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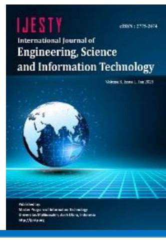

Performance Structural Analysis of U2C Building with the Kobe Earthquake Spectrum

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Abstract

An investigation into the performance of the building structure in receiving the earthquake load must ensure that the building structure is able to receive it within safe limits. A non-linear approach is generally done through pushover analysis. The purpose of this study is to find out how the behavior or performance of building structures when receiving earthquake loads. The analysis is carried out by modeling the structure of the building using the help of the STERA 3D application. Then it is done by entering the Kobe earthquake spectrum data into the software. From the results of the analysis, the value of the deviation between directional levels X 0.0058 m with a base shear of 10,090 KN was obtained. While the Y direction capacity curve has the largest displacement of 0.0084 m with a base shear of 13,270 KN. The result of structural deviation when the performance point is reached for X direction and Y direction loading of 0.0042 m and 0.0063 m, resulting in a yellow color at each point of the column and beam relationship which means that it is still within the range of 1 < U <5 (AMP (response force) analysis), this indicates that the condition of the building structure remains safe during an earthquake.

***Keywords**: Basic Shear, Limits Of The Service Of The Structure, Interstate Deviations, Earthquake Load.*

1. Introduction

Indonesia has a fairly high seismic activity. The high potential for earthquakes that occur makes building structure planning must be calculated appropriately according to existing conditions. Therefore, buildings should be planned to be able to withstand earthquakes, so that a correct planning is needed according to the planning of earthquake-resistant buildings in Indonesia contained in earthquake planning procedures for buildings [1]. This is so that when exposed to earthquake loads, the building structure does not collapse. The study aims to evaluate the performance of the structure with a review based on displacement, drift, and base shear. Based on this background, research was conducted on evaluating the performance of high-rise buildings with a time history analysis method. Structural models are vibrated by using specific earthquake recordings to predict the behavior of building structure damage due to earthquake plans. The results of this analysis are in the form of displacement, drift, and base shear. The results of the analysis are used to control the performance of service limits, the performance of ultimate limits and the level of performance of the structure. The conclusions of the study show that the structure of the building remains safe according to [1].
The safety requirements of multi-floor building structures are based on [1], with a review of deviations between levels and [2] with a maximum total drift value. Research shows that due to the influence of the Imperial Valley, Kobe, Kocaeli, Northridge, and San Fernando input earthquakes, the inter-level deviations that occur are still in the safe category because they do not exceed the deviation between permit levels, which is 48.4615 mm. Buildings are included in the Immediate Occupancy (IO) performance level based on [2], the maximum total drift value is below the limit of 0.01 [3].
In Indonesia, many large earthquakes have been recorded due to the activity of the Eurasian tectonic plates, the Indo-Australian plate and the Pacific Plate. Such as the earthquake that occurred in Nusa Dua in 2011 (6.8 SR), the Donggala earthquake in 2018 (7.4 SR), and the most recent earthquake in Jembrana-Bali in 2019 (5.8 SR). This certainly needs to be considered because earthquakes can cause a lot of damage and casualties. Of the many islands in Indonesia, Bali is one with a high earthquake intensity [4].
Analysis of the state of voltage on the Nojima Fault, the source of the 1995 Kobe earthquake Mw6.9. Statistical analysis shows the maximum horizontal voltage (σ H max) at depths shallower than 500 m. The results showed the accumulation of compressive stress, the driving force of the fault in the deep seismic zone since the 1995 earthquake, implying the fault zone has healed continuously over the 22-year post seismic periode [5].
The design of the structure is carried out by dynamic time history load analysis on the SRPMK building (special moment-bearing frame structure). B10-level floor collateral, regular shape, in the SRPMK building. The structural element that is reviewed in analyzing the displacement in the building structure is in a column, both for fixed base SRPMK buildings and for SRPMK buildings with base insulators. Data analysis is carried out using the help of SAP2000 computer software. The results of the analysis show that the displacement of the SRPMK fixed base building structure maximum columns on the 3rd floor reaches 27.97 mm from the SRPMK fixed base base. Meanwhile,

in the base insulator, there is a displacement of 5.79 mm from the base SRPMK base insulator. As well as the results of the analysis obtained that the SRPMK base isolation building compared to the SRPMK building, the value of the displacement of the final floor building structure (10th floor) can be reduced to 15.85%. The application of the base insulator in this case can be used according to its function can reduce earthquake load [6].

The Research with two dynamic methods used, namely the response spectrum method and the time history method. The structure analyzed in this study is the SKA Pekan Baru Hotel Building. This study examines the performance of structures consisting of story shifting, displacement and story deviation when receiving seismic loads. The spectrum response used is the Pekan Baru City spectrum response by referring to [1], while the time history used in this study is the time history of the El-Centro Earthquake, Mentawai Aceh Earthquake, Earthquake and Padang earthquake. response spectrum method Analysis results in Damage Control (DC) performance levels in X direction and Y direction. time history El - Centro earthquake analysis results in structural stability (SS) performance levels in the X direction and direction Y. time history Mentawai Earthquake analysis results in Immediate Occupancy (IO) performance levels in X direction and Y direction. History Time Aceh Earthquake analysis produces Damage Control (DC) performance levels in X direction and Y direction. History of time Padang Earthquake analysis produces Structural Stability (SS) performance levels in X direction and Y direction [7].

In the third case obtained drift with a safe category value based on [2], the permission drift value which is 7.5 cm. The maximum Drift was obtained in case 3, with El-Centro earthquake data of 4.28 cm in the X direction. The smallest Drift was obtained in case 1, with El-Centro earthquake data of 2.95 cm in the X direction. E base shear valuations that occur in all three building cases are still within safe limits to base shear from all earthquake data. The minimum required values [2], for each case are 8138,065KN for case 1, 7990,382kN for case 2 and 7953,461 kN for case 3. The results of the 3D STERA output processing showed that the largest story base shear occurred in case 1 in the X-direction El-Centro earthquake data with a value of 8755.20kN. While the smallest story base shear occurred in case 3 in the Chi - chi earthquake data in the Y direction with a value of 8108.01kN [8].

