T.R.
VAN YÜZÜNCÜ YIL UNIVERSITY
INSTITUTE OF NATURAL AND APPLIED SCIENCES
DEPARTMENT OF CIVIL ENGINEERING

QUICK DETERMINATION OF THE PERFORMANCE OF EXISTING BUILDINGS IN SULAYMANY CITY (BAKHTYARY) USING STREET- WALK METHODS

M.Sc. Thesis

Suraya Muhamed Mansur AHMED
Supervisor: Assoc. Prof. Dr. Murat MUVAFIK

VAN – 2023

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ACCEPTANCE AND APPROVAL PAGE

This thesis entitled “Evaluation of Existing Multi Story Building During Earthquake in Sulaimany City-Iraq” presented by Suraya Muhamed Mansur AHMED under supervision of Assoc. Dr. Murat MUVAFIK in the department of Civil Engineering, has been accepted as a M. Sc. thesis according to Legislations of Graduate Higher Education on 29/5/2023 with unanimity of votes members of jury.

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Member : Assoc. Prof. Dr. Barış ERDİL Signature:

Member: Assoc. Prof. Dr. Ercan IŞIK Signature:

This thesis has been approved by the committee of The Institute of Natural and Applied Sciences on ……. /…… /……. with decision number of ....

Signature

………………….

Director of Institute

ETHICAL DECLARATION

I declare that all the information in this thesis has been obtained and presented within the framework of ethical behavior and academic rules, and that in this thesis, which has been prepared in accordance with the thesis writing rules, all kinds of statements and information that do not belong to me have been fully cited.

Signature

Suraya Muhamed Mansur AHMED

ABSTRACT

QUICK DETERMINATION OF THE PERFORMANCE OF EXISTING BUILDINGS IN SULAYMANY CITY (BAKHTYARY) USING STREET- WALK METHODS

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MSc. Thesis, Department of Civil Engineering
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In this study, the building performance of (512) buildings in Bakhtyary district have been evaluated during an earthquake, comprising 55 reinforced concrete and 457 masonry buildings; Bakhtyary/Sulaymany/Iraq has been taken as a case study, most of the houses in this area were built before 1983, and some of these buildings are renovated only by painting or other finishing material or reconstructed by changing the building plan, adding or removing a wall, most frame buildings have been newly constructed in the past 15 years, buildings are of different ages and designs in this area, the evaluation will give clue about the performance of the building, whether they are safe or not, because in North Iraq, there are not so much research about earthquakes and evaluation of buildings for building performance in earthquakes, especially for old buildings.

The method used to evaluate this large number of structures is Street Scan Method, in this method, the building data are gathered from the street outside of the building, then the data will be calculated to evaluate building performance.

There are some methods for rapid evaluation for data analysis, the method used is law no 6306, one of the Street Scan methods.

A computer program (EPA) created by (Özdemir, 2019) is used for data calculation and showing the result on a map.

Keywords: Building performance, Earthquake, Evaluation, Street scan

ÖZET

IRAK-SÜLEYMANİYE İLİ BAKHTYARY MAHALESİ’NDEKİ MEVCUT BİNALARIN SOKAK TARAMASI YÖNTEMİ İLE DEPREM PERFORMANSLARININ HIZLI DEĞERLENDİRİLMESİ

AHMED, Suraya Muhamed Mansur
Yüksek Lisans Tezi, İnşaat Mühendisliği Anabilim Dalı
Danışman: Doç. Dr. Murat MUVAFIK
Haziran 2023, 63 Sayfa

Bu çalışma, Süleymaniye şehrinin Bahtiyary semtindeki 512 nolu binanın deprem sırasındaki yapı performansları bakımından değerlendirmesini içermektedir. Bu bölgedeki evlerin bir kısmı 1983 yılından önce inşa edilmiş ve bazı binalarda duvar ekleme-çıkarma veya sadece boya gibi diğer yöntemlerle yenileme ve tadilatlar yapıldığı tespit edilmiştir. Ancak, çevre binaların çoğu son 15 yılda yeniden inşa edilerek kullanıma açılmıştır. Bu tür bölgelerde evlerin deprem bakımından incelenmesi ‘sokak tarama yöntemi’ şeklinde veri elde edilerek yapılmaktadır. Bu yöntemde, bina verileri genellikle sokaktan toplanır ve daha sonra hesaplamaya dayalı olarak bina performansı sistemi içinde değerlendirmeye tabi tutulur.

Bu yöntem, verilerin daha hızlı elde edilerek değerlendirilmesi noktasında kolaylıklar sağlamaktadır. Veri analizi için kullanılan bu yöntem (Sokak Tarama yöntemi) 6306 sayılı kanun çerçevesinde gerçekleşmektedir. Sokak tarama yöntemini kullanarak elde ettiğimiz verilerin kağıt üzerinde haritalanması (Özdemir, 2019) tarafından üretilen EPA isimli bir bilgisayar programı kullanılarak gerçekleştirilmektedir.

Anahtar kelimeler: Bina performansı, Deprem, Değerlendirme, Sokak taramas

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In this thesis, my instructor, Associate Professor Dr. Murat MUVAFIK, deserves my appreciation, who Shared all his knowledge and experience on the analysis of buildings with rapid evaluation methods during the postgraduate course, and every teacher and professor in the civil engineering department of Yuzuncu Yil university; that shared with us priceless knowledge during my master's degree, and every teacher during school and my teachers and professors in the civil engineering department in the University of Sulaimani.

I like to thank EPA Program developer Muhammet ÖZDEMİR, who produced this program and gave us a chance to use it.

A special thanks to my father and mother, who always pushed me to succeed in my life till this moment and took care of my children during my studying, and thank my three brothers, who help me always and especially during my master's degree were a real support specially my brother Samal.

I want to thank my husband for supporting me to finish my thesis, and my children (6 years old Mand and 4 years old Zeen) for their patience and understanding at such young ages.

2023

Suraya Muhamed Mansur AHMED

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SYMBOLS AND ABBREVIATIONS

Some symbols and abbreviations used in this thesis are presented below, along with their descriptions.

Symbols	**Description**
EPA	Earthquake Performance Analysis
GDACS	Global Disaster Alert and Coordination System
KRG	Kurdistan Regional Government
RVS	Rapid Visual Screening

Abbreviations	**Description**
BS	Base score
NPS	Negativity Parameter Score
PPS	Positive Parameter Score
PS	Performance Score

1. INTRODUCTION

Recently, earthquakes have become a more significant source of concern in Iraq, particularly in certain regions located in higher seismicity zones in the northern part of the country, on the northeastern margins of the Arabian Plate, Iraq is located in a seismically active area, the corresponding Zagros-Taurus belts are connected to the Iranian and Anatolian plates (as shown in Figure 1.1), every year, the seismic activity in Iraq varies in intensity, and there is historical data on seismic activity that shows that it has a certain pattern based on the main tectonic elements found in the nation.

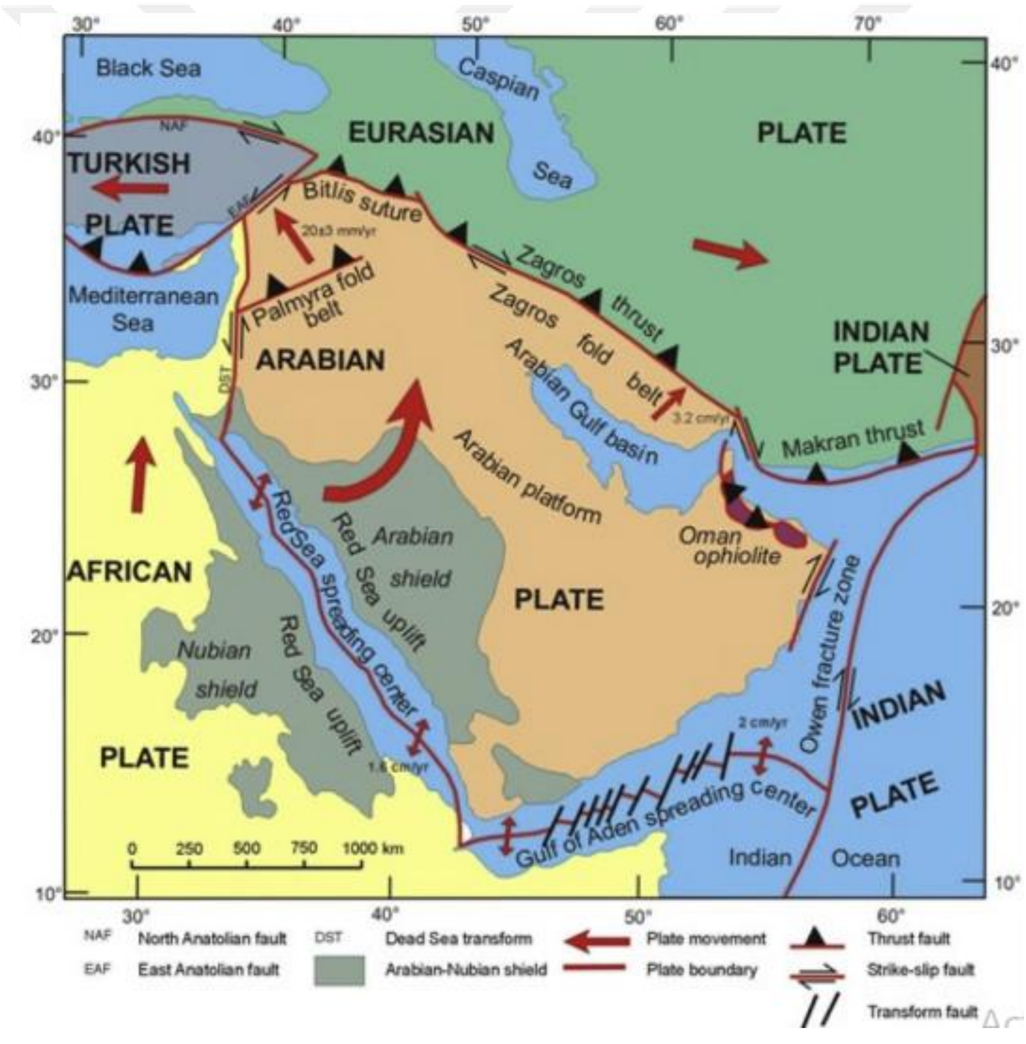


Figure 1.1 Tectonic plates (Aldama-Bustos and Bommer, 2009)

As per the United States Geological Survey (USGS), the area has encountered a number of earthquakes over the previous ten years; the most significant was a magnitude 7.3 earthquake on November 12, 2017, the earthquake's epicenter is situated 32 kilometers away from Halabja city, the Global Disaster Alert and Coordination System (GDACS) reports that the quake caused more than 530 fatalities and thousands of injuries in Iran. In Iraq the Kurdistan Regional Government (KRG) reported that nine people were killed and 550 wounded.

The Darbandikan area has been the most severely affected, with earthquake-related injuries reported in Darbandikan, Halabja, and Garmyan districts, many houses in Darbandikhan, Maidan, Quurato, and Bamo areas were damaged, and some were destroyed. (Figure 1.2).

From 1900 to 2018, Iraq experienced two earthquakes of magnitude 7.0 or higher, 12 earthquakes of magnitude 6.0 to 7.0, and 139 earthquakes of magnitude 5.0 to 6.0. In 2021, and was rocked by two earthquakes of magnitude 5.0 or greater degree.

Figure 1.2 Darbandikan after the earthquake (Elders and AlHashimi, 2020)

2. LITERATURE REVIEW

Information about the Earth's movement during an earthquake and the way of the movement, and understanding the way of that building members reacting for that force are important points when observing earthquake risks on buildings.

In structure design, using the elastic acceleration spectrum method, a structure with a degree - of - freedom could be connected to a force exerted on it by its masses and moved in accordance with the stiffness of the member, the stiffness and strength of the member working together can’t be separated, strength is less critical than stiffness which directly related with displacement because displacement will change the building's shape and control damage, FARDIS, M. N. (ED.) (2010).

2.1 Engineering Point of View of Earthquake

Since the establishment of earthquake resistance standards for building codes, major purpose of code requirements is to guarantee protection of life by giving a reasonable assurance that buildings would not damage at projected shaking levels. Structural engineers in the United States started developing structural design processes to lessen the financial and other losses brought on by earthquake damage after the 1989 Loma Prieta and 1994 Northridge earthquakes.

The approaches and standards that emerged later became known as "performance-based design".

The global seismic engineering community has increased interest in these technologies (Hamburger, 2004), seismic load is one of the big challenges for the structures that humans build or engineers design and build.

Annually many buildings are damaged and cause loss of life and billions of dollars, engineers are trying to reduce the impact of this force even more when designing buildings to provide a safe environment for all against this dynamic natural force.

2.2 Iraq Seismic Zone

In 2017 many earthquakes activity happened in Iraq, the recorded earthquakes were between (4.0 to 7.3) and had depths of 6.21 to 42.32 km.

Table 2.1 Earthquakes activity happened in Iraq

Event No.	Year	Magnitude (Richter scale)	Remarks
1	820	-	Buildings in Baghdad City had only minor damages.
2	881	-	Most of the buildings in Baghdad were destroyed.
3	893	-	Damages were severely recorded.
4	957	-	An earthquake struck Baghdad.
5	979	-	In almost every building, there was major damage.
6	1058	-	In almost every building, there was major damage.
7	1072	-	Six felt rebounds from the powerful earthquake that struck Baghdad on the same day.
8	1117	-	An earthquake struck Baghdad
9	1193	-	Baghdad was struck by a powerful earthquake, and building damage was reported.
10	1203	-	An earthquake struck Mosul
11	1252	-	A powerful earthquake struck Baghdad, causing practically all of the city's structures to fall.
12	1648	-	Baghdad, Mosul, and Ana west of Iraq all experienced earthquakes.
13	1689	-	An earthquake in Baghdad damaged all buildings
14	1702	-	Severe earthquake hit Baghdad with total collapse of several buildings
15	1864	-	Baghdad was struck by three earthquakes on the same day, severely damaging every building.
16	1917	-	An earthquake struck Baghdad
17	1946	-	Severe earthquake hit Baghdad
18	1960	6.0 to 6.7	Halabjah city, which is northeast of Baghdad, was severely damaged by earthquakes.
19	1967	6.1	Northeast of Baghdad, 100 km away from Halabjah city, there were earthquakes.
20	2013	5.6 and 5.8	Northeast of Baghdad, 60 kilometers south of Halabjah City, there were two earthquakes.
21	2017	7.3	Northeast of Baghdad, Iraq, a series of earthquakes with a maximum magnitude of 7.3 were felt 30 kilometers south of Halabjah city.
22	2018	4.0 to 4.5	Series of earthquakes with magnitude of 4.0-4.5 struckt northeast of Baghdad, Iraq

Table 2.1 reveals that on November 12, 2017, a significant earthquake with a magnitude of 7.3 on the Richter scale took place.

Data shows from 2017 number of earthquakes greater than 4 degrees has increased in Iraq-Iran border from north to south Iraq and the Zagros border.

Over the past 17 years, there have been five times as many earthquakes of a magnitude of four or higher than there were from 1970 to 2000, which is concluded from those 500 earthquakes recorded from 1970 to 2017.

