1st Proceeding of International Conference on Science and Technology UISU (ICST)
"Contribution of Engineering Disciplines to Achieving Sustainable Development Goals Research Realizing the Vision of Golden Indonesia 2045"
ISSN: 3063-7929 (Online)
DOI: https://doi.org/10.30743/icst

Shape Control Techniques for Earthquakes Structures in Hospital Buildings Using ETABS Software

Hermansyah [1], Y A Manullang[1], Habib Satria[1], Indri Dayana[1*], D M Hutauruk[2]
[1]Faculty of Engineering, Universitas Medan Area, Medan. Indonesia
[2]Faculty of Engineering, Universitas Negeri Medan, Medan. Indonesia
*Corresponding author: dayanaindri27@gmail.com

Abstract - Earthquakes are a natural phenomenon that can cause damage to multi-storey buildings such as hospital buildings. The occurrence of earthquakes cannot be predicted, so deeper studies are needed to analyze building structures, especially to minimize ground movements when activities caused by tectonic earthquakes occur. Therefore, a structural analysis model was carried out to fulfill the protection requirements for buildings using the time history method based on Etabs V.18 software w ith the aim of analyzing the structure of safety requirements according to established standards and reviewing deviations between levels and ATC-40 by considering the total maximum speed. Implementation of the use of Etabs V.18 software in analyzing building structures using the time history method, then to support the analysis of this research, the building model parameters were reviewed using one earthquake accelerogram input. The research results show that in the X direction the largest inter-floor deviation is 50.90, and in the Y direction the largest inter-floor deviation is 50.90. Based on the ATC-40 measurement results, thebuilding is included in the Immediate Occupancy (IO) performance level, with a maximum total deviation value below the limit of 0.01.

Keywords : Control, Earthquakes, Structure, Building

1. INTRODUCTION

Sumatra is an island that has a high level of seismicity because the subduction zone activity of the Indo-Australian plate subducts beneath the Eurasian plate so that the subduction zone activity forms an earthquake path [1]. The path of the earthquake caused a large fault in the earth's crust that split along the island of Sumatra, which became known as the Great Sumatran Fault [2]. In accordance with the depth of subduction of the Indo-Australian plate under the Eurasian plate, the source of earthquakes in Java and Sumatra can reach 700 km below the earth's surface [3]. On the mainland of Sumatra there are shallow earthquake sources caused by the activity of the Sumatran fault [4]. Earthquakes have negative impacts on humans and the environment in the area, such as loss of life, damage to buildings and damage to public facilities. Building structural components must be designed to withstand earthquake loads in advance of the impact of the earthquake. The structural stiffness value shows that high-rise buildings must have strength, durability and comfort [5]. The tendency of a structure to deviate horizontally or laterally is influenced by its stiffness value.

Multi-storey buildings are designed to anticipate lateral displacement due to earthquake loads in order to achieve a comfortable and safe structure. With the earthquake in Indonesia, many earthquake structure analyzes were developed and protection systems [6]. Earthquake analysis is divided into two, namely static and dynamic earthquake analysis. earthquake analysis [7], [8]. Dynamic earthquake analysis is used to determine structural performance in tall, multi-storey, irregular buildings and buildings that require very high precision. Dynamic earthquake analysis includes time history analysis. Previous research still used manual calculations so that information and descriptions regarding the behavior of building structures due to the influence of earthquake loads were not very visible [9], [10]. However, compared to previous research, the research was developed by carrying outadditional software simulation models that are more measurable in simulating building structure events due to earthquakes so that earthquake-resistant building structure planning is more optimal.

Based on this, the aim of this research is to carry out modeling in analyzing the performance level of hospital building structures in the city of Medan. Then the advantage and novelty of this model is that it utilizes the time history method using Etabs V.18 software to carry out simpler accuracy at the level of structural performance at the hospital in Medan after entering earthquake loads.

