Participatory Assessment of Housing Vulnerability

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Participatory Assessment
of
Housing Vulnerability

(Training on Housing Stock Vulnerability Assessment)

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UNNATI
Organisation for Development Education

people in centre

Cordaid

Foreword

Building community resilience to disaster risk is one of the major objectives of Cordaid India partners working on community managed Disaster Risk Reduction. Housing vulnerability is one of the major reasons for damage and loss in disasters. In any post-disaster recovery, large amounts of resources are used for rebuilding the houses. The understanding of housing vulnerability can enable the community to make interventions and incorporate safety features to make the houses risk resistant. In this context, a training programme for Assessing Housing Stock Vulnerability was organised for Cordaid India partners and other collaborating agencies.

This programme was jointly organised by Unnati and People in Centre. The training design and modules were based on our collaborative work on vulnerability assessment through a field research in Porbandar district of Gujarat. The methodology was sharpened also by interacting with experts like Mr. Rajendra Desai of the National Centre For People's Action In Disaster Preparedness (NCPDP), Ahmedabad, Dr. Sanjay Chikarmane, of Indian Institute of Technology -Bombay (IIT-B), Mumbai, and Mr. Kiran Vaghela of Hunnarshala Foundation. They not only provided inputs in developing the design but also joined the training programme as resource persons and provided immense insight into the subject. On behalf of Unnati and People in Centre, we offer our sincere gratitude to all three resource persons. Sincere thanks to the team from Unnati and People in Centre for organising and facilitating the training programme.

Without the generous involvement of representatives of the gram panchayat of Vondh village and many house owners, it would not have been possible to apply the theoretical understanding in a practical context. We sincerely thank them for their kind support.

We hope this training programme provided clearer ideas to undertake Housing Vulnerability Assessment and to take up simple measures for improving the safety of houses to ensure disaster risk reduction. We will very much appreciate if this learning is taken forward and feedback and narratives are provided from the field to enrich our collective understanding.

Binoy Acharya
UNNATI

Alka Palrecha
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Context and Training Objectives

There is an increasing realisation of the need for disaster risk reduction. Every natural disaster further reinforces the need to mainstream a framework for disaster risk reduction. The loss of life, housing and infrastructure causes the maximum impact on the community. Housing damage and collapse itself is usually a major cause of loss of life. It is, therefore, of utmost importance to understand the vulnerabilities of existing housing and identify the extent of risks so as to undertake disaster mitigation measures. The involvement of the community in the development process has emerged as a critical component for mainstreaming disaster risk reduction strategies. Within the framework of Community Managed Disaster Risk Reduction (CMDRR), it is important to develop an appropriate approach and methodology to reduce the vulnerability of human habitat and consequent risks. The CMDRR framework includes measures taken to ensure the readiness and ability of the community to undertake precautionary steps to face potential threats. It helps to make communities and individuals aware of potential hazards and how they can reduce their vulnerability.

Most of the rural houses have been constructed by people themselves involving local artisans and using easily available materials. These houses have been constructed over a period of time in an incremental manner. Factors like various socio-economic complexities, induced changes of so-called modernity in housing, constraints in the availability of local materials, changing occupational patterns and almost non-existing techno-legal regime in rural areas have led to the poor quality of houses, making them vulnerable to disasters. The poor housing stock has always led to devastating consequences during floods, earthquakes or tsunami. The loss of human life in recent earthquakes in Chile, Haiti, New Zealand and Japan has again reminded us about the housing vulnerabilities. In India, even though buildings are constructed using modern materials, the design and construction is based more on the experience of practice rather than engineering design as per building codes. As a result, even the modern types of houses are not safe. For reducing housing vulnerability, there is a need to develop scientific methodology that helps communities to accurately assess the risks and identify the strengthening measures.

The training organised aims to prepare the community-level housing facilitators to develop the skill to enable community members identify the vulnerability so that owner-driven strengthening measures are initiated to minimise the disaster risks.

A training programme was conceived to introduce a framework to assess the existing housing stock vulnerability to multiple hazards, particularly cyclones, floods, sea surges and earthquakes. This framework focuses on vulnerability assessment and risk reduction measures. The training includes theoretical framework as well as practical exercises to undertake assessment covering typology identification, use of hazard maps, identification of vulnerability factors, method of weightage and participatory survey, assessment and synthesis of information. It is a rigorous methodology and framework evolved with inputs from technical academic institutions as well as disaster risk reduction (DRR) professionals having a community empowerment perspective.

The objectives of this training were to enhance the understanding and skills of participants to:

- Understand, analyse and assess the extent of housing vulnerability of any non-engineered house or habitat;
- Promote community awareness on vulnerabilities and risks involved in existing housing conditions;
- Bring focus in housing safety programmes and mobilise communities to undertake relevant DRR measures;
- Develop appropriate skill training programmes for building artisans;
- Offer technical solutions to address vulnerabilities to existing housing;
- Advocate with the government for required attention to critical vulnerabilities;
- Ensure safety of the community in the event of likely disasters; and
- Encourage a culture of safe housing construction.

Introductory Session and Overview of the Training

DURATION: 1 Hour 45 Minutes

The participants were drawn from different organisations working with Disaster Risk Reduction strategy in their respective regions. The idea of vulnerability assessment as an important aspect of DRR strategy was introduced, as it would help to understand the probable risk before it turns into a disaster.

To aquaint the participants with one another, they were asked to interact between and among themselves. Before introducing the framework for the training programme, it was decided to conduct it in Hindi as well as English since some participants were comfortable with Hindi and others with English. Whenever further explanation was required the participants were free to raise queries.

The participants were informed briefly about the programme for next four days and different resource persons coming for different modules. The main points discussed during the introductory session were:

- At least in Indian context, Disaster Risk Reduction (DRR) is an exercise carried out in post-disaster context and, in that sense, mostly limited to post-disaster response.
- It is observed that in rural areas most of the houses are usually constructed by families themselves.
- There is a need to assess the vulnerability of the houses that are located in disaster-prone areas.
- The following questions emerge from the experiences:
  - Is it possible to scientifically determine if the house we live in is disaster-resistant or not?
  - Is it true that engineered houses are disaster safe?
  - Is it possible to determine the extent of vulnerability of a house to multiple disasters?
- Arrive at a conceptual understanding on the assessment process by theoretical discussions as well as by field exercises.
- In any village situation, one may find a range of houses in terms of people built, government built and agency built. In terms of materials and designs, also there would be enough variety. Selection of any village could be good for study through sample survey. (For the training a nearby village Vondh was identified for field exercises)
- The training was designed for non-technical people who could be familiarised with certain basic technical aspects. For this, participants with technical background could also help the others.

Work Profile of Participating Organisations:

- Participants from an organisations working in Brahmputra basin in Assam and Ghaghara river basin in Uttar Pradesh informed about the annual floods in the region and damage to house, which was one of their focus areas of work.

- Organisation from Tamilnadu that began working in the field of house construction after communal clash continued the activity during post-tsunami reconstruction. Insurance, relocation to elevated place, access to *pucca* houses, safer community centres, infrastructure in higher places, etc. are the interventions they focus their work on. Agriculture promotion after sand-filling due to floods and advise on alternating the crops as well as savings for disasters are other interventions for post-disaster situations. The organisation works to form a consortium of panchayat members so that they can collectively negotiate the implementation of government programmes in their region with state government.

- Mason training and disaster-safe houses formed the main focus for organisation based in Delhi. The organisation also focused on promoting safer eco-friendly housing through research and training. The Indira Aawas Yojana (IAY) and other such schemes would also be influenced by their interventions.

- Two organisations focusing on retrofitting were also represented in the training. Timely assessment is important beginning to arrive at right decision for retrofitting.

- Participants from the organisation working in Rajasthan expressed that innovative construction materials and methods may be useful to counter the impact of impending disasters. Yet, the experiences show that *kutcha* and *pucca* categorisation needs to be relooked at from the point of their relevance and safety. Also they expressed concern about changing the pattern of traditional construction without consulting the people or rethink on the probable hazards.