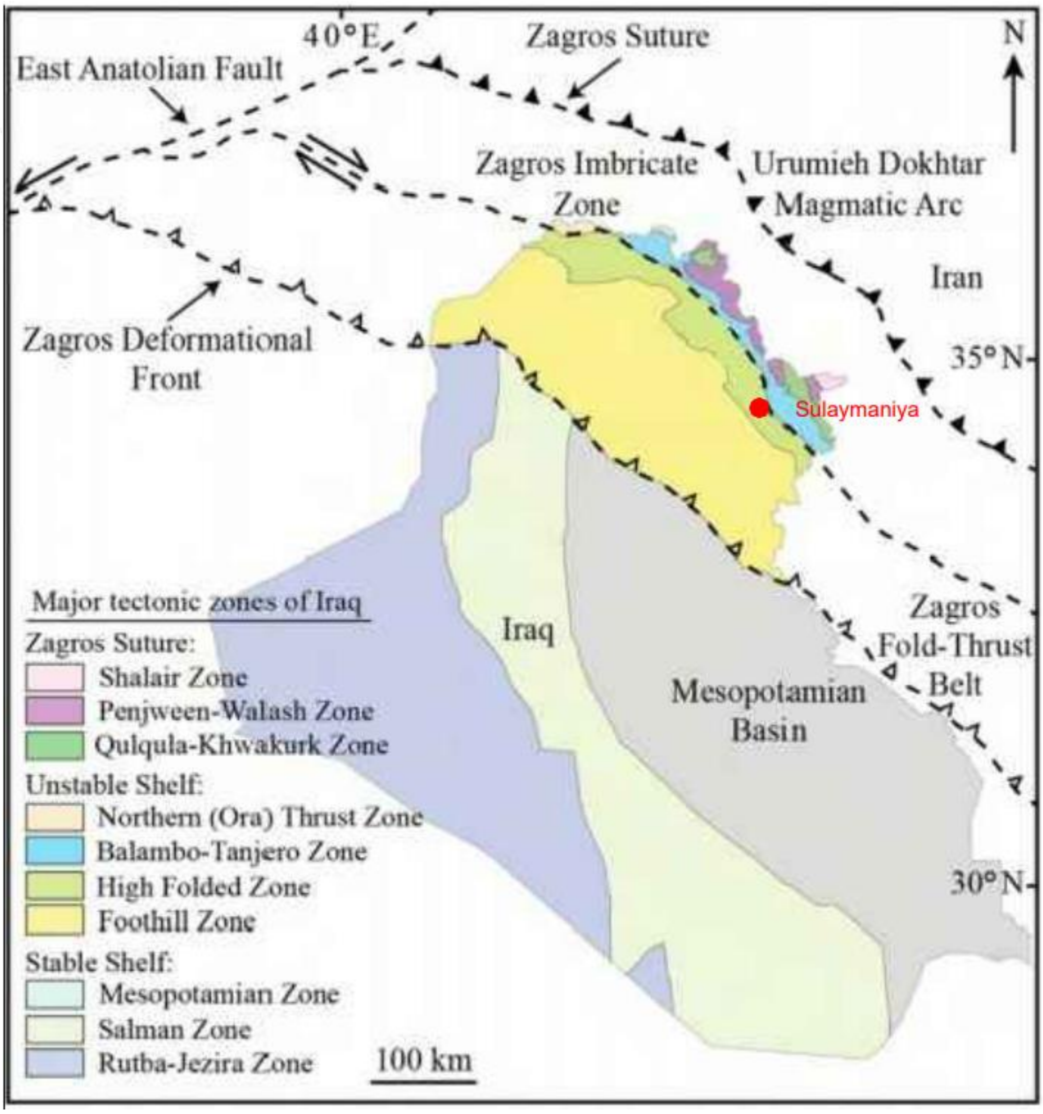


Figure 2.1 Major tectonic zones of Iraq (Doski, 2019)

Kurdistan region is more active in terms of earthquakes according to another area of Iraq (Hosseini, Lashkaripour, Moghadas, & Ghafoori, 2014) because this area is between the northeast boundary with the Arabian plate and the Anatolian Eurasian plates; Sulaimany city is located at latitude 35°34´0.7104´´N. and longitude of 45°24´57.9852´´E which affected by these boundaries.

Table 2.2 Sensitivity of 2%-in-50-year PGA to the selection of GMPES for select cities in Iraq

2%-in fifty year PGA (cm/s2)	Active tectonic area GMPES	Stable continental area GMPES	Mean PGA
Baghdad	129	311	220
Erbil	199	517	358
Basra	109	259	184
Suleymaniyah	280	655	468
Thiqar	105	224	165

Fouad (2015), based on structural disparities, Iraq's western Zagros fold-thrust belt, has divided into four regions or areas, namely the low folded zone, the high folded zone, the imbricated zone, and the suture zone, according to Fouad (2012), basement-involved thrust faulting beneath the sedimentary cover identifies the high folded zone, Jassim et al. (2006) further describe this zone as having a high-elevation basement topography of approximately 8 kilometers, on the other hand, the imbricate zone is defined by a sequence of imbricate thrust fan systems, as explained by Fouad (2012), according to Buday and Jassim (1987), this particular zone has deeper basement rocks than the high-folded zone, the Zagros basement is considered as an extension of the Pan-African rocks that are exposed in the Arabian shield, as noted by Bahroudi and Talbot (2003), the N-S Nabitah (LDS) system, the NW-SE Najd system, and the NE-SW or E-W transversal system are the three major fault systems that define the subterranean structure of Iraq, as described by Jassim et al. (2006), the fault systems were created during the Late Precambrian Nabitah orogeny and were reactivated during the Phanerozoic era, these systems are still active in the present, as noted by Alsinawi et al. (2006).

The Zagros belt is known for being a seismically active mountain range, according to Berberian (1995). Alsinawi et al. (2006) also point out that most seismic activity in Iraq occurs in the high folded, imbricated, and suture zones.

An earthquake is the sneakiest type of natural calamity, even tornadoes, monsoons, and blizzards have seasons, making them at least somewhat predictable and trackable weeks in advance, but earthquakes occur completely unannounced (Papathoma-Köhle and Dominey-Howes, 2018), however, recent research suggests that earthquake activity will increase in the coming year and that preparations should be made for this possibility (Bilham, 2009).

3. MATERIALS AND METHODS

3.1 Street Scan Methods of Building Evaluation

The rapid visual screening (RVS) approach has been created to identify, catalog, and screen buildings that may be prone to earthquakes risky (Yang and Goettel, 2007). There are plenty of different ways to evaluate buildings detailed methods or less detailed, such large number of structures should be further assessed by a design professional with experience in seismic design after being identified as possibly hazardous to establish whether they are seismically unsafe.

The surveyor fills out a data collection form after making visual observations of the structure from the exterior and, if possible, the interior as part of the RVS approach, which employs a methodology based on a sidewalk survey of a building (Harirchian et al., 2020).

The two-page data collection form has spaces for recording building identifying information, such as its function and size, as well as sketches, a picture of the facility, and any relevant information regarding seismic performance, after gathering information during the survey, a rating is computed to determine the anticipated earthquake performance of the structure, planning, such as training the assessors and methodically controlling the entire process, might hasten the assessment if it is decided to carry out a swift visual evaluation of a community or a collection of buildings (American Society of Civil Engineers, 2003; Haryanto et al., 2020).

Building damage from earthquakes may be directly correlated with the amount of story drift that takes place during the quakes; the volume of drift is governed by the overall stiffness of the building, which is dependent on the stiffness of the building's individual structural and nonstructural elements (Chapain and Aly, 2019).

Nevertheless, because of the poor use of the data on the stiffness given by filler walls, determining the overall structural stiffness would take a lot of time to compute. On the other hand, calculating the area of structural and nonstructural building elements that contribute to stiffness is straightforward, different weights are allocated to a column, reinforced concrete walls, and non-reinforced infill walls area to account for differences in stiffness. (Hassan and Sozen, 1997).

3.1.1 Law no. 6306

The evaluation method used in this research is the “Street Scan Method”, which is a method of collecting data on the buildings from outside of the buildings, there are some methods to calculate those data, law no. 6306 is one of those methods, in this research, the buildings are calculated by this method.

A building that has the risk of collapse or severe damage is defined as a risky building; the rules to be applied in the determination of risky structures are specified in these principles.

This method for determining earthquake safety was created by “Güney ÖZCEBE” within the scope of a TÜBİTAK (Turkish Scientific and Technological Research Center) project (Guney et al., 2000).

The parameters used in the method are the number of floors, heavy overhang, structure order/impact effect, short column, soft story, apparent quality, vertical irregularity, horizontal irregularity, hill/slope effect, and ground values.

This method aims to rank the buildings in terms of earthquake risk with the criteria that can be observed from the outside without going inside the buildings and to estimate the number of buildings considered risky and their distribution within the city (Grant et al., 2007).

The regulation under law no. 6306 will be selected from the street scanning methods, buildings evaluated according to the parameters used in the street scanning method, and risky structures will be determined and mapped using the EPA program, the earthquake council (2004) indicated the parameters that are included in the data collection form reinforced concrete structures and that use in the Street Scanning method; number of stories, structural system type, visual quality, soft story / weak floor, short column, impact effect, heavy projection, soil type, vertical irregularity, horizontal irregularity (irregularity in plan), hill/slope effect, design spectral acceleration coefficient, geographic coordinates, estimated age of building, purpose of use.

The reserve structure area determinations are the documents that include the coordinated base map, the area's size, and the satellite image, if it is desired to determine the risky area, a technical report about the risk of buildings, and soil type or a coordinated delimitation map of the area.

Table 3.1 Building evaluation methods parameter

Parameters	FEMA	SY	RBT	HS	Y	P25	MVP	6306	No. of Procedure
1. Column area, Ac		X		X	X	X	X	X	6
2. Shear wall area, Asw		X		X	X	X	X	X	6
3. Soft/Week story	X	X	X		X	X	X	X	7
4. Total floor area		X	X	X	X				4
5. Concrete strength, fc					X	X	X		4
6. No. of stories	X	X	X			X	X	X	6
7. Seismic zone	X	X	X			X	X	X	6
8. Infill wall area, Am		X	X	X	X	X	X	X	6
9. Frame discontinuity		X	X		X	X			4
10. Short column	X	X	X		X	X	X	X	7
11. Soil factor	X					X		X	2
12. Weight of the bldg.			X		X				2
13. Building type			X					X	2
14. Torsion	X				X	X	X		4
15. Construction year						X	X	X	3
16. Heavy overhang	X	X	X		X	X	X	X	7
17. Period of the bldg.									
18. Stiffness factor						X			1
19. Basement									
20. Foundation						X	X		2
21. Quality of the Construction	X	X	X		X			X	5
22. Story height						X	X	X	3
23. Plan dimensions			X			X		X	3
24. Ductility									
25. Ground floor area.		X							1
26. Pounding	X	X				X			3
27. Time dependent									
28. Topography	X	X	X				X	X	5
29. Corrosion						X			1
30. Ground water table						X			1
31. Load distribution effect						X	X		2
32. Mezzanine story						X	X		2
33. Strong column criteria						X	X		2
No. of parameter	10	15	13	4	12	23	17	15	

In the table below, there are parameters for some methods that are used for building performance evaluation, some parameters are repeated in most of the methods, and some parameters that only some methods take into consideration (law no. 6306) parameters are also in this table compared to other methods parameters.

3.2 EPA Seismic Performance Analyses Program (Muvafık and Özdemir, 2019)

This program was created by Muvafık and Özdemir (2019), it is a computer program designed to calculate the data of buildings by Ozcebe et al. (2003) method, the data are inputted into the program with each building coordinate.

3.2.1 Program Home Screen

By opening the program, the below window opens on the left side of the window, and there is toolbar on which evaluation methods are written, in this research law no 6306 which name (AFET) method in the program is used, this is currently the only method used in this program, and other methods are still not ready to work.

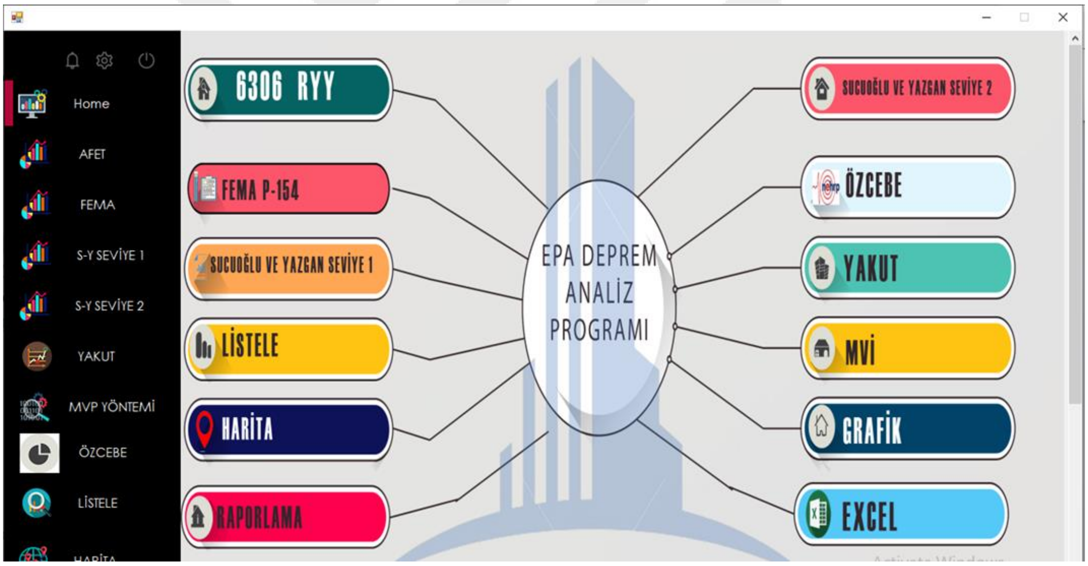


Figure 3.1 EPA seismic performance analyses program home screen

3.2.2 AFET Method Screen

By choosing AFET method the below window opens,

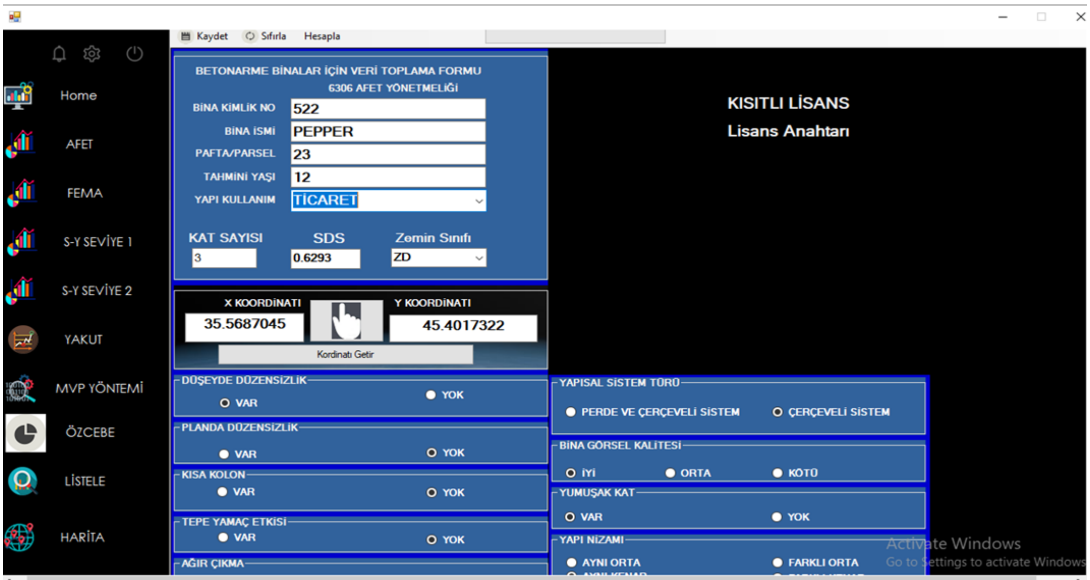


Figure 3.2 EPA seismic performance analyses program AFET screen

To enter the information of buildings, the below information should be filled:

Building ID (Bina kimlik): The house or building ID is entered in this field. Alternatively, an ID can be given to the house or building to identify the house, because some buildings in the case study area do not have any ID.

Building Name (Bina Isim): For this field, the name of the building is entered if the building has a name. If it has multiple names, one of the names is selected and entered, and if it does not have a name, a name is entered.