2. METHOD

In this research, a linear time history analysis method is used to simplify the geometry of the structure. The time history analysis process requires a minimum of five earthquake records of horizontal ground motion acceleration which must be selected from several earthquake events. Each selected time history must be scaled, so that its response spectrum resembles the location to be considered. The earthquake data recorded from the accelerogram is then simulated into earthquake acceleration using structural analysis software. Then, to monitor the spectrum response analysis, Etabs V.18 software is needed as a parameter in analyzing the structural performance design of hospital buildings in the city of Medan. Then, for the object of this research, the structure of a 12-story building in one of the hospitals in the city of Medan was used. Supporting data in simulating the design of this

1st Proceeding of International Conference on Science and Technology UISU (ICST)
"Contribution of Engineering Disciplines to Achieving Sustainable Development Goals Research Realizing the Vision of Golden Indonesia 2045"
ISSN: 3063-7929 (Online)
DOI: https://doi.org/10.30743/icst

building structure also uses soft soil types. The hospital building that will be used is included in category IV and has a priority factor of 1.5. The soil type classification is assumed to be medium soil type. The quality of concrete used in beams, columns and floor slabs is 35 Mpa. And the quality of plain steel reinforcement is 240 Mpa and threaded reinforcement is 400 Mpa. Floor Plates The floor plates used in the Medan Hospital building structure measure 15 cm. Then, to support data collection in the analysis, shop drawings were implemented as modeling in accordance with the existing drawings so that the analysis did not deviate from the existing drawings. All structures modeled must be in accordance with the Shop Drawing, non-structural buildings are not modeled because they do not have a significant influence in this 3D modeling. Then the measurement of the performance level of the ATC-40 structureis determined from the roof displacement. One of the parameters used in determining the performance level is maximum total drift.

The following are several procedures carried out in this research, namely a) conducting a literature study, b) preparing research data in the form of secondary data, namely building structure data and actual earthquake accelerograms, c) calculating the loads on the building structure, namely from the dead load itself, dead load additional, live loads and earthquake loads, d) building structure modeling, e) inputting structural properties in the form of cross-sectional dimensions and material quality, f) analyzing the structure with Etabs V.18 Software) analyzing the performance of the structure against earthquake loads and ATC-40, h) summing up the final results. According to Table 1, these are the beams that will be used in designing hospital building.

Table1**.** Beam composition in hospital building

No	Type	Dimensions (cm)
1	BPBeam	35x60
2	Joist	25x60
3	Mainbeam	30x60
4	BeamB14	30x60
5	BasementWallBeams	60x90
6	BeamB12	30x70

Based on the type and dimension usage scenario in Table 1 with a total of 6 main beams, the data will then be simulated later in the EtabsV.18 software. The percentage of blocks for each dimension to be used is shown in Figure1.