- Participants from a Delhi-based organisation informed that their organisation works on disaster-safe houses and tries to share best-practices among different organisations working in the area. There is absence of policy that enables poor people's concern to construction market. This results into poor quality houses. Rural housing policy will help improve the housing stock in rural areas.

- Participants working in Bhal in central Gujarat explained that flooding was the main hazard in the region. Houses constructed in low-lying areas would be affected easily. Making disaster-safe houses was a better way of dealing with the hazard than post-disaster help. In post-disaster period, people demolish their undamaged houses due to false perception of vulnerability, since there is no scientific way available to the people in rural areas.

Expectations from the Training:

- There is no scientific way to analyse the vulnerability apart from categorising them in *kutcha* and *pucca*, which does not necessarily reflect the vulnerability. Most people build houses using bamboo, which fall under *kutcha* category. With the training to assess vulnerability of houses, the scientific rigour in analysis could be understood. The damage in post-disaster scenario is usually assessed as fully damaged, partly damaged or not damaged. A detailed analytical method for assessment would help in designing better programmes not just for vulnerability assessment but also for post-disaster surveys and recovery.

- Housing vulnerability assessment could also be part of the trainings imparted on housing construction in the region and improve upon the shortcomings in terms of disaster vulnerability.

- *Kutcha* and *pucca* needed to be re-defined to include safety and maintenance factors. Scientific aspects of safety are important features to be learnt from such training.

- After the disasters, IAY house-owners usually do not get any compensation, since they already had received help for housing earlier. Housing vulnerability analysis would make a case for improvement of such houses in peacetime.

- The DRR is a cross cutting component of the proposed rural housing policy. The 12th five year plan also emphasises on the DRR. The vulnerability assessment of existing housing stock could be helpful in further policy decisions regarding rural housing.

- The DRR is relatively a new field and there is not much of formal knowledge about it. Making disaster-resistant house is also a post-disaster response.

- In present context, *pucca* was not related to safety. Even where both type of houses collapsed, *pucca* house with loan may be burden for the family. In that sense, vulnerability assessment was not purely technical, but a social process.

- Participants expected to know the assessment method that people could carry out even without technical knowledge.

- Despite the use of good design, materials and construction techniques, the buildings are damaged. The assessment may lead to understand the reasons for such problem and possible solutions.

- Housing vulnerability assessment will help making people and organisations aware of the extent of possible damage rather than a false perception of exaggerated vulnerability.

Module 1: Why Assess Housing Vulnerability?

OBJECTIVE: To understand the need for assessing vulnerability

METHODOLOGY: Presentation by the resource person

DURATION: 1 Hour

Module Details:

After the introductory session and views from different participants regarding the training, the need for assessment of housing stock for disaster vulnerability was discussed. The main points of the presentation are noted below:

- The vulnerability in the context of this training means housing vulnerability though it touches on other vulnerabilities, like life, occupational or livelihood, health, trauma, nutrition and asset loss, etc.
- Poverty, combined with limited resources, poor skill and non-availability of appropriate materials, can lead to the vulnerability of houses.
- Inputs into our traditional skills are fading, while a lot more investment goes into modern technologies which are not reaching the poor in an affordable manner. Poor practice of modern technology combined with no inputs in improving traditional practices contributes to poor housing stock.
- Aspirations have changed. This results in the use of different materials, technologies and structural systems in a single building, leading to complicated construction.
- After loss of life, the second biggest loss in any disaster is damage to houses. Also, the loss of life usually is the result of the vulnerability of houses. Thus, the DRR can be significantly achieved by improving the safety of the houses.
- Housing typology varies as per the culture, regions, lifestyle, available skills, material availability, climatic conditions and affordability. Hence, each typology needs to be assessed to measure the different vulnerability and extent of each vulnerability. Based on the assessment, remedial measures through policy and programmes should be promoted.
- During the discussion, participants related the need for assessing housing vulnerability to their work context.

Module 2: Vulnerability of Buildings in Different Hazards

OBJECTIVE: To understand the possible damages to buildings in various disaster situations, before the occurrence of disaster

METHODOLOGY: Presentation by resource person, group work and group presentation

DURATION: 1 Hour 30 Minutes

Module Details:

The module began with a presentation on different types of hazards and their impact on buildings. Damage through flood, earthquake, cyclones, etc. in various regions in the world was described. The presentation also conveyed the message that all types of houses could be vulnerable, regardless of *pucca* or *kutcha* construction. It was stressed that post-disaster damage was easy to identify. Pre-disaster assessment was different in the sense that it did not have visible damage from which one could find the reason for damage. The possible damage and the reasons needed to be identified before the disaster. While assessing the vulnerability, the possibility of multiple hazards needed to be kept in mind.

Since the participants were from different regions, it was important to discuss and detail the hazards as well as vulnerability of houses in their own regions. Hence, the participants formed three different groups to identify and describe the damage to the built forms in their own regions. Each group discussed earthquake, floods and cyclones in different regions it came from. The session concluded with a presentation from each group and discussion on its findings.

DISCUSSION POINTS:

- To understand the vulnerability, disaster history is a very important factor along with data from government departments on risk zones. Hence, relying only on people's memory or engineering knowledge would be an insufficient approach. From a post-disaster situation one can learn about the factors that helped a building withstand the hazard. Documentation of such examples may help one prepare for future disasters.

- Engineering calculations may help understand the behaviour of engineered buildings but for non-engineered buildings, observations were very important, though this might be a long-term exercise.

- People often prefer bad *pucca* houses even though good *kutcha* houses perform better in disasters. This is not a scientific approach but a perception of the people. Both scientific research and addressing the social aspects of housing needed to be clubbed to understand the sound house construction practices.

The main points of the presentations and discussions on each disaster are listed further:

Flood:

- During flash floods, the soil around the foundation gets washed away, leaving the foundation without support.

- *Kutcha* houses may completely collapse if walls are made of earth and exposed to water for long.

- During heavy rains that come often along with floods, walls exposed to rain from the side or the top due to roof damage can also collapse.

- Scouring of soil around the house may cause uneven settlement of the foundation and walls, causing severe structural damage.

- The houses on bamboo stilts built by the Mishing community of Assam withstand floods up to a certain level due to their unique design.

- During the discussion, the importance of the location of the house, the type of soil, material degradation due to frequent floods, weaker joinery and the plinth height, etc. were also identified as the deciding factors for the vulnerability of houses in floods.

Wind Storm/ Cyclone:

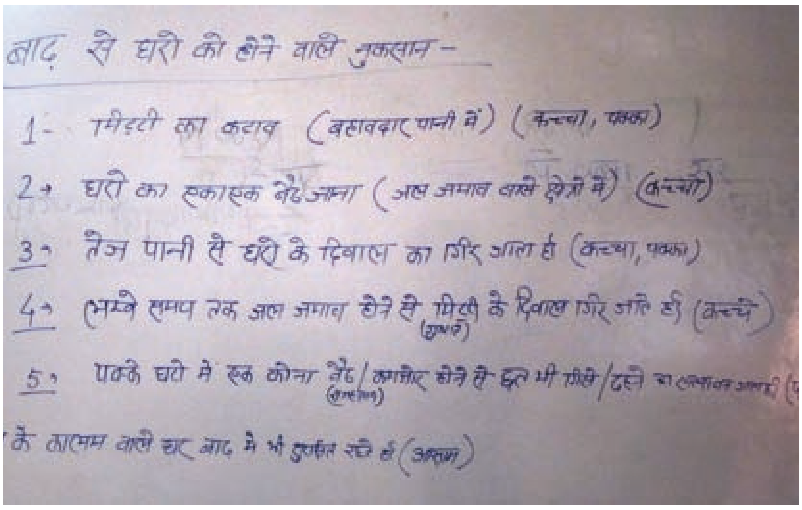
- Roof is the most vulnerable element of the house in high winds or cyclones.
- Due to high wind, trees or electricity polls may fall on the houses damaging the house further. In case of a fall of electricity polls, there is an added possibility of fire.
- The scouring of soil may happen for the houses built on an elevated ground due to a high velocity of wind. This may damage the foundation and structure of the house.
- Sheet roofing, popular in recent times, is quite prone to flying off during high speed winds. This may be fatal.
- During a cyclone in the desert, people as well as animals lose the sense of direction.
- Often, high speed wind is accompanied by rain near the seashore, exposing the houses and people to flood.

