A Primer on

Rapid Visual Screening (RVS)

Consolidating Earthquake Safety Assessment Efforts in India

October 2020

National Disaster Management Authority

A Primer on Rapid Visual Screening

A Primer on Rapid Visual Screening

National Disaster Management Authority
Ministry of Home Affairs
Government of India

सत्यमेव जयते

प्रधान मंत्री

Prime Minister

MESSAGE

I am pleased to learn that National Disaster Management Authority (NDMA) has developed a Rapid Visual Screening (RVS) Primer for better insight into structural safety in the wake of earthquake risks.

The primer will serve as a pioneering document to screen various kinds of buildings for their structural stability. This will help assess and estimate the possible damage during an earthquake. Structural status of buildings before and after the earthquake will shape our preparedness and guide our response.

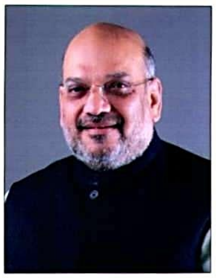
The document will surely provide an effective checkpoint for government institutions, industries, private organisations and local bodies against the threats posed by earthquakes.

The RVS Primer, prepared jointly by NDMA and IIIT Hyderabad, will go a long way in making our buildings safer and more resilient to earthquakes. It will also enhance the sense of security among citizens and help in minimising the loss of life and property.

Best wishes to NDMA for its endeavours.

(Narendra Modi)

अमित शाह
AMIT SHAH



सत्यमेव जयते

गृह मंत्री
भारत
HOME MINISTER
INDIA

संदेश

यह हर्ष का विषय है कि राष्ट्रीय **आपदा प्रबंधन प्राधिकरण (NDMA)** ने IIIT हैदराबाद के साथ **रैपिड विजुअल स्क्रीनिंग (आर.वी.एस.) प्राइमर** दस्तावेज विकसित किया है। मुझे विश्वास है कि यह प्राइमर इमारतों की संरचनात्मक सुरक्षा का त्वरित मूल्यांकन के माध्यम से भूकंप के जोखिम को कम करने के लिए एक रास्ता प्रदान करेगा।

यह प्राइमर राष्ट्रीय और अंतर्राष्ट्रीय प्रथाओं के अनुरूप तैयार किया गया है और भूकंप के जोखिमों को समझने पर केन्द्रित है। मुझे आशा है कि यह प्राइमर कम समय में मौजूदा 30 करोड इमारतों की संरचनात्मक स्थिति का मूल्यांकन करने में मदद करेगा और उन इमारतों में अंतदृष्टि प्रदान करेगा जिन पर लंबे समय में ध्यान केन्द्रित करने एवं कमजोर इमारतों की स्क्रीनिंग के लिए एक बुनियादी उपकरण के रूप में सेवा करेगा और भूकंप संभावित जोखिम को कम करने हेतु उचित कदम उठाने के लिए निर्णय लेने वालों की सहायता करेगा।

मैं आशा करता हूँ कि सभी राज्य और केन्द्र शासित प्रदेश की सरकारें भूकंप के जोखिम के आकलन को एक औपचारिक गतिविधि बनायें जिससे आपदा जोखिम मुक्त भारत की दृष्टि को पूरा किया जा सके। मैं इस रैपिड विजुअल स्क्रीनिंग प्राइमर को जारी करने के लिए राष्ट्रीय आपदा प्रबंधन और अन्य हित धारकों को अपनी शुभकामनाएँ प्रेषित करता हूँ।

शुभकामनाओं सहित !

(अमित शाह)

Office : Ministry of Home Affairs, North Block, New Delhi-110001
Tel. : 23092462, 23094686, Fax : 23094221
E-mail : hm@nic.in

Acknowledgements

I acknowledge the valuable contribution of Prof. Pradeep Kumar Ramancharla, International Institute of Information Technology (IIIT), Hyderabad and his team of research students for preparing this PRIMER.

The credit is also due to Technical experts of the field who constantly guided the development of the RVS Primer. I also acknowledge the team of experts who participated in the discussion meetings held at IIIT Hyderabad and gave critical inputs in the development of the RVS Primer.

It is hoped that this report will prove to be useful to the concerned engineers, city officials, town planners and other stakeholders to undertake the rapid visual screening as well as detailed earthquake safety activities for earthquake risk reduction.

(Sandeep Poundrik)
Adviser (Mitigation)

Executive Summary

The *Disaster Management Act, 2005* seeks a paradigm shift from the hitherto *Relief– centric* approach to a *Mitigation–* and *Preparedness–centric* approach with continued focus on *Response*, which is *proactive*, *holistic* and *integrated*. In keeping with this *Act*, NDMA took steps to initiate actions that are not only significant and far-reaching, but also holistic and integrated. One of the actions identified was to assess *earthquake risk* of the existing *built environment*. It was noticed that a clear understanding is required on the various *methods* of earthquake risk assessment currently practiced. Buildings were in focus to begin with. Since the total number of buildings is well over 30.5 Crores, *preliminary screening* is required. It was noticed that to undertake this, a number of methods were available for this screening. Thus, NDMA charged IIIT Hyderabad with the task of hosting a meeting of those working in the subject of earthquake safety assessment and deliberate on these available methods of *preliminary screening* and providing a road map. It was required to prepare *A Primer on Rapid Visual Screening (RVS) – Consolidating Earthquake Safety Assessment Efforts in India.*

Background

Rapid Visual Survey (RVS) of buildings has caught momentum and the attention of the decision makers in India. There is a need to clarify RVS in clear and tangible terms, so that the end users are made aware of the outcomes of such an assessment. Hence, towards ensuring the *objective use* of RVS of buildings, the key questions that need to be answered are:

(1) What are the uses of *Rapid Visual Survey (RVS)* of houses, and what it is *not intended for*?

(2) Why the RVS score is *not helpful* in its present form?

(3) How should data be collected after earthquakes to benchmark the RVS Method?

To discuss and understand the above, a two-day *discussion meeting* was organized by NDMA at IIIT Hyderabad during 30-31 August 2017. Around 20 participants attended the meeting (List of Attendees is presented in *Annexure A*).

Need

During the meeting, urgency was expressed for agreeing on the *METHODS of earthquake safety assessment of buildings* and engagement was sought of the participants to focus their thoughts to set *the broad boundaries* of the roadmap for *building consensus* on the methods for earthquake safety assessment of buildings. Also, it was felt that there are challenges associated with this effort, because a significant part of the existing stock of buildings is unregulated in India, resulting in a wide spectrum of housing typologies.

The salient suggestions that emerged during the meeting are:

(1) RVS can be done *BEFORE* the earthquake and *AFTER* the earthquake.

(2) The uses of RVS *before* an earthquake are:

- (a) Assess the status of buildings constructed along the five domains, namely *siting*, *architectural form*, *structural system*, *material condition,* and *construction details*, and use the same in initiating modifications of bye-laws and Indian Standards;

(b) Capture *likely damages* and guide local communities with *pre-emptive preparedness* to address the same before and after earthquakes, and use the same in earthquake disaster preparedness of the area;
(c) Understand *relative earthquake vulnerabilities* in the different geographical regions towards reducing mortalities, and use the same in steering broad municipal actions within and across the States and UTs in India;
(d) Arrive at preliminary estimates of *life loss and economic loss*, and use the same in pushing for actions towards earthquake disaster mitigation;
(e) Correlate *field* and *experimental data* with *analytically derived fragility functions*, and use the same in refining the penalty scores employed in the RVS Method.

(3) The uses of RVS *after* an earthquake are:
(a) Determine whether *immediate occupancy* can be allowed by owners of damaged buildings after an earthquake; and
(b) Determine the category of damage towards finalizing the *financial aid* to be offered by governments.

The *nuances* and *issues* behind assessment of buildings in the India context, where the typologies are large, and the variation within the typologies is significant. It was suggested that the typologies should be identified, and the variation within each typology should be addressed by negative or positive score over the base score for variation from accepted features. Further, while actions taken before the earthquake will help in affecting *policy changes*, those after the earthquake will help in *meeting legal requirements* by governments.

Levels of Assessment

The following *four levels* of earthquake safety assessment of buildings, namely are proposed:

Level 1: *Simplified QUALITATIVE Assessment* (or *Rapid VISUAL Screening*) for determining *Pre-Earthquake Assessment and post-earthquake assessment of occupancy* of damaged buildings;

Level 2: *Detailed QUALITATIVE Assessment* (or *Conceptual VISUAL Survey*) for undertaking pre-earthquake typology study along five domains (namely *siting*, *architectural form*, *structural system*, *material condition*, and *construction details*) that affect the degree of damage in buildings and *post-earthquake assessment;*

Level 3: *Simplified QUANTITATIVE Assessment* (or *Horizontal Shear Capacity*) for estimating pre-earthquake the *overall horizontal safety* of buildings, and further prioritize buildings for retrofitting; and

Level 4: *Detailed QUANTITATIVE Assessment* (or *Complete Structural Safety*) for identifying *deficiencies in components & overall building*, and arriving at details of retrofitting to be undertaken (namely *type*, *location* and *level* of retrofitting).

In *Level 1* and *Level 2* assessments, a telescopic approach is adopted. *Life threatening factors* and *economic loss inducing factors* are segregated. The *life-threatening factors* are taken as the basis for RVS mentioned in *Level 1 Assessment*, and all are considered for *Level 2 Assessment*. Also, all four methods proposed above should deal separately the *Structure* and the *Non-Structural Elements*, with the following domains under each of these:

(1) **Structure**: *Siting and Foundation*, *Architectural Form*, *Structural System*, *Material Condition* and *Construction Details*; and
(2) **Non-Structural Elements**: *Acceleration and/or Displacement Hazards*, and *Lifelines*.

The outcome of the RVS should help in prioritizing the level of life losses that can be expected in the building stock, and initiating possible changes in the bye-laws to outlaw unsafe typologies.

These Assessment Methods and Forms should be simple and make the potential users engage *thoughtfully* and *logically* into the assessment process. The method (and the forms) may be visited in 3-5 years, should new information become available from the experience of *Earthquake Safety Assessment of Buildings* in the interim period.

Considering the above framework and suggestions, a draft report on *A Primer on Rapid Visual Screening* was prepared by IIIT Hyderabad and a one-day discussion meeting was organized by NDMA at IIIT Hyderabad on 9 January 2020 to discuss and finalize the same. Again around 20 participants attended this discussion meeting (List of Attendees is presented in *Annexure A*).

Based on the discussions with the concerned domain experts, the recommended forms for *Pre- Earthquake* and *Post-Earthquake Level 1 Assessments* for 7 building typologies (These forms are presented in *Annexure B*) is developed.

The forms are developed to tag the various building attributes in terms of Red, Yellow and Green. If one of the Red category attributes is present in the building, the building would fall in the Red Category. Similarly, one Yellow category attributes are present with no Red category attributes, the building would fall in the yellow category.

The Way Forward…

Wide dissemination of the *PRIMER* to public may be initiated through *National Earthquake Safety* initiatives, towards highlighting its benefits to various sections of the society; teachers, students, professional architects and engineers may develop better understanding of the structural behavior. The concerned stakeholders may document the building typology and develop inventory of identified building typologies to carry out the building safety assessment, vulnerability assessment and retrofitting thereon.

Towards demystifying the subject of *Rapid Visual Screening*, it is proposed that a *MANUAL* be prepared to clarify the intent, method, process, forms and roles of stakeholders. The development and use of the *MANUAL* could be:

(1) *Academia and R&D Organisations*
- (a) Define an *Ideal House*;
- (b) Arrive at *penalties* for each departure, & maximum penalties for each domain, and
- (c) Document Housing Typologies.

(2) *Industries*
- (a) Make use of the forms and partner in formal studies.

(3) *Governments*
- (a) Take the outcomes and initiate changes in bye-laws and standards.

Also, it was felt that the data collected after earthquake should be of *uniform format*; this can be possible, only if the *Post-Earthquake Damage Assessment Teams* use the same forms and are trained formally in the process of collection of data. It was proposed to initiate the program of training *Post-Earthquake Damage Assessment Teams*, especially in Seismic Zones IV and V.

Project Team

1. International Institute of Information Technology, Hyderabad

1. Prof.Ramancharla Pradeep Kumar
2. Aniket Bhalkikar
3. Pulkit Dilip Velani
4. Pammi Raghu Nandan Vyas
5. Bharat Prakke
6. Neelima V S Patnala
7. Niharika Talyan

2. Domain Experts provided valuable inputs

1. Prof. C.V.R. Murty, IIT Madras
2. Prof. Ravi Sinha, IIT Bombay
3. Prof. Yogendra Singh, IIT Roorkee
4. Prof. Rupen Goswami, IIT Madras
5. Dr. Hemant B. Kaushik, Associate Professor, IIT Guwahati
6. Dr. Goutam Mondal, Assistant Professor, IIT Bhubaneswar
7. Dr. Dipti Ranjan Sahoo, Associate Professor, IIT Delhi
8. Dr. Sunitha Palissery, Assistant Professor, IIIT Hyderabad
9. Dr. Ajay P. Chourasia, Chief Principal Scientist, CBRI, Roorkee
10. Dr. Hemant Kumar Vinayak, Assistant Professor, NIT, Hamirpur
11. Dr.O. R. Jaiswal, Professor, VNIT, Nagpur
12. Dr. Surendranadh Somala, Assistant Professor, IIT Hyderabad
13. Dr. Srinagesh Davuluri, Head, Seismology Laboratory, CSIR NGRI, Hyderabad
14. Dr. R. K. Chadha, Raja Ramanna Fellow, CSIR NGRI, Hyderabad
15. Shri Hari Kumar, Managing Director, Geohazards Society, New Delhi
16. Shri Arvind K. Jaiswal, Chief Consultant, EON Designers, Secunderabad
17. Shri Jaswant N. Arlekar, Principal Consultant, M/s Mandrekar & Associates, Mumbai

Contents

1.
Earthquake Safety Assessment of Buildings

1.1 INTRODUCTION

In India, many houses are vulnerable to earthquake shaking effects, and the main reasons behind this are:

(1) The *self-styled* approach to development of built environment – including from the standpoints of both *structural design* and *construction*. It is a common practice in India that house is constructed at Owner's convenience and choice, without any involvement of a *competent* engineer or architect;

(2) Lack of awareness of the provisions *Earthquake Standards* for *design* and *construction*; and

(3) Majority of the land area in the country is under the threat of *moderate* to *severe* earthquake shaking.