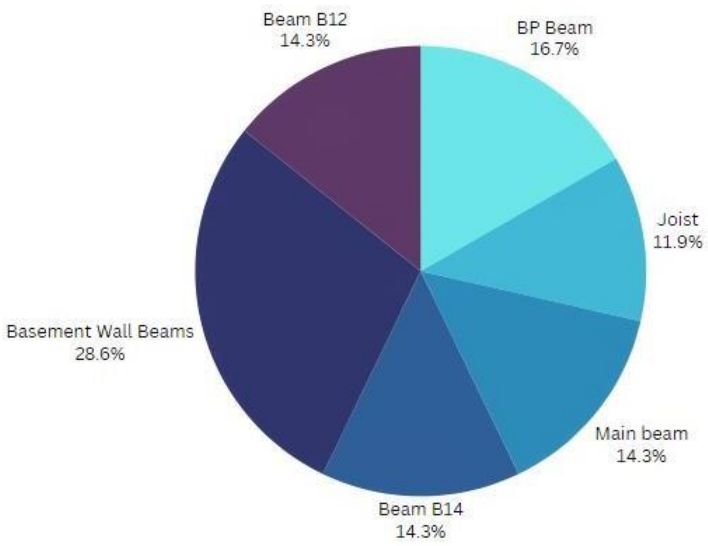

Figure 1**.** Percentage of material for each beam

Based on Figure 1, namely the use of beam material, which is steel beams cast in concrete for the construction of hospitals to make them stronger with the highest percentage, namely the supply of basement wall beams up to 28.6%. Then the BP Beam supporting beam is 16.7% and while the B12 beam, B14 beam and main beam with a percentage of cast concrete for dimensions are around 14.3%. Meanwhile, cast concrete supply joists for hospital construction was 11.9%.Then the scenario to support the design of the hospital building structure requires the

ISSN: 3063-7929 (Online)
DOI: https://doi.org/10.30743/icst

column dimensions shown in Table 2. All of these columns, which consist of 6 basic columns, will later become parameters in building the hospital building structure when inputting data using Etabs V.18 software.

Table 2. Composition of columns in the hospital building frame

No	Type	Dimensions (cm)
1	Column K1	80x80
2	Column K2	60x60
3	ColumnK3	50x50
4	ColumnK4	30x60
5	ColumnK5	40x60
6	ColumnK8P	50x100

3. RESULTSAND DISCUSSION

The overall data modeling of the structure to be built consists of the type of construction, namely a hospital building, the number of floors is around 12 floors, the building length is 66.5 meters and the building width is around 97 m. The structural planning of an earthquake-resistant hospital building in the city of Medan using Etabs V.18 software is shown in Figure 2.

