SEISMIC RISK MAPPING OF URBAN SECTORS OF ISLAMABAD

Final Year Project- UG Batch 2019

NUST Institute of Civil Engineering (NICE)

School of Civil and Environmental Engineering (SCEE)

National University of Sciences and Technology Islamabad, Pakistan

Submitted by: | **ADVISOR:**

Jan Muhammad | Lec. Arsalan Mushtaq

Ahmed Ali

Syeda Rafia Bukhari

Muhammad Tayyab

This is to certify that

Final year project

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Submitted by

Jan Muhammad	304084
Ahmed Ali	284204
Syeda Rafia Bukhari	308867
Muhammad Tayyab	288644

Has been accepted towards the requirements.

for the undergraduate degree in

Civil engineering.

____

Engr. Arsalan Mushtaq

Lecturer (Structural Engineering)

NUST Institute of Civil Engineering (NICE)

NUST, H-12, Islamabad, Pakistan

Acknowledgement

The completion of our project is solely due to the vision and guidance of our Supervisor Lecturer Arsalan Mushtaq. His utmost efforts and guidance enabled us to develop a deep understanding of not only our project but also its associated topics too. His friendly guidance and continuous encouragement enabled us to envision beyond the horizon and strive harder than ever to develop an understanding of our topic.

Our efforts towards a seismic field are also due to the 80,000 people that lost their lives in the deadly Earthquake of 05th-Oct-2005. Their lives have changed our views and enabled us to understand the importance of Seismic safety of our structures. These efforts will remain continued, and we have tried to play our part at our level in it.

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ABSTRACT:

Pakistan is seismic hazardous zone and most of our buildings were built before the BCP-2007 which is why we need a vulnerability assessment of different regions so that we prepare from any upcoming earthquake. For our vulnerability assessment we selected zone 1 of Islamabad. Individual analysis of each building is quite a long process, so we need to screen out some buildings which seems potentially hazardous and need detailed analysis for further vulnerability assessment, that's why we used an empirical technique called Rapid Visual Screening of FEMA-154 in which we identify buildings which needs detail analysis. We performed this technique on the commercial buildings of F, I sector of Islamabad. We evaluated a total of 253 buildings. As a result, we have screened out 5 buildings which are highly vulnerable according to our assessment and need a detailed analysis.

Chapter 1: INTRODUCTION

1. Seismicity in Pakistan:

Pakistan, due to the continuous subduction of the Indian plate beneath the Eurasian plate, is recognized as one of the world's most seismically active regions. Over the past fifty years, the Pakistan Meteorological Department (PMD) has recorded 58 earthquakes of considerable magnitude, which have inflicted significant damage on both lives and the economy. Some of the major earthquakes are:

1. Balochistan (Harnai Earthquake (2021)
2. Kashmir earthquake 2005
3. Awaran earthquake 2013
4. Mirpur Azad Kashmir (2019)

The Kashmir earthquake that occurred in 2005 caused a devastating impact, resulting in approximately 73,000 fatalities, 80,000 injuries, and leaving around 2.8 million people homeless. The estimated total losses due to this calamity were around US$ 5198 million. The reasons behind this massive loss were the lack of awareness and the failure to adhere to building codes. It is evident that our level of preparedness to face such natural disasters is inadequate.

We simply aren't prepared. These losses are also due to inefficient policies and ineffective implementation of effective policies. It is a result of the massive loss of infrastructure and people. Seismic vulnerability assessments are required in seismically prone districts throughout Pakistan's history.

Typically, Pakistani structures are built without following building designs and are either semi-engineered or non-engineered. According to surveys, 90% of the buildings in Pakistan are non-engineered masonry. Furthermore, relatively little study on these nonengineered buildings is being undertaken. These non-engineered structures fare well against gravity stresses but fail to withstand lateral loads. As a result, it's vital to examine the susceptibility of such buildings in high-risk earthquake zones.

Earthquakes are potentially dangerous events and when they occur the results are catastrophic. From recent earthquakes is quite evident we have very poor seismic designed buildings, and we need vulnerability assessment so we can prepare for future earthquakes. The Rapid Visual Screening method RVS was developed to identify and screen potentially seismic vulnerable buildings.it is a very fast and less expensive method to screen out potentially hazardous buildings. Once those buildings are identified we can perform detailed analysis and retrofit them if needed so they don’t collapse during an earthquake.

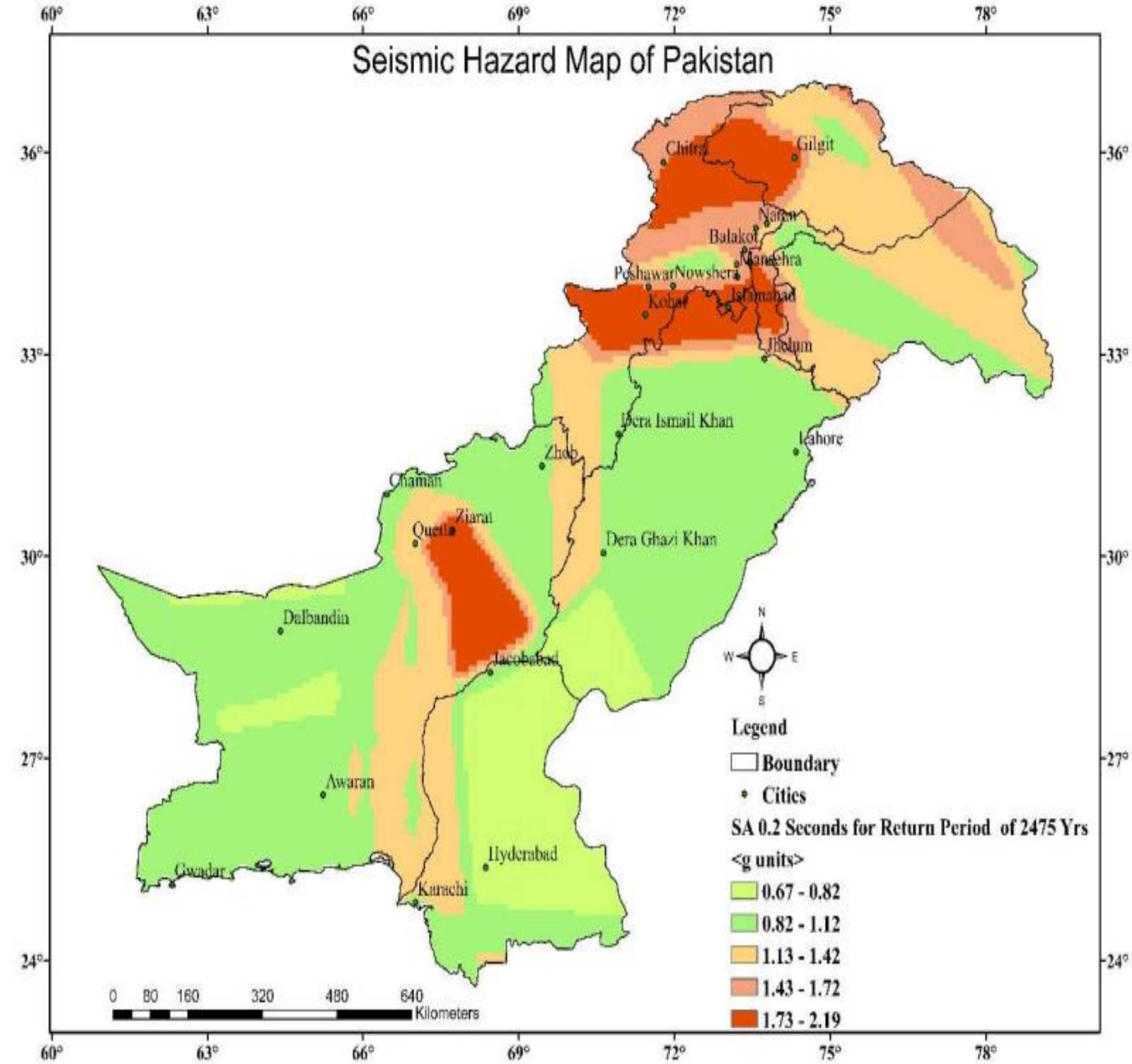


Figure 16: Mean spectral acceleration (0.2 s) map for 2 % or probability of exceedance in 50 years

1.1 SEISMIC HAZARD ASSESSMENTS:

Seismic hazard assessment is a type of assessment done to predict economic loss and infrastructure damage in case of an earthquake.

1.2 Types Of Seismic Assessment:

1. Seismic Hazard Assessment:

   Seismic hazard assessment is the process of evaluating the potential for earthquakes to occur in a particular region and estimating the potential damage that could result from these earthquakes region and estimating the potential damage that could result from these earthquakes.

2. Seismic Vulnerability Assessment:

   Seismic vulnerability assessment is the process of evaluating the susceptibility of buildings, structures, and infrastructure to damage or collapse during an earthquake. The purpose of seismic vulnerability assessment is to identify weaknesses and deficiencies in the built environment that could pose a risk to human life or property in the event of an earthquake.

We used RAPID VISUAL SCREENING in our project.

1.3 RAPID VISUAL SCREENING:

This method was proposed in the USA by the FEMA as "Rapid Visual Screening of Buildings for Potential Seismic Hazards".

In RVS we take different structural and non-structural details about the buildings. After the data is collected, we score each building according to the FEMA form. We use this score for assessing the building damage in case of seismic shocks.

1.4 Problem Statement:

With the advancement of technology Researchers have identified many hazards in Pakistan related to earthquake. There emphasizes the need for seismic vulnerability assessment of buildings in a selected area to identify those that may be at risk of damage or collapse during an earthquake. Islamabad is a seismically active zone, and no large-scale vulnerability assessment has been done, not even by the NDMA. There are many buildings which are potentially dangerous, and we need to identify them. So, we can improve or retrofit them, so we can prepare for any future earthquakes.

Chapter 2: LITERATURE REVIEW

1. Rapid visual screening is a speedy and basic methodology frequently utilized by scientists to gauge the seismic weakness of structures in a space. In this review, fundamental seismic weakness evaluation of 500 structures arranged at Northern and Eastern George Town, Malaysia, was completed by using a changed FEMA-154 (2002) technique that suits Malaysian circumstances. Information was gathered from online sources by means of Google Guides and Google Earth rather than customary reviewing information assortment through road screening. The seismic evaluation investigation of this review depended on the RVS execution score and the harm state order for each building typology. This approach creates, for each structure, a last presentation score considering overseeing boundaries like underlying opposing framework, level, primary abnormalities, building age, and soil type. The discoveries uncovered the prompt requirement for viable seismic relief procedures, as 90% of the concentrated-on structures expected a further definite investigations to pinpoint their careful seismic weakness execution. Most of the overviewed structures were anticipated to encounter moderate-to-significant harm, with 220 out of 500 being classed as harm state 2 (D2) and harm state 3 (D3). A GIS map, "RVS Malaysian Structure George Town Region", was created through ArcGIS and imparted to general society to give crucial data to additional examination (Kassem et al., 2021).

2. The seismic performance of schools is of high significance due to their extraordinary inhabitance and their role after any seismic event. Bangladesh is exceptionally helpless against earthquakes because it lies on the vicinity of tectonic plates and fault lines. Chittagong is a significant driving city and business capital of Bangladesh which is situated in the southeastern piece of the nation, falls in the moderate seismic zone as per Bangladesh building regulation (BNBC, 2015 draft) with a seismic zone coefficient of 0.28 g in view of 2% likelihood in 50 years. In this city most of the public schools were worked before execution of seismic code. Thusly, examining the seismic exhibition of existing structures in government elementary schools in Chittagong City is fundamental. In the current review, an underlying record of existing government grade school structures in Chittagong City Organization region has been created. The seismic weakness of these structures has been assessed by utilizing FEMA 154. The consequence of the review addresses that the all-out 107 structures of government elementary school in Chittagong City Enterprise are protected against earthquakes and 216 structures need detail assessment to determine the degree of damage (Mahmud et al., 2018).

3. Earthquakes have caused tremendous infrastructural harms alongside loss of lives in the new past. Persistent subduction of the Indian plate underneath the Eurasian plate has made Pakistan a seismically dynamic district on the planet. Malakand, situated in the Khyber Pakhtunkhwa Territory of Pakistan, is proclaimed at high seismic risk by the National Disaster Management Authority of Pakistan, calling for a seismic vulnerability evaluation study for its current structures. Vulnerability evaluation of a delegate test of various structure use-types was done utilizing the fast visual screening (RVS) system of FEMA P-154. The example size was determined in light of Yamane recipe. RVS sheets are utilized to compute underlying scores, and possible seismic harm is portrayed as an element grades of European Full scale Seismic Scale. Of the structures examined, it was seen that close to half of the structures fall in harm grade 4 and 5, suggesting areas of strength for an of weighty underlying and non-primary harms on account of future seismic event. Government school structures were viewed as less defenseless than private partners. Most of the business structures were not developed by building regulation, making them exceptionally vulnerable to harm. In view of the consequences of vulnerability assessment of building structures, the article suggests execution of construction laws which can prompt a reduction in infrastructural harms and financial misfortunes following a future seismic event (Khan et al., 2019).

CHAPTER 3: METHODOLOGY

We will use Rapid Visual screening (RVS) which is a well-known and most empirical technique.