As a consequence, buildings have performed poorly during past earthquakes. With over *300 million* buildings already built in India by the above method, the above deficiencies raise a critical need to assess the earthquake safety of these existing buildings.

1.2 FOUR LEVELS OF ASSESSMENT

Four levels of assessment can be undertaken to estimate the vulnerability of buildings to strong earthquake shaking, namely:

(1) *Rapid Visual Screening* (RVS),
(2) *Detailed Visual Study* (DVS),
(3) *Simplified Quantitative Assessment* (SQA), and
(4) *Detailed Quantitative Assessment* (DQA).

The use of these four levels of assessment are summarized in Table 1 and elaborated in the sections below.

1.2.1 Rapid Visual Survey (RVS)

RVS can be conducted: (a) before an earthquake, and (b) after an earthquake.

(a) RVS before an Earthquake

The main purpose of this assessment is to *understand the risk* that a community, town or city is faced with, from the standpoint of collapse of houses during the expected earthquake shaking in the region of the site. Normally, an experienced group of assessors should take about 15-30 minutes per building, by standing in front of the building without having to enter it, and without having to undertake any technical calculations. This assessment method is useful for projecting a *scenario* (with a preliminary level estimate of possible damage during an earthquake event of expected intensity of shaking in the region of the building site under consideration). This method is based purely on *visual* observations; hence, it provides a good *overall idea* of safety, and does not guarantee *high accuracy*. Clearly, detailed assessments are necessary to ascertain accurately the earthquake safety of the building.

Table 1: Uses of the *Four Levels* of *Earthquake Safety Assessments*

Level	*Assessment Method*	*Timing of Assessment*	*Factors being examined*	*Focus of Level of Assessment*
1	Rapid Visual Screening	BEFORE the Earthquake	Life Threatening Factors	Understanding treat to life
		AFTER the Earthquake	Life Threatening Factors	Determining whether the building can be occupied in its current condition after the earthquake, based on available capacity to resist existing vertical loads (without any effects of earthquake shaking)
2	Detailed Visual Study	BEFORE the Earthquake	Life Threatening Factors + Economic Loss Inducing Factors	Understanding de-alienating factors that result in structural deficiencies in the building from the points of view of: (a) *Architectural Form*, (b) *Material Choices*, (c) *Structural System*, (d) Construction Details, and (e) *Maintenance Quality*.
		AFTER the Earthquake	Life Threatening Factors + Economic Loss Inducing Factors	Understanding and de-alienating factors that result in structural deficiencies in the building from the points of view of: (a) *Architectural Form*, (b) *Material Choices*, (c) *Structural System*, (d) Construction Details, and (e) *Maintenance Quality*. Improving the assessment method based on performance of buildings, especially from the standpoint of *penalty factors* of *Life-Threatening Factors* and *Economic Loss Inducing Factors*
3	Simplified Quantitative Assessment	BEFORE and AFTER the Earthquake	Overall Lateral Shear Force Capacity	Check one of the three fundamental safety requirements of overall safety, namely *Horizontal Force Equilibrium*, *i.e.,* Lateral Shear Force Demand (specified by Earthquake *Hazard* standard) to be less than the Lateral Shear Force Capacity (specified by Earthquake Assessment standard)
4	Detailed Quantitative Assessment	BEFORE and AFTER the Earthquake	Overall Earthquake Safety of Building, and Earthquake Safety of Structural Components	Undertake all checks as laid down in the classical theory of structures, using equilibrium, compatibility and constitutive law, to ensure overall safety of the building and safety of each component of the building

(b) RVS after an Earthquake

The main purpose of this assessment is to *ascertain* whether or not the building affected during an earthquake can be occupied by tenants *immediately* after the earthquake; after such an assessment, buildings are tagged as *green*, *yellow* and *red*. *Green* tag represents that the building *can be occupied* after the earthquake, *yellow* tag that the building *can be occupied after some alterations*, and *red* tag that the building *cannot be occupied*. The success of this method is dependent largely on the experience of the assessors in understanding the damage and their implications on the stability of the building. The assessors examine only the capacity of the building to carry their *self-weight* and *imposed loads* (like live load). Normally, an experienced group of assessors should take about 30-40 minutes per building, by standing in front of the building without having to enter it, and without having to undertake any technical calculations. Assessors using this procedure need to recognize the main limitation of this method, that it is a *visual* assessment; hence, the assessors should make *conservative* assessments.

1.2.2 DVS before and after an Earthquake

The main purpose of RVS is assessing conceptually the various features of the building, namely:

(a) Site and Soil Features,
(b) *Architectural Form* and *Material Choices*,
(c) *Structural System*,
(d) *Construction Details*, and
(e) *Maintenance Quality*.

The study is focused on understanding and de-alienating factors that can result in structural deficiencies in the building in the above five domains.

This method undertakes a *Base Level Technical Evaluation* of a house before an earthquake to understand the possible performance of a house of a certain typology during strong earthquake shaking. This telescopic scheme has two evaluations, namely the

(a) *Safety Index*, and
(b) *Seismic Performance Rating*.

The former assesses the overall safety of the house (life safety) in the event of an earthquake based on global parameters, and the latter helps estimate *the extent of damage* (*i.e.,* economic losses) in the event of an earthquake, based on components of the *structure* and *contents* of the house. The second evaluation, *Seismic Performance Rating*, is performed only when building typology passes the first evaluation of *Safety Index*. This telescopic sequence is proposed to recognize that, if a building does not have basic safety assured through the global parameters, economic assessment is not meaningful. This assessment method is useful for both (a) as a *first level evaluation* exercise before undertaking detailed retrofitting of a house, (b) to evaluate the safety and performance of an individual house of a certain typology.

RVS can be conducted: (a) before an earthquake, and (b) after an earthquake. Before an earthquake, it provides a rating of the building, and after the earthquake it provides inputs for undertaking structural changes that help improve the performance of the building, especially from the standpoints of eliminating or reducing *penalties* of *Life Threatening Factors* and of *Economic Loss Inducing Factors*.

1.2.3 SQA before and after an Earthquake

Assessing the structural safety of *existing* buildings is important particularly in seismic zones with potential to sustain *moderate* to *severe* seismic shaking. Buildings are seen to be extremely vulnerable under lateral earthquake shaking effects, as observed in the recent earthquakes in India. There are several reasons for buildings to have become vulnerable to earthquake shaking; prominent reasons include:

(a) *Poor structural configuration* (*e.g.,* unreinforced masonry buildings, and RC MRF buildings with open-ground storeys, *i.e.,* with few or no infills in the ground storey);

(b) *Poor structural design and detailing* (*e.g.,* no mechanisms to ensure compliance with the national standards for seismic design of buildings, even though buildings may have been designed for gravity load actions); and

(c) *Poor quality control and quality assurance in construction* (*e.g.,* no or inadequate supervision overseeing on-going construction, and continued use of 90°-degree hook ends in transverse reinforcement).

Thus, it is necessary to assess structural safety of existing buildings, which have the above common deficiencies. A procedure is described in this Chapter as a *Simplified Quantitative Assessment (SQA)* of *structural safety* of existing Buildings. This SQA considers primarily the *shear capacity* as the factor in focus, with intended emphasis on safety against *abrupt brittle failures*, a critical failure mechanism.

1.2.4 DQA before and after an Earthquake

The DQA relies on the fact that structures possess many virtues, and uses *three* of them, namely *strength*, *stiffness* and *ductility*. Buildings built may have deficiencies in one or more of these virtues, and that these may be assessed by comparing *the demand* on the building with its *capacity*. The demand is estimated using the actual seismic hazard as provided in the Indian Standards, and the capacity using the *classical theory of structures*, using *equilibrium*, *compatibility* and *constitutive law*. In this method, NDT tests are required to be conducted at appropriate locations/elements in the building. Later, safety check can be done at the overall building level and at each component level.

It employs *nonlinear* structural analyses to estimate the capacity of the building, and requires as-built dimensions and reinforcement details of all structural elements, along with material and soil properties. This method involves calculating:

(1) *Demand Side:*

- (a) Distribution of lateral forces by equivalent static method,
- (b) Eccentricity between *Center of Resistance* and *Center of Mass*,
- (c) Storey Shear Force Demand,
- (d) Shear Force Demand on each structural element, and
- (e) Deformation Demand in each storey.

(2) *Capacity Side:*

Axial Force, Shear Force, bending Moment and Torsional Capacity of all structural elements, and performing *safety checks* of:

(a) All structural members, including *Strong-Column Weak-Beam* check, and

(b) Storey Drift of the building.

This method of assessment can be employed:

(1) *Before* the earthquake, to understand structural deficiencies (at component and overall levels) and undertake *retrofit of the building*, and
(2) *After* the earthquake, to understand structural reasons (at component and overall levels) and improve *design standards*.

2.
Rapid Visual Screening

2.1 INTRODUCTION

As the name suggests, *Rapid Visual Screening (RVS)* is a quick method of earthquake assessment of buildings, and requires least time of all the four method of assessment. The idea behind the development of this method is to *minimize* (and thereby *save*) the time, money and technical human resources required for assessment of large stock of existing buildings in the country. From the results of RVS (a *final score*), one can prioritize the building stock for *the next three levels of assessment*.

Since this is an approximate method of assessment, many versions of RVS were proposed and practiced in different countries. All of them tend to use a *one-page form*, even though they focus on different *structural factors*. This form has three sections, namely:

(1) *General Information* of the building (like street address of the building, owner's name, contact details, and year of construction),

(2) *Basic Structural Information* of the building (like rough sketch of building plan and elevation, structural system, materials used), and

(3) *Vulnerable Structural Factors* and *scores* assigned to each of them. The *score value* is the numerical depiction of effect of the *vulnerable* factor on building's behavior. The sum of the score values for all factors gives the *final score* of the building. This *final score* reflects the vulnerability of the building, indirectly representing the level of possible damage in the building during an earthquake.

Some RVS versions use a *higher final score* and others a *lower final score* for reflecting *better* building behavior. Also, the *final score* is measures against a *rating scale* of scores (given in ranges) to identify the potential level of overall damage (namely *no or slight structural damage*, *moderate structural damage*, *severe structural damage* or *complete collapse*) that the building is likely to experience due to one or more vulnerable parameters present in that building.

In any RVS form, the score value plays a major role in deciding the vulnerability of building. These score values in different RVS forms are derived by different bases. For example, in the *BMTPC* version, *scores* for different structural factors are derived by the *Delphi Method, i.e., expert judgment* is employed to ascribe a value to each structural factor on the severity of damaged can be caused by that structural factor. Similarly, the *scores* for different structural factors are *derived* by statistical regression analysis, whereas in the other versions, they are derived by structural analysis. The vulnerable structural parameters are similar, which are employed in different RVS versions. But, the *score* assigned to each structural factor vary significantly in different RVS versions, and thereby the *final score* varies and results in distinctly different conclusions.

2.2 LITERATURE

2.2.1 RVS in USA

A number of guidelines were developed by the Federal Emergency Management Agency (FEMA) in the U.S.A. for seismic risk assessment and rehabilitation of buildings. These include FEMA 178 (1992), FEMA 310 (1998) and FEMA 154 (2005, 2015) for rapid visual screening of buildings. In developing a handbook on rapid visual screening of seismically hazardous buildings, FEMA evaluated existing procedures, recommended a rapid screening procedure and developed supplementary information on heavy debris removal and urban rescue. The Basic Structural Hazard Scores in the first edition were calculated using expert's opinion and ground motion maps which specified effective peak acceleration ground motion having 10% probability of being exceeded in 50 years. The performance modification factors (PMF) developed in the first edition was related to the significant deviation from the normal structural practice. The PMF's were assigned values also based on the judgement.

Several significant changes and enhancements were incorporated in the revised edition of the FEMA 154 handbook. The new basic structural hazard scores are based on the (1) the HAZUS methodology and fragility curves and (2) new Maximum Considered Earthquake (MCE) seismic design spectral acceleration response values which are based on ground motion having a 2% probability of being exceeded in 50 years. The new PMFs named as Score Modifiers were proposed for mid-rise buildings, high-rise buildings, plan irregularity, vertical irregularity, pre-code buildings, post benchmark buildings, soil type C and D, etc. The revised edition of FEMA 154 for RVS methodology provides very useful information on planning, execution and interpretation of the RVS program. Some example of application of the RVS procedure on example building are also provided in FEMA 154 handbook.

2.2.2 RVS in Turkey

The *Earthquake Master Plan for Istanbul* was developed by a consortium of four leading Turkish universities. Multi stage building assessment procedures were developed in three stages – first stage assessment or rapid visual assessment from the street, second stage assessment requiring access to the building and third stage assessment requiring the detailed computational assessment procedure. The RVS method developed by one the four universities, *Middle East Technical University* (METU) in 2003, revised in 2007 is based on the data from 454 three to six storey reinforced concrete framed buildings surveyed after the *1999 Duzce earthquake* and classified in four damage grades. Based on this data, the METU Method assigns a *Basic Score* to different RC frame buildings depending on number of stories and seismic zone. The method uses the seismic zones based on the expected range of peak ground velocity (PGV) in the area under consideration. The score modifiers assigned to the different vulnerable parameters were based on the statistical study conducted on the 454 buildings.

2.2.3 RVS in Greece

A fuzzy logic based Rapid Visual Screening procedure was developed in Greece for the categorization of buildings into five different damage grades in the event of future earthquakes. The method was developed based on information of 102 buildings affected by the Athens earthquake of 1999. The Earthquake Planning and Protection Organization (OASP) in Greece adopted FEMA 154 methodology with necessary adjustments for the structural properties of Greek buildings. The Fuzzy Logic based RVS proposed a probabilistic reasoning method that treats the structural properties of a building is a holistic way and gives a score that represents possible damage in case of a major seismic event.