A non-linear approach is carried out using pushover analysis. The analysis was performed through modeling the structure of the building using the SAP 2000 application. Furthermore, two stages of loading are carried out, namely the gravitational load and then the earthquake load in the X direction and the Y direction which are gradually increased. The result of the analysis obtained the X directional capacity curve has the largest displacement of 0.276691 m, with a base shear of 1,569.1707 tons. While the Y direction capacity curve has the largest displacement of 0.220862 m, with a base shear of 1.955.6531 tons. Evaluation of structural deviations when performance points are reached for X direction and Y direction loading of 0.023 m, and 0.019 m, resulting in drift ratios of 0.0697% and 0.0576% of the total building height of 33 m. The structural deviation ratio does not exceed the required deviation limit [2], with an Immediate Occupancy (IO) level of 1% which means the building remains safe in the event of an earthquake [9].

The Muisne earthquake showed greater PGA and Pdh values than other important seduction earthquakes, such as 1985 Mw7.8 Valparaiso-Chile, 1985 Mw8.1 Michoacán-Mexico and 2010 Mw8.8 El Maule-Chile. In addition, the soil effect can be ex-petted due to the high destructive potential, low zero crossing intensity and the phenomenon of free ground vibration in some accelerator-grams. All these statements attest to the high seismic danger in Ecuador and are a warning voice for the future development of high-rise projects in many cities settled on soft land along the country [10].

Evaluation of structural behaviors such as mass participation, plastic design, displacement, rotation, and basic sliding with a history of leveling time to be leveled (leveling time history). The time history load can be identified the first part of the structure that collapsed and the maximum load that the structure can withstand for mitigation efforts. The analysis uses a nonlinear dynamic time history analysis with the most dominant combination being the earthquake combination. The research shows that there are differences in structural performance, structural failure location, and the maximum load that the reinforced concrete structure and steel structure of building E ITERA can withstand [11].

The structure analyzed is a 4-story symmetrical building for the building. Static earthquake loads are obtained according to [1]. The load of dynamic earthquakes is also taken into account. Analysis of the structure obtained the magnitude of static shear force 1,082.64 KN and dynamic shear force, Fx = 1,057 KN and Fy = 983.5 KN. The magnitude of the force of the column and beam elements is also obtained. The fulcrum reaction and the transfer of the buhul point can be known from the results of the analysis carried out. The inter-floor deviations occurring in the structural model do not exceed the allowable deviations [12].

The dormitory building of the PPATK Depok Pusdiklat is a construction with its construction planning able to withstand earthquake forces and behave non-linearly. However, the building does not yet have data on the building's resistance to earthquake forces. This construction requires an analysis of this building using one of the methods of analyzing the strength of the building against the earthquake force, namely the pushover method. This analysis was performed using the SAP2000 program. The conclusion of the analysis results shows that the greater the force (base force) given, the greater the displacement that occurs in buildings. The maximum earthquake load that the building is capable of receiving is 730.383kN. Based on [2], the building performance limit is at the IO level, indicating that the building is safe to use in the event of an earthquake [13].

Recorded moderate to strong earth eruptions caused by active tectonics from crustal faults occurring in the northwestern coastal areas of Ecuador. The brief seismic record began with a major earthquake and tsunami on 31 January 1906 (Mw8.8), followed by another destructive earthquake and tsunami in the sub-diction zone recorded on 19 January 1958 (Mw7.6) and 12 December 1979 (Mw 7.7). The earthquake of medium earth from faults occurred on April 9, 1976 (Mw6.7), January 2, 1981 (Mw5.9), June 25, 1989 (Mw 6.3), April 20, 2016 (Mw6.0) and January 31, 2017 (Mw5.5, MLv5.7) [14]. The accelerogram of a large tectonic earthquake is characterized by the duration of the earthquake. Some cases lead to an absolute response spectrum with two peaks. Such special features are related to the effect of the separate participation of the soil response in different stages of energy release, and the forces that dominate plate tectonics. A Chilean accelerogram obtained from 2010, Nepal 2015, Ecuador 2016, and the 2017 Mexico earthquake. After analysis shows 2PRS for large subduction earthquakes is the rule for soft soils. In addition, it was shown that the peak period of the land coincided with that estimated by the Nakamura method. The importance of 2PRS for earthquake engineering is that the source peak affects a house or medium-rise building and the ground peak affects a high-rise building or isolated building. Therefore, the design response spectrum considered in the seismic code for soft soils must be modified in the future to consider both effects [15]. It analyzes seismic events occurring in the Ecuadorian region north of Esmeraldas, beginning two months after the 2016 mega thrust earthquake Mw7.8 Pedernales, Ecuador. These findings indicate the need for further investigation into the potential seismic hazards of shallow upper plate faults and the potential for mega thrust earthquakes to trigger slow and shallow slippage seismic in separate subduction zone segments [16]. We identified a low Vp region (~5.5 km/s) that runs along the strike, in the sea front arc. To the North, we correlate this low Vp and Vp/Vs (<1.80) region to a subducted submarine mountain that may be part of the Carnegie Ridge(CR). In the South, the low Vp region is associated with high Vp/Vs (>1.85) which we interpret in depth cracking, possibly hydrated OC caused by subducted CR. These features play an important role in controlling the seismic behavior of margins. While subducted underwater mountains may have contributed to nucleation of intermediate mega thrust earthquakes in the northern segment, CR appears to be the main feature that controls seismic in the region by promoting creeping events and slow slips offshore it can be attributed to the up dip boundary of large mega thrust earthquakes in the northern segment and the absence of them in the southern region during the instrumental period [17].

The January 17, 1995 earthquake at magnitude 7.2 in Japan Meteorological Agency Scale or Mw = 6.9, which struck the northwest, north, and northeastern coastlines of Japan's Osaka Bay, was the most devastating earthquake to affect the region this century. The earthquake resulted in worst natural disaster since 1923 The great Kanto earthquake devastated Tokyo and Yokohama. The quake resulted in more than 6000 deaths and more than 30 000 injuries. The fire after the earthquake was burned on par with 70 U.S. city blocks. Together they demolished 150,000 buildings and left about 300,000 homeless people. The economic losses from this earthquake are estimated at $200 billion, the most expensive earthquake in the world so far, and the impact has been felt around the world [18].