Approximate Age (Tahmin Yaşi): To determine the age of the building, which can be done by asking the owner of the house and buildings or the type of materials used in the buildings, the age of the building can be assumed.

Parcel & coordinate: Numbering buildings and getting their coordinates to locate buildings on a map.

According to each building's data, the below parameters are entered into the program.

1- Vertical irregularity (Düşey Düzensizlik)

2- Plan irregularity (Planda Düzensizlik)

3- Short column (Kisa Kolon)

4- Natural ground slope (Tepe Yamaç)

5- Heavy overhang (Ağir çikma)

6- Structural system (Yapisal sistem türü)

7- Visual quality (Bina Gürsel)

8- Soft story (Yümüşak kat)

9- Adjacent building (Yapi Nizami)

3.2.3 List Screen (Listele)

After entering the data and saving it on the AFET screen by clicking on the list (listed) in the black tape on the left side, this window will come up, containing all data for the evaluated building.

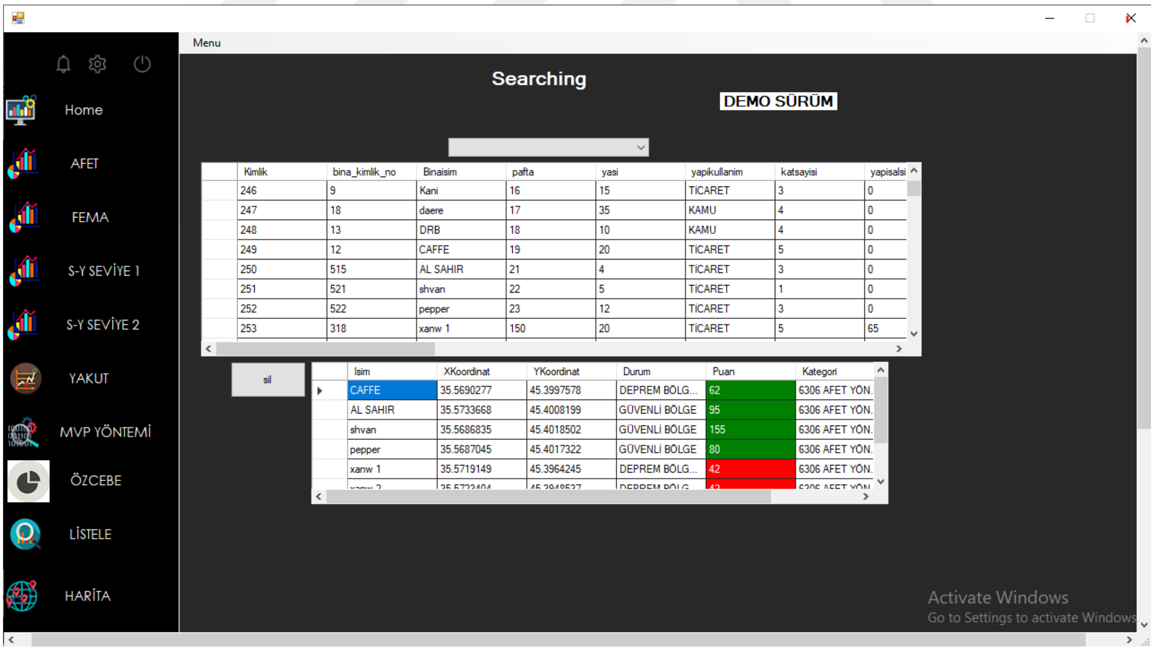


Figure 3.3 EPA Seismic performance analyses program list screen

The data can be exported to an excel sheet or sent to a map from the List screen. The program calculates the data of the buildings and also shows the buildings' range of safety in an excel sheet and also on a map to

3.2.4 Map Screen (HARITA)

By clicking on (HARITA), the map screen opens, then clicking on “Show added buildings” all buildings sent to the map will be shown on the map with different colors according to safety range, as shown in Figure 3.4.

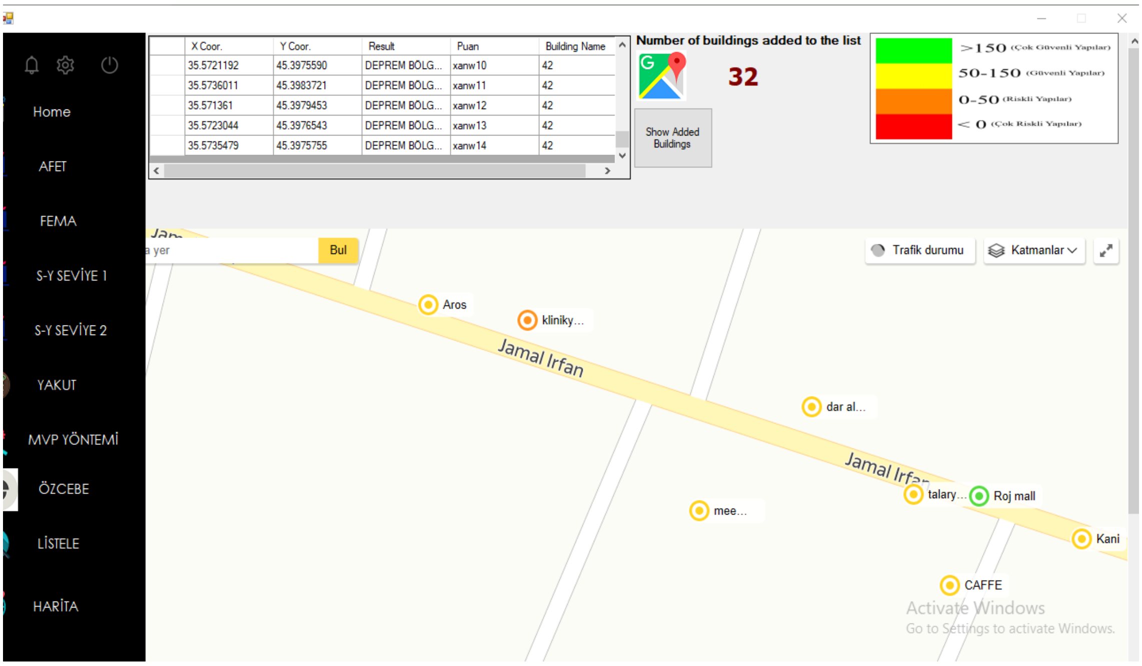


Figure 3.4 EPA seismic performance analyses program Map Screen (Harita)

Every range of safety has a different color

1- The green color is for a very safe building
2- Yellow color is for a moderately safe building
3- Orange color is for moderately hazardous building
4- The red color is for highly hazardous building

3.2.5 Advantages and Weakness of The Program

3.2.5.1 Advantages of This Program

1- This program calculates the data and gives the results in an excel sheet with all inputted information about the buildings.

2- The evaluated ranges indicated by colors make the result clearer to understand.

3- The program shows the buildings on the map to indicate the location of safe and unsafe buildings.

3.2.5.2. Weakness of This Program

1- Because the program is still under development, the only method that can be appropriately used is the law no. 6306 method, and the other methods are still needed for development.

2- In the 6306 method, the program cannot calculate masonry buildings; it should be calculated by hand calculation and then according to the building range inputted into the program.

3- The map also needs some development because when it shows the result, many the buildings cannot be put on the map together, the maximum number of buildings is 130, according to my experience using this program.

3.3 Data Collection

Data collection according to the 6306 method, buildings in case study area are between 1 to 5 stories, and there are two main types of buildings, which are masonry and frame buildings, each type has a different procedure for calculating parameter, frame building and masonry building, data collection according to the 6306 method and how to calculate data is explained below to find the buildings' range of safety.

The first thing that should be known is the area's soil type and (Sds) to indicate the seismic zone.

SD1= 0.2933

The soil type is D

Sds = 0.6293

Short-term spectral response acceleration is measured by the parameter SDS, while long-term spectral response acceleration is measured by the parameter SD1.

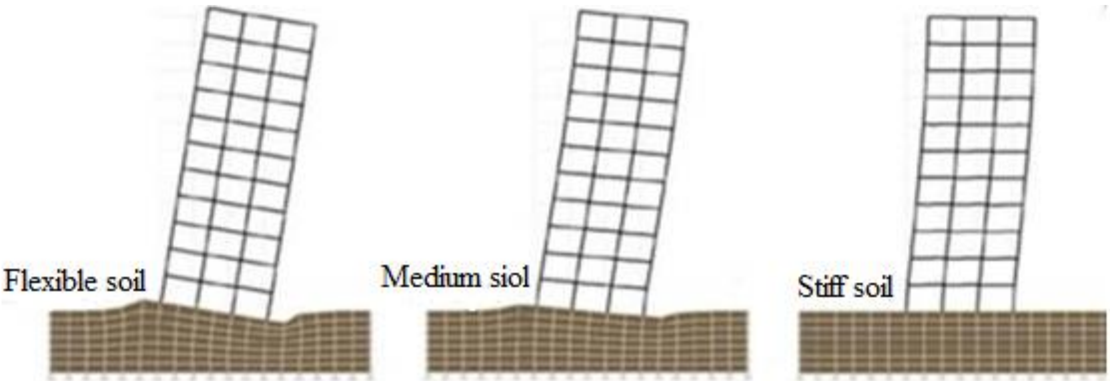


Figure 3.5 Soil type effect on building performance during earthquake

The type of soil is one of the most crucial factors of earthquake risk analysis determination in the street scanning method, and soils are handled in (A, B, C, D, E) class as in Table 3.2.

Table 3.2 Soil type

Site Class Definition	VS	N or Nch	Su
A Hard rock	>1500 m/s	-	-
B Rock	760 to 1500 m/s	-	-
C Very dense soil or soft rock	370 to 760 m/s	>50	>100 kpa
D Hard soil	180 to 370 m/s	15 to 50	50 to 100 kpa
E Soft clayey soil	<180 m/s	<15	<50kpa

According to SDS and soil type, the seismic zone is zone III, as shown in Table 3.3.

Table 3.3 Seismic hazard zone

Seismic zone	SDS	Soil type
I	Sds ≥ 1.0	ZC /ZD /ZE
II	Sds ≥ 1.0	ZA /ZB
	Sds ≥0.75	ZC /ZD /ZE
III	1.0 > Sds ≥ 0.75	ZA /ZB
	0.75 ≥ Sds ≥0.50	ZC /ZD /ZE
IV	0.75 ≥ Sds ≥0.50	ZA /ZB
	2.0 0.50 ≥ Sds	All soil types

3.3.1 Building Structure System

The first thing in data collection for a building to look at is the structural building system because frame building and masonry building have different types of calculation.

3.3.1.1 Frame System

Frame building: a building that has made of a bearing frame, which consists of beams and columns and transfers the weight of the walls, floors, and slabs to the foundations, the frames are made of steel, reinforced concrete, or composite materials (Concrete and steel).

Figure 3.6 Frame system building

The parameters collected for this type of building are shown in the Table 3.4.

Table 3.4 Negative parameter values for frame system

Negative parameter no	Negative parameter	Case 1		Case 2	
		Parameter detection	Parameter value	Parameter detection	Parameter value
1	Visual quality	Good	0	Moderate (Bad)	1 (2)
2	Soft story	No	0	Yes	1
3	Vertical irregularity	No	0	Yes	1
4	Heavy overhang	No	0	Yes	1
5	Plan irregularity	No	0	Yes	1
6	Short column	No	0	Yes	1
7	Adjacent Building	Separate	0	Adjacent / Adjacent from one side	1

3.3.1.2 Masonry Structural System

A masonry structure is a building with walls supporting the weight of the structure above the wall, the load is transferred from the walls to the foundation, the primary materials used to construct these load-bearing walls in buildings are typically brick, concrete block, or stone.

Figure 3.7 Masonry structural systems

Masonry structural systems have some parameters to be collected in the Table 3.5, the parameters are shown:

Table 3.5 Negative Parameter Values for Masonry Systems

Negative parameter no	Negative parameter	Case 1		Case 2	
		Parameter detection	Parameter value	Parameter detection	Parameter value
1	Adjacency	Separate	0	Adjacent / Adjacent from one side	1
2	Material Quality	Good	0	Moderate, (Bad)	1, (2)
3	Workmanship	Good	0	Moderate, (Bad)	1, (2)
4	Existing damage	No	0	Yes	1
5	Plan irregularity	Regular	0	Irregularity (Extremely Irregular)	1, (2)
6	Lack of beams	Wall Copings, window copings	0	No	1
7	Lack of walls	A lot	0	Medium, (Low)	1, (2)
8	Vertical wall and opening irregularity	Regular	0	Less Regular, (Irregular)	1, (2)
9	Irregularity of story heights	No	0	Yes	1
10	Soft story	No	0	Yes	1
11	Slab type	Reinforced concrete	0	Wood, Volto	1
12	Mortar type	Cement	0	Limestone, Mud, None	1
13	Wall – Wall connection	Good	0	Bad	1
14	Wall- Slab connection	Good	0	Bad	1
15	Roof material	Corrugated tile, Steel sheet, Concrete	0	Soil	1

3.3.2 Story Number

One of the parameters needed when calculating the building performance, the story above the ground level, is taken for this method; story number affects building vibration and the maximum distance of building movement, and also the vibration period.

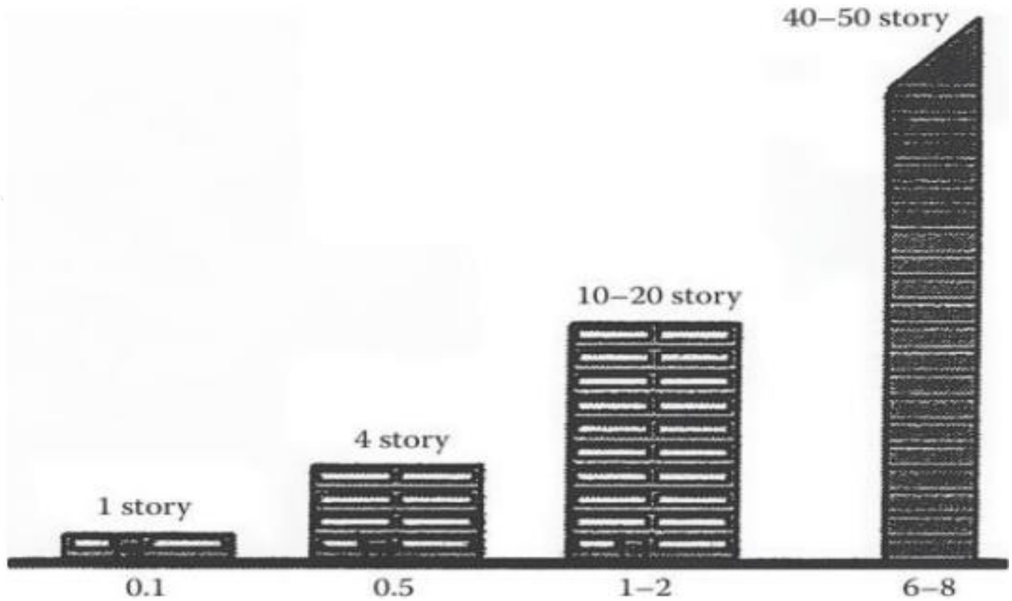


Figure 3.8 Building period (s)

As we see in the explanatory picture, the higher number of the story directly affects the building's performance during an earthquake.

The number of floors that are free is counted, but the basement is not counted in the calculation, as shown in Figure 3.9.

