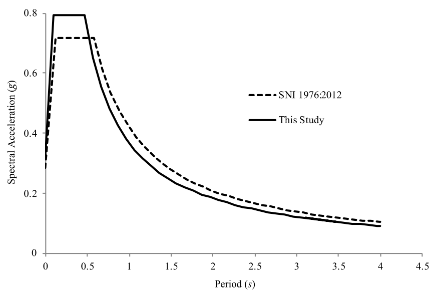

Figure 7 Response spectrum for SD

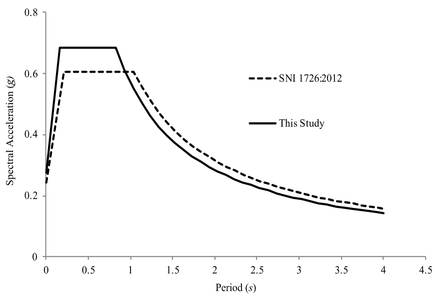

Figure 8 Response spectrum for SE

However, the soft soils generate the long period response more than the medium soils. For a period of T = 1 s, the spectral acceleration for medium soil is 0.367 *g* and for soft soil 0.569 *g*. This trend is consistent with that found in existing building seismic standards where the medium soil spectrum has an acceleration of 0.386 *g* and soft soils of 0.606 *g* each in the long period. During this period, SNI 1726:2012 shows a slightly higher acceleration than the results of this study.

Primarily, a similar shape of the response spectrum curve is seen between the results of this study and the current code. The trend is similar when the medium soil (SD) has higher spectral acceleration than the soft soil (SE) in the short period, but the effect of soft soil higher on spectral acceleration is seen over a longer period as shown in Fig. 9. Such findings are also reported by Dhakal et al. in [26]. During the calculation of seismic loads, the response spectrum is very important. Short period spectral acceleration values are used for an equivalent static analysis to calculate the seismic response factor C_S. Therefore, the effects of the 2018 Lombok earthquake, which produces higher spectral accelerations in a short period of time, may increase the safety of structural designs and improve seismic resistance.

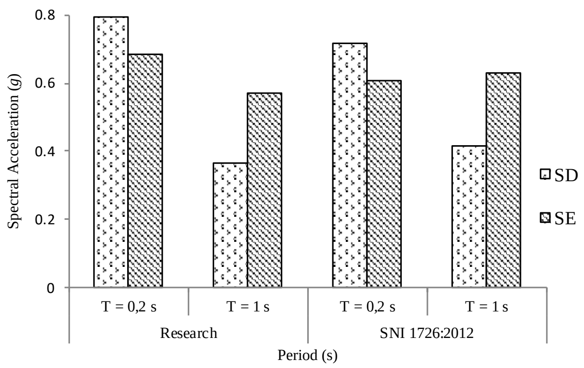

Figure 9 Spectral acceleration at T = 0.2 s and T= 1 s for different soil types

4.4 Seismic Response Coefficient, C_S

Using the procedure for determining seismic response factors (C_S) specified by SNI 1726:2012 in [7], Table 3 shows the values for C_S, maximum C_S, and minimum C_S. The C_S value is calculated under several conditions: risk category = 2, importance factor = 1, response modification factor = 8, building height from base = 20 meters. Coefficients are implemented for both SD and SE types of site classes. The coefficient calculated based on the current code's spectral acceleration is also displayed as a comparison.

Table 3. Seismic Response Coefficient, C_S

Seismic Parameter	Site Class D		Site Class E	
	SNI 1726:2012	This Study	SNI 1726:2012	This Study
S_{DS} (*g*)	0.717	0.795	0.606	0.686
S_{D1} (*g*)	0.418	0.367	0.631	0.569
C_S	0.090	0.099	0.076	0.086
C_S -maximum	0.766	0.673	1.156	1.044
C_S -minimum	0.032	0.035	0.027	0.030

All C_S values are between the minimum and maximum C_S values. In general, the C_S of site class D is higher than the C_S of site class E. This is because C_S depends on the value of the short period spectral acceleration, S_{DS}. As can be seen from Table 3, the S_{DS} for site class D is higher than the S_{DS} for site class E. Therefore, C_S increases in site class D. Conversely, the maximum C_S value for site class E is greater than the maximum value for site class D because of the large spectral acceleration value of S_{D1} at T = 1 s. The maximum value of C_S depends on the value of S_{D1}.

In this study, both sites have higher C_S results compared to SNI 1976: 2012. After a strong Lombok earthquake, the seismic coefficient C_S increases by 10.782% when compared to C_S calculated using the current code. The effect is more severe in soft soil areas, which is an increase of 13.168%. The higher the C_S, the greater the seismic load on the building structure. It is recommended that current seismic regulations be revised to consider the effects of the last strong earthquake, as this will have a significant effect on the increase in seismic loads experienced by the structure. Changes include enhancements to existing building structures. Therefore, new or old buildings may be more resistant to future earthquakes. A similar recommendation has also been delivered by

Ramdani, Setiani, and Setiawati in [27] that studies on the Lombok earthquake could support a robust mitigation system for the area.