2.2.4 RVS in Canada

The method suggested by National Research Council, Canada (NRCC 1993) is based on a Seismic Priority Index which accounts for both, structural and non-structural factors including soil condition, building occupancy, building importance and falling hazards to life safety and a factor based on occupied density and the duration of occupancy.

2.2.5 RVS in Japan

The Japanese procedure (JPDPA 2001) is based on Seismic Index (Is) for total earthquake resisting capacity of a storey which is estimated as the product of a basic seismic index based on strength and ductility indices, an irregularity index and a time index. The evaluation is based on a scoring or rating system.

2.2.5 RVS in New Zealand

The New Zealand code (NZSEE 2006) recommends a two-stage seismic performance evaluation of buildings. The initial evaluation procedure (IEP) involves making an initial assessment of performance of existing buildings against the standard required for a new building which is defined as 'percentage new building standard' (assessed structural performance of building taking into consideration all reasonably available information, compared with requirements for a new building expressed as percentage). A *%NBS* of 33 or less means that the building is assessed as "potentially earthquake prone" in terms of the Building Act and a more detailed evaluation of the building is required.

2.2.5 RVS in India

(a) IIT Bombay Method

IIT Bombay [Sinha & Goyal, 2004] proposed a RVS method using a procedure similar to that suggested in FEMA 2002, with focus on Indian conditions. This method considered few dominant building types in India, and seismic hazard and soil conditions as per the IS1893. Among building typologies considered, the *construction technology* and *typologies* were common in both the countries. Therefore, the base score values for such building types are similar and the same value changes for other building types. One additional component in this procedure was estimation of damage level from the RVS score. Limiting values were identified for different grades of damage.

2.2.5.2 BIS

In 2004, Indian Standard IS 13935 (2004) released a document that included the RVS method for RCC as well as Masonry buildings in India. The screening is based on Code based seismic intensity, building type and damageability grade as observed in past earthquake and covered in MSK Intensity Scale. When an earthquake with particular damage intensity strikes a region, different types of buildings experience different levels of structural damage depending on their inherent characteristics. Therefore, the Code focuses on *seismic vulnerability of building types* based on *choice of building materials* and *construction technology adopted*; code states that buildings are *more* vulnerable with the *use of local materials without engineering input* (like use of mud, stone, un-burnt bricks in masonry), and *less* with the use of engineered materials (concrete and steel). The vulnerable parameters considered are *torsion irregularity*, *re-entrant corners*, *diaphragm discontinuity* and *out-of-plane offset* as *plan irregularities*, and *mass irregularity* and *stiffness irregularity* as *vertical* irregularities. This RVS method is one of the few methods, which assign no score values to any factor; the Code recommends detailed evaluation, if any

one of these vulnerability factors is present in the building. The level of damage experienced by building depends only on the type of a building – its *lateral load resisting system* and *type of materials*.

2.2.5.3 IIT Gandhinagar Method

IIT Gandhinagar [Jain and Mitra, 2010] proposed another RVS method for the RC frame buildings in India. The method is based on the original METU Method (proposed in Turkey), which was one part of the *Earthquake Master Plan Project* for Istanbul, undertaken by *Metropolitan Municipality of Istanbul*. Unlike the FEMA method, this method is purely based on statistics from damages in past earthquakes. A statistical study was conducted on the buildings data surveyed after the 2001 Bhuj earthquake. A team of students surveyed nearly 6,500 buildings in Ahmedabad and its surrounding areas, and assigned damage grades ranging from G0 (*i.e.,* no damage) to G5 (*i.e.,* collapse) to the buildings; *RC* and *load bearing masonry* buildings were main focus.

2.2.5.4 BMTPC Method

BMTPC [Murty *et al*, 2012] commissioned a study, which developed a methodology for seismic safety of typical housing typologies in India. The study undertook intensive field survey in 7 towns in high seismic regions across India; the study offered a *base-level* method for technical evaluation of buildings from five standpoints, namely (a) *Site and Soil Features*, (b) *Architectural Form* and *Material Choices*, (c) *Structural System*, (d) *Construction Details*, and (e) *Maintenance Quality*.

The method provides both *Seismic Safety Index* and *Performance Rating* to a particular house, with respect to an *ideal house* of the same typology. The *Seismic Safety Index* is defined for each vulnerable parameter for each housing typology. These index values or the score values for each parameter are based on the *Delphi Method*, which employs expert's opinion, against empirical, analytical or any other procedures employed in other methods. Experts based on previous study and their experiences assign score value to each factor. Further the form clearly divides all the parameters into two sets of factors, *i.e.*, *Life Threatening Factors (L)* and *Economic Loss-Inducing Factors (E)*. Each of these two sets of factors are divided into two more factors such as *Structural Elements-related Factors* and *Non-Structural Elements-related Factors*.

This method is recommended by this *Primer on RVS*, for its relatively detailed nature and conceptual clarity. Details of this method are given in Section A.

2.3 USES OF RESULTS OF RVS

While the principal purpose of the RVS methods is to identify buildings potentially vulnerable to strong earthquake shaking, the results from RVS can be used for other purposes as well, including:

(1) Ranking a community's earthquake retrofit needs;
(2) Designing earthquake disaster mitigation programs for a community;
(3) Developing inventories of buildings for use in regional earthquake damage and loss impact assessments;
(4) Planning post-earthquake building safety evaluation efforts; and
(5) Developing building-specific earthquake vulnerability information for purposes, such as insurance rating, decision-making during building ownership transfers, and possible triggering of remodeling requirements during the permitting process.

2.4 RVS PROJECTS UNDETAKEN IN INDIA AND ABROAD

Tables 2 and 3 show a list of RVS projects undertaken in India and abroad by various organizations. Understandably, this list is based on literature that could be collected from public domain; other studies that were published but could not be collected, and the unpublished reports are included in this list.

Table 2: List of RVS Projects Undertaken in India

S.No.	*RVS Project*	*Area of Survey*	*Year*	*Undertaken By*
1.	Rapid Visual Screening of different Housing Typologies in Himachal Pradesh, India	Himachal Pradesh	2014	IIIT, Hyderabad
2.	Rapid Visual Screening for Seismic Evaluation of Existing Buildings in Himachal Pradesh, India	Himachal Pradesh	2015	IIIT, Hyderabad
3.	Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Case Study of Chiplun City	Chiplun, Maharashtra	2017	Department of Civil Engineering, S.G.I. Atigre, Maharashtra
4.	Seismic Vulnerability Assessment Using High Resolution Satellite Data and Field Studies	Banglore	2012	IISc, Banglore
5.	Seismic Vulnerability of Guwahati Region	Guwahati, Assam	2008	Department of Seismology, MoES, Government of India
6.	Seismic Vulnerability Assessment of Existing Building to Supplement Rehabilitation practices with special emphasis to North Eastern Region	North Eastern Region, India	2013 – 2014	IIEST, Shibpur
7.	Seismic vulnerability and risk assessment of Kolkata City	Kolkata	2015	IIT Kharagpur
8.	Structural Health Monitoring Of Historical Monuments By Rapid Visual Screening: Case Study of Bhand Deval Temple, Arang	Raipur, Chhatisgarh	2012	KL University, Vijayawada, and KITE, Raipur
9.	Hazard, Vulnerability and Risk Assessment of Guwahati City, Silchar, Dibrugarh Towns and Dhemaji District, Assam	Guwahati, Silchar and Dibrugarh towns, and Dhemaji District in Assam State	2011	Government of India, Manual by North Eastern Space Applications Centre.

Table 3: List of RVS Projects Undertaken Abroad

S.No.	*RVS Project*	*Area of Survey*	*Year*	*Undertaken By*
1.	Preliminary Structural Upgrading Strategy for Groningen	Groningen	2013	NAM Dutch
2.	Rapid Visual Screening of Critical Facilities: An Overview of the FEMA Methodology and Its Application to Selected Critical Facilities in Kingston & St Andrew	Jamaica	2014	UNDP
3.	Rapid Visual Screening for Seismic Evaluation of RC Hospital Buildings	Northern Italy	2015	Independent
4.	1. GEO-CAN II : Validating Assessments of Seismic Damage Made From Remote Sensing	Port-au-Prince	2011	Cambridge Architectural Research and World Bank sponsored.
5.	A Report on Post-Earthquake Rapid Visual Damage Assessment of Buildings of Tribhuvan International Airport	Katmandu, Nepal	2015	Tribhuvan Airport, Civil Engineering Division
6.	Assessment of Historical Buildings using Rapid Visual Screening Procedures	Greece	-	Department of Civil Engineering, Aristotele University
7.	Vulnerability Assessment of The Old City Centre of Horta, Portugal	Horta, Portugal	2016	University of Averio, Portugal
8.	Seismic Vulnerability Assessment of Historical Urban Centres	Seixal, Portugal	2011	University of Coimbra, Coimbra, Portugal
9.	Earthquake Master Plan for Istanbul (EMPI)	Istanbul, Turkey	2003	Istanbul Metropolitan Municipality (IMM)

2.5 DO's AND DON'Ts

When performing the RVS in an area, the assessors of buildings should:

(1) Verify and update building identification information,

(2) Walk around buildings and sketch a plan and elevation on the form,

(3) Estimate occupancy (that is, the building use and number of occupants),

(4) Assess soil type, if not identified during the pre-planning process,

(5) Identify potential non-structural falling hazards,

(6) Identify *lateral-load resisting system* (entering the building, if possible, to facilitate this process) and circle *Basic Score* on the form,

(7) Identify and circle appropriate earthquake performance *Score* (*e.g.,* number of stories, design date, and soil type) on the form,

(8) Determine the *Final Score* (by summing up *scores* in Step 7), and decide if a detailed evaluation is required, and
(9) Photograph the building; and
(10) Check quality and fill data in the record keeping system or database.

2.6 CONFLICTS

Over the years, the use of RVS has increased significantly. The main reason for this is that it reduces the time as well as manpower employed to assess buildings, and it highlights those buildings, which are in critical condition. Another positive side of this method is the flexibility in its use, *i.e.*, it can be used over any region, either *before an earthquake* to understand the risk of community or town, or *after an earthquake* to estimate the level of damage and loss. These reasons were enough for many researchers to develop the various RVS methods suitable to specific region or building type.

The use of an RVS method will not be useful unless, it addresses the critical issues. For example, if in a particular region, *open ground storey* and *large overhangs* are present in most buildings, then using FEMA's RVS method will underestimate the risk associated with these features in those buildings. Therefore, it is equally important to identify the key structural factors, which not only affect the building's performance during an earthquake, but also damage the building. In this regard, the BMTPC method is relatively the most inclusive method, considering the largest number of structural factors among all RVS methods.

The most widely used *conventional technique* compares different constructions of the same typology in certain region, analyzing parameters that affect building behavior and calibrated by expert's opinion. These scores value provides relative measure of vulnerability but does not allow the introduction of new data or its application to other buildings and region. Another similar technique is *typological method* which classifies buildings into classes depending on materials and construction technique and it gives the probability of structure suffering damage for particular seismic intensity. But, this method is valid only for the area, which is assessed or other area that has equal level of earthquake hazard. Other commonly used techniques involve the determination of a score value or index value for vulnerable parameter by defining the correlation between damage and seismic intensity using statistical studies of past earthquake damage data. This method has limitations in its use. To arrive at an accurate score value for any factor, an extensive database of building characteristics is needed along with a large repository of observed damages during past earthquakes, which is difficult to get in most instances.

Apart from this a major conflict arises when different RVS methods are used to assess the same group of buildings in a region. A particular study showed that, although the objective of these RVS methods is the same, these results differed significantly. The reasons include: (1) List of factors considered in assessing the vulnerability of building, (2) Procedure adopted for assigning *score* to each factor, and (3) Weights assigned to each vulnerable factor that contributes to the overall damage of the building.

3.
Methodology of Earthquake Assessment

3.1 INTRODUCTION

Generally, during past earthquakes, most *load-bearing buildings* sustained *brittle collapses*, while well-designed *reinforced concrete (RC) buildings* sustained *ductile failure*. The notion of an *Ideal House* is employed to benchmark the performance of buildings normally built. During strong earthquake shaking expected at the site, the *Ideal House* is expected to sustain *damage* that is: (a) of an acceptable type, (b) within acceptable range, and (c) at pre-determined locations; this ensures *zero fatality* in the building. The characteristics of an *Ideal House* include:
(1) Built on a flat ground with hard strata,
(2) Has simple regular shape,
(3) Has symmetry in plan as well as in elevation,
(4) Is at sufficient distance from its adjoining buildings,
(5) Has no heavy overhangs,
(6) Is symmetrical in its lateral stiffness and strength,
(7) Has prescribed horizontal bands, if masonry, and ductile design and detailing, if RC,
(8) Follows all Code provisions,
(9) Has good construction quality and proper maintenance, and
(10) Appropriately secured non-structural elements.

Departures in structural features and other aspects from the above, leads the building to become vulnerable; the extent of vulnerability depends on the number and criticality of such departures. Some of the critical features are:
(1) Built on sloped ground or river terraces;
(2) Built on soft soil, loose sandy soil or on liquefiable sandy soil;
(3) Has an open storey, either at the ground or at an intermediate storey;
(4) Has short and stub columns;
(5) Touches adjacent buildings;
(6) Has complex shape in plan and in elevation;
(7) Has irregular orientation of frames or structural walls;
(8) Has large overhangs or large openings in walls;
(9) Has heavier upper storeys, or rooftop water tanks not anchored to structural system; and
(10) Has poor quality of construction (including insufficient curing leading to poor strength).

3.2 Base Score and Penalties

The earthquake behavior of *Ideal Building* not only depends on the structural characteristics of building, but also on the earthquake hazard and the earthquake forces acting on the building. Most RVS methods employ the notion of an *Ideal Building*, by ascribing the *Base Score* to such an Ideal Building, and then assigning *penalties* to each departure. The *BMTPC Method* explicitly employs this by stating that the score of the *Ideal Building* is 100, and then deducting the *penalties* for the various departures from the desirable features in the buildings built.