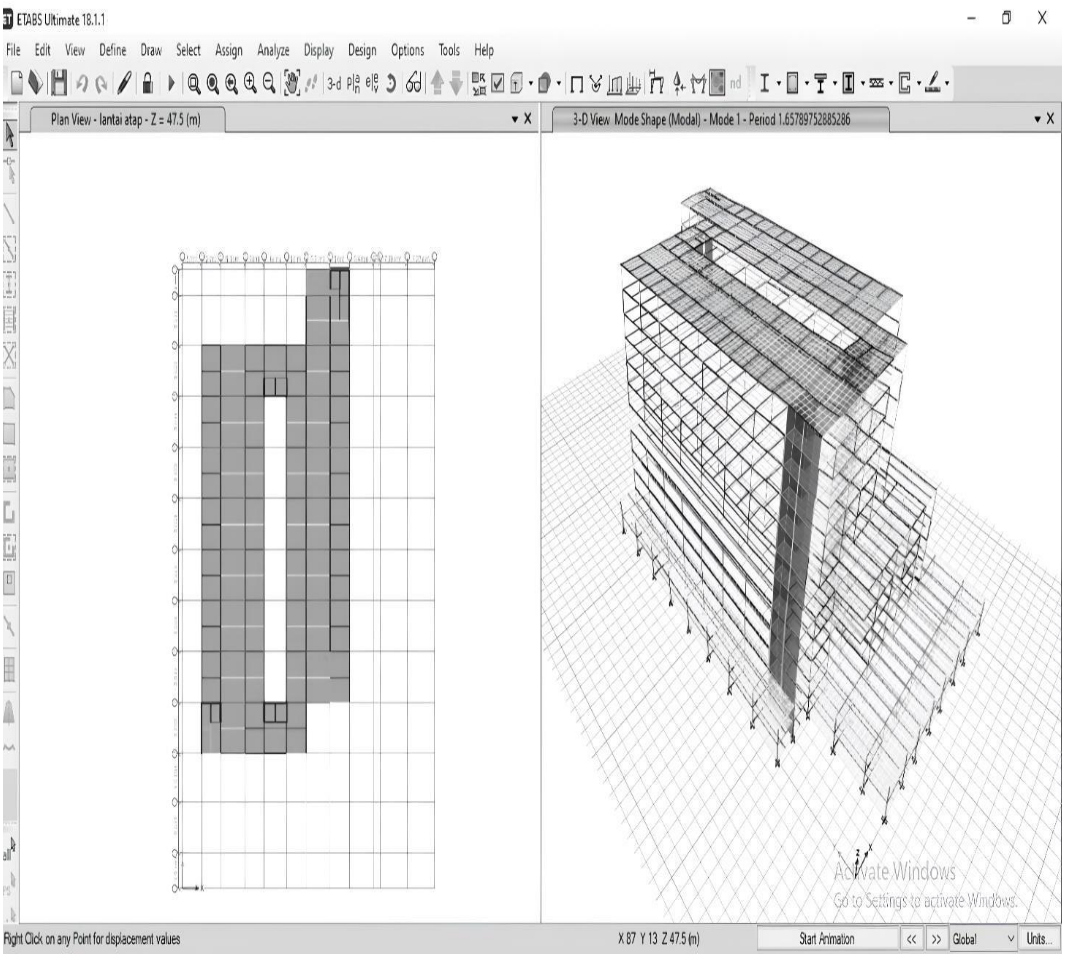

Figure 2. 3D building structure modeling in hospitals based on Etabs V.18 software.

3.1 Accelelogram Model

An accelerogram is a graphical recording of the acceleration of the ground surface at the time of an earthquakethatarrivesatan earthquakestation. This accelerogram is produced from arecording device, name lyan

ISSN: 3063-7929 (Online)
DOI: https://doi.org/10.30743/icst

ccelerograph orcommon lycalledan accelerometer. The accelerogram model that has been simulated for hospital buildings is by inputting earthquake movement analysis as building resistance with a magnitude 5.5 SR experiment.

3.2 Building Structure Control Results

The value of mass participation is obtained from the results of analysis in modeling using the Etabs program. Mass participation analysis is required to add sufficient total variation to obtain a combined mass participation result of more than 90%.Then to control the building structure in controlling the risk of building damage by paying attention to wind speed, air mass density, geographical location, the height of a building and the stiffness of the building structure in the hospital.

3.3 Time History Analysis

To view the recorded data and analysis results of the displacement, the displacement in the X and Y directionsis shown in Table 3.

Table 3**.** Earthquake load displacement output data uses Etabs V.18 software

No	Floor	X Direction (mm)	Y Direction (mm)
1	Roof	86.87	82.42
2	10	77.48	73.48
3	9	67.49	63.83
4	8	57.03	53.76
5	7	46.39	43.91
6	6	35.85	33.95
7	5	22.94	25.38
8	4	14.78	14.77
9	3	7.62	7.96
10	2	2.40	2.56
11	1	0.18	0.19
12	Base 2	0.02	0.01
13	Base 1	0	0

3D building design modeling using Etabs V.18 software with the aim of being able to analyze the structure, one of which is determining the base shear that works on the building structure. The base shear value is the output of Etabs V.18 and also the base share value that has been obtained will later be used in calculating the serviceability limits of building structures and reviewing the building performance reliability system as a result of tectonic earthquake loads. The results of the base shear values are shown in Table 4.

Table 4**.** Base Shearin the Directions X and Y

Base Shear	
Vx (kN)	Vy (kN)
349,915.9575	753,635.791

3.4 Results of Structural Control Based on ATC-40

The structural performance level based on ATC-40 is based on recorded earthquake scenarios in the X direction using the maximum drift parameter. The building performance level data obtained is structural stability. Then the maximum in-elastic drift at the non-linear building performance level is obtained by structural stability data. Meanwhile, according to ATC-40, building performance in the Y direction at maximum drift shows that the building performance level data is structural stability and for maximum in-elastic drift, the level of non-linear building performance is structural stability. Then, after all data parameters have been obtained, the accuracy of the design spectrum response graph can be assessed for earthquake acceleration by running a time history which is useful for monitoring the vibration time response parameters experienced by structures in hospital buildings, shown in Figure 3.