5 Conclusion

This study describes the parameters of Mataram's seismic building design by considering the effects of the 2018 earthquake in Lombok.

• Short period spectral acceleration, S_S increased 18.323% compared to the values listed in SNI 1976:2012. However, the value of the spectral acceleration in for the period T = 1 s, $S_{1,}$ is smaller than the value described in the existing earthquake code.

• Higher design spectral acceleration values shown in this study do not change the design of the Mataram earthquake category

• According to response spectrum curve, overall, the acceleration value in this study is found relatively greater than the that of the existing code for periods of less than 0.462 s for site class D, and in periods less than 0.830 s in site class E. The maximum acceleration in site class D from the results of the study is 0.795 *g* in the period of 0.092 to 0.462 s. For site class E, the maximum spectrum acceleration value is 0.686 *g* in the period of 0.1166 to 0.830 s.

•Soft soils react longer than medium soils. For the time period of T = 1 s, the spectral acceleration of medium soil is 0.346 *g* and soft soil produces 0.553 *g*.

• Basically, a similar shape of the response spectrum curve is seen between the results of this study and recent codes. Medium soil (SD) has higher spectral acceleration than soft soil (SE) in a short period, but the effect of soft soil higher on spectral acceleration is seen over a longer period.

•In this study, both site classes D and E have a higher seismic response coefficient compared to SNI 1976:2012. The seismic coefficient C_S after the Lombok strong ground motion increases by 10.782% compared to the C_S calculated using the current code. Soft soil is more prone because the C_S increases 13.168%.

• Immediate revisions to current seismic building codes by considering the impact of the last strong earthquake to strengthen the preparation of seismic structures is recommended.

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13104 [jets] Editor Decision from Journal of Engineering and Technological Sciences

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Title	: Evaluation of Building Seismic Design Parameters in Mataram City Using Lombok Earthquake 2018 Ground Motion
Authors	: Ni Nyoman Kencanawati, Didi Supriyadi Agustawijaya & Rian Mahendra Taruna
Submission date	: February, 7th 2020
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J. Eng. Technol. Sci, Vol. XX, No. X, 20XX, XX-XX

An Investigation of Building Seismic Design Parameters in Mataram City Using Lombok Earthquake 2018 Ground Motion

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Novelty: The strong earthquake in Lombok in 2018 caused an increase in spectral acceleration compared to what is stated in Indonesia's current earthquake code. As a result, changes affect building design parameters. This paper showed that the seismic response factor of the building increased by 10.782% and 13.168% on medium and soft soil, respectively, compared to that of the current code. It also recommends that seismic codes need to be improved to provide better preparedness for future seismic risk reduction.

Highlight:
- Spectral acceleration using the Lombok Earthquake 2018 is analyzed,
- The spectral acceleration is greater than the existing seismic code acceleration,
- The seismic response coefficient is higher than the existing seismic codes,
- Existing seismic building standards need to be improved.

Abstract. Mataram is the capital of West Nusa Tenggara. West Nusa Tenggara is made up of two islands, Lombok and Sumbawa. The 2018 earthquake on Lombok has undoubtedly affected spectral acceleration. This is an important factor to be addressed in structural design. Short period spectral acceleration, S_S increases 18.323% compared to the value listed in the seismic code SNI 1976:2012 corresponding to the 2500 return period. However, even if the S_S value increases, the design category of the building does not change and remains in the D category. In general, the acceleration value in this study is found relatively greater than that of the existing code for periods of less than 0.462 s for site class D, and in periods of less than 0.830 s in site class E. In addition, the seismic response coefficient, $C_{S,}$ for medium soil, it increases by 10.782% compared to the C_S calculated using of the current code. This effect is more severe in soft soil areas where the increase reaches 13.168%. Improving existing codes with seismic design parameters for new buildings affected by the ground motion of recent strong earthquakes will lead to more preparedness and will be an important part of local disaster risk reduction.

Received ________, Revised ________, Accepted for publication __________

Keywords: *Lombok earthquake 2018; spectral acceleration; seismic design parameters, seismic code*

1 Introduction

The West Nusa Tenggara region is an area of high seismic activity, surrounded by two active seismic sources. In the south is the subduction zone of the Indo-Australia Sea Plate, and in the north is the back-arc thrust zone. According to the National Institutes of Meteorology, Climatology, and Geophysics (Indonesian: Badan Meteorologi, Klimatologi, dan Geofisika (BMKG)), a magnitude 6.2 magnitude earthquake on June 9, 2016, occurred in Mataram and Central Lombok and caused some damages. Later, in 2017, several quakes were hit at the scale of II-III MMI in Mataram City, as written by Taruna et al. in [1]. In addition, officials reported that there were 3699 earthquake events in 2018 and 215 events were felt. One of a series of Lombok earthquakes on August 5, 2018, with a magnitude of 7.0, caused severe damage to a number of buildings and houses, even some collapsed in Lombok area, including the city of Mataram, as announced by BMKG in [2] and published by Pomonis in [3] and Asmirza in [4].