Earthquake:

- Earthquake forces are lateral, affecting the houses at the corners and junctions.
- Settlement of the foundation can be an issue during earthquake in certain soil conditions.
- Failure due to earthquake forces perpendicular to the wall (out of plane failure) causes damage mainly to the corners and joints.
- Failure due to earthquake forces parallel to the wall (in plane failure) causes cracks at the openings, especially when the openings are more or bigger in size.
- There is a higher impact on the upper floors as the building acts as cantilevered from ground during earthquake.
- Depending on the soil type, liquefaction may cause the settling of the building.
- Earthquake may cause damage to masonry walls, gable walls and roof.
- Landslide and tsunami may be caused by earthquake.
- Earthquake also cause damage to dams, drainage systems and bores/wells, causing secondary hazards. Short-circuits and fire are other possible secondary hazards.

House damage in Kashmir due to the earthquake in 2005

Possible damage due to floods, a presentation by participants



Module 3: Methods for Vulnerability Assessment

OBJECTIVE: To make the participants understand the prevalent practices of vulnerability assessment

METHODOLOGY: Presentation by resource person

DURATION: 1 Hour 30 Minutes

Module Details:

This module focuses on different vulnerability assessment methods for buildings already used in different parts of the world. Six different assessment methods are taken into consideration. Each method is for a specific purpose and hence looks at the vulnerability of a building in different levels of details. All the existing methods focus on earthquake hazard, ignoring the vulnerability to other hazards.

The six methods

1) FEMA 154 method by the Federal Emergency Management Agency (FEMA), USA
2) FEMA 310 method by the Federal Emergency Management Agency, USA
3) Rapid Visual Survey (RVS) method by the IIT-B, Mumbai
4) Modified FEMA methodology used in Haiti after the 2010 earthquake
5) Rapid Visual Survey methodology by the National Society for Earthquake Technology (NSET), Nepal
6) Rapid Visual Assessment methodology by the Standards and Quality Control Authority (SQCA), Bhutan

FEMA 154:

- FEMA 154 is a sidewalk survey based on visual observations of the assessor. It is meant for building inspectors and owners.
- Though it requires some pre-planning and data of the area, it is very simple to carry out. The use of building, area, size and simple structural information are assessed.
- It is applied to certain pre-decided building typologies only, for which experts have calculated the numerical scores.
- Numeric seismic score is provided in the form which the assessors circle as appropriate.

<table>
<tr><th rowspan="2">Mate-rial</th><th rowspan="2">Type of Load-Bearing Structure</th><th rowspan="2">Sub-Types</th><th colspan="6">Vulnerability Class</th></tr>
<tr><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr>
<tr><td rowspan="15">Masonry</td><td rowspan="2">Stone Masonry Walls</td><td>Rubble stone (field stone) in mud/lime mortar or without mortar (usually with timber roof)</td><td>O</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Massive stone masonry (in lime/cement mortar)</td><td>|-</td><td>-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td rowspan="4">Earthen/Mud/ Adobe/Rammed Earthen Walls</td><td>Mud walls</td><td>O</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Mud walls with horizontal wood elements</td><td>|-</td><td>O</td><td>-|</td><td></td><td></td><td></td></tr>
<tr><td>Adobe block walls</td><td>O</td><td>-|</td><td></td><td></td><td></td><td></td></tr>
<tr><td>Rammed earth/Pise construction</td><td>O</td><td>-|</td><td></td><td></td><td></td><td></td></tr>
<tr><td rowspan="6">Burnt clay brick/block masonry walls</td><td>Unreinforced brick masonry in mud mortar</td><td>|-</td><td>O</td><td>-|</td><td></td><td></td><td></td></tr>
<tr><td>Unreinforced brick masonry in mud mortar with vertical posts</td><td>|-</td><td>O</td><td>-</td><td>-|</td><td></td><td></td></tr>
<tr><td>Unreinforced brick masonry in lime mortar</td><td>|-</td><td>O</td><td>-</td><td>-|</td><td></td><td></td></tr>
<tr><td>Unreinforced brick masonry in cement mortar with reinforced concrete floor/roof slabs</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Unreinforced brick masonry in cement mortar with lintel bands (various floor/roof systems)</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Confined brick/block masonry with concrete posts/tie columns and beams</td><td></td><td></td><td>|-</td><td>O</td><td>-|</td><td></td></tr>
<tr><td rowspan="2">Concrete block masonry</td><td>Unreinforced, in lime/cement mortar (various floor/roof systems)</td><td></td><td>|-</td><td>O</td><td>-|</td><td></td><td></td></tr>
<tr><td>Reinforced, in cement mortar (various floor/roof systems)</td><td></td><td></td><td>|-</td><td>O</td><td>-|</td><td></td></tr>
</table>

Categorisation of building classes as per EMS 98 (method developed by IIT-B, Mumbai

- Score modifiers are applied to the main score, based on visual observations of the details of the building.

- There are different forms for different seismic zones. The assessors have to fill in a single-page form per building.

FEMA 310

- FEMA 310 is a detailed engineering assessment carried out with exact structural data of the building using engineering modelling methods.

- It can be applied only to engineered buildings.

- FEMA methods (FEMA 154 and FEMA 310) form the basis for other methods.

Rapid Visual Survey (RVS) method by IIT-B, Mumbai

- RVS methodology developed by IIT-B, Mumbai, has identified 10 building typologies and categorised different vulnerability classes for them as per European Micro-seismic Scale 98.

- The methodology arrives at the score for the building based on the vulnerability class and other design/ structural observations. This score determines the expected damage level for the given building.

Modified FEMA methodology used in Haiti

- For the assessment of housing damage in Haiti earthquake, a modified version of FEMA 154 was used adding a few factors from FEMA 310.

RVS methodology by NSET, Nepal

- NSET, a premier institute of Nepal for earthquake technology, has devised a methodology for earthquake vulnerability based on visual observations, particularly for non-engineered buildings.

- This method replaces the numerical scoring method of FEMA 154. It first categorises the building typology as per EMS 98 and arrives at expected damage categorisation.

- This method classifies all buildings made with one material and in the same region under the same category. Therefore, it does not provide a very accurate assessment of vulnerability.

- However, this methodology can easily be carried out by non-technical persons.

RV assessment methodology by SQCA, Bhutan

- RVA adopted for assessment of vulnerability in Bhutan is very close to the method developed by the NSET. Therefore, it has similar advantages and limitations as the NSET methodology.

DISCUSSION POINTS:

- The method for multiple hazard vulnerability assessment is essential since buildings face not just one hazard. Different types of houses may respond to different hazards differently. Hence each typology would have different factors affecting its vulnerability.

- Since most buildings constructed in rural areas are non-engineered buildings, the method should be able to assess such buildings accurately.

- Methodology should be such that non-technical people can also participate in carrying out the assessment.

- The assessment method needs to be such that the results should show vulnerability not just for a few buildings but can be applied to the entire region. Cumulative data on different hazards and their impact on prevalent typologies would determine the overall vulnerability of the region at village, taluka or district level.

Module 4a: Identification of Building Typologies - I

OBJECTIVE: To understand building typologies and parameters defining the typology

METHODOLOGY: Group work, group presentation and presentation by resource person

DURATION: 2 Hours 30 Minutes

Module Details:

The module focuses on identification of various typologies in the region prone to different types of disaster. Participants formed groups and identified prevalent typologies and impact of different disasters in their regions. Three groups were formed and each group explained typologies of the region represented by the group members. The typologies presented were from Uttar Pradesh, Delhi, Bihar, Assam, Tamilnadu, Rajasthan and Gujarat.

