A National Policy for Seismic Vulnerability Assessment of Buildings and Procedure for Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

Prof. Ravi Sinha and Prof. Alok Goyal
Department of Civil Engineering
Indian Institute of Technology Bombay

Background

India has experienced several devastating earthquakes in the past resulting in a large number of deaths and severe property damage. During the last century, 4 great earthquakes struck different parts of the country: (1) 1897 Great Assam earthquake, (2) 1905 Kangra earthquake, (3) 1934 Bihar-Nepal earthquake and (4) 1950 Assam earthquake. In recent times, damaging earthquakes experienced in our country include (1) 1988 Bihar Nepal earthquake, (2) 1991 Uttarkashi earthquake, (3) 1993 Killari earthquake, (4) 1997 Jabalpur earthquake, (5) 1999 Chamoli earthquake and (6) 2001 Bhuj earthquake. The frequent occurrence of damaging earthquakes clearly demonstrates the high seismic hazard in India and highlights the need for a comprehensive earthquake disaster risk management policy.

The urban areas have experienced very rapid population growth during the last few decades due to economic factors such as decrease in economic opportunities in rural areas and consequent migration to the urban areas. The rapid urbanisation has led to proliferation of slums and has severely strained the resources in our urban areas. Most recent constructions in the urban areas consist of poorly designed and constructed buildings. The older buildings, even if constructed in compliance with relevant standards at that time, may not comply with the more stringent specifications of the latest standards. Until the 2001 Bhuj earthquake, our country was fortunate not to experience a large earthquake in an urban area. The very high vulnerability of urban India was starkly demonstrated during the Bhuj earthquake, in which the urban centres of Bhuj, Anjar and Bhachau experienced extensive damage and losses to both new and old constructions. During this earthquake, a large number of recently constructed concrete buildings in Ahmedabad were also badly damaged even though the city is located over 200 km from the epicentre and these buildings should have suffered only minor damage if properly designed and constructed.

There is an urgent need to assess the seismic vulnerability of buildings in urban areas of India as an essential component of a comprehensive earthquake disaster risk management policy. Detailed seismic vulnerability evaluation is a technically complex and expensive procedure and can only be performed on a limited number of buildings. It is therefore very important to use simpler procedures that can help to rapidly evaluate the vulnerability profile of different types of buildings, so that the more complex evaluation procedures can be limited to the most critical buildings.

India's national vulnerability assessment methodology, as a component of earthquake disaster risk management framework should include the following procedures:

1. Rapid visual screening (RVS) procedure requiring only visual evaluation and limited additional information (Level 1 procedure). This procedure is recommended for all buildings.
2. Simplified vulnerability assessment (SVA) procedure requiring limited engineering analysis based on information from visual observations and structural drawings or on-site measurements (Level 2 procedure). This procedure is recommended for all buildings with high concentration of people.
3. Detailed vulnerability assessment (DVA) procedure requiring detailed computer analysis, similar to or more complex than that required for design of a new building (Level 3 procedure). This procedure is recommended for all important and lifeline buildings.

The building profile for different construction types that is developed on the basis of application of the first procedure (rapid visual screening) will be useful to short-list the buildings to which simplified vulnerability assessment procedure should be applied. The simplified vulnerability assessment procedure will provide more reliable assessment of the seismic vulnerability of the building, and will form the basis for determining need for more complex vulnerability assessment. The rapid visual screening will be useful for all buildings except critical structures where detailed vulnerability assessment is always required.

A simpler and more approximate procedure for vulnerability assessment (Level 0 procedure) can also be developed; however, this is not recommended due to the non-technical and highly empirical nature of Level 0 assessment procedure, which will make progressive transition to higher level procedures untenable. The use of Level 0 procedure in a national earthquake disaster risk management framework for urban areas may also communicate incorrect message regarding the complexity of the problem and make later migration to technically rigorous procedures difficult.

A procedure for rapid visual screening (RVS) was first proposed in the US in 1988, which was further modified in 2002 to incorporate latest technological advancements and lessons from earthquake disasters in the 1990s. This RVS procedure, even though originally developed for typical constructions in the US have been widely used in many other countries after suitable modifications. The most important feature of this procedure is that it permits vulnerability assessment based on walk-around of the building by a trained evaluator. The evaluation procedure and system is compatible with GIS-based city database, and also permits use of the collected building information for a variety of other planning and mitigation purposes.

