The Performance analysis of high-rise building structure base on SNI 03-1726-2012 and SNI 03-1726-2019

by Library Referensi

Submission date: 10-Jul-2025 04:39PM (UTC+0700)
Submission ID: 2712809812
File name: JUDDD9_1.PDF (299.99K)
Word count: 2888
Character count: 14422

Journal of Infrastructure Planning and Engineering Vol. 2, Issue. 1, Juni 2023, pp 36 - 41

Journal of Infrastructure Planning and Engineering (JIPE)

Journal homepage: https://ejournal.warmadewa.ac.id/index.php/jipe

The performance analysis of high-rise building structure based on SNI 03-1726-2012 and SNI 03-1726-2019 (case study: tower 1 transit-oriented development apartment Pondok Cina, Depok)

Sudarno P Tampubolon[1*], Pinondang Simanjuntak[1], Gracela P Tarapandjang[1], I Putu Ellsa Sarassantika[2]

[1]*Civil Engineering Department, Universitas Kristen Indonesia, Jakarta, 13630, Indonesia*
[2]*Civil Engineering Department, Universitas Warmadewa, Denpasar, 80235, Indonesia*
*sudarno.tampubolon@uki.ac.id

Received on 22 April 2023, accepted on 25 May 2023, published on 30 June 2023

ABSTRACT

Indonesia has recently implemented a new seismic standard, SNI 03-1726-2019, which replaces SNI 03-1726-2012. The goal of this research is to compare the calculations and analyses of TOD apartments in Pondok Cina, Depok, based on SNI 03-1726-2012 and SNI 03-1726-2019, and to determine the main characteristics that differ between the two standards. The comparative results show that the parameter values of SS and S1 in SNI 03-1726-2019 have increased, affecting the reference values for computing the acceleration value of the response spectrum. Furthermore, as a result of the large increase in the acceleration spectral design response compared to SNI 03-1726-2012, the fundamental static and dynamic shear force values in the X and Y directions in SNI 03-1726-2019 have increased by 18% and 15%, respectively. The TOD apartment complex in Pondok Cina, Depok, is rated as Immediate Occupancy under the performance-based planning approach, suggesting that it can resist an earthquake while staying functional and minimizing the danger of casualties. Such a technique can provide useful information regarding the seismic behavior of the building as well as the extent to which the earthquake may influence its structural integrity.

Keywords: Performance level; response spectrum; SNI 03-1726-2019.

1 Introduction

Indonesia is a country with fairly active tectonic conditions in the world because it is located in the Pacific Ring of Fire and between three plates of the earth, namely the Pacific plate, the Indo-Australian plate, and the Eurasian plate. An earthquake is a phenomenon that involves the movement or shaking of the earth's crust [1]. Earthquakes occur when the pressure by the plate cannot be resisted by the edge of the plate [2]. An earthquake is a disturbance in the earth's crust that causes shocks that radiate to the earth's surface [3].

When an earthquake occurs, the strength of the building structure is an absolute requirement so that the building does not collapse to minimize casualties and the impact of losses due to the earthquake [4]. One of the factors that influence the structure to accept the load is the configuration of the structure, where a regularly configured building is better at resisting earthquake forces so that structural damage can be avoided [5]. In addition, the magnitude of the earthquake force also affects the response of the structure that occurs because the earthquake force will be received by the base of the building [6]–[9].

Performance-based seismic design is a method that can be used to strengthen (upgrade) existing building structures as well as planning for new building structures to be constructed by considering the risk of occupant safety (life), the readiness of the building for use (occupancy) and loss of property (economic loss) [10]–[14]. The important thing in the evaluation target based on building performance against earthquakes is the level of performance (performance level) or the level of damage that is allowed when the earthquake is working [15], namely the Immediate Occupancy (IO) in the event of a small earthquake the level of damage, the building can be reused and the risk of human casualties is very small,

DOI: https://doi.org/10.22225/jipe.2.1.2023.36-41 E-ISSN: 2829-5153

then the Level Damage Control (DC) performance with the level of damage between Levels Immediate Occupancy (IO) to Life Safety Level (LS), then Level Life Safety with the level of damage that occurs is limited so that it can be repaired, then Level Structural Stability/Collapse Prevention Performance with a degree of structural may occur but human casualties must be avoided.