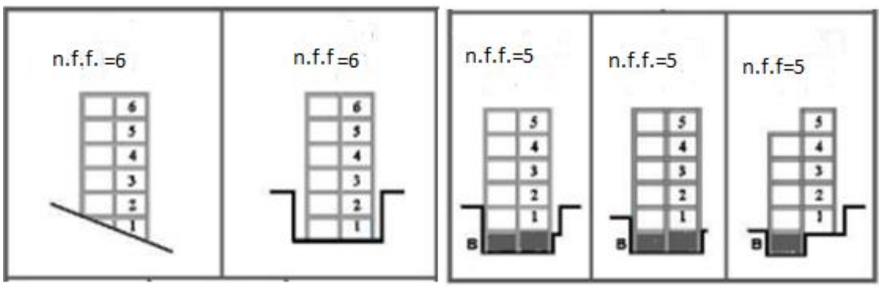


Figure 3.9 Free story number

3.3.3 Plan Irregularity

Some irregularities in building plans affect the safety of the building during the earthquake shown in Figure 3.10. For the building plan irregularity, when there is a certain irregularity, as shown in the Figure 3.10, these buildings act as different parts, causing torsion in the structure and may cause damage between these parts during the earthquake.

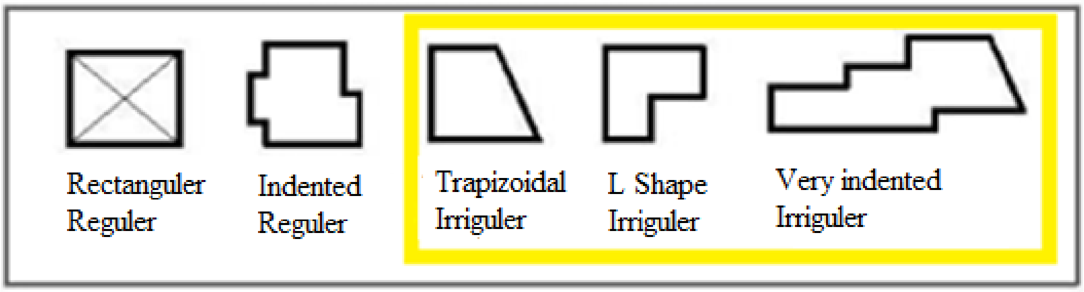


Figure 3.10 Plan irregularity (continued)

Figure 3.10 Plan irregularities

3.3.4 Vertical Opening Irregularity

Another parameter to consider for masonry buildings in this method is the irregularity in the openings of the building (location or size), such as doors and windows, when the windows and doors are not at the same line or have different dimensions, it affects the performance of the building, and it is another weak point for the building.

Figure 3.11 Vertical opening irregularity (1,2)

3.3.5 Adjacent Building

The neighboring buildings are affecting each other, if the building is adjacent to another building, and the slab level of one of the buildings is at the level of the column of the neighbor building, in that case, the slab may break the column for the adjacent building during the earthquake and cause the building to collapse.

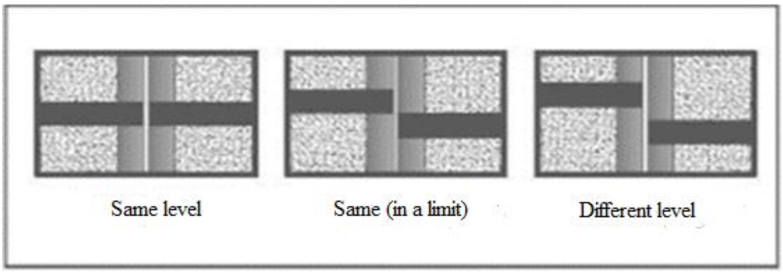


Figure 3.12 Adjacent building (continued)

Figure 3.12 Adjacent building (1,2)

According to this method, there is different punishment for buildings if there are adjacent to other buildings from one side or both sides but if the building is not adjacent to another building there is not punishment in this case.

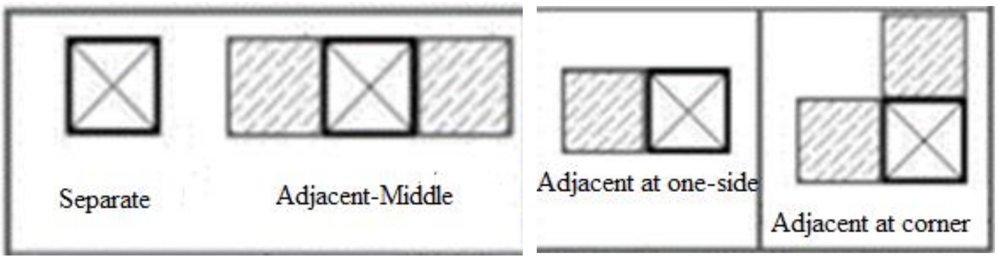


Figure 3.12 Adjacent building

3.3.6 Visual Quality

The visual quality of a building tells us some information about the building's performance because sometimes there are old buildings with bad quality.

Figure 3.13 Bad visual quality of a building

3.3.7 Short Column

It is safer for the building to have the same column height for all stories, some building has columns of different height, or there is a wall between the columns with a lower height than the column height, which makes the column act as two short columns during an earthquake, as you see in the explained in the picture 3.14 below.

Having that change in the column height as in the Figure 3.14, affect badly on building performance.

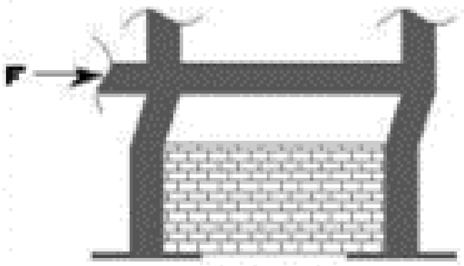


Figure 3.14 Short column (continued)

Figure 3.14 Short column

3.3.8 Soft Storey

A soft story is a story that is weaker than the other stories in the building, it implies that a structure with a soft story could fall during an earthquake and lead to other buildings collapsing, this type of story occurs when there is column discontinuity for that story or shear wall discontinuity or if that story is higher than the other story; according to Iraqi code, if a story stiffness is less than %70 of the other story stiffness of another story in that building, that story is considered a soft story.

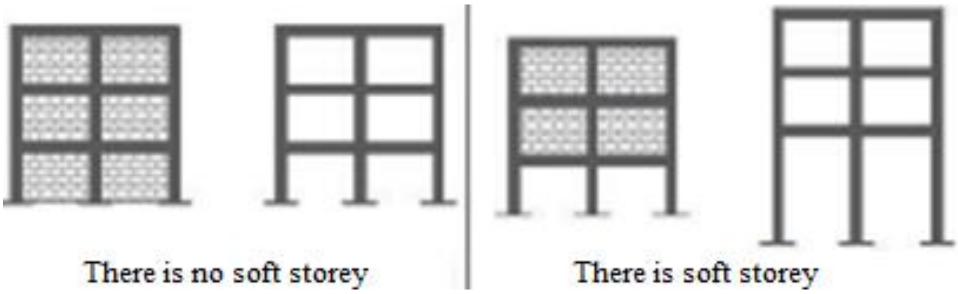


Figure 3.15 Soft story (continued)

Figure 3.15 Soft story

3.3.9 Heavy Overhang

It is the difference in horizontal area between the floors above the ground floor and the ground floor in buildings; these overhangs are either closed with a wall or a fence to use as a balcony, since heavy overhangs form cantilevers, columns are exposed to shear forces more than normal during earthquakes, causing irregularity in the building's center of mass and stiffness, structures with heavy overhangs are more affected by earthquakes than those without (Sucuoğlu, 2007).

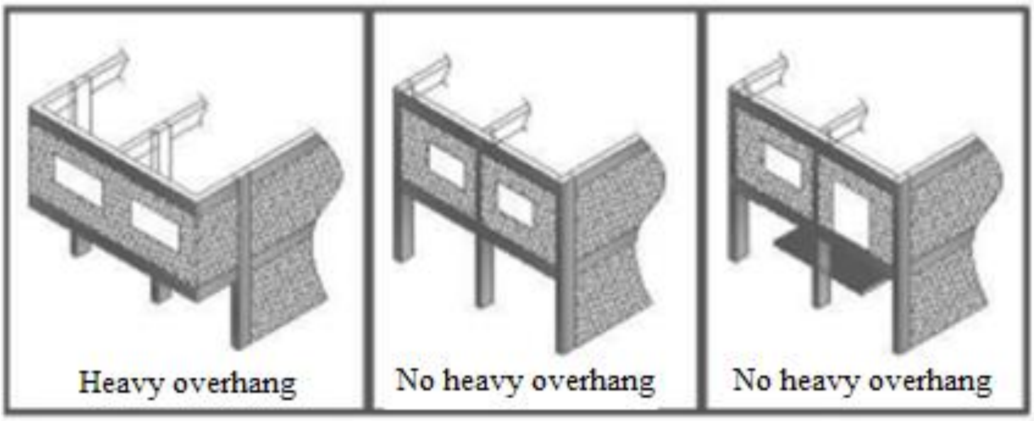


Figure 3.16 Heavy overhang (continued)

Figure 3.16 Heavy overhang

3.3.10 The Level of the Ground

It is a parameter that should be considered for the earthquake performance score due to the difference in stiffness between the sections below and above the slope and the short column effect in buildings located on slopes with a ground slope exceeding 30%.

Figure 3.17 The level of the ground (continued)

3.3.11 Other Parameters

Some other parameters are taken into consideration in evaluating this method, such as wall discontinuity workmanship, lack of beams, lack of walls, different height story, slab type, mortar type, material quality, wall-to-wall connection, wall-to-slab connection, and roof material. More moreover, every parameter affects building performance according to the 6306 method.

3.4 Evaluation

To collect data for each building, it is necessary to complete this form and record the information provided on the form

1- Frame building form

Table 3.6 Frame building form

Data collection form for frame building		
Building identification	Date:	16-8-2022
	No:	522

Building no.	522	
Governorate	Sulaimanyah	
City	Sulaimanyah	
Neighbourhood	Bakhtyary	
street		
Door no.		
Building name	Pepper	
sheet	23	
Performance		
Parcel		
Building code		
building estimated age	12	
Coordinate	Horizontal: 35.5687045 Longitudinal: 45.4017322	

Building use	☐	Residential	■	Commercial	☐	Industry	☐	Public	☐	Abandoned

Building technical information

Structural system Type	■	Ba cerçeve	☐	Ba çerçeve ve perde
Number Of Free Floor (NFF)	3			

Building visual quality	■	Good	☐	Medium	☐	Bad
Soft floor/ weak floor	■	There Is	☐	There Is Not		
Vertical irregularity	■	There Is	☐	There Is Not		
Heavy overhang	■	There Is	☐	There Is Not		
Plan irregularity	☐	There Is	■	There Is Not		
Short column effect	☐	There Is	■	There Is Not		
Building neighbor	☐	Separate	☐	Adjoining	■	Corner Adjustable
Floor level with Adjustable buildings	■	Same	☐	Different		
Natural floor slope	■	Straight		Inclined (Tilt 30°)		
Soil Type	☐ A	☐ B	☐ C	■ D	☐ E	
Not:						

2- Building performance

Score is calculated according to the data collected from the buildings, the law of evaluating frame building is as follows: -

PS=BS+ Ni*NP+ PPS

PS : Performance Score

BS : Base score

Ni : Each Negative Parameter

NP : Negativity Parameter Score

PPS : Positive Parameter Score

The base score is shown in Table 3.4.2. This score depends on the story number.

Table 3.7 Base and structural system score table (Tozlu, 2015)

Total of story Number	Base score (BS)				Structural system score (PPS)	
	Hazard zone				Frame	Frame+ wall
	I	II	III	IV		
1 ve 2	90	120	160	195	0	100
3	80	100	140	170	0	85
4	70	90	130	160	0	75
5	60	80	110	135	0	65
6 ve 7	50	65	90	110	0	55

According to Sds and soil type, the seismic zone is zone III, as shown in Table 3.4.3.

Table 3.8 Soil types

Seismic zone	SDS	Soil type
I	Sds ≥1.0	ZC/ZD/ZE
II	Sds ≥1.0	ZA/ZB
	1.0 > Sds ≥0.75	ZC/ZD/ZE
III	> Sds ≥0.75	ZA/ZB
	0.75 ≥ Sds ≥0.50	ZC/ZD/ZE
IV	0.75 ≥ Sds ≥0.50	ZA/ZB
	0.50≥ Sds	All soil types

Table 3.9 Negativity parameter scores (NP)

All story number	Soft story	Visual quality	Heavy overhang	Slab level/Adjacency building status: Same middle	Same-one side	Different middle	Different-one side	Vertical irregularity	Irregularity/Torsion in plan	Short column	Hill/slope effect
1,2	-10	-10	-10	0	-10	-5	-15	-5	-5	-5	-3
3	-20	-10	-20	0	-10	-5	-15	-10	-10	-5	-3
4	-30	-15	-30	0	-10	-5	-15	-15	-10	-5	-3
5	-30	-25	-30	0	-10	-5	-15	-15	-10	-5	-3
6,7	-30	-30	-30	0	-10	-5	-15	-15	-10	-5	-3

Table 3.10 Risk limit of buildings according to earthquake scores

Building performance score range	PS <0	0 ≤ PS≤50	50≤PS≤ 100	PS> 100
Building performance status	Very risky	Moderately risky	Moderately safe	Very safe

Table 3.11 Masonry building form (continued)

Data collection form for masonry buildings

Building identification information

Date: 16-8-2022
No: 565

Building no.	565
Governorate	Sulaimanyah
City	Sulaimanyah
Mahalle	Bakhtyary
Street	
Door no	
Builing name	Adys
Sheet	
Performance	
Parcel	
Building code	
Building estimated age	20
Coordinates	Enlem: 35.5706075 Boylam: 45.3943967

Building use: ☐ Residential ■ Commercial ☐ Industry ☐ Public ☐ Abandoned ☐

Bina teknik bilgileri

Load-bearing wall type: ☐ Full brick ☐ Full briquette ☐ Stone wall ☐ Hollow brinket

Table 3.11 Masonry building form

	□ Vertical perforated brick	■ Concrete block	□ Adobe	□ Horizontal perforated brick
Masonry building type	■ Unreinforced wall □ Reinforced wall		□ Besieged wall □ Mixed (frame + masonry)	
Free floor no. (F.F.N.)				
Building nNeighbour	□ Separet	■ Adjust at one side	□ Köşede bitişik	
Bitişik bina ile döşeme seviyesi	□ Ayni		■ Farkli	
Yiğma duvar malzeme kalitesi	□ İyi	■ Orta	□ Kötü	
Yiğma duvar işçiliği	□ İyi	■ Orta	□ Kötü	
Mevcut hasar	■ Yok		□ Var	
Planda düzensizlik	■ Düzenli	□ Düzensiz	□ Aşiri düzensiz	
Yatay hatil	□ Pencere Üstü	□ Duvar üstü	□ Yok	
Zemin kat plan genişliği (ön cephe) (M)	5	Zemin kat boşluk miktari (ön cephe) (M)		
Zemin kat plan genişliği (yan cephe) (M)	20	Zemin kat boşluk miktari (yan cephe) (M)		
Düşey boşluk düzensizliği	■ Düzenli	□ Az düzenli	□ Düzensiz	
Cepheye göre kat farkliliği	□ Yok		□ Var	
Yumuşak kat / zayif kat	□ Yok		■ Var	
Döşeme tipi	□ Betonarme	□ Ahşap	□ Volto	
Harç malzemesi	■ Çimento	□ Kireç	□ Çamur	□ Yok
Duvar duvar bağlantilari	■ İyi		□ Kötü	
Duvar döşeme bağlantilari	■ İyi		□ Kötü	
Çati malzemesi	□ Kiremit	■ Beton	□ Sac	□ Toprak
Zemin sinifi	□ Za ■ Zd	□ Zb □ Ze	□ Zc □	

Table 3.12 Negative parameter values (principles for detection of risky structures)