The simplified vulnerability assessment (SVA) procedure is more complex (and therefore more accurate) than the RVS procedure. This method utilises engineering information such as size and strength of lateral load resisting members and more explicit information on the design ground motion. This data is used to carry out a highly simplified analysis of the structure to estimate the building drift. Since good correlation exists between building drift and damage, the analysis results can be used to estimate the potential seismic hazard of the building. Unlike the RVS procedure, the simplified vulnerability assessment requires the use of a computer; however, the required inputs can be collected in paper form for later entry into the software system. Such procedure has been developed for RCC buildings by IIT Bombay and the SVA procedure can be adopted on a large scale. The results of the simplified vulnerability assessment procedure can be used to determine the potential status of the selected buildings, and to further short-list the buildings requiring detailed vulnerability assessment.

The detailed vulnerability assessment (DVA) of a building requires carrying out comprehensive engineering analysis considering the nature of potential ground motions and the non-linear behaviour of the structural members. The detailed vulnerability assessment procedure is highly specialised and very few engineers in our country are currently capable of performing this task. The procedure also requires extensive as-built information regarding a building, which may not be readily available in the Indian context. Since very reliable information is essential for some critical facilities, the detailed vulnerability assessment procedure is most suitable for these structures. The DVA procedure should also be integrated in the national policy for seismic vulnerability assessment so that suitable tools and human resources can be developed as per national requirement.

While developing the earthquake disaster risk management framework, the current status of technical knowledge in India also needs to be considered. Our country currently does not have the required technical skills and trained manpower to implement any vulnerability assessment programme on a large scale. While broad consensus on the procedures for Level 1, Level 2 and Level 3 assessment exists among the experts, these procedures should also be benchmarked with experiences from our past earthquake. There is an urgent need to continue implementation of vulnerability assessment procedures in parallel with the other tasks of fine-tuning the technical aspects of these procedures based on benchmarking with past earthquake field data.

RVS Procedure, Objectives and Scope

The rapid visual screening method is designed to be implemented without performing any structural calculations. The procedure utilises a scoring system that requires the evaluator to (1) identify the primary structural lateral load-resisting system, and (2) identify building attributes that modify the seismic performance expected for this lateral load-resisting system. The inspection, data collection and decision-making process typically occurs at the building site, and is expected to take around 30 minutes for each building.

The screening is based on numerical seismic hazard and vulnerability score. The scores are based on the expected ground shaking levels in the region as well as the seismic design and construction practices for the city or region. The scores use probability concepts and are consistent with the advanced assessment methods. The RVS procedure can be integrated with GIS-based city planning database and can also be used with advanced risk analysis software. The methodology also permits easy and rapid reassessment of risk of buildings already surveyed based on availability of new knowledge that may become available in future due to scientific or technological advancements.

The RVS methodology can be implemented in both rural and urban areas. However, the variation in construction practice is more easily quantifiable for urban areas and the reliability of the RVS results for rural areas may be very low. It is therefore preferable that the RVS methodology be used for non-standard (or non-government) constructions in rural areas only with adequate caution. The RVS methodology is also not intended for structures other than buildings. For important structures such as bridges and lifeline facilities, the use of detailed evaluation methods is recommended. Even in urban areas, some very weak forms of non-engineered buildings are well-known for their low seismic vulnerability and do not require RVS to estimate their vulnerability. These building types are also not included in the RVS procedure.

Uses of RVS Results

The results from rapid visual screening can be used for a variety of applications that are an integral part of the earthquake disaster risk management programme of a city or a region. The main uses of this procedure are:

1. To identify if a particular building requires further evaluation for assessment of its seismic vulnerability.
2. To rank a city's or community's (or organisation's) seismic rehabilitation needs.
3. To design seismic risk management program for a city or a community.
4. To plan post-earthquake building safety evaluation efforts.
5. To develop building-specific seismic vulnerability information for purposes such as regional rating, prioritisation for redevelopment etc.
6. To identify simplified retrofitting requirements for a particular building (to collapse prevention level) where further evaluations are not feasible.
7. To increase awareness among city residents regarding seismic vulnerability of buildings.