The resource person made a presentation on the method of defining building typologies with regard to vulnerability assessment. In the context of vulnerability assessment, the definition of a building typology covers three parameters.

1) structural system- foundation, structure type -load bearing, frame or composite, etc.
2) materials used- foundation, walling and roofing materials
3) architectural configuration- shape and size of building, opening sizes, symmetry, etc.

DISCUSSION POINTS:

- During the group discussion, participants discussed and tried to arrive at the main building typologies found in their respective regions.

- Group 1 discussed that many rural houses use bamboo and wood, while some houses also have brick and RCC structure. Thus, the categorisation of typology can be based on the primary materials for wall construction.

- Group 2 focused on materials used for construction as well as overall form of the house. The houses were categorised as *kutcha* and *pucca* based on the materials and perception of the people.

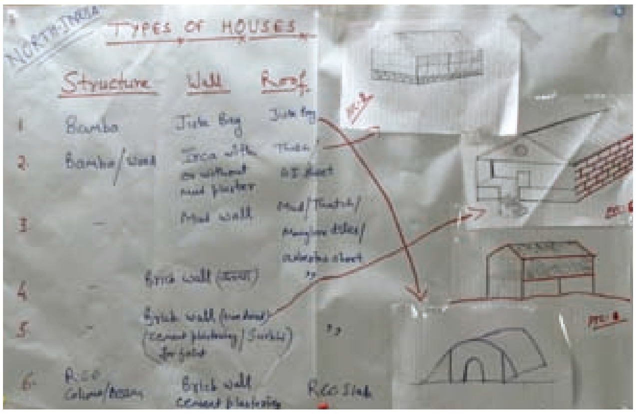
- Group 3 discussed that traditional ways of construction are rapidly being displaced by modern materials and design. The group defined houses in terms of houses for poor, middle class and wealthy families. Also the typology was based primarily on design and then subdivided, based on the materials used.

Further points discussed during the presentation on building typologies were:

- It is necessary to make a reconnaissance visit of the area to be surveyed to observe and identify different typologies based on possible damage.

- Building typologies in which a larger number of buildings fall in the region provides a clearer idea about the overall vulnerability.

- It is also important to observe the factors that may have an impact on the safety of a house of any given typology (features with higher probability of damage).



Learning building typologies

Group presentation on building typologies

day 1

Module 4b: Identification of Building Typologies - II

OBJECTIVE: To understand building typologies and parameters defining the typology

METHODOLOGY: Field visit, presentation by participants and discussion

DURATION: 4 Hours 15 Minutes

Load-bearing brick masonry with tiled roof

Load-bearing brick masonry with CGI roof

Load-bearing brick masonry with RCC roof

Module Details:

The participants were exposed to the process of identification of typologies through a field visit. A reconnaissance visit to Vondh village was carried out to identify different typologies in three different groups. It was also intended to identify the important parameters to define a building typology and the impact of important typologies on the overall vulnerability of the village.

The first step in the field visit was rapport building and gathering basic information on the village such as population, the number of houses and probable hazards in the region from the panchayat members.

Information on the impact and subsequent reconstruction after the 2001 earthquake was also collected. The entire village was reconstructed on a new site. However, it continued to remain unoccupied and the people rebuilt their houses at their earlier location. Hence, Vondh presented a wide range of building typologies.

Participants were taken to different parts of the village for observation of typologies. Each of the groups included an engineer, an architect and someone who could speak the local language. Also one person from the panchayat joined each group to facilitate the visit.

The groups were asked to identify a few different typologies that they come across along with the parameters defining the typology. The groups presented their observations through photographs taken during the field visit. Each presentation was followed by comments, questions and discussions on the house typology observed by the group.

DISCUSSION POINTS:

The main points of discussion during group presentations were:

Group 1 came across different typologies that they could identify based on three criteria of materials, composition and structure. The group observed buildings with frame structure with RCC roof, brick wall and Corrugated Galvanised Iron (CGI) sheet roofing with gable roof as well as walls with composite materials. As part of structural strengthening of the house, the gable end of the walls were retrofitted with wire-mesh. They noted that often the retrofitting was carried out inappropriately and hence did not serve the purpose. The foundation was usually made with stone, regardless of walling materials. This was a common observation among all the groups.

Group 2 observed two main types of houses, one consisting of a single room, verandah and kitchen, using masonry units with gable roof. Manglore/ Morbi tiles were commonly found as roofing with wooden under-structure. There were also houses with RCC columns and brick walls, with RCC roof. This cannot be classified as a frame structure, since beams were missing. During the discussion, it was suggested that it be classified as confined masonry structure.

Group 3 visited the relocation site built through contractors where many houses were unoccupied. There were some plots where people also built houses with the help of other NGOs and had masonry walls and tiled roofing with wooden under-structure. Poor quality of construction was noticed in the contractor-made houses.

Towards the end of the discussion, three prominent building typologies were identified to be assessed for vulnerability.

1. Confined masonry construction with RCC slab
2. Single material masonry unit walls with tiled roofing and wooden under-structure
3. Composite materials masonry unit walls with sheet roofing using wooden or steel under-structure.

Group discussing the typologies of village Vondh

Module 5: Performance of Buildings in Hazards

OBJECTIVE: To understand the performance of structural systems in different load conditions

METHODOLOGY: Presentation by resource person and discussion

DURATION: 1 Hour 30 Minutes

Module Details:

The vulnerability of rural housing and role of engineering and technical assessment was discussed in the presentation. The main points of the presentation were:

- The past experiences show that non-engineered as well as engineered houses were damaged in the disasters.

- Though there was a lot of wisdom in the traditional methods, there was dilution in these practices. Hence, engineering interventions were required for lot of constructions.

- Engineering brought in certain value addition, but it could not replace the traditional wisdom. Engineering approach needed to be combined with practical knowledge, which involved people and local artisans.

- While there were several problems with vernacular construction, it might use appropriate modern techniques.

- Traditional was defined as knowledge from the past and vernacular as something learning from the past combining contemporary knowledge to achieve appropriate construction for the present and the future.

- There was need to identify the ideal house for each typology carefully, which was vernacular. This vernacular ideal would also mean that it remained within the confines of the contextual limitations. It was something a community ccould achieve and was appropriate.

Seismic hazard map of India

Wind hazard map of India

- It is possible to achieve an 'ideal house' that the community can aspire to build using any material and architectural combinations. The ideal house should be defined for each typology which has the potential to withstand multiple hazards in the region.

- Though activities like mountain climbing may be far riskier than sitting under a structure, it is our perception of the risk that makes the risk acceptable. The vulnerability of a house is more difficult to accept since the risk perception is low. Mountain climbing is considered high risk still people opt for it by choice. In mathematical terms, the risk is probability of failure multiplied by gravity of outcome.

- In normal conditions, most structures are designed with optimum safety features, where chances of failure increase with small increase in the probability of hazards. The ideal condition should not be too close to optimum requirements, but should have some flexibility to absorb the failure.