3.1 Introduction to RVS

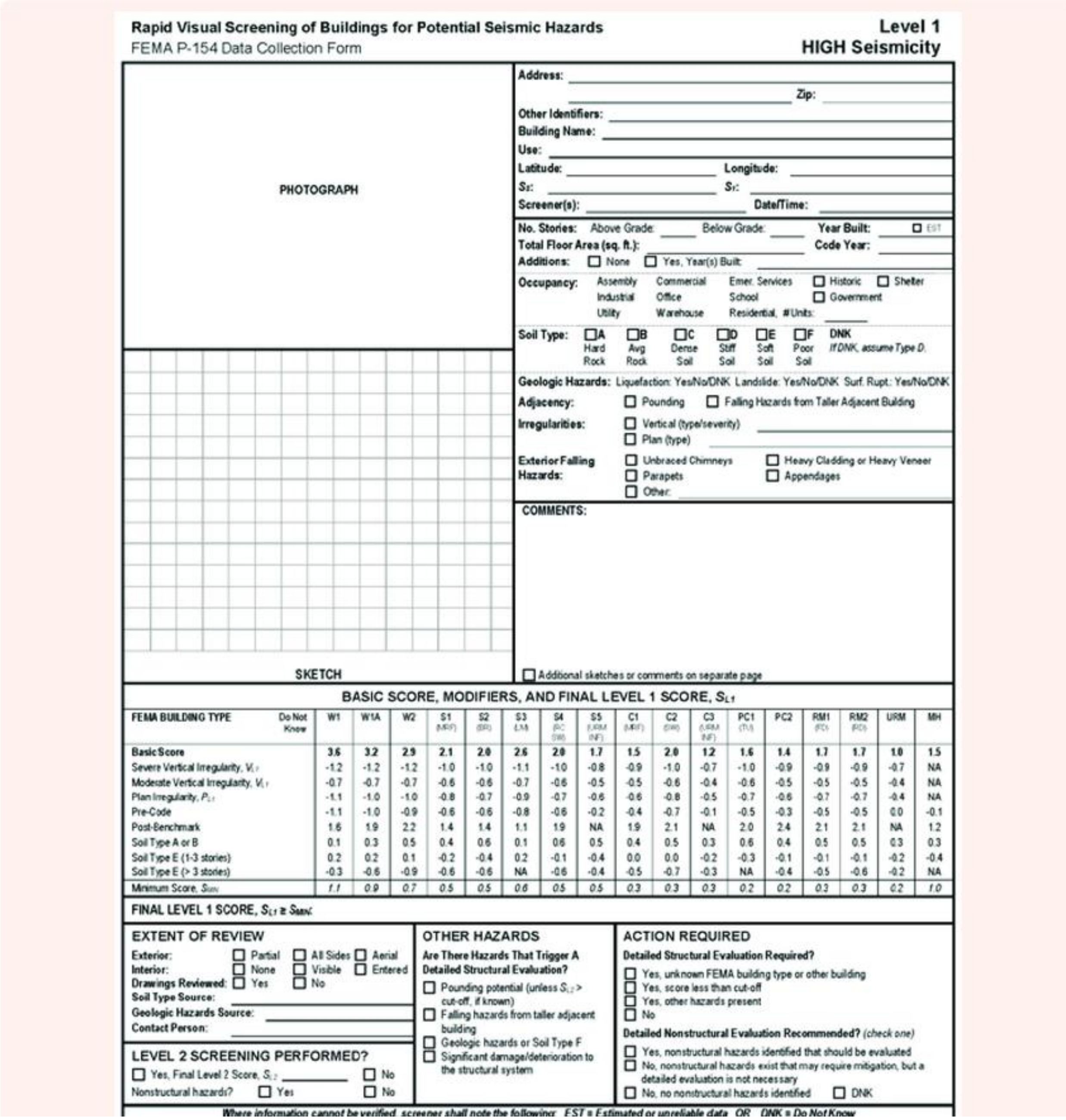
Rapid visual screening (RVS) is advanced technology to find, list, and display buildings that may be potentially dangerous during a seismic activity. The RVS technique is a methodology that is entirely based on a sidewalk survey of a building based entirely on observations of the building's exterior and, if possible, interior. The person doing the survey fills out a Data Collection Form on the building. There are different ways for screening, including the ones listed below:

I. *FEMA P-154 (USA)*
II. *EMS (98) (Europe)*
III. *IITK – GGSDMA (Indian)*
IV. *EMPI (Turkish)*

We will be using *FEMA P-154 (USA)* as it is a detailed form which covers various characteristics of a building.

3.2 FEMA P-154 (USA) form:

Below figure shows the characteristics of the FEMA form.



Rapid Visual Screening of Buildings for Potential Seismic Hazards — **Level 1**
FEMA P-154 Data Collection Form — **HIGH Seismicity**

PHOTOGRAPH

Address:
Zip:
Other Identifiers:
Building Name:
Use:
Latitude: **Longitude:**
S_S: S_1:
Screener(s): **Date/Time:**

No. Stories: Above Grade: Below Grade: **Year Built:** ☐ EST
Total Floor Area (sq. ft.): **Code Year:**
Additions: ☐ None ☐ Yes, Year(s) Built:
Occupancy: Assembly, Commercial, Emer. Services, ☐ Historic, ☐ Shelter, Industrial, Office, School, ☐ Government, Utility, Warehouse, Residential, #Units:
Soil Type: ☐A Hard Rock ☐B Avg Rock ☐C Dense Soil ☐D Stiff Soil ☐E Soft Soil ☐F Poor Soil DNK *If DNK, assume Type D.*
Geologic Hazards: Liquefaction: Yes/No/DNK Landslide: Yes/No/DNK Surf. Rupt.: Yes/No/DNK
Adjacency: ☐ Pounding ☐ Falling Hazards from Taller Adjacent Building
Irregularities: ☐ Vertical (type/severity) ☐ Plan (type)
Exterior Falling Hazards: ☐ Unbraced Chimneys ☐ Heavy Cladding or Heavy Veneer ☐ Parapets ☐ Appendages ☐ Other:

COMMENTS:

SKETCH

☐ Additional sketches or comments on separate page

BASIC SCORE, MODIFIERS, AND FINAL LEVEL 1 SCORE, S_{L1}

FEMA BUILDING TYPE	Do Not Know	W1	W1A	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM	MH
Basic Score		**3.6**	**3.2**	**2.9**	**2.1**	**2.0**	**2.6**	**2.0**	**1.7**	**1.5**	**2.0**	**1.2**	**1.6**	**1.4**	**1.7**	**1.7**	**1.0**	**1.5**
Severe Vertical Irregularity, V_{L1}		-1.2	-1.2	-1.2	-1.0	-1.0	-1.1	-1.0	-0.8	-0.9	-1.0	-0.7	-1.0	-0.9	-0.9	-0.9	-0.7	NA
Moderate Vertical Irregularity, V_{L1}		-0.7	-0.7	-0.7	-0.6	-0.6	-0.7	-0.6	-0.5	-0.5	-0.6	-0.4	-0.6	-0.5	-0.5	-0.5	-0.4	NA
Plan Irregularity, P_{L1}		-1.1	-1.0	-1.0	-0.8	-0.7	-0.9	-0.7	-0.6	-0.6	-0.8	-0.5	-0.7	-0.6	-0.7	-0.7	-0.4	NA
Pre-Code		-1.1	-1.0	-0.9	-0.6	-0.6	-0.8	-0.6	-0.2	-0.4	-0.7	-0.1	-0.5	-0.3	-0.5	-0.5	0.0	-0.1
Post-Benchmark		1.6	1.9	2.2	1.4	1.4	1.1	1.9	NA	1.9	2.1	NA	2.0	2.4	2.1	2.1	NA	1.2
Soil Type A or B		0.1	0.3	0.5	0.4	0.6	0.1	0.6	0.5	0.4	0.5	0.3	0.6	0.4	0.5	0.5	0.3	0.3
Soil Type E (1-3 stories)		0.2	0.2	0.1	-0.2	-0.4	0.2	-0.1	-0.4	0.0	0.0	-0.2	-0.3	-0.1	-0.1	-0.1	-0.2	-0.4
Soil Type E (> 3 stories)		-0.3	-0.6	-0.9	-0.6	-0.6	NA	-0.6	-0.4	-0.5	-0.7	-0.3	NA	-0.4	-0.5	-0.6	-0.2	NA
Minimum Score, S_{MIN}		*1.1*	*0.9*	*0.7*	*0.5*	*0.5*	*0.6*	*0.5*	*0.5*	*0.3*	*0.3*	*0.3*	*0.2*	*0.2*	*0.3*	*0.3*	*0.2*	*1.0*

FINAL LEVEL 1 SCORE, $S_{L1} \geq S_{MIN}$:

EXTENT OF REVIEW
Exterior: ☐ Partial ☐ All Sides ☐ Aerial
Interior: ☐ None ☐ Visible ☐ Entered
Drawings Reviewed: ☐ Yes ☐ No
Soil Type Source:
Geologic Hazards Source:
Contact Person:

LEVEL 2 SCREENING PERFORMED?
☐ Yes, Final Level 2 Score, S_{L2} ______ ☐ No
Nonstructural hazards? ☐ Yes ☐ No

OTHER HAZARDS
Are There Hazards That Trigger A Detailed Structural Evaluation?
☐ Pounding potential (unless S_{L2} > cut-off, if known)
☐ Falling hazards from taller adjacent building
☐ Geologic hazards or Soil Type F
☐ Significant damage/deterioration to the structural system

ACTION REQUIRED
Detailed Structural Evaluation Required?
☐ Yes, unknown FEMA building type or other building
☐ Yes, score less than cut-off
☐ Yes, other hazards present
☐ No
Detailed Nonstructural Evaluation Recommended? *(check one)*
☐ Yes, nonstructural hazards identified that should be evaluated
☐ No, nonstructural hazards exist that may require mitigation, but a detailed evaluation is not necessary
☐ No, no nonstructural hazards identified ☐ DNK

Where information cannot be verified, screener shall note the following: EST = Estimated or unreliable data OR DNK = Do Not Know

Different parts of the form are discussed below:

3.3 Site Identification Information:

Complete address, location and other following attributes are filled in this section.

Address: ______________________________

______________________ Zip: __________

Other Identifiers: ______________________________

Building Name: ______________________________

Use: ______________________________

Latitude: ______________ Longitude: ______________

S_S: ______________ S_1: ______________

Screener(s): ______________ Date/Time: ______________

3.4 Site Characteristics:

Following site characteristics are filled in the below section.

No. Stories: Above Grade: _____ Below Grade: _____ Year Built: _____ ☐

Total Floor Area (sq. ft.): ______________ Code Year: _____

Additions: ☐ None ☐ Yes, Year(s) Built: ______________

3.4.1 Number of Stories:

In this section both below and above ground numbers of stories are written. Different numbers of stories indicate the peak of the site.

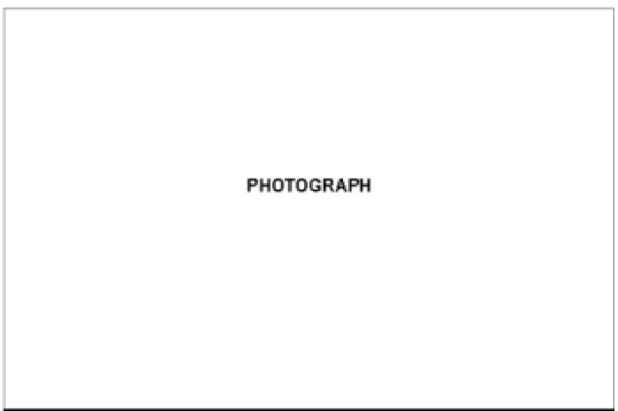
3.4.2 Year Built and Code Year:

It can be asked from the owner and if no data source is available, it can be estimated using architectural pattern. As in different ages, different patterns were used. It can also be estimated with respect to adjacent buildings.

3.4.3 Total Floor Area:

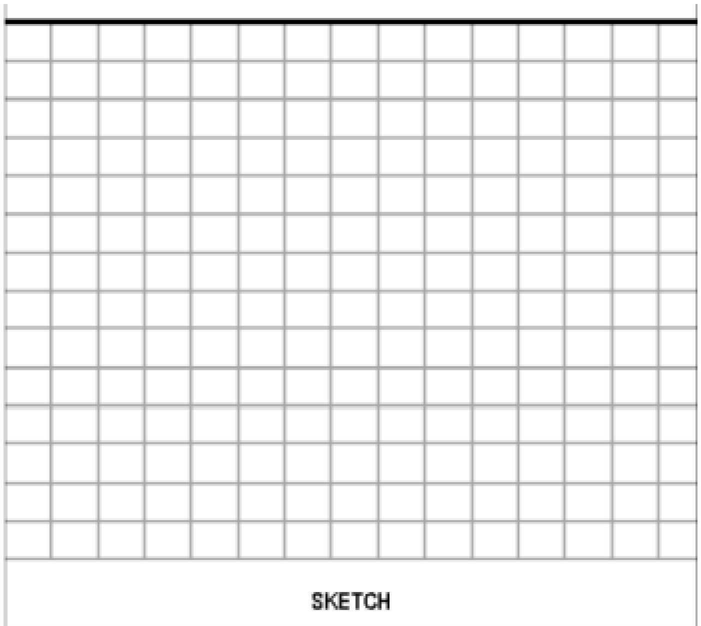
It can be calculated by multiplying width and length (this can also be measured from GIS data i.e., google earth). It can be used for occupancy load estimating.

3.5 Photographing the Site:



At least one photo of the building must be added here. Photo should be taken from the angle showing most of the details. Multiple photos can be taken from different angles to get more details.

3.6 Sketching the Site:



The elevation and plan view are sketched here. It should show numbers of columns, beams, building height, bay length and other important attributes.

3.7 Site Occupancy:

Site occupancy delineates its use. It is no longer valuable as structural system is more important.

3.7.1 Occupancy classes:

Following types of occupancy can be marked here and any other type can be written.

Occupancy:	Assembly	Commercial	Emer. Services	☐ Historic	☐ Shelter
	Industrial	Office	School	☐ Government	
	Utility	Warehouse	Residential, # Units: ________		

3.8 Soil Type:

The soil type of the foundation soil is determined and ticked in the below box. Where soil type is difficult to determine or unknown, soil type D can be taken.

Soil Type:	☐A Hard Rock	☐B Avg Rock	☐C Dense Soil	☐D Stiff Soil	☐E Soft Soil	☐F Poor Soil	DNK *If DNK, assume Type D.*

3.9 Geological Hazards:

For any of the following hazards, if found, the building needs detailed evaluation.

Geologic Hazards: Liquefaction: Yes/No/DNK Landslide: Yes/No/DNK Surf. Rupt.: Yes/No/DNK

3.10 Adjacency:

Adjacency: ☐ Pounding ☐ Falling Hazards from Taller Adjacent Building

If buildings are very close to each other, pounding affect can occur. Pounding mean collision of buildings in case of seismic activity/vibrations. A minimum gap of 2 inches per story must be provided to avoid this effect. If adjacent building is taller, it can fall over it in case of seismic activity, so this effect is also considered.

3.11 Irregularities:

Multiple types of irregularities can be found in buildings due to structural or architectural designs.

Irregularities: ☐ Vertical (type/severity) ______
☐ Plan (type) ______

3.11.1 Vertical Irregularities:

Vertical irregularities have a major effect in the case of seismic activity. The following types of vertical irregularities can be found in buildings.

1) Setbacks
    i) Out of plan setback
    ii) In Plan set setback
2) Split levels
3) Short column
4) Weak story
5) Sloping site

3.11.2 Plane Irregularities:

The following types of plane irregularities can be found in buildings.

1) Non-parallel systems (i.e., U-shaped buildings)
2) Diaphragm Openings
3) Reentrant Corner
4) Beams do not align with columns.
5) Torsion

3.12 Exterior Falling Hazards:

Exterior Falling Hazards:	☐ Unbraced Chimneys	☐ Heavy Cladding or Heavy Veneer
	☐ Parapets	☐ Appendages
	☐ Other: ______	

These can fall over the building and help in damage in case of earthquake activity, so their effect is also considered and marked here.

3.13 Identifying the FEMA Site Type:

Structural system of the building is configured out in this section. Usually, buildings structures are:

- Timber
- Steel
- Concrete
- Masonry

These structures are further classified according to force resisting system. It can be:

- Framed structure
- Braced frame structure
- Bearing wall

FEMA BUILDING TYPE	Do Not Know	W1	W1A	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM	MH

Legend: MRF = Moment-resisting frame, BR = Braced frame; RC = Reinforced concrete, SW = Shear wall; URM INF = Unreinforced masonry infill, TU = Tilt up; MH = Manufactured Housing, LM = Light metal; FD = Flexible diaphragm, RD = Rigid diaphragm

So, these are the building types, where

W is for Wood structures

S is for steel structures

C for reinforced concrete structures

In our research, our sample data was mostly consisting of C3 buildings (Moment Resisting frame structures with infilled masonry walls).