Seismicity in India

As per IS 1893:2002 (Part 1), India has been divided into 4 seismic zones (Figure 1). The details of different seismic zones are given below:

Zone II	Low seismic hazard (maximum damage during earthquake may be upto MSK intensity VI)
Zone III	Moderate seismic hazard (maximum damage during earthquake may be upto MSK intensity VII)
Zone IV	High seismic hazard (maximum damage during earthquake may be upto MSK intensity VIII)
Zone V	Very high seismic hazard (maximum damage during earthquake may be of MSK intensity IX or greater)

When a particular damage intensity occurs, different building types experience different levels of damage depending on their inherent characteristics. For carrying out the rapid visual screening, only three hazard zones have been defined, corresponding to low seismic risk (Zone II), moderate seismic risk (Zone III) and high seismic risk (Zones IV and V). More precise categorisation of hazard zones between Zone IV and Zone V does not enable better assessment of structural vulnerability using RVS procedure due to the influence of a large number of other factors on the building performance when the ground shaking is very intense.

Building Types Considered in RVS Procedure

A wide variety of construction types and building materials are used in urban areas of India. These include local materials such as mud and straw, semi-engineered materials such as burnt brick and stone masonry and engineered materials such as concrete and steel. The seismic vulnerability of the different building types depends on the choice of building materials. The building vulnerability is generally highest with the use of local materials without engineering inputs and lowest with the use of engineered materials.

The basic vulnerability class of a building type is based on the average expected seismic performance for that building type. All buildings have been divided into six vulnerability class, denoted as Class A to Class F based on the European Macroseismic Scale (EMS-98) recommendations. The buildings in Class A have the highest seismic vulnerability while the buildings in Class F have lowest seismic vulnerability. A building of a given type, however, may have its vulnerability different from the basic class defined for that type depending on the condition of the building, presence of earthquake resistance features, architectural features etc. It is therefore possible to assign a vulnerability range for each building type to encompass the expected vulnerability considering the different factors affecting its likely performance. The vulnerability ranges and the basic vulnerability class of different building types are given in Table 1. The basic class is denoted by O in Table 1, while the brackets specify the likely range of vulnerability of the buildings.

The RVS procedure has considered 10 different building types, based on the building materials and construction types that are most commonly found in urban areas. These included both engineered constructions (designed and constructed by following the specifications) and non-engineered constructions (designed or constructed without following the specifications). Some masonry building types constructed using local materials are prevalent in urban areas but are not included in this methodology since their seismic vulnerability is known to be very high (vulnerability class A and B) and do not require visual screening to provide any additional information regarding their expected structural performance. These include all constructions using random rubble masonry in mud mortar, earthen walls, adobe and tin sheet constructions.

The likely damage to structures have been categorised in different grades depending on their impact on the seismic strength of the building. The different damage levels that have been recommended by European Macroseismic Scale (EMS-98) are described in Table 2.

Table 3 provides guidance regarding likely performance of the building in the event of design-level earthquake. This information can be used to decide the necessity of further evaluation of the building using higher level procedures. It can also be used to identify need for retrofitting, and to recommend simple retrofitting techniques for ordinary buildings where more detailed evaluation is not feasible. Generally, the score $S < 0.7$ indicates high vulnerability requiring further evaluation and retrofitting of the building.

Table 1. Seismic vulnerability classification for different structural types.

All buildings can be divided into the following primary categories: (1) masonry buildings, (2) RCC buildings, (3) steel buildings, and (4) timber buildings. These can be further divided into various sub-categories. Based on their seismic resistance the following vulnerability classification has been proposed based on the European Macroseismic Scale (EMS-98) and modified during development of World Housing Encyclopaedia.