The *FEMA Method* uses a *Basic Structural Hazard Score (BSH Score)* is a generic score for a particular class of buildings, *i.e.,* the class of a building considered for calculating BSH Score follows all the Code provisions and has no vulnerable factor present in it. So, the BSH Score excludes all the parameters that may or may not affect the building behavior. These base scores and penalties of buildings depend largely on typology of building and seismic zone in which building is built. Few examples of *Base Score* are shown in Tables 4, 5 and 6. The *Basic Score* of a building decreases with increase in earthquake hazard. Therefore, the *Ideal Building* constructed in a lower earthquake zone performs better than the same *Building* constructed in a higher earthquake zone. This *BSH Score* is modified for a building using *Score Modifiers (SMs)* specific to particular building typology, depending on the number of vulnerable factors present in that building. Each SM represents a particular vulnerable factor.

Table 4: *Basic Structural Hazard (BSH) Score* as per FEMA Method [FEMA 154, 2002]

	C1 (MRF)	*C2 (SW)*	*C3 (INF)*	*PC1*	*PC2*	*RM1*	*RM2*
Low Seismicity	4.4	4.8	4.4	4.4	4.6	4.8	4.6
Moderate Seismicity	3.0	3.6	3.2	3.2	3.2	3.6	3.4
High Seismicity	2.5	2.8	1.6	2.6	2.4	2.8	2.8

Table 5: *Basic Structural Hazard (BSH) Score* as per IIT Bombay Method [Sinha & Goyal, 2004]

Seismic Zone	*C1 (MRF)*	*C2 (SW)*	*C3 (INF)*	*URM1*	*URM2*	*URM3*	*URM4*
II	4.4	4.8	4.4	4.6	4.8	4.6	3.6
III	3.0	3.6	3.2	3.4	3.6	3.0	2.4
IV & V	2.5	2.8	2.6	2.8	2.8	1.8	1.4

Table 6: *Base Score* for RC Buildings as per IIT Gandhinagar Method [Jain & Mitra, 2010]

Seismic Zone	*Hard Soil*	*Medium Soil*	*Soft Soil*
V	110	95	80
IV	95	80	65
III	80	65	50
II	65	50	35

3.3 Studies to develop RVS

The basic purpose conducting *RVS* is to identify buildings vulnerable to earthquake shaking in a large stock of building in any city or a town. Also, understanding each *RVS Method* carefully, results in conclusions that will help improve building safety and help engineers understand the structural deficiencies present in the building typologies.

The RVS studies can also help in the following:

(1) Evaluation of earthquake safety of buildings after an earthquake;

(2) Develop building specific earthquake vulnerability information for the purposes rating a region and prioritizing redevelopment;

(3) Identify simplified retrofitting techniques for particular building (to avoid collapse) where further evaluations are not possible

1. rank a city's or community's seismic rehabilitation needs
2. increase awareness regarding the seismic vulnerabilities of buildings

3.4 Initial Focus

As per the BMTPC study, the most dominant building typology in India is brick masonry buildings and its contribution in total number of buildings in the country is more than 70%. Therefore, it is important to develop strategies to secure the safety of these building during an earthquake, and consequently main reason for selecting the *Brick Masonry Buildings* as initial study. The reason for selecting the *Reinforced Concrete Buildings* typology is the recent high demand on reinforced concrete houses in the many parts of the country, because of its many advantages over other typologies.

Apart from these, literature survey on RVS studies shows that very little attention has paid to RVS of other building typologies, such as stone masonry, mud houses, wooden houses, mixed typology houses. Hence, as a second level development, RVS of may be taken up of stone masonry, mud houses, and wooden houses. Also, studies be undertaken to prepare RVS forms for these typologies.

3.5 Recommended Pre and Post Earthquake Rapid Earthquake Safety Assessment

This *RVS PRIMER* recommends the following building typology forms which is developed for Pre and Post Earthquake Rapid Earthquake Safety Assessment:

- i. Reinforced Concrete Building
- ii. Burnt Clay Bricks Building
- iii. Confined Masonry Building
- iv. Random Rubble Masonry Building
- v. Mud House
- vi. Dhajji Dewari
- vii. Ekra House

These forms developed are uniform in nature wherein Red tag parameters, yellow tag attributes and Green tag parameters are compartmentalized. The uses of the tags in procedure of safety Pre and Post Earthquake Rapid Earthquake Safety Assessment are as follows:

i. Even if one parameter with the RED tag is present in the building then the Building is declared as RED i.e unusable even
ii. Building can be used with temporary intervention (yellow) if there is no red parameter and at least one yellow parameter is present
iii. Building is usable as it is if there is no red and yellow parameters are present

…

4. Proposed Field Studies using this *PRIMER*

4.1 Strategy

The level of earthquake risk of a city depends *not only* the vulnerability of buildings in that city (through typologies of building, topography of city, soil conditions in the city), *but also* on factors such as seismicity, population, possibilities of collateral hazards (*e.g.*, liquefaction of soil, landslides, and fire), and building use category (*e.g.*, residential, office or commercial use; and floor area ratio (FAR)). Likewise, the safety of a building depends not only on compliance of code by the structural design but also on factors such as quality of construction, and building use category after construction. For example, even if the prescribed guidelines are followed in the structural design of a G+5 storeyed RC frame building, but soil investigation is not performed and the building is built on very loose soil strata, the building may be unsafe under severe earthquake shaking. So, earthquake risk assessment of a particular building typology in a given area will require considering all factors.

It is difficult to collect detailed information of all buildings of a certain typology across the country. Also, even if it collected, the same buildings of the same typology will have strong local or regional biases. Hence, it is best undertaking city-wise assessment of earthquake risk to buildings of a certain typology. A criterion is proposed as target: *at least 1% of the total number of buildings will be surveyed in major cities located in Seismic Zones III, IV & V listed in Annex E of IS 1983 (Part 1): 2016*. The cities selected are those having population more than 3,00,000 and in Seismic Zone III, IV and V (Table 7). And, after estimating *Earthquake Risk Index* of each typology using the 1% surveyed buildings in each of these cities, the *Earthquake Risk Index* of each City will be extrapolated using the total number of houses of each typology in that city.

4.2 Pre-Earthquake Risk Assessment

In the pre-earthquake *Rapid Visual Screening (RVS) Method*, the *Earthquake Risk Index* of individual building requires *visual inspection* and *simple calculations* based on the status of its factors. The *RVS Form* has predefined set of questions regarding the presence or absence of factors, and in general has to be documented in the field manually. The collection of data of buildings of different typologies shall be carried out with the help of Faculty Members of *Colleges of Architecture* and *Colleges of Engineering* in the region. But, considering the large time required for undertaking the field survey, and transferring field data into online database for further analysis, the Faculty Members undertaking the field studies shall collect photographs to assist the Central Agency to make any last minute changes during processing of data (for activating or negating the influence of some critical factors). As a result, all the risk calculations and results will be documented in a systematic format and saved on an online database.

The following procedure is proposed for this data collection for *pre-earthquake* RVS Method based assessment of *Earthquake Risk Index* of a city:

(1) The NDMA shall identify a *Central Agency* to steer the RVS Project;

(2) The *Central Agency* shall undertake a building typology Study in each region and provide the detailed methodology for *pre-earthquake* RVS Method;
(3) The *Central Agency* shall develop *Electronic Forms* for recording: (a) detailed information of selected houses of each typology, and (b) overall information of buildings in the city;
(4) The *Central Agency* shall identify *willing and experienced* Faculty Members of the *Colleges of Architecture* and *Colleges of Engineering* in the region, and train them on RVS Method;
(5) The interested & trained Faculty Members in the *Colleges of Architecture* and *Colleges of Engineering* in the region shall collect the data along with their students in a project mode. The building data shall be collected by filling online forms, if the IT service is available, else it shall be collected on hard copy and logged from the Colleges. Online telephonic help can be made available from the *Central Agency* for any special situations.
(6) The *Central Agency* can undertake 5% random audit *in person* of the data filled by the Faculty Members, and provide near-start and mid-course corrections to the Faculty Members steering the project;
(7) The *Central Agency* shall process the on-line data;
(8) The *Central Agency* shall send the processed data to NDMA; and
(9) The NDMA shall share the data with City Administration for improvements, if any.
(10) Based on the inputs received from the City Administrations, the *Central Agency* shall finalise the report and submit the same to the NDMA.

Table 7: List of cities in Zone III, IV & V with population >3,00,000 as per IS1893(1):2016

S.No.	*Town*	*Zone*	*S.No.*	*Town*	*Zone*	*S.No.*	*Town*	*Zone*
1	Agra	III	28	Durgapur	III	55	Pilibhit	IV
2	Ahmedabad	III	29	Gangtok	IV	56	Pune	III
3	Almora	IV	30	Guwahati	V	57	Rajkot	III
4	Ambala	IV	31	Gaya	III	58	Roorkee	IV
5	Amritsar	IV	32	Gorakhpur	IV	59	Sadiya	V
6	Asansol	III	33	Imphal	V	60	Salem	III
7	Bahraich	IV	34	Jabalpur	III	61	Shillong	V
8	Barauni	IV	35	Jorhat	V	62	Shimla	IV
9	Bareilly	III	36	Kakrapara	III	63	Solapur	III
10	Belgaum	III	37	Kalpakkam	III	64	Srinagar	V
11	Bhatinda	III	38	Kanchipuram	III	65	Surat	III
12	Bhubaneswar	III	39	Kanpur	III	66	Tarapur	III
13	Bhuj	V	40	Karwar	III	67	Tezpur	V
14	Bijapur	III	41	Kochi	III	68	Thane	III
15	Bikaner	III	42	Kohima	V	69	Thiruvananthapuram	III
16	Bokaro	III	43	Kolkata	III	70	Thiruvannamalai	III
17	Bulandshahr	IV	44	Lucknow	III	71	Vadodara	III
18	Burdwan	III	45	Ludhiana	IV	72	Varanasi	III
19	Calicut	III	46	Mandi	V	73	Vellore	III
20	Chandigarh	IV	47	Mangalore	III	74	Vijayawada	III
21	Chennai	III	48	Monghyr	IV	75	Dharwad	III
22	Chitradurga	II	49	Moradabad	IV	76	Dehra Dun	IV
23	Coimbatore	III	50	Mumbai	III	77	Dharampuri	III
24	Cuttack	III	51	Nainital	IV	78	Delhi	IV
25	Darbhanga	V	52	Nasik	III	79	Osmanabad	III
26	Darjeeling	IV	53	Nellore	III	80	Panjim	III
27	Patiala	III	54	Patna	IV			

4.3 Roles of Three Principal Stakeholders

Earthquake Disaster Mitigation (and thereby *Earthquake Disaster Risk Reduction*) requires active engagement of three principal stakeholders (Figure 1), namely:

(1) *Academia*, which needs to create and disseminate knowledge:

It shall: (a) identify and document various building typologies; (b) study these typologies in detail and describe ideal building in each typology category; (c) identify penalties for each departure by conducting analytical and/or experimental research; and (d) train manpower for undertaking design of new constructions and retrofit existing buildings;

(2) *Industry*, which needs to improve and implement skills

It shall: (a) outlaw unsafe typologies and encourage good typologies, (b) propose new technologies, (c) build facilities to undertake full-scale testing, (d) build skills in its artisans; (d) encourage continuing education, (e) undertake to build competence in retrofit of unsafe constructions, (f) actively engage in developing standards, and (g) update its fraternity with the latest developments in earthquake safety, by charging all its professional societies to train engineers in design of earthquake resistant buildings, and specialized teams to undertake retrofit projects.

(3) *Government*s, which need to sensitize and steer the attitude of the people of the nation:

They shall ensure that policies are in place for: (a) ensuring all future constructions to be earthquake resistant; (b) identify cities whose earthquake risks are high, (c) peer review of structural safety of new constructions and modifications to existing constructions; (d) licensing of engineers responsible for safety of the built environment, and (e) modify by-laws to reflect that only safe constructions are allowed.

