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Seismic Vulnerability of Pocket Settlement: A Study of Traditional Architecture of Baglamukhi

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Abstract

Valley has experienced lots of earthquakes and the earthquake that the generation still remember bitterly is of 1935. As we know Earthquakes do not kill the people but buildings do, it obviously is the lack of proper knowledge and measures in construction methodology which is responsible for loss of lives. The aim of the study was to examine the seismic vulnerability of traditional Newari settlement by using FEMA P-154 RVS considering the physical factors like building typology, plan irregularities, no. of stories, exterior falling, design date, soil type, adjacency, pre-code, post benchmark, etc. for Rapid Visual Screening (RVS) and social factors for assessing the level of vulnerability that those factors contribute to the settlement during and after seismic hazards. From this assessment study and according to the basic scores for regions, Kathmandu falls under the category of high seismic criteria. A pocket settlement of 41 buildings were examined out of which 10 Reinforced Masonry buildings with rigid floor and roof diaphragms (RM2) is found vulnerable to Grade 3 substantial to heavy damage (moderate structural damage, heavy non-structural damage), large and extensive cracks in most walls, detached roof tiles, chimneys fracture at the roof line, failure of individual non-structural elements (partitions, gable walls etc.). Altogether 31 i.e. 12 buildings of Concrete frame buildings with unreinforced masonry infill walls (C3) +19 buildings of Unreinforced masonry bearing-wall buildings (URM) are found to be vulnerable under the category of Grade 4 substantial to very heavy damage (heavy structural damage, very heavy non-structural damage), serious failure of walls (gaps in walls), partial structural failure of roofs and floors. Vulnerability scores of the screening found from that of RVS methodology of assessing vulnerability is interpreted in tabular form at last.

Keywords

traditional Newari settlement, seismic vulnerability, FEMA P-154 RVS, physical factors, social factors, vulnerability score

1. Introduction

The survival of traditional architecture is threatened world-wide by the forces of economic, cultural and architectural homogenization. How these forces can be met is a fundamental problem that must be addressed by communities and also by governments, planners, architects, conservationists and by a multidisciplinary group of specialists. The revival of traditional architecture of that place must be carried out by multidisciplinary expertise recognizing the inevitability of change and development, and the need to respect the community's established cultural identity. A need for scientific research to have the know-how of technical consideration while reviving those tradition of any particular region is immense as traditional architecture has that threshold to stand intact for ages if undergoes through maintenance and conservation frequently and hence is proved to be economical and sustainable approach to lead the reconstruction works to the path of building back a better Nepal than before. [1]

1.1 Background

Nepal lies in subduction zone therefore it happens to be the region of high seismicity. Kathmandu Valley due its underlying soft rock, earthquake waves amplify when it travels towards surface. This makes the valley more vulnerable to earthquake. Masonry construction practice has born approximately 10,000 years ago and is the oldest building technique known to man. With time construction practice has been advanced. However, there are still many traditional brick masonry buildings which were constructed locally with mud mortar and burnt clay bricks. Though these buildings have survived for centuries, they lack seismic resistant measures to fight the future severe earthquake hazards. But also, to the contrary, they have those potential to endure seismic hazards through their flexibility and performances. Other factors also play a pivotal role in determining their performances. Historical and heritage importance and safety of lives dwelling in those buildings motivates the research study in this field with the aim of their sustainability.[2]

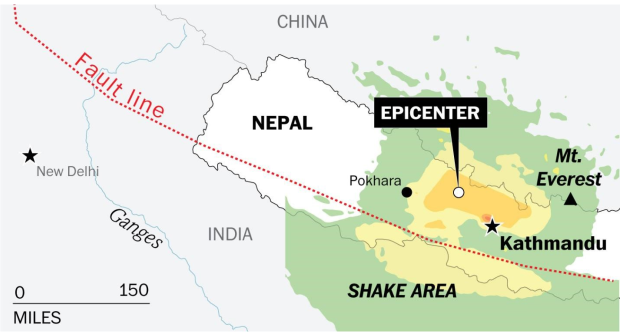


Figure 1: Epicenter, the fault line and shake area

1.1.1 Terminologies

The word tradition comes from the Latin noun ‘traditio’ meaning ‘handing over’, which derives from the verb ‘tradere’ (hand over, deliver).

Traditional architecture is a category of architecture handed over by ancestors which was once built by considering localized needs and construction materials, and reflecting local traditions. It refers to traditional buildings that have been designed and build to match the local climate and culture. Traditional building is the traditional and natural way by which communities house themselves. It is a continuing process including necessary changes and continuous adaptation as a response to social constraints.