<table>
<tr><th rowspan="2">Mate-rial</th><th rowspan="2">Type of Load-Bearing Structure</th><th rowspan="2">Sub-Types</th><th colspan="6">Vulnerability Class</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr>
<tr><td rowspan="14">Masonry</td><td rowspan="2">Stone Masonry Walls</td><td>Rubble stone (field stone) in mud/lime mortar or without mortar (usually with timber roof)</td><td>O</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Massive stone masonry (in lime/cement mortar)</td><td>|-</td><td>-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td rowspan="4">Earthen/Mud/ Adobe/Rammed Earthen Walls</td><td>Mud walls</td><td>O</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mud walls with horizontal wood elements</td><td>|-</td><td>O</td><td>-|</td><td></td><td></td><td></td></tr>
<tr><td>Adobe block walls</td><td>O</td><td>-|</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rammed earth/Pise construction</td><td>O</td><td>-|</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Burnt clay brick/block masonry walls</td><td>Unreinforced brick masonry in mud mortar</td><td>|-</td><td>O</td><td>-|</td><td></td><td></td><td></td></tr>
<tr><td>Unreinforced brick masonry in mud mortar with vertical posts</td><td>|-</td><td>O</td><td>-</td><td>-|</td><td></td><td></td></tr>
<tr><td>Unreinforced brick masonry in lime mortar</td><td>|-</td><td>O</td><td>-</td><td>-|</td><td></td><td></td></tr>
<tr><td>Unreinforced brick masonry in cement mortar with reinforced concrete floor/roof slabs</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Unreinforced brick masonry in cement mortar with lintel bands (various floor/roof systems)</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Confined brick/block masonry with concrete posts/tie columns and beams</td><td></td><td></td><td>|-</td><td>O</td><td>-|</td><td></td></tr>
<tr><td rowspan="2">Concrete block masonry</td><td>Unreinforced, in lime/cement mortar (various floor/roof systems)</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Reinforced, in cement mortar (various floor/roof systems)</td><td></td><td></td><td>|-</td><td>O</td><td>-|</td><td></td></tr>
<tr><td rowspan="8">Structural concrete</td><td rowspan="6">Moment resisting frame</td><td>Designed for gravity loads only (predating seismic codes i.e. no seismic features)</td><td>|-</td><td>-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Designed with seismic features (various ages)</td><td></td><td></td><td>|-</td><td>-</td><td>O</td><td>-|</td></tr>
<tr><td>Frame with unreinforced masonry infill walls</td><td></td><td>|-</td><td>O</td><td>-</td><td>-|</td><td></td></tr>
<tr><td>Flat slab structure</td><td></td><td>|-</td><td>O</td><td>-</td><td>-|</td><td></td></tr>
<tr><td>Precast frame structure</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Frame with concrete shear walls (dual system)</td><td></td><td></td><td>|-</td><td>-</td><td>O</td><td>-|</td></tr>
<tr><td rowspan="2">Shear wall structure</td><td>Walls cast in-situ</td><td></td><td></td><td></td><td>|-</td><td>O</td><td>-|</td></tr>
<tr><td>Precast wall panel structure</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td rowspan="5">Steel</td><td rowspan="3">Moment-resisting frame</td><td>With brick masonry partitions</td><td></td><td></td><td>|-</td><td>O</td><td>-</td><td>-|</td></tr>
<tr><td>With cast in-situ concrete walls</td><td></td><td></td><td>|-</td><td>-</td><td>O</td><td>-|</td></tr>
<tr><td>With lightweight partitions</td><td></td><td></td><td></td><td>|-</td><td>O</td><td>-|</td></tr>
<tr><td>Braced frame</td><td>With various floor/roof systems</td><td></td><td></td><td></td><td>|-</td><td>O</td><td>-|</td></tr>
<tr><td>Light metal frame</td><td>Single storey LM frame structure</td><td></td><td></td><td>|-</td><td>-</td><td>O</td><td>-|</td></tr>
<tr><td rowspan="6">Wooden structures</td><td rowspan="6">Load-bearing timber frame</td><td>Thatch roof</td><td>|-</td><td>-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Post and beam frame</td><td></td><td></td><td>|-</td><td>O</td><td>-|</td><td></td></tr>
<tr><td>Walls with bamboo/reed mesh and post (Wattle and Daub)</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Frame with (stone/brick) masonry infill</td><td>|-</td><td>-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Frame with plywood/gypsum board sheathing</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Frame with stud walls</td><td></td><td></td><td></td><td>|-</td><td>O</td><td>-|</td></tr>
</table>

O Most likely vulnerability class
|- Most likely lower range
-| Most likely upper range

Table 2. Classification of damage to buildings.

The damage classifications based on the European Macroseismic Scale (EMS-98) define building damage to be in Grade 1 to Grade 5. The damage classifications help in evaluation of earthquake intensity following an earthquake. They are used in RVS to predict potential damage of a building during code-level earthquake.