In the past, some countries have changed their seismic codes after large earthquakes that caused various damage to structures and buildings. As studied by Okamura in [5] and Karakostas et al. in [6], the seismic code has been improved with a new response spectrum affected by recent ground acceleration. Similarly, Indonesia has the current code for seismic structures, namely SNI 1726: 2012 in [7]. The ground motion is calculated with a 2% probability of being exceeded within 50 years. The return period of the spectral acceleration is 2500 years. It replaces SNI 1726:2002 in [8]. SNI 1726:2002 provides spectral acceleration by dividing all areas of Indonesia into six seismic zones. The current Seismic Building Code has been improved by providing spectrally accelerated design values at each coordinate point in Indonesia. Seismic acceleration maps are also attached for spectral accelerations at T = 0 s (PGA), T = 0.2 s (short period), and T = 1 s (long period).

The previous seismic design code, SNI 1726:2002, has been reviewed by Sengara et al. [9]. In addition, compared to the previous seismic code SNI 1726:2002 presented by Arfiadi and Satyarno in [10], some of the Indonesian short period design spectral acceleration, S_{DS}, have a significant increase in current seismic code SNI 1726:2012. Significant increases in S_{DS} are evident in some areas, such as Aceh, Palu, Yogyakarta, and Padang, which were affected by major earthquakes during the time when the previous code was applied. Therefore, the values have been modified in the current code. In Palu, S_{DS} has the largest increase, with 116.7%, 85.7% and 41.2% in hard, medium, and soft soils, respectively. This region was hit by a magnitude 7.7 earthquake in 2008, and the 2012 seismic code changed the spectral acceleration. In the other prone areas mentioned above, the S_{DS} of three types of soil has risen from 10% to 80%. Conversely, Lombok did not show significant seismic activity during that period. Therefore, the 2012 seismic code shows little change in acceleration.

To obtain a new spectral acceleration that includes the site amplification factor, strong ground motions after the earthquake must be considered. This is compared to the existing spectral acceleration provided by the existing code to make sure there is a sufficient design to face strong earthquakes that may occur in the future, as reported by Panzera et al. in [11] and Mase, Likitlersuang, and Tobita in [12]. Furthermore, the evaluation of seismic codes after earthquakes has been carried out in some countries. The earthquake code has been updated to consider the recent ground acceleration due to the earthquake. In addition to the response spectrum, details of the structural design have been improved further as given by Okamura in [5], Karakostas et al. in [6], Sezen et al. in [13], Ergün, Kiraç, and Bacsaran in [14], Mosleh et al. in [15] and Baros and Santa-Maria in [16].

The analysis describes the seismic hazard in Mataram city using seismic data up to 2017 with a 2% probability of being exceeded in 50 years (return period of 2500 years). The short period of bedrock acceleration S_S (T = 0.2 s) and the long period of bedrock acceleration S_1 (T = 1 s) were reported to be in the range of 0.37-0.45 g (g = 9.81m/s^2) and 0.16-0.18 g, respectively. Furthermore, the values of S_S and S_1 in the northern region of Mataram are higher than those in the southern region of Mataram. This is due to the superiority of the Back Arc Thrust activity in northern Lombok as given by Taruna in [1].

The 2018 earthquake on Lombok is an important consideration in spectral acceleration. This is an important factor to be addressed in structural design. Improving the calculation of parameters will lead to the reproduction of the structural design under seismic loading, which is part of disaster risk reduction. It could potentially save millions of people and reduce major risks in the region in the future. Therefore, a new spectral acceleration needs to be approached using the recent 2018 seismic data, which applies to some seismic parameters that will help better seismic structures.

2 Related Research and Theory

According to Agustawijaya, Sulistyono, and Elhuda in [17], Lombok is classified as moderate to high seismic activity. Before the strong earthquake of 2018, this study states that the South Subduction Megathrust and the North Back-Arc Thrust have established the tectonic pattern of Lombok Island as an effect of compression between the Australian continental plate and Eurasia. Then in 2018, a series of earthquakes occurred in North Lombok which was triggered by Flores back arc trust. The ground motion initially began on July 28 with an M_w 6.4 earthquake in the northern part of Lombok. Aftershocks with M_w<5 followed the first earthquake a few hours later. On August 5, a larger shock of M_w 7.0 occurred. Then, in the following two weeks, an M_w 6.9 earthquake hit the island on August 19, 2018. The sequences of Lombok ground motions have been studied in detail by some researchers in [18], [19].

As reported by Marjiyono in [20], in general, the plains of Mataram City are dominated by alluvial deposits with sandy materials, either product of the eastern river process or marine products of the West Side. The alluvium fills an ancient form in the form of a basin in the western part of Mataram. Physically, alluvial sediments are soft and are indicated by low shear wave velocity values. This condition is potentially for areas that experience such wave amplification during an earthquake [21]. In addition, the average measurement of shear wave velocity v_s shows the value range of 135-201 m/s in Mataram City. This value is included in site class D (SD) and site class E (SE) of the current building seismic code.