During **earthquake re-construction phase** i.e. the long-term phase of post disaster where recoiling back to previous pre-functioning is considered and even a better resilient condition carrying a goal of 3-Bs (build-back-better) is endeavored, recovery is to be focused on revisited thoughts of traditional aspects of recovery as they are impartial aspects to one’s daily life.

Settlement is a process that introduces built environment for the community. This built environment potentially defines the social system as one interlinked with other subsystems of the community. However, following a fundamental trend in the system, restoring the equilibrium of a community requires certain basic conditions. Settlement fails if the built environment does not provide these basic conditions. Failure in terms of built environment has been recorded in studies based on the inappropriate house design, insufficient infrastructure, inappropriate new environment, and alike.

Vulnerability is the characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. Vulnerability is a function of existing hazard, characteristics and quality of resources, population etc. Seismic vulnerability is the referring to the condition or state of groups or communities exposed to external stresses and disturbances due to physical, social, cultural, political and environmental circumstances caused during an onset of earthquake. Vulnerability is focused on risk.

Vulnerability assessment is the process of identifying, quantifying and prioritizing (or ranking) the vulnerabilities in a system.

Seismic vulnerability assessment has to consider (i) number of stories, (ii) minimum gap between adjacent buildings, (iii) building site location, (iv) soil type, (v) irregularity in elevation, (vi) soft storey, (vii) vertical irregularity, and (viii) cladding for allocating PMF(Performance Modification Factors) scores that are based on damage surveys undertaken previously. Apart from these, parameters pertaining to (i) roofing material, (ii) parapet height, (iii) re-entrant corner, (iv) heavy mass at the top, (v) construction quality, (vi) condition/ maintenance, and (vii) overhang length have been included in the present study, so as to make the assessment suitable for the building in the region.

A**vulnerability score** is a measure of the exposure of a population to some hazard. Typically, the score is a composite of multiple quantitative indicators that via some assigned value according to guidelines, delivers a single numerical result.

1.2 Need and Importance of Study

Due to the homogenization of culture and of global socio-economic transformation, traditional structures all around Nepal are extremely vulnerable, facing serious problems of obsolescence, internal equilibrium and integration. People are being detached from the practice of utilizing the availed indigenous material for construction of building with those techniques of scientifically and practically sound methods of construction that stand for ages. People are being detached from the civilization of core rural settlement pattern. Traditional architecture is being replaced by contemporary architecture and we are building back a 'jungle of concrete' instead of building back better and native using indigenous materials which is creating a kind of negative psycho-socio impact on our day-to-day lives. So, it needs to be addressed before much delay. Similarly, architectural ambience is highly being encroached by disjoint and nuclear dwelling pattern. Traditional courtyards of Newari culture and different public spaces are being on the verse of extinct. High rise buildings and apartments along with mushrooming dwelling sites on open spaces in city area is a huge threat to human as there will be no open accessible space for evacuation during earthquake.

It is necessary, therefore, to establish principles for the implementation and protection of our traditional architecture and techniques, a manner of building shared by the community, a recognizable local or regional character responsive to the environment i.e. settlement planning, coherence of style, form and appearance, or the use of traditionally established building typology to bear the seismic loads and act as earthquake resilient buildings. [3]

1.3 Objective of Study

The primary objective of this research is:

- To identify the state of vulnerability of building typologies in a pocket settlement through Rapid Visual Assessment.

Further, the gist of research is dedicated to find out the response to following questions:

- To find out the factors of traditional buildings making it vulnerable to seismic hazard and tally with that of FEMA P-154 score modifier.
- To know the physical and social contribution to seismic vulnerability of a pocket settlement.

2. Literature Review

2.1 Review of FEMA P-154

Rapid Visual Screening Method (RVS) (FEMA-154 2002) is simpler procedures that can help to rapidly evaluate the vulnerability profile of different types of buildings. In (FEMA-154 2002), the basic Structural Hazard Scores, Modifiers and final Scores are based on: building type, design, construction practices and soil types. Using statistical analysis, a "structural score" for a building is developed. Final Structural Score (S) all relate to the probability of building collapse. Final score, S typically range from 0 to 7. Building receiving lower score are determined as potential risk. [4] The scoring methodologies was taken reference from Federal Emergency Management Agency (FEMA) 154: Rapid Visual Screening of Buildings for Potential Seismic Hazards. In doing so, building typologies that are unique to Nepal, topological and soil parameter were taken into account. Building typologies used in this analysis include the following three categories:

a. Concrete frame buildings with unreinforced masonry infill walls (C3)

b. Reinforced masonry buildings with rigid floor and roof diaphragms (RM2)

c. Unreinforced masonry bearing-wall buildings (URM)

