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Assessment of Building Seismic Risk in the Environment of Ibn Khaldun University Bogor

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ABSTRACT

The city of Bogor has varied contours and high rainfall. Potential natural disasters that often occur include floods, landslides, collapsed buildings, fires, landslides, hurricanes, earthquakes, and landslides. The city of Bogor is included in the zone 4 earthquake. Buildings in the Ibn Khaldun University (UIKA) Bogor were erected vertically as an optimization of limited land. The study of the vulnerability of buildings to earthquakes is very important to ensure that building users are in a safe condition during the service life of buildings against earthquakes using the Rapid Visual Screening (RVS) Method and the Hazus Method. The RVS form is obtained from the design spectra and the response spectrum, namely the high seismicity level based on the building coordinates. Based on the results of the RVS, the value of the vulnerability of buildings in the UIKA Bogor environment is 0.086% with an average value of 3.156. Based on the inspection that has been carried out, the buildings are classified as C1 and S1 building types, vertical irregularities occur in 3 buildings, plan irregularities occur in 1 building out of a total of 9 buildings and the land is assumed to be medium soil (type D) because there is no soil investigation.

Keywords: building vulnerability; earthquake; Rapid Visual Screening (RVS); FEMA P-154.

INTRODUCTION

The Bogor City area has a minimum height of 190 meters and a maximum of 330 meters above sea level (Jabarprov, 2021). The city of Bogor has varied contours and high rainfall. Potential natural disasters that often occur include floods, landslides, collapsed buildings, fires, landslides, hurricanes, earthquakes, land subsidence (BPBD Bogor City, 2021). The city of Bogor is included in the zone 4 earthquake. The study of the vulnerability of buildings to earthquakes is very important to ensure that building users are in a safe condition during the service life of the building. The study was conducted on buildings within the Ibn Khaldun University (UIKA) Bogor using the Rapid Visual Screening (RVS) Method based on FEMA P-154 2015 regarding the potential for seismic hazards in buildings. The building identified in UIKA Bogor is located on Jalan KH. Sholeh Iskandar Km. 2 Kedung Badak, Tanah Sareal District, Bogor City, West Java, totaling 13 buildings with varying heights from 1 floor to 5 floors with structures made of concrete and steel that function as offices, lectures, and laboratories. The purpose of the study is to determine the level of vulnerability of buildings in the UIKA Bogor environment to earthquakes with the 2015 FEMA P-154 standard based on the value obtained from the final score (S), if $S \leq 2$ then the building is declared at risk of earthquake threats and further evaluation needs to be carried out. carry on. This research is limited by several provisions including, the vulnerability analysis of the building is carried out in the UIKA Bogor environment, the structural analysis includes the upper structure and does not analyze the base structure, the vulnerability analysis of the building uses the 2015 FEMA P-154 standard with the RVS method, the analysis is carried out on 9 buildings. which is considered vital from a total of 19 buildings in UIKA Bogor.

Disasters can be caused by natural events (natural disasters) or by humans (man-made disasters). Factors that can cause disasters include: Natural hazards (natural hazards) and man-made hazards which according to the United Nations International Strategy for Disaster Reduction (UN-ISDR) can be grouped into geological hazards (geological hazards). , hydrometeorological hazards, biological hazards, technological hazards and environmental degradation, the high vulnerability of the community. Infrastructure and elements within cities/areas that are at risk of disasters are low in capacity from various components in the community (BPBD, 2016). Earthquake (earthquake) is an event that vibrates or shakes the earth due to the sudden movement of rock layers in the earth's crust due to the movement of tectonic plates. Earthquakes caused by the movement of tectonic plates are called tectonic earthquakes. But apart from that, earthquakes can also occur due to volcanic activity which is known as volcanic earthquakes (Sunarjo, Gunawan & Pribadi, 2012).

Simple residential buildings must meet the technical requirements stipulated in Law no. 28 of 2002 concerning buildings. In the city of Bogor, there are areas that have the potential for landslides and ground movements that can threaten the safety of their residents (Lutfi, et al, 2019).

Some of the main factors causing the vulnerability of buildings technically include location, topography, soil carrying capacity, the use of building materials that do not match specifications and buildings that are inadequate to those in earthquake areas (Zulfiar, et al, 2014).