S_S and S_1 must be determined at T = 0.2 s and T = 1 s, respectively, provided in the ground motion map of the SNI 1726:2012 code, and may exceed 2% in 50 years. By multiplying the S_S and S_1 values by the amplification factor from each site class, the short-period, S_{MS}, and long-term S_{M1} surface maximum ground acceleration can be calculated directly [22], [23]. The amplification factor F_a is related to the acceleration of the short-period S_S, while the amplification factor associated with S_1 is F_v. Furthermore, S_{MS} and S_{M1} values are used to calculate design spectral acceleration parameters for short period, S_{DS} and long period S_{D1}, as described by in SNI 1726:2012 in [7].

3 Method

3.1 Ground Acceleration Data

Ground acceleration data is based on previous work studied by Taruna, Agustawijaya, and Kencanawati in [24]. Earthquake data was obtained from Engdahl ISC (EHB), USGS, and BMKG in 1922-2018. The data was taken at coordinates of the latitude of 7°-12° and longitude of 113.5°-122.5° or about 300 km from Mataram City with magnitude, $M_w \geq 4.5$. This magnitude is assumed to be the standard for earthquakes related to the risk of seismic disasters. In this study, the values of peak ground motion in the bedrock soil layer from the previous study are used. Ground motion or maximum acceleration will be adopted as the parameters used in this study. These parameters are S_S and S_1 which are related to the technical design of earthquake-resistant structures, as shown in Figs. 1-2.

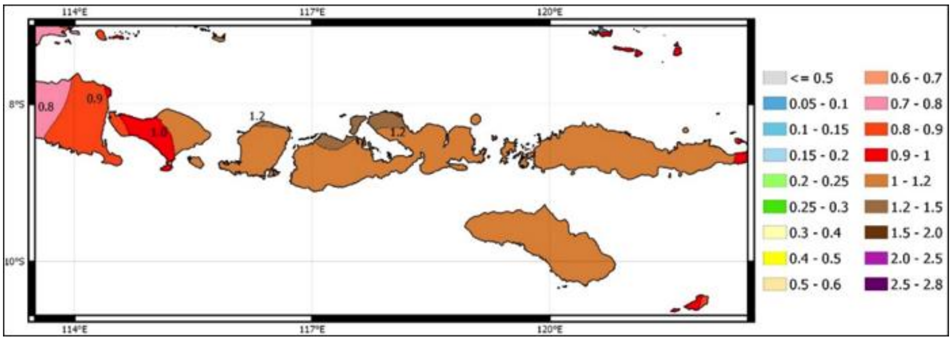

Figure 1 Spectral Acceleration at T = 0.2 s in bedrock with a probability exceeding 2% in 50 years for Bali-West Nusa Tenggara region, Taruna in [24]

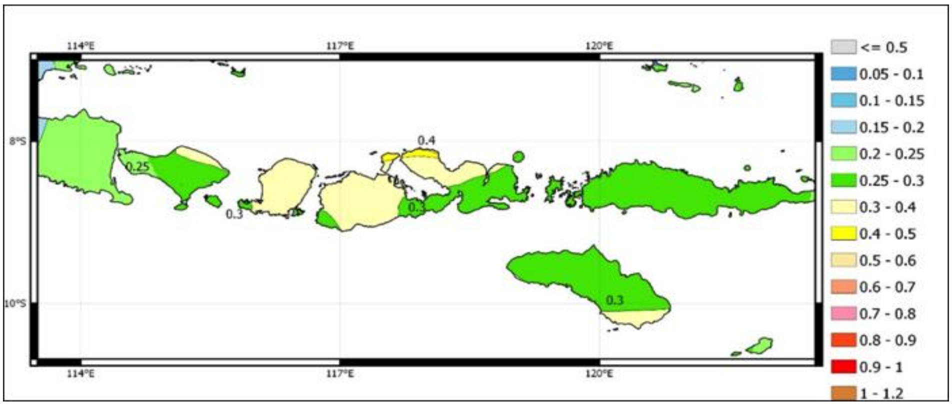

Figure 2 Spectral Acceleration at T = 1 s in bedrock with a probability exceeding 2% in 50 years for Bali-West Nusa Tenggara region, Taruna in [24]

As shown in Fig. 1, in most Lombok regions, S_S values range from 1-1.2 *g*, and in North Lombok, the values are over 1.2 *g*. S_S values tend to be larger than the 0.9-1.2 *g* values for Lombok, calculated in SNI 1726:2012 (Fig. 3). This could be caused by the large earthquake data used in previous studies, especially the increase in the 2018 Lombok earthquake series. On the other hand, the maximum acceleration of S_1 is 0.25 to 0.4 *g*. The S_1values in the Lombok region used in this study are lower than those of SNI 1726:2012 (Fig. 4). In SNI 1726:2012, Lombok's S_1 values range from 0.3 to 0.5 *g*, with the maximum seen in the north.