Negative parameter no	Negative parameter	Case 1		Case 2	
		Parameter detection	Parameter value	Parameter detection	Parameter value
1	Adjacency	Separate	0	Adjacent / Adjacent from one side	1
2	Material Quality	Good	0	Moderate, (Bad)	1, (2)
3	Workmanship	Good	0	Moderate, (Bad)	1, (2)
4	Existing damage	No	0	Yes	1
5	Plan irregularity	Regular	0	Irregularity (Extremely Irregular)	1, (2)
6	Lack of beams	Wall Copings, window copings	0	No	1
7	Lack of walls	A lot	0	Medium, (Low)	1, (2)
8	Vertical wall and opening irregularity	Regular	0	Less Regular, (Irregular)	1, (2)
9	Irregularity of story heights	No	0	Yes	1
10	Soft story	No	0	Yes	1
11	Slab type	Reinforced concrete	0	Wood, Volto	1
12	Mortar type	Cement	0	Limestone, Mud, None	1
13	Wall – Wall connection	Good	0	Bad	1
14	Wall- Slab connection	Good	0	Bad	1
15	Roof material	Corrugated tile, Steel sheet, Concrete	0	Soil	1

Table 3.13 Base score table (principles for detection of risky structures)

	Earthquake danger zone		
Number of floors	Zone I Sds ≥ 1.0	Zone II-III 0.5≤ Sds < 1.0	Zone IV Sds < 0.5
1	110	120	130
2	100	110	120
3	90	100	110
4	80	90	100
5	70	80	90

Table 3.14 Current status and negative quality scores (Tozlu, 2015)

Material quality (0/1/2)	Masonry (0/1/2)	Current Damage (0/1)
-10	-5	-5

Table 3.15 Negative scores in the plan (Tozlu, 2015)

Geometry (0/1/2)	Wall Quantity (0/1/2)	Column/lintil (0/1)
-5	-5	-5
-10	-5	-5
-10	-10	-5
-15	-10	-5
-20	-15	-5

Table 3.16 Vertical negative scores (Tozlu, 2015)

Storey number	Space layout (0/1/2)	Floor difference according to the facade (0/1)	Soft floor/weak floor(0/1)
1	5	-5	0
2	-5	-5	-5
3	-5	-5	-5
4	-10	-5	-10
5	-10	-5	-10

Table 3.17 Building order and floor levels negativity scores (Tozlu, 2015)

Separate	Adjacency middle - Same	Adjacency- one side –Same	Adjacency middle - different	Adjacency one side - different
0	0	-5	-5	-10

Table 3.18 Risk range of buildings according to earthquake scores

Building performance score range	PS<70	70≤PS≤100	PS>100
Building performance state	Moderately hazardous range	Moderately safe range	Very safe range

4. RESULT AND DISSCUSION

4.1 Number of Floors

Buildings in this area are of two types, masonry buildings and frame buildings. Masonry buildings usually have one floor up to three floors, frame building is used if the building is higher than three floors, most commercial buildings are frame buildings and frame building story numbers also start from 1 story to 5 stories from the ground level in case study area.

Table 4.1 Number of floors

Number of floors		
Number	Number of floors	Number of Buildings
1	One floor	50
2	Two floors	275
3	Three floors	161
4	Four floors	25
5	Five floors	1

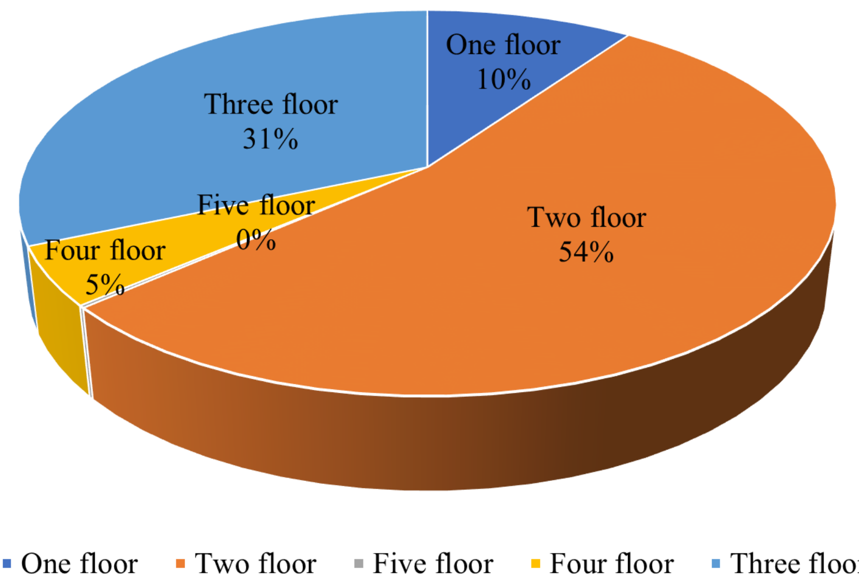


Figure 4.1 Number of floors

4.2 Visual Quality

Buildings in the Bakhtyry area vary in visual quality; some of the old buildings look bad because they have not been renovated, some old buildings have been renovated or covered with decorative finishing materials that cover the building, which will hide the actual quality of the building material.

Table 4.2 Visual Quality of buildings

Visual quality		
Good	Medium	Bad
240	223	49

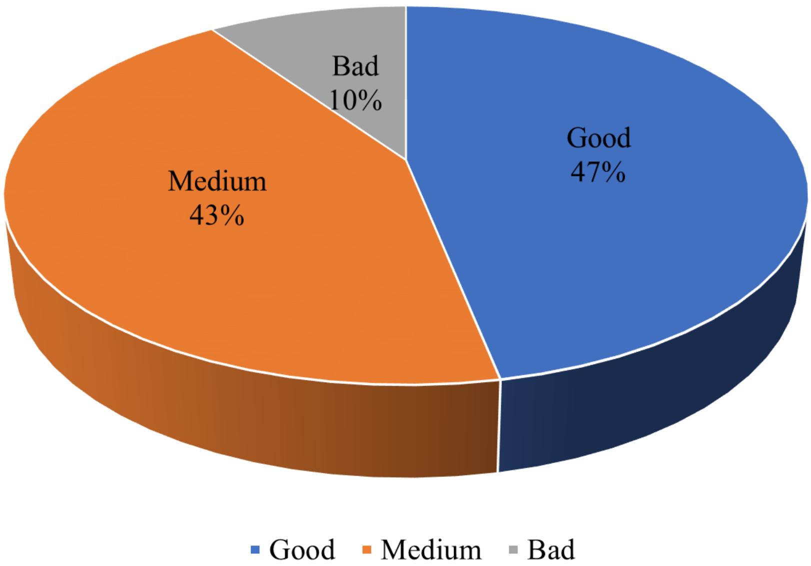


Figure 4.2 Visual quality of buildings

4.3 Structural System

The study case area is a residential in the city center, many masonry building exist in this area, and the first story of those buildings is used as garage or small shops.

The commercial buildings are built with masonry or by frame system, and the newest commercial buildings most likely built by structural frame system.

Table 4.3 Structural system of buildings

Structural system		
Number	Structural system	Number of houses
1	Masonry system	457
2	Frame system	55

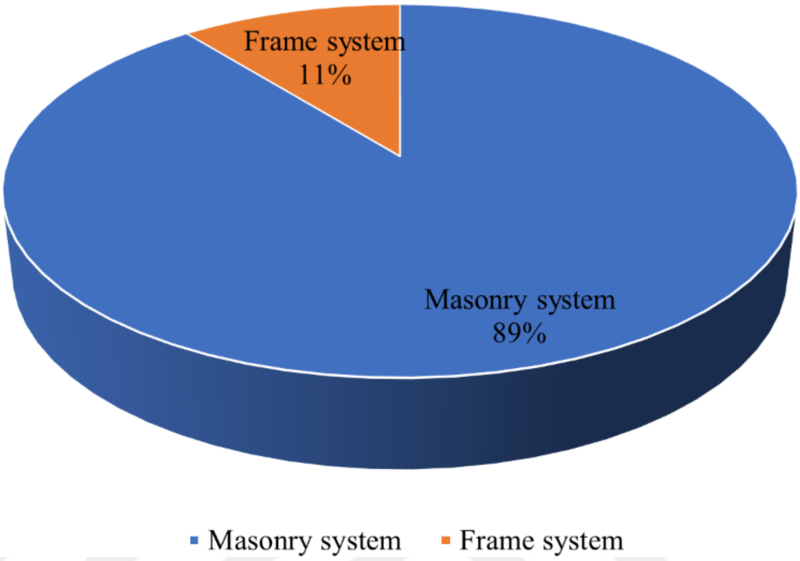


Figure 4.3 Structural systems of buildings

4.4 Soft Story

Residential houses usually do not have a soft story; commercial buildings usually have a soft story which is a ground story in this area in most cases.

Table 4.4 Soft Story of buildings

Soft Story		
Number	Yes/No	Number of houses
1	Yes	155
2	No	357

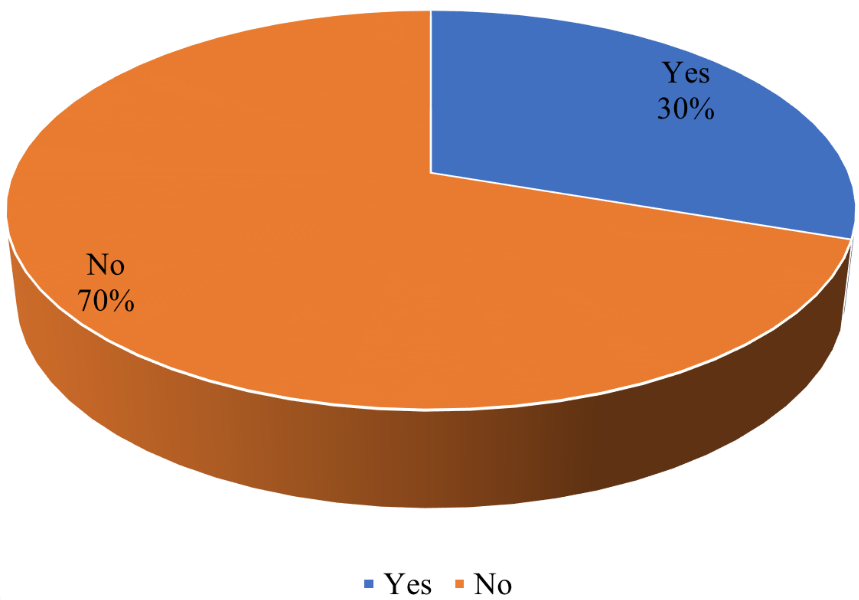


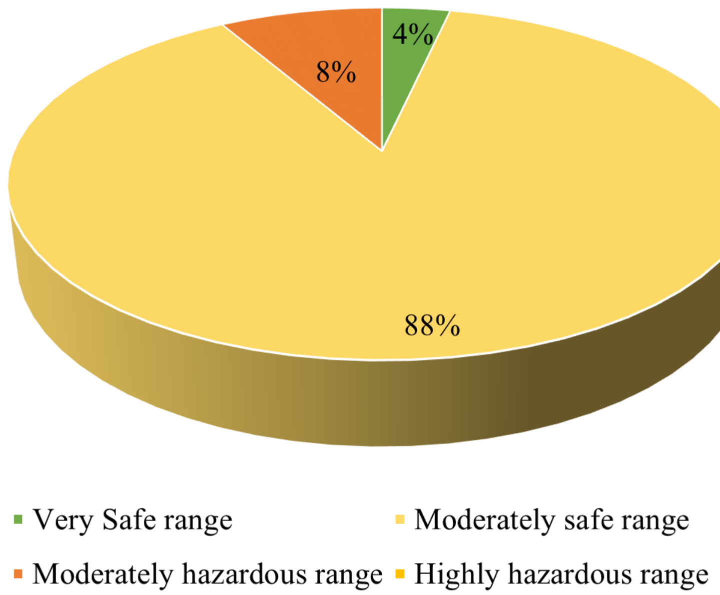
Figure 4.4 Soft story in buildings

4.5 Evaluated Safety

By calculating building parameters for each building, the final result was as shown in the figure 6.5, the largest ratio of the building is a moderately safe building which is =88% of all buildings, after that moderately hazardous building which is =8%, and then very safe building which is=4%

Table 4.5 Evaluated safety of buildings

	Safety range	
Number	Safety range	Number of Houses
1	Very Safe range	18
2	Moderately safe range	451
3	Moderately risky range	43
4	Highly risky range	0



4.5 Evaluated safety of buildings

4.6 Map

After entering all the buildings in the program and locating them on Google Maps by entering the coordinates of all the buildings, here are the images of the buildings on Google Maps; the program can zoom in completely and see the buildings clearly on the map, but when zooming out the screen, the building coordinate color (which explain the safety range) is not clear.

And because not all buildings can be entered into the program simultaneously, they cannot all be identified together on the map, for this reason, they have been entered and taken pictures in parts

According to the program, each range of safety has a different color

1- Green color is for a very Safe building

2- Yellow color is for a moderately safe building

3- Orange color is for moderately risky building

4- Red color is for highly risky building

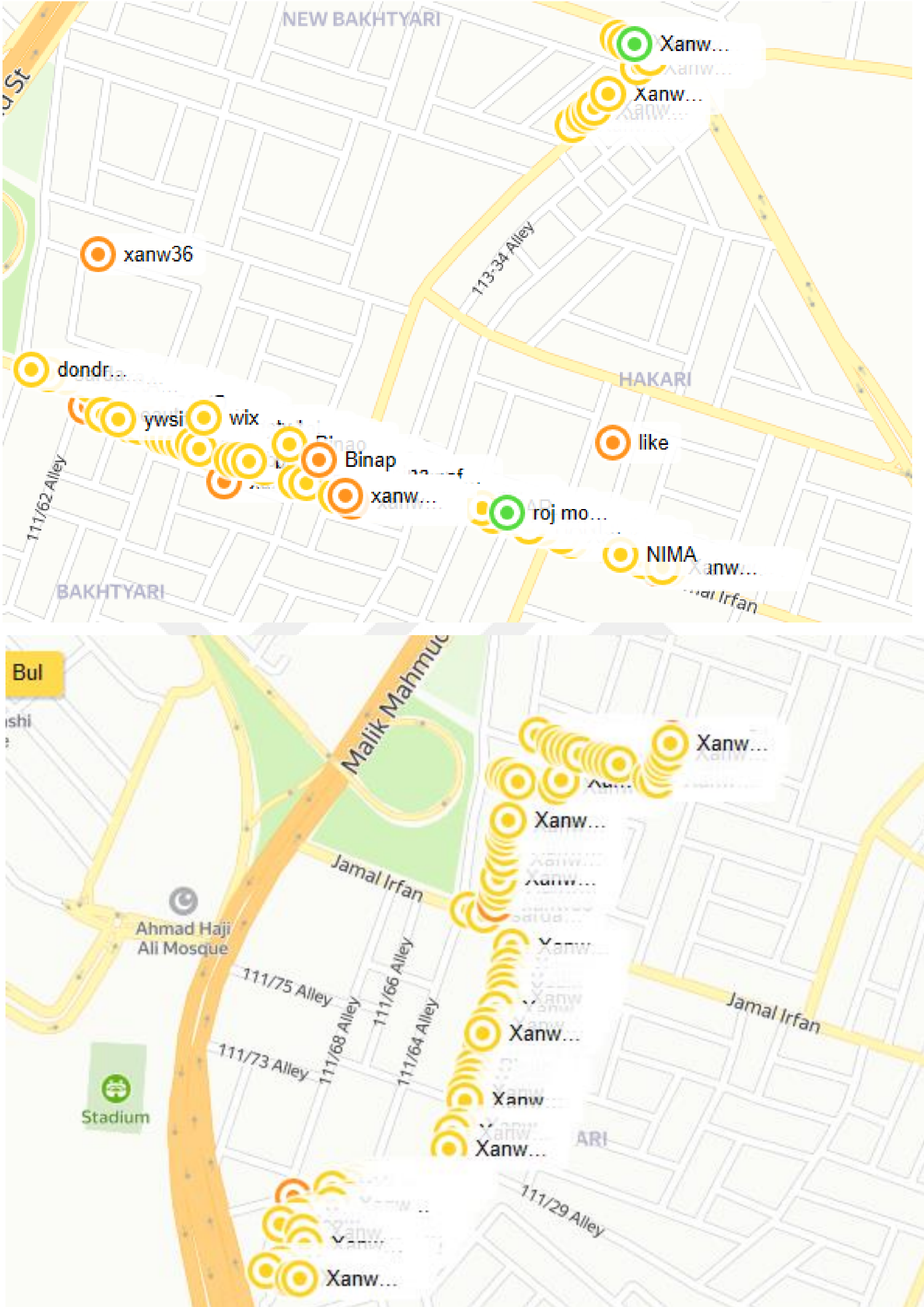


Figure 4.6 Buildings on the map (continued)