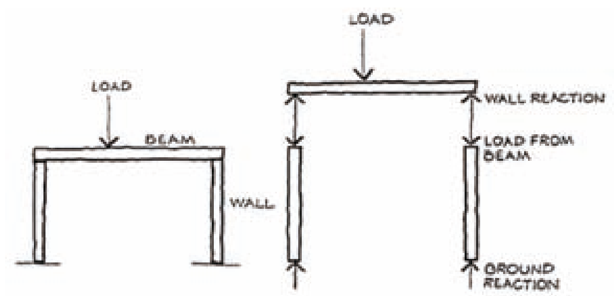
- With different examples and analysis three types of forces acting upon a building were explained:
  1) vertical downwards load
  2) horizontal thrust
  3) uplifting force

- Each force travels through different load

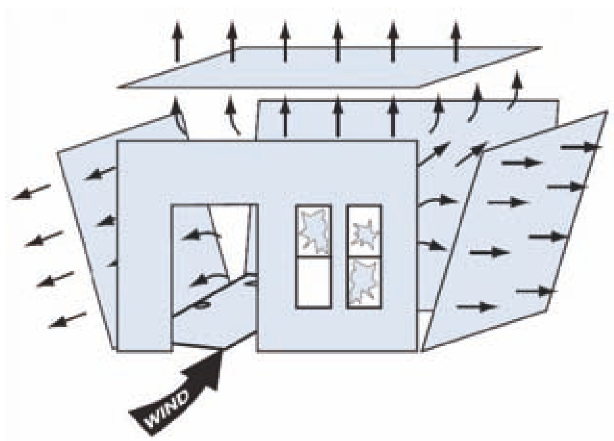
- Paths which finally transfer the force to stable ground. If the load does not get transferred to the ground, that indicates the failure of the structure. An intuitive method of analysis to understand the load paths in any structure is helpful. The load paths intuitively explains which members of the structure would be affected. Complexity of load paths would indicate structural complexity.

- While analysing a structure, columns and beams should be defined by their relative direction to the applied force. In case of earthquake or cyclone, the structural behaviour of elements like column and beam may change, since the direction of applied force is different. To consider such lateral forces, the elements should be designed appropriately.

- The joints are crucial in any construction, as they come under maximum stress during load transfer. The fact that joints often combine not just two elements, but also different materials, they are prone to separation and failure. In any construction, the details are most important.



Vertical load transfer in a building



Impact of wind on a building

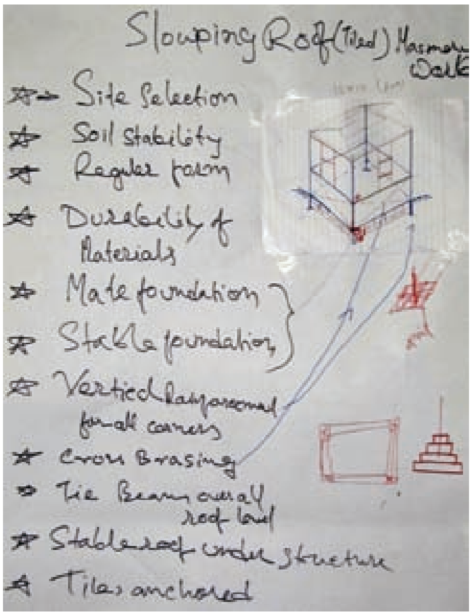
day 2

Module 6: Defining the Ideal House

OBJECTIVE: To arrive at the most appropriate construction for the region within a given typology

METHODOLOGY: Group discussion and presentations by participants

DURATION: 2 Hours



Defining the ideal house - group work

Module Details:

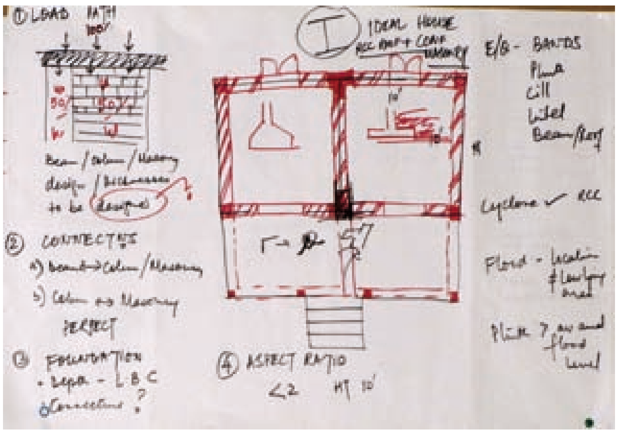
Participants were asked to arrive at the ideal house for each identified typology and list the reasons for arriving at the ideal house, based on their observations and learning from earlier modules.

Group 1 presented an ideal house for confined masonry with RCC roof. During the group discussion, they discussed the fact that usually in the village, the beams are absent in construction, but for confined masonry to work well, beams between the columns were ideal to transfer equal load on the masonry walls so that the construction works as confined masonry structure. Foundation, walls, roof and joinery details were also discussed in arriving at the ideal house for this typology.

Group 2 presented the ideal house for masonry walls and tiled roof with wooden under-structure. The group defined the ideal condition for different aspects and elements of the house, like site, soil condition, form, foundation, walls, roof and other safety features.

Group 3 defined the ideal house for composite masonry using concrete blocks and bricks as superstructure with sheet roofing. Since the members were mainly from north India and Assam, they considered flood as one more vulnerability along with earthquake and high winds. The ideal house was defined to be resilient to all these hazards.

Towards the end of the session, the groups were asked to refine the ideal house conditions for a given typology and factors affecting the vulnerability if the ideal conditions were not achieved.



Defining the ideal house - group work

Group presentation on the ideal house

Module 7: Classification of Vulnerability Factors and Scores

OBJECTIVE: To identify the factors affecting the performance of a building and understanding non-performance rating values.

METHODOLOGY: Presentation by resource person, group discussion and presentations

DURATION: 3 Hours 45 Minutes

Module Details:

The next presentation focused on the classification of vulnerability factors and their ratings to assess the vulnerability of buildings. The main points of the presentation were:

- Organising the factors in different groups provides a systematic approach to examine house safety. There are two main types of factors: structural factors (S factors) and content factors (C factors).

  S Factors
  For structural aspects, five factors are most important:
  a. Site condition
  b. Soil and foundation condition
  c. Architectural condition
  d. Material and construction condition
  e. Structural condition

  C factors
  These factors can be mainly categorised into two types
  a. Falling and pulling hazards
  b. Hazard-induced secondary hazards

  Both the S factors and the C factors can be further divided into two subcategories:
  1. Life threatening factors
  2. Economic loss-inducing factors

- The loss of life is unacceptable, while the other factors like severe injury or temporary disability may lead to economic loss, and hence for the ease they are categorised as economic loss-inducing factors.

- While analysing the building, **the first level of assessment** would be to check whether the building damage may be life threatening or not. If anything life threatening is found in a building, it gets 0 grades, and is not further assessed till that possibility is addressed first. The life-threatening factor may be S factor or C factor.

- **If it is not life threatening, then further assessment is carried out.**

- The method of assessment is based on comparison of the building with the ideal house of the same typology, which would be defined before the assessment begins. Based on the ideal marks for each factor/sub factor grades will be deducted from ideal grades for each deviation.

- **There are three levels of details considered in factors.** At the first level the factors are divided into five categories. **The rating at level 1 defines the overall importance of a particular factor. Level 2 factors are more for reference, while level 3 is further detailed for the purpose of rating.**
- Level 1 factors are constant throughout all categories, regions or types of hazards they might face. The second level may change depending upon the type of building. The third level lists the vulnerabilities in fine details which helps in rating the building.
- Total grades of level 1 for each typology would lead to 100 marks. At level three, the subtraction of marks happens, within the maximum marks decided at level 1. It is important to design the ideal house, keeping the five factors at level 1 in mind.
- The MNPRV or Maximum Non-Performance Rating Value for each level 1 factors limit the maximum marks that can be deducted for that particular category even if more marks could be cut at level 3 analysis.

After the presentation, the groups were asked to discuss among themselves and determine the maximum non-performance rating values for level 1 factors for their given typologies.