2.2 Importance of FEMA P-154

Before embarking on seismic retrofitting, seismic deficiencies shall have to be identified through a seismic evaluation process using a RVS form:

- The first phase assessment is general seismic vulnerability assessment method based on qualitative approach to identify the seismic deficiencies in the building.
- The first phase study finds seismic deficiencies in the building and possible seismic performance is not up to the acceptable level/criteria.
- It recommends either second phase assessment or concludes the evaluation and state that potential deficiencies are identified.

3. Study area

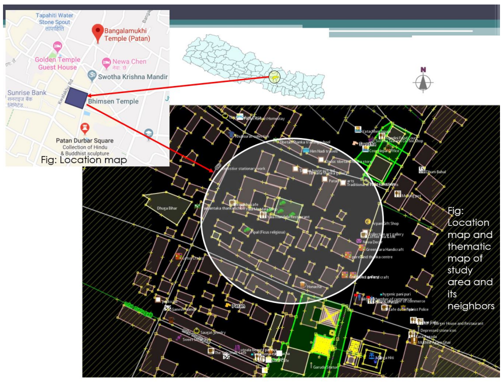


Figure 2: Location map

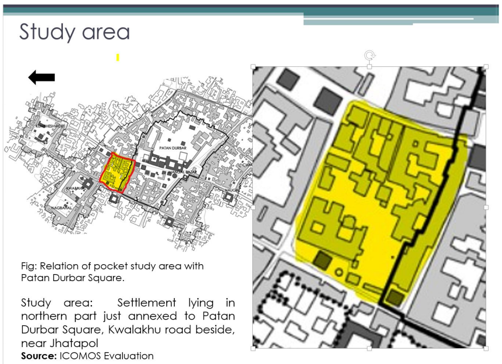

Study area

Fig: Relation of pocket study area with Patan Durbar Square.

Study area: Settlement lying in northern part just annexed to Patan Durbar Square, Kwalakhu road beside, near Jhatapol

Source: ICOMOS Evaluation

Figure 3: Figure showing the pocket settlement

4. Methodology

The research uses a co-relational research strategy where we first will find out the variables on which viability of traditional or indigenous architecture depends on analyzing the degree of co-relation between the variables that could affect the local architecture. The methodological framework of the study is shown in figure 4.

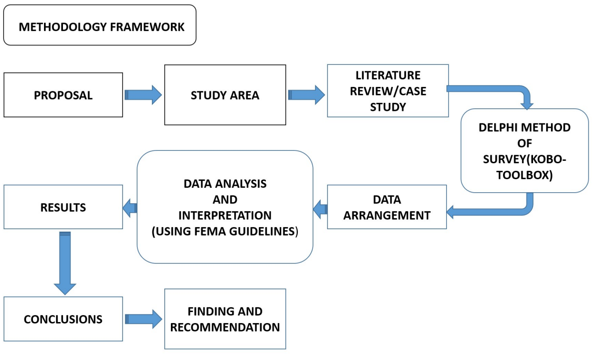


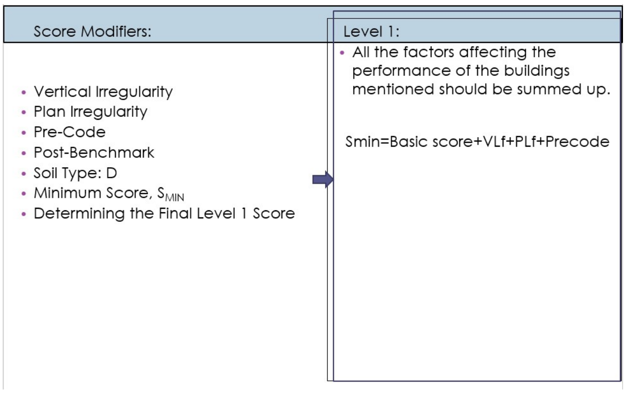
Figure 4: Methodology

4.1 Data cleaning

In data analysis, superstructure typology and damage categories were some of the most critical information. For example, a building of which superstructure was categorized as adobe/mud construction also had additional description of mud-mortar and others. However, multiple description for the building superstructure complicates the data analysis. Hence, those data points with multiple superstructure typologies were cleaned to have only one typology which is the weakest of all the selected.