3.14. Score Modifiers:

Once we are done with the first half of the form, now we can calculate the FEMA score of buildings. There are basic scores which are assigned according to basic structure of buildings and then there are score modifiers which reduce those scores. Following are the modifiers:

BASIC SCORE, MODIFIERS, AND FINAL LEVEL 1 SCORE, S_{L1}

FEMA BUILDING TYPE	Do Not Know	W1	W1A	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM	MH
Basic Score		**3.6**	**3.2**	**2.9**	**2.1**	**2.0**	**2.6**	**2.0**	**1.7**	**1.5**	**2.0**	**1.2**	**1.6**	**1.4**	**1.7**	**1.7**	**1.0**	**1.5**
Severe Vertical Irregularity, V_{L1}		-1.2	-1.2	-1.2	-1.0	-1.0	-1.1	-1.0	-0.8	-0.9	-1.0	-0.7	-1.0	-0.9	-0.9	-0.9	-0.7	NA
Moderate Vertical Irregularity, V_{L1}		-0.7	-0.7	-0.7	-0.6	-0.6	-0.7	-0.6	-0.5	-0.5	-0.6	-0.4	-0.6	-0.5	-0.5	-0.5	-0.4	NA
Plan Irregularity, P_{L1}		-1.1	-1.0	-1.0	-0.8	-0.7	-0.9	-0.7	-0.6	-0.6	-0.8	-0.5	-0.7	-0.6	-0.7	-0.7	-0.4	NA
Pre-Code		-1.1	-1.0	-0.9	-0.6	-0.6	-0.8	-0.6	-0.2	-0.4	-0.7	-0.1	-0.5	-0.3	-0.5	-0.5	0.0	-0.1
Post-Benchmark		1.6	1.9	2.2	1.4	1.4	1.1	1.9	NA	1.9	2.1	NA	2.0	2.4	2.1	2.1	NA	1.2
Soil Type A or B		0.1	0.3	0.5	0.4	0.6	0.1	0.6	0.5	0.4	0.5	0.3	0.6	0.4	0.5	0.5	0.3	0.3
Soil Type E (1-3 stories)		0.2	0.2	0.1	-0.2	-0.4	0.2	-0.1	-0.4	0.0	0.0	-0.2	-0.3	-0.1	-0.1	-0.1	-0.2	-0.4
Soil Type E (> 3 stories)		-0.3	-0.6	-0.9	-0.6	-0.6	NA	-0.6	-0.4	-0.5	-0.7	-0.3	NA	-0.4	-0.5	-0.6	-0.2	NA
Minimum Score, S_{MIN}		*1.1*	*0.9*	*0.7*	*0.5*	*0.5*	*0.6*	*0.5*	*0.5*	*0.3*	*0.3*	*0.3*	*0.2*	*0.2*	*0.3*	*0.3*	*0.2*	*1.0*

3.14.1 Final Score calculation SL1(Score Level 1):

Final Score of building is calculated after adding all the modifiers, which are usually negative, and they reduce the scores.

3.14.2 Minimum Score, SMIN:

If SL1 is less than S minimum, which is present in the last row of figure above. It is conservative approach and has disadvantages, as score shows less risk than the one present.

3.15 Documenting the Extent of Review:

Extent of review is documented in this section of the form. It shows, how detailed the building is evaluated.

EXTENT OF REVIEW

Exterior: ☐ Partial ☐ All Sides ☐ Aerial
Interior: ☐ None ☐ Visible ☐ Entered
Drawings Reviewed: ☐ Yes ☐ No
Soil Type Source: ____________
Geologic Hazards Source: ____________
Contact Person: ____________

3.16 Documenting the Level 2 Screening Results:

If detailed evaluation is required and done, we record those scores in the given section below.

LEVEL 2 SCREENING PERFORMED?

☐ Yes, Final Level 2 Score, S_{L2} ____________ ☐ No
Nonstructural hazards? ☐ Yes ☐ No

3.17 Documenting Other Hazards:

If any of the following hazard is identified, level 2 screening is required. Following is list of hazards which must be checked:

OTHER HAZARDS

Are There Hazards That Trigger A Detailed Structural Evaluation?

- ☐ Pounding potential (unless S_{L2} > cut-off, if known)
- ☐ Falling hazards from taller adjacent building
- ☐ Geologic hazards or Soil Type F
- ☐ Significant damage/deterioration to the structural system

3.18 Determining the Action Required:

This step is performed, to recommend the level 2 screening, if required.

ACTION REQUIRED

Detailed Structural Evaluation Required?

- ☐ Yes, unknown FEMA building type or other building
- ☐ Yes, score less than cut-off
- ☐ Yes, other hazards present
- ☐ No

Detailed Nonstructural Evaluation Recommended? *(check one)*

- ☐ Yes, nonstructural hazards identified that should be evaluated
- ☐ No, nonstructural hazards exist that may require mitigation, but a detailed evaluation is not necessary
- ☐ No, no nonstructural hazards identified ☐ DNK

3.18.1 Detailed Structural Evaluation:

We recommend whether the detailed structural evaluation is required or not. Following factors can be considered to identify this:

- If existing structure does not lie in any of the 17 FEMA types i.e., unknown site structural configuration, we may recommend level 2 screening for detailed structural evaluation.
- If scores are much less than the cut off score, mean building is more vulnerable and required detailed evaluation.
- If other hazards are present, discussed above, detailed evaluation is required.

- No is marked in any other case.

3.18.2 Detailed Non-Structural Evaluation:

In this section, we recommend whether detailed non-structural evaluation is required or not.

Yes, if nonstructural hazards are identified such as heavy cladding, parapet wall etc.

No, if there isn't any nonstructural hazard is found.

DKN, if we can't determine, if action is required or not.

3.19 Damage Grades

Rapid Visual Screening Score	Damage Potential
S < 0.3	High probability of Grade 5 damage; Very high probability of Grade 4 damage
0.3 < S < 0.7	High probability of Grade 4 damage; Very high probability of Grade 3 damage
0.7 < S < 2.0	High probability of Grade 3 damage; Very high probability of Grade 2 damage
2.0 < S < 2.5	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 2.5	Probability of Grade 1 damage

Through these FEMA scores we categorize the buildings in the following damage grades:

Classification of damage to masonry buildings	
	**Grade 1: Negligible to slight damage (no structural damage, slight non-structural damage)** Hair-line cracks in very few walls. Fall of small pieces of plaster only. Fall of loose stones from upper parts of buildings in very few cases.
	**Grade 2: Moderate damage (slight structural damage, moderate non-structural damage)** Cracks in many walls. Fall of fairly large pieces of plaster. Partial collapse of chimneys.
	**Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)** Large and extensive cracks in most walls. Roof tiles detach. Chimneys fracture at the roof line; failure of individual non-structural elements (partitions, gable walls).
	**Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)** Serious failure of walls; partial structural failure of roofs and floors.
	**Grade 5: Destruction (very heavy structural damage)** Total or near total collapse.

Chapter 4: EXECUTION

4 Execution:

We would visit the commercial sectors and take the data in following format:

- We would firstly note the coordinates of the building with the help of google earth.
- We would then measure the distance of the building in X and Y directions using the digital laser machine. After that we would measure the bay lengths and the column dimensions.
- We would also note the story heights.
- We would take pictures of the building.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STUDY ABROAD
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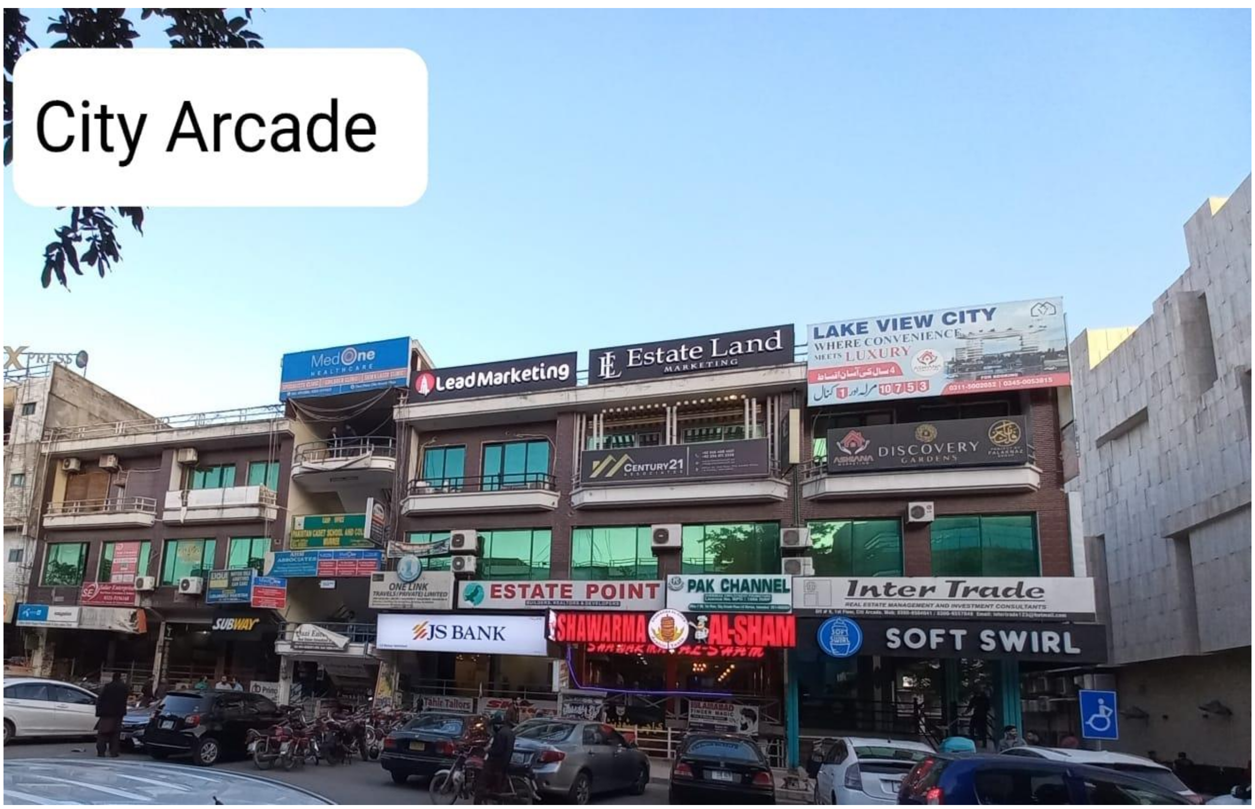
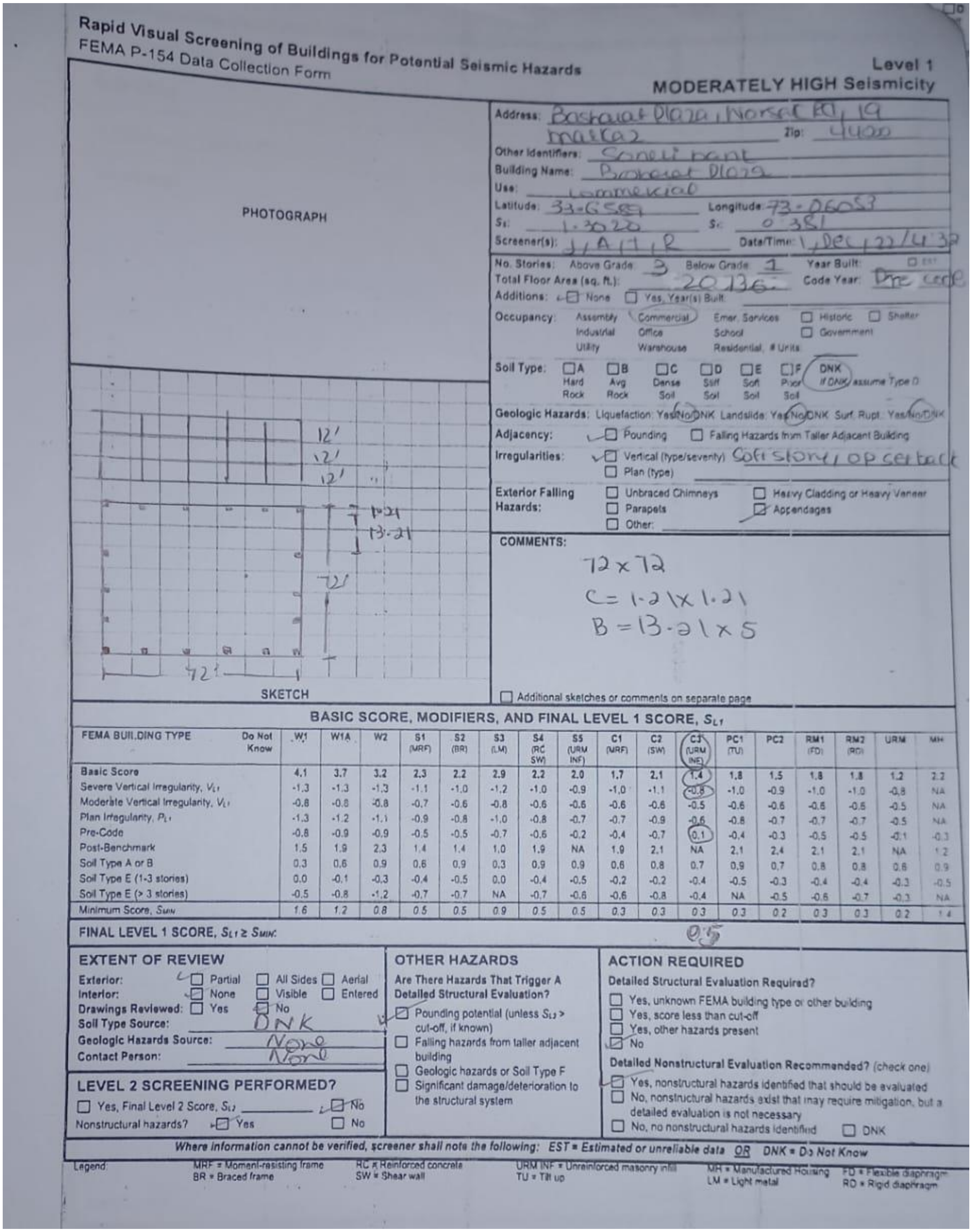

City Arcade
MedOne
Lead Marketing
Estate Land
LAKE VIEW CITY
WHERE CONVENIENCE MEETS LUXURY
DISCOVERY GARDENS
CENTURY 21
ESTATE POINT
PAK CHANNEL
Inter Trade
JS BANK
SHAWARMA AL-SHAM
SOFT SWIRL
SUBWAY

- We would note down the plan of the building.
- We look for any exterior hazards and note them down in the form
- We would then analyze the building and score the building according to the FEMA form.

Here is an example of a building and how we scored it

here is building named Basharat plaza located in I9 Markaz, we took all its details and filled it in such manner.