Concrete is a material for buildings, both buildings and roads. The strength of concrete depends on the age of the concrete and the mixture and the quality of the concrete-forming materials. The quality of water and the composition of the water mixture will also affect the quality of the concrete. Good concrete will last more than 50 years if treated with the right mixture (Putranto Fr et.al 2019; Chayati N et.al, 2017; Rulhendri R et.al, 2017; Syaiful S, 2020; Syaiful S, 2021).

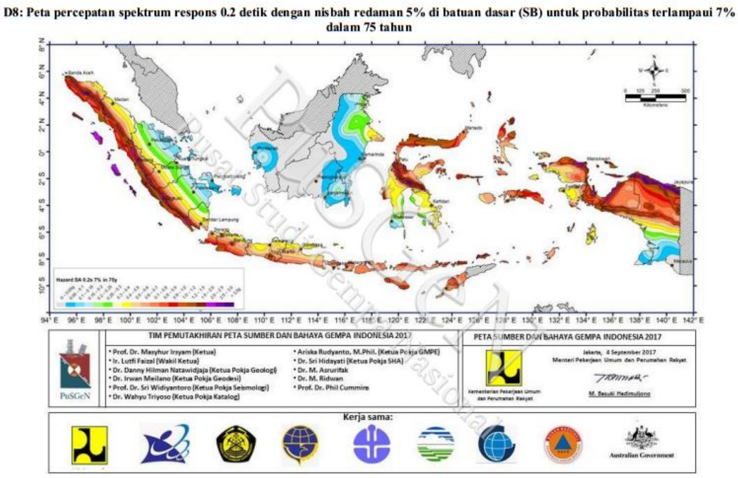

Figure 1. Map of earthquake response acceleration spectrum Source: National Earthquake Study Center, 2017

RESEARCH METHODS

Research on seismic risk assessment was conducted at UIKA Bogor in November 2021-January 2022, which is located at Jalan KH. Sholeh Iskandar Km. 2 Kedung Badak, Tanah Sareal District, Bogor City, West Java 16162. The method used in this study is the 2015 FEMA P-154 Rapid Visual Screening (RVS) Method.

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Figure 2. Research Location Map
Source: Google satellite 2021

Figure 3. Front View of Ibn Khaldun University, Bogor
Source: Personal Documentation