Score Modifiers determines overall vulnerability level of each building considering other parameters such as soil type, building height, ground slope, distance from river, age of building and building foundation type. Table 1 summarizes the vulnerability score assignment.

The Rapid Visual Screening sample form for level-1 and level-2 high seismicity (which is annexed latter in the paper) along with its calculation formula is given below.


Score Modifiers:

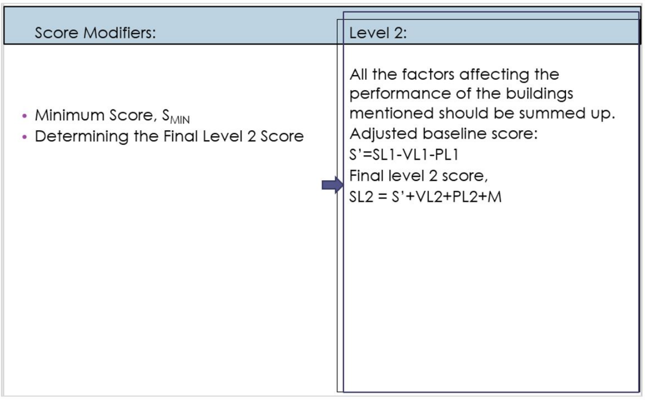
- Vertical Irregularity
- Plan Irregularity
- Pre-Code
- Post-Benchmark
- Soil Type: D
- Minimum Score, S_{MIN}
- Determining the Final Level 1 Score

Level 1:

- All the factors affecting the performance of the buildings mentioned should be summed up.

Smin=Basic score+VLf+PLf+Precode

Figure 5: Calculation: RVS level-1


Score Modifiers:

- Minimum Score, S_{MIN}
- Determining the Final Level 2 Score

Level 2:

All the factors affecting the performance of the buildings mentioned should be summed up.
Adjusted baseline score:
S'=SL1-VL1-PL1
Final level 2 score,
SL2 = S'+VL2+PL2+M

Figure 6: Calculation: RVS level-2

5. Result

5.1 Building typology

The building typologies are scored as per the guidelines which is tabulated below:

Table 1: Building Typology scores as per the guidelines

SN	Building Model	FEMA 154 Score (S)	EMS-98 Damage Grade
1	C3	0.2	Grade 4
2	RM2	0.3	Grade 3
3	URM	0.2	Grade 4

Where, Concrete frame buildings with unreinforced masonry infill walls = (C3)

Reinforced masonry buildings with rigid floor and roof diaphragms = (RM2)

Unreinforced masonry bearing-wall buildings = (URM)

5.2 Physical infrastructures

The likelihood of an earthquake disaster increases when the community's-built environment (i.e., buildings and lifeline systems–or community infrastructure) is comprised of the following vulnerable elements [5] . Therefore, they are studied and marked into the map.