Factor set - Level 1	Factor set - Level 2	Factor set - Level 3
Soil and Foundation	Suitability of soil type	The house is built on expansive soil
	Foundation	The strip foundation is on a non uniform base (i.e. the ground underneath the foundation is sloping or the strata are varying)
		The foundation has insufficient depth
		The foundation width is less than 45cm
Architectural Configuration	Plan shape	The rooms are larger than 200 sqft and/or the house has a complex overall plan
	Elevation profile	The house has large projections or overhangs that are more than 4 feet in length
		The house has storey heights that are more than 12 feet in height
	Door and window openings in walls	The openings in the walls are close to corners (i.e. the windows/doors are closer than 1 foot to corners)
		The openings are larger than 4 feet in width
	Distance from adjacent building	The house touches neighbouring houses

Levels of vulnerability factors

DISCUSSION POINTS:

The group presentation and discussions are summed up in the following points.

Group 1 had listed factors for safety giving importance to construction and materials as well as structural system with 30 marks each, while architectural design was given 20 marks. Site conditions, soil and foundation were given 10 marks each. The discussion led to the weightage changed to 15, 25, 40, 10 and 10 as structural system, construction and material used, architectural design, soil and foundation as well as site condition respectively.

Group 2 gave 10, 10, 20, 25 and 35 marks each to site, foundation, design, construction and structure respectively. This was later modified to 10, 10, 20, 30 and 30 since the resource persons and group members felt that design factor is not so important for the brick wall houses. Construction and especially structural aspects are very important in determining the disaster resistance here.

Group 3 rated 20, 15, 10, 25 and 30 marks each for site, foundation, design, construction and structure respectively. It was modified to 10, 10, 20, 35 and 25 grades respectively. Composite walls may require better materials and construction quality, but structural system may be simpler. Architectural composition will also have considerable impact on safety of the house in hazards for this typology.

Discussing the performance rating values

Group presentation on performance rating values

Feedback by resource persons

Level 1 Factors	Site Conditions	Soil and Foundation	Architectural Configuration	Materials and Construction	Structural System
Group 1	10	10	40	25	15
Group 2	10	10	20	30	30
Group 3	10	10	20	35	25

Performance rating values for each group after discussion and feedback

Module 8: Determining Non-Performance Rating Values

OBJECTIVE: To understand the method for arriving at the appropriate penalties for deviations from ideal house conditions.

METHODOLOGY: Presentation by resource person, Delphi discussion, group presentation and feedback by resource people

DURATION: 4 Hours 30 Minutes

Module Details:

- There may be various methods to define and decide different factors affecting the vulnerability of a building in given conditions. Each factor may affect the resistance of a building in a different way, hence may be identified as important or unimportant within the context of typology and possible hazards.
- Since there are no predefined typologies or comprehensive engineering knowledge about different designs, constructions and materials in Indian context, the decision to define a typology and marks for ideal house as well as deviations from that is based on context and interpretations.
- Delphi discussion is helpful in arriving at a consensus where there may be several various stakeholders and different viewpoints.
- Through discussions, the agreement should be sought regarding different hazards, typologies, main factors affecting the vulnerability, their impact and rating values.

After the presentation, the groups are asked to decide rating values for the level 3 factors for a given typology for the village. This forms the base for the sample assessment for the field trip.

Factor set - Level 1	Factor set - Level 3	NPRV	MNPRV
Soil and Foundation	The house is built on expansive soil	-2	-10
	The strip foundation is on a non uniform base (i.e. the ground underneath the foundation is sloping or the strata are varying)	-5	
	The foundation has insufficient depth	-5	
	The foundation width is less than 45cm	-10	
Architectural Configuration	The rooms are larger than 200 sqft and/or the house has a complex overall plan	-5	-20
	The house has large projections or overhangs that are more than 4 feet in length	-5	
	The house has storey heights that are more than 12 feet in height	-5	
	The openings in the walls are close to corners (i.e. the windows/doors are closer than 1 foot to corners)	-2	
	The openings are larger than 4 feet in width	-2	
	The house touches neighbouring houses	-3	

Determining NPRVs and MNPRVs

DISCUSSION POINTS:

On Delphi discussion, participants felt that the size and composition of group may vary based on the complexity of situation, technical expertise within the group, region, typologies, hazards and number of houses, etc. The size may vary from case to case, but the group should be comprised in such a manner that different viewpoints of stakeholders and expert opinions are covered and final decision is reached with consensus and a fair degree of clarity.

Presentation of Group 1:

- Black cotton soil should not be considered for penalty, but inappropriate foundation type for such soil should be penalised.
- Saline soil should be penalised since there is not much remedial steps possible to avert the effects of the building on saline soil.
- Width is usually more important for foundation, but depth may be critical for some soil types.
- Vulnerability should not be seen in future context but in context of the present. Future conditions may completely change.
- The experts felt that material and construction quality was too harshly judged in their grading.
- Masonry will usually develop cracks but if the cracks are formed such that the whole wall is divided into columns and sections, then it will be a very serious issue.
- Reinforcement bars getting exposed due to concrete falling is a serious issue and it should be penalised for more than 10 marks at level 3. The falling of plaster should not be considered a serious issue.
- Sill band is not as important as plinth or lintel band and should be penalised with different weightage. The RCC roof and confined masonry typology will ideally have beams, hence roof band is not necessary.

Presentation of Group 2:

- Doors and windows may be closer to corners if all sides are secured with RCC jambs, else that should attract penalty.
- Two materials will not be a problem for composite masonry typology, and hence should not be penalised.
- Degradation of materials may be penalised with up to 15 marks, but small degradation should not be penalised severely. If needed, further factors should be added at level 3 to consider different levels of degradation.

- If the factor does not comply during the survey, relevant marks need to be deducted. There may not be intermediate levels of marks cut, and the judgement should not be left to the surveyor. To consider in-between situations, more factors may be added describing separate degrees of severity of the factor with relevant marks.
- Incremental construction should not be a negative factor in itself, though bad joinery may attract severe penalty.
- A precise description of the factors and penalties is very important. The survey form should be non-ambiguous for the surveyor to efficiently carry out the assessment.
- The same factor should not be penalised twice as it may lead to wrong assessment.
- Sill band for RCC column house is not so important, but is a must for composite construction.
- Even with the presence of J-bolts in sheet roofing, load-wall on top is very important.

Presentation of Group 3:

- Low-lying condition is not severe in the context of Kutch, since flood is not frequent phenomena in the region. Hence, penalty on that could be mild.
- High-tension electric line over the building was an important factor for vulnerability assessment.
- Width in general is more important than depth of foundation for typology.

The weightage should not be directly implied from other typologies as each type may react to different hazards differently.

Participants involved in Delphi discussion

Module 9: Vulnerability Assessment Field Survey

OBJECTIVE: To carry out sample assessment of vulnerability of different typologies in the village

METHODOLOGY: Field survey

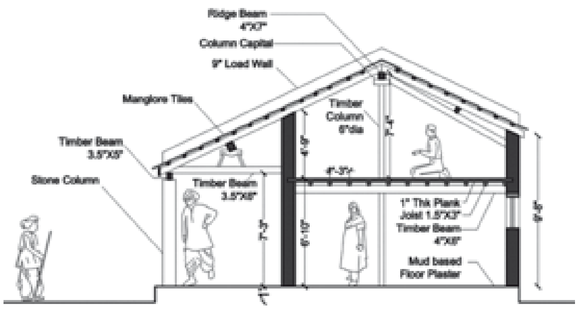
DURATION: 4 Hours 30 Minutes

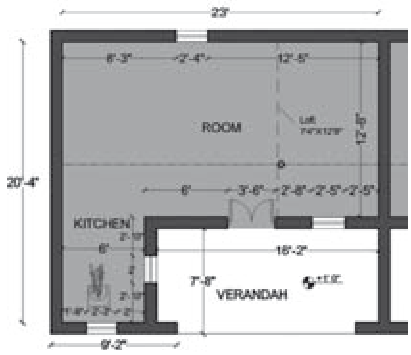
Module Details:

Early in the day, all participants went to Vondh village. In the previous field visit, different typologies were already identified.