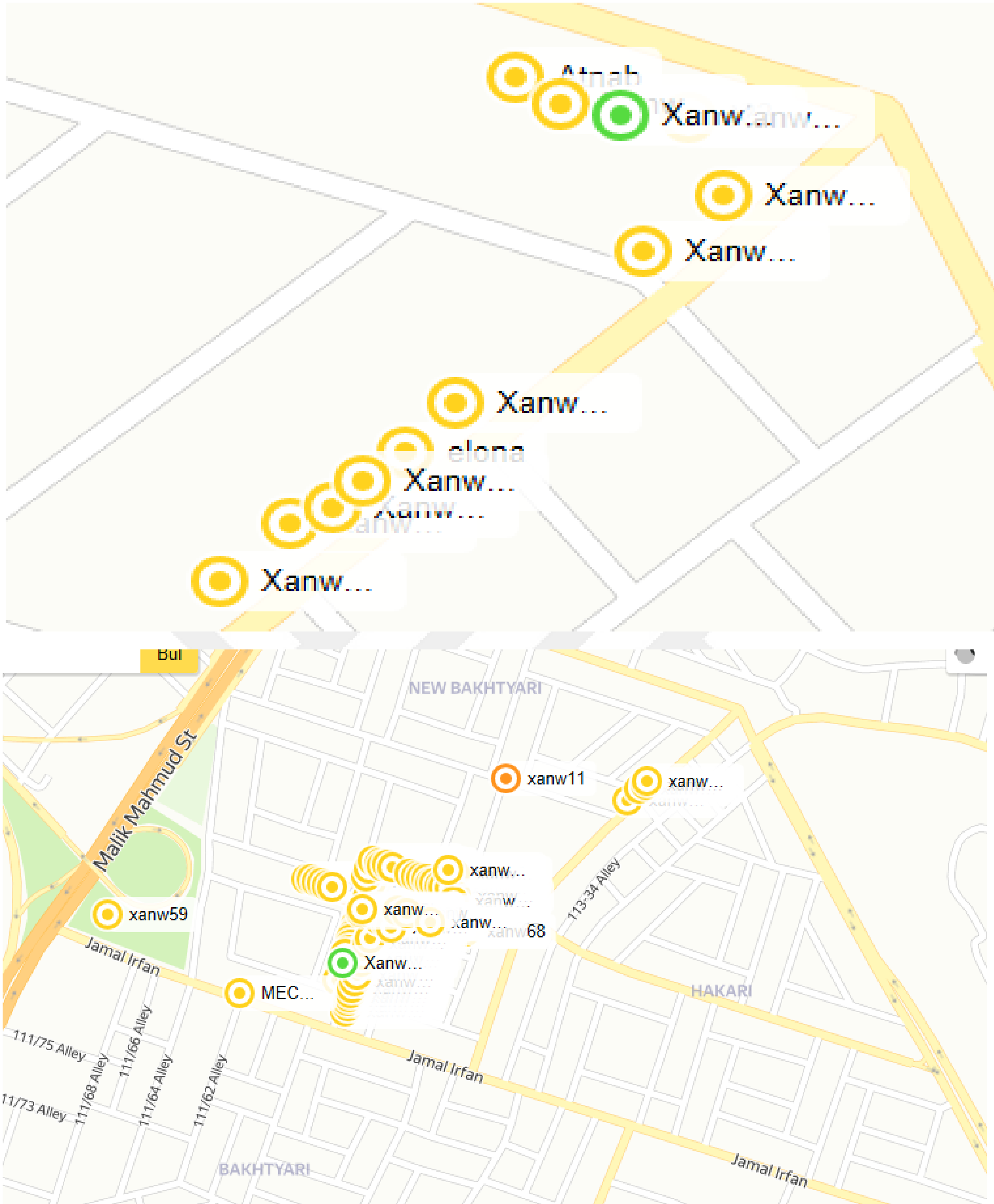


Figure 4.6 Buildings on the map (continued)

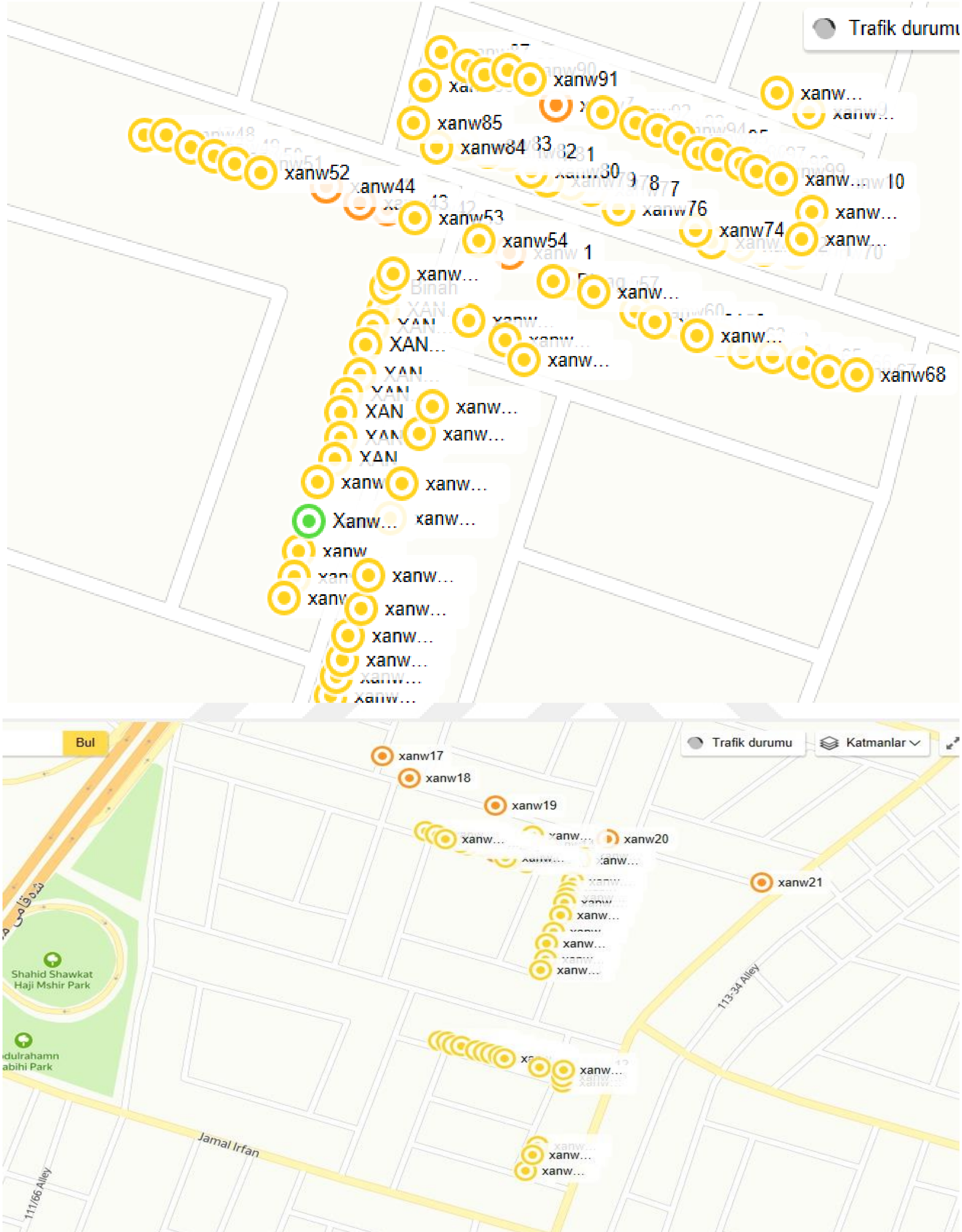


Figure 4.6 Buildings on the map (continued)

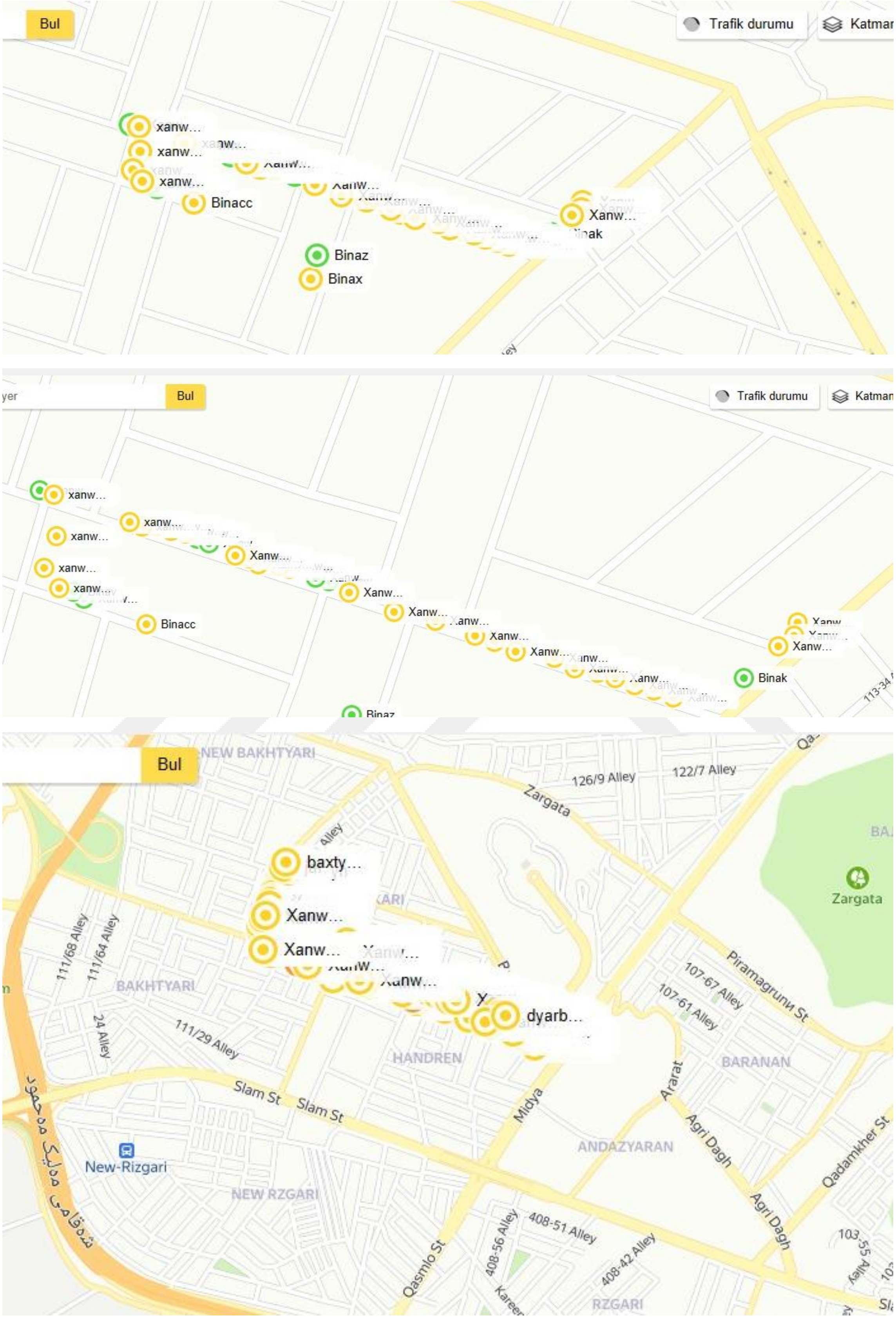


Figure 4.6 Buildings on the map (continued)