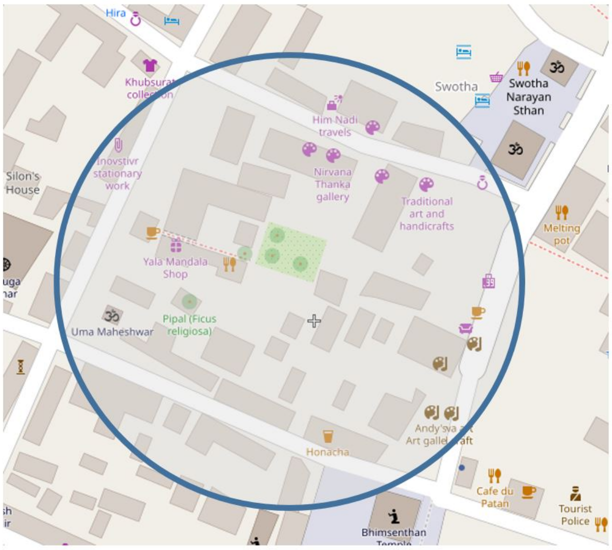


Figure 7: Shops nearby

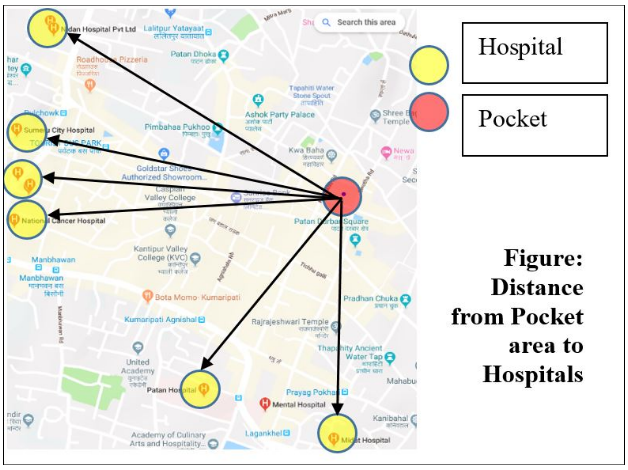


Figure 8: Hospital nearby

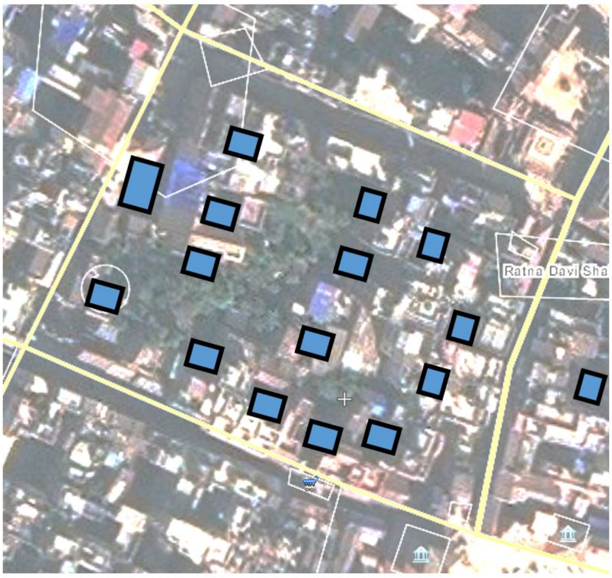
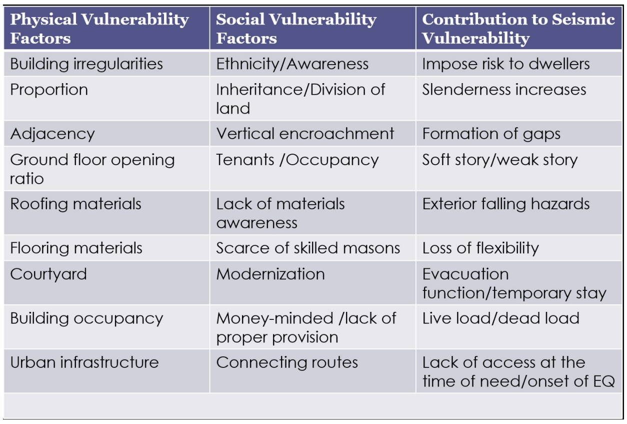


Figure 9: Courtyards nearby



Physical Vulnerability Factors	Social Vulnerability Factors	Contribution to Seismic Vulnerability
Building irregularities	Ethnicity/Awareness	Impose risk to dwellers
Proportion	Inheritance/Division of land	Slenderness increases
Adjacency	Vertical encroachment	Formation of gaps
Ground floor opening ratio	Tenants /Occupancy	Soft story/weak story
Roofing materials	Lack of materials awareness	Exterior falling hazards
Flooring materials	Scarce of skilled masons	Loss of flexibility
Courtyard	Modernization	Evacuation function/temporary stay
Building occupancy	Money-minded /lack of proper provision	Live load/dead load
Urban infrastructure	Connecting routes	Lack of access at the time of need/onset of EQ

Figure 10: Physical and social factors contributing to seismic vulnerability

6. Conclusion

Vulnerability assessment was performed from the process of defining, identifying, classifying and prioritizing vulnerabilities in applications and network infrastructures. The performance of masonry structures used to be noticeably inferior than the performance of RC framed structures due to construction technology, load concentration and structural binding. [6] In addition to this, masonry houses in Nepal are used at least by three generations without any strengthening measures, so during every earthquake in Nepal the older masonry structures claim enormous damage of life and properties. Building units were commonly of adobe, brick or stone masonry and RC structures in our site. The construction technology, construction materials, binding materials are noticeably changing in settlements of Banglamukhi, Patan.

10 Reinforced Masonry buildings with rigid floor and roof diaphragms (RM2) is found vulnerable to the probability of $1/(10)^{(0.3)}$ to seismic hazard.

12 C3 +19 URM are found to be vulnerable under the category of Grade 4 to the probability of $1/(10)^{(0.2)}$.

6.1 Scope and limitation of Study

Study is limited to only visual assessment of those buildings and settlement as a part of case study classification as per the score of vulnerability.It is limited to qualitative assessment, not quantitative assessment. Reliability of assessment lowers because it not only relies on secondary information but also involves primary data collection. This study also does not incorporate the influences of institutional factors in detail.