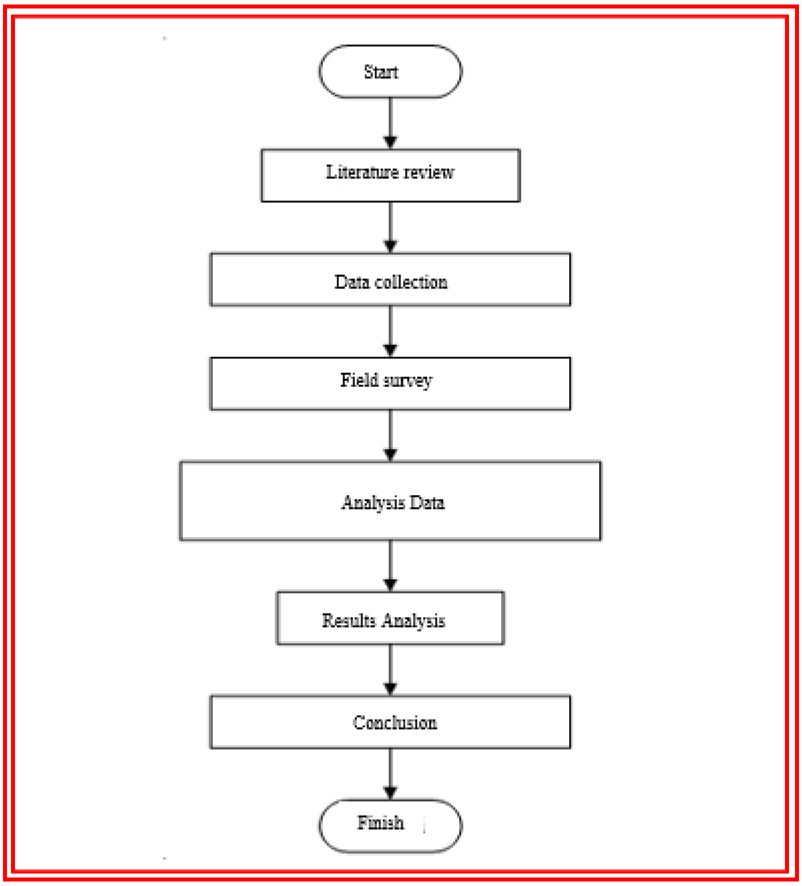

Figure 3. Research flow chart Source: Personal documentation

RESULTS AND DISCUSSION

Rapid Visual Screening (RVS)

Rapid Visual Screening (RVS) is the first step to evaluate the seismic risk assessment of buildings against earthquake disasters, namely by means of field surveys, conducting direct observations of buildings and documenting photos for further data information. The stages are as follows:

1. Soil data is assumed to be of medium soil type (type D) according to FEMA P-154 2015 if no soil investigation is carried out.

2. Coordinates of buildings located in UIKA Bogor are obtained from the Coordinates application based on the Global Positioning System (GPS) in Table 1.

Table 1. Building coordinates

No.	Building Name	Coordinate	
		Latitude	Longitude
1	Gd. DR. H. Marzoeki Mahdi	-6,560683	106,791977
2	Gd. Prof. Dr. H. Abdullah Siddiq, S. H.	-6,560683	106,792125
3	Gd. H. E. M. Kahfie	-6,560142	106,792372
4	Gd. Ulil Albab	-6,560800	106,793168
5	Gd. Ir. H. Prijono Hardjosentono	-6,559663	106,793576

6	Gd. Riise Center	-6,559345	106,793330
7	Gd. K. H. Sholeh Iskandar	-6,559176	106,793469
8	Gd. Fakultas Ilmu Kesehatan	-6,558654	106,792631
9	Gd. Fakultas Agama Islam	-6,558575	106,792389

3. The results of Ss and S1 based on building coordinates are obtained from the Indonesian Spectra Design application (Ministry of PUPR, 2021), as shown in Table 2 below.

Table 2. Design Value Spectra

No.	Coordinate		S_S	S_1
	Latitude	Longitude		
1	-6,560683	106,791977	1.0234	0.4684
2	-6,560683	106,792125	1.0234	0.4684
3	-6,560142	106,792372	1.0230	0.4682
4	-6,560800	106,793168	1.0232	0.4683
5	-6,559663	106,793576	1.0224	0.4680
6	-6,559345	106,793330	1.0223	0.4679
7	-6,559176	106,793469	1.0221	0.4679
8	-6,558654	106,792631	1.0220	0.4679

Source: Spectra Design application (ministry of PUPR, 2021)

From the data above, the average value of Ss and S1 = 1.0227 and the value of S1 = 0.4681. The average result is then selected the RVS form with a high level of seismicity.

4. After conducting a field survey and knowing the Ss and S1 values of each building coordinate, and to determine the seismic risk of a building using the RVS Method based on FEMA P-154 2015, using the High Seismicity form. Here are the steps to fill out the RVS form.
   a. Verify and update building identification information;
   b. Live inspection around the building to identify the number of floors and shapes, and sketch plans and elevation displays on data collection forms;
   c. Documentation of the determination of the building;
   d. Review soil types and geological hazards, as identified during the pre-field planning process;
   e. Identify proximity problems, building deviations, and potential fall hazards from outside the building;
   f. Adding any comments about unusual conditions or circumstances may affect identification;
   g. Identify building materials, gravity load carrying systems, and seismic force resisting systems to identify the FEMA building type (enter the building, if possible, to facilitate this process) and circle the baseline value on the data collection form;
   h. Circle the appropriate seismic performance attribute score (eg deviation, design date, and soil type) on the data collection form;
   i. Determine the final score for level 1, SL 1 (by adjusting the base score from step 8 with the score modifier identified in step 9);
   j. Complete a summary at the bottom of the form (eg, extent of review, other hazards and required actions);
   k. Complete a summary at the bottom of the form (eg, extent of review, other hazards and required actions).