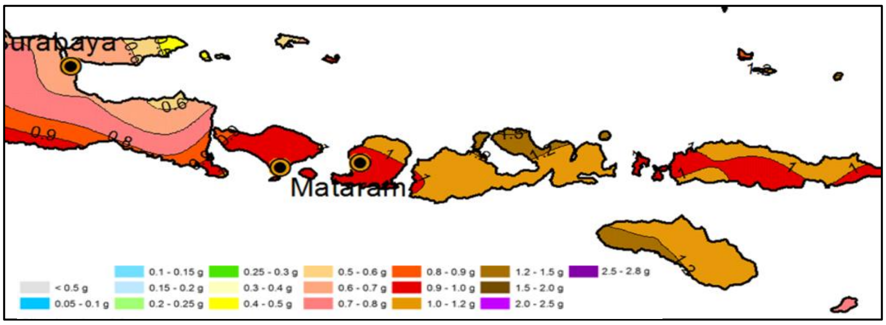

Figure 3 Spectral Acceleration at T = 0.2 s in bedrock with a probability exceeding 2% in 50 years for the Bali-West Nusa Tenggara region, SNI 1726:2012 in [7]

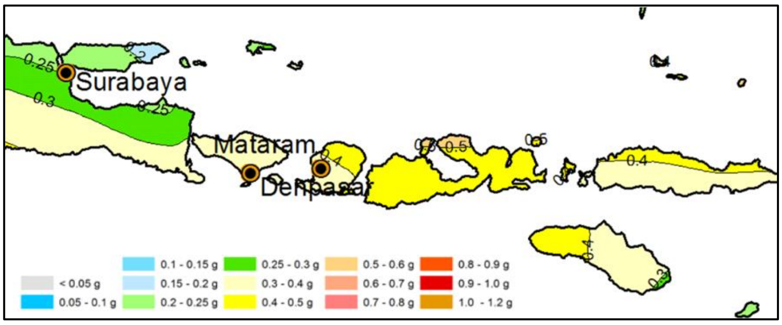

Figure 4 Spectral Acceleration at T = 1 s in bedrock with a probability exceeding 2% in 50 years for the Bali-West Nusa Tenggra region, SNI 1726:2012 in [7]

3.2 Equivalent Lateral Load Factor

The dynamic properties of seismic loads are simplified to horizontal forces with an equivalent lateral load procedure. For the analysis, the seismic response coefficient C_S is determined. SNI 1726:2012 provides instructions for obtaining C_S. It depends on spectral acceleration, S_{DS} and S_{D1} values and parameters such as seismic design category, importance factor, structural fundamental period, response modification factor, etc.

4 Result and Discussion

4.1 Spectral Acceleration

As shown in Figs. 5-6, the strong earthquake in Lombok in 2018 increased the spectral acceleration S_S of Mataram by 1.143 *g*. This value represents the location of Mataram latitude: -8.5606 and longitude: 116.0707. This is an increase of 18.323% from the value listed in SNI 1976:2012. Approximately the same increase as the spectral acceleration in Padang City when provided in the previous seismic code compared to the current code (SNI 1976:2012). This is because Padang experienced a major earthquake in 2009, the transition period between the previous code and the current code. The following Indonesian seismic code assumed that the acceleration of Mataram would be potentially higher due to the 2018 Lombok earthquake, as this study shows. Meanwhile, Sharma in [25] reported that after the Nepal earthquake (M_w 7.9) ground motion, existing spectral accelerations were still applicable to seismic structural engineering design.

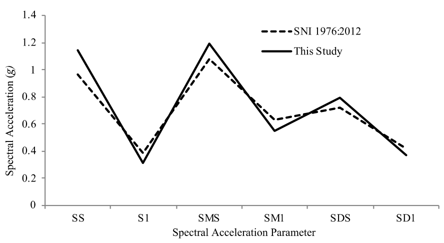

Figure 5 Spectral acceleration parameters in medium soil

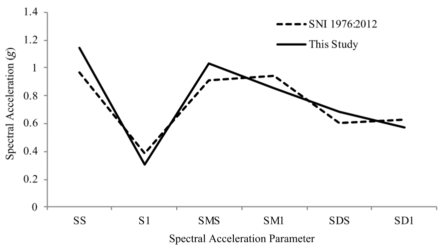

Figure 6 Spectral acceleration parameters in soft soil

Figure 5-6 also shows the spectral acceleration of the maximum considered and design basis earthquakes on the surface at T = 0.2 s (S_{MS} and S_{DS}) and T = 1 s (S_{M1} and S_{D1}) on medium soil (Fig. 5) whereas the parameters for soft soil is illustrated in Fig. 6. The acceleration of the surface is calculated for site class D (SD) and site class E (SE) because Mataram city is made up of medium and soft soils as given by Marjiyono in [20]. The spectral acceleration provided by SNI 1726: 2012 is also shown for comparison.