Each group identified a few houses of a particular typology and carried out the vulnerability assessment of those houses by on-site observations and talking to the house-owners/ occupants. The observations were made for each vulnerability factor finalised after the Delphi discussion. These observations on vulnerability factors were recorded in the pre-designed format. Vondh gram panchayat representatives facilitated the field survey. Each group carried out assessment of 7 to 10 houses. After the assessment, the groups returned to the training centre for consolidating the data gathered and further analysis.

[A sample format is presented in Annexure ii.]





Sample plan of a village house

Participants carrying out vulnerability assessment field survey

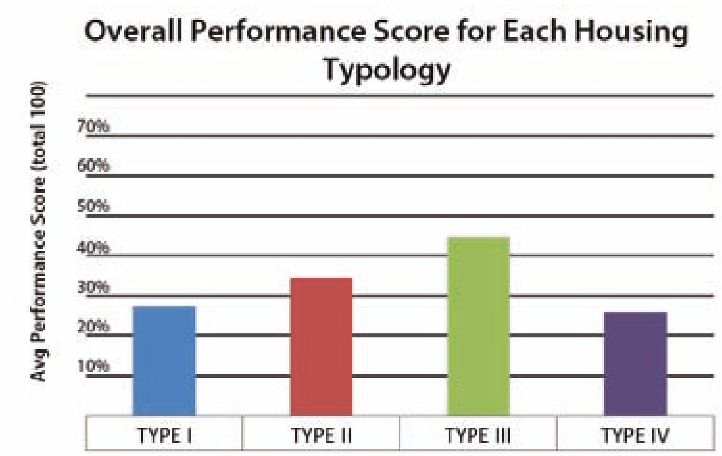
day 4

Module 10: Arriving at the Building Performance Score

OBJECTIVE: To calculate the grades and determine the final vulnerability score for the typologies and housing stock

METHODOLOGY: Data entry, analysis, group presentation and discussion

DURATION: 2 Hours



Housing performance analysis

Module Details:

The groups calculated the scores for each house based on their field observations and non-performance rating values. Appropriate NPRVs were deducted for 'Level 3' factors from the ideal situations keeping maximum limit of MNPRV for each 'Level 1' factors. Based on the performance scores of different typologies, better performing typologies could be identified. Within each typology, it could be possible to identify deviations which were resulting in maximum penalties and hence, were critical for improving the disaster safety. For example, if the assessment identifies absence of gable band in a particular typology as the main reason for penalty, the simple recommendation would be to incorporate it.

DISCUSSION POINTS:

The main points of discussions and comments from the presentations of grades were:

Group 1

- The absence of beam would attract deduction of grades and presence of band cannot compensate the absence of beam.
- Openings might not be a problem for dead load, as the folded partitions might act better for vertical load transfer, but in case of lateral forces too many openings would make the wall vulnerable.
- A well anchored parapet might not be dangerous and hence might not attract penalty.
- Presence of column-like structure would not make it confined masonry structure. It might still be a badly constructed load bearing structure with some unnecessary elements that weaken the structure. A proper footing for column would be a very important factor for such structure.
- There is no 'passing grade' as there is always the possibility of improvement in any house based on the ideal house of the same typology.

Group 2

- Degradation of material may not be related to the age of the building. If degradation of material is a factor deciding vulnerability then it should be stated, rather than the age of the building.
- The buildings should not be penalised more than once for the same factor due to ambiguity, misinterpretations or repetition.

Group 3

- The NPRV should be based on relative importance of the factor in safety. Too strict NPRV will result in an unrealistic score for the typology.
- Most issues were found to be with roof with the absence of cyclone hooks and diagonal bracing.

Module 11: How to Reduce Vulnerability of Houses

OBJECTIVE: To understand steps to improve the safety of the buildings once the assessment results are known

METHODOLOGY: Presentation by resource person and discussion

DURATION: 1 Hour 30 Minutes

Module Details:

The presentation focused on retrofitting as a possible step to withstand hazards.

The main points of the presentation were:

- Retrofitting usually costs maximum up to 20% of the total cost of demolishing and constructing a new house.
- It can be carried out on-site without much demolition and hence avoids the efforts required in removal of debris, bringing new materials and the labour required. Retrofitting can be done with small changes in the original building and is faster up to 6 times than constructing a new building.
- Retrofitting can be carried out in stages. While the work is going on, the original house can be used. It is economically more manageable.
- Despite many advantages, building owners do not opt for retrofitting due to lack of awareness, misconceptions about the process as well as shortage of technical people who can carry out the retrofitting safely and carefully. It is often easy to recommend demolishing a building rather than carefully analysing and retrofitting.

DISCUSSION POINTS:

- Provision of vertical reinforcement bar in retrofitting of a four-storey brick wall structure is not for structural support, but to provide ductility. In a load-bearing wall, the vertical load transfer is well taken care of, but lateral stability and ductility provision of vertical reinforcement bar is important.
- Common engineering standards should be applied for designing the diagonal-bracings in retrofitting. The angle of 45 degrees for the diagonal-bracings should be adhered to ensure the effectiveness of the bracings. However, too long bracing should be avoided.
- During the discussion on the importance of trusses in roof, it was concluded that though truss helps in the stability of the structure, it is not a must for small structures.
- Hipped roof performs better than gable roof due to equal height of all the walls and absence of gable end walls. But practical problems like cost, technical know-how and skilled craftsmen as well as possibility to drain rain water on all four sides are some of the limitations.

- Retrofitting may be taken in incremental manner.
- Though retrofitting seems economically a better choice, bad execution of retrofitting can be a dead investment. This led to the question whether it is a method that can be fully relied upon in all cases. Through the example of the Latur earthquake reconstruction, it was explained that very good analysis of the existing structure is prerequisite for successful retrofitting, along with innovative solutions and careful implementation. The economic advantages are huge if the house-owner is convinced about retrofitting instead of demolishing and rebuilding. The cost of small room construction can be equal to retrofitting of a large house with ten times more area.
- It was further discussed that retrofitting is easier to carry out soon after disaster. As the time passes, people easily forget about safety of the house. As a mitigation strategy, retrofitting is perhaps the most viable but requires more awareness building.
- There is a dearth of subject experts and skilled artisans to carry out retrofitting. There are also administrative issues involved in working with government, like lack of schedule of rates, etc. To promote such innovative practices, policy changes are required along with awareness building.

Recapitulating and Summing Up

DURATION: 30 Minutes

Identification of typologies :

- Before starting the full survey, it is necessary to carry out a sample survey. This helps in identifying different typologies and inclusion of different factors for level 2 and level 3, as well as design of visual guide for the surveyors.

- A Clear definition of vulnerability factors is most important for arriving at accurate end results. Team for the Delphi discussion and its outcome are very crucial for accuracy and acceptability of the end results.

Developing visual guide and survey form:

- A visual guide should be developed for each typology and should cover possible variations clearly establishing the reference for rating for the assessors.

- The guide should be carried by the surveyor while doing the assessment. The clarity and simplification of survey form should be derived from the factors and their weightage after the Delphi discussion.

- In a large-scale survey, when the team surveying the houses is different from the one involved in the Delphi discussion a simplified form is necessary.

Recapitulating and summing up

Data analysis:

- The Vulnerability of the region may be understood by analysing the data collected. For this one need to identify three to four critical factors on which most houses in a given typology default. The houses in each typology need to be evaluated based on the identified factors to arrive at an understanding of the overall vulnerability of the region.

Vulnerability Assessment:

- It needs to be kept in mind that the method for this assessment is still far from perfect in present form. The thrust should be to arrive at a better understanding of the vulnerability of the houses and eventually the entire region.

- The advantage of this methodology is that it is multi-tiered and can offer clues for improving the safety for the house owners, policy makers, trainers and technical people. During the training, due to the limitation of time and resources, housing vulnerability was not applied on the whole typology in an area. Participants may apply the knowledge and skills in their respective work areas and further sharpen the methodology.

Concluding Remarks

DURATION: 1 Hour

The concluding session was an informal discussion between the training facilitators and participants on assessment methodology and its applicability.