Rapid Visual Screening of Buildings for Potential Seismic Hazards
FEMA P-154 Data Collection Form

Level 1
MODERATELY HIGH Seismicity

PHOTOGRAPH

Address: Basharat Plaza, Norsat Rd, I9 markaz Zip: 4400
Other Identifiers: Sonali bank
Building Name: Basharat Plaza
Use: commercial
Latitude: 33.6589 Longitude: 73.06053
S_S: 1.3022 S_1: 0.381
Screener(s): J, A, H, R Date/Time: 1, Dec, 22 / 4:32

No. Stories: Above Grade: 3 Below Grade: 1 Year Built: ☐ EST
Total Floor Area (sq. ft.): 20736 Code Year: Pre code
Additions: ☑ None ☐ Yes, Year(s) Built:
Occupancy: Assembly, (Commercial), Emer. Services, ☐ Historic, ☐ Shelter, Industrial, Office, School, ☐ Government, Utility, Warehouse, Residential, # Units
Soil Type: ☐ A Hard Rock ☐ B Avg Rock ☐ C Dense Soil ☐ D Stiff Soil ☐ E Soft Soil ☐ F Poor Soil (DNK) If DNK, assume Type D
Geologic Hazards: Liquefaction: Yes/(No)/DNK Landslide: Yes/(No)/DNK Surf. Rupt.: Yes/(No)/DNK
Adjacency: ☑ Pounding ☐ Falling Hazards from Taller Adjacent Building
Irregularities: ☑ Vertical (type/severity) Soft story, op setback
☐ Plan (type)
Exterior Falling Hazards: ☐ Unbraced Chimneys ☐ Heavy Cladding or Heavy Veneer ☐ Parapets ☑ Appendages ☐ Other:

COMMENTS:
72 x 72
C = 1.21 x 1.21
B = 13.21 x 5

☐ Additional sketches or comments on separate page

SKETCH
12'
12'
12'
1.21
13.21
72'
72'

BASIC SCORE, MODIFIERS, AND FINAL LEVEL 1 SCORE, S_{L1}

FEMA BUILDING TYPE	Do Not Know	W1	W1A	W2	S1 (MRF)	S2 (BR)	S3 (LM)	S4 (RC SW)	S5 (URM INF)	C1 (MRF)	C2 (SW)	C3 (URM INF)	PC1 (TU)	PC2	RM1 (FD)	RM2 (RD)	URM	MH
Basic Score		4.1	3.7	3.2	2.3	2.2	2.9	2.2	2.0	1.7	2.1	1.4	1.8	1.5	1.8	1.8	1.2	2.2
Severe Vertical Irregularity, V_{L1}		-1.3	-1.3	-1.3	-1.1	-1.0	-1.2	-1.0	-0.9	-1.0	-1.1	-0.8	-1.0	-0.9	-1.0	-1.0	-0.8	NA
Moderate Vertical Irregularity, V_{L1}		-0.8	-0.8	-0.8	-0.7	-0.6	-0.8	-0.6	-0.6	-0.6	-0.6	-0.5	-0.6	-0.6	-0.6	-0.6	-0.5	NA
Plan Irregularity, P_{L1}		-1.3	-1.2	-1.1	-0.9	-0.8	-1.0	-0.8	-0.7	-0.7	-0.9	-0.6	-0.8	-0.7	-0.7	-0.7	-0.5	NA
Pre-Code		-0.8	-0.9	-0.9	-0.5	-0.5	-0.7	-0.6	-0.2	-0.4	-0.7	0.1	-0.4	-0.3	-0.5	-0.5	-0.1	-0.3
Post-Benchmark		1.5	1.9	2.3	1.4	1.4	1.0	1.9	NA	1.9	2.1	NA	2.1	2.4	2.1	2.1	NA	1.2
Soil Type A or B		0.3	0.6	0.9	0.6	0.9	0.3	0.9	0.9	0.6	0.8	0.7	0.9	0.7	0.8	0.8	0.6	0.9
Soil Type E (1-3 stories)		0.0	-0.1	-0.3	-0.4	-0.5	0.0	-0.4	-0.5	-0.2	-0.2	-0.4	-0.5	-0.3	-0.4	-0.4	-0.3	-0.5
Soil Type E (> 3 stories)		-0.5	-0.8	-1.2	-0.7	-0.7	NA	-0.7	-0.6	-0.6	-0.8	-0.4	NA	-0.5	-0.6	-0.7	-0.3	NA
Minimum Score, S_{MIN}		1.6	1.2	0.8	0.5	0.5	0.9	0.5	0.5	0.3	0.3	0.3	0.3	0.2	0.3	0.3	0.2	1.4

FINAL LEVEL 1 SCORE, $S_{L1} \geq S_{MIN}$: 0.5

EXTENT OF REVIEW
Exterior: ☑ Partial ☐ All Sides ☐ Aerial
Interior: ☑ None ☐ Visible ☐ Entered
Drawings Reviewed: ☐ Yes ☑ No
Soil Type Source: DNK
Geologic Hazards Source: None
Contact Person: None

LEVEL 2 SCREENING PERFORMED?
☐ Yes, Final Level 2 Score, S_{L2} ______ ☑ No
Nonstructural hazards? ☑ Yes ☐ No

OTHER HAZARDS
Are There Hazards That Trigger A Detailed Structural Evaluation?
☑ Pounding potential (unless S_{L2} > cut-off, if known)
☐ Falling hazards from taller adjacent building
☐ Geologic hazards or Soil Type F
☐ Significant damage/deterioration to the structural system

ACTION REQUIRED
Detailed Structural Evaluation Required?
☐ Yes, unknown FEMA building type or other building
☐ Yes, score less than cut-off
☐ Yes, other hazards present
☑ No
Detailed Nonstructural Evaluation Recommended? (check one)
☑ Yes, nonstructural hazards identified that should be evaluated
☐ No, nonstructural hazards exist that may require mitigation, but a detailed evaluation is not necessary
☐ No, no nonstructural hazards identified ☐ DNK

Where information cannot be verified, screener shall note the following: EST = Estimated or unreliable data OR DNK = Do Not Know

Legend: MRF = Moment-resisting frame; BR = Braced frame; RC = Reinforced concrete; SW = Shear wall; URM INF = Unreinforced masonry infill; TU = Tilt up; MH = Manufactured Housing; LM = Light metal; FD = Flexible diaphragm; RD = Rigid diaphragm

Chapter 5: RESULTS

This is how we have divided buildings into different damage grades from data collected.

F-6:

S No	Co-ordinates	Basic High score	High seismicity RVS	Damage Grade
1	33.6838730,72.9874820	1.3	1.5	2
2	33.6838290,72.9885270	0.9	1.1	3
3	2.6831730,72.987862	0.9	1.1	3
4	33.6832290,72.9875350	0.9	1.1	3
5	33.683077,72.9874820	0.9	1.1	3
6	33.6840970,72.9861970	1.3	1.5	2
7	33.684440,72.981110	0.9	1.1	3
8	33.6875030,72.9859320	0.9	1.1	3
9	33.6827340,72.9804570	0.9	1.1	3
10	33.6826100,72.9800010	1.3	1.5	2
11	33.682591,72.9799270	0.8	1	3
12	33.682135,72.9801950	0.8	1	3
13	33.683573,72.9761920	0.8	1	3
14	33.682404,72.980261	0.8	1	3
15	33.6825030,72.9801660	1.3	1.5	2
16	33.73057,73.077521	1.3	1.5	2
17	33.6847580,72.989048	1.4	1.6	2
18	33.6844060,72.9889560	1.4	1.6	2
19	33.6832870,72.9887420	1.4	1.6	2
20	33.6832450,72.9893580	1.4	1.6	2
21	33.6834210,729887920	0.8	1	3
22	33.6831890,72.9887000	0.8	1	3
23	33.682990,72.980193	0.8	1	3
24	33.6823930,72.9803860	1.4	1.6	2
25	33.682230,72.980521	1.4	1.6	2
26	33.682911,72.980698	1.4	1.6	2
27	33.6823930,72.980782	1.4	1.6	2
28	33.682523,72.980468	1.4	1.6	2

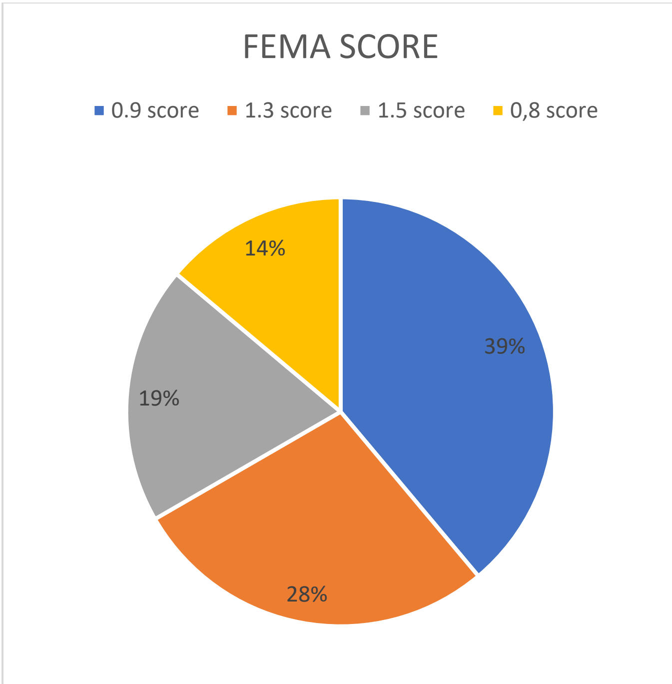


Figure 1.a

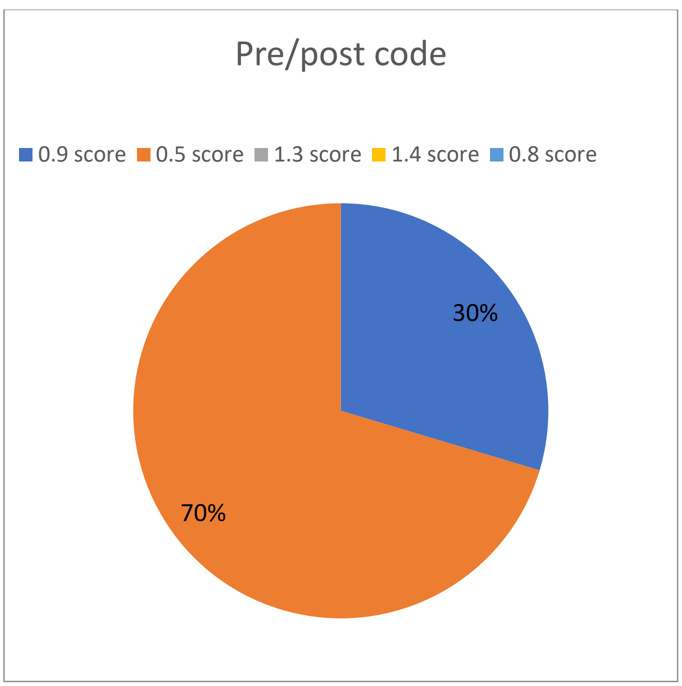


Figure 1.b

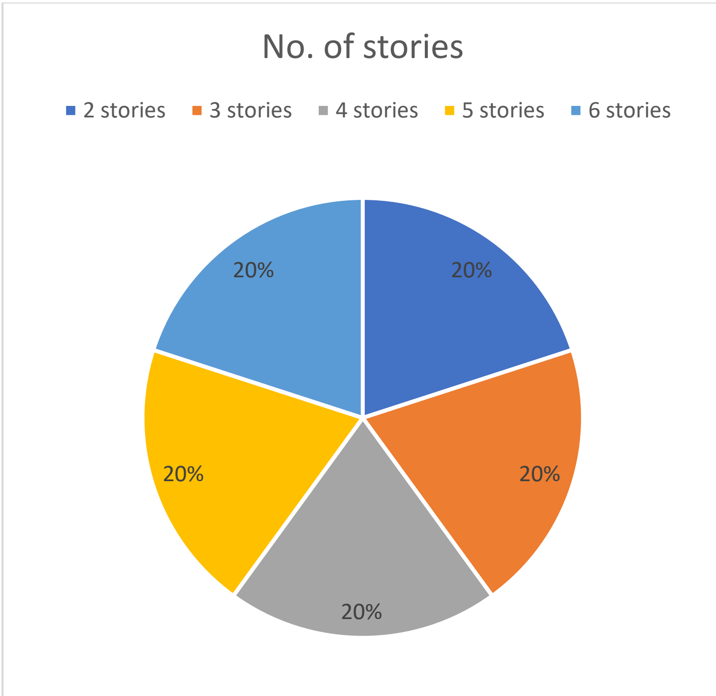

No. of stories
2 stories
3 stories
4 stories
5 stories
6 stories
20%
20%
20%
20%
20%

Figure 1.c

F-7:

S.No	Co-ordinates	Basic High score	High Seismicity RVS	Damage Grade
1	33.722081,73.058172	0.8	1	3
2	33.722097,73.058145	0.8	1	3
4	33.721246,73.058114	1.3	1.5	2
4	33.721017,73.056473	0.8	1	3
5	33.720748,73.056409	0.8	1	3
6	3.72085,73.056254	0.8	1	3
7	33.720344,73.057269	0.9	1.1	3
8	33.72065,73.053461	1.5	1.7	2
9	33.720344,73.053461	1.3	1.5	2
10	33.71945,73.05376	0.9	1.1	3
11	33.719866,73.05532	0.9	1.1	3
12	33.71948,73.05563	1.3	1.5	2
13	33.719488,73.055411	1.3	1.5	2
14	33.71872,73.05353	0.9	1.1	3
15	33.71828,73.0533	1.3	1.5	2
16	33.71947,73.05288	0.9	1.1	3
17	33.71947,73.05288	0.9	1.1	3
18	33.717769,73.055419	1.3	1.5	2
19	33.71975,73.05833	1.3	1.5	2
20	33.71932,73.05357	1.3	1.5	2
21	33.719436,73.053603	1.3	1.5	2
22	33.719184,73.050413	1.3	1.5	2
23	33.719375,73.054523	0.9	1.1	3
24	33.71923,73.5472	0.9	1.1	3
25	33.72181,73.06003	0.9	1.1	3
26	33.722,73.05989	1.5	1.7	2
27	33.72228,73.05983	0.9	1.1	3
28	33.72333,73.0598	1.5	1.7	2
29	33.72284,73.0593	1.5	1.7	2
30	33.72273,73.0591	0.9	1.1	3
31	33.72258,73.05887	0.9	1.1	3
32	33.72248,73.05864	0.9	1.1	3
33	33.72209,73.05896	0.9	1.1	3
34	33.72174,73.05887	1.5	1.7	2
35	33.72214,73.05924	1.5	1.7	2
36	33.72137,73.05905	1.5	1.7	2