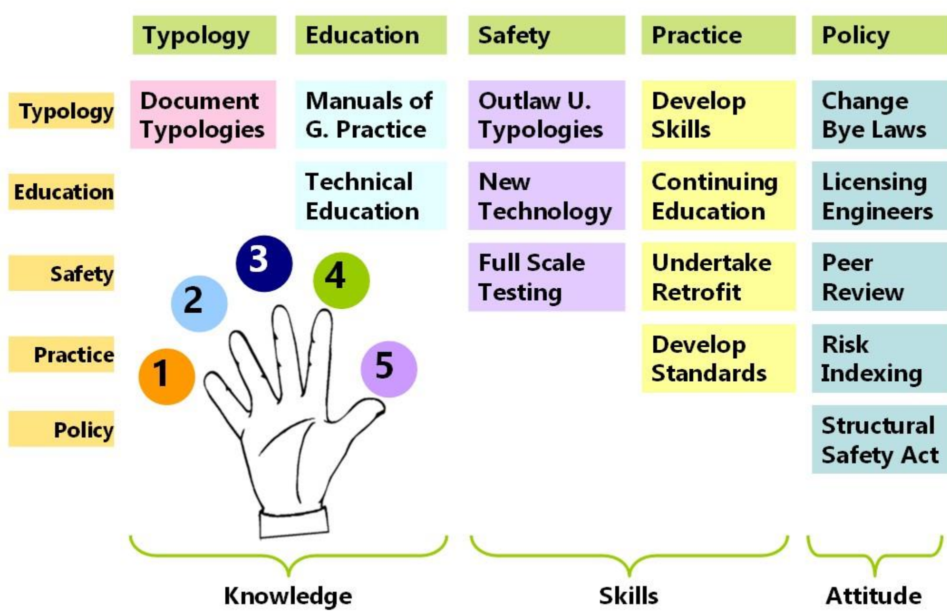


Figure 1: Principal activities involved in *Earthquake Disaster Mitigation* and *Risk Reduction*

Annexure

Annexure A: Meeting Participants
Annexure B: Recommended Pre and Post Rapid Earthquake Assessment Method

Annexure A

List of Participants of the Discussion Meeting

2-Day Discussion Meeting on

Earthquake Safety Assessment of Buildings in India

30-31 August 2017 at IIIT Hyderabad

List of Participants

Academia

1. Yogendra Singh, Professor, IIT Roorkee
2. Hemant B. Kaushik, Associate Professor, IIT Guwahati
3. Suresh R. Dash, Assistant Professor, IIT Bhubaneswar
4. Goutam Mondal, Assistant Professor, IIT Bhubaneswar
5. Rupen Goswami, Associate Professor, IIT Madras
6. C. V. R. Murty, Professor, IIT Madras
7. Dipti Ranjan Sahoo, Associate Professor, IIT Delhi
8. Ravi Sinha, Professor, IIT Bombay
9. R. Pradeep Kumar, Professor, IIIT Hyderabad
10. Hemant Kumar Vinayak, Assistant Professor, NIT, Hamirpur
11. O. R. Jaiswal, Professor, VNIT, Nagpur
12. Surendranadh Somala, Assistant Professor, IIT Hyderabad

R&D

13. Srinagesh Davuluri, Head, Seismology Laboratory, CSIR NGRI, Hyderabad
14. R. K. Chadha, Raja Ramanna Fellow, CSIR NGRI, Hyderabad
15. Ajai P. Chaurasia, Chief Principal Scientist, CBRI, Roorkee

Industry

16. Hari Kumar, Managing Director, Geohazards Society, New Delhi
17. Arvind K. Jaiswal, Chief Consultant, EON Designers, Secunderabad
18. Jaswant N. Arlekar, Principal Consultant, M/s Mandrekar & Associates, Mumbai

Government

19. Sri Kamal Kishore, Member, NDMA, Government of India, New Delhi
20. Sri Mahendra Meena, Sr. Consultant (Earthquake & Tsunami), NDMA, Government of India, New Delhi

List of Participants of the Discussion Meeting

One-Day Discussion Meeting on

A Primer on Rapid Visual Screening (RVS)

Consolidating Earthquake Safety Assessment Efforts in India

9 January 2020 at IIIT Hyderabad

List of Participants

Government

1. Sri Kamal Kishore, Member, NDMA, Government of India, New Delhi
2. Sri Sandeep Poundrik, JS (Mitigation), NDMA, Government of India, New Delhi
3. Sri Mahendra Meena, Sr. Consultant (Earthquake & Tsunami), NDMA, Government of India, New Delhi
4. Sri Javed Iqbal, Jr. Consultant (Earthquake), NDMA, Government of India, New Delhi

Academia

5. Hemant B. Kaushik, Associate Professor, IIT Guwahati
6. Goutam Mondal, Assistant Professor, IIT Bhubaneswar
7. Rupen Goswami, Associate Professor, IIT Madras
8. C. V. R. Murty, Professor, IIT Madras
9. Dipti Ranjan Sahoo, Associate Professor, IIT Delhi
10. Ravi Sinha, Professor, IIT Bombay (through Skype)
11. Sunitha Palissery, Assistant Professor, IIIT Hyderabad
12. R. Pradeep Kumar, Professor, IIIT Hyderabad
13. Hemant Kumar Vinayak, Assistant Professor, NIT, Hamirpur
14. O. R. Jaiswal, Professor, VNIT, Nagpur
15. Surendranadh Somala, Assistant Professor, IIT Hyderabad

R&D

16. Srinagesh Davuluri, Head, Seismology Laboratory, CSIR NGRI, Hyderabad
17. R. K. Chadha, Raja Ramanna Fellow, CSIR NGRI, Hyderabad
18. Ajai P. Chaurasia, Chief Principal Scientist, CBRI, Roorkee

Industry

19. Hari Kumar, Managing Director, Geohazards Society, New Delhi
20. Arvind K. Jaiswal, Chief Consultant, EON Designers, Secunderabad
21. Jaswant N. Arlekar, Principal Consultant, M/s Mandrekar & Associates, Mumbai

Annexure B

Recommended Pre and Post Rapid Earthquake Assessment Forms for:

1. Reinforced Concrete Building
2. Burnt Clay Bricks Building
3. Confined Masonry Building
4. Random Rubble Masonry Building
5. Mud House
6. Dhajji Dewari
7. Ekra House

A: RC

Pre-Earthquake Rapid Visual Screening
Reinforced Concrete Buildings

Inspection
Inspector ID:
Inspection Date :
Inspection Time:

Building Description
Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N__________ ° E__________ °

Structural System

Structural System
☐ Moment Frame ☐ Moment Frame with Braces
☐ Moment Frame with Structural Walls ☐ Other__________

Structural Components
FLOOOR ☐ In-situ ☐ Precast Planks with in-situ screed ☐ Precast ☐ Other__________
ROOF ☐ Flat ☐ Pitched ☐ Hipped ☐ Split ☐ Other__________

Occupancy

RESIDENTIAL	Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ __________		

S.No.	Life Threatening Parameters		Tag
1.	**Siting Issues**	1.1 Building is built on hill slope or adjacent to hill slope, that is vulnerable to falling debris.	Red
		1.2 Building rests adjoining a severely deteriorated or damaged building or structure.	Red
2.	**Soil & Foundation Conditions**	2.1 Building is built on liquefiable soil.	Red
		2.2 Building is built on river terraces that can slide or creep.	Red
		2.3 Building is built on hill slope that can slide.	Red
3.	**Architectural Features**	3.1 Building has exterior plan dimension smaller at the plinth level than at upper storeys.	Red
		3.2 Building has heavier upper storeys.	Red
		3.3 Building has large unanchored projections or overhangs.	Red
		3.4 Building has an Open Storey (at ground /other level) with slender columns.	Red
		3.5 Building has RC frame with Floating Columns.	Red
		3.6 Building has irregular plan geometry and or plan aspect ratio > 4.0.	Red

4.	***Structural Aspects***	*4.1 Building has Slender Columns and Stiff Beams, with glass infills or no infills.*	***Red***
		4.2 Building has Flat Slabs without any RC Structural Walls in each plan direction.	***Red***
5.	***Siting Issues***	*5.1 Building is resting on cracked ground.*	***Yellow***
		5.2 Building is adjoining another building on the side with no gap.	***Yellow***
6.	***Soil & Foundation Conditions***	*6.1 Building is resting on weak or non-uniform soil along the length in plan.*	***Yellow***
7.	***Architectural Features***	*7.1 Building has large or heavy cantilever parapet walls.*	***Yellow***
		7.2 Building has large or heavy cantilever chimneys.	***Yellow***
		7.3 Building has large or heavy cantilever balconies or sunshades.	***Yellow***
		7.4 Building has large room sizes and large storey heights.	***Yellow***
		7.5 Building has windows larger than 50% of the length of the wall.	***Yellow***
8.	***Structural Aspects***	*8.1 Building has an irregular structural grid.*	***Yellow***
		8.2 Building has RC walls unsymmetrical in both directions.	***Yellow***
		8.3 Building has staircase at unsymmetrical location in plan.	***Yellow***
		8.4 Building has unanchored water tanks on roof.	***Yellow***
9.	***Construction and Maintenance Details***	*9.1 Building has longitudinal cracks and/or spalling in Beams and Columns.*	***Yellow***
		9.2 Building has poor construction quality material.	***Yellow***
10.		*None of the above.*	*Green*

FINAL RATING		
GREEN (Usable)	***YELLOW (Usable with temporary interventions)***	***RED (Unusable)***
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ Not Recommended ☐ Recommended

Level 2 Detailed Visual Screening : ☐ Not Recommended ☐ Recommended

.

B: RC

Post-Earthquake Rapid Visual Screening
Reinforced Concrete Buildings

Inspection
Inspector ID:
Inspection Date :
Inspection Time:

Building Description
Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N_______________° E______________°

Structural System

Structural System

☐ Moment Frame ☐ Moment Frame with Braces
☐ Moment Frame with Structural Walls ☐ Other_______________

Structural Components

FLOOOR	☐ In-situ	☐ Precast Planks with in-situ screed	☐ Precast		☐ Other___________
ROOF	☐ Flat	☐ Pitched	☐ Hipped	☐ Split	☐ Other___________

Occupancy

RESIDENTIAL	☐ Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ ___________________		

S.No.	Life Threatening Parameters			Tag
1.	**Siting Issues**	1.1	Building is resting on ground that has failed due to Landslide/Fissures and Liquefaction.	Red
		1.2	Building is tilted.	Red
		1.3	Building is resting on hill slopes or adjacent to hill slopes, and has unsafe/tilted adjoining/uphill building or loose boulders.	Red
2.	**Soil & Foundation Conditions**	2.1	Building is resting on river terraces that have cracked soil.	Red
		2.2	Building has sustained uneven settlement of the ground.	Red
		2.3	Building is resting on liquefied soil.	Red
		2.4	Uneven Settlement of building leading to visual damage.	Red
3.	**Structural Aspects**	3.1	Building has pounding damage from adjoining building or structure.	Red
		3.2	Building has collapsed/damaged staircase/mumty or blockade of staircase.	Red
		3.3	Building has an Open storey (at ground /other level) with columns having shear cracks.	Red
		3.4	Building has Floating Columns with cracked supporting beams.	Red
		3.5	Building has main load resisting columns with shear cracks.	Red
		3.6	Building has main load resisting short columns with shear cracks.	Red
		3.7	Building has Flat Slab with punching shear failure.	Red

		3.8 Building has spalling of cover concrete in main load resisting columns.	**Red**
		3.9 Building has extensive X cracking or out-of-plane collapse of infills.	**Red**
		3.10 No seismic separation between staircase and building	**Red**
4.	***Siting Issues***	*4.1 Building is adjacent to a failed slope.*	***Yellow***
5.	***Structural Aspects***	*5.1 Building has sustained collapse of cantilevers, balconies, chimneys and parapets.*	***Yellow***
		5.2 Building has water tanks on roof displaced from their supports.	***Yellow***
		5.3 Building has sustained extensive separation between infill wall and frame members, and has no damage in columns.	***Yellow***
6.		*None of the above.*	Green

FINAL RATING		
GREEN ***(Usable)***	***YELLOW*** ***(Usable with temporary interventions)***	***RED*** ***(Unusable)***
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ *Not Recommended* ☐ *Recommended*

Level 2 Detailed Visual Screening : ☐ *Not Recommended* ☐ *Recommended*

A : BCBM

Pre-Earthquake Rapid Visual Screening

Burnt Clay Brick Masonry Buildings

Inspection

Inspector ID:

Inspection Date :

Inspection Time:

Building Description

Building Name :

Address 1 :

Address 2 :

City/Town :

Coordinates : N______________° E______________°

Structural Components

STRUCTURAL SYSTEM	☐ Load Bearing Masonry Structure			☐ Other__________
FLOOR	☐ RC Slab	☐ Precast Planks with In-situ screed		☐ Other__________
ROOF GEOMETRY	☐ Pitched	☐ Hipped	☐ Split	☐ Other__________
ROOF MATERIAL	☐ RC Slab	☐ Wood with Clay tiles	☐ Wood truss with Corrugated sheets	
		☐ Wood with Wooden Planks		☐ Other__________
MORTAR	☐ Cement	☐ Mud ☐ Lime	☐ No mortar	☐ Other__________

Occupancy

RESIDENTIAL	☐ Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ ____________		

S.No.	Life Threatening Parameters			Tag
1.	**Siting Issues**	1.1	Building is built on hill slope or adjacent to hill slope, that is vulnerable to falling debris.	Red
		1.2	Building rests adjoining a severely deteriorated or damaged building or structure.	Red
2.	**Soil and foundation conditions**	2.1	Building is built on liquefiable soil.	Red
		2.2	Building is built on river terraces that can slide or creep.	Red
		2.3	Building is built on hill slope that can slide.	Red
3.	**Architecture Features**	3.1	Building has exterior plan dimension smaller at the plinth level than at upper storeys.	Red
		3.2	Building has heavier upper storeys.	Red
		3.3	Building has large unanchored projections or overhangs.	Red
		3.4	Building has irregular plan geometry and/or plan aspect (length-to-width ratio) >4.0.	Red
		3.5	Building has storey height more than about 25 times wall thickness.	Red
		3.6	Building has unsupported height more than 2.5m.	Red
		3.7	Building has stiff upper storeys.	Red
4.		4.1	Building has no continuous lintel band, roof band and gable band.	Red

	Structural Aspects	*4.2 Building has door/window openings in walls close to corners.*	**Red**
		4.3 Building has masonry walls not integrated into each other at corners.	**Red**
		4.4 Building has walls made without lime / cement mortar or mud mortar exposed to vagaries.	**Red**
		4.5 Building has roof not anchored into the walls.	**Red**
		4.6 Building has thick walls made of two wythes and no through stones.	**Red**
		4.7 Building has out-of-plumb walls.	**Red**
		4.8 Building has separation between walls and between walls and floor/roof.	**Red**
		4.9 Building has cracks in walls.	**Red**
5.	***Construction and Material details***	*5.1 Buildings have walls made with mud mortar and deteriorated significantly owing to vagaries of the outside weather (especially rainwater beating).*	**Red**
6.	***Siting Issues***	*6.1 Building is resting on cracked ground.*	**Yellow**
		6.2 Building is adjoining another building on the side with no gap.	**Yellow**
		6.3 Building is resting on sloped ground with access to house at two/three levels, i.e., ground, middle floor and roof.	**Yellow**
		6.4 Building is connected to the sloped ground and there is no gap between the building and the natural slope of the ground.	**Yellow**
7.	***Soil and foundation conditions***	*7.1 Building is resting on weak or non-uniform soil along the length in plan.*	**Yellow**
8.	***Architectural Features***	*8.1 Building has large or heavy cantilever parapet walls.*	**Yellow**
		8.2 Building has large or heavy cantilever chimneys.	**Yellow**
		8.3 Building has large or heavy cantilever balconies or sunshades.	**Yellow**
		8.4 Building has large room sizes and large storey heights.	**Yellow**
		8.5 Building has windows larger than 50% of the length of the wall.	**Yellow**
		8.6 Building has unanchored water tanks on roof.	**Yellow**
9.	***Structural Aspects***	*9.1 Building has an irregular grid of masonry walls in plan.*	**Yellow**
		9.2 Building has staircase at unsymmetrical location in plan.	**Yellow**
		9.3 Building has loosely placed country tiles on the roof.	**Yellow**
10	***Construction and Material details***	*10.1 Building has vertical cracks in masonry walls.*	**Yellow**
		10.2 Building has poor construction quality material.	**Yellow**
11		*None of the above.*	**Green**

FINAL RATING		
GREEN (Usable)	***YELLOW (Usable with temporary interventions)***	***RED (Unusable)***
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ *Not Recommended* ☐ *Recommended*

Level 2 Detailed Visual Screening : ☐ *Not Recommended* ☐ *Recommended*

.