Suggestions and learning:

- This methodology is helpful for DRR projects, as it is a simple methodology with a larger impact on housing safety. It can be replicated in different regions of the country. It can contribute to community-level preparedness.

- The methodology does not require highly technical people at all levels.

- The results of the survey may give direction or focus to housing programmes in terms of house safety features.

- It may help in prioritising various measures of safety as per the available resources.

- Based on different surveys in different regions, accumulated database for different typologies and factors can be developed. This will be very useful to understand and define the housing typologies at the national level.

- Once ideal conditions for a housing typology are well defined, it can be helpful not only in assessing the existing housing stock, but also in designing new houses.

- It may have an impact on government schemes like IAY as well as provide inputs to improve the quality of mason trainings.

- The results of the assessment can be combined with socio-economic assessment, which may help in targeting socio-economically weaker groups for improving housing vulnerability.

- Such assessment can be integrated within village panchayat's annual planning and budget allocations. This will strengthen their outlook of the region with regard to safer housing. This may be extended to other development projects like check dams, village roads, water tanks, etc. to assess vulnerability. In that sense, the present methodology provides a systematic approach for a larger positive impact on village development.

- Participatory assessment will build stakeholder ownership for promoting housing safety.

Limitations:

- This assessment method is most suited for small rural houses. If the building typology becomes complex, methodology will need more expert inputs and may restrict the role of non-technical people.

- Additional inputs to the participants will be useful before carrying out the assessment in their area.

- For a lot of non-engineered buildings, there is not enough scientific data available to clearly arrive at comparative importance of various factors. Though the effort to overcome this limitation is made through the Delphi discussion, it should be acknowledged that this is not a perfect solution.

Annexure i. Schedule of Training

Time		Module Details
DAY 1 (December 8, 2011)		
9.15 to 11.00		Introductory Session and Overview of Training
11.00 to 12.00	Module 1	Why Assess Housing Vulnerability? Presentation by Resource Person
12.00 to 13.30	Module 2	Vulnerability of Buildings in Different Hazards Presentation by Resource Person Group work Group Presentation
13.30 to 14.30		Lunch Break
14.30 to 16.00	Module 3	Methods for Vulnerability Assessment Presentation by Resource Person Participant Discussion
16.00 to 18.30	Module 4a	Identification of Building Typologies - I Presentation by Resource Person Group work Group Presentation & Discussion
DAY 2 (December 9, 2011)		
9.15 to 13.30	Module 4b	Identification of Building Typologies - II Field Visit Group work Group Presentation & Discussion
13.30 to 14.30		Lunch Break
14.30 to 16.00	Module 5	Performance of Buildings in Hazards Presentation by Resource Person Participant Discussion
16.00 to 18.00	Module 6	Defining the Ideal House Group work Group Presentation & Feedback by Resource Persons
DAY 3 (December 10, 2011)		
9.15 to 13.00	Module 7	Classification of Vulnerability Factors and Scores Presentation by Resource Person Delphi Discussion Group Presentation & Feedback by Resource Persons
13.00 to 14.00		Lunch Break
14.00 to 18.30	Module 8	Determining Non-Performance Rating Values Delphi Discussion Group Presentation & Feedback by Resource Persons
DAY 4 (December 11, 2011)		
9.15 to 13.30	Module 9	Vulnerability Assessment Field Survey Field Visit for Housing Survey
13.30 to 14.30		Lunch Break
14.30 to 16.30	Module 10	Arriving at the Building Performance Score Group work Group Presentation & Discussion
16.30 to 17.00	Module 11	How to Reduce Vulnerability of Houses Presentation by Resource Person Participant Discussion
17.00 to 17.30		Recapitulating and Summing Up
17.30 to 18.30		Concluding Remarks and Future Plans

Annexure ii. Sample Format for Assessment of Vulnerability

A sample form for field survey based on a study carried out by Unnati and People in Centre- 'Assessing natural hazard vulnerability of existing rural housing stock (district Porbandar, Gujarat). The form was developed for a particular typology in a particular hazard context. This is for reference purpose only and appropriate form may be developed in different contexts.

Houseowner's Name	
Address	
Village	
Phone No.	
Form No.	

Block Masonry with Sloping Tile Roof – Sample Typology				Sample Penalty Scores	
S.N.	**Factor set - Level 1**	**Factor set - Level 2**	**Factor set - Level 3**	**NPRV**	**MNPRV**
1	Site Conditions	Site Conditions	The house is built within a flood zone	-8	-10
			The house is located too close to an apparent unsafe house (i.e. the adjacent house can fall on the house in question)	-2	
2	Soil and Foundation	Suitability of soil type	The house is built on expansive soil	-2	-10
		Foundation	The strip foundation is on a non uniform base (i.e. the ground underneath the foundation is sloping or the strata are varying)	-5	
			The foundation has insufficient depth	-5	
			The foundation width is less than 45cm	-10	
3	Architectural Configuration	Plan shape	The rooms are larger than 200 sqft and/or the house has a complex overall plan	-5	-20
		Elevation profile	The house has large projections or overhangs that are more than 4 feet in length	-5	
			The house has storey heights that are more than 12 feet in height	-5	
		Door and window openings in walls	The openings in the walls are close to corners (i.e. the windows/doors are closer than 1 foot to corners)	-2	
			The openings are larger than 4 feet in width	-2	
		Distance from adjacent building	The house touches neighbouring houses	-3	
4	Material and construction conditions	Quality	The house has composite walls (i.e. the walls are made of more than one material)	-15	-25
			The age of house is more than 15 years	-10	
			The house is built with low quality timber/untreated bamboo	-3	
			The mortar used is lean, i.e the ratio of cement to sand is greater than 1:6	-1	
		Workmanship	The wall is out of plumb	-10	
			The block masonry used is evident of poor workmanship, specifically - there are unfilled joints in the wall	-10	

			The roof joineries are of poor workmanship	-10	
			The house has inappropriately done phased construction	-5	
5	**Structural System**	**Walls**	The horizontal band is not present at roof levels	-15	-35
			The horizontal band is not present at lintel level	-5	
			The horizontal band is not present at plinth level	-5	
			Masonry column has insufficient size (i.e column size is less than 10x10 inch)	-5	
		Roof	The roof has a two-way slope, without a load wall	-5	
			The roof does not have in-plane diagonal bracings	-5	
			The roof members are not connected to the wall appropriately and/or roof understructure members are not tied to each other appropriately (i.e. the rafter is not tied to the wall)	-15	
			The tiles are not tied with the understructure of the roof	-5	
			The ridge beam is not anchored to gable wall appropriately	-8	
			Total Penalty Score		-100

Investigator's name	
Date	

Annexure iii. Reading Material for Participants

UNDERSTANDING VULNERABILITIES: VULNERABILITY OF PHYSICAL STRUCTURES
Excerpts from **Capacity Building in Asia using Information Technology Applications (CASITA) Module - 5**
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by Ravi Sinha, Alok Goyal
Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai

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People in Centre Consulting and Unnati - Organisation for Development Education, Ahmedabad

SEISMIC VULNERABILITY EVALUATION GUIDELINE FOR PRIVATE AND PUBLIC BUILDINGS - PART 1
National Society for Earthquake Technology, Kathmandu

Annexure vi. Participants and Resource Persons

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UNNATI - Organisation for Development Education is a voluntary non-profit organisation. The mission is to promote social inclusion and democratic governance so that the vulnerable sections of our society, particularly the dalits, tribal, women and persons with disabilities, are empowered to effectively and decisively participate in mainstream development and the decision making process. This aim is accomplished through providing strategic issue based support to development initiatives by undertaking collaborative research, public education, advocacy, direct field level mobilisation and implementation with multiple stakeholder participation. While we work at the grassroots level to policy level environment for ensuring basic rights of citizens, we derive inspiration from the struggles of the vulnerable and strength from the partners. Social Determinants of Disaster Risk Reduction is one of the core theme areas of intervention.

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