Classification of damage to masonry buildings	**Classification of damage to reinforced concrete 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 1: Negligible to slight damage** **(No structural damage, slight non-structural damage)** Fine cracks in plaster over frame members or in walls at the base. Fine cracks in partitions and infills.
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 and mumptys.	**Grade 2: Moderate damage** **(Slight structural damage, moderate non-structural damage)** Cracks in columns and beams of frames and in structural walls. Cracks in partition and infill walls; fall of brittle cladding and plaster. Falling mortar from the joints of wall panels.
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 etc.).	**Grade 3: Substantial to heavy damage (moderate structural damage, heavy non-structural damage)** Cracks in columns and beam-column joints of frames at the base and at joints of coupled walls. Spalling of concrete cover, buckling of reinforced bars. Large cracks in partition and infill walls, failure of individual infill panels.
Grade 4: 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.	**Grade 4: Very heavy damage (heavy structural damage, very heavy non-structural damage)** Large cracks in structural elements with compression failure of concrete and fracture of rebars; bond failure of beam reinforcing bars; tilting of columns. Collapse of a few columns or of a single upper floor.
Grade 5: Destruction (very heavy structural damage) Total or near total collapse of the building.	**Grade 5: Destruction (very heavy structural damage)** Collapse of ground floor parts (e.g. wings) of the building.

Table 3. Expected damage level as function of RVS score.

The probable damage can be estimated based on the RVS score and is given below. However, it should be realised that the actual damage will depend on a number of factors that are not included in the RVS procedure. As a result, this table should only be used as indicative to determine the necessity of carrying out simplified vulnerability assessment of the buildings. These results can also be used to determine the necessity of retrofitting buildings where more comprehensive vulnerability assessment may not be feasible.

RVS 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 < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