B : BCBM

Post-Earthquake Rapid Visual Screening
Burnt Clay Brick Masonry Buildings

Inspection
Inspector ID:
Inspection Date :
Inspection Time:

Building Description
Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N____________ ° E____________ °

Structural Components

STRUCTURAL SYSTEM	☐ *Load Bearing Masonry Structure*			☐ *Other________*
FLOOR	☐ *RC Slab*	☐ *Precast Planks with In-situ screed*		☐ *Other________*
ROOF GEOMETRY	☐ *Pitched*	☐ *Hipped*	☐ *Split*	☐ *Other________*
ROOF MATERIAL	☐ *RC Slab*	☐ *Wood with Clay tiles*	☐ *Wood truss with Corrugated sheets*	
		☐ *Wood with Wooden Planks*		☐ *Other________*
MORTAR	☐ *Cement*	☐ *Mud* ☐ *Lime*	☐ *No mortar*	☐ *Other________*

Occupancy

RESIDENTIAL	☐ *Individual House*	☐ *Apartments*	
EDUCATIONAL	☐ *School*	☐ *College*	☐ *Institute/University*
LIFELINE	☐ *Hospital*	☐ *Police Station*	☐ *Fire Station*
	☐ *Power Station*	☐ *Water Plant*	☐ *Sewage Plant*
COMMERCIAL	☐ *Hotel*	☐ *Shopping*	☐ *Recreational*
OFFICE	☐ *Government*	☐ *Private*	
MIXED USE	☐ *Residential and Commercial*		☐ *Residential and Industrial*
INDUSTRIAL	☐ *Agriculture*	☐ *Live Stock*	
OTHER	☐ ____________		

S.No.	*Life Threatening Parameters*			Tag
1.	**Siting Issues**	1.1	*Building is resting on ground that has failed due to Landslide/Fissures and Liquefaction.*	**Red**
		1.2	*Building is tilted.*	**Red**
		1.3	*Building is resting on hill slopes or adjacent to hill slopes.*	**Red**
2.	**Soil and foundation conditions**	2.1	*Building is resting on river terraces that have cracked or soil.*	**Red**
		2.2	*Building has sustained uneven settlement of the ground.*	**Red**
		2.3	*Building is resting on liquefied soil.*	**Red**
		2.4	*Uneven Settlement of building leading to visual damage.*	**Red**
3.	**Structural Aspects**	3.1	*Building has pounding damage from adjoining building or structure.*	**Red**
		3.2	*Building has collapsed/damaged staircase/mumty or blockade of staircase.*	**Red**
		3.3	*Building has plinth masonry severely damaged.*	**Red**
		3.4	*Building has horizontally slid at any storey.*	**Red**
		3.5	*Building has suffered separation of wall junctions at corners.*	**Red**
		3.6	*Building has floor-wall junction separated with walls out-of-plumb.*	**Red**
		3.7	*Building has suffered gable collapse.*	**Red**
		3.8	*Building has walls separated into wythes.*	**Red**
		3.9	*Building has diagonal shear cracking in wall piers and/or spandrels.*	**Red**

		3.10 Building has crushed masonry at wall base.	***Red***
		3.11 No seismic separation between staircase and building.	***Red***
4.	***Siting Issues***	*4.1 Building is adjacent to a failed slope.*	***Yellow***
5.	***Structural Aspects***	*5.1 Building has sustained collapse of cantilevers, balconies, chimneys and parapets.*	***Yellow***
		5.2 Building has water tanks on roof displaced from their supports.	***Yellow***
6.		*None of the above.*	***Green***

FINAL RATING		
GREEN (Usable)	***YELLOW (Usable with temporary interventions)***	***RED (Unusable)***
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ *Not Recommended* ☐ *Recommended*

Level 2 Detailed Visual Screening : ☐ *Not Recommended* ☐ *Recommended*

A: CM

Pre-Earthquake Rapid Visual Screening
Confined Masonry

Inspection

Inspector ID:

Inspection Date :

Inspection Time:

Building Description

Building Name :

Address 1 :

Address 2 :

City/Town :

Coordinates : N______________° E_____________°

Structural System

Structural System

Load Bearing Masonry Structure with
- ☐ Burnt clay bricks
- ☐ Cement blocks
- ☐ Stone blocks
- ☐ Others ______________

Structural Components

FLOOR ☐ RC Slab ☐ Other____________

ROOF GROMETRY ☐ Pitched ☐ Hipped ☐ Split ☐ Other______________

ROOF MATERIAL ☐ RC Slab ☐ Wood Truss with
- ○ Clay tiles
- ○ Corrugated sheets
- ○ Wood Planks

☐ Other______________________

Occupancy

RESIDENTIAL	☐ Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ _______________		

S.No.	Life Threatening Parameters		Tag
1.	**Siting Issues**	1.3 Building is built on hill slope or adjacent to hill slope, that is vulnerable to falling debris.	Red
		1.4 Building rests adjoining a severely deteriorated or damaged building or structure.	Red
2.	**Soil & Foundation Conditions**	2.4 Building is built on liquefiable soil.	Red
		2.5 Building is built on river terraces that can slide or creep.	Red
		2.6 Building is built on hill slope that can slide.	Red
3.	**Architectural Features**	3.7 Building has exterior plan dimension smaller at the plinth level than at upper storeys.	Red
		3.8 Building has heavier upper storeys.	Red
		3.9 Building has large unanchored projections or overhangs.	Red
		3.10 Building has no continuous tie beams or tie columns.	Red

		3.11 Building has no Tie Beams at plinth, lintel or roof levels.	Red
		3.12 Building has no Tie Columns at wall junctions.	Red
		3.13 Building has plan aspect (length-to-width ratio) more than 4.0.	Red
		3.14 Building has irregular plan.	Red
		3.15 Building has storey height more than about ~25 times wall thickness.	Red
4.	**Structural Aspects**	4.1 Building has door/window openings in walls close to corners.	Red
		4.2 Building has no toothing between masonry walls and Tie Columns.	Red
		4.3 Building has Tie Columns spaced at more than 1.5 times Storeyheight.	Red
		4.4 Building has out-of-plumb walls.	Red
5.	**Siting Issues**	5.1 Building is resting on cracked ground.	Yellow
		5.2 Building is adjoining another building on the side with no gap.	Yellow
6.	**Soil & Foundation Conditions**	6.1 Building is resting on weak or non-uniform soil along the length in plan.	Yellow
7.	**Architectural Features**	7.1 Building has large or heavy cantilever parapet walls.	Yellow
		7.2 Building has large or heavy cantilever chimneys.	Yellow
		7.3 Building has large or heavy cantilever balconies or sunshades.	Yellow
		7.4 Building has large room sizes and large storey heights.	Yellow
		7.5 Building has windows larger than 50% of the length of the wall.	Yellow
		7.6 Building has Tie Columns spaced at more than Storey Height.	Yellow
		7.7 Building has no spandrel masonry between Tie Columns and Tie Beams above lintel.	Yellow
		7.8 Floors with (a) Timber planks with Timber or Steel Joists, (b) Timber Planks and Stone Slabs, and/or (c) Brick, brick coba or mud overlay.	Yellow
8.	**Structural Aspects**	8.1 Building has an irregular grid of masonry walls in plan.	Yellow
		8.2 Building has staircase at unsymmetrical location in plan.	Yellow
		8.3 Building has loosely placed country tiles on the roof.	Yellow
		8.4 Building has unanchored water tanks on roof.	Yellow
		8.5 Building has no anchorage of steel bar in Tie Columns into foundation.	Yellow
		8.6 Building has discontinuous Tie Beams at sill and lintel levels.	Yellow
9.	**Construction and Maintenance Details**	9.1 Building has vertical cracks in masonry walls, and/or longitudinal cracks and spalling in Tie Beams and Tie Columns.	Yellow
		9.2 Building has poor construction quality material.	Yellow
10.		None of the above.	Green

FINAL RATING		
GREEN (Usable)	**YELLOW (Usable with temporary interventions)**	**RED (Unusable)**
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ Not Recommended ☐ Recommended

Level 2 Detailed Visual Screening : ☐ Not Recommended ☐ Recommended

B: CM

Post-Earthquake Rapid Visual Screening
CONFINED MASONRY

Inspection
Inspector ID:
Inspection Date :
Inspection Time:

Building Description
Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N______________° E_____________°

Structural System

Structural System

Load Bearing Masonry Structure with
- ☐ Burnt clay bricks
- ☐ Cement blocks
- ☐ Stone blocks
- ☐ Others ______________

Structural Components

FLOOR	☐ RC Slab	☐ Other____________		
ROOF GROMETRY	☐ Pitched	☐ Hipped	☐ Split	☐ Other______________
ROOF MATERIAL	☐ RC Slab	☐ Wood Truss with	○ Clay tiles ○ Corrugated sheets ○ Wood Planks	
		☐ Other______________________		

Occupancy

RESIDENTIAL	☐ Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ __________________		

S.No.	Life Threatening Parameters			Tag
1.	**Siting Issues**	1.1	Building is resting on ground that has failed due to Landslide/Fissures and Liquefaction.	Red
		1.2	Building is tilted.	Red
		1.3	Building is resting on hill slopes or adjacent to hill slopes, and has unsafe/tilted adjoining/uphill building or loose boulders.	Red
2.	**Soil & Foundation Conditions**	2.1	Building is resting on river terraces that have cracked or soil.	Red
		2.2	Building has sustained uneven settlement of the ground.	Red
		2.3	Building is resting on liquefied soil.	Red
		2.4	Uneven Settlement of building leading to visual damage.	Red
3.	**Structural Aspects**	3.1	Building has pounding damage from adjoining building or structure.	Red
		3.2	Building has collapsed/damaged staircase/mumty or blockade of staircase.	Red

		3.3 Building has plinth masonry severely damaged.	**Red**
		3.4 Building has horizontally slid at any storey.	**Red**
		3.5 Building has suffered separation of Tie columns and masonry wallsat corners.	**Red**
		3.6 Building has floor-wall junction separated with walls out-of-plumb.	**Red**
		3.7 Building has suffered gable collapse.	**Red**
		3.8 Building has through cracks across Tie Columns and Tie Beams.	**Red**
		3.9 Building has diagonal shear cracking in wall panels.	**Red**
		3.10 Building has crushed masonry at wall base.	**Red**
		3.11 No seismic separation between staircase and building.	**Red**
4.	**Siting Issues**	4.1 Building is adjacent to a failed slope.	**Yellow**
5.	**Structural Aspects**	5.1 Building has sustained collapse of cantilevers, balconies, chimneys and parapets.	**Yellow**
		5.2 Uneven settlement of adjacent building.	**Yellow**
		None of the above.	Green

FINAL RATING

GREEN (Usable)	**YELLOW (Usable with temporary interventions)**	**RED (Unusable)**
	Suggested interventions:	

Further Actions

Building to be quarantined ☐ Not Recommended ☐ Recommended

Level 2 Detailed Visual Screening ☐ Not Recommended ☐ Recommended

A: RRSM

Pre-Earthquake Rapid Visual Screening
Random Rubble Stone Masonry

Inspection

Inspector ID:

Inspection Date :

Inspection Time:

Building Description

Building Name :

Address 1 :

Address 2 :

City/Town :

Coordinates : N______________ ° E_____________ °

Structural System

Structural System

Load Bearing Masonry Structure with
- ☐ Igneous rocks
- ☐ Sedimentary rocks
- ☐ Slate blocks
- ☐ Others ______________

Structural Components

FLOOR ☐ RC Slab ☐ Timber planks on Timber beams ☐ Other_____________

ROOF GROMETRY ☐ Pitched ☐ Hipped ☐ Split ☐ Other_____________

ROOF MATERIAL ☐ RC Slab ☐ Wood Truss with ○ Clay tiles ○ Corrugated sheets ○ Wood Planks

☐ Steel Truss with corrugated sheeting ☐ Other_____________

MORTAR ☐ Cement ☐ Mud ☐ Lime ☐ No mortar ☐ Other_____________

Occupancy

RESIDENTIAL	☐ Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ ________________		

S.No.	Life Threatening Parameters		Tag
1.	Siting Issues	1.5 Building is built on hill slope or adjacent to hill slope, that is vulnerable to falling debris.	Red
		1.6 Building rests adjoining a severely deteriorated or damaged building or structure.	Red
2.	Soil & Foundation Conditions	2.7 Building is built on liquefiable soil.	Red
		2.8 Building is built on river terraces that can slide or creep.	Red
		2.9 Building is built on hill slope that can slide.	Red
3.	Architectural Features	3.16 Building has exterior plan dimension smaller at the plinth level than at upper storeys.	Red
		3.17 Building has heavier upper storeys.	Red
		3.18 Building has large unanchored projections or overhangs, e.g., parapets.	Red