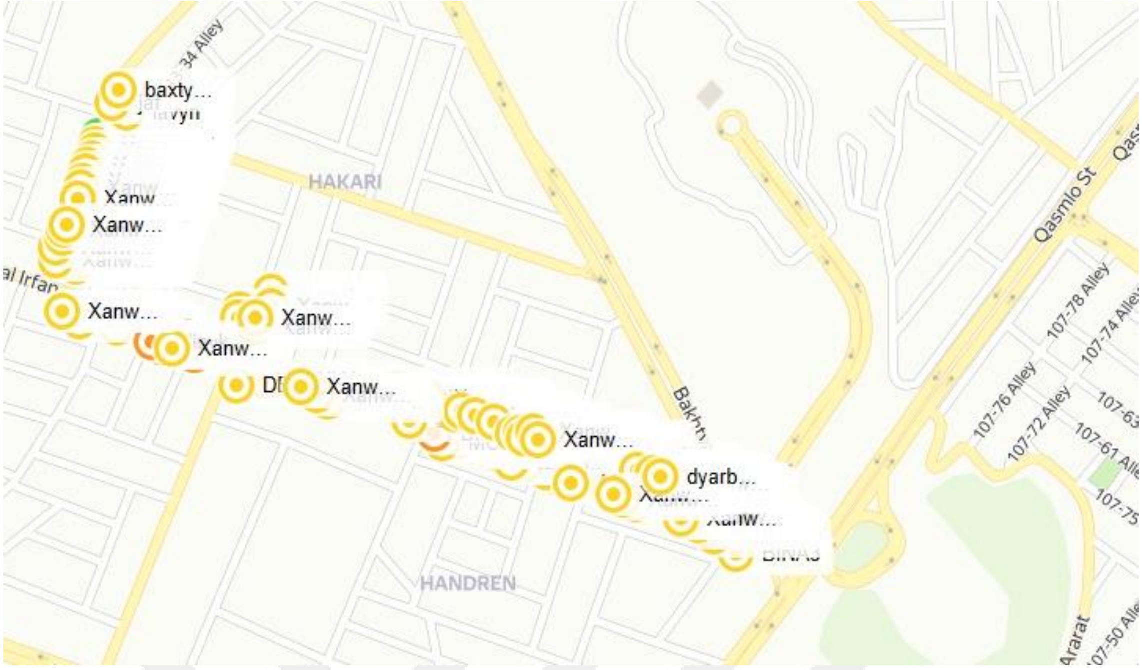


Figure 4.6 Buildings on the map

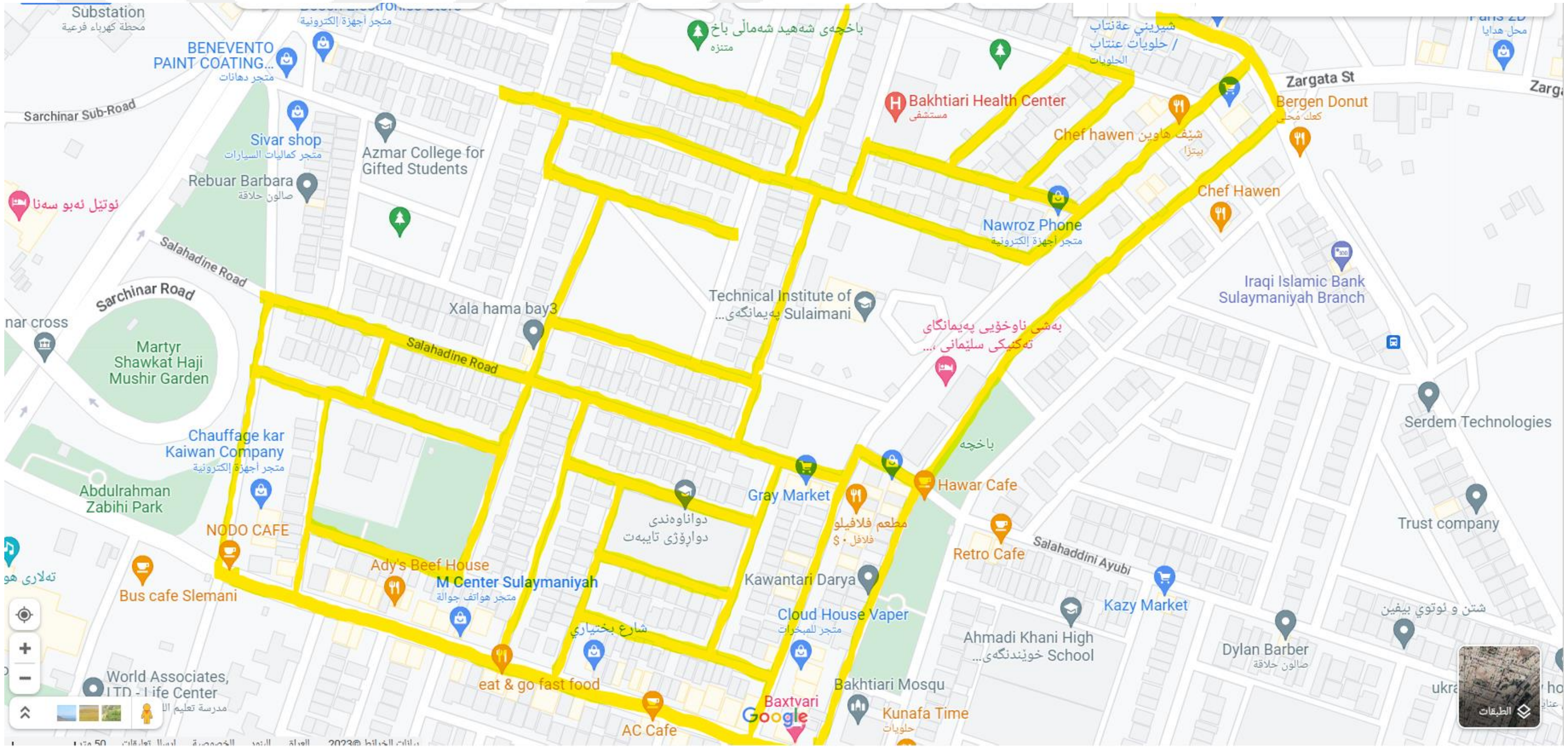


Figure 4.7 Survey area on the map (continued)

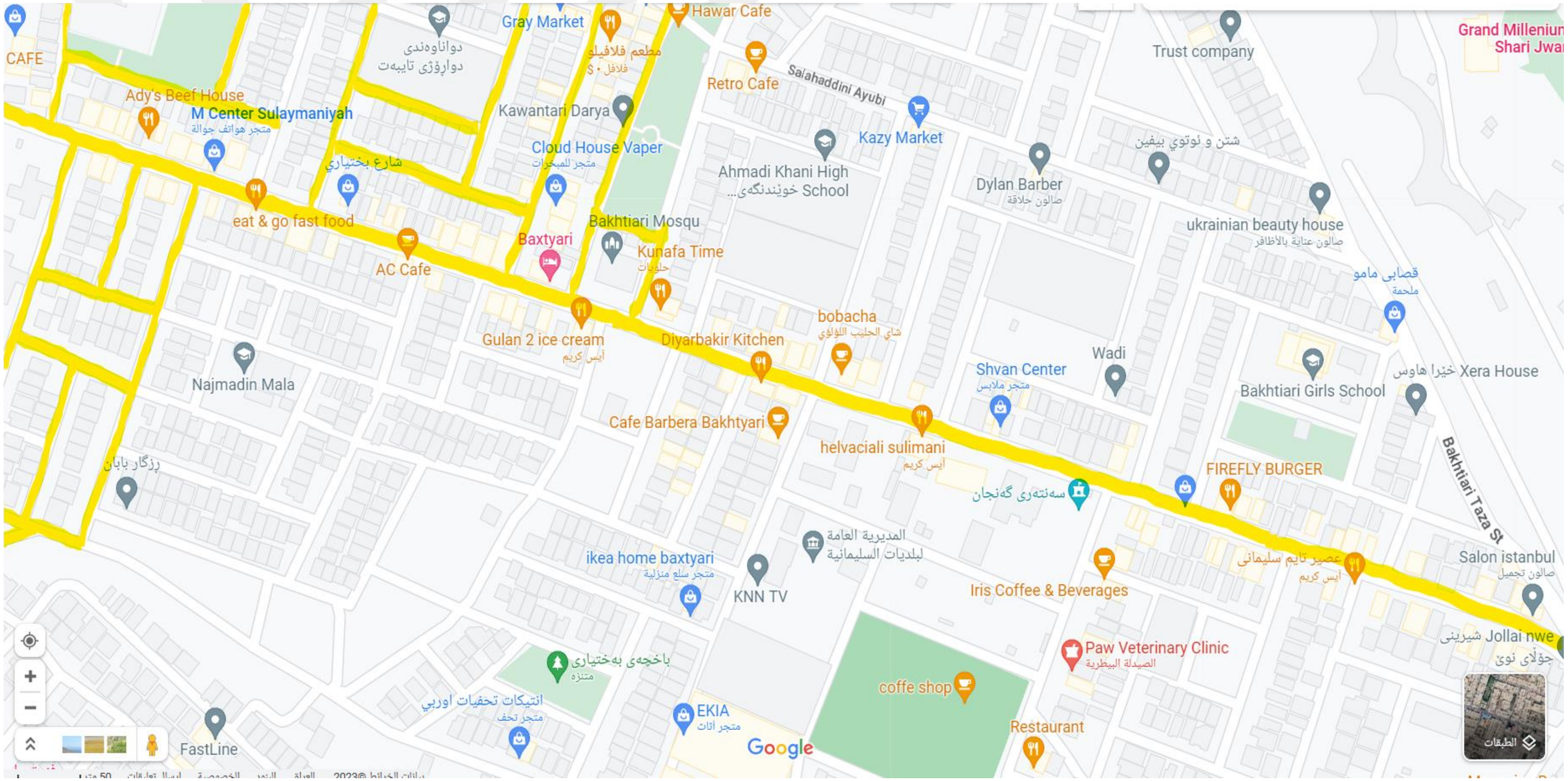


Figure 4.7 Survey area on the map (continued)

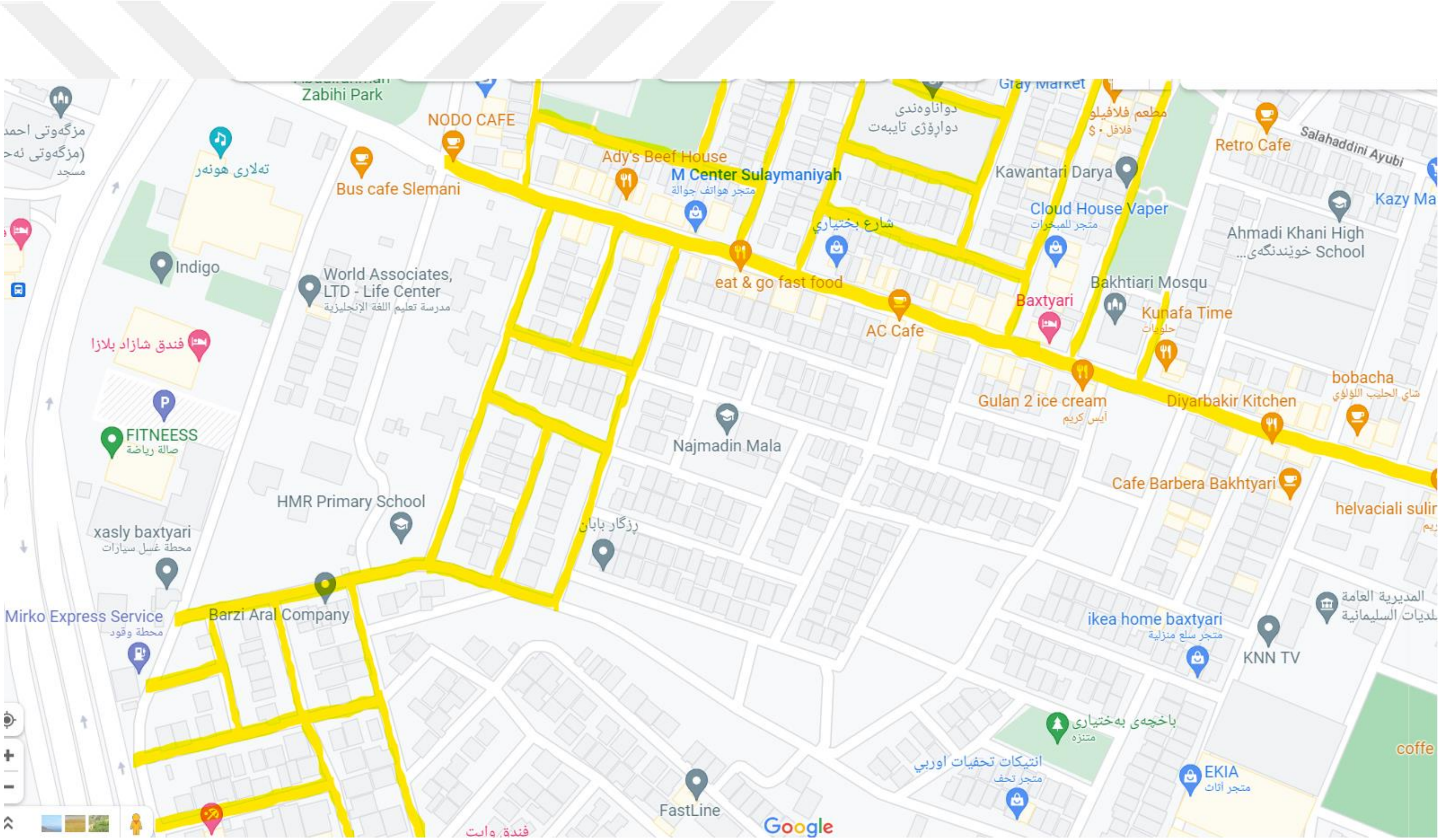


Figure 4.7 Survey areas on the map

5. CONCLUSION AND RECOMMENDATIONS

Rapid assessment methods are divided into street scanning and preliminary assessment methods; the 6306 method is one of street scan methods.

The main purposes of this method are to determine the score range and the order of priority in which buildings to carry out detailed examinations.

The street scanning method of law no. 6306 on the detection of risky buildings was used to assess 512 buildings in total, comprising 55 reinforced concrete and 457 masonry buildings, the parameters of the method were used, and the buildings were calculated with the (Earthquake Performance Analysis) program.

Reinforced concrete structures as in the score, (<0 high hazardous structure), (0-50 moderately hazardous Structures), (50-150 moderately Safe Structures) and (> 150 Very Safe Structures), masonry structures on the other hand were classified and mapped and the range of safety of the building is (<70 moderately hazardous Structures), (70-100 moderately safe Structures) and (>100 very safe Structures) ranges.

These ranges are determined by the researcher according the building situation.

457 masonry structures are solved with the Microsoft excel program using the 6306 RYY method. Masonry structures were mapped in the program by matching (masonry)-(reinforced concrete) risk ranges. Buildings are 8% moderately risky, 88% moderately safe and 4% very safe buildings, this study will fill an essential gap in the literature, as it is the first field study conducted in Sulaimany with the first-stage evaluation method, it is thought that it can be a start for evaluating the buildings in Sulaimany city.

It is important to conduct a comprehensive review of such studies throughout the city through universities, civil engineers, as well as master's theses, doctoral theses and various projects.

In Bakhtyary neighborhoods, moderately risky reinforced concrete and masonry buildings, whose performance scores are determined and mapped by the street scan evaluation method, buildings that are risky as a result of earthquake performance can be evaluated by more detailed method, to determine if the building needed to either be strengthened or demolished, as a result of detailed analyzes linear or nonlinear to be made, buildings that will need to be demolished should be included in the scope of urban transformation as soon as possible.

REFERENCES

Aldama-Bustos, G., Bommer, J. J., Fenton, C. H., Stafford, P. J. (2009). Probabilistic seismic hazard analysis for rock sites in the cities of Abu Dhabi, Dubai and Ra's Al Khaymah, United Arab Emirates. Georisk, 3(1), 1-29.

Alsinawi, S., Jassim, S., Goff, J. (2006). Seismicity. In: Jassim SZ, Goff JC (eds) geology of Iraq. Dolin, Prague and Moravian Museum, Czech Republic, 84-90.

American Society of Civil Engineers. (2003). *Seismic evaluation of existing buildings*. American Society of Civil Engineers.

Bahroudi, A., Talbot, C. (2003). The configuration of the basement beneath the Zagros Basin. *Journal of Petroleum Geology,* 26(3), 257-282.

Bilham, R. (2009). The seismic future of cities. *Bulletin of Earthquake Engineering,* 7, 839-887.

Buday, T., Jassim, S. (1987). The regional geology of Iraq: tectonic, magmatism and metamorphism. *Geological Survey and Mineral Investigation,* 2, 356.

Chapain, S., Aly, A. M. (2019). Vibration attenuation in high-rise buildings to achieve system-level performance under multiple hazards. *Engineering Structures,* 197, 109352.

Doski, J. A. (2019). Tectonic interpretation of the Raniya earthquake, Kurdistan, northern Iraq. *Journal of Seismology,* 23(2), 303-318.

Elders, J., AlHashimi, H. (2020). Left-sided humerus fracture as an unusual complication of defibrillation threshold testing following S-ICD implantation. *Case Reports,* 2(2), 255-257.

Fouad, S. F. (2012). Western Zagros fold–thrust belt, part I: The low folded zone. *Iraqi Bulletin of Geology Mining,* (5), 39-62.

Fouad, S. F. (2015). Tectonic map of Iraq, scale 1: 1000 000, 2012. *Iraqi Bulletin of Geology Mining,* 11(1), 1-7.

Free, M. A., Porovic, E. A., Manning, J. A., Fourniadis, Y. A., Lagesse, R. Ting, C. A., Campbell, G. A., Koskosidi, A. A., Farrant, A. B., Terrington, R. B., Carter, G. B., Omar, T. (2018). Offshore geological, geotechnical and geohazard modelling and design for Abu Dhabi, UAE. **Offshore Technology Conference held in Houston**, Texas, USA.

Grant, D. N., Bommer, J. J., Pinho, R., Calvi, G. M., Goretti, A., Meroni, F. (2007). A prioritization scheme for seismic intervention in school buildings in Italy. *Earthquake Spectra,* 23(2), 291-314.

Harirchian, E., Lahmer, T., Buddhiraju, S., Mohammad, K., Mosavi, A. (2020). Earthquake safety assessment of buildings through rapid visual screening. *Buildings*, 10(3), 51.

Haryanto, Y., Hu, H. T., Widyaningrum, A., Alfidiah, E., Hidayat, B. A. (2020). *FEMA 310 Tier 1 seismic evaluation of existing building: A case study of a 7-story academic RC building of Jenderal Soedirman University, Indonesia*. IOP Conference Series: Materials Science and Engineering. Academic RC Building of Jenderal Soedirman University, Indonesia.

Hassan, A. F., Sozen, M. A. (1997). Seismic vulnerability assessment of low-rise buildings in regions with infrequent earthquakes. *ACI Structural Journal,* 94(1), 31-39.