Acknowledgments

The authors like to convey a special thanks goes to Assoc. Prof. Nagendra Raj Sitoula (coordinator of Disaster Risk Management) for his continuous support and informative direction. A number of local people assisted by providing their valuable ideas and observations during the course of survey. Many people also participated in survey, providing crucial information and feedback. The several numbers of people who kindly gave their time to participate and respond to the survey questions are highly appreciated.

References

[1] Caterina Bonapace and Valerio Sestini. *Traditional materials and construction technologies used in the Kathmandu valley*. United Nations Educational, Scientific and Cultural Organization Paris, 2003.

[2] Mohan N Shrestha. Nepal's traditional settlement: Pattern and architecture. *Journal of Cultural Geography*, 1(2):26–43, 1981.

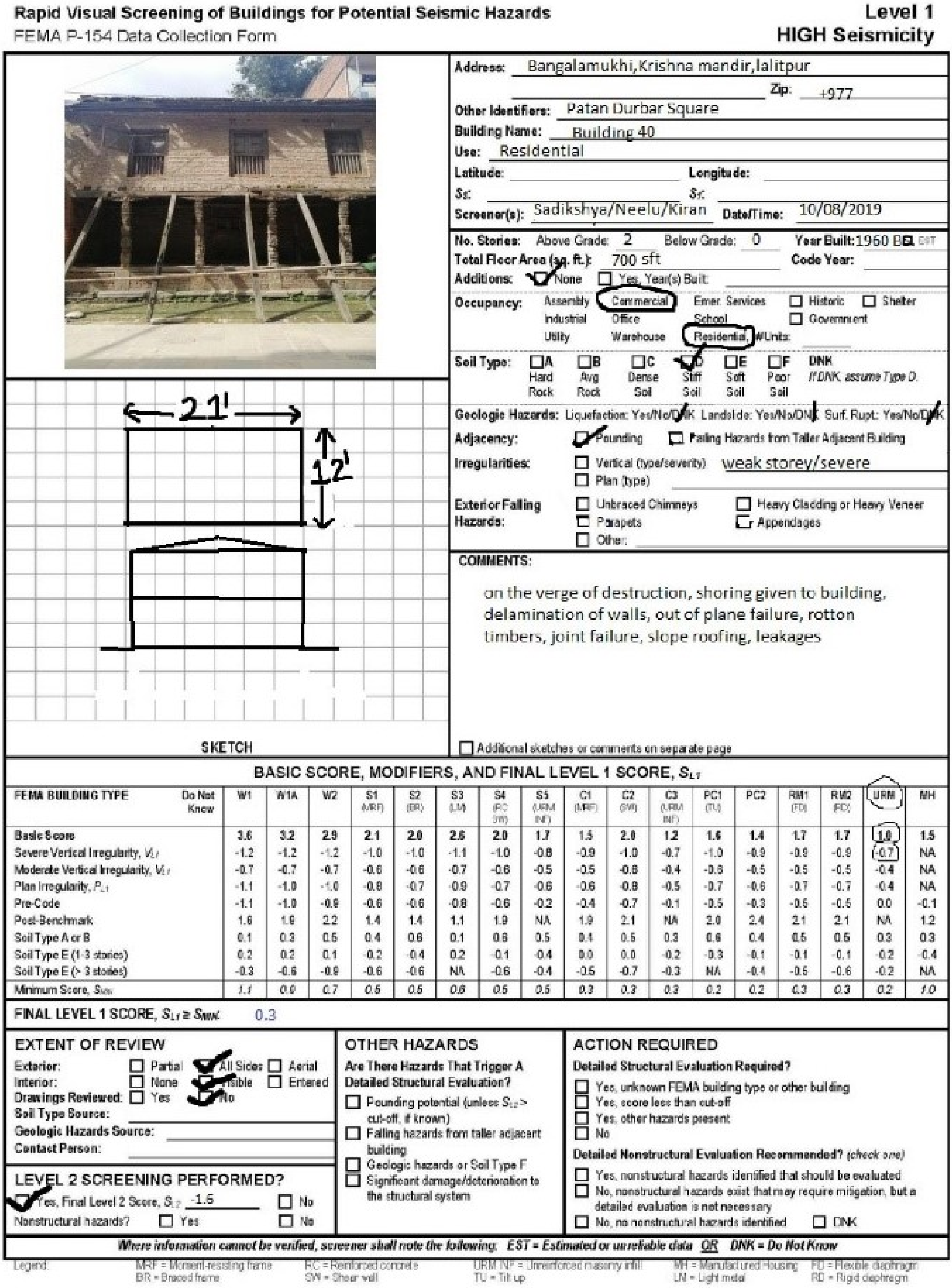
[3] Hemchandra Chaulagain, Hugo Rodrigues, Enrico Spacone, and Humberto Varum. Assessment of seismic strengthening solutions for existing low-rise rc buildings in nepal. *Earthq Struct*, 8(3):511–539, 2015.