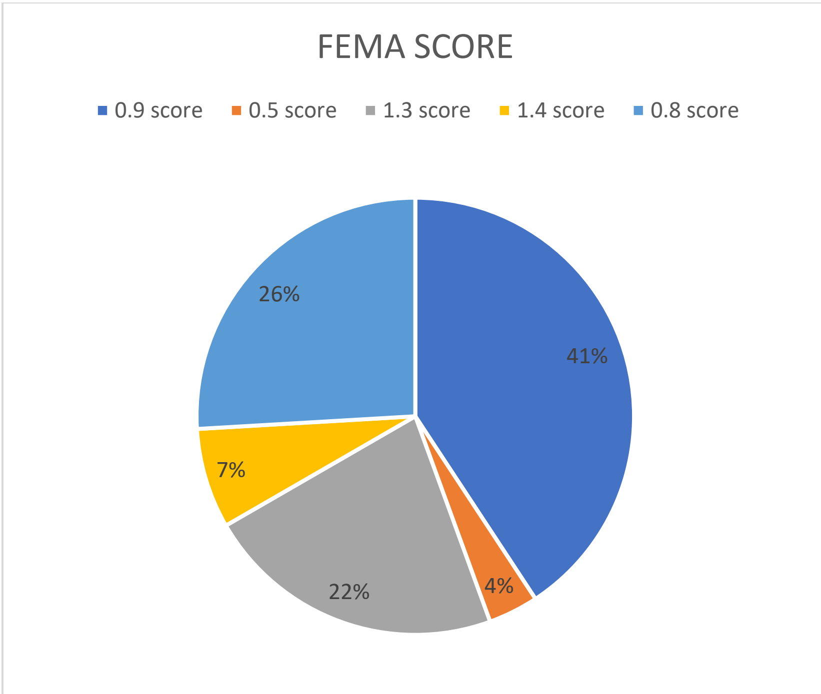


Figure 2.a

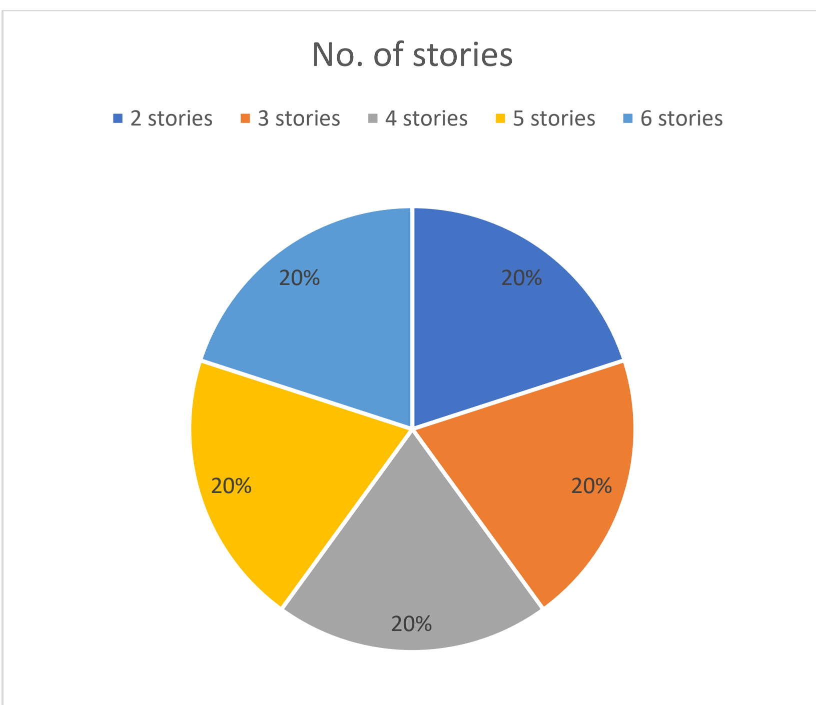


Figure 2.b

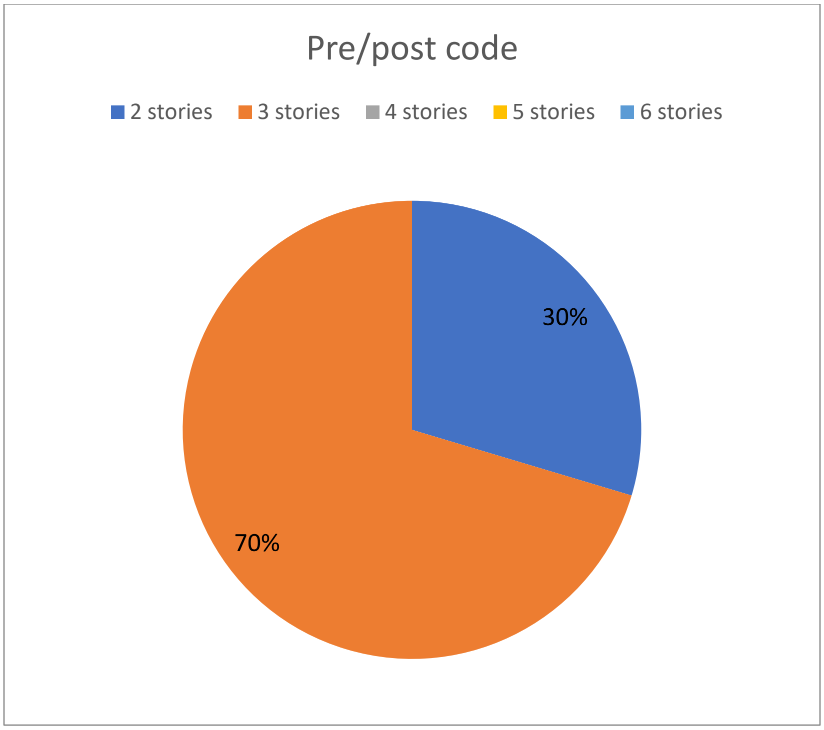

Pre/post code
2 stories
3 stories
4 stories
5 stories
6 stories
30%
70%

Figure 2.c

F-8:

S.No	Co-ordinates	Basic High score	High Seismicity RVS	Damage Grade
1	33.71006, 73.03965	0.5	0.7	3
2	33.71118, 73.0146	0.5	0.7	3
3	33.71106, 73.04135	0.5	0.7	3
4	33.71101, 73.04107	0.5	0.7	3
5	33.71115, 73.04089	0.5	0.7	3
6	33.711146, 73.04107	0.5	0.7	3
7	33.7134, 73.04127	0.5	0.7	3
8	33.71183, 73.04105	0.5	0.7	3
9	33.71175, 73.04086	0.5	0.7	3
10	33.71171, 73.04056	0.5	0.7	3
11	33.71246, 73.0403	0.9	1	3
12	33.7126, 73.04051	0.5	0.7	3
13	33.71245, 73. 03981	0.5	0.7	3
14	33.71269, 73. 03902	0.5	0.7	3
15	33.71224, 73. 03932	0.5	0.7	3
16	33.7124, 73. 03726	0.5	0.7	3
17	33.71212, 73. 03712	0.5	0.7	3
18	33.71193, 73. 03755	0.9	1.1	3
19	33.71164, 73. 0378	0.6	0.8	3
20	33.7113, 73. 0381	0.5	0.7	3
21	33.71178, 73. 03816	0.5	0.7	3
22	33.71207, 73. 03877	0.9	1	3
23	33.71222, 73. 03879	0.5	0.7	3
24	33.7124, 73. 03866	0.5	0.7	3
25	33.7173, 73. 0379	0.5	0.7	3
26	33.71095, 73. 03822	0.5	0.7	3
27	33.71066, 73. 03854	0.5	0.7	3
28	33.71046, 73. 03914	0.5	0.7	3
29	33.71095, 73. 03941	0.5	0.7	3
30	33.71081, 73. 03982	0.9	1.1	3

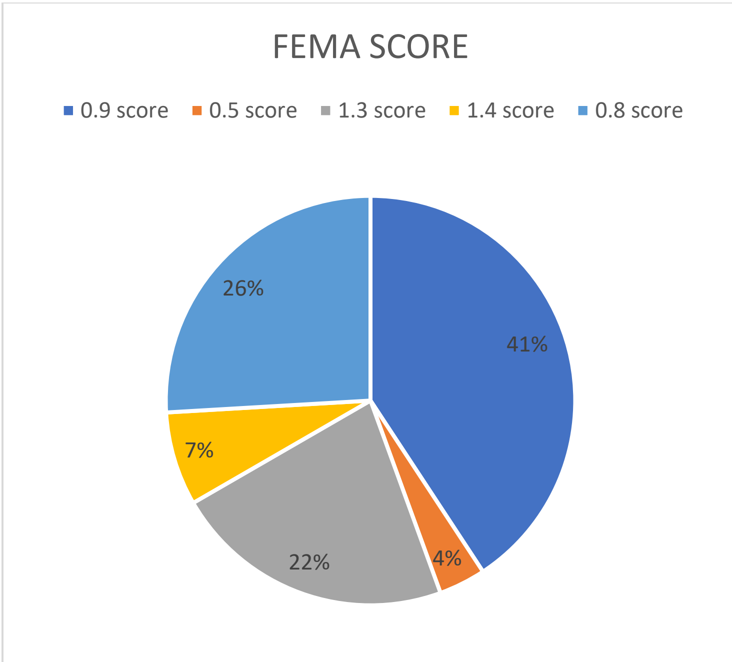


Figure 3.a

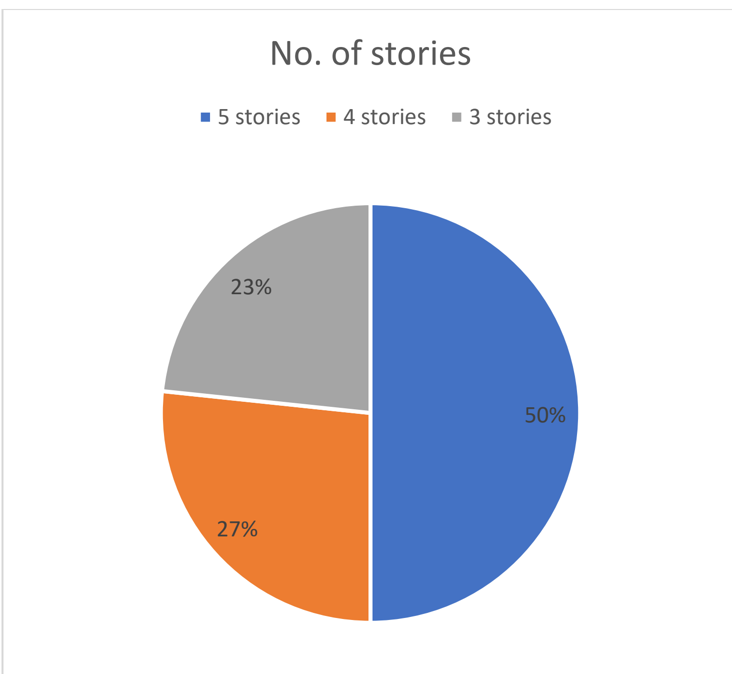


Figure 3.b

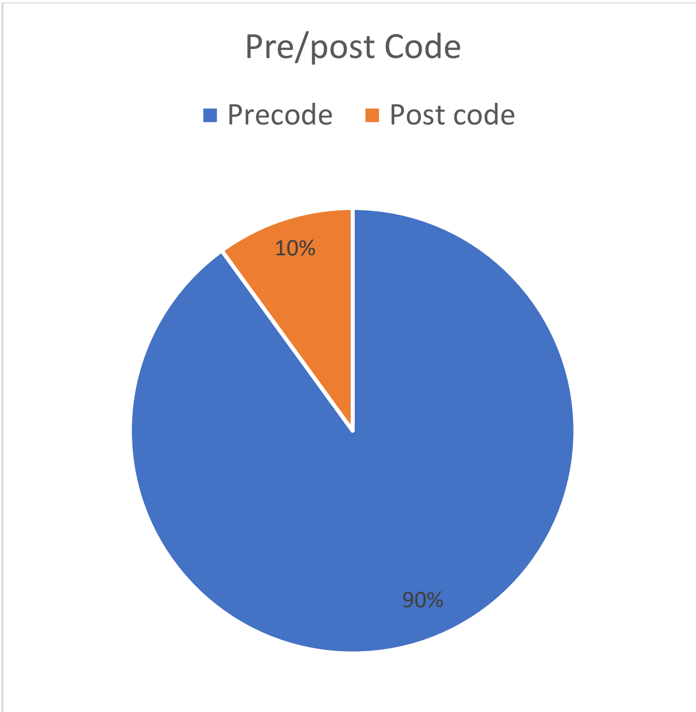


Figure 3.c

F-10

S.NO	Co-ordinates	Basic High score	High Seismicity RVS	Damage Grade
1	33.696104,73.013110	0.8	1	3
2	33.696212,73.012730	0.8	1	3
3	33.695698,73.012164	0.8	1	3
4	33.696025,73.012051	0.8	1	3
5	33.69612,73.0118	0.8	1	3
6	33.695962,73.011839	0.8	1	3
7	33.695507,73.012327	0.8	1	3
8	33.694935,73.012048	0.8	1	3
9	33.694766,73.012390	0.9	1.1	3
10	33.695599,73.013358	0.9	1.1	3
11	33.695431,73.013509	0.8	1	3
12	33.6957722,73.013551	0.9	1.1	3
13	33.695214,73.013775	0.8	1	3
14	33.695078,73.013762	0.8	1	3
15	33.694452,73.013417	0.8	1	3
16	33.694675,73.012489	0.8	1	3
17	33.69414,73.01292	0.8	1	3
18	33.69451,73.01382	1.5	1.6	2
19	33.69463,73.01395	0.8	1	3
20	33.69472,73.01401	0.8	1	3
21	33.69471,73.01413	0.8	1	3
22	33.69467,73.0143	0.8	1	3
23	33.69401,73.01434	0.8	1	3
24	33.6945,73.01441	0.8	1	3
25	33.69427,73.01453	0.8	1	3
26	33.69404,73.01473	0.8	1	3
27	33.69384,73.01444	0.8	1	3
28	33.69369,73.01409	0.8	1	3
29	33.69368,73.01410	0.8	1	3
30	33.69346,73.01363	0.8	1	3
31	33.6937,73.01357	0.8	1	3
32	33.6937,73.01358	0.8	1	3
33	33.69395,73.01344	0.8	1	3
34	33.69411,73.01324	0.8	1	3
35	33.69318,73.01388	0.8	1	3
36	33.69311,73.01393	0.8	1	3
37	33.69292,73.014146	0.8	1	3
38	33.69274,73.01435	0.8	1	3

39	33.69299,73.01488	0.8	1	3
40	33.6932,73.01518	0.8	1	3
41	33.6970951,73.0107162	0.5	0.7	3
42	33.6974707,73.0106079	0.8	1	3
43	33.6975721,73.0107635	0.8	1	3
44	33.6975721,73.0107635	0.8	1	3
45	33.6977465, 73.0110589	0.8	1	3
46	33.6978853, 73.0114061	0.5	0.7	3
47	33.6974576 ,73.0116362	0.5	0.7	3
48	33.6966798, 73.0118174	0.8	1	3
49	33.6966986, 73.0113831	0.8	1	3
50	33.6966986, 73.0113831	0.8	1	3
51	33.6964071, 73.0115739	0.8	1	3
52	33.6963771, 73.0118509	0.8	1	3
53	33.6963802, 73.0118486	0.8	1	3
54	33.6965483, 73.0122363	0.8	1	3
55	33.6965577, 73.0122362	0.8	1	3
56	33.6965576, 73.0122360	0.8	1	3
57	33.6963755, 73.0126935	0.5	0.7	3
58	33.6962866, 73.0128439	0.8	1	3