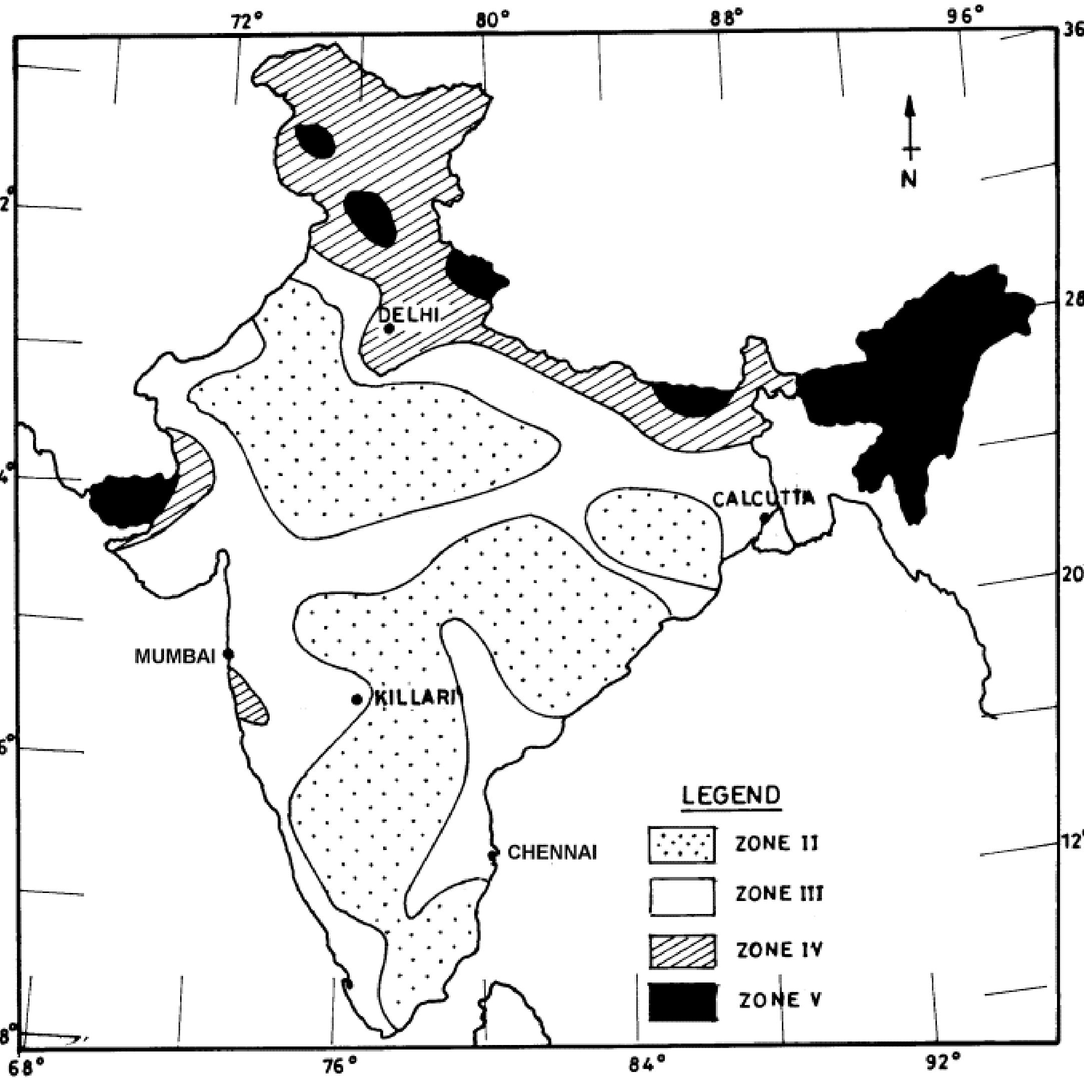

Figure 1. Seismic zoning map of India (IS 1893-2002 (Part 1)).

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form **(Seismic Zone II)**

Address: ____________________
____________________ Pin ____________
Other Identifiers ____________________
GPS Coordinates (if available) ____________________
No. Stories ____________ Year Built ____________
Surveyor ____________ Date ____________
Total Floor Area (sq. ft./sq. m) ____________________
Building Name ____________________
Use ____________________
Current Visual Condition: Excellent ☐/ Good ☐/ Damaged ☐/ Distressed ☐
Building on Stilts / Open Ground Floor: Yes ☐ / No ☐
Construction Drawings Available: Yes ☐ / No ☐

Plan and Elevation Scale:

PHOTOGRAPH
(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY					**SOIL TYPE (IS 1893:2002)**			**FALLING HAZARDS**			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office Residential School	Max. Number of Persons 0 – 10 101 – 1000	 11 – 100 1000+	**Type I** Hard Soil	**Type II** Medium Soil	**Type III** Soft Soil	☐ Chimneys	☐ Parapets	☐ Cladding	☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**6.0**	**4.6**	**4.6**	**4.4**	**4.8**	**4.4**	**4.6**	**4.8**	**4.6**	**3.6**
Mid Rise (4 to 7 stories)	N/A	+0.2	N/A	+0.4	-0.2	-0.4	-0.2	-0.4	-0.6	-0.6
High Rise (>7 stories)	N/A	+1.0	N/A	+1.0	0.0	-0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-1.5	-2.0	-2.0	-1.5	-2.0	-1.5	-1.5
Plan Irregularity	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
Code Detailing	N/A	+0.4	N/A	+0.6	+0.4	N/A	N/A	N/A	N/A	N/A
Soil Type II	-0.4	-0.8	-0.4	-0.6	-0.4	-0.4	-0.2	-0.4	-0.4	-0.4
Soil Type III	-0.8	-1.4	-1.0	-1.4	-0.8	-0.8	-0.8	-0.8	-0.8	-0.8
Liquifiable Soil	-2.0	-2.0	-2.0	-2.0	-2.0	-2.0	-1.6	-1.4	-1.4	-1.4

FINAL SCORE, *S*

Result Interpretation (*Likely building performance*)

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 < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

Further Evaluation Recommended

YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm
SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)
URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form **(Seismic Zone III)**

Address: ______________________________
______________________________ Pin __________
Other Identifiers ______________________________
GPS Coordinates (if available) ______________________________
No. Stories ______________ Year Built ______________
Surveyor ______________ Date ______________
Total Floor Area (sq. ft./sq. m) ______________________________
Building Name ______________________________
Use ______________________________
Current Visual Condition: Excellent ☐/ Good ☐/ Damaged ☐/ Distressed ☐
Building on Stilts / Open Ground Floor: Yes ☐ / No ☐
Construction Drawings Available: Yes ☐ / No ☐

Plan and Elevation Scale:

PHOTOGRAPH

(OR SPECIFY PHOTOGRAPH NUMBERS)

OCCUPANCY					**SOIL TYPE (IS 1893:2002)**			**FALLING HAZARDS**			
Assembly Commercial Emer.Service	Govt. Historic Industrial	Office Residential School	Max. Number of Persons 0 – 10 101 – 1000	 11 – 100 1000+	**Type I** Hard Soil	**Type II** Medium Soil	**Type III** Soft Soil	☐ Chimneys	☐ Parapets	☐ Cladding	☐ Other:

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**4.4**	**3.6**	**3.8**	**3.0**	**3.6**	**3.2**	**3.4**	**3.6**	**3.0**	**2.4**
Mid Rise (4 to 7 stories)	N/A	+0.4	N/A	+0.2	+0.4	+0.2	+0.4	+0.4	-0.4	-0.4
High Rise (>7 stories)	N/A	+0.8	N/A	+0.5	+0.8	+0.4	N/A	N/A	N/A	N/A
Vertical Irregularity	-3.0	-2.0	N/A	-2.0	-2.0	-2.0	-2.0	-2.0	-1.5	-1.5
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+1.4	N/A	+1.2	+1.6	+1.2	+2.0	+2.0	N/A	N/A
Soil Type II	-0.2	-0.6	-0.6	-0.6	-0.8	-0.6	-0.8	-0.8	-0.4	-0.4
Soil Type III	-0.6	-1.2	-1.0	-1.0	-1.2	-1.0	-1.2	-1.2	-0.8	-0.8
Liquifiable Soil	-1.2	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6	-1.6

FINAL SCORE, *S*

Result Interpretation (*Likely building performance*)

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 < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage
S > 3.0	Probability of Grade 1 damage

Further Evaluation Recommended

YES NO

* = Estimated, subjective, or unreliable data
DNK = Do Not Know

FRAME = Steel Frame
INF = Burnt Brick Masonry Infill Wall
MRF = Moment-Resisting Frame
FD = Flexible Diaphragm

SW = Shear Wall
LM = Light Metal
BAND = Seismic Band
URM4 = Unreinforced masonry (lime mortar)

URM3 = Unreinforced burnt brick or stone masonry (cem mortar)
RD = Rigid diaphragm

Rapid Visual Screening of Buildings for Potential Seismic Vulnerability

FEMA-154/ATC-21 Based Data Collection Form **(Seismic Zones IV & V)**

Address: ______________________________

______________________________ Pin ____________

Other Identifiers ______________________________

GPS Coordinates (if available) ______________________________

No. Stories ____________ Year Built ____________

Surveyor ____________ Date ____________

Total Floor Area (sq. ft./sq. m) ______________________________

Building Name ______________________________

Use ______________________________

Current Visual Condition: Excellent ☐/ Good ☐/ Damaged ☐/ Distressed ☐

Building on Stilts / Open Ground Floor: Yes ☐ / No ☐

Construction Drawings Available: Yes ☐ / No ☐

PHOTOGRAPH

(OR SPECIFY PHOTOGRAPH NUMBERS)

Plan and Elevation Scale:

OCCUPANCY					SOIL TYPE (IS 1893:2002)			FALLING HAZARDS			
Assembly	Govt.	Office	Max. Number of Persons		**Type I** Hard Soil	**Type II** Medium Soil	**Type III** Soft Soil	☐ Chimneys	☐ Parapets	☐ Cladding	☐ Other:
Commercial	Historic	Residential	0 – 10	11 – 100							
Emer.Service	Industrial	School	101 – 1000	1000+							

BASIC SCORE, MODIFIERS, AND FINAL SCORE, S

BUILDING TYPE	Wood	S1 (FRAME)	S2 (LM)	C1 (MRF)	C2 (SW)	C3 (INF)	URM1 (BAND+RD)	URM2 (BAND+FD)	URM3	URM4
Basic Score	**3.8**	**2.8**	**3.2**	**2.5**	**2.8**	**2.6**	**2.8**	**2.8**	**1.8**	**1.4**
Mid Rise (4 to 7 stories)	N/A	+0.2	N/A	+0.4	+0.4	+0.2	+0.4	+0.4	-0.2	-0.4
High Rise (>7 stories)	N/A	+0.6	N/A	+0.6	+0.8	+0.3	N/A	N/A	N/A	N/A
Vertical Irregularity	-2.0	-1.0	N/A	-1.5	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
Plan Irregularity	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5	-0.5
Code Detailing	N/A	+0.4	N/A	+0.2	+1.4	+0.2	N/A	N/A	N/A	N/A
Soil Type II	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
Soil Type III	-0.8	-0.6	-0.6	-0.6	-0.6	-0.4	-0.6	-0.6	-0.6	-0.6
Liquifiable Soil	-0.8	-1.2	-1.0	-1.2	-0.8	-0.8	-0.6	-0.6	-0.8	-0.8

FINAL SCORE, *S*

Result Interpretation (*Likely building performance*)

		Further Evaluation Recommended
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 < 3.0	High probability of Grade 2 damage; Very high probability of Grade 1 damage	**YES NO**
S > 3.0	Probability of Grade 1 damage	

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