Based on the analysis of the variety of response spectrum in the X and Y directions resulting in Vi ≥ 0.85 V, it can be concluded that the final value of the dynamic response of building structures using seismic isolation and those that do not use seismic isolation against nominal earthquake loading due to the influence of the Kobe and El-Centro earthquakes has met the requirements of [20]. Based on the performance evaluation according to [2], the performance level of the West Aceh Women's Dormitory Building building with seismic isolation and without seismic isolation with a load of Kobe is classified as Damage Control. Meanwhile, the West Aceh Women's Dormitory Building building with seismic isolation and without seismic isolation with the load of El - Centro is classified as Immediate Occupancy [19].

Periodic earthquake safety evaluations for building construction are necessary because they have been used all along in the planning of high-rise buildings. Many approaches can be used to evaluate them, one of which is pushover analysis. This analysis is performed by applying additional load then reading that displacement occurs and comparing it to the response spectrum demand retrieving performance points. Moreover, the historical record of time can be used to determine the displacement that appears in the structure. This study aims to conduct a 3D evaluation of reinforced concrete buildings. The building sample was selected from academic buildings in Yogyakarta, Indonesia which have 7 floors. The analysis is performed using 3D STERA software. Three historical records namely El-Centro, Kobe, and Park-field earthquakes are used to determine displacement. The results show the level of performance of the building and its displacement resulted from including the history of time, compared to the displacement limit of [2]. The results showed that the initial performance level was indicated with spectral displacement achieved at 13 cm [21], in pushover analysis that met the height limitation of 0.01 refer to [2].

The ETABS program has provided the facility to conduct structural performance evaluations with appropriate pushover analysis [2]. Performance points can be obtained by pushover analysis. Determining the point of performance (intermediate target) is very important as a parameter for the evaluation of the performance of the structure. Performance evaluation can provide information on the extent to which an earthquake will affect the building structure of the building. This is important for the evaluation of the seismic behavior of post-melting building structures. Although the acceleration of the original ground level peak of the Bucharest earthquake was smaller than the acceleration of the ground level peaks of regions 4 and 6, the transition that occurred was greater than the target of the transition (push-over analysis). This shows that the transition does not depend on the large/small value of the acceleration of the peak of the ground level, but is more influenced by earthquake characteristic factors. The El-Centro, Flores, and Pacoima earthquakes when compared to the analysis of thrust load, the results of switching out, drift and plastic joint rotation that occur are much smaller, the thrust load analysis is quite rational and reliable for the evaluation of seismic behavior [22].

A study has been conducted to evaluate the seismic performance of building shapes using pushover analysis. The work presented has considered four buildings, designed on the basis of [25]. Pushover analysis has been carried out forming using the following methods: spectrum capacity method [2]; method of displacement coefficient [23]; and displacement modification method [24]. Pushover analysis is a relatively simple way to monitor the nonlinear behavior of buildings. Three methods ([2]; [23]; and [24]) is used to determine the displacement target (δt) that produces different results. The capacity spectrum method [2], provides the lowest target displacement. However, all three methods show that the margin of safety against collapse is high and there is sufficient strength and dis-reserve placement. The maximum story drift ranges from 0.04 (0.01H) and 0.08 (0.02H), which can be categorized under damage control (DC). Building damage is still limited to all buildings as the worst elements produce at IO to LS levels. In general, the building is designed according to [25] meets three methods ([2], [23], [24]).

2. Methods

The flow of research is carried out in stages to get the results of a good planning, a good method must be carried out. In this planning the planning method will be spelled out in each planning step. The data used in this analysis planning are taken based on primary and secondary data. Systematic data retrieval starts from data collection and data processing. In this analysis process, the author collects secondary and primary data in the form of studies on the implementation of analysis, information about buildings, literature and as for the spectrum data of design responses that the author took from the Indonesian spectra design [1], data that the author collected to make it easier for the author to analyze the building.

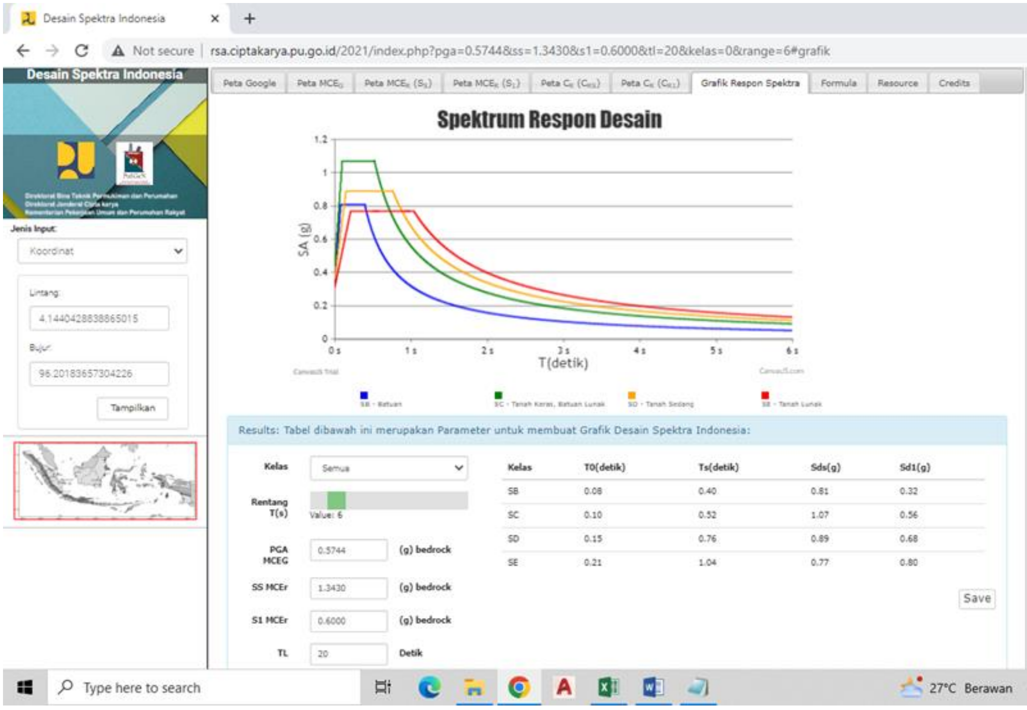

Fig 1. Spectrum response area design University Teuku Umar

There are Several measures are taken in calculating the loading on the floors of this construction namely, the calculation of the live load and the dead load on the roof construction, the first-floor construction, the second-floor construction, the third-floor construction and, the fourth-floor construction. The results of the loading calculation from the excel application are then input into the 3d Stera application for analysis. At this stage the author has a slight change in the image where the building in the shape of the author's circle changes to a symmetrical shape, this is because the author changed it so that there is a comparison between the building which was originally semicircular and now after analysis is symmetrical.