[4] Federal Emergency Management Agency. *Rapid visual screening of buildings for potential seismic hazards: Supporting documentation*. Government Printing Office, 2015.

[5] ND Kunene. *Assessment of social vulnerability to seismic events: the case of Khuma, North West Province*. PhD thesis, North-West University, 2018.

[6] Pankaj Agrawal and Manish Shrikhande. *Earthquake resistant design of structures*. PHI Learning Pvt. Ltd., 2006.

Annexe-I



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

Level 1
HIGH Seismicity

Address: Bangalamukhi,Krishna mandir,lalitpur
Zip: +977
Other Identifiers: Patan Durbar Square
Building Name: Building 40
Use: Residential
Latitude: **Longitude:**
S_S: **S_1:**
Screener(s): Sadikshya/Neelu/Kiran **Date/Time:** 10/08/2019

No. Stories: Above Grade: 2 Below Grade: 0 **Year Built:** 1960 BE ☒ EST
Total Floor Area (sq. ft.): 700 sft **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) weak storey/severe
☐ Plan (type)
Exterior Falling Hazards: ☐ Unbraced Chimneys ☐ Heavy Cladding or Heavy Veneer
☐ Parapets ☐ Appendages
☐ Other:

COMMENTS:

on the verge of destruction, shoring given to building, delamination of walls, out of plane failure, rotton timbers, joint failure, slope roofing, leakages

☐ 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, $S_{L1} \geq S_{MIN}$: 0.3

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} -1.6 ☐ 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

Figure 11: RVS form: level-1

Annexe-II

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

Level 2 (Optional)
HIGH Seismicity

Optional Level 2 data collection to be performed by a civil or structural engineering professional, architect, or graduate student with background in seismic evaluation or design of buildings

Bldg Name: Building 40	**Final Level 1 Score:**	S_{L1} = 0.3	*(do not consider S_{MIN})*
Screener: Sadikshya/Neelu/Kiran	**Level 1 Irregularity Modifiers:**	*Vertical Irregularity,* V_{L1} = -0.7	*Plan Irregularity,* P_{L1} =
Date/Time: 10/08/2019	**ADJUSTED BASELINE SCORE:**	$S' = (S_{L1} - V_{L1} - P_{L1})$ = 1	