		3.19 Building has irregular plan geometry and/or plan aspect (length-to-width ratio) >4.0.	**Red**
		3.20 Building has storey height more than about 25 times wall thickness.	**Red**
		3.21 Building has unsupported height more than 2.5m.	**Red**
		3.22 Building has stiff upper storeys.	**Red**
4.	***Structural Aspects***	*4.3 Building has no continuous lintel band, roof band and gable band.*	**Red**
		4.4 Building has door/window openings in walls close to corners.	**Red**
		4.5 Building has masonry walls not integrated into each other at corners.	**Red**
		4.6 Building has walls made with no or mud mortar exposed to vagaries.	**Red**
		4.7 Building has roof not anchored into the walls.	**Red**
		4.8 Building has thick walls made of two wythes and no through stones.	**Red**
		4.9 Building has out-of-plumb walls.	**Red**
		4.10 Building has openings close to wall junctions or corners, or to floors/roof.	**Red**
		4.11 Building has separation between walls and between walls and floor/roof.	**Red**
		4.12 Building has cracks in walls.	**Red**
5.	***Construction and Maintenance Details***	*5.1 Building has walls made with mud mortar and deteriorated and cracked significantly owing to vagaries of outside weather (especially rainwater beating).*	**Red**
6.	***Siting Issues***	*6.1 Building is resting on cracked ground.*	**Yellow**
		6.2 Building is adjoining another building on the side with no gap.	**Yellow**
		6.3 Building is resting on sloped ground with access to house at two/three levels, i.e., ground, middle floor and roof.	**Yellow**
		6.4 Building is connected to the sloped ground and there is no gap between the building and the natural slope of the ground.	**Yellow**
7.	***Soil & Foundation Conditions***	*7.1 Building is resting on weak or non-uniform soil along the length in plan.*	**Yellow**
8.	***Architectural Features***	*8.1 Building has large or heavy cantilever parapet walls.*	**Yellow**
		8.2 Building has large or heavy cantilever chimneys.	**Yellow**
		8.3 Building has large or heavy cantilever balconies or sunshades.	**Yellow**
		8.4 Building has large room sizes and large storey heights.	**Yellow**
		8.5 Building has windows larger than 50% of the length of the wall.	**Yellow**
		8.6 Building has unanchored water tanks on roof.	**Yellow**
9.	***Structural Aspects***	*9.1 Building has an irregular grid of masonry walls in plan.*	**Yellow**
		9.2 Building has staircase at unsymmetrical location in plan.	**Yellow**
		9.3 Building has loosely placed country tiles on the roof.	**Yellow**
10.	***Construction and Maintenance Details***	*10.1 Building has vertical cracks in masonry walls.*	**Yellow**
		10.2 Building has poor construction quality material.	**Yellow**
11.		*None of the above.*	Green

FINAL RATING		
GREEN (Usable)	***YELLOW (Usable with temporary interventions)***	***RED (Unusable)***
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ *Not Recommended* ☐ *Recommended*

Level 2 Detailed Visual Screening : ☐ *Not Recommended* ☐ *Recommended*

B: RRSM | *Post-Earthquake* Rapid Visual Screening
Random Rubble Stone Masonry

Inspection

Inspector ID:
Inspection Date :
Inspection Time:

Building Description

Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N____________° E____________°

Structural System

Structural System

Load Bearing Masonry Structure with ☐ *Igneous rocks* ☐ *Sedimentary rocks* ☐ *Slate blocks* ☐ *Others ____________*

Structural Components

FLOOR	☐ RC Slab	☐ Timber planks on Timber beams		☐ Other____________
ROOF GROMETRY	☐ Pitched	☐ Hipped	☐ Split	☐ Other____________
ROOF MATERIAL	☐ RC Slab	☐ Wood Truss with	○ Clay tiles ○ Corrugated sheets ○ Wood Planks	
	☐ Steel Truss with corrugated sheeting			☐ Other____________
MORTAR	☐ Cement	☐ Mud	☐ Lime ☐ No mortar	☐ Other____________

Occupancy

RESIDENTIAL	☐ Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ ________________		

S.No.	*Life Threatening Parameters*		Tag
1.	***Siting Issues***	*1.4 Building is resting on ground that has failed due to Landslide/Fissures and Liquefaction.*	**Red**
		1.5 Building is tilted.	**Red**
		1.6 Building is resting on hill slopes or adjacent to hill slopes, and has unsafe/tilted adjoining/uphill building or loose boulders.	**Red**
2.	***Soil & Foundation Conditions***	*2.5 Building is resting on river terraces that have cracked or soil.*	**Red**
		2.6 Building has sustained uneven settlement of the ground.	**Red**
		2.7 Building is resting on liquefied soil.	**Red**
3.	***Structural Aspects***	*5.3 Building has pounding damage from adjoining building or structure.*	**Red**
		5.4 Building has collapsed/damaged staircase/mumty or blockade of staircase.	**Red**
		5.5 Building has plinth masonry severely damaged.	**Red**

		5.6 *Building has horizontally slid at any storey.*	***Red***
		5.7 *Building has suffered separation of wall junctions at corners.*	***Red***
		5.8 *Building has floor-wall junction separated with walls out-of-plumb.*	***Red***
		5.9 *Building has suffered gable collapse.*	***Red***
		5.10 *Building has walls separated into wythes.*	***Red***
		5.11 *Building has diagonal shear cracking in wall piers and/or spandrels.*	***Red***
		5.12 *Building has crushed masonry at wall base.*	***Red***
4.	***Siting Issues***	4.1 *Building is adjacent to a failed slope.*	***Yellow***
5.	***Structural Aspects***	5.1 *Building has sustained collapse of cantilevers, balconies, chimneys and parapets.*	***Yellow***
		5.2 *Uneven settlement of adjacent building.*	***Yellow***
		None of the above	*Green*

FINAL RATING		
GREEN (Usable)	***YELLOW (Usable with temporary interventions)***	***RED (Unusable)***
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ *Not Recommended* ☐ *Recommended*

Level 2 Detailed Visual Screening : ☐ *Not Recommended* ☐ *Recommended*

A: MH

Pre-Earthquake **Rapid Visual Screening**

Mud House

Inspection

Inspector ID:

Inspection Date :

Inspection Time:

Building Description

Building Name :

Address 1 :

Address 2 :

City/Town :

Coordinates : N_____________ ° E____________ °

Structural System

Structural System

Load bearing mud walls Structure with
- ☐ *Un-strengthened mud courses*
- ☐ *Slurry of wet mud*
- ☐ *Locally available grass*

Other ☐ ________________

Structural Components

FLOOR	☐ *Mud plastered*	☐ *Other*________	
ROOF GEOMETRY	☐ *Pitched*	☐ *Hipped*	☐ *Other*____________
ROOF MATERIAL	☐ *Thach + Bamboo*	☐ *Wood truss with*	○ *Clay tiles* ○ *Corrugated sheets* ○ *Wood planks*

Occupancy

RESIDENTIAL	☐ Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ ______________		

S.No.	*Life Threatening Parameters*			*Tag*
1.	**Siting Issues**	1.1	*Building is built on hill slope or adjacent to hill slope, that is vulnerable to falling debris.*	**Red**
		1.2	*Building rests adjoining a severely deteriorated or damaged building or structure.*	**Red**
2.	**Soil & Foundation Conditions**	2.1	*Building is built on liquefiable soil.*	**Red**
		2.2	*Building is built on river terraces that can slide or creep.*	**Red**
		2.3	*Building is built on hill slope that can slide.*	**Red**
		2.4	*Building is built on ground with high water table.*	**Red**
3.	**Architectural Features**	3.1	*Building has exterior plan dimension smaller at the plinth level than at upper storeys.*	**Red**
		3.2	*Building has heavier upper storey.*	**Red**
		3.3	*Building has large unanchored projections or overhangs.*	**Red**
		3.4	*Building has irregular plan geometry and/or plan aspect (length-to-width ratio) more than 4.0.*	**Red**

		3.5 Building has storey height more than about 25 times wall thickness.	Red
		3.6 Building has unsupported height more than 2.5m.	Red
4.	**Construction Style**	4.1 Building has no or no continuous lintel band, roof band and gable band.	Red
		4.2 Building has door/window openings in walls close to corners.	Red
		4.3 Building has masonry walls not integrated into close to corner.	Red
		4.4 Building has roof not anchored into the walls.	Red
		4.5 Building has thick walls made of two wythes and no through mesh of timber.	Red
		4.6 Building has out-of-plumb walls.	Red
		4.7 Building has cracks in walls.	Red
		4.8 Building has no vertical wood posts along the length of the wall.	Red
		4.9 Building has no wood posts under each rafters of floor/roof.	Red
5.	**Construction and Material Details**	5.1 Building has mud walls deteriorated and cracked significantly owing to vagaries of the outside weather (especially rainwater beating).	Red
6.	**Siting Issues**	6.1 Building is resting on cracked ground.	Yellow
		6.2 Building is adjoining another building on the side with no gap.	Yellow
7.	**Soil & Foundation Conditions**	7.1 Building is resting on weak or non-uniform soil along the length in plan.	Yellow
8.	**Architectural Features**	8.1 Building has large room sizes and large storey heights.	Yellow
		8.2 Building has poor distribution of walls in plan of the building.	Yellow
		8.3 Building has wall aspect ratio more than 2.	Yellow
		8.4 Building has windows larger than 50% of the width of the wall.	Yellow
		8.5 Building has floors with brick, brick coba or mud overlay on (a) Timber joists and planks, and/or (b) Timber planks and stone slabs.	Yellow
9.	**Structural Aspects**	9.1 Building has an irregular grid of masonry walls in plan.	Yellow
		9.2 Building has staircase at unsymmetrical location in plan.	Yellow
		9.3 Building has irregular plan in geometry.	Yellow
10.	**Construction and Maintenance Details**	10.1 Building has vertical cracks in mud walls.	Yellow
		10.2 Poor quality of materials.	Yellow
11.		None of the above.	Green

FINAL RATING		
GREEN (Usable)	**YELLOW (Usable with temporary interventions)**	**RED (Unusable)**
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ Not Recommended ☐ Recommended

Level 2 Detailed Visual Screening : ☐ Not Recommended ☐ Recommended

B: MH

Post-Earthquake Rapid Visual Screening
Mud Houses

Inspection

Inspector ID:
Inspection Date :
Inspection Time:

Building Description

Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N______________ ° E______________ °

Structural System

Structural System

Load bearing mud walls Structure with
- ☐ Un-strengthened mud courses
- ☐ Slurry of wet mud
- ☐ Locally available grass

Other ☐ ____________________

Structural Components

FLOOR	☐ Mud plastered	☐ Other_________	
ROOF GEOMETRY	☐ Pitched	☐ Hipped	☐ Other_____________
ROOF MATERIAL	☐ Thach + Bamboo	☐ Wood truss with	○ Clay tiles ○ Corrugated sheets ○ Wood planks

Occupancy

RESIDENTIAL	☐ Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ ____________________		

S.No.	Life Threatening Parameters		Tag
1.	**Siting Issues**	1.1 Building is resting on ground that has failed due to Landslide/Fissures and Liquefaction.	Red
		1.2 Building is tilted.	Red
		1.3 Building is resting on hill slopes or adjacent to hill slopes, and has unsafe/tilted adjoining/uphill building or loose boulders.	Red
2.	**Soil & Foundation Conditions**	2.1 Building is resting on river terraces that have cracked or soil.	Red
		2.2 Building has sustained uneven settlement of the ground.	Red
		2.3 Building is resting on liquefied soil.	Red
3.	**Structural Aspects**	3.1 Building has suffered gable collapse.	Red
		3.2 Separation of wythes observed.	Red
		3.3 Building has suffered damage to masonry plinth.	Red
4.	**Siting Issues**	4.1 Building is adjacent to a failed slope.	Yellow
5.	**Structural Aspects**	5.1 Building has sustained collapse of cantilevers, balconies, chimneys and parapet.	Yellow

		5.2 Uneven settlement of adjacent building.	**Yellow**
6.		*None of the above.*	**Green**

FINAL RATING

GREEN *(Usable)*	**YELLOW** *(Usable with temporary interventions)*	**RED** *(Unusable)*
	Suggested interventions:	

Further Actions

Building to be quarantined	:	☐ *Not Recommended*	☐ *Recommended*
Level 2 Detailed Visual Screening	:	☐ *Not Recommended*	☐ *Recommended*

A:DD

Pre-Earthquake Rapid Visual Screening
Dhajji Diwari

Inspection
Inspector ID:
Inspection Date :
Inspection Time:

Building Description
Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N____________° E____________°

Structural Components

STRUCTURAL SYSTEM	☐ Timber frame without diagonal braces		
	☐ Timber frame with diagonal braces		☐ Other__________
FLOOR	☐ Timber beams with Wooden Planks		
	☐ Timber frame with stone planks		☐ Other__________
ROOF GEOMETRY	☐ Flat	☐ Pitched	☐ Hipped
	☐ Split		☐ Other__________
ROOF MATERIAL	☐ Timber truss with Timber planks		
	☐ Timber truss with corrugated GI sheets		☐ Other__________
OTHER	☐ __________		

Occupancy

RESIDENTIAL	☐ Individual House	☐ Apartments	
EDUCATIONAL	☐ School	☐ College	☐ Institute/University
LIFELINE	☐ Hospital	☐ Police Station	☐ Fire Station
	☐ Power Station	☐ Water Plant	☐ Sewage Plant
COMMERCIAL	☐ Hotel	☐ Shopping	☐ Recreational
OFFICE	☐ Government	☐ Private	
MIXED USE	☐ Residential and Commercial		☐ Residential and Industrial
INDUSTRIAL	☐ Agriculture	☐ Live Stock	
OTHER	☐ __________		

S.No.	Life Threatening Parameters			Tag
1.	**Siting**	1.1	Building is built on hill slope or adjacent to hill slope, that is vulnerable to falling debris.	Red
		1.2	Building rests adjoining a severely deteriorated or damaged building or structure.	Red
2.	**Soil and foundation conditions**	2.1	Building is built on liquefiable soil.	Red
		2.2	Building is built on river terraces that can slide or creep.	Red
		2.3	Building is built on hill slope that can slide.	Red
3.	**Architecture**	3.1	Building has exterior plan dimension smaller at the plinth level than at upper storeys.	Red
		3.2	Building has heavier upper storeys.	Red
		3.3	Building has large unanchored projections or overhangs.	Red
		3.4	Building has an Open Storey (at ground /other level).	Red
		3.5	Building has timber frame with Floating Columns.	Red
		3.6	Building has discontinuous vertical and horizontal runners in walls.	Red