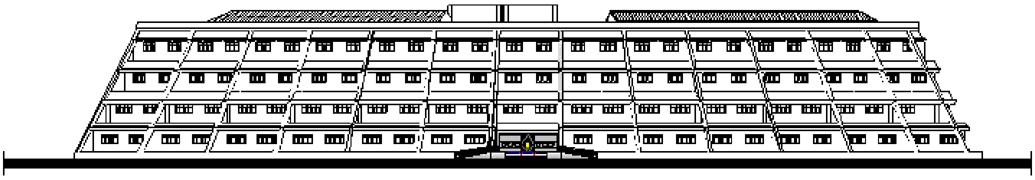

Fig 2. Unsymmetrical Front View Image

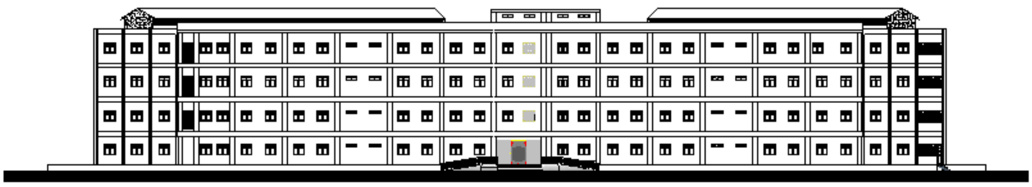

Fig 3. Assumed symmetrical Visible Images

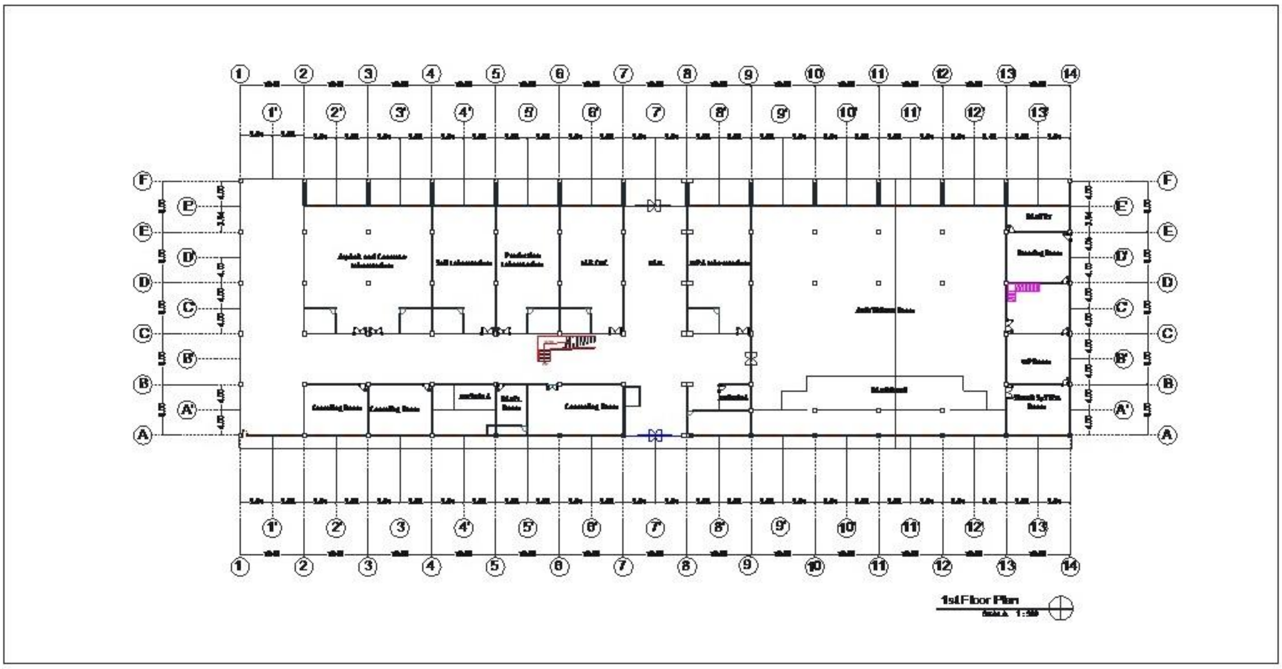

Fig 4. 1st Floor Plan

At this stage, the author uses modeling to enter data / information from each work item of the combining structure, namely sloof, columns, beams, and walls. The information data entered in the analysis includes: Sloof size, reinforcement diameter, distance between concrete blankets, spacing distance, strengthening quantity, reinforcement distance, brick quality, and specific gravity. Measurement columns, diameter of reinforcement, distance between concrete blankets, distance of spacing, quantity of reinforcement, specific gravity, distance of reinforcement, and quality of concrete. Beam size, reinforced bar diameter, distance between concrete blankets, reinforcement distance, reinforcement quantity, specific gravity, spacing distance, and concrete quality. Wall width, brick thickness, brick width, brick length and, spacing thickness.