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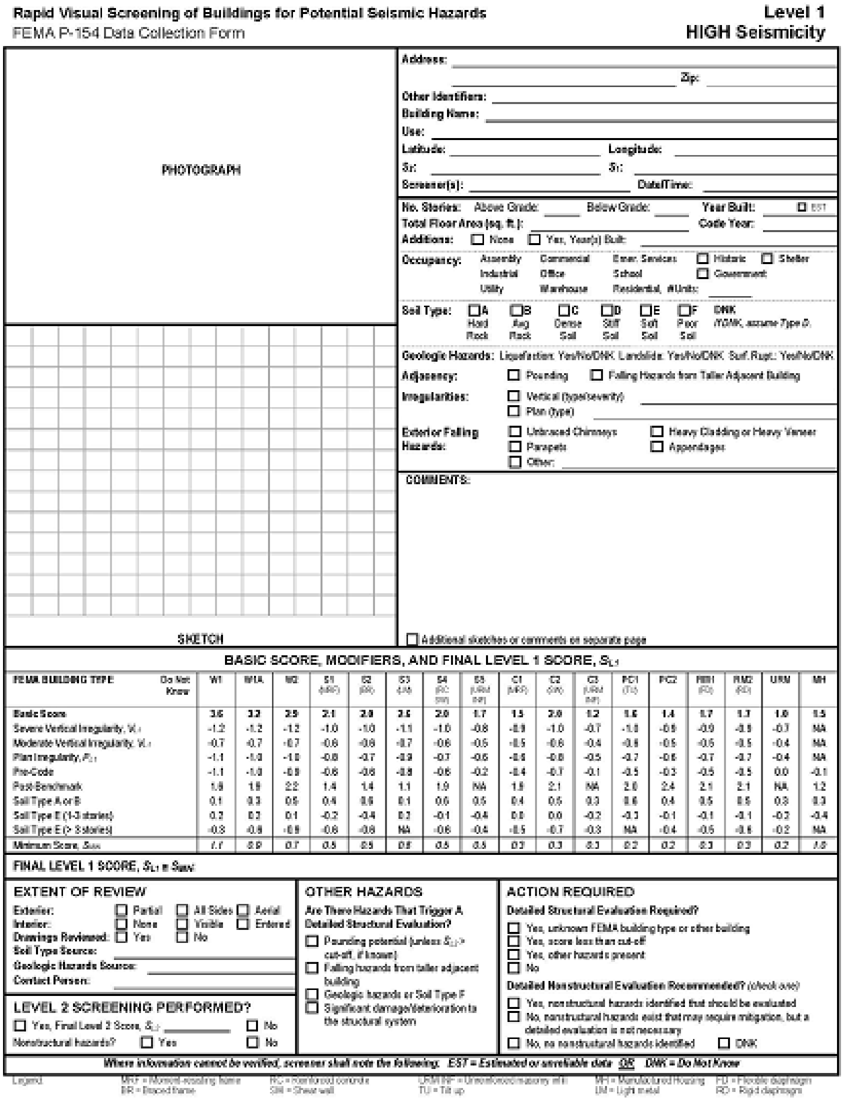

Figure 4. RVS Form Source: FEMA P-154 2015

Research Analysis

Seismic risk assessment of buildings in UIKA Bogor is carried out by obtaining a final score. The final score is the probability that the building will collapse if it experiences a shock or earthquake. The results of the research at UIKA Bogor 8 buildings including category C1 (concrete moment-resisting frames) had a minimum score of 0.3 and 1 S1 building (steel moment-resisting frame) had a minimum score of 0.5.

Figure 5. Structural and Falling Hazard Elements

Figure 6. Split level in the DR building. H. Marzoeki Mahdi

Figure 7. Shaped in the Riise Center building

Based on Figure 5, all the evaluated buildings have non-structural factors that are harmful to building users in the event of a shock from the subgrade or an earthquake. In the evaluation, there were several falling hazard elements that were evaluated, such as ceilings, LCD projectors, fans, and lighting lamps attached to the ceiling in almost the entire room. Vertical irregularity in buildings is classified as a split level category on the roof of the building as shown in Figure 6, this condition occurs in 3 buildings in UIKA Bogor. Plan irregularities occur in 1 building that is classified as Lsahped on the building plan as shown in Figure 7 above. The buildings in UIKA Bogor that were selected in this study were built after the existence of national standard rules, so that the buildings in the UIKA Bogor environment were built with standard regulations for earthquake resistance planning for building structures (SNI 1726-2002)