In Indonesia, earthquake activity has been recorded in the last eight years which caused thousands of casualties, damage to buildings, and property loss, namely the Aceh Earthquake and Tsunami measuring 9.2 SR in 2004, Nias Earthquake measuring 8.6 SR in 2005, Padang Earthquake measuring 7.6 SR., Mentawai earthquake measuring 7.2 SR in 2010, Halmahera Earthquake measuring 7.3 SR in 2019, Maluku earthquake measuring 6.2 SR in 2019, West Sulawesi earthquake measuring 6.2 SR in 2021, Larantuka earthquake measuring 7.4 SR in 2021 [16]. In response to the above, in 2019 the government has issued the latest earthquake-resistant regulation, namely SNI 03-1726-2019 which replaces the previous regulation SNI 03-1726-2012. As a result of the implementation of the latest earthquake-resistant regulations SNI 03-1726-2019, there have been designing spectral changes in several areas [17]-[18]. With the design spectral changes, further research was carried out on the performance of the building structure against earthquakes in the Transit-Oriented Development (TOD) apartment building Pondok Cina, Depok.

2 Data and Methods

The methodology used in this research is the dynamic analysis method of the response spectrum with the ETABS V18.0.2 program. The research started by collecting building data and parameter data. Table 1. Show the parameters and information data building.

Table 1. Parameters and Information Building

No	Name	Building Informations and Parameters
1	Project Location	Jl. Margonda Raya no. 369, Depok
2	Building Function	Aparment Building
3	Number of Floors	29 levels
4	Main Structure	Reinforced Concrete
5	Column (f'c)	40 MPa
6	Beam (f'c)	30 MPa
7	Floor Plate (f'c)	30 MPa
8	Shear Wall (f'c)	40 MPa
9	Yield Stress (fy)	400 MPa

The building data are the location of the building, the function of the building, the type of the structural system, while the parameter data are the response spectra of the city of Depok. For dimension of beam and column show at the Table 2.

Table 2. Parameter dimension Beam and Column

Floor	Column Dimensions (mm)	Beam Dimension (mm)
Ground Floor-15th Floor	800 x 1500	400 x 600
16th Floor – 22nd Floor	700 x 1100	400 x 700
23rd Floor – 27th Floor	600 x 1000	400 x 800
28th *Roof top*	500 x 900	500 x 600

Figure 1. show the 3D structural modeling is carried out and continued by calculating and inputting the loads acting on the building structure, then a comparison of the response spectrum of the design of SNI 03-1726-2019 against SNI 03-1726-2012 is carried out to determine which parameters make a significant difference between SNI 03-1726-2019 against SNI 03-1726-2012, then comparison analysis *output* and control of the results of the analysis on regulatory limits is carried out to review the feasibility of the structure in carrying working loads. In the last stage, from a comparative analysis of the overall indicator parameters, it can be concluded by the objectives set in the study.

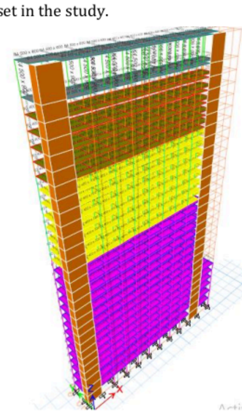


Figure 1. Modeling Structure 3-D

3 Results and Discussion

3.1 Design Response Spectrum Comparison

The issuance of SNI 03-1726-2019 will certainly affect building planning against earthquake loading [19]. For this reason, the design spectra of SNI 03-1726-2019 will be compared with SNI 03-1726-2012 in the city of Depok to see how far the significant differences in the design spectra response parameters (Table 3) (Figure 2).

Table 3. Comparison of Design Response Spectra Parameters

No	Parameters	SNI 03-1726-2012	SNI 03-1726-2019	% Increase
1	S_s	0,7	0,9	22,22
2	S_1	0,3	0,4	25
4	Fa	1,1	1,3	15,38
5	Fv	2,7	2,4	-12,50
6	S_{MS}	0,7	1,1	36,36
7	S_{M1}	0,8	1,0	20,00
8	S_{DS}	0,6	0,7	14,29
9	S_{D1}	0,5	0,6	16,67