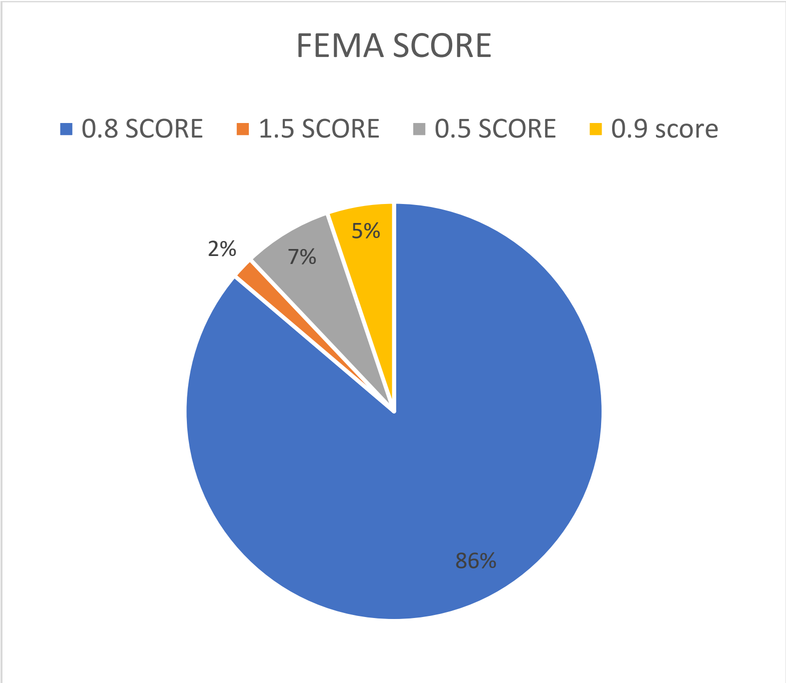


Figure 4.1

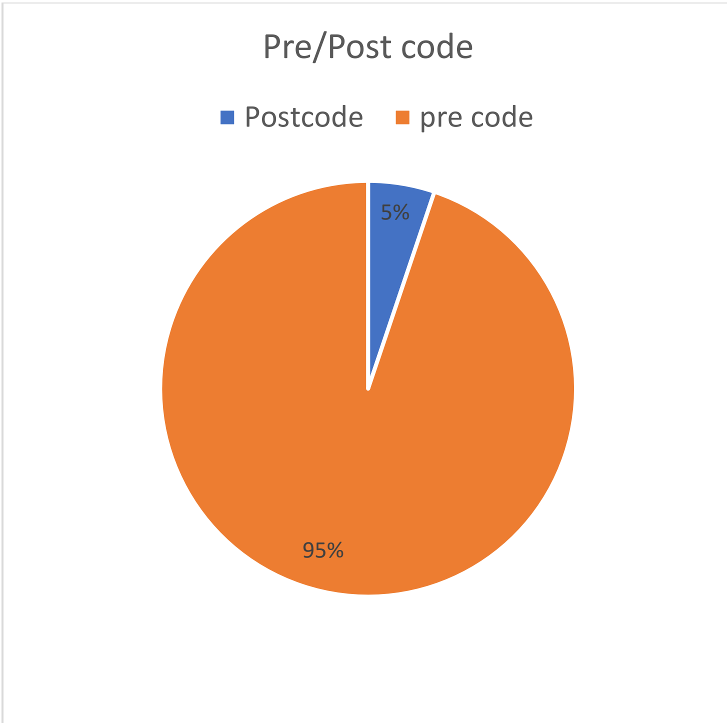


Figure 4.b

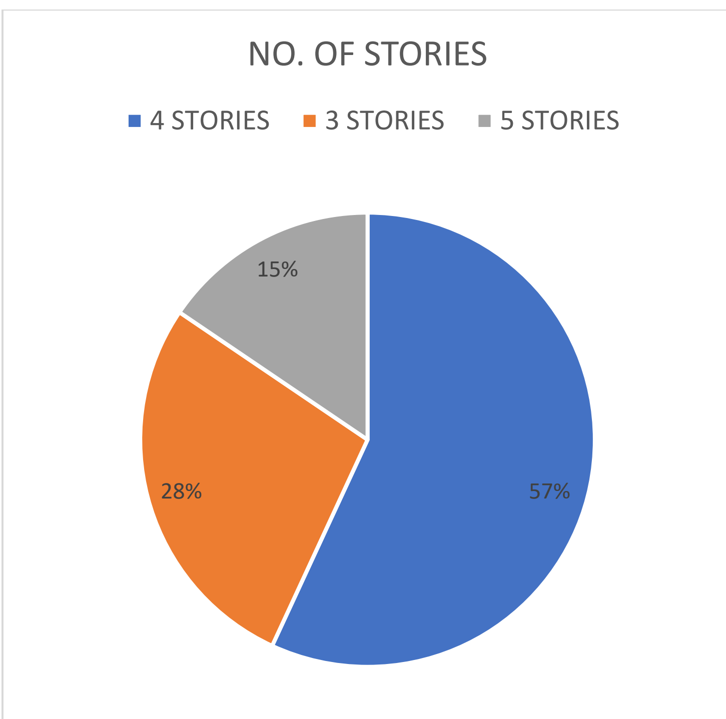


Figure 4.c

F-11:

S.NO	Co-ordinates	Basic High score	High seismicity RVS	Damage Grade
1	33.6838730,72.9874820	1.3	1.5	2
2	33.6838290,72.9885270	0.9	1.1	3
3	2.6831730,72.987862	0.9	1.1	3
4	33.6832290,72.9875350	0.9	1.1	3
5	33.683077,72.9874820	0.9	1.1	3
6	33.6840970,72.9861970	1.3	1.5	2
7	33.684440,72.981110	0.9	1.1	3
8	33.6875030,72.9859320	0.9	1.1	3
9	33.6827340,72.9804570	0.9	1.1	3
10	33.6826100,72.9800010	1.3	1.5	2
11	33.682591,72.9799270	0.8	1	3
12	33.682135,72.9801950	0.8	1	3
13	33.683573,72.9761920	0.8	1	3
14	33.682404,72.980261	0.8	1	3
15	33.6825030,72.9801660	1.3	1.5	2
16	33.73057,73.077521	1.3	1.5	2
17	33.6847580,72.989048	1.4	1.6	2
18	33.6844060,72.9889560	1.4	1.6	2
19	33.6832870,72.9887420	1.4	1.6	2
20	33.6832450,72.9893580	1.4	1.6	2
21	33.6834210,729887920	0.8	1	3
22	33.6831890,72.9887000	0.8	1	3
23	33.682990,72.980193	0.8	1	3
24	33.6823930,72.9803860	1.4	1.6	2
25	33.682230,72.980521	1.4	1.6	2
26	33.682911,72.980698	1.4	1.6	2
27	33.6823930,72.980782	1.4	1.6	2
28	33.682523,72.980468	1.4	1.6	2

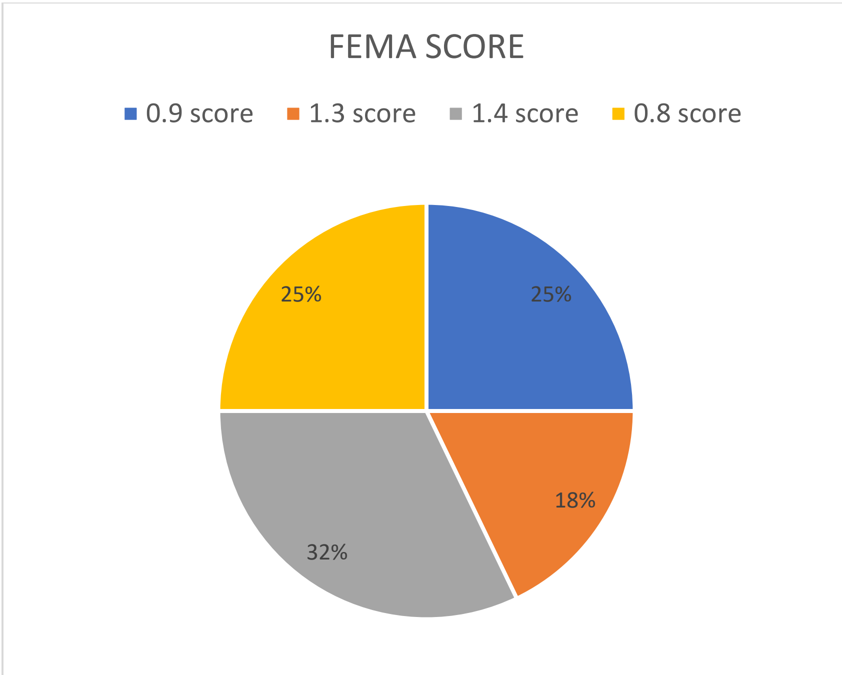


Figure 5.a

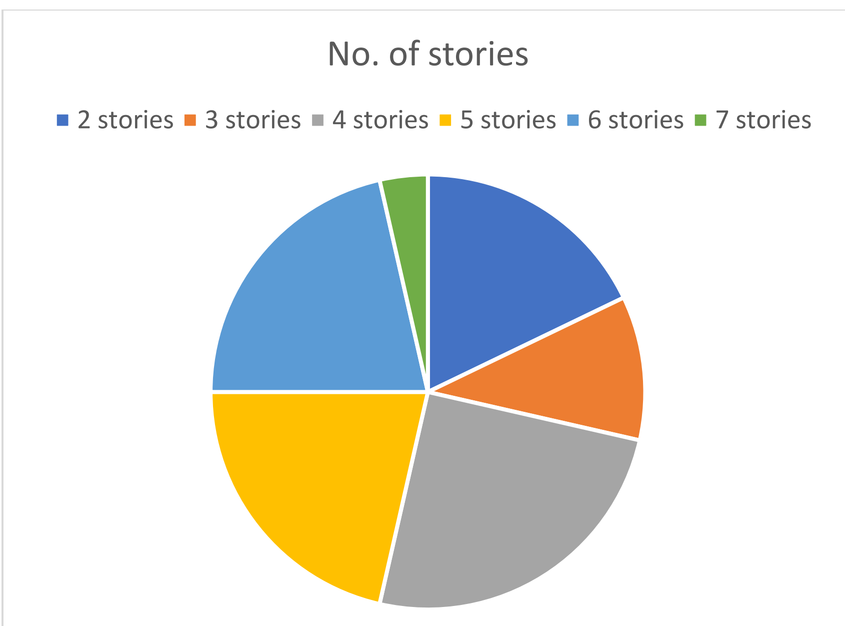


Figure 5.b

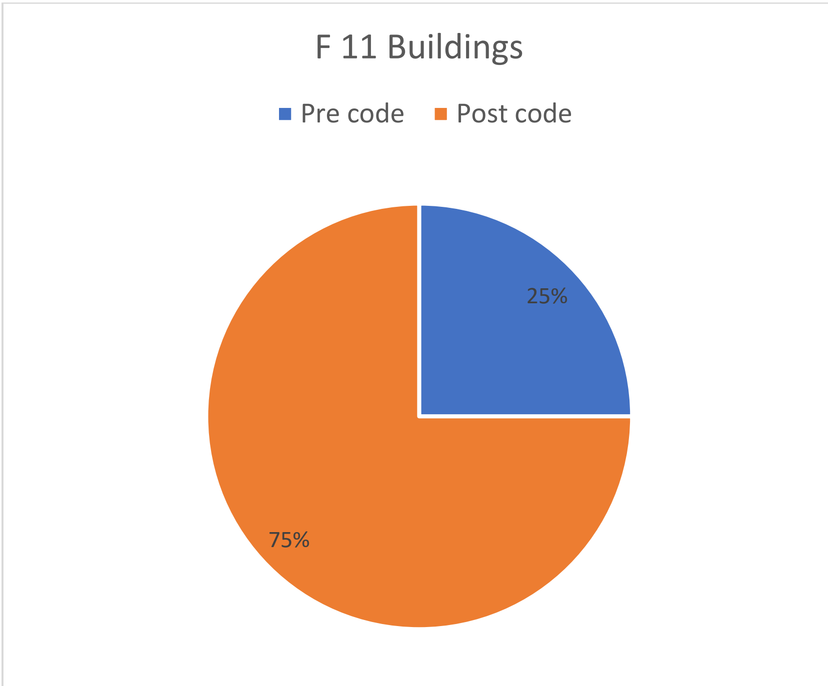


Figure 5.c

I-8:

S.No	Co-ordinates	Basic High score	High Seismicity RVS	Damage Grade
1	33.6691273, 73.0751629	0.9	1.1	3
2	33.6692803, 73.0745044	0.9	1.1	3
3	33.668774, 73.0742003	0.9	1.1	3
4	33.6667446, 73.074301	0.9	1.1	3
5	33.6670635, 73.0747256	0.9	1.1	3
6	33.66683, 73.0737095	0.5	0.7	3
7	33.6671337, 73.0735758	0.5	0.7	3
8	33.6665836, 73.0755626	0.5	0.7	3
9	33.6664348, 73.0760916	0.5	0.7	3
10	33.6665131, 73.0761685	0.9	1.1	3
11	33.6673026, 73.0759897	0.9	1.1	3
12	33.6672067, 73.0755848	0.9	1.1	3
13	33.6681728, 73.0758589	0.3	0.5	4
14	33.6687683, 73.0749875	0.9	1.1	3
15	33.6689217, 73.075348	0.5	0.7	3
16	33.6688115, 73.0762772	0.5	0.7	3

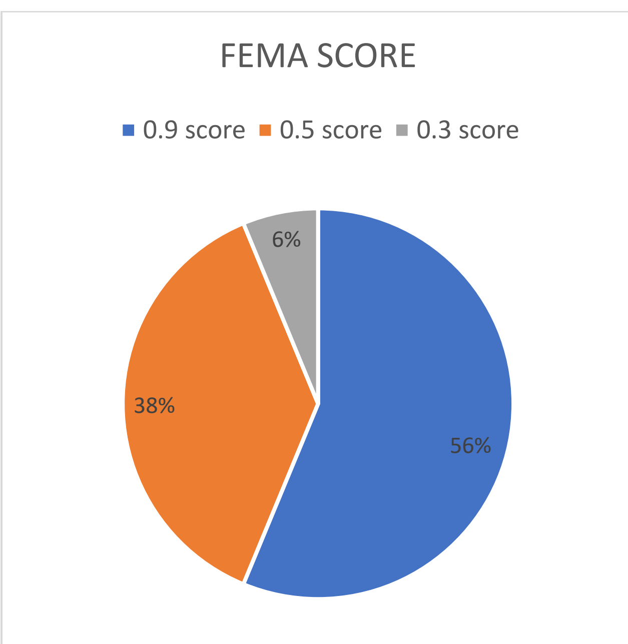


Figure 6.a

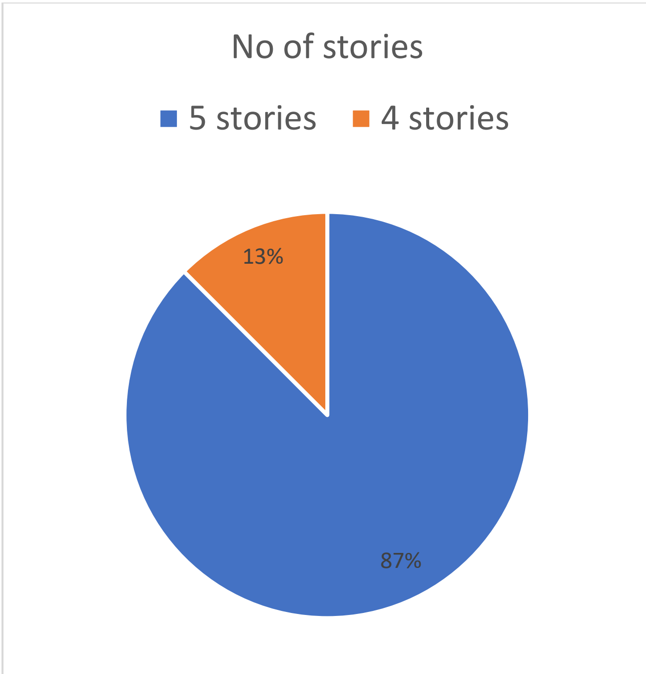


Figure 6.b

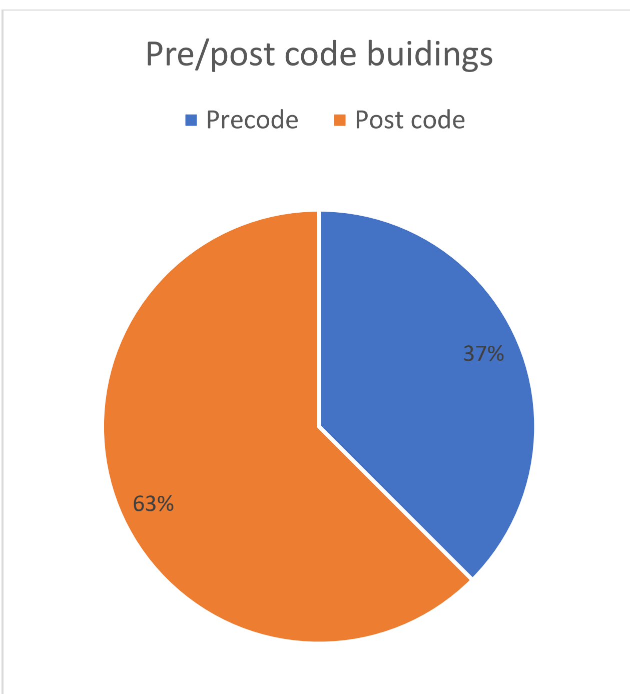


Figure 6.c

I-9:

S.No	Co-ordinates	Basic High score	High Seismicity RVS	Damage Grade
1	33.6589, 73.06053	0.5	0.7	3
2	33.65877, 73.06029	0.5	0.7	3
3	33.65857, 73.05995	0.5	0.7	3
4	33.65874, 73.05981	0.5	0.7	3
5	33.65862, 73.05957	0.5	0.7	3
6	33.65852, 73.05937	0.5	0.7	3
7	33.65818, 73.05938	0.5	0.7	3
8	33.65841, 73.05854	0.5	0.7	3
9	33.6814, 73.05901	0.5	0.7	3
10	33.65807, 73.05849	0.5	0.7	3
11	33.65773, 73.05848	0.5	0.7	3
12	33.65697, 73.05676	0.5	0.7	3
13	33.65965, 73.05654	0.5	0.7	3
14	33.65635, 73.05576	0.5	0.7	3
15	33.65627, 73.05513	0.5	0.7	3
16	33.65611, 73.05519	0.5	0.7	3
17	33.6558, 73.05425	0.5	0.7	3
18	33.65569,73.0532	0.5	0.7	3
19	33.65557, 73.05396	0.5	0.7	3
20	33.65401, 73.05088	0.5	0.7	3
21	33.65386, 73.05041	0.5	0.7	3
22	33.65365, 73.05056	0.5	0.7	3
23	33.65362, 73.05009	0.5	0.7	3
24	33.65336, 73.0994	0.5	0.7	3
25	33.65317, 73.04996	0.5	0.7	3
26	33.65308, 73.04922	0.5	0.7	3

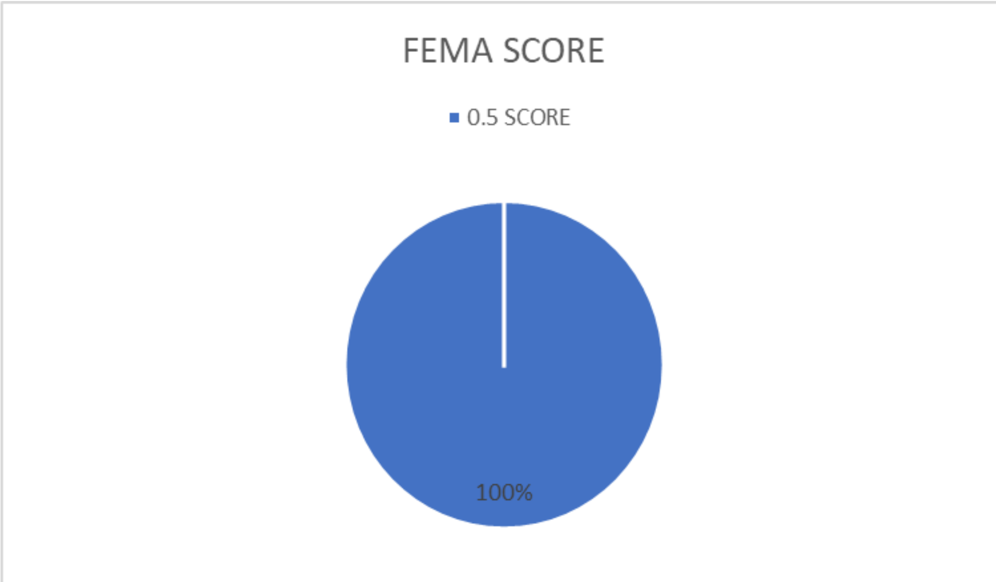


Figure 7.a

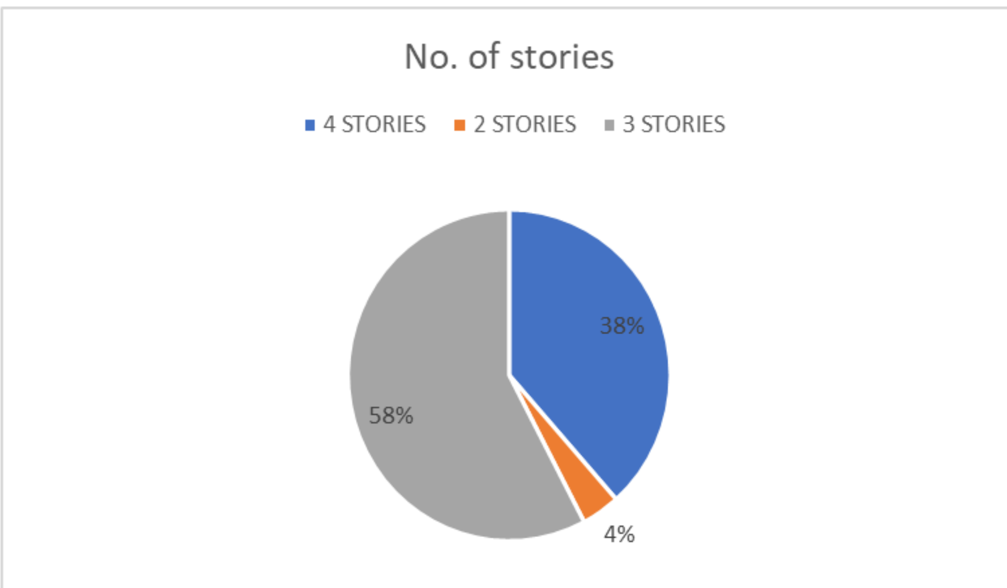


Figure 7.b

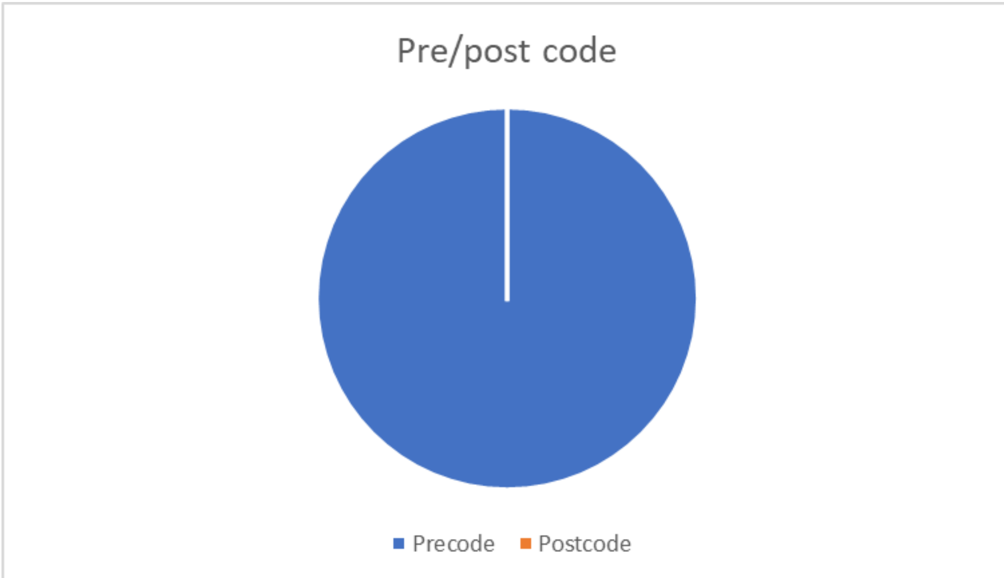


Figure 7.c

I-10:

S.No	Co-ordinates	Basic High score	High Seismicity RVS	Damage Grade
1	33.643789,73.031174	0.8	1	3
2	33.643514,73.031239	0.8	1	3
3	33.643871,73.031393	0.9	1.1	3
4	33.64401,73.031590	0.8	1	3
5	33.643960,73.031943	0.8	1	3
6	33.644095,73.031912	0.8	1	3
7	33.64568,73.03525	0.8	1	3
8	33.646067,73.035411	0.8	1	3
9	33.645803,73.035596	0.8	1	3
10	33.646216,73.035763	0.8	1	3
11	33.646036,73.035924	0.8	1	3
12	33.646293,73.036028	0.8	1	3
13	33.646430,73.036276	0.9	1.1	3
14	33.646477,73.036494	0.8	1	3
15	33.646714,73.036823	0.8	1	3
16	33.646714,73.036823	0.8	1	3
17	33.646744,73.037282	0.9	1.1	3
18	33.647679,73.038607	0.8	1	3
19	33.648311,73.039888	0.8	1	3
20	33.648434,73.040474	0.9	1.1	3
21	33.648651,73.040603	0.8	1	3
22	33.648525,73.040658	0.8	1	3
23	33.65003,73.04305	0.8	1	3
24	33.650021,73.04325	0.9	1.1	3
25	33.650389,73.043684	0.8	1	3
26	33.650238,73.043911	0.8	1	3
27	33.650810,73.044527	0.8	1	3

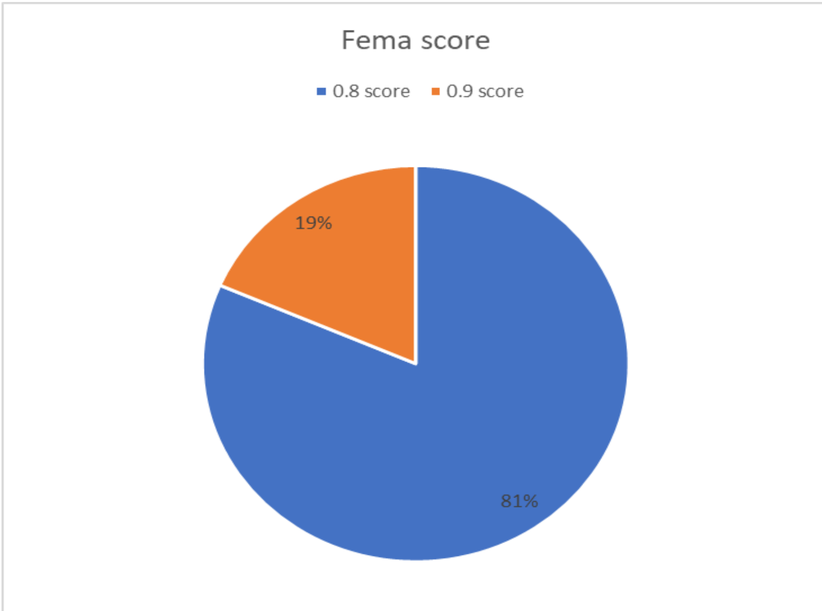


Figure 8.a

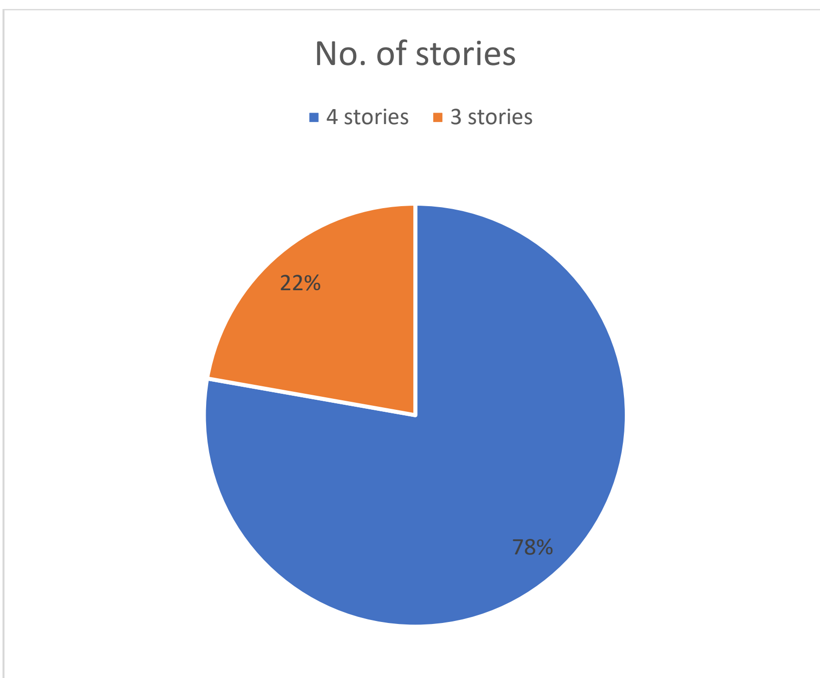


Figure 8.b

Figure 8.c

CHAPTER 6: CONCLUSION

After our vulnerability assessment, we almost evaluated almost 300 buildings and are our results:

FEMA Scores of all buildings in zone 1:

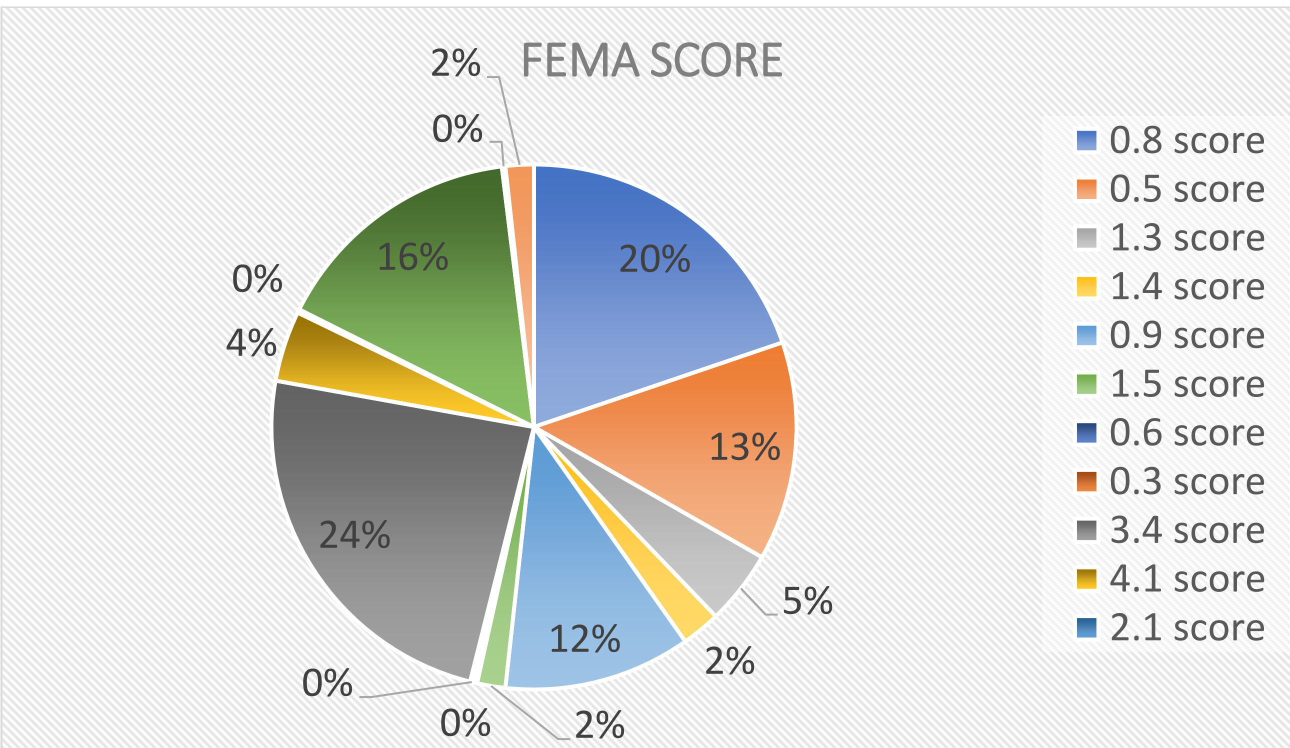


Figure A

Here we have categorized the pie chart such that 0.8 is the FEMA score for most buildings and then all others are in descending order.