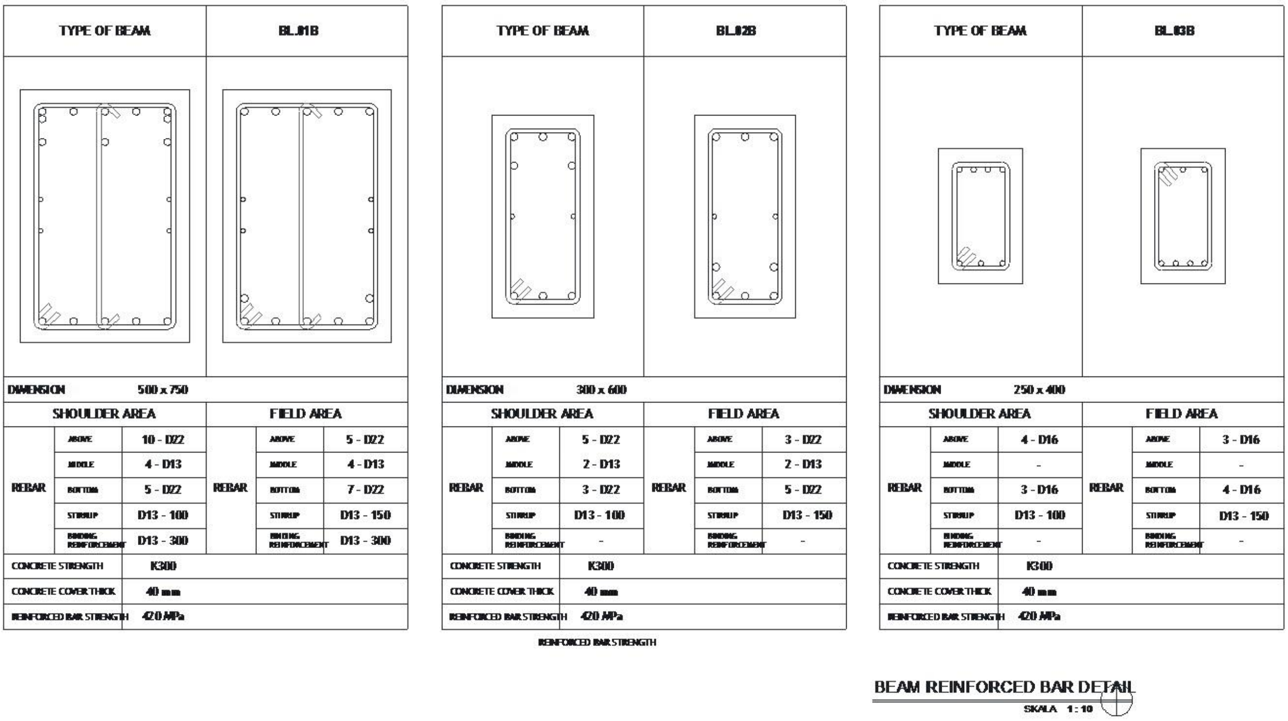

Fig 5. Beam Reinforced Details

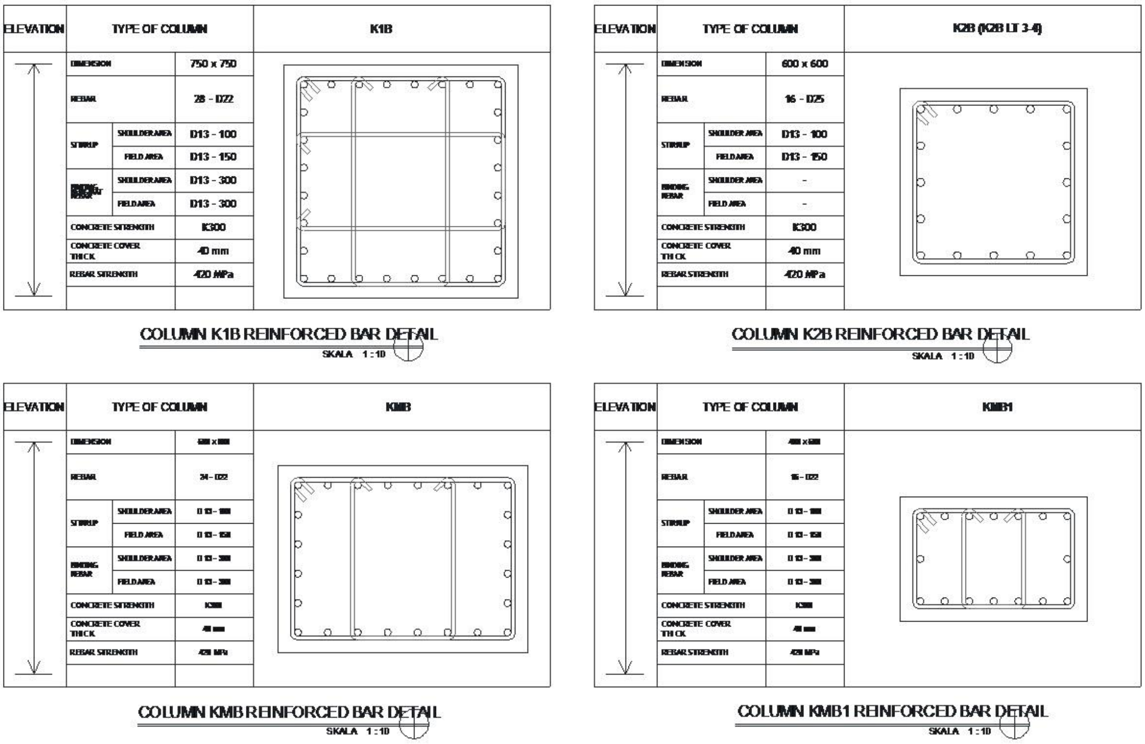

Fig 6. Column Reinforced Details

At this stage, the components that the author has entered into the 3d Stera application will be analyzed using the Kobe earthquake load where this analysis takes ±1 hour depending on the shape and area of the building. The application used is Stera 3d where Stera 3d software can be used to analyze earthquake reinforced concrete structures specially designed in three dimensions planning and education. Stera 3d has illustrations of building models and shows the results are obtained quickly and easily.

Stera 3d allows users to perform the following building analysis:

1. Capital analysis in three dimensions,
2. Nonlinear static push-over analysis in three dimensions,
3. Study of nonlinear seismic responses in three dimensions.

There are several models that can be done with this 3d Stera software, but in this analysis the author only does some modeling including:

1. Beam
2. Column
3. Wall
4. Sloof

The readings from the analysis results obtained from running on the 3d Stera application are calculated using the Microsoft excel program so that the data is required.

The basic shear force obtained from the results of spectrum response analysis, the minimum is 85% of the basic shear force that is carried based on the equivalent static method. When the base-shear force of the analysis results of the spectrum response analysis is smaller than 85%. The following is explained the calculation of the basic shear force [1]:

$$C1 = \frac{SD1}{T} \tag{1}$$

$$V1 = \frac{C1.I}{R}.Wt \tag{2}$$

Description:

C1	:	The value of the earthquake response factor obtained from the earthquake response spectrum plan for the fundamental natural earthquake time of the building structure.
SD1	:	MCE spectral response acceleration parameter at 1-second period, 5% attenuation
T	:	The natural vibrating time of building structures is expressed in seconds
V1	:	The nominal basic shear force acting at the base level of the building structure is irregular with the general degree of Ductility, calculated based on the fundamental natural vibrating time of the building structure
I	:	Building primacy factor
R	:	Earthquake reduction factor

Wt : Total weight of the building

The earthquake resistance planning procedure for building and non-building structures, gives a limit on deviations between floor levels (Δ) that must not exceed the deviations between floors of the permit level (Δs), where H is the floor height of the building, which is 4.2 m per floor [1].