Table 3. Final Score Results of Buildings

No	Nama Gedung	Vertical Irregularity	Plan Irregularity	Tipe Bangunan	Basic Score	Severe Vertical Irregularity (V_{L1})	Moderate Vertical Irregularity (V_{L1})	Plan Irregularity (P_{L1})	Pre-Code	Post-Benchmark	Soil Type	Minimum Score (S_{min})	Nilai S
1	DR. H. Marzoeki Mahdi	√	-	C1	1,5	-	-0,5	-	-	1,9	D	0,3	2,9

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2	Prof. Dr. H. Abdullah Siddiq, S. H.	-	-	C1	1,5	-	-	-	-	1,9	D	0,3	3,4
3	H. E. M. Kahfie	√	-	C1	1,5	-	-0,5	-	-	1,9	D	0,3	2,9
4	Ulil Albab	√	-	C1	1,5	-	-	-	-	1,9	D	0,3	2,9
5	Ir. H. Prijono Hardjosentono	-	-	C1	1,5	-	-	-	-	1,9	D	0,3	3,4
6	Riise Center	-	√	S1	2,1	-	-	-0,8	-	1,4	D	0,5	2,7
7	K. H. Sholeh Iskandar	-	-	C1	1,5	-	-	-	-	1,9	D	0,3	3,4
8	Fakultas Ilmu Kesehatan	-	-	C1	1,5	-	-	-	-	1,9	D	0,3	3,4
9	Fakultas Agama Islam	-	-	C1	1,5	-	-	-	-	1,9	D	0,3	3,4

From table 3 there are 5 buildings in UIKA Bogor that have the highest final score, namely the Prof. Dr. H. Abdullah Siddiq, S. H., Ir. H. Prijono Hardjosentono, K. H. Sholeh Iskandar building, Faculty of Health building and Faculty of Islamic Religion building with a final score of 3.4. The building that has the lowest final score is the Riise Center building with a final score of 2.7. even though it has the lowest final score of all buildings that have been researched, this value is still in accordance with the 2015 FEMA P-154 final score (SL1) regulation which has a minimum score of 0.5 so it is still classified as a safe building in the event of a shock or earthquake.

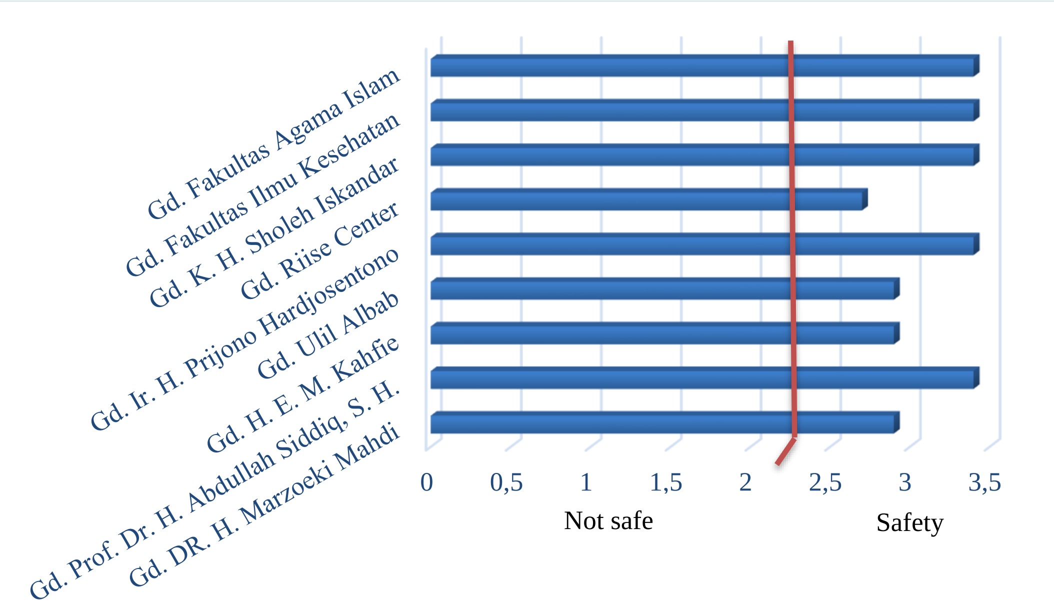

Figure 8. Graph of the final score of the vulnerability of buildings in the UIKA Bogor environment

Based on the results of the final score obtained, a seismic risk analysis of buildings in the UIKA Bogor environment is carried out as follows in table 4 below.