Code compliant and non-code compliant RC structures:

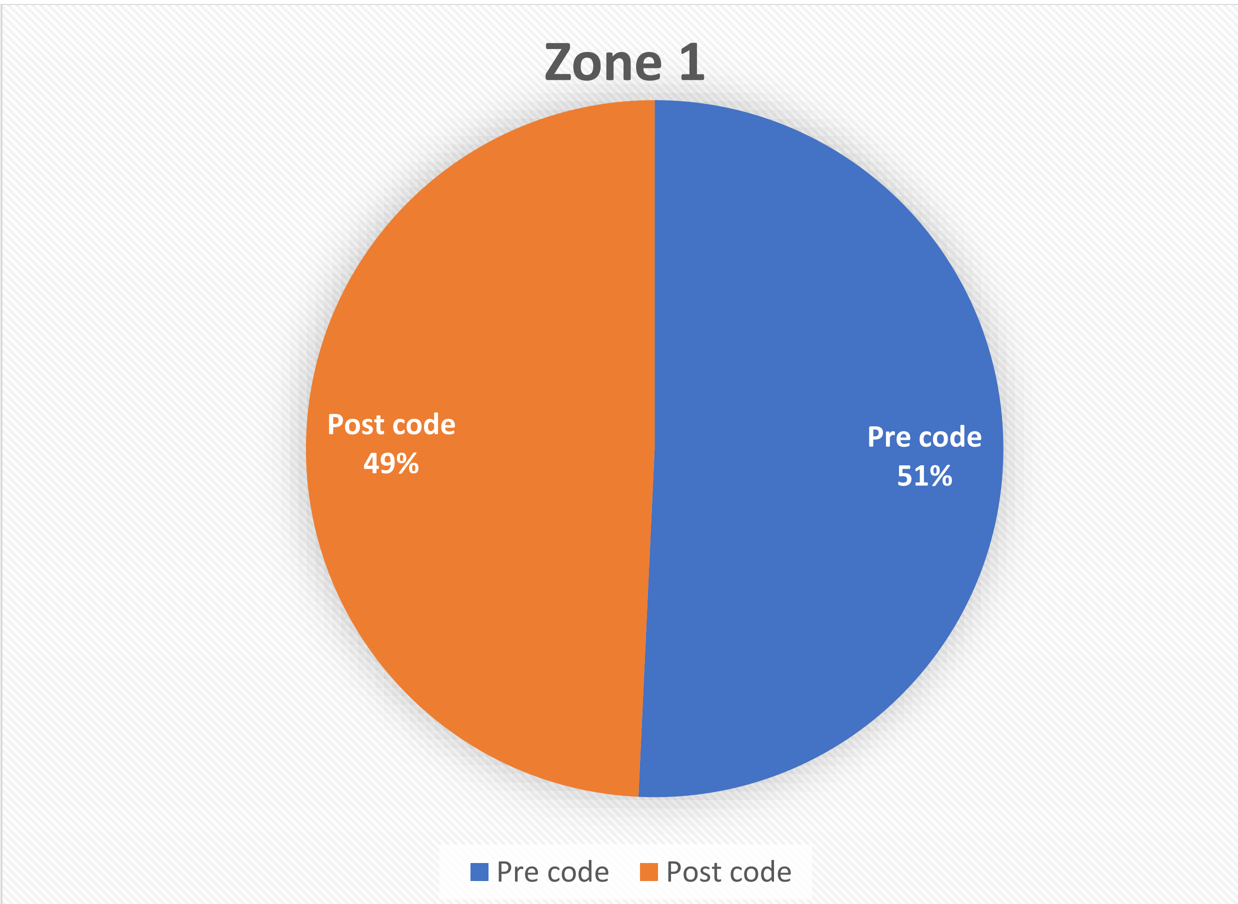


Figure B

Here are all the buildings categorized as post code and pre code. They are almost the same. Here we have assumed that all the buildings built after the BCP-2007 are code compliant.

No. of stories of buildings in zone 1:

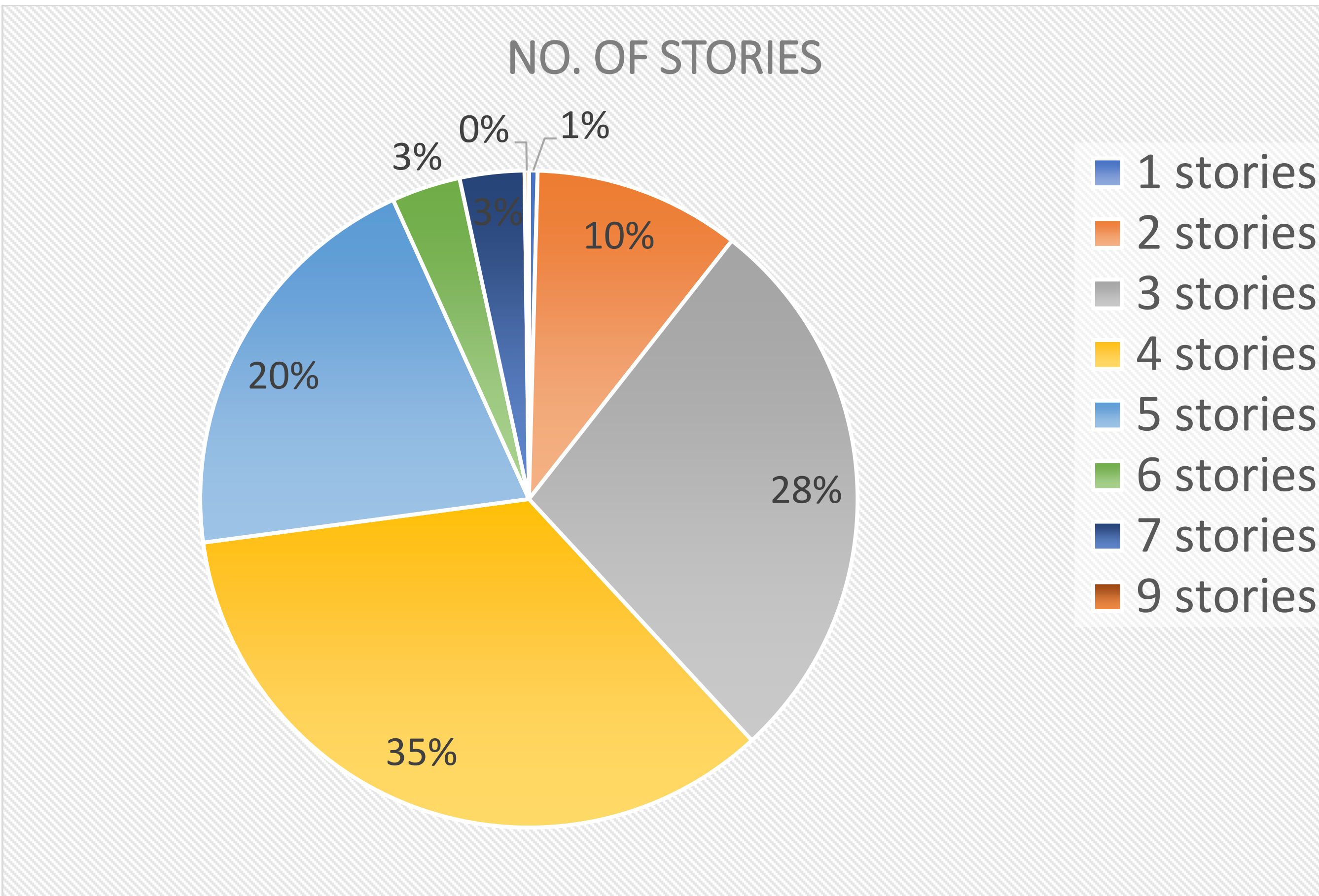
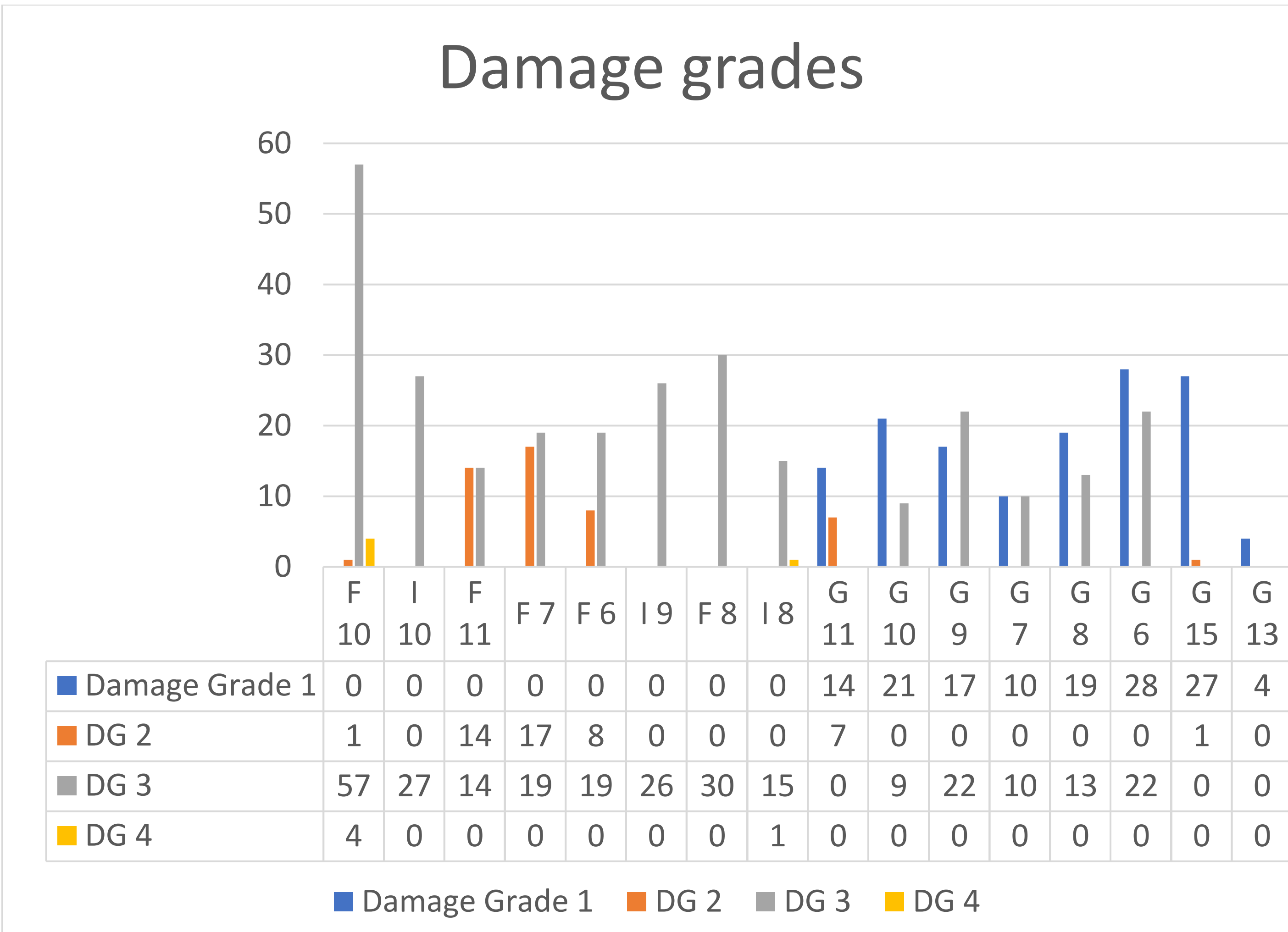


Figure C

These are the overall number of stories of building in zone and as you can see from the figure most of them have 4 stories.

Damage Grades of buildings of Zone 1:



	F 10	I 10	F 11	F 7	F 6	I 9	F 8	I 8	G 11	G 10	G 9	G 7	G 8	G 6	G 15	G 13
Damage Grade 1	0	0	0	0	0	0	0	0	14	21	17	10	19	28	27	4
DG 2	1	0	14	17	8	0	0	0	7	0	0	0	0	0	1	0
DG 3	57	27	14	19	19	26	30	15	0	9	22	10	13	22	0	0
DG 4	4	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0

Figure D

The following data is the one in which we have categorized all the buildings into damage grades.

PLAGARISM REPORT

Thesis

ORIGINALITY REPORT

6%	2%	2%	4%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

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12	Mathavanayakam Sathurshan, Julian Thamboo, Chinthaka Mallikarachchi, Kushan Wijesundara, Priyan Dias. "Rapid seismic visual screen method for masonry infilled reinforced concrete framed buildings: Application to typical Sri Lankan school buildings", International Journal of Disaster Risk Reduction, 2023 Publication	<1 %
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Khan, S. U., Qureshi, M. I., Rana, I. A., & Maqsoom, A. (2019). Seismic vulnerability assessment of building stock of Malakand (Pakistan) using FEMA P-154 method. *SN Applied Sciences*, *1*(12), 1625.

Mahmud, M. R., Ali, S. B., & Bhuiyan, M. A. R. (2018). Seismic Vulnerability Assessment Primary School Buildings at Chittagong City Corporation, Bangladesh Using FEMA 154. Proceedings of the 4th International Conference on Advances in Civil Engineering,