The following is an explanation of the calculation of deviations between levels:

$$\Delta S < \frac{0,03}{R}.H \tag{3}$$

Description:
Δs = Deviation between levels.
R = Response modification factor.
H = Floor height.

Based on [1], the ultimate boundary of the building is determined by the deviation and deviation between the levels of the building structure due to the influence of the earthquake plan in the condition of the building on the verge of collapse, namely to limit the possibility of collapse of the building structure that can cause casualties and to prevent dangerous collisions between buildings or between parts of the building structure that are separated between separators (dilatation). The deviation and deviation between levels must be calculated from the deviation of the building structure due to nominal earthquake loading, multiplied by the multiplier factor ξ. Before calculating the performance of the Ultimate limit of direction X of the rah Y fund, it is necessary to find the scale factor first as explained below:

ξ = (0.7xR)/(Scale factor) (4)

The scale factor is obtained, then the calculation of the performance of the Ultimate limit is carried out with the specified conditions.

ξ x Δs between levels<0,02 x H (5)

Description:
ξ = Multiplier factor
Δs = Deviation between levels
H = High level
R = Reduction factor

The maximum allowable inter-floor deviation value due to the influence of the planning earthquake load is [1]:

$$\frac{0,015.H}{P} \tag{6}$$

Description:
H = High story
P = Reduction factor

3. Results and Discussion

The loading on the construction of this building consists of the loading of the roof and the loading of the floor which is calculated dead load and live load, then after that the results of this calculation are combined in relation to the overall construction weight. The results of these calculations can be seen in Table 1.

Table 1. Building Load

Weight Construction	Level of Floor				
	Ground Floor Load	*1st Floor Load*	*2nd floor load*	*3rd Floor Load*	*4th Floor Load*
Weight of Floor (Ton)	1276	2553	4209	3097	2169
Weight of Floor (kN)	12756	25532	42093	30787	21692

Based on the results of the analysis that has been carried out in the 3d Stera application, the results of the base shear with the Kobe earthquake load can be seen in Table 2.

Table 2. Base Shear with Kobe Earthquake Load

Floor	*Base Shear Direction X (kN)*	*Base Shear Direction Y (kN)*
1	1276	2553

Based on [1], the basic shear force obtained from the results of spectrum response analysis, the minimum is 85% of the basic shear force that is carried based on the equivalent static method. When the base-shear force of the analysis results the spectrum response is smaller than 85%. Furthermore, the results of the calculation of the evaluation of the earthquake load in the X direction and Y direction, can be seen in Table 3.

Table 3. Evaluation of earthquake load direction X and Y earthquake load Kobe

Floor	Evaluation of the seismic load in the direction X and Y	
	Base-Shear Direction X (kN)	*Base-Shear Direction Y (kN)*
1	10,090	13,270

The earthquake resistance planning procedure for building and non-building structures, provides a limit on deviations between floor levels (Δ) that is, it must not exceed the deviation between floors of the permit level (Δs) as seen in Table 4, where H is the floor height of the building, which is 4.2 m per floor [1].

Table 4. Performance control of structure service limits with Kobe earthquake load

Floor	*Heigth (m)*	*Δs Direction X (m)*	*Δs Direction Y (m)*	*Δs Inter-Levels X (m)*	*Δs Inter-Levels Y (m)*	*Condition (m) {(0,03/R)* H}*	*X*	*Y*
4	4.2	0.0058	0.0084	0.0042	0.0063	0.063	Ok	Ok
3	4.2	0.0016	0.0021	0.0002	0.0001	0.063	Ok	Ok
2	4.2	0.0015	0.0021	0.0002	0.0005	0.063	Ok	Ok
1	4.2	0.0012	0.0016	0.0000	0.0000	0.063	Ok	Ok

Based on [1], earthquake resistance planning procedures for building and non-building structures. The performance of the ultimate limit of the building is determined by the deviation and deviation between the m levels of the building structure due to the influence of the earthquake plan in the condition of the building on the verge of collapse, that is, to limit the possibility of collapse of the building structure that can cause casualties and to prevent dangerous collisions between buildings or between parts of the building structure that are separated between separators (Dilatation). The deviation and deviation between levels must be calculated from the deviation of the building structure due to nominal earthquake loading, multiplied by the multiplier factor ξ. Before calculating the performance of the Ultimate limit of the X direction and Y direction, it is necessary to first search for the scale factor. Henceforth, the results of the calculation of the performance control of the Ultimate limit of earthquake loads in the X direction and Y direction, can be seen in Table 5.

Table 5. Ultimate Boundary Control

Floor	*Heigth (m)*	*Δm Direction X (m)*	*Δm Inter-Levels X (m))*	*ξ Δm Inter-Levels X (m))*	*Δm Direction Y (m)*	*Δm Inter-Levels Y (m)*	*ξ Δs Inter-Levels Y (m))*	*Condition (m) {(0,03/R)* H}*	*X*	*Y*
4	4.2	0.0058	0.0042	0.0058	0.0084	0.0063	0.0088	0.084	Ok	Ok
3	4.2	0.0016	0.0002	0.0003	0.0021	0.0001	0.0001	0.084	Ok	Ok
2	4.2	0.0015	0.0002	0.0003	0.0021	0.0005	0.0006	0.084	Ok	Ok
1	4.2	0.0012	0.0000	0.0000	0.0016	0.0000	0.0000	0.084	Ok	Ok

Control of deviations between the maximum floors of the building structure due to the influence of the earthquake can be seen in Table 6 below:

Table 6. Maximum Displacement Analysis of Kobe Earthquake Sepectrum

Number	*Heigth (m)*	*Displacement Direction X (m)*	*Displacement Direction Y (m)*	*Condition [(0.015hx/)/p] (m)*	*X*	*Y*
4	12.6	0.0058	0.0084	0.0042	Ok	Ok
3	8.40	0.0016	0.0021	0.0002	Ok	Ok
2	4.20	0.0015	0.0021	0.0002	Ok	Ok
1	0.00	0.0012	0.0016	0.0000	Ok	Ok

1. The physical condition of the building before the analysis was carried out, which had an area of ±5025.0084 and had four floors, can be seen in Figure 7.