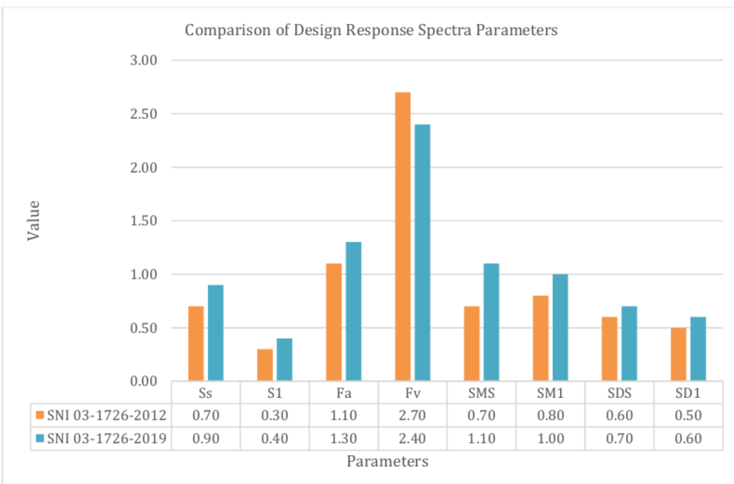


Figure 2. Comparison of Design Response Spectra Parameters

Based on the observations in Table 3 and Figure 2 there was an increase in the parameter values of S_S and S_1 by 22.22% and 25% which resulted in an increase in the values of Fa and Fv as the multiplier coefficients to get the values of S_{MS} and S_{M1} so that it is related to an increase in the value of S_{DS} and S_{D1}. This causes a difference in the design response spectra curve Figure 2.

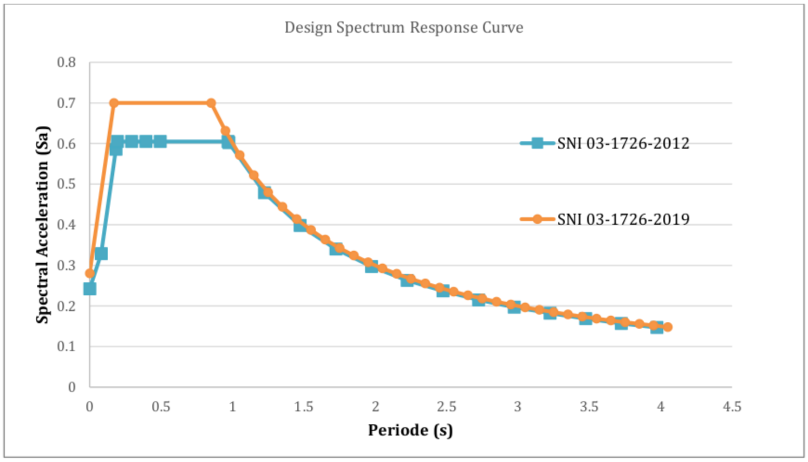


Figure 3. Design Spectrum Response Curve

Based on Figure 3. the maximum response acceleration (Sa) value of SNI 03-1726-2019 is greater or tends to be higher than SNI 03-1726-2012 due to changes in the 2010 Indonesia Earthquake Hazard Map on SNI 03-1726-2012 and the 2017 Indonesian Earthquake Hazard Map on SNI 03-1726-2019, so that there is an increase in the parameter values of S_S and S_1 which is quite significant so that it affects the parameters S_{DS} and S_{D1}.

3.2 Comparison of Mass Participation

The fundamental period is the time required for a vibration when an earthquake occurs against the structure. Mass participation can be seen in Figure 4 (a) and (b).

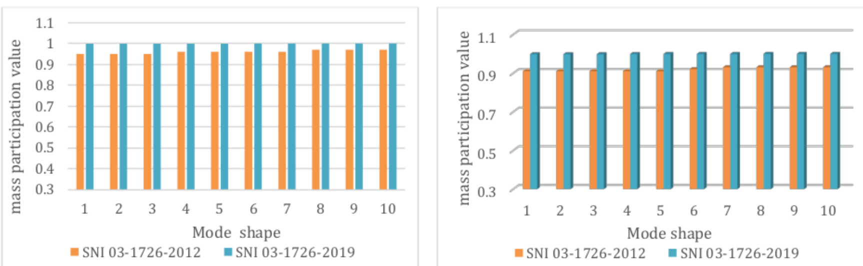
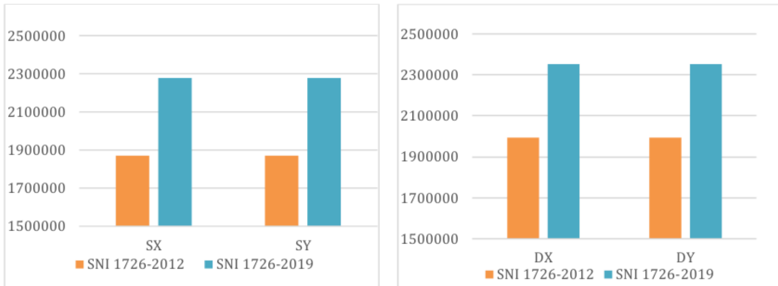


Figure 4. Comparison of Mass Participation: (a) x direction; (b) y direction.