STRUCTURAL MODIFIERS TO ADD TO ADJUSTED BASELINE SCORE

Topic	Statement *(If statement is true, circle the "Yes" modifier; otherwise cross out the modifier.)*		Yes	Subtotals
Vertical Irregularity, V_{L2}	Sloping Site	W1 building: There is at least a full story grade change from one side of the building to the other.	-1.2	
		Non-W1 building: There is at least a full story grade change from one side of the building to the other.	-0.3	
	Weak and/or Soft Story *(circle one maximum)*	W1 building cripple wall: An unbraced cripple wall is visible in the crawl space.	-0.6	
		W1 house over garage: Underneath an occupied story, there is a garage opening without a steel moment frame, and there is less than 8' of wall on the same line (for multiple occupied floors above, use 16' of wall minimum).	-1.2	
		W1A building open front: There are openings at the ground story (such as for parking) over at least 50% of the length of the building.	[✓ -1.2]	
		Non-W1 building: Length of lateral system at any story is less than 50% of that at story above or height of any story is more than 2.0 times the height of the story above.	-0.9	
		Non-W1 building: Length of lateral system at any story is between 50% and 75% of that at story above or height of any story is between 1.3 and 2.0 times the height of the story above.	-0.5	
	Setback	Vertical elements of the lateral system at an upper story are outboard of those at the story below causing the diaphragm to cantilever at the offset.	-1.0	
		Vertical elements of the lateral system at upper stories are inboard of those at lower stories.	-0.5	
		There is an in-plane offset of the lateral elements that is greater than the length of the elements.	-0.3	
	Short Column/ Pier	C1,C2,C3,PC1,PC2,RM1,RM2: At least 20% of columns (or piers) along a column line in the lateral system have height/depth ratios less than 50% of the nominal height/depth ratio at that level.	-0.5	
		C1,C2,C3,PC1,PC2,RM1,RM2: The column depth (or pier width) is less than one half of the depth of the spandrel, or there are infill walls or adjacent floors that shorten the column.	-0.5	
	Split Level	There is a split level at one of the floor levels or at the roof.	-0.5	
	Other Irregularity	There is another observable severe vertical irregularity that obviously affects the building's seismic performance.	-1.0	V_{L2} = -1.2
		There is another observable moderate vertical irregularity that may affect the building's seismic performance.	-0.5	*(Cap at -1.2)*
Plan Irregularity, P_{L2}	Torsional irregularity: Lateral system does not appear relatively well distributed in plan in either or both directions. *(Do not include the W1A open front irregularity listed above.)*		-0.7	
	Non-parallel system: There are one or more major vertical elements of the lateral system that are not orthogonal to each other.		-0.4	
	Reentrant corner: Both projections from an interior corner exceed 25% of the overall plan dimension in that direction.		-0.4	
	Diaphragm opening: There is an opening in the diaphragm with a width over 50% of the total diaphragm width at that level.		-0.2	
	C1, C2 building out-of-plane offset: The exterior beams do not align with the columns in plan.		-0.4	P_{L2} = ______
	Other irregularity: There is another observable plan irregularity that obviously affects the building's seismic performance.		-0.7	*(Cap at -1.1)*
Redundancy	The building has at least two bays of lateral elements on each side of the building in each direction.		+0.3	
Pounding	Building is separated from an adjacent structure by less than 1% of the height of the shorter of the building and adjacent structure and:	The floors do not align vertically within 2 feet. *(Cap total pounding modifiers at -1.2)*	[✓ -1.0]	
		One building is 2 or more stories taller than the other.	-1.0	
		The building is at the end of the block.	-0.5	
S2 Building	"K" bracing geometry is visible.		-1.0	
C1 Building	Flat plate serves as the beam in the moment frame.		-0.4	
PC1/RM1 Bldg	There are roof-to-wall ties that are visible or known from drawings that do not rely on cross-grain bending. *(Do not combine with post-benchmark or retrofit modifier.)*		+0.3	
PC1/RM1 Bldg	The building has closely spaced, full height interior walls (rather than an interior space with few walls such as in a warehouse).		+0.3	
URM	Gable walls are present.		[✓ -0.4]	
MH	There is a supplemental seismic bracing system provided between the carriage and the ground.		+1.2	
Retrofit	Comprehensive seismic retrofit is visible or known from drawings.		+1.4	*M* = -1.4

FINAL LEVEL 2 SCORE, $S_{L2} = (S' + V_{L2} + P_{L2} + M) \geq S_{MIN}$: 1-1.2-1.4= -1.6 *(Transfer to Level 1 form)*

There is observable damage or deterioration or another condition that negatively affects the building's seismic performance: ☐ Yes ☑ No
If yes, describe the condition in the comment box below and indicate on the Level 1 form that detailed evaluation is required independent of the building's score.

OBSERVABLE NONSTRUCTURAL HAZARDS

Location	Statement (*Check "Yes" or "No"*)	Yes	No	Comment
Exterior	There is an unbraced unreinforced masonry parapet or unbraced unreinforced masonry chimney.		✓	
	There is heavy cladding or heavy veneer.		✓	
	There is a heavy canopy over exit doors or pedestrian walkways that appears inadequately supported.		✓	
	There is an unreinforced masonry appendage over exit doors or pedestrian walkways.		✓	
	There is a sign posted on the building that indicates hazardous materials are present.		✓	
	There is a taller adjacent building with an unanchored URM wall or unbraced URM parapet or chimney.		✓	
	Other observed exterior nonstructural falling hazard:	✓		Roof tiles may fall out
Interior	There are hollow clay tile or brick partitions at any stair or exit corridor.			
	Other observed interior nonstructural falling hazard:			

Estimated Nonstructural Seismic Performance (*Check appropriate box and transfer to Level 1 form conclusions*)

☐ Potential nonstructural hazards with significant threat to occupant life safety → Detailed Nonstructural Evaluation recommended
☐ Nonstructural hazards identified with significant threat to occupant life safety → But no Detailed Nonstructural Evaluation required
☑ Low or no nonstructural hazard threat to occupant life safety → No Detailed Nonstructural Evaluation required

Comments:

Figure 12: RVS form: level-2