Contrary to the acceleration of T = 0.2 s, the acceleration of T = 1 s used in this study is smaller than that of SNI 1726:2012 because the constant attenuation equation is not the same between S_S and S_1. Furthermore, theoretically, S_1 is a long period spectrum affected by far-field earthquakes. On the other hand, this study is more dominant near earthquakes.

4.2 Building Seismic Design Category

Considering the ground motion of recent earthquakes, the S_{DS} and S_{D1} values for Mataram are 0.795 *g* and 0.367 *g* for medium soil and 0.686 *g* and 0.569 *g* for soft soil, respectively. According to SNI 1976:2012, buildings at sites with an S_{DS} greater than 0.5 *g* are designed as D categories for all risk categories I-IV (shown in bold in Table 1). Similarly, for S_{D1} values, as shown in Table 2, Mataram has values greater than 0.2 *g* in both medium and soft soils. Therefore, it is included in the D seismic design category (shown in bold in Table 2). S_{DS} values exceed 0.5 *g* and S_{D1} values exceed 0.2 *g*. This is similar to the value in the current code. Thus, even though the results of the study's spectral acceleration appear larger than those present in the current seismic code, there is no change in the seismic design category between the current seismic code and the results of this study.

The D-design seismic category is intended for structures built in the sites which to be potential for severe and damaging earthquakes, but not located close to major faults. As given by Giouncu and Mazolani in [22] dan Duggal in [23], structures on poor soils generally fall into the D class for seismic design. According to Sharma et al. in [25] as mentioned above, there is no change in the spectral acceleration between the existing code and the spectral acceleration after the Nepal earthquake, however, it is recommended to implement the existing code to develop mitigation strategies and structures.

Table 1. Seismic design category for short period response acceleration S_{DS} [5]

S_{DS} (*g*)	**Risk Category**	
	I or II or III	**IV**
S_{DS} < 0,167	A	A
0.167 ≤ S_{DS} ≤ 0.133	B	C
0.133 ≤ S_{DS} ≤ 0.50	C	D
0.50 ≤ S_{DS}	**D**	**D**

Table 2. Seismic design category for long period response acceleration S_{D1} [5]

S_{D1} (*g*)	**Risk Category**	
	I or II or III	**IV**
S_{D1} < 0,067	A	A
0.067 ≤ S_{D1} ≤ 0.133	B	C
0.133 ≤ S_{D1} ≤ 0.20	C	D
0.20 ≤ S_{D1}	**D**	**D**

4.3 Response Spectrum Curve

The spectral acceleration parameters previously obtained in Sub Section 4.1 are described using a response spectrum, which is important for building design as presented in Fig. 7 and Fig. 8, intended for medium soil (SD) and soft soil (SE) respectively. For comparison, the dashed line also shows the spectral acceleration graph based on the current earthquake code SNI 1726:2012. In general, the acceleration in this work is found relatively greater than that of in the current code for periods of less than 0.462 s for D site class (SD), and for periods less than 0.830 s in E site class (SE). The maximum acceleration in SD is 0.795 *g* in the period of 0.092-0.462 s. Meanwhile, in site class E, the maximum spectrum acceleration value is 0.686 *g* in the period of 0.1166-0.830 s. Also, it can be seen that over this period, medium soils amplify the spectral acceleration response more than soft soils.

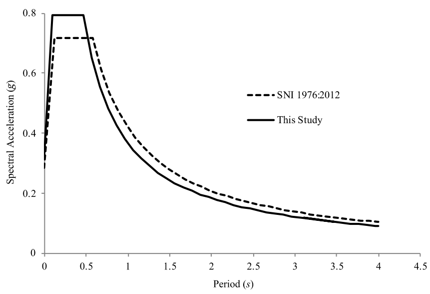

Figure 7 Response spectrum for SD

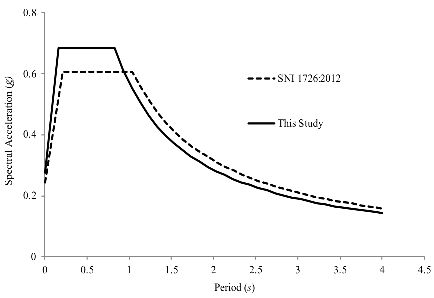

Figure 8 Response spectrum for SE

However, the soft soils generate the long period response more than the medium soils. For a period of T = 1 s, the spectral acceleration for medium soil is 0.367 *g* and for soft soil 0.569 *g*. This trend is consistent with that found in existing building seismic standards where the medium soil spectrum has an acceleration of 0.386 *g* and soft soils of 0.606 *g* each in the long period. During this period, SNI 1726:2012 shows a slightly higher acceleration than the results of this study.