Based on Figure 4 (a) for the X directions and Figure 4 (b) for Y directions, it shows that the combined mass participation variance has met the requirements of SNI 03-1726-2012 of 90% and 100% of SNI 03-1726-2019 clause 7.9.1.1.

3.3 Comparison of the Basic Shear Force

From the calculation of the basic shear force using SNI 03-1726-2012 and SNI 03-1726-2019.comparison of the basic shear force can be seen in Figure 5 (a) and (b).



(a) (b)

Figure 5. Basic Shear Force

Based on Figure 5(a) the value of the static base shear force in the X and Y directions in SNI 03-1726-2019 experienced an increase of 18% from the value of the basic static shear force in SNI 03-1726-2012 and based on Figure 5(b) the value of the dynamic basis shear force in the X and Y directions in SNI 03-1726-2019 experienced an increase of 15% from the value of the force dynamic base shear in SNI 03-1726-2012. The basic shear force increases because the acceleration spectral design response has a high increase in 03-1726-2019 instead of SNI 03-1726-2012.

3.4 Evaluation of Structural Performance

Deformation limits for the performance level of building structures are set out in [20]. Table 3 shows the limits of the deviation ratio to Building performance level.

Table 4. Level Performance Building

Direction Earthquake Load	Maximum total Drift	Maximum total In-elastic Drift	Performance Level
x	0,007	0,0020	IO
y	0,007	0,0027	IO

Based on Table 4 shows the results of calculating the performance level of the building structure for the X direction and the Y direction, which is included in the Immediate Occupancy (IO) which means when it occurs the earthquake building did not suffer heavy damage, it can still be used and the risk of casualties is very small.

4 Conclusion

1. Parameters S_S and S_1 in SNI 1726-2019 increased by 22.22% and S_1 by 25% which resulted in an increase in the values of Fa and Fv by 15.38% and -12.50%, thus affecting the values of S_{MS} and S_{M1}. In the value of S_{MS} and $_{M1}$ there was an increase of 36.36% and 20%, respectively. An increase in the value of S_{DS} and S_{D1} of 14.29% and 16.67% then affect the response spectrum graph which has increased in SNI 03-1726-2019. The thing that causes the value of the response spectra to increase is the change Hazard on SNI 03-1726-2012 and the 2017 Indonesian Earthquake Hazard Map on SNI 03-1726-2019.
2. The basic shear force increases because the acceleration *spectral design response* has a high increase in SNI 03-1726-2019 compared to SNI 03-1726-2012.
3. Performance-based planning can provide information on how the building behaves during an earthquake and the extent to which the earthquake will affect the structure.

References

[1] R. Villaverde, *Fundamental Concepts of Earthquake Engineering*. 2009.

[2] M. A. Nur, "Gempa Bumi, Tsunami Dan Mitigasinya," *J. Geogr.*, vol. 7, no. 1, 2010, doi: 10.15294/jg.v7i1.92.

[3] B. Mustafa, "Analisis gempa nias dan gempa sumatera barat dan kesamaannya yang tidak menimbulkan tsunami," vol. 2, no. 1, pp. 44–50, 2010.

[4] S. P. Tampubolon, C. Y. Wang, and R. Z. Wang, "Numerical simulations of the bond stress-slip effect of reinforced concrete on the push over behavior of interior beam-column joint," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 725, no. 1, 2020, doi: 10.1088/1757-899X/725/1/012028.

[5] S. P. Tampubolon, I. P. E. Sarassantika, and I. W. G. Suarjana, "Analisis Kerusakan Struktur Bangunan dan Manajemen Bencana Akibat Gempa Bumi, Tsunami, dan Likuifaksi di Palu," *Bentang J. Teor. dan Terap. Bid. Rekayasa Sipil*, vol. 10, no. 2, pp. 169–186, 2022, doi: 10.33558/bentang.v10i2.3263.

[6] A. S. Elnashai and L. Di Sarno, "Fundamentals of Earthquake Engineering," *Fundam. Earthq. Eng.*, pp. 1–347, 2008, doi: 10.1002/9780470024867.