ISSN: 3063-7929 (Online)
DOI: https://doi.org/10.30743/icst

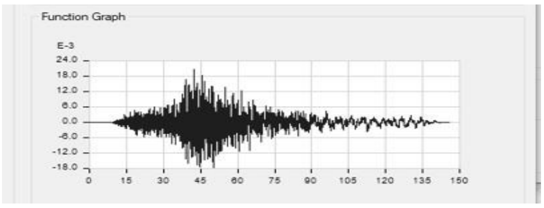

Figure 3**.** Simulation of earthquake activity for hospital building structures based on time history

4. CONCLUSION

The application of building structure design using Etabs V.18 software and also supported by the time history analysis method can run well. If the data on the ATC-40 hospital building is input using an earthquake vibration scenario, the level of structural performance is obtained using the stability category for the hospital building structure. Then, ATC-40 data was obtained on a building when it was subjected to a trial earthquake load of magnitude 5.5 on the SR with a model simulation in the IO category (Immediate Occupancy) meaning that the building structure was still safe with minor damage. This is also due to the support of the beam material which is a steel beam cast in concrete for the construction of the hospital to make it stronger with a percentage of material in the basement wall beams reaching 28.6%. Then the BP Beam supporting beam is 16.7% and while the B12 beam, B14 beam and main beam with a percentage of cast concrete for dimensions are around 14.3%. Meanwhile, cast concrete supply joists forhospital construction was 11.9%. The shape control technique for hospital building structures that will be developed has reliability according to established standards.

ACKNOWLEDGMENTS

Thank you for the funding support for publication as well as the full support from the collaboration betweenthe Civil Engineering Study Programand the Electrical Engineering Study Program as wellas Medan Area University

REFERENCES

[1] Alvanchi A and Seyrfar A, 2020, Improving facility management of public hospitals in Iran using building information modeling *Sci. Iran.***27** 2817–29

[2] Olanrewaju A and Tan W X, 2022, An artificial neural network analysis of the satisfaction of hospital building maintenance services *IOP Conference Series: Materials Science and Engineering* vol 1218 (IOP Publishing Ltd) pp 1–6

[3] Liu S, Suardi I, Xu X, Yang S and Tong, P, 2021, The Geometry of the Subducted Slab Beneath Sumatra Revealed by Regional and Teleseismic Traveltime Tomography *J. Geophys. Res. Solid Earth***126** 1–29

[4] Dhoopati S and Chenna R 2021 Seismic performance assessment of a G+4 school building in Gujarat, Ahmadabad *Asian J. Civ. Eng.***22** 1–11

[5] Afolabi S A, Babalola O, Olaniyan O M and Aseyan B, 2022, Maintenance Culture in Selected Public Buildings within Ibadan Metropolis *Eur. J. Dev. Stud.***2** 58–69

[6] Satria H, Mungkin M, Dayana I, Ramdan D, Maizana D and Syafii S, 2024, Development of energy conversion and lightning strike protection simulation for photovoltaic-wind turbine on grid *Int. J. Electr. Comput. Eng.*14 66–74

[7] Yildizlar B, 2021, Seismic performance analysis and rehabilitation applications for a historical masonrybuilding through field works and experimental investigations *Structures*34 1811–1833

[8] Mungkin M, Satria H, Maizana D, Isa M, Syafii and Puriza M Y, 2023, Analysis of the feasibility of adding a grid-connected hybrid photovoltaic system to reduce electrical load *Int. J. Power Electron. Drive Syst.*14 1160–71

[9] Permana D A and Rohman F, 2018, Analysis And Design Structure Of Cideres Hospital Building *J. Green Sci. Technol.***2** 23–8

[10] Qu Z, Wang F, Chen X, Wang X and Zhou Z, 2023, Rapid report of seismic damage to hospitals in the 2023 Turkey earthquake sequences *Earthq. Res. Adv.***3** 1–24