Hosseini, R., Lashkaripour, G. R., Moghadas, N. H., Ghafoori, M. (2014). I*nternational*

Journal of Current Life Sciences. Int. J. Curr. Life Sci., 4(11), 9060-9066.
Jassim, S., Buday, T. (2006). Evaluation of foundation settlement under various added loads in different locations of Iraq using finite element. ***Engineering***, 8(5), 71-83.
Jassim, S., Buday, T., Museum, M. (2006). Late Toarcian-Early Tithonian (Mid-Late Jurassic) Megasequence AP7, chapter 10. *Geology of Iraq, first edition: Brno, Czech Republic, Prague*, 117-123.
Law No. 6306. (2012). Implementation Regulation of the Law on Transformation of Areas Under Disaster Risk. Official Gazette dated 15/12/2012 and numbered 28498, Ankara, Turkey.
Law No. 6306. (2019). Regulation Amending the Implementation Regulation of Law No. 6306. Official Gazette dated 21/06/2019 and numbered 30808, Ankara, Turkey.
Muvafık, M., Özdemir, M. (2019). Computer aided quick determination of earthquake performance of buildings by using street survey and preliminary assessment methods. *Academic Perspective Procedia*, 2(2), 200-210.
Ozcebe, G., Ersoy, U., Tankut, T., Gulkan, P., Sucuoglu, H., Wasti, T., Bousias, S. (2000). ***Seismic assessment and rehabilitation of existing buildings***. Department of Civil Engineering, Middle East Technical University.
Ozcebe, G., Yucemen, M., Aydogan, V., Yakut, A. (2003). Preliminary seismic vulnerability assessment of existing reinforced concrete buildings in Turkey. Department of Civil Engineering. Middle East Technical University, Ankara, Turkey
Papathoma-Köhle, M., Dominey-Howes, D. (2018). Risk governance of limited-notice or No-notice natural hazards. In *Oxford Research Encyclopedia of Natural Hazard Science*.
Tozlu, Z. (2015). *Mevcut yapıların risk durumunun belirlenmesi için 6306 sayılı kanun kapsamında yer alan hızlı değerlendirme tekniğinin uygulanması.* Yüksek Lisans Tezi. Gazi Üniversitesi, Fen Bilimleri Enstitüsü, Ankara, Türkiye.
Yang, Y., Goettel, K. A. (2007). *Enhanced rapid visual screening (E-Rvs) method for prioritization of seismic retrofits in Oregon*: Oregon Department of Geology and Mineral Industries Portland, OR, USA.

EXTENDED TURKISH SUMMARY
(GENİŞLETİLMİŞ TÜRKÇE ÖZET)

IRAK-SÜLEYMANİYE İLİ BAKHTYARY MAHALESİ'NDEKİ MEVCUT BİNALARIN SOKAK TARAMASI YÖNTEMİ İLE DEPREM PERFORMANSLARININ HIZLI DEĞERLENDİRİLMESİ

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Haziran 2023, 63 Sayfa

Bu çalışmada Bakhtyary Mahallesi'ndeki (512) binanın yapı performansları değerlendirilmiştir. Irak/Süleymaniye ili Bakhtyary Mahallesi'ndeki mevcut binalar, bir vaka çalışması olarak ele alınmıştır. Bu bölgedeki binaların çoğu 1983'ten önce inşa edilmiş ve bu binaların bir kısmı ya sadece boya veya diğer kaplama malzemeleri ile yenilenmiş ya da bina planı değiştirilerek, eklemeler veya çıkarmalar yapılarak yeniden inşa edilmiş ve duvarlar eklenmiştir.

Buna karşın çerçeve binaların çoğu, son 15 yıl içinde yeniden inşa edilmiştir. Bu kadar çok sayıdaki yapının durumlarını değerlendirmek için Sokak Tarama Yöntemi kullanılmıştır. Nitekim bu yöntemde bina verileri binanın dışından sokak taramasıyla toplanır, ardından bina performansının hesaplamak için veriler değerlendirilir.

Binaların deprem performanslarını hızlı değerlendirme için bazı yöntemler kullanılmaktadır. Burada kullanılan yöntem Sokak Tarama yöntemlerinden biri olarak 6306 sayılı yasa ile öngörülen yöntemdir. Elde edilen verilerin hesaplanması ve sonucun harita üzerinde gösterilmesi için (Özdemir, 2019) tarafından oluşturulmuş bir bilgisayar programı (EPA) kullanılarak bir sonuca varılmaktadır.

Son zamanlarda, depremler Irak'ta daha önemli bir endişe kaynağı haline gelmiştir. Özellikle ülkenin kuzeyindeki depremin yüksek risk taşıdığı bazı bölgeler ile Arap Plakası'nın kuzeydoğu alanlarında Irak sismik analizlerine göre aktif deprem bölgesi olarak değerlendirilmiştir.

Irak'ta en büyük deprem 12 Kasım 2017'de meydana gelen 7,3 büyüklüğündeki deprem olarak kayıtlara geçmiştir. Bu depremin merkez üssü Halepçe vilayetine 32 kilometre uzaklıkta bulunan yer olarak belirlenmiştir. Küresel Afet Uyarı ve

Koordinasyon Sistemi (GDACS)’ne göre bu depremin bölgeye yakın olan İran'da 530'dan fazla ölüme ve binlerce yaralanmaya neden olmuştur.

Bu deprem sırasında Irak'ta Kürdistan Bölgesel Hükümeti’nin bildirdiğine göre (KBY) bu bölgede de dokuz kişi vefat etmiş, 550 kişi yaralanmıştır. Depremin meydana getirdiği bu yıkım, sismik yükün insanların inşa ettiği veya mühendislerin tasarlayıp inşa ettiği yapılar için ne büyük zorluklar meydana getirdiğini göstermesi bakımından önemli görülmüştür.

Nitekim her yıl birçok bina depremlerde hasar görmekte binlerce can ve milyarlarca dolar kaybolabilmektedir. Mühendisler binaları tasarlarken bu dinamik doğal güce karşı herkes için güvenli bir ortam sağlamak için bu gücün etkisini daha da azaltmayı sağlamak için çaba sarf etmektedirler.

2017 yılı verilerine göre Irak-İran sınırında kuzeyden güneye Irak ve Zagros sınırında 4 dereceden büyük deprem sayılarında artış meydana gelmiştir. Kürdistan bölgesi Irak'ın diğer bölgelerine göre depremler açısından daha aktif bir konumda yer almaktadır (Hosseini vd., 2014). Nitekim bu bölge, Arap kırık levhası ve Avrasya levhası ile kuzeydoğu sınırı arasında yer almaktadır.

Hızlı görsel tarama (HGT) yaklaşımına göre deprem riski taşıyan binaları belirlemek daha kolay hale gelmiştir. Buna bağlı olarak bu yöntem, binaları katagorileştirmek ve taramak için iyi bir envanter sağlamaktadır (Yang ve Goettel, 2007). Bu yöntemin hızlı ve çok sayıda binada işe yaramasını sağlayan şey, araştırıcının HGT yaklaşımı kapsamında yapının dışarıdan ve mümkünse içeriden görsel gözlemlerini yaptıktan sonra bir “Veri Toplama Formu” doldurmasıdır. Bir binanın sokak taramasına dayalı bir metodoloji kullanan mühendisler, daha bilimsel veriler elde edebilmektedirler (Harirchian ve diğerleri, 2020).

Depremlerden kaynaklanan bina hasarı, depremler sırasında meydana gelen bina kayması miktarı ile doğrudan ilişkili görülmüştür. Ötelenme miktarı, binanın tek tek yapısal ve yapısal olmayan elemanlarının rijitliğine ve sünekliğine bağlı olan binanın genel rijitliğine bağlı olarak belirlenir (Chapain ve Aly, 2019).

Bu araştırmada kullanılan değerlendirme yöntemi, binalar hakkında bina dışından veri toplama yaklaşımı olan bir "Sokak Tarama Yaklaşımı"dir. Elde edilen verileri değerlendirmek için bazı yaklaşımlar vardır. 6306 sayılı kanunda öngörülen yöntem bu yöntemlerden biridir. Bu araştırmada binalar bu yöntemle hesaplanmıştır. Yıkılma veya ağır hasar görme riski olan bir bina, riskli bina olarak tanımlanır. Riskli yapıların tespitinde uygulanacak kurallar bu esaslarda belirtilir. Deprem güvenliğini belirlemeye yönelik bu yöntem, "Güney ÖZCEBE" tarafından bir TÜBİTAK (Türkiye Bilimsel ve Teknik Araştırma Kurumu) projesi kapsamında geliştirilmiştir (Özcebe vd., 2000).

Yöntemde kullanılan parametreler olarak; kat sayısı, ağır çıkıntı, yapı düzeni/darbe etkisi, kısa kolon, yumuşak kat, görünen kalite, düşey düzensizlik, yatay düzensizlik, tepe/eğim etkisi ve zemin ele alınır. Bu yöntem, binaların içine girmeden dışarıdan gözlemlenebilen kriterler ile binaları deprem riski açısından öncelik sıralamasını belirlemeyi ve riskli kabul edilen bina sayısını ve şehir içindeki dağılımını tahmin etmeyi amaçlamaktadır (Grant vd., 2007). Bu tez kapsamında yapılan çalışma 6306 sayılı yasa kapsamındaki düzenlemeler ile sokak tarama yöntemi seçilerek, binaların sokak tarama yönteminde kullanılan parametrelere göre değerlendirilmesini, riskli yapıların EPA programı kullanılarak belirlenmesini, haritalanmasını kapsamaktadır. Ayrıca deprem konseyinin 2004'te dahil ettiği ve parametreleri belirttiği Sokak tarama yönteminde kullanılan betonarme yapılardan veri toplamada ise kat sayısı, yapısal sistem tipi, görsel kalite, yumuşak kat / zayıf zemin, kısa kolon, darbe etkisi, ağır projeksiyon, zemin tipi, düşey düzensizlik, yatay düzensizlik (planda düzensizlik), tepe/eğim etkisi, tasarım spektral ivme katsayısı, coğrafi koordinatlar, binanın tahmini yaşı gibi parametreler kullanılarak yapılmaktadır.

EPA sismik performans analiz programı (Muvafık ve Özdemir, 2019), Muvafık ve Özdemir tarafından oluşturulmuş olup, Özcebe ve diğerleri tarafından geliştirilen yöntemi kullanarak, binaların verilerini değerlendirip binaların muhtemel performanslarını hesaplamak için tasarlanmış bir bilgisayar programı olarak literatüre girmiştir. Bu programda veriler her bina koordinatıyla birlikte programa girilir.

Binaların verilerine göre aşağıdaki parametreler programa girilir.

- Düşey düzensizlik,

- Planda düzensizlik,
- Kısa kolon,
- Tepe yamaç etkisi,
- Ağır çıkma.
- Yapısal sistem türü,
- Bina görseli,
- Yumuşak kat,
- Yapı Nizamı,

Programın avantajları:

- Bu program verileri değerlendirir ve sonuçları, binalar hakkında girilen tüm bilgilerle birlikte Excel formatında bir dosyaya aktarabilir.
- Renklerle gösterilen aralıklar, sonucun daha net anlaşılmasını sağlar.
- Program, güvenli ve güvensiz binaların yerini belirtmek için binaları harita üzerinde gösterir.

Veri toplama:

- Bilinmesi gereken ilk şey, bölgenin zemin tipi ve (Sds) deprem bölgesini belirlemektir.

SD1= 0,2933

Toprak tipi DZ

Ss = 0,6293

Sokak tarama yönteminde deprem risk analizi belirlemede en önemli faktörlerden biri olan zemin tipi, zemin tipi tablosunda olduğu gibi (A, B, C, D, E) sınıflarında ele alınmaktadır.

- Binalar için veri toplamada bir diğer önemli nokta, yapısal bina sistemine bakmaktır. Çünkü karkas bina ile yığma bina bazı farklı parametrelere sahiptir:

1. Betonarme Binalar
2. Yığma Binalar

Betonarme ve yığma binaları değerlendirmesi:

$PP = TP + \mathrm{N}i \ast \mathrm{N}Pi + YSP$

(PP) = Performans puanı

(TP) = Taban puanı

(Ni)= Olumsuzluk parametresi

(NPi)= Olumsuzluk parametresi puan

(YSP) =Yapısal sistem puanı

Bu tez, bu alandaki binaların durumunu ve etkinliğini gösteren ve bu yönteme göre deprem anında bina performansını etkileyen faktörleri belirleyen bir değerlendirme içermektedir.

Aynı zamanda, çalışmada kullanılan yöntemdeki parametreler, yeni binalarda depreme karşı dirençli bir binaya sahip olmak için bu parametrelerden hangilerinin arttırılması hangilerinin ise azaltılması gerektiğini ortaya koyabilmektedir.

Çalışma yapılan bölgedeki mevcut binalar neredeyse 40 yıllık olmakla birlikte özellikle ticari amaçla yapılan yeni binalar da bulunmaktadır.

Yapı parametrelerine göre çerçeve bina güvenliği puan aralıkları;

0> Yüksek derecede tehlikeli bina,

0-50 orta derecede tehlikeli bina,

50-150 orta derecede güvenli bina,

>150 çok güvenli bina

şeklinde öngörülmektedir. Buna karşın yığma bina güvenlik aralığı puanı

<70 Orta derecede tehlikeli bina,

70-100 Orta derecede güvenli bina,

>100 Çok güvenli bina

olarak dikkate alınmaktadır.

Bu güvenlik aralıkları, istatistiki çalışmalara dayandırılarak araştırmacıların değerlendirilmesine dayanarak belirlenmiştir. Yine bu aralık belirlenme işlemi, negatif parametre miktarı ve negatif parametrenin çok ağır olup olmamasına dayanmaktadır. Ayrıca güvenlik aralıkları, binaların görsel kalitesinin iyi olup olmasına da bağlı olarak değişmektedir.

Bu bağlamda binalardaki parametreler baz alındığında binaların %8'i orta derece denilebilecek bir tehlike aralığında yer alırken, %88'i orta derecede güvenli %4'ü ise çok güvenli bina denilebilecek bir parametre aralığında ele alınmıştır. Değerlendirilen binaların taşıyıcı sistemlerinin %11'i çerçeve binalar, %89'u yığmadır.

Bu parametreler, bina türlerine bağlı olarak; incelenen binaların %30'u yumuşak zemine sahip, %70'i yumuşak katı olmayan şeklinde değerlendirmiştir. Yine binaların görsel kalitesi % 47 iyi olarak değerlendirilirken, %43 orta %10 iyi olmayan yani kötü olarak değerlendirilmiştir. Bu değerlendirme, kat sayısı 1 ile 5 arasında olan binalar için geçerlidir.

Bu araştırmaların, diğer bölgelerdeki, genel olarak inşa edildikleri eski binalardaki tahmini yapılar için referans olarak alınması önemlidir. Ayrıca bu araştırmanın, bina performansını etkileyen parametrelerin öğrenilmesi ve gelecekteki binalarda oluşmasının önlenmesi açısından faydalı olacağı ve Irak'ta yapı malzemeleri ve yapıları için daha uygun tahmin yöntemlerinin elde edilmesi için Irak'ta daha fazla araştırma yapılmasının da önemli olduğunu değerlendirilmektedir.

Bu çalışma birinci aşama değerlendirme yöntemiyle Süleymaniye'de yapılan ilk saha çalışması olması nedeniyle literatürdeki önemli bir boşluğu dolduracağı umulmaktadır. Süleymaniye kentindeki yapıların değerlendirilmesi için bir başlangıç olabileceği umulmaktadır.

Üniversiteler, İnşaat Mühendisleri, yüksek lisans tezleri, doktora tezleri ve çeşitli projeler aracılığıyla kent genelinde bu tür çalışmaların kapsamlı bir incelemesinin yapılması ve bu konuda yapılacak çalışmalara bir ön ayak olması, bu çalışmanın en büyük hedeflerindendir.

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VAN YÜZÜNCÜ YIL UNIVERSITY
THE INSTITUTE OF NATURAL AND APPLIED SCIENCES
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