[7] S. P. Simanjuntak, P. Tampubolon, "Evaluasi respon seismik struktur bangunan Universitas Terbuka Palu terhadap gempa Sulteng 28 September 2018," vol. 3, no. 2, pp. 119–129, 2023.

[8] R. Sulaksitaningrum *et al.*, "The optimal damper placement configuration for three-dimensional RC building," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 669, no. 1, 2019, doi: 10.1088/1757-899X/669/1/012056.

[9] B. Fernandus and I. P. E. Sarassantika, "Reducing the torsional behavior in irregular special moment resisting frames with steel dampers," vol. 1, no. 2, pp. 68–74, 2022.

[10] W. Dewobroto, "Evaluasi Kinerja Struktur Baja Tahan Gempa dengan Analisa Pushover," *Semin. Bid. Kaji.*, p. 28, 2005.

[11] S. P. Tampubolon, C. Y. Wang, and R. Z. Wang, "Numerical simulations of the bond stress-slip effect of reinforced concrete on the push over behavior of wall," *IOP Conf. Ser. Mater. Sci. Eng.*, vol. 3, no. 11, pp. 39–45, 2018, doi: 10.1088/1757-899X/725/1/012028.

[12] I. W. M. Andreasnata, I. N. Sinarta, N. K. Armaeni, and I. P. E. Sarassantika, "Column structure strengthening with FRP (Fiber Reinforced Polymer) due to story addition," *J. Infrastrcuture Plan. Engfineering*, vol. 1, no. 1, pp. 38–45, 2022.

[13] I. P. E. Sarassantika and H. L. Hsu, "Improving brace member seismic performance with amplified-deformation lever-armed dampers," *J. Constr. Steel Res.*, vol. 192, p. 107221, 2022, doi: 10.1016/j.jcsr.2022.107221.

[14] I. P. E. Sarassantika and H. L. Hsu, "Upgrading framed structure seismic performance using steel Lever-Armed dampers in the Braces," *Eng. Struct.*, vol. 280, no. January, p. 115683, 2023, doi: 10.1016/j.engstruct.2023.115683.

[15] FEMA 273, "NEHRP GUIDELINES FOR THE SEISMIC REHABILITATION OF BUILDINGS (FEMA Publication 273)," *Earthq. Spectra*, vol. 16, no. 1, pp. 227–239, 1997, doi: 10.1193/1.1586092.

[16] E. Purnomo, E. Purwanto, and A. Supriyadi, "Analisis dinamik respon spektrum menggunakan software Etabs (studi kasus: bangunan hotel di Semarang)," *Matriks Tek. Sipil*, vol. 2, no. 4, pp. 569–576, 2014.

[17] A. S. Nana Patria, "Perbandingan Parameter Spektrum Respons Desain Sni 1726:2012 Dengan Sni 1726:2019 Pada 39 Kabupaten/Kota Di Pulau Jawa," *J. Kacapuri J. Keilmuan Tek. Sipil*, vol. 4, no. 1, p. 126, 2021, doi: 10.31602/jk.v4i1.5336.

[18] R. R. Darmawan, E. Susanti, and ..., "Studi Komparasi Parameter Respons Spectrum Gempa SNI 1726-2012 Terhadap SNI 1726-2019 Dengan Studi Kasus Gedung C Stie Perbanas," *Teknol. Perenc.*, 2021.

[19] A. S. Nurul Sodik and R. Andayani, "Pengaruh Penerapan SNI 1726:2019 Terhadap Desain Struktur Rangka Momen Beton Bertulang Di Indonesia," *J. Rekayasa Sipil*, vol. 17, no. 1, p. 1, 2021, doi: 10.25077/jrs.17.1.1-12.2021.

[20] ATC-40, "Seismic evaluation and retrofit of concrete buildings volume 1 ATC-40," *ATC 40, Appl. Technol. Counc.*, vol. 1, p. 334, 1996.

The performancehe performancehe performancehe performancehe performancehe performancehe performancehe performancehe performancehe performancehe performancehe performancehe performancehe performance an

ORIGINALITY REPORT

19%	19%	5%	0%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	garuda.kemdikbud.go.id Internet Source	13%
2	repository.uki.ac.id Internet Source	3%
3	www.ejournal.warmadewa.ac.id Internet Source	3%

Exclude quotes	On	Exclude matches	< 2%
Exclude bibliography	On		