Primarily, a similar shape of the response spectrum curve is seen between the results of this study and the current code. The trend is similar when the medium soil (SD) has higher spectral acceleration than the soft soil (SE) in the short period, but the effect of soft soil higher on spectral acceleration is seen over a longer period as shown in Fig. 9. Such findings are also reported by Dhakal et al. in [26]. During the calculation of seismic loads, the response spectrum is very important. Short period spectral acceleration values are used for an equivalent static analysis to calculate the seismic response factor C_S. Therefore, the effects of the 2018 Lombok earthquake, which produces higher spectral accelerations in a short period of time, may increase the safety of structural designs and improve seismic resistance.

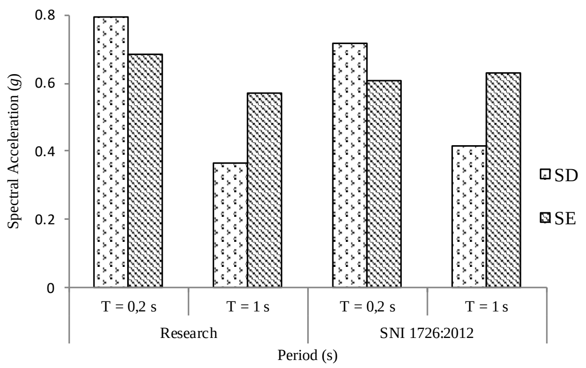

Figure 9 Spectral acceleration at T = 0.2 s and T= 1 s for different soil types

4.4 Seismic Response Coefficient, C_S

Using the procedure for determining seismic response factors (C_S) specified by SNI 1726:2012 in [7], Table 3 shows the values for C_S, maximum C_S, and minimum C_S. The C_S value is calculated under several conditions: risk category = 2, importance factor = 1, response modification factor = 8, building height from base = 20 meters. Coefficients are implemented for both SD and SE types of site classes. The coefficient calculated based on the current code's spectral acceleration is also displayed as a comparison.

Table 3. Seismic Response Coefficient, C_S

Seismic Parameter	**Site Class D**		**Site Class E**	
	SNI 1726:2012	**This Study**	**SNI 1726:2012**	**This Study**
S_{DS} (g)	0.717	0.795	0.606	0.686
S_{D1} (g)	0.418	0.367	0.631	0.569
C_S	0.090	0.099	0.076	0.086
C_S -maximum	0.766	0.673	1.156	1.044
C_S -minimum	0.032	0.035	0.027	0.030

All C_S values are between the minimum and maximum C_S values. In general, the C_S of site class D is higher than the C_S of site class E. This is because C_S depends on the value of the short period spectral acceleration, S_{DS}. As can be seen from Table 3, the S_{DS} for site class D is higher than the S_{DS} for site class E. Therefore, C_S increases in site class D. Conversely, the maximum C_S value for site class E is greater than the maximum value for site class D because of the large spectral acceleration value of S_{D1} at T = 1 s. The maximum value of C_S depends on the value of S_{D1}.

In this study, both sites have higher C_S results compared to SNI 1976: 2012. After a strong Lombok earthquake, the seismic coefficient C_S increases by 10.782% when compared to C_S calculated using the current code. The effect is more severe in soft soil areas, which is an increase of 13.168%. The higher the C_S, the greater the seismic load on the building structure. It is recommended that current seismic regulations be revised to consider the effects of the last strong earthquake, as this will have a significant effect on the increase in seismic loads experienced by the structure. Changes include enhancements to existing building structures. Therefore, new or old buildings may be more resistant to future earthquakes. A similar recommendation has also been delivered by

Ramdani, Setiani, and Setiawati in [27] that studies on the Lombok earthquake could support a robust mitigation system for the area. Other works related to the Lombok post-earthquake evidence showed that several damages on concrete structures and steel structures existed as evaluated by Salim et al. in [28]. Further improvements have been recommended to the structures by considering the basic requirement for earthquake resistance structures as given by Siswanto and Salim in [29]. In addition, such a comprehensive structural design based on seismic risk has been introduced by Mangkoesoebroto, Prayoga, and Parithusta in [30] and Sidi in [31]. It is suggested that the presented works shall be considered for the next seismic code to be a better structural response against future earthquakes.

5 Conclusion

This study describes the parameters of Mataram's seismic building design by considering the effects of the 2018 earthquake in Lombok.

• Short period spectral acceleration, S_S increased 18.323% compared to the values listed in SNI 1976:2012. However, the value of the spectral acceleration in for the period T = 1 s, S_1, is smaller than the value described in the existing earthquake code.

• Higher design spectral acceleration values shown in this study do not change the design of the Mataram earthquake category

• According to response spectrum curve, overall, the acceleration value in this study is found relatively greater than the that of the existing code for periods of less than 0.462 s for site class D, and in periods less than 0.830 s in site class E. The maximum acceleration in site class D from the results of the study is 0.795 *g* in the period of 0.092 to 0.462 s. For site class E, the maximum spectrum acceleration value is 0.686 *g* in the period of 0.1166 to 0.830 s.