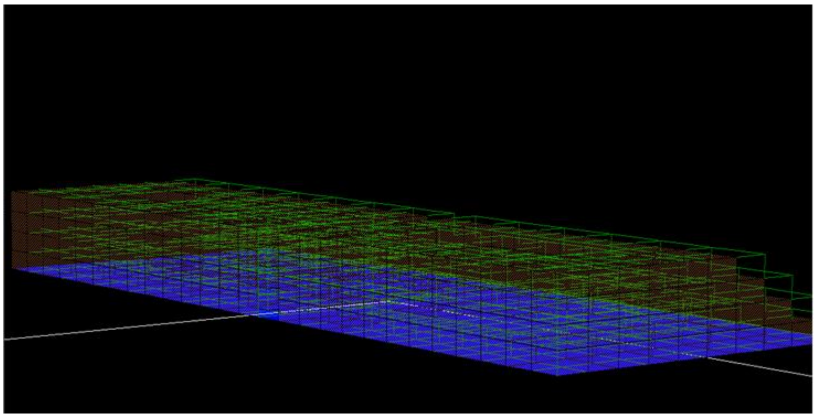

Fig 7. Building Structure Condition before Analysis

2. The physical condition of the university building after analysis with earthquake response and static response through 3d Stera software, where 1 < U <5 (AMP (response force) analysis) which utilizes Kobe earthquake recordings that lasted about an hour analysis marked in yellow, and 5 < U (showing moderate to severe damage) marked in red can be seen in Figures 8 and 9. From the results of the 3D Stera analysis, it can be seen that the meeting points of the beams and columns are yellow, which means that the condition of the U2C building structure is still safe.

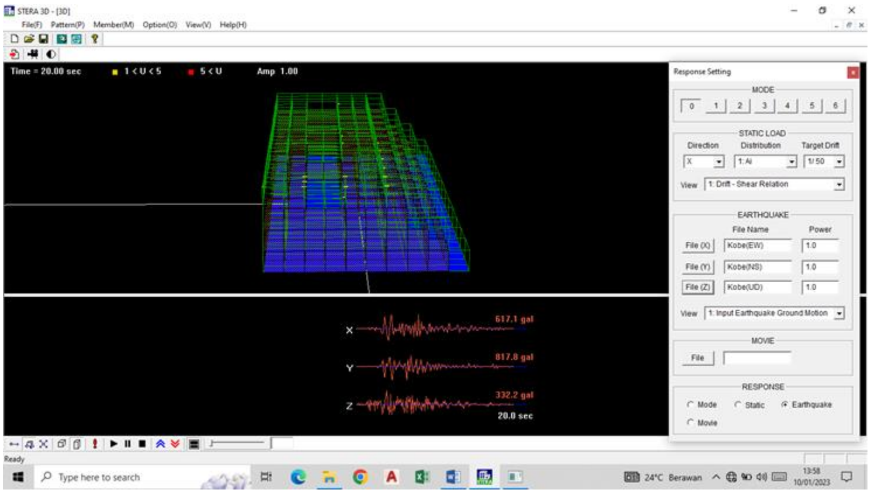

Fig 8. Building Structure Condition after earthquake response analysis

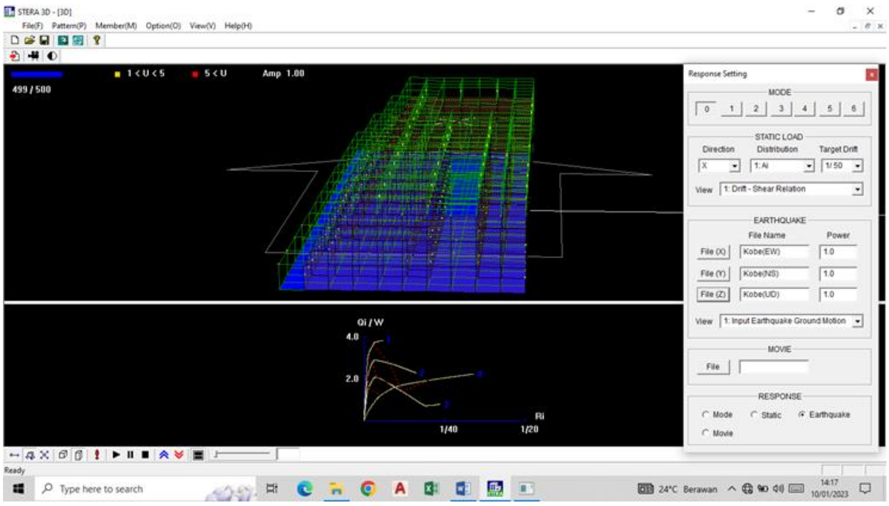

Fig 9. Building Structure Condition after response static analysis

4. Conclusion

From the results of the analysis, the value of the deviation between directional levels X 0.0058 m with a base shear of 10,090 KN was obtained. While the Y direction capacity curve has the largest displacement of 0.0084 m with a base shear of 13,270 KN. The result of structural deviation when the performance point is reached for X direction and Y direction loading of 0.0042 m and 0.0063 m, resulting in a yellow color at each point of the column and beam relationship which means that it is still within the range of 1 < U <5 (AMP (response force) analysis), this indicates that the condition of the building structure remains safe during an earthquake. The physical condition of the university building after analysis was carried out with earthquake response and static response through 3d Stera software, where 1 < U <5

(AMP analysis (response force)) which utilizes Kobe earthquake recordings that lasted about an hour analysis marked in yellow, and 5 < U (indicating moderate to severe damage) marked in red.

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References

[1] SNI. 1726:2019, Tata cara perencanaan ketahanan gempa untuk struktur bangunan gedung dan non gedung, ICS 91.120.25; 91.080.01 ed., Jakarta: Badan Standardisasi Nasional, 2019.