Table 4. Results of Building Seismic Risk Analysis

No.	Building name	Nilai S	10^{SL1}	$1/10^{SL1}$	Potential Vulnerabilities (%)
1	DR. H. Marzoeki Mahdi	2,9	794,328	0,00126	0,126
2	Prof. Dr. H. Abdullah Siddiq, S. H.	3,4	2511,886	0,00040	0,040
3	H. E. M. Kahfie	2,9	794,328	0,00126	0,126
4	Ulil Albab	2,9	794,328	0,00126	0,126
5	Ir. H. Prijono Hardjosentono	3,4	2511,886	0,00040	0,040
6	Riise Center	2,7	501,187	0,00200	0,200
7	K. H. Sholeh Iskandar	3,4	2511,886	0,00040	0,040
8	Fakultas Ilmu Kesehatan	3,4	2511,886	0,00040	0,040
9	Fakultas Agama Islam	3,4	2511,886	0,00040	0,040
	Average	3,156	1715,956	0,00086	0,086

From the table above, the results of the analysis of buildings in the UIKA Bogor environment can be described as follows.

1. DR. H. Marzoeki Mahdi obtained an S value of 2.9 and has a potential vulnerability of 0.126% in the event of an earthquake.
2. Prof. Building Dr. H. Abdullah Siddiq, S. H. obtained an S value of 3.4 and has a potential vulnerability of 0.040% in the event of an earthquake.
3. The H. E. M. Kahfie building has an S value of 2.9 and has a potential vulnerability of 0.126% in the event of an earthquake.
4. Ulil Albab Building has an S value of 2.9 and has a potential vulnerability of 0.126% in the event of an earthquake.
5. Building Ir. H. Prijono Hardjosentono obtained an S value of 3.4 and has a potential vulnerability of 0.040% in the event of an earthquake.
6. The Riise Center building has an S value of 2.7 and has a potential vulnerability of 0.20% in the event of an earthquake.
7. The K. H. Sholeh Iskandar building has an S value of 3.4 and has a potential vulnerability of 0.040% in the event of an earthquake.
8. The Faculty of Health Sciences building has an S score of 3.4 and has a potential vulnerability of 0.040% in the event of an earthquake.
9. The Faculty of Islamic Religion building has an S score of 3.4 and has a potential vulnerability of 0.040% in the event of an earthquake.

Of all the buildings that were assessed at UIKA Bogor, the value of the vulnerability of buildings in the UIKA Bogor environment has an average value of 3.156 so that it is declared safe and has a potential vulnerability value of 0.086% in the event of an earthquake. Buildings in UIKA Bogor that were not damaged were 99.914% based on the results of the 2015 Rapid Visual Screening (RVS) and FEMA P-154 assessments.

CONCLUSION

Based on the results of the assessment and analysis that has been carried out, the following are the conclusions of the buildings in UIKA Bogor. The results of the assessment using the Rapid Visual Screening (RVS) Method in the UIKA Bogor environment, buildings have vulnerability to earthquakes because of buildings classified as vertical irregularities of -0.5 and plan irregularities of -0.8 which affect the basic score. All buildings assessed have a potential vulnerability to ground shaking or earthquakes of 0.086%, with the highest final score being the Prof. Dr. H. Abdullah Siddiq, S. H., Ir. H. Prijono Hardjosentono, the K. H. Sholeh Iskandar building, the Health Sciences Faculty building and the Islamic Religion Faculty building with a final score of 3.4 and the lowest final score being the Riise Center building. Buildings in UIKA Bogor that were not damaged were 99.914% based on the results of the 2015 Rapid Visual Screening (RVS) and FEMA P-154 assessment methods.

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