•Soft soils react longer than medium soils. For the time period of T = 1 s, the spectral acceleration of medium soil is 0.346 *g* and soft soil produces 0.553 *g*.

• Basically, a similar shape of the response spectrum curve is seen between the results of this study and recent codes. Medium soil (SD) has higher spectral acceleration than soft soil (SE) in a short period, but the effect of soft soil higher on spectral acceleration is seen over a longer period.

•In this study, both site classes D and E have a higher seismic response coefficient compared to SNI 1976:2012. The seismic coefficient C_S after the Lombok strong ground motion increases by 10.782% compared to the C_S calculated using the current code. Soft soil is more prone because the C_S increases 13.168%.

• Immediate revisions to current seismic building codes by considering the impact of the last strong earthquake to strengthen the preparation of seismic structures is recommended.

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We would like to inform you that your paper is accepted and planned to be published on Journal of Engineering and Technological Sciences Vol. 52 No.5 , 2020. We have set your paper into our publication template, please notify our comments regarding to some parts on your paper and do some revision. Please sign the assignment of copyright transfer. We should be grateful if you are able to complete it by 19 August 2020.

Thank you for your support and cooperation.

Kind regards,

Journal of Engineering and Technological Sciences

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Ni Nyoman Kencanawati <nkencanawati@unram.ac.id>

13104 [jets] Editor Decision from Journal of Engineering and Technological Sciences

1 pesan

jets@lppm.itb.ac.id <jets@lppm.itb.ac.id> 21 Agustus 2020 pukul 17.36
Kepada: nkencanawati@unram.ac.id
Cc: itbjournal <itbjournal@gmail.com>

Dear Dr Ni Nyoman Kencanawati,

We have reached a decision regarding your submission to Journal of Engineering and Technological Sciences, "Evaluation of Building Seismic Design Parameters in Mataram City Using Lombok Earthquake 2018 Ground Motion".

We are pleased to inform you that your manuscript referenced above has been accepted for publication in Journal of Engineering and Technological Sciences.

Next, the paper will be sent to our copy editor to improve the English writing, and then sent to layout editor to improve the paper layout.

Many thanks for submitting your fine paper to Journal of Engineering and Technological Sciences. We look forward to receiving additional papers from you in the future.

With kind regards,

Prof.Dr. Tjandra Setiadi
Journal of Engineering and Technological Sciences
Institut Teknologi Bandung
jets@lppm.itb.ac.id

Ni Nyoman Kencanawati <nkencanawati@unram.ac.id>

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jets@lppm.itb.ac.id

Ni Nyoman Kencanawati <nkencanawati@unram.ac.id>

13104 [jets] Proofreading Request (Author)

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jets@lppm.itb.ac.id <jets@lppm.itb.ac.id> 6 Oktober 2020 pukul 14.02
Kepada: nkencanawati@unram.ac.id
Cc: itbjournal <itbjournal@gmail.com>

Dr Ni Nyoman Kencanawati:

Your submission "Evaluation of Building Seismic Design Parameters in Mataram City Using Lombok Earthquake 2018 Ground Motion" to Journal of Engineering and Technological Sciences now needs to be proofread by folllowing these steps.
1. Click on the Submission URL below.
2. Log into the journal and view PROOFING INSTRUCTIONS
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Username: kencana

We should be grateful if you are able to proof your paper and send final proofreading if you have any revision before 12 October 2020.
Thank you for your support and cooperation.

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Journal of Engineering and Technological Sciences
Institut Teknologi Bandung
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Ni Nyoman Kencanawati <nkencanawati@unram.ac.id> 7 Oktober 2020 pukul 16.54
Kepada: "Prof.Dr. Tjandra Setiadi" <jets@lppm.itb.ac.id>
Cc: itbjournal <itbjournal@gmail.com>

Dear Journal Editor,
I would like to inform you that I have conducted proofreading. In the conclusion section, there were little changes symbols that have been made. The correction version is attached to this email.
Thank you very much for your kind cooperation.

My Best Regards,
Ni Nyoman Kencanawati
[Kutipan teks disembunyikan]

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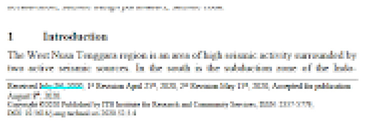
Ni Nyoman Kencanawati <nkencanawati@unram.ac.id> 7 November 2020 pukul 12.12
Kepada: "Prof.Dr. Tjandra Setiadi" <jets@lppm.itb.ac.id>

Dear Prof. Tjandra Setiadi,
Thank you for publishing my paper. I apologize that I missed the footer infornation regarding the received date of the paper.
I would like to deeply appreciate for considering the revision. Thank you very much for your kind cooperation.
Sincerely yours,
Ni Nyoman Kencanawati
[Kutipan teks disembunyikan]


1 Introduction

The West Nusa Tenggara region is an area of high seismic activity surrounded by two active seismic sources. In the south is the subduction zone of the Indo-

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