[2] ATC-40, Seismic Evaluation and Retrofit of Concrete Buildings, Redwood City, California 94065: APPLIED TECHNOLOGY COUNCIL, 1996.

[3] F. A. Karima, "Analisis Struktur Gedung Bertingkat Rendah Akibat Pengaruh Beban V," *JRSDD,* vol. 9, no. 4, pp. 655 - 668, 2021.

[4] I Gede Gegiranang Wiryadi, "ANALISIS RIWAYAT WAKTU PERILAKU STRUKTUR GEDUNG SMA NEGERI 9 DENPASAR," *JURNAL ILMIAH KURVA TEKNIK,* vol. 10, no. 2, pp. 43 - 52, 2021.

[5] T. Nishiwaki, "Recovery of stress during the interseismic period around the seismogenic fault of the 1995 Mw 6.9 Kobe earthquake, Japan," AGU PUBLICATION, Kyoto, Japan, 2018.

[6] Muliadi, "ANALISIS PERPINDAHAN PADA STRUKTUR BANGUNAN MENGGUNAKAN BASEISOLATOR DI WILAYAH GEMPA KUAT," *PORTAL JURNAL TEKNIK SIPIL,* vol. 9, no. 1 , pp. 1 - 15, 2017.

[7] R. Rendra, "KINERJA STRUKTUR AKIBAT BEBAN GEMPA DENGAN METODE," *JOM FTEKNIK,* vol. 2, no. 2, pp. 1 - 15, 2015.

[8] I. N. Handoyo, "Evaluasi Kinerja Gedung 20 Lantai dengan Variasi Dinding Geser Berdasarkan Analisis Time History Gempa," *Journal of The Civil Engineering Student,* vol. 1, no. 3, pp. 83 - 90, 2019.

[9] A. Krisdiantoe, "ANALISIS KEKUATAN BANGUNAN TERHADAP GAYA GEMPA DENGAN METODE ANALISIS PUSHOVER (STUDI KASUS GEDUNG PPIIG UPR 2020)," *journal.umbjm.ac.id/index.php/density,* vol. 4, no. 2, pp. 50 - 55, 2022.

[10] M. Gallegos, "ANALYSIS OF STRONG-MOTION ACCELEROGRAPH RECORDS OF THE 16 APRIL 2016 Mw 7.8 MUISNE, ECUADOR EARTHQUAKE," in 16th World Conference on Earthquake Engineering, 16WCEE 2017, Santiago Chile, 2017.

[11] A. Yudi, "ANALISIS PERILAKU STRUKTUR BETON DAN BAJA DENGAN METODE LEVELLING TIME HISTORY (STUDI KASUS GEDUNG E ITERA, LAMPUNG, INDONESIA)," *REKAYASA SIPIL,* vol. 13, no. 3, pp. 173 -183, 2019.

[12] A. W. Zebua, "ANALISIS GAYA GEMPA BANGUNAN RUMAH TINGGAL DI WILAYAH GEMPA TINGGI," *Jurnal Teknik Sipil Siklus,* vol. 4, no. 1, pp. 23 - 35, 2018.

[13] T. P. Utami, "ANALISIS KEKUATAN BANGUNAN TERHADAP GAYA GEMPA DENGAN METODE PUSHOVER STUDI KASUS GEDUNG ASRAMA PUSDIKLAT PPATK, DEPOK," *J. Infras,* vol. 3, no. 2, pp. 99 - 106, 2017

[14] K. Chunga, "REVIEW OF EARTHQUAKES AND TSUNAMI RECORDS ANDCHARACTERIZATION OF CAPABLE FAULTS ON THE NORTHWESTERN COASTOF ECUADOR," *Journal of Tsunami Society International,* vol. 36, no. 3, p. 100, 2017.

[15] G. Saragoni, "Evidence of two peaks response spectra (2PRS) due to separated effects of soil and source in recent subduction earthquakes," in *Conference: Earthquake Geotechnical Engineering for Protection and Development of Environment and Constructions*, Rome, Italy, 2019

[16] M. C. Hoskins, "Triggered crustal earthquake swarm across subduction segmentboundary after the 2016 Pedernales, Ecuador megathrust earthquake," *Earth and Planetary Science Letters,* vol. 553, no. 116620, pp. 1 - 13, 2021.

[17] S. León-Ríos, "3D Local Earthquake Tomography of the Ecuadorian Margin in the Source Area of the 2016 Mw 7.8 Pedernales Earthquake," *Journal of Geophysical Research: Solid Earth,* vol. 10.1029/2020JB020701, pp. 1 - 21, 2021.

[18] NIST, The January 17, 1995 Hyogoken-Nanbu (Kobe) Earthquake, Gaithersburg, MD 20899-0001: Building and Fire Research Laboratory, 1996.

[19] A. Yusra, "ANALYSIS OF STRUCTURAL BUILDING STRENGTH ASRAMA PUTRI ACEH BARAT WITH USE SEISMIC ISOLATION ON KOBE AND EL – CENTRO EARTHQUAKE," *Jurnal Teknik Sipil Fakultas Teknik Universitas Teuku Umar,* vol. 1, no. 1, pp. 1 - 10, 2015

[20] SNI. 1726:2012, Tata cara ketahanan gempa untuk struktur gedung dan non gedung, Jakarta: Badan Santadardisasi Indonesia, 2012.

[21] T. I. Maulana, "Preliminary Seismic Performance-based Evaluation of Academic Reinforced Concrete Building in Yogyakarta based on Displacement Parameter," *Advances in Engineering Research,,* vol. 187, pp. 72 - 77, 2019.

[22] Y. A. Pranata, "EVALUASI KINERJA GEDUNG BETON BERTULANG TAHAN GEMPA dengan PUSHOVER ANALYSIS," *Jurnal Teknik Sipil Universitas Kristen Maranatha, Bandung,* vol. 3, no. 1, pp. 41 - 52, 2006

[23] FEMA-356, Prestandard and Commentary for the Seismic Reha-, Washington, D.C.: AMERICAN SOCIETY OF CIVIL ENGINEERS, 2000.

[24] FEMA-440, Improvement of Nonlinear Static Seismic Analysis, Washington, D.C.: Federal Emergency Management Agency, 2005.
[25] SBC-301, Structural—Loading and Forces, Saudi Arabia: The Saudi Code National Building Committee, 2007.