		3.7 Building has irregularly spaced grid of vertical and horizontal runners in walls.	Red
		3.8 Building has irregular plan.	Red
		3.9 Building has plan aspect (length-to-width) ratio exceeds 4.0.	Red
4.	**Structural**	4.1 Building has a roof that is not integral.	Red
		4.2 Building does not rest on stiff ground.	Red
		4.3 Building has too many panel with no infills between vertical and horizontal runners.	Red
		4.4 Building has vertical timber members spaced more than 1.5 times the height.	Red
		4.5 Building has vertical timber members not anchored to plinth masonry.	Red
		4.6 Building has inadequate mortise and tendon joints.	Red
5.	**Siting**	5.1 Building is resting on cracked ground.	Yellow
		5.2 Building is adjoining another building on the side with no gap.	Yellow
6.	**Soil and foundation conditions**	6.1 Building is resting on weak or non-uniform soil along the length in plan.	Yellow
7.	**Architectural**	7.1 Building has large or heavy cantilever balconies or sunshades.	Yellow
		7.2 Building has large room sizes and large storey heights.	Yellow
		7.3 Building has windows larger than 50% of the length of the wall.	Yellow
		7.4 Building has more than three storeys.	Yellow
8.	**Structural**	8.1 Building has an irregular structural grid.	Yellow
		8.2 Building has braces in vertical plane placed in unsymmetrical locations in plan.	Yellow
		8.3 Building has staircase at unsymmetrical location in plan.	Yellow
		8.4 Building has unanchored water tanks on roof.	Yellow
		8.5 Building has discontinuous vertical and horizontal runners.	Yellow
		8.6 Building has Jharokhas not anchored to external wood frame of the building.	Yellow
		8.7 Building has diagonal braces only in upper storeys.	Yellow
9.	**Construction and Material details**	9.1 Building has loose connections at junctions of vertical and horizontal wood runners.	Yellow
		9.2 Building has poor construction quality material.	Yellow
10.		None of the above.	Green

FINAL RATING

GREEN (Usable)	YELLOW (Usable with temporary interventions)	RED (Unusable)
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ Not Recommended ☐ Recommended

Level 2 Detailed Visual Screening : ☐ Not Recommended ☐ Recommended

B:DD

Post-Earthquake Rapid Visual Screening
Dhajji Diwari

Inspection

Inspector ID:
Inspection Date :
Inspection Time:

Building Description

Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N________ ° E________ °

Structural Components

STRUCTURAL SYSTEM	☐ *Timber frame without diagonal braces*	
	☐ *Timber frame with diagonal braces*	☐ *Other*________
FLOOR	☐ *Timber beams with Wooden Planks*	
	☐ *Timber frame with stone planks*	☐ *Other*________
ROOF GEOMETRY	☐ *Flat* ☐ *Pitched* ☐ *Hipped*	
	☐ *Split*	☐ *Other*________
ROOF MATERIAL	☐ *Timber truss with Timber planks*	
	☐ *Timber truss with corrugated GI sheets*	☐ *Other*________
OTHER	☐ ________	

Occupancy

RESIDENTIAL	☐ *Individual House*	☐ *Apartments*	
EDUCATIONAL	☐ *School*	☐ *College*	☐ *Institute/University*
LIFELINE	☐ *Hospital*	☐ *Police Station*	☐ *Fire Station*
	☐ *Power Station*	☐ *Water Plant*	☐ *Sewage Plant*
COMMERCIAL	☐ *Hotel*	☐ *Shopping*	☐ *Recreational*
OFFICE	☐ *Government*	☐ *Private*	
MIXED USE	☐ *Residential and Commercial*		☐ *Residential and Industrial*
INDUSTRIAL	☐ *Agriculture*	☐ *Live Stock*	
OTHER	☐ ________		

S.No.	*Life Threatening Parameters*		Tag
1.	***Siting***	1.1 *Building is resting on ground that has failed due to Landslide/Fissures and Liquefaction.*	*Red*
		1.2 *Building is tilted.*	*Red*
		1.3 *Building is resting on hill slopes or adjacent to hill slopes.*	*Red*
2.	***Soil and foundation conditions***	2.1 *Building is resting on river terraces that have cracked or soil.*	*Red*
		2.2 *Building has sustained uneven settlement of the ground.*	*Red*
		2.3 *Building is resting on liquefied soil.*	*Red*
3.	***Structural***	3.1 *Building has separation at junction wood floor to vertical wood frame.*	*Red*
		3.2 *Building has vertical walls out of plumb.*	*Red*
		3.3 *Building has suffered gable collapse.*	*Red*
		3.4 *Building has sustained jharoka collapse.*	*Red*
		3.5 *Building has suffered extensive damage to masonry plinth.*	*Red*
		3.6 *Building has suffered horizontal sliding at any storey.*	*Red*
4.	***Siting***	4.1 *Building is adjacent to a failed slope.*	*Yellow*

5.	**Structural**	5.1 *Building has sustained collapse of cantilevers, balconies, chimneys and parapets.*	**Yellow**
		5.2 *Building has water tanks on roof displaced from their supports.*	**Yellow**
		5.3 *Building has sustained extensive separation between wood frame members and infill wall, and has no damage in columns.*	**Yellow**
6.		*None of the above*	**Green**

FINAL RATING		
GREEN ***(Usable)***	**YELLOW** ***(Usable with temporary interventions)***	**RED** ***(Unusable)***
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ *Not Recommended* ☐ *Recommended*

Level 2 Detailed Visual Screening : ☐ *Not Recommended* ☐ *Recommended*

A: EH

Pre-Earthquake Rapid Visual Screening
Ekra House

Inspection
Inspector ID:
Inspection Date :
Inspection Time:

Building Description
Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N_____________ ° E_____________ °

Structural System

Structural System

☐ *Timber frame without diagonal braces* ☐ *Timber frame with diagonal braces*
☐ *Other*_____________

Structural Components

FLOOR	☐ *Timber beams with wooden planks*	☐ *Timber beams with wooden planks*
	☐ *RC Slab*	☐ *Other*_____________
ROOF GEOMETRY	☐ *Pitched*	
ROOF	☐ *Timber Truss with timber planks*	☐ *Timber Truss with Thatch*
	☐ *Timber Truss with Corrugated GI sheets*	☐ *Other*_____________
WALLS	☐ *Wood frame infilled with Thatch*	☐ *Wood frame infilled with masonry*
	☐ *Wood frame infilled with bamboo matting*	
	☐ *Wood frame nailed with metal sheeting on vertical wall surface*	
	☐ *Wood frame infilled with Ekra matting and plastered with mud*	
OTHER	☐ _____________	

Occupancy

RESIDENTIAL	☐ *Individual House*	☐ *Apartments*	
EDUCATIONAL	☐ *School*	☐ *College*	☐ *Institute/University*
LIFELINE	☐ *Hospital*	☐ *Police Station*	☐ *Fire Station*
	☐ *Power Station*	☐ *Water Plant*	☐ *Sewage Plant*
COMMERCIAL	☐ *Hotel*	☐ *Shopping*	☐ *Recreational*
OFFICE	☐ *Government*	☐ *Private*	
MIXED USE	☐ *Residential and Commercial*		☐ *Residential and Industrial*
INDUSTRIAL	☐ *Agriculture*	☐ *Live Stock*	
OTHER	☐ _____________		

S.No.	*Life Threatening Parameters*			Tag
1.	**Siting Issues**	1.1	*Building is built on hill slope or adjacent to hill slope, that is vulnerable to falling debris.*	Red
		1.2	*Building rests adjoining a severely deteriorated or damaged building or structure.*	Red
2.	**Soil & Foundation Conditions**	2.1	*Building is built on liquefiable soil.*	Red
		2.2	*Building is built on river terraces that can slide or creep.*	Red
		2.3	*Building is built on hill slope that can slide.*	Red
3.	**Architectural Features**	3.1	*Building built on stilts.*	Red
		3.2	*Building has large unanchored projections or overhangs.*	Red
		3.3	*Building has no continuous sill or plinth bands.*	Red

		3.4 Building is built adjoining a severely deteriorated or damaged building or structure.	Red
4.	**Structural Aspects**	4.1 Building has door/window openings close to wall corners.	Red
		4.2 Building has vertical wood members spaced at more than 1.5 times building height.	Red
		4.3 Building has vertical wood members not anchored to foundation.	Red
		4.4 Building has roof that is not anchored into the walls.	Red
		4.5 Building has walls that are not integrated into each other at the corners.	Red
		4.6 Building has vertical posts of unequal lengths.	Red
		4.7 Building has roof rafters and purlins tied to vertical posts with deteriorated choir ropes.	Red
5.	**Siting Issues**	5.1 Building is resting on cracked ground.	Yellow
		5.2 Building is adjoining another building on the side with no gap.	Yellow
6.	**Soil & Foundation Conditions**	6.1 Building is resting on weak or non-uniform soil along the length in plan.	Yellow
7.	**Architectural Features**	7.1 Building has large or heavy cantilever balconies or sunshades.	Yellow
		7.2 Building has large room sizes and large storey heights.	Yellow
		7.3 Building has windows larger than 50% of the length of the wall.	Yellow
		7.4 Building has more than two storeys.	Yellow
		7.5 Building has non-uniform location of vertical posts in plan.	Yellow
		7.6 Houses have small gaps between them.	Yellow
8.	**Structural Aspects**	8.1 Building has an irregular structural grid.	Yellow
		8.2 Building has braces in vertical plane placed in unsymmetrical locations in plan.	Yellow
		8.3 Building has staircase at unsymmetrical location in plan.	Yellow
		8.4 Building has diagonal braces only in upper storeys.	Yellow
		8.5 Building has connections using natural materials, like coir ropes and reeds, of poor quality.	Yellow
		8.6 Building has discontinuous vertical and horizontal runners.	Yellow
9.	**Construction and Maintenance Details**	9.1 Building has loose connections at junctions of vertical and horizontal wood runners.	Yellow
		9.2 Building has poor construction quality material.	Yellow
10.		None of the above.	Green

FINAL RATING		
GREEN (Usable)	**YELLOW (Usable with temporary interventions)**	**RED (Unusable)**
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ Not Recommended ☐ Recommended

Level 2 Detailed Visual Screening : ☐ Not Recommended ☐ Recommended

B: EH

Post-Earthquake Rapid Visual Screening
Ekra House

Inspection
Inspector ID:
Inspection Date :
Inspection Time:

Building Description
Building Name :
Address 1 :
Address 2 :
City/Town :
Coordinates : N____________° E____________°

Structural System

Structural System

☐ *Timber frame without diagonal braces* ☐ *Timber frame with diagonal braces*
☐ *Other*____________

Structural Components

FLOOR	☐ *Timber beams with wooden planks*	☐ *Timber beams with wooden planks*
	☐ *RC Slab*	☐ *Other*____________
ROOF GEOMETRY	☐ *Pitched*	
ROOF	☐ *Timber Truss with timber planks*	☐ *Timber Truss with Thatch*
	☐ *Timber Truss with Corrugated GI sheets*	☐ *Other*____________
WALLS	☐ *Wood frame infilled with Thatch*	☐ *Wood frame infilled with masonry*
	☐ *Wood frame infilled with bamboo matting*	
	☐ *Wood frame nailed with metal sheeting on vertical wall surface*	
	☐ *Wood frame infilled with Ekra matting and plastered with mud*	
OTHER	☐ ____________	

Occupancy

RESIDENTIAL	☐ *Individual House*	☐ *Apartments*	
EDUCATIONAL	☐ *School*	☐ *College*	☐ *Institute/University*
LIFELINE	☐ *Hospital*	☐ *Police Station*	☐ *Fire Station*
	☐ *Power Station*	☐ *Water Plant*	☐ *Sewage Plant*
COMMERCIAL	☐ *Hotel*	☐ *Shopping*	☐ *Recreational*
OFFICE	☐ *Government*	☐ *Private*	
MIXED USE	☐ *Residential and Commercial*		☐ *Residential and Industrial*
INDUSTRIAL	☐ *Agriculture*	☐ *Live Stock*	
OTHER	☐ ____________		

S.No.	Life Threatening Parameters		Tag
1.	**Siting Issues**	1.4 Building is resting on ground that has failed due to Landslide/Fissures and Liquefaction.	**Red**
		1.5 Building is tilted.	**Red**
		1.6 Building is resting on hill slopes or adjacent to hill slopes, and has unsafe/tilted adjoining/uphill building or loose boulders.	**Red**
2.	**Soil & Foundation Conditions**	2.1 Building is resting on river terraces that have cracked or soil.	**Red**
		2.2 Building has sustained uneven settlement of the ground.	**Red**
		2.3 Building is resting on liquefied soil.	**Red**
3.	**Structural Aspects**	3.1 Building has separation at junction wood floor to vertical wood frame.	**Red**

		3.2 Building has vertical walls out of plumb.	**Red**
		3.3 Building has suffered gable collapse.	**Red**
		3.4 Building has suffered extensive damage to masonry plinth.	**Red**
		3.5 Building has suffered horizontal sliding at any storey.	**Red**
		3.6 Building has differential settlement of vertical posts.	**Red**
4.	**Siting Issues**	*4.1 Building is adjacent to a failed slope.*	**Yellow**
5.	**Structural Aspects**	*5.1 Building has sustained collapse of cantilevers, balconies, chimneys and parapets.*	**Yellow**
		5.2 Building has sustained extensive separation between wood frame members and infill wall, and has no damage in columns.	**Yellow**
6.		*None of the above*	**Green**

FINAL RATING

GREEN (Usable)	YELLOW (Usable with temporary interventions)	RED (Unsable)
	Suggested interventions:	

Further Actions

Building to be quarantined : ☐ Not Recommended ☐ Recommended

Level 2 Detailed Visual Screening : ☐ Not Recommended ☐ Recommended

